APPENDIX B:

ENVIRONMENTAL

1 Model Assumptions and Results

1.1 Annualization of Benefits

When conducting the habitat modeling for this study, the PDT considered the timing of when benefits would be achieved, and how those benefits could potentially change over the period of analysis (50 years), with particular regard to the sensitivity of the models being used to assess these changes. With regard to the smallmouth bass habitat suitability index (HSI), the only anticipated changes from the current condition to the future without project condition over the 50 year period of analysis are to water temperatures due to climate change. This has the potential to alter scores for variables 10, 11, 12, and 13. However, in order to change the score for these variables in the HSI, the water temperature would have to change by more than 10 degrees, which is highly unlikely to occur. In summary, while conditions may change slightly between the current condition and the future without project forecast, the model used is not sensitive enough to these small changes that it would affect the habitat score.

There are three variables driving the benefits being achieved by the alternatives which featuring aquatic habitat restoration (2 and 3): dominant substrate type, percent pools, and percent cover. The substrate type changes are driven by the aquatic substrate alteration while the percent pools and cover are driven by the aquatic habitat features including dikes, backwaters, and large woody debris placement. Both of these changes will be experienced immediately following construction. Substrate was sized according to engineering analyses to remain in place throughout the 50 year period of analysis and will be monitored with the potential to implement Adaptive Management in the five years following construction to add additional structural elements if flows are higher than anticipated and substrate is being lost. Additional, the constructed habitat features are anticipated to remain in place throughout the 50 year period of analysis.

For the Floristic Quality Assessment (FQA) used to determine floodplain habitat benefits, this method relies on a species assemblage to assess benefits. For the future without project condition, it was assumed that the area of invasive species would increase while the area of native species would continue to decrease. However, it was assumed that the species composition would stay the same. In the FQA model, the result of this is that habitat score remains unchanged between the current condition and the FWOP condition. Similarly, for the action alternatives involving changes to the floodplain habits (3 and 4), while the proliferation of various species may change over time, the overall species composition is anticipated to remain fairly consistent over the period of analysis with the sponsor conducting annual maintenance to remove invasive species and re-plant native species as needed.

Because of these considerations with the model, only two time steps were used for the annualization of benefits (Year 0 and Year 50) and both time steps have the same value. The result is that the annualized benefits are equivalent to the benefits in Year 0, immediately following construction.

1.2 Area of Habitat Restored

For floodplain habitats restored, the determination of acres of habitat restored was based on the areas treated or constructed using GIS measurements of the area that were then translated into project plans and used as the basis of feasibility-level designs and cost estimates. For acres of aquatic habitat restored, the aquatic project area was measured using GIS. The shoreline was projected out 100 feet into the river across the extent of the project area as this was the designated area of potential work used to define the project area based on the engineering assumptions of where work could conducted. For Alternative 2, this was estimated at 5.6 acres and for Alternative 4, this was estimated at 4.0 acres (the 5.6 acres was reduced due to the intrusion of 1.0 acres of additional reshaped bankline projecting into the aquatic habitat zone above water and an additional 0.6 acres projecting under the water surface). These acreages were also used for HSI variables that acquired acreage assessments such as percent pools and percent cover. When comparing to the future without project condition, the acreage of the future without project and the future with project was held constant in order to analyze the actual change in habitat quality. This decision was made because there is abundant available low-quality habitat in this vicinity and a reduction in acreage to account for floodplain habitats would have a significant effect on the forecasted benefits and would significantly underestimate the improvements in habitat quality.

1.3 Aquatic Habitat Benefits - Habitat Suitability Index

The Smallmouth Bass HSI model was used to measure the benefits of aquatic habitat restoration measures (Edwards et. al., 1983). This model was selected because the life requisites of bass and habitat characteristics reflected in the model (such as pools, gravel substrates, and habitat structure) are important to a number of target species including walleye, paddlefish and numerous mussel species. There are 13 variables that are used to calculate the overall HSI score (see Table B-1). The below table includes both the value for each variable and the resulting suitability index calculated based on that value for each variable. Five different HSI scores were calculated for the alternatives that involve aquatic habitat restoration. Alternative 1 was calculated primarily based on existing conditions that were assumed to continue as part of the no action alternative / future without project condition. Alternative 2 was calculated based on the formulated measures and acreages which focused on amending the substrates and restoration of two backwaters. Following is a discussion of the assumptions and sources that were used to calculate these variables.

Variable 1: Dominant substrate type – For Alternative 1, existing conditions were based on "Riverbed Substrate Characterization Ground-Truthing of Side Scan Acoustic Signatures Ohio River Mile 0.0 - 40.0 W911WN-07-D-0001-014" report from 2010 which states that within Emsworth pool "were almost wholly comprised of fines or medium sand." For this report, fines were defined as <0.25 mm and medium sands were defined as <0.5 mm. For variable 1 in the HSI model, silt and sand are defined as <2.0 mm so for the purposes of the model, the existing condition was characterized as "silt and sand". For the action alternatives, all involved placement of gravels within the project area to the extent that greater than 50% of the area would be gravel, which is categorized as sediments from 16 – 20 mm for the purposes of the model.

Variable 2: Percent Pools – In the model, pools are defined as areas >4.3 ft deep with little to no current. Based on the bathymetric cross-sections available, it was determined that approximately 10% of the existing project area was comprised of pools. For the action alternatives, acreages of pools that

would develop based on the proposed measures were assessed and divided by the overall project area to determine percent pools.

Variable 4: Average Depth of Pools Mid-Summer – Average depth was developed based on existing bathymetric cross-sections for the No Action alternative. For the action alternatives, it was based on the increased depth due to placement of substrate.

Variable 5: Percent Cover – Percent cover in the model is defined as those areas that are protected by stumps, trees and boulders. Under the existing condition, it is assumed that only about 10% of the area contains cover from downed trees adjacent to shoreline and a few boulders. Under the action alternatives, this would be increased by an additional 10% due to placement of dead trees removed during clearing operations. These would be placed within backwaters or anchored under dikes that are placed.

Variable 6: Average pH level – Defined as the average during the year, the pH level within the project area was derived data in the Upper Ohio Navigation Study (USACE, 2014). Average pH level was assumed to be unchanged under the No Action and Action Alternatives.

Variable 8: Minimum Dissolved Oxygen – This is the minimum throughout the calendar year. Data from the Upper Ohio Navigation Study was used to populate this variable and was assumed to be unchanged between the No Action and Action Alternatives.

Variable 9: Average Maximum Turbidity – This is defined as maximum turbidity "during the summer". Best available information from the nearest water quality monitoring station (USGS Gauge 03086000, Ohio River at Sewickley) was used to estimate turbidity during the summer months over the available period of record (July 2001 – September 2003). Turbidity in the model is in JTU's but the only available information was in NTU's; however these units are roughly equivalent. No change between the No Action Alternative and the Action Alternatives is anticipated.

Variable 10: Temperature (May to October) – This is water temperature in selected habitats during the growing season. Best available information from the nearest water quality monitoring station (USGS Gauge 03086000, Ohio River at Sewickley) was used to estimate temperature during the years of 2009-2014. No change between the No Action Alternative and the Action Alternatives is anticipated.

Variable 11: Water Temperature in Spawning Habitat – This is defined as water temperatures in selected [spawning] habitat for 45 days following spawning. Spawning for smallmouth bass is initiated when water temperatures reach 15 degrees Celsius which is around mid-May in the project area. Best available information from the nearest water quality monitoring station (USGS Gauge 03086000, Ohio River at Sewickley) was used to estimate temperature during the period of mid-May through late-June for the years of 2009-2014. No change between the No Action Alternative and the Action Alternatives is anticipated.

Variable 12: Water Temperature during Growing Season – This is defined as water temperature in selected (fry) habitat during the months of May-October. Best available information from the nearest water quality monitoring station (USGS Gauge 03086000, Ohio River at Sewickley) was used to estimate temperature during the years of 2009-2014. No change between the No Action Alternative and the Action Alternatives is anticipated.

Variable 13: Water Temperature during Growing Season – This is defined as water temperature in selected (juvenile) habitat during the months of May-October. Best available information from the

nearest water quality monitoring station (USGS Gauge 03086000, Ohio River at Sewickley) was used to estimate temperature during the years of 2009-2014. No change between the No Action Alternative and the Action Alternatives is anticipated.

Variable 14: Water Level Fluctuations – Defined as water level fluctuations during and for 45 days after spawning, this was assumed to be "stable" for all alternatives due to the managed pool levels provided by Emsworth dam.

Variable 15: Stream Gradient – Defined as the stream gradient within a representative reach, existing bathymetric cross-sections were used to estimate this variable. No change between the No Action Alternative and the Action Alternatives is anticipated.

Table B-1: Summary of HSI Model Results

Variable	Alt 1		Alt 2 parallel dikes + substrate		Alt 2a Backwaters+ Substrate		Alt 2b perp. dikes + substrate		Alt 2c Substrate alone		Alt 4 parallel dikes + substrate		Alt 4a/c/ d substrate alone		Alt 4b Back-waters + substrate		Alt 4e perp. dikes + substrate	
	Value	SI	Value	SI	Value	SI	Value	SI	Value	SI	Value	SI	Value	SI	Value	SI	Value	SI
V1 - Dominant Substrate Type	Sand	0.2	Gravel	1	Gravel	1	Gravel	1	Gravel	1	Gravel	1	Gravel	1	Gravel	1	Gravel	1
V2 - Percent Pools	10	0.1	20	0.30	18	0.28	25	0.39	18	0.1	25	0.42	10	0.1	20	0.30	30	0.55
V3 - NA																		
V4 - Avg Depth of Pools mid summer	3	1	2.7	1	2.7	1	2.7	1	2.7	1	2.7	1	2.7	1	2.7	1	2.7	1
V5 - Percent Cover	10	0.2	20	0.9	20	0.9	20	0.9	20	0.9	20	0.9	20	0.9	20	0.9	20	0.9
V6 - Avg pH Level	8	1	8	1	8	1	8	1	8	1	8	1	8	1	8	1	8	1
V7 - NA																		
V8 - Min dissolved O2	5	0.9	5	0.9	5	0.9	5	0.9	5	0.9	5	0.9	5	0.9	5	0.9	5	0.9
V9 - Avg Max Turbidity	25	1	25	1	25	1	25	1	25	1	25	1	25	1	25	1	25	1
V10 - Temperature (May to Oct)	21	0.9	21	0.9	21	0.9	21	0.9	21	0.9	21	0.9	21	0.9	21	0.9	21	0.9
V11 - Water Temp in spawning habitat	21	1	21	1	21	1	21	1	21	1	21	1	21	1	21	1	21	1
V12 - Water Temp Growing Season	21	0.9	21	0.9	21	0.9	21	0.9	21	0.9	21	0.9	21	0.9	21	0.9	21	0.9
V13 - Water Temp Growing Season	21	0.9	21	0.9	21	0.9	21	0.9	21	0.9	21	0.9	21	0.9	21	0.9	21	0.9
V14 - Water level fluctuations	stable	1	stable	1	stable	1	stable	1	stable	1	stable	1	stable	1	stable	1	stable	1
V15 - Stream gradient	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1
CF - Food		0.16		0.65		0.63		0.71		0.45		0.72		0.45		0.65		0.79
CC - Cover		0.375		0.80		0.795		0.82		0.75		0.83		0.75		0.80		0.86
CWQ - Water Quality		0.94		0.94		0.94		0.94		0.94		0.94		0.94		0.94		0.94
CR - Reproduction		0.62		0.97		0.97		0.97		0.97		0.97		0.97		0.97		0.97
COT- Other		1		1		1		1		1		1		1		1		1
HSI Score		0.51		0.86		0.86		0.88		0.79		0.89		0.79		0.86		0.91

Table B-2: Aquatic Habitat Benefits Calculations

	Acres	Year 0 HSI	Year 0 HUs	Year 50 HSI	Year 50 HUs	AAHU	CHU
Alt 2 FWP	5.6	0.86	4.82	0.86	4.82	4.82	240.8
FWOP	5.6	0.51	2.86	0.51	2.86	2.86	142.8
Net Change (FWP - FWOP)						1.96	98.0

	Acres	Year 0 HSI	Year 0 HUs	Year 50 HSI	Year 50 HUs	AAHU	CHU
Alt 4 FWP	4.0	0.89	3.56	0.89	3.56	3.56	178.0
FWOP	4.0	0.51	2.04	0.51	2.04	2.04	102.0
Net Change (FWP - FWOP)						1.52	76.0

	Acres	Year 0 HSI	Year 0 HUs	Year 50 HSI	Year 50 HUs	AAHU	CHU
Alt 2a FWP	5.6	0.86	4.82	0.86	4.82	4.82	240.8
FWOP	5.6	0.51	2.86	0.51	2.86	2.86	142.8
Net Change (FWP - FWOP)						1.96	98.0

	Acres	Year 0 HSI	Year 0 HUs	Year 50 HSI	Year 50 HUs	AAHU	CHU
Alt 4a/c/d FWP	4.0	0.79	3.16	0.79	3.16	3.16	158.0
FWOP	4.0	0.51	2.04	0.51	2.04	2.04	102.0
Net Change (FWP - FWOP)						1.12	56.0

	Acres	Year 0 HSI	Year 0 HUs	Year 50 HSI	Year 50 HUs	AAHU	CHU
Alt 2b FWP	5.6	0.88	4.93	0.88	4.93	4.93	246.4
FWOP	5.6	0.51	2.86	0.51	2.86	2.86	142.8
Net Change (FWP - FWOP)						2.07	103.6

	Acres	Year 0 HSI	Year 0 HUs	Year 50 HSI	Year 50 HUs	AAHU	CHU
Alt 4b FWP	4.0	0.86	3.44	0.86	3.44	3.44	172.0
FWOP	4.0	0.51	2.04	0.51	2.04	2.04	102.0
Net Change (FWP - FWOP)						1.40	70.0

	Acres	Year 0 HSI	Year 0 HUs	Year 50 HSI	Year 50 HUs	AAHU	CHU
Alt 2c FWP	5.6	0.79	4.42	0.79	4.42	4.42	221.2
FWOP	5.6	0.51	2.86	0.51	2.86	2.86	142.8
Net Change (FWP - FWOP)						1.57	78.4

	Acres	Year 0 HSI	Year 0 HUs	Year 50 HSI	Year 50 HUs	AAHU	CHU
Alt 4e FWP	4.0	0.91	3.64	0.91	3.64	3.64	182.0
FWOP	4.0	0.51	2.04	0.51	2.04	2.04	102.0
Net Change (FWP - FWOP)						1.60	80.0

1.4 Floodplain Habitat Benefits - Floristic Quality Assessment

Field surveys of existing site conditions were conducted by the members of the Pittsburgh District's Regulatory Branch in order to determine the current condition for areas where invasive species would be removed. For the "Removal of Invasive Plant Species" measure, it was assumed that all invasive species would be removed from the site and that the sponsor would maintain these areas to ensure that invasive species would not become established in these areas within the period of analysis. This revised plant list was entered into the system. New species lists were developed for restoration plantings associated with the floodplain wetlands, floodplain shelf, reshape existing banks and greenwalls measures. These species would be planted during the construction period and maintained over the period of analysis (50 years) by the sponsor as part of the Operations and Maintenance plan. The results of running these mixes through the FQA is included below. To determine the benefits of the various measures, we used the total mean coefficient of conservation (Total Mean C below) as a metric of habitat quality. Since this number ranges from 0 to 10, dividing Total Mean C by 10 provides a habitat quality index that can be applied to a given acreage in order to obtain "habitat units" that measure both the quantity and quality of habitat to be restored. For each measure, a habitat quality index (HQI) was applied to a given acreage based on the specifics of the area to be restored for each alternative. A summary of the HQI's per measure is listed below. For the Invasive Species Removal Measure, the difference in HQI between the restored and the existing condition was used to measure change in quality.

Table B-3: Summary of FQAI Model Results

Measure	Total Mean C	HQI
Invasive Species Removal	3.6 (minus 2.3 existing)	0.13
Floodplain Wetlands	6.0	0.60
Floodplain Shelf	5.6	0.56
Reshape Banks	5.3	0.53
Greenwalls	5.4	0.54

Table B-4: Floristic Quality Assessment Report – Existing / FWOP Conditions
Ecoregion: Allegheny Plateau

FQI	28.8	Total Mean C	2.3	Native Mean C	3.6
Adjusted FQI	18.7	Total Count	100	Native Count	65

Figure B-1: Floristic Quality Assessment Figures - Existing Conditions

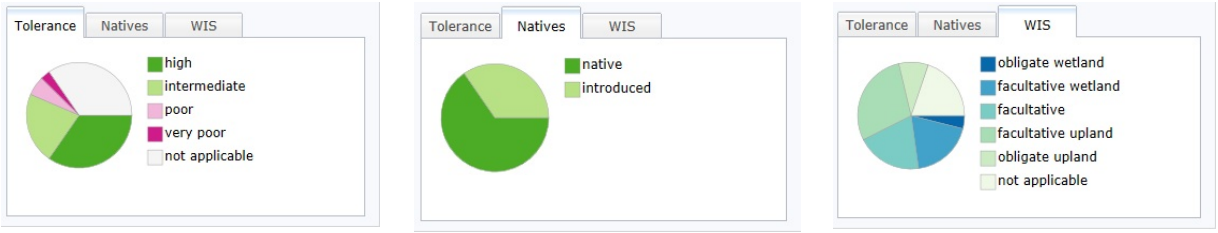

Table B-5: Floristic Quality Assessment Report - Existing Conditions Species List

Scientific Name	Family	Native	C
Eupatorium perfoliatum	Asteraceae	Y	3
Datura stramonium	Solanaceae	N	
Vernonia noverboracensis	Asteraceae	Y	3
Lythrum salicaria	Lythraceae	N	
Verbesina alternifolia	Asteraceae	Y	2
Artemisia vulgaris	Asteraceae	N	
Celastrus scandens	Celastraceae	Y	5

Urtica dioica	Urticaceae	N	
Ajuga reptans	Lamiaceae	N	
Daucus carota	Apiaceae	N	
Securigera varia	Fabaceae	N	
Solidago canadensis	Asteraceae	Y	2
Hedera helix	Araliaceae	N	
Desmodium canadense	Fabaceae	Y	4
Impatiens capensis	Balsaminaceae	Y	3
Bidens frondosa	Asteraceae	Y	2
Arctium minus	Asteraceae	N	
Polygonum orientale	Polygonaceae	N	
Fallopia japonica	Polygonaceae	N	
Helianthus tuberosus	Asteraceae	Y	3
Oenothera biennis	Onagraceae	Y	1
Plantago lanceolata	Plantaginaceae	N	
Cirsium arvense	Asteraceae	N	
Solanum carolinense	Solanaceae	Y	2
Physalis longifolia var. subglabrata	Solanaceae	Y	2
Asclepias syriaca	Asclepiadaceae	Y	1
Verbena hastata	Verbenaceae	Y	3
Monarda fistulosa	Lamiaceae	Y	5
Dichanthelium clandestinum	Poaceae	Y	2
Ageratina altissima	Asteraceae	Y	3
Hypericum perforatum	Clusiaceae	N	

Eupatoriadelphus fistulosus	Asteraceae	Y	4
Rumex obtusifolius	Polygonaceae	N	
Agrostis gigantea	Poaceae	N	
Saponaria officinalis	Caryophyllaceae	N	
Linaria vulgaris	Scrophulariaceae	N	
Eupatorium hyssopifolium	Asteraceae	Y	1
Melilotus officinalis	Fabaceae	N	
Erechtites hieraciifolia	Asteraceae	Y	1
Sonchus asper	Asteraceae	N	
Cirsium vulgare	Asteraceae	N	
Leucanthemum lacustre	Asteraceae	N	
Apocynum cannabinum	Apocynaceae	Y	2
Phytolacca Americana	Phytolaccaceae	Y	1
Cyperus esculentus	Cyperaceae	Y	0
Verbascum Thapsus	Scrophulariaceae	N	
Phalaris arundinacea	Poaceae	Y	0
Mimulus ringens	Scrophulariaceae	Y	5
Asclepias incarnata	Asclepiadaceae	Y	5
Chasmanthium latifolium	Poaceae	Y	7
Rudbeckia laciniata	Asteraceae	Y	5
Eupatorium serotinum	Asteraceae	Y	2
Verbascum blattaria	Scrophulariaceae	N	
Baptisia australis	Fabaceae	Y	9
Pseudognaphalium obtusifolium	Asteraceae	Y	1

Digitaria sanguinalis	Poaceae	N	
Anthriscus sylvestris	Apiaceae	N	
Cornus racemosa	Cornaceae	Y	5
Cornus amomum	Cornaceae	Y	4
Cornus sericea	Cornaceae	Y	4
Photinia melanocarpa	Rosaceae	Y	8
Cephalanthus occidentalis	Rubiaceae	Y	7
Viburnum dentatum	Caprifoliaceae	Y	5
Physocarpus opulifolius	Rosaceae	Y	7
Frangula alnus	Rhamnaceae	N	
Viburnum opulus var. americanum	Caprifoliaceae	Y	9
Amorpha fruticosa	Fabaceae	Y	5
Ailanthus altissima	Simaroubaceae	N	
Robinia pseudoacacia	Fabaceae	Y	1
Acer rubrum	Aceraceae	Y	1
Platanus occidentalis	Platanaceae	Y	5
Liquidambar styraciflua	Hamamelidaceae	Y	1
Acer negundo	Aceraceae	Y	2
Paulownia tomentosa	Scrophulariaceae	N	
Populus deltoides	Salicaceae	Y	4
Fraxinus pennsylvanica	Oleaceae	Y	5
Ulmus rubra	Ulmaceae	Y	4
Celtis occidentalis	Ulmaceae	Y	4
Rhus typhina	Anacardiaceae	Y	2

Betula alleghaniensis	Betulaceae	Y	7
Morus alba	Moraceae	N	
Morus rubra	Moraceae	Y	6
Salix fragilis	Salicaceae		
Salix nigra	Salicaceae	Y	2
Cercis Canadensis	Fabaceae	Y	5
Catalpa speciosa	Bignoniaceae	N	
Acer saccharinum	Aceraceae	Y	5
Acer platanoides	Aceraceae	N	
Tilia americana	Tiliaceae	Y	7
Ulmus pumila	Ulmaceae	N	
Toxicodendron radicans	Anacardiaceae	Y	1
Convolvulus arvensis	Convolvulaceae	N	
Parthenocissus quinquefolia	Vitaceae	Y	3
Cuscuta gronovii	Cuscutaceae	Y	3
Ambrosia artemisiifolia	Asteraceae	Y	1
Xanthium strumarium var. glabratum	Asteraceae	Y	0
Vitis riparia	Vitaceae	Y	4
Clematis virginiana	Ranunculaceae	Y	3
Bidens coronata	Asteraceae	Y	9
Andropogon gerardii	Poaceae	Y	5
Chamaesyce maculata	Euphorbiaceae	Y	0

Table B-6: Floristic Quality Assessment Report - Invasive Species Removal
Ecoregion: Allegheny Plateau

FQI	29.2	Total Mean C	3.6	Native Mean C	3.6
Adjusted FQI	35.9	Total Count	66	Native Count	66

Figure B-2: Floristic Quality Assessment Figures - Invasive Species Removal

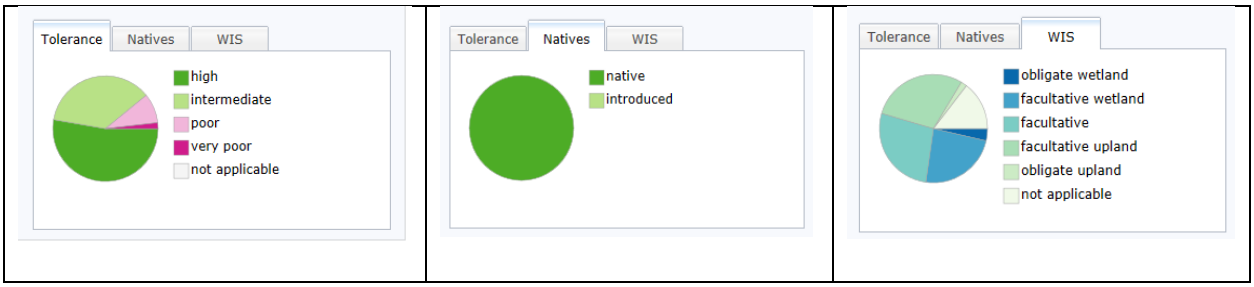

Table B-7: Floristic Quality Assessment Report - Invasive Species Removal Species List

Scientific Name	Family	Native	C
Eupatorium perfoliatum	Asteraceae	Y	3
Vernonia noverboracensis	Asteraceae	Y	3
Verbesina alternifolia	Asteraceae	Y	2
Celastrus scandens	Celastraceae	Y	5
Solidago canadensis	Asteraceae	Y	2
Desmodium canadense	Fabaceae	Y	4
Impatiens capensis	Balsaminaceae	Y	3
Bidens frondosa	Asteraceae	Y	2
Helianthus tuberosus	Asteraceae	Y	3
Oenothera biennis	Onagraceae	Y	1
Solanum carolinense	Solanaceae	Y	2
Physalis longifolia var. subglabrata	Solanaceae	Y	2
Asclepias syriaca	Asclepiadaceae	Y	1
Verbena hastata	Verbenaceae	Y	3
Monarda fistulosa	Lamiaceae	Y	5
Dichanthelium clandestinum	Poaceae	Y	2
Ageratina altissima	Asteraceae	Y	3
Eupatoriadelphus fistulosus	Asteraceae	Y	4
Eupatorium hyssopifolium	Asteraceae	Y	1
Erechtites hieraciifolia	Asteraceae	Y	1
Apocynum cannabinum	Apocynaceae	Y	2
Phytolacca Americana	Phytolaccaceae	Y	1
Cyperus esculentus	Cyperaceae	Y	0

Phalaris arundinacea	Poaceae	Y	0
Mimulus ringens	Scrophulariaceae	Y	5
Asclepias incarnata	Asclepiadaceae	Y	5
Chasmanthium latifolium	Poaceae	Y	7
Rudbeckia laciniata	Asteraceae	Y	5
Eupatorium serotinum	Asteraceae	Y	2
Baptisia australis	Fabaceae	Y	9
Pseudognaphalium obtusifolium	Asteraceae	Y	1
Cornus racemosa	Cornaceae	Y	5
Cornus amomum	Cornaceae	Y	4
Cornus sericea	Cornaceae	Y	4
Photinia melanocarpa	Rosaceae	Y	8
Cephalanthus occidentalis	Rubiaceae	Y	7
Viburnum dentatum	Caprifoliaceae	Y	5
Physocarpus opulifolius	Rosaceae	Y	7
Viburnum opulus var. americanum	Caprifoliaceae	Y	9
Amorpha fruticosa	Fabaceae	Y	5
Robinia pseudoacacia	Fabaceae	Y	1
Acer rubrum	Aceraceae	Y	1
Platanus occidentalis	Platanaceae	Y	5
Liquidambar styraciflua	Hamamelidaceae	Y	1
Acer negundo	Aceraceae	Y	2
Populus deltoides	Salicaceae	Y	4
Fraxinus pennsylvanica	Oleaceae	Y	5
Ulmus rubra	Ulmaceae	Y	4
Celtis occidentalis	Ulmaceae	Y	4
Rhus typhina	Anacardiaceae	Y	2
Betula alleghaniensis	Betulaceae	Y	7
Morus rubra	Moraceae	Y	6
Salix nigra	Salicaceae	Y	2
Cercis Canadensis	Fabaceae	Y	5
Acer saccharinum	Aceraceae	Y	5
Tilia americana	Tiliaceae	Y	7
Toxicodendron radicans	Anacardiaceae	Y	1
Parthenocissus quinquefolia	Vitaceae	Y	3
Cuscuta gronovii	Cuscutaceae	Y	3
Ambrosia artemisiifolia	Asteraceae	Y	1

Xanthium strumarium var. glabratum	Asteraceae	Y	0
Vitis riparia	Vitaceae	Y	4
Clematis virginiana	Ranunculaceae	Y	3
Bidens coronata	Asteraceae	Y	9
Andropogon gerardii	Poaceae	Y	5
Chamaesyce maculata	Euphorbiaceae	Y	0

Table B-8: Floristic Quality Assessment Report – Floodplain Wetlands
Ecoregion: Allegheny Plateau

FQI	31.3	Total Mean C	6.0	Native Mean C	6.0
Adjusted FQI	60.2	Total Count	27	Native Count	27

Figure B-3: Floristic Quality Assessment Figures - Floodplain Wetlands

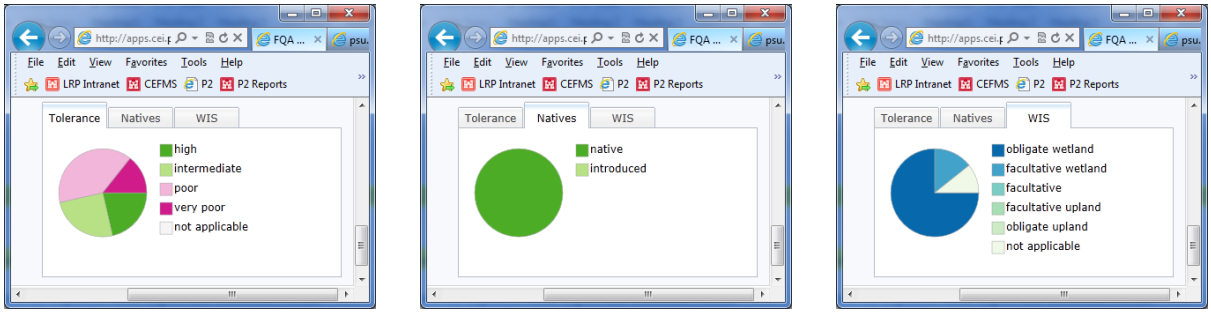

Table B-9: Floristic Quality Assessment Report - Floodplain Wetlands Species List

Scientific Name	CommonName	Native	C
Alisma subcordatum	Water Plantain	Y	4
Equisetum hyemale	Scouring Rush	Y	2
Hibiscus militaris	Halberd-leaved Hibiscus	Y	7
Hibiscus moscheutos	Rose Mallow Hibiscus	Y	5
Iris cristata	Crested Iris	Y	9
Iris versicolor	Blue Flag	Y	7
Juncus effusus	Soft Rush	Y	2
Juncus roemerianus	Black Rush	Y	8
Justicia americana	Water Willow	Y	9
Leersia oryzoides	Rice Cut Grass	Y	3
Lemna minor	Duck Weed	Y	4

Lobelia cardinalis	Red Cardinal Flower	Y	6
Nuphar lutea	Spatterdock	Y	5
Nymphaea odorata	Fragrant Water Lily	Y	4
Orontium aquaticum	Golden Club	Y	8
Peltandra virginica	Arrow Arum	Y	8
Polygonum amphibium	Water Smart Weed	Y	8
Pontederia cordata	Pickerel Weed	Y	8
Potamogeton pectinatus	Sago Pond Weed	Y	8
Sagittaria graminea	Arrowhead	Y	7
Sagittaria lancifolia	Arrowhead	Y	8
Saururus cernuus	Lizard Tail	Y	9
Schoenoplectus fluviatilis	River Bullrush	Y	9
Scirpus americanus	Three Square Rush	Y	2
Scirpus cyperinus	Wool Grass	Y	6
Sparganium eurycarpum	Burr Reed	Y	7
Spartina alterniflora	Cord Grass - Smooth	Y	3
Typha latifolia	Cattail Small	Y	2

Table B-10: Floristic Quality Assessment Report – Floodplain Shelf
Ecoregion: Allegheny Plateau

FQI	33.1	Total Mean C	5.6	Native Mean C	5.6
Adjusted FQI	56.0	Total Count	35	Native Count	35

Figure B-4: Floristic Quality Assessment Figures - Floodplain Shelf

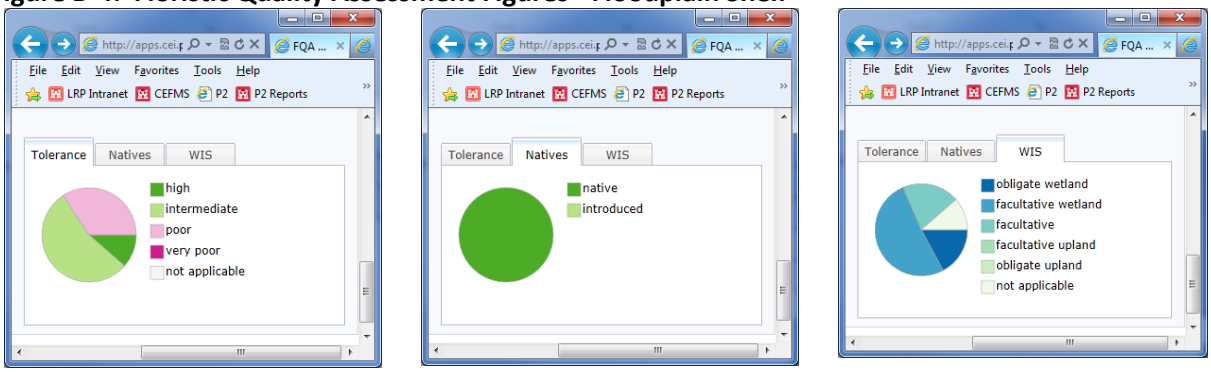

Table B-11: Floristic Quality Assessment Report - Floodplain Shelf Species List

Scientific Name	CommonName	Native	C
Alisma subcordatum	Water Plantain	Y	4
Equisetum hyemale	Scouring Rush	Y	2
Hibiscus militaris	Halberd-leaved Hibiscus	Y	7

Hibiscus moscheutos	Rose Mallow Hibiscus	Y	5
Iris cristata	Crested Iris	Y	9
Iris versicolor	Blue Flag	Y	7
Juncus effusus	Soft Rush	Y	2
Juncus roemerianus	Black Rush	Y	8
Justicia americana	Water Willow	Y	9
Leersia oryzoides	Rice Cut Grass	Y	3
Lemna minor	Duck Weed	Y	4
Lobelia cardinalis	Red Cardinal Flower	Y	6
Nuphar lutea	Spatterdock	Y	5
Nymphaea odorata	Fragrant Water Lily	Y	4
Orontium aquaticum	Golden Club	Y	8
Peltandra virginica	Arrow Arum	Y	8
Polygonum amphibium	Water Smart Weed	Y	8
Pontederia cordata	Pickerel Weed	Y	8
Potamogeton pectinatus	Sago Pond Weed	Y	8
Sagittaria graminea	Arrowhead	Y	7
Sagittaria lancifolia	Arrowhead	Y	8
Saururus cernuus	Lizard Tail	Y	9
Schoenoplectus fluviatilis	River Bullrush	Y	9
Scirpus americanus	Three Square Rush	Y	2
Scirpus cyperinus	Wool Grass	Y	6
Sparganium eurycarpum	Burr Reed	Y	7
Spartina alterniflora	Cord Grass - Smooth	Y	3
Typha latifolia	Cattail Small	Y	2

Table B-12: Floristic Quality Assessment Report – Reshape Existing Banks
Ecoregion: Allegheny Plateau

FQI	30.5	Total Mean C	5.3	Native Mean C	5.3
Adjusted FQI	53.0	Total Count	33	Native Count	33

Figure B-5: Floristic Quality Assessment Figures - Reshape Existing Banks

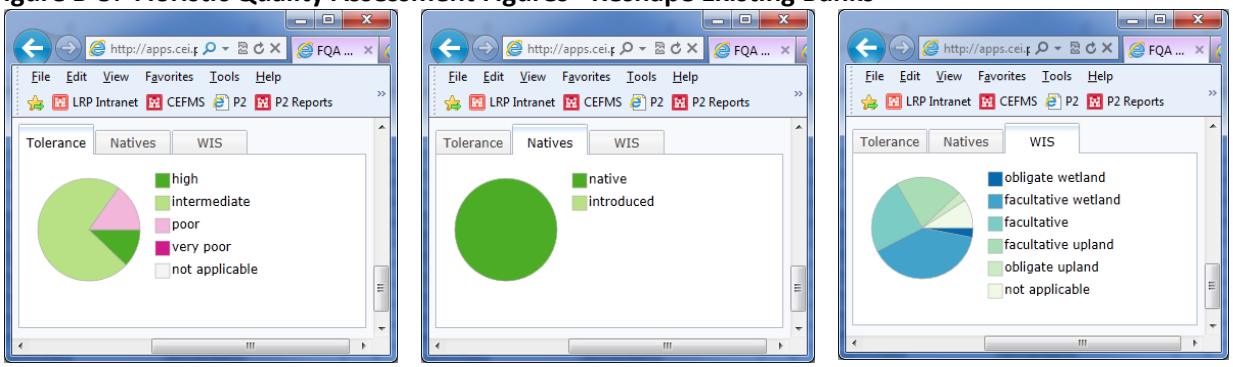

Table B-13: Floristic Quality Assessment Report - Reshape Existing Banks Species List

Scientific Name	Commom Name	Native	C
Acer negundo	Box Elder	Y	2
Acer saccharinum	Silver Maple	Y	5
Actaea racemosa	Black Snakeroot	Y	6
Adiantum pedatum	Maidenhair Fern	Y	7
Aquilegia canadensis	Wild Columbine	Y	6
Arisaema triphyllum	Jack in the Pulpit	Y	5
Aster umbellatus	Flat-topped Aster	Y	6
Carya ovata	Shagbark Hickory	Y	6
Cornus racemosa	Gray Dogwood	Y	5
Elymus canadensis	Wild rye	Y	6
Eupatorium purpureum	Joe Pye Weed	Y	5
Fraxinus pennsylvanica	Green Ash	Y	5
Heliopsis helianthoides	Oxeye Sunflower	Y	5
Lilium superbum	Turk's Cap Lily	Y	6
Mertensia virginica	Virginia Bluebells	Y	8
Mimulus ringens	Monkey Flower	Y	5
Osmunda cinnamomea	Cinnamon Fern	Y	6
Physocarpus opulifolius	Ninebark	Y	7
Platanus occidentalis	Sycamore	Y	5
Polygonatum pubescens	Solomon's Seal	Y	6
Populus deltoides	Eastern Cottonwood	Y	4
Prunus serotina	Black cherry	Y	3
Quercus bicolor	Swamp White Oak	Y	8
Salix humilis	Prairie Willow	Y	6
Sanguinaria canadensis	Bloodroot	Y	5
Sisyrinchium angustifolium	Blue-eyed Grass	Y	2
Smilacina racemosa	False Solomon's Seal	Y	5
Staphylea trifolia	Bladdernut	Y	7
Symphyotrichum novi-belgii	New York Aster	Y	6
Ulmus americana	American elm	Y	5
Ulmus rubra	Slippery elm	Y	4
Vernonia noveboracensis	New York Ironweed	Y	3
Viburnum dentatum	Arrowwood viburnum	Y	5

Table B-14: Floristic Quality Assessment Report - Greenwalls
Ecoregion: Allegheny Plateau

FQI	22.3	Total Mean C	5.4	Native Mean C	5.4
Adjusted FQI	54.1	Total Count	17	Native Count	17

Figure B-6: Floristic Quality Assessment Figures - Greenwalls

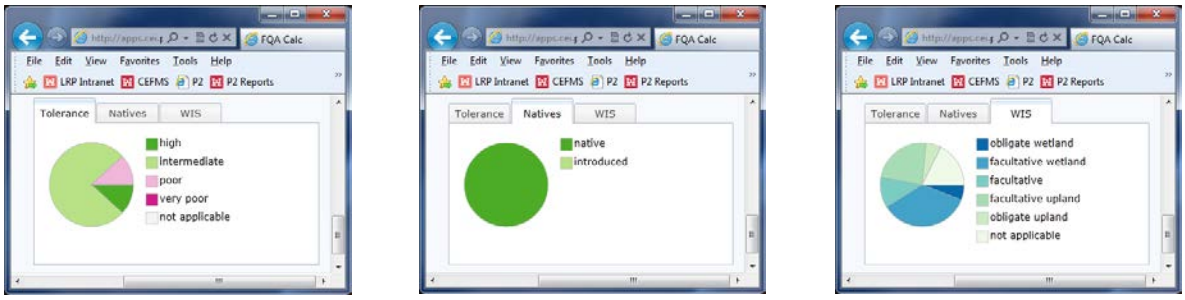

Table B-15: Floristic Quality Assessment Report - Greenwalls Species List

Scientific Name	CommonName	Native	C
Actaea racemosa	Black Snakeroot	Y	6
Adiantum pedatum	Maidenhair Fern	Y	7
Aquilegia canadensis	Wild Columbine	Y	6
Arisaema triphyllum	Jack in the Pulpit	Y	5
Aster umbellatus	Flat-topped Aster	Y	6
Elymus canadensis	Wild rye	Y	6
Eupatorium purpureum	Joe Pye Weed	Y	5
Heliopsis helianthoides	Oxeye Sunflower	Y	5
Lilium superbum	Turk's Cap Lily	Y	6
Mertensia virginica	Virginia Bluebells	Y	8
Mimulus ringens	Monkey Flower	Y	5
Osmunda cinnamomea	Cinnamon Fern	Y	6
Polygonatum pubescens	Solomon's Seal	Y	6
Sanguinaria canadensis	Bloodroot	Y	5
Sisyrinchium angustifolium	Blue-eyed Grass	Y	2
Smilacina racemosa	False Solomon's Seal	Y	2
Vernonia noveboracensis	New York Ironweed	Y	3

Table B-16: Benefits Calculations for Floodplain Habitat Management Measures

	Acres	Year 0 Total Mean C	Year 0 HQI	Year 0 HUs	Year 50 HQI	Year 50 Total Mean C	Year 50 HUs	AAHU	CHU
Invasive Removal FWP	1.9	3.6	0.36	0.68	3.6	0.36	0.68	0.68	34.20
FWOP	1.9	2.3	0.23	0.44	2.3	0.23	0.44	0.44	21.85
Net Change (FWP - FWOP)								0.25	12.35

	Acres	Year 0 Total Mean C	Year 0 HQI	Year 0 HUs	Year 50 HQI	Year 50 Total Mean C	Year 50 HUs	AAHU	CHU
Floodplain Shelf Alt 3 FWP	2.2	5.6	0.56	1.23	5.6	0.56	1.23	1.23	61.60
FWOP	0.0	0.0	0.00	0.00	0.0	0.00	0.00	0.00	0.00
Net Change (FWP - FWOP)								1.23	61.60

	Acres	Year 0 Total Mean C	Year 0 HQI	Year 0 HUs	Year 50 HQI	Year 50 Total Mean C	Year 50 HUs	AAHU	CHU
Greenwalls FWP	0.01	5.4	0.54	0.01	5.4	0.54	0.01	0.01	0.27
FWOP	0.0	0.0	0.00	0.00	0.0	0.00	0.00	0.00	0.00
Net Change (FWP - FWOP)								0.01	0.27

	Acres	Year 0 Total Mean C	Year 0 HQI	Year 0 HUs	Year 50 HQI	Year 50 Total Mean C	Year 50 HUs	AAHU	CHU
Reshape Banks Alt 3 FWP	2.8	5.3	0.53	1.48	5.3	0.53	1.48	1.48	74.20
FWOP	0.0	0.0	0.00	0.00	0.0	0.00	0.00	0.00	0.00
Net Change (FWP - FWOP)								1.48	74.20

	Acres	Year 0 Total Mean C	Year 0 HQI	Year 0 HUs	Year 50 HQI	Year 50 Total Mean C	Year 50 HUs	AAHU	CHU
Wetland FWP	0.4	6.0	0.60	0.24	6.0	0.60	0.24	0.24	12.00
FWOP	0.0	0.0	0.00	0.00	0.0	0.00	0.00	0.00	0.00
Net Change (FWP - FWOP)								0.24	12.00

	Acres	Year 0 Total Mean C	Year 0 HQI	Year 0 HUs	Year 50 HQI	Year 50 Total Mean C	Year 50 HUs	AAHU	CHU
Reshape Banks Alt 4 FWP	1.0	5.3	0.53	0.53	5.3	0.53	0.53	0.53	26.50
FWOP	0.0	0.0	0.00	0.00	0.0	0.00	0.00	0.00	0.00
Net Change (FWP - FWOP)								0.53	26.50

1.5 Benefits and Costs for Alternatives Analysis

The following table displays the benefits and initial cost estimates developed for measures (not including contingencies, design costs, real estate, monitoring, interest rate, etc.) for alternatives considered during cost effectiveness and incremental cost analysis in the report.

Table B-17: Benefits and Costs for Alternatives

Alterantive	Measures	AAHU	CHU	Cost
Alternative 2	Parallel Dikes, Substrate	1.96	98.00	**$ 2,710,700**
Total		**1.96**	**98.00**	**$ 2,710,700**
Alternative 2a	Backwater, Substrate	1.96	98.00	$ 3,383,700
Total		**1.96**	**98.00**	**$ 3,383,700**
Alternative 2b	Perpendicular Dikes, Substrate	2.07	103.60	$ 5,144,400
Total		**2.07**	**103.60**	**$ 5,144,400**
Alternative 2c	Substrate	1.57	78.40	$ 1,055,700
Total		**1.57**	**78.40**	**$ 1,055,700**
Alternative 3	Wetland	0.24	12.00	$ 649,946
	Floodplain Shelf	1.23	61.60	$ 4,484,550
	Reshape Banks	1.48	74.20	$ 2,328,000
	Invasive Removal	0.25	12.35	$ 89,912
Total		**3.20**	**160.15**	**$ 7,552,408**
Alternative 3a	Greenwalls	0.01	0.27	$ 98,750
Total		**0.01**	**0.27**	**$ 98,750**
Alternative 3b	Wetland	0.24	12.00	$ 649,946
Total		**0.24**	**12.00**	**$ 649,946**
Alternative 3c	Invasive Removal	0.25	12.35	$ 89,912
Total		**0.25**	**12.35**	**$ 89,912**
Alternative 3d	Floodplain Shelf	1.23	61.60	$ 4,484,550
Total		**1.23**	**61.60**	**$ 4,484,550**
Alternative 3e	Reshape Banks	1.48	74.20	$ 2,328,000
Total		**1.48**	**74.20**	**$ 2,328,000**
Alternative 3f	Reshape Banks	1.48	74.20	$ 2,328,000
	Invasive Removal	0.25	12.35	$ 89,912
Total		**1.73**	**86.55**	**$ 2,417,912**
Alternative 3g	Floodplain Shelf	1.23	61.60	$ 4,484,550
	Reshape Banks	1.48	74.20	$ 2,328,000
	Invasive Removal	0.25	12.35	$ 89,912
Total		**2.96**	**148.15**	**$ 6,902,462**

Alterantive	Measures	AAHU	CHU	Cost
Alternative 4	Wetland	0.24	12.00	$ 649,946
	Reshape Banks	0.53	26.50	$ 1,508,289
	Invasive Removal	0.25	12.35	$ 89,912
	Parallel Dikes, Substrate	1.52	76.00	$ 2,279,300
Total		**2.54**	**126.85**	**$ 4,527,447**
Alternative 4a	Wetland	0.24	12.00	$ 649,946
	Reshape Banks	0.53	26.50	$ 1,508,289
	Invasive Removal	0.25	12.35	$ 89,912
	Substrate	1.12	56.00	$ 624,300
Total		**2.14**	**106.85**	**$ 2,872,447**
Alternative 4b	Wetland	0.24	12.00	$ 649,946
	Reshape Banks	0.53	26.50	$ 1,508,289
	Invasive Removal	0.25	12.35	$ 89,912
	Backwater, Substrate	1.40	70.00	$ 2,952,300
Total		**2.42**	**120.85**	**$ 5,200,447**
Alternative 4c	Wetland	0.24	12.00	$ 649,946
	Invasive Removal	0.25	12.35	$ 89,912
	Substrate	1.12	56.00	$ 624,300
Total		**1.61**	**80.35**	**$ 1,364,158**
Alternative 4d	Reshape Banks	0.53	26.50	$ 1,508,289
	Invasive Removal	0.25	12.35	$ 89,912
	Substrate	1.12	56.00	$ 624,300
Total		**1.90**	**94.85**	**$ 2,222,501**
Alternative 4e	Wetland	0.24	12.00	$ 649,946
	Reshape Banks	0.53	26.50	$ 1,508,289
	Invasive Removal	0.25	12.35	$ 89,912
	Perpendicular Dikes, Substrate	1.60	80.00	$ 4,713,000
Total		**2.62**	**130.85**	**$ 6,961,147**