DEPARTMENT OF THE ARMY
PITTSBURGH DISTRICT, COPRS OF ENGINEERS
WILLIAM S. MOORHEAD FEDERAL BUILDING
1000 LIBERTY AVENUE
PITTSBURGH, PA 15222-4186

REPLY TO
ATTENTION OF

CELRP-EC

05 JULY 2018

MEMORANDUM FOR Commander Great Lakes and Ohio River Division, 550 Main Street, Room 10524, Cincinnati, OH 45202-3222

SUBJECT: Request for Deviation from the Approved Water Control Plan at Berlin Lake, OH

1. The Pittsburgh District is requesting approval to deviate from Berlin Lake's WCP from 25 June or thereafter to 13 October 2018. The deviation entails holding the pool to a modified WCP illustrated in Figure 1, provided that the downstream minimum water quality flow target is met at Leavittsburg, OH. This deviation will allow additional recreation opportunities for the reservoir users. The justification for this deviation is detailed below, and the associated Environmental Assessment and FONSI are enclosed.

2. Background.

a. Berlin Lake was authorized by the Flood Control Act of 1938 for "flood control and other purposes in the Ohio River Basin". In 1941 the Definitive Project Report, entitled "Berlin Dam and Reservoir, Mahoning River, Ohio" was approved by the Chief of Engineers providing flood control storage and a specific allocation of storage for low-flow regulation. The project is currently operated for flood control and downstream low flow augmentation for water quality and water supply, with consideration for recreation and fish and wildlife enhancement.

b. In July 2017 the Pittsburgh District held a visioning meeting for Berlin Lake. The main concern expressed by participants was the shortness of the summer boating season due to the early summer reservoir drawdown. Local residents, business owners, and organizations have long requested the Pittsburgh District maintain a higher reservoir level for an extended period for recreation purposed resulting in economic benefits to the surrounding community. With the current drawdown schedule, the reservoir drawdown begins at the end of June to reach winter pool by late August. The meeting participants requested the Corps of Engineers, Pittsburgh District (District) to hold summer pool at Berlin Lake through Labor Day before drawing down to the Lake's winter pool elevation.

3. Deviation Justification.

a. Deviation Description. To fulfil the request of the meeting participants, the District would have to deviate from the Berlin Lake Water Control Plan (WCP) from 25 June to 13 October, as shown in the Figure 1. The existing WCP is depicted by solid lines and it begins a drawdown at the end of June to reach winter pool by late August. The

visioning meeting participants have requested to hold the maximum summer conservation pool until the end of July, then gradually draw down to elevation 1021 ft (NAVD88) by Labor Day, and to the maximum winter conservation pool by the end of October. To achieve this result, the District would have to deviate from the WCP in a manner as depicted by the dashed lines in Figure 1. However, the District determined that such a deviation would not be feasible as it would violate two of the reservoir's authorized project purposes – downstream water quality and water supply schedule.

b. Therefore, the District is requesting from the Great Lakes and Ohio River Division (Division) a modification of the the visioning meeting members' request to temporarily deviate from the WCP and to hold the pool in the range of 1021-1024 ft (NAVD88) through Labor Day 2018, provided that the downstream minimum flow target is met at Leavittsburg, OH. This will allow the District to operate the reservoir per its authorized project purposes of flood control and downstream water quality and water supply. This deviation request will affect the water control plan from 25 June 2018 to 13 October 2018 only at Berlin Lake and will not affect the operations at Michael J. Kirwan Dam and Reservoir (MJ Kirwan) or Mosquito Creek Lake. A more comprehensive watershed assessment is required to properly study and model the Mahoning River watershed needs to then evaluate modifications to reservoir operations. The following information, analysis, and discussion pertains to the District's modification of the original pool adjustment request. Berlin Lake's WCP also includes Lake Milton's WCP in addition to the combined storage between them, as shown in Figures 2 and 3. Similar to Figure 1, the existing WCP is shown with a solid line and the proposed WCP is shown with a dashed line.

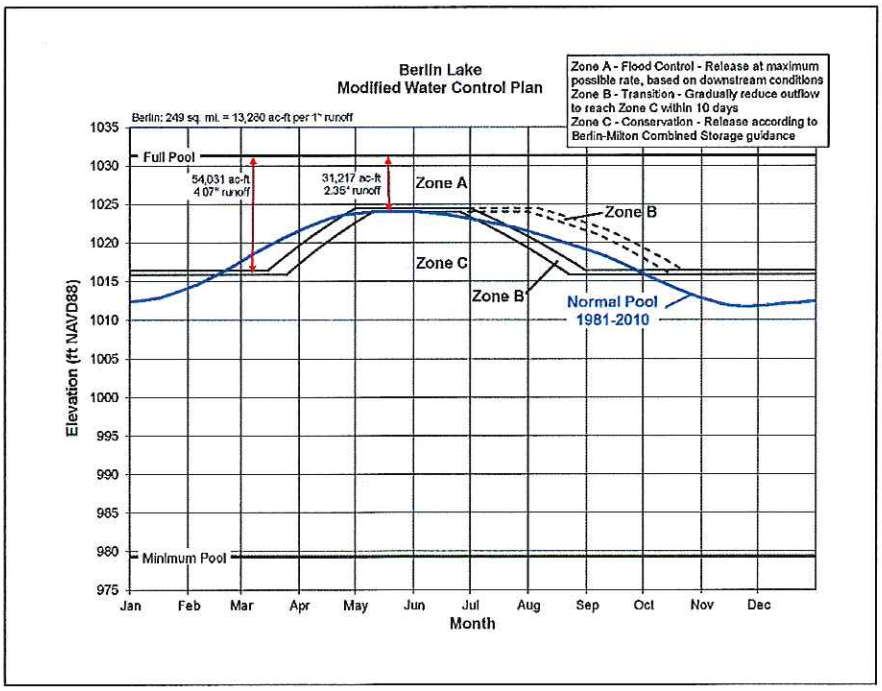

Figure 1. Berlin Lake Modified Water Control Plan

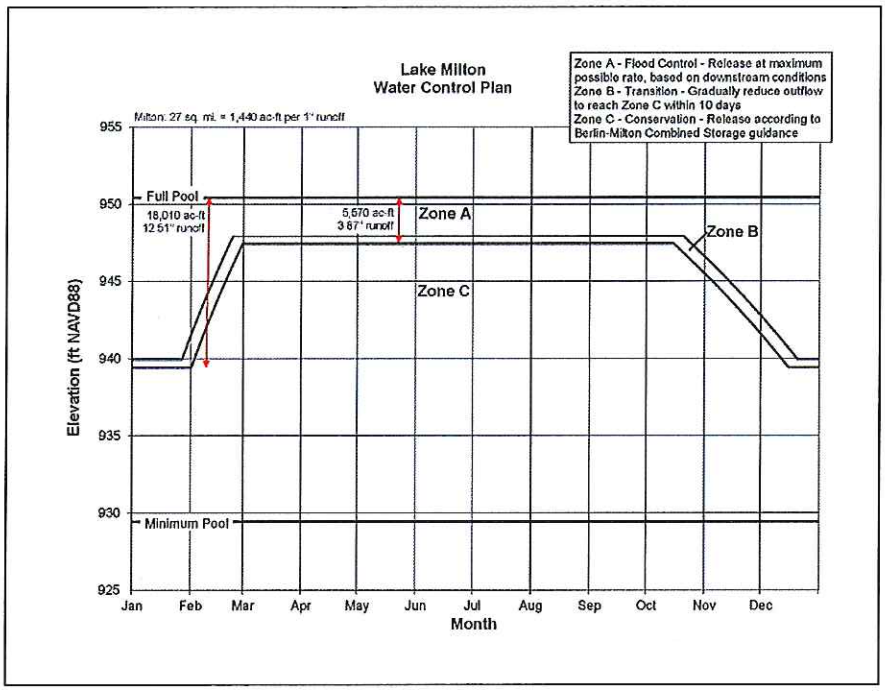

Figure 2. Lake Milton Water Control Plan

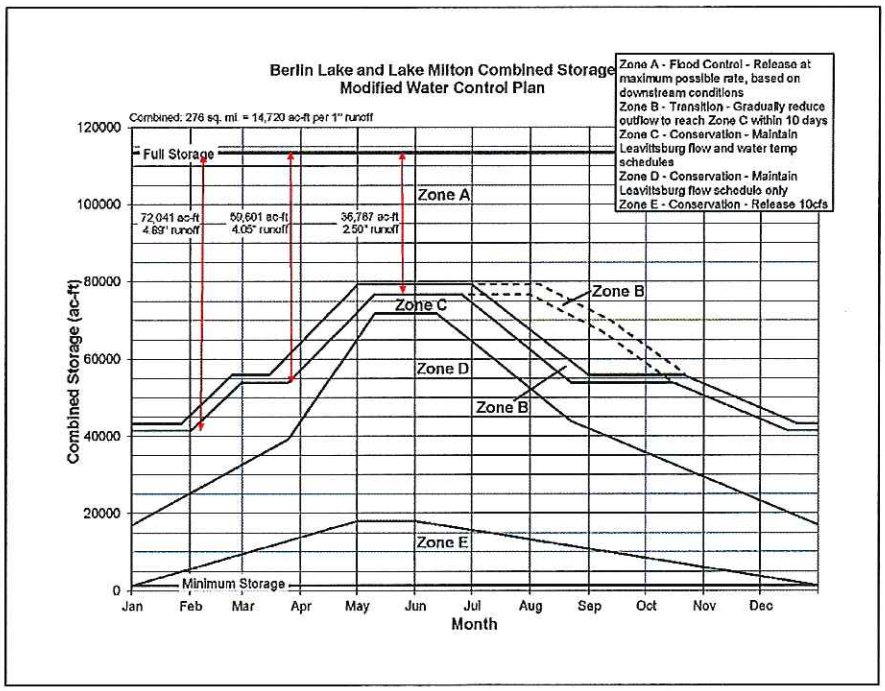

Figure 3. Berlin Lake and Lake Milton Combined Storage Modified Water Control Plan

4. History of Similar Deviations. During a drought in July 1992, the District requested a Major Deviation to the downstream flow schedule in the Mahoning River. In 1992, the Corps of Engineers, along with the Ohio Environmental Protection Agency (OEPA),

Ohio Department of Natural Resources (ODNR), and the Pennsylvania Department of Environmental Protection (PADEP) agreed upon a water conservation plan for the Mahoning River in order to retain enough water to provide for project's authorized purposes. OEPA investigated the effect on Mahoning River water quality from a flow reduction. They used their existing water quality models to analyze several flow schedules at Leavittsburg, OH. OEPA concluded that a reduction in the flow schedule to 250 cubic feet per second (cfs) would still maintain water quality standards, in the event 1991 drought conditions reoccured. The ODNR endorsed the reduction, believing that action was necessary to protect the water resources in the Mahoning River basin. The PADEP endorsed the modification as a temporary solution to the drought concerns. The water quality of the affected streams was monitored according to a plan developed between the Corps of Engineers and the OEPA. This approved plan reduced the downstream flow requirements for the remainder of 1992. On July 10, 1992, the plan was implemented with an approximate 25 cfs reduction in discharge from Mosquito Creek Lake and 65 cfs reduction from Berlin Lake. No reduction in discharge was implemented at MJ Kirwan or Lake Milton. The reduced downstream requirements concluded in 1992 and the original scheduled was followed in 1993. In October 2006, the District requested a Major Deviation to divert flows from Berlin Lake to Meander Creek in order to assist in the construction of a new eastbound I-80 bridge.

5. This current deviation request is the first time that the District has requested a deviation to the WCP in regards to reservoir levels at Berlin Lake. The visioning meeting participants were very vocal in their request to hold summer pool through Labor Day. They have engaged with local elected officials and several media outlets. On July 10, 2017 they presented the District a binder containing 3,500 signatures objecting to current Berlin Lake operations because they believe that summer reservoir levels are negatively affecting recreation and the local economy.

a. Deviation Consequences. Employing the requested deviation could have many possible consequences, many of which are unknown even with a four month analysis. Deviating from the WCP, while continuing to meet the downstream water quality and water supply schedule, would likely result in more water being stored in the reservoir and therefore less water released downstream. Raising the maximum conservation curve (guide curve showing the maximum pool level that we manage to at a given time) during the period from 25 June to 13 October will result in an average of 20% reduction in flood control storage, with a reduction of at least 30% from July 28 to August 26. A concern with this deviation is that, even with the additional water stored in the reservoir, if the reservoir elevation still remains below 1021 ft (NAVD88) through Labor Day, then there won't be any benefits to the local community, and the District would have withheld water from the downstream river.

b. Alternate Plans. The only alternate plan within the scope of this deviation request which would guarantee that the Berlin Lake pool elevation would be between 1021-1024 ft (NAVD88) through Labor Day, as the locals requested, is to disregard the reservoir's authorized project purpose of water quality and water supply (i.e., not meet the

downstream flow schedule). This action is not recommended. This would have severe consequences on the water quality within the 71-mile long reach of the Mahoning River located between Berlin Lake and its confluence with the Beaver River. State pollution discharge permits and water withdrawal permits are based on the Q7,10. The Q7,10 is the average annual 7-day minimum flow that is expected to be exceeded on average in 9 out of 10 years. The Berlin Lake flow schedule created the Q7,10, and therefore, drastically reducing the flow up to 80% from Berlin Lake during dry conditions (typically June to October) would have a significant impact on the downstream water quality.

c. Further in-depth analysis is required, including watershed water quality modeling, to determine current downstream flow requirements and evaluate whether the current downstream flow schedule at Leavittsburg, OH still applies. However, given the short timeline, results of the Ohio Environmental Protection Agency's (OEPA) 2016 Integrated Water Quality Report were utilized to assess water quality impacts related to this proposed deviation.

d. The OEPA conducted comprehensive chemical, physical, and biological monitoring in the lower Mahoning River basin (35 mile reach of the Mahoning River from Leavittsburg OH to the PA/OH state line) during 2013 to identify the pollutants impairing beneficial uses and to support the development of Total Maximum Daily Loads (TMDLs) for those pollutants. Results, which were included in their 2016 report, indicated significant recovery of biological communities since the previous assessment that was conducted in 1994 when over 85% of the reach was in non-attainment of the aquatic life use. However, this reach of the Mahoning River was still impaired, that is, it did not attain the OEPA's aquatic life, recreation, and human health designated uses. Sources of Impairment included combined sewer overflows, municipal point source discharges, upstream sources, and sedimentation/siltation (http://wwwapp.epa.ohio.gov/gis/test/ir/ir2016reports.html?lrau=050301039001).

e. OEPA prepared a TMDL for pathogens for this reach of the Mahoning River in 2004, which in addition to pathogens, identified metals, sediments, nutrients, and related low dissolved oxygen levels as issues of concern (http://epa.ohio.gov/dsw/tmdl/MahoningRiver.aspx).

f. It is likely that water quality conditions along the sections of the Mahoning River that are not currently in attainment, or are only partially attaining designated uses, would be exacerbated by the implementation of the proposed deviation since it will reduce Mahoning River summer flows. In addition, the proposed deviation could increase reservoir storage and retention time, which could lead to stronger reservoir stratification, higher biological productivity, and hypolimnetic anoxia, negatively impacting reservoir water quality and aquatic life, which could lead to an increased risk of a Harmful Algal Bloom (HAB). Therefore, to avoid potential water quality impacts, real-time continuous water quality monitoring (pH, dissolved oxygen, water temperature, and specific conductivity) would be initiated in the reservoir and also the Mahoning River downstream of major sources of industrial and municipal pollution (Warren,

Youngstown, Lowellville OH) prior to and continuing throughout the deviation period. If/when any of the water quality standards are not met, as outlined in Table 1, then the proposed deviation would be terminated. Operation of the reservoir would return to the current WCP, likely resulting in a lower reservoir level.

Table 1. Water Quality Parameters and Acceptable Levels

Gage Location	Water Quality Parameter	Acceptable Level
Mahoning River at Warren, OH	pH	>6.5 or <9.5 (pH units)
	WT July 1 - Sept 15	89 (deg F)
	WT Sept 16 - 30	83 (deg F)
	WT Oct 1 - 15	77 (deg F)
	WT Oct 16 - 31	72 (deg F)
	DO Daily Average	>5.0 (mg/L)
	Specific Conductivity	<600 (uhmos/cm)
Mahoning River at Youngstown, OH	pH	>6.5 or <9.5 (pH units)
	WT July 1 - Sept 15	89 (deg F)
	WT Sept 16 - 30	83 (deg F)
	WT Oct 1 - 15	77 (deg F)
	WT Oct 16 - 31	72 (deg F)
	DO Daily Average	>5.0 (mg/L)
	Specific Conductivity	<600 (uhmos/cm)
Mahoning River at Lowellville, OH	pH	>6.5 or <9.5 (pH units)
	WT July 1 - Sept 15	89 (deg F)
	WT Sept 16 - 30	83 (deg F)
	WT Oct 1 - 15	77 (deg F)
	WT Oct 16 - 31	72 (deg F)
	DO Daily Average	>5.0 (mg/L)
	Specific Conductivity	<600 (uhmos/cm)
Berlin Lake buoy @ 10 ft deep	pH	<9.0 (pH units)
	WT	>85 (deg F)
	DO	>4.0 (mg/L)
	Specific Conductivity	<600 (uhmos/cm)
	Chlorophyll	<50 (ug/L)
	Phycocyanin	<5 (ug/L)

* Water Temperature (WT), Dissolved Oxygen (DO)

6. Deviation Effects. By raising the maximum conservation curve from June 25 to October 13, flows in the Mahoning River will be reduced since water that was previously released into the river will be stored in the reservoir. While the minimum flow schedule will still be met, during this time period the river often receives additional flow as Berlin

Lake follows the forced drawdown required by the current WCP. With the proposed new curve for this 2018 deviation, the reservoir draw down would be delayed until the fall, and therefore less water will be discharged into the river during July – October, which are typically the hottest and driest months of the year.

a. The Berlin Lake Flood Seasonality Analysis for the full period of record (1 March 1944 through 31 December 2017) is shown in Figure 4. Based on the full period of record, the relative frequency of a flood event occurring in July is 0.03 and the relative frequency of a flood event occurring in August is 0.04. This is compared with slightly higher relative frequencies in May and June of 0.09 and 0.08, respectively. The highest frequency of flooding occurs in February-March and the lowest frequency of flooding occurs in September-November. Based on these preliminary results, the risk of holding pool through July-August is not expected to be significantly higher than the risk that USACE currently assumes by holding summer pool in May-June. However, the cumulative relative frequency of flooding will increase from 0.17 (May-June) to 0.23 (May-August), which will increase the overall risk of higher pool elevations during the summer season.

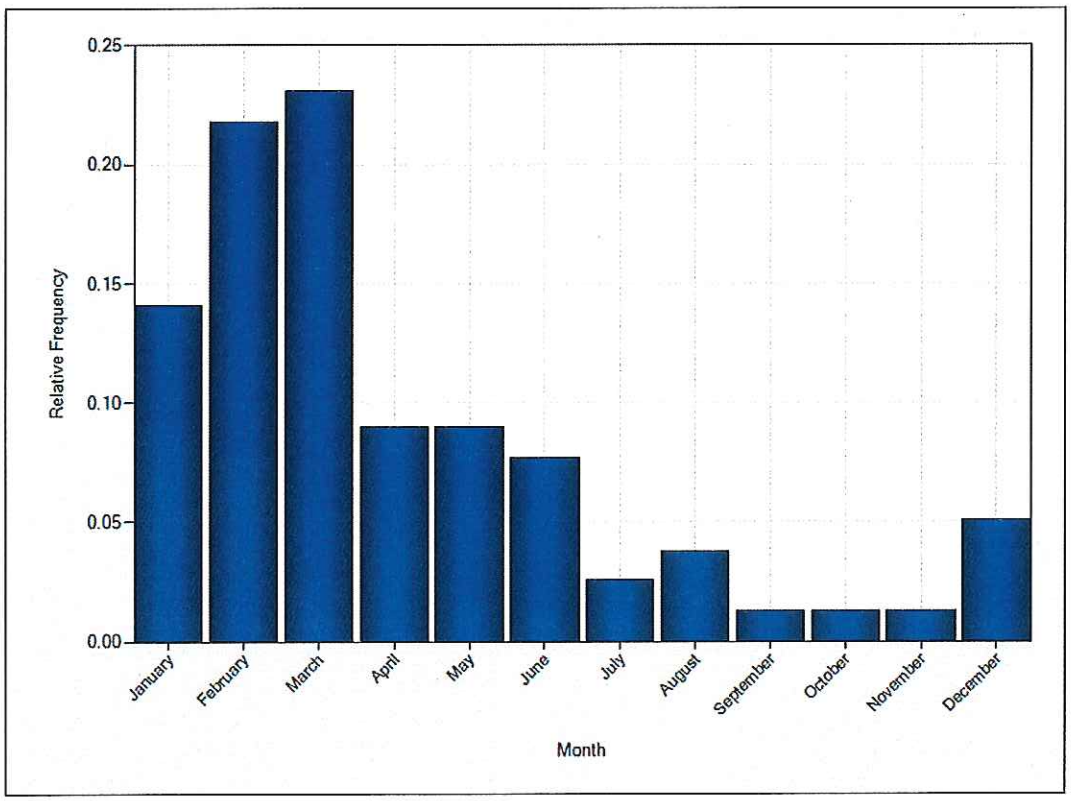

Figure 4. Berlin Lake Flood Seasonality Analysis

b. The stage (elevation) frequency plot shown in Figure 5 is based on the 2017 Berlin Periodic Assessment work. The 2017 PA Monte Carlo Reservoir Analysis Model (MCRAM) analysis was used as input to Risk Management Center – Reservoir

Frequency Analysis (RMC-RFA) program and the resulting stage frequency curve is labeled as the "2018 RMC-RFA based on 2017 PA". For the purposes of this deviation request, the RMC-RFA analysis was updated to include adjustments to the reservoir starting stage duration table. As a worst case assumption of starting pool under the 2018 Planned Deviation, the May starting stage duration data was copied to June and July and the original July starting stage duration data was copied to August-October. The resulting stage frequency curve is labeled as the "2018 Deviation Expected". Upper and lower uncertainty bounds representing the 90% confidence limits (5% and 95% exceedance curves) are also shown and closely agree with the 2017 PA MCRAM confidence limits.

c. The 2017 PA MCRAM analysis actually produces slightly more frequent pool loadings below an Annual Chance of Exceedance (ACE) of 0.02 compared to the RMC-RFA analysis using the same data, so any differences between the MCRAM and RMC-RFA analyses are probably within the margin of error associated with these tools, since the confidence limits are similar. There are no significant differences between the RMC-RFA analyses using the 2017 PA assumptions, versus the worst case (reservoir starting stage duration table) for the 2018 Planned Deviation. These minor differences illustrate from a flood control or hydrologic loading standpoint that the risks of holding pool higher in July-August, and even July-October are minimal.

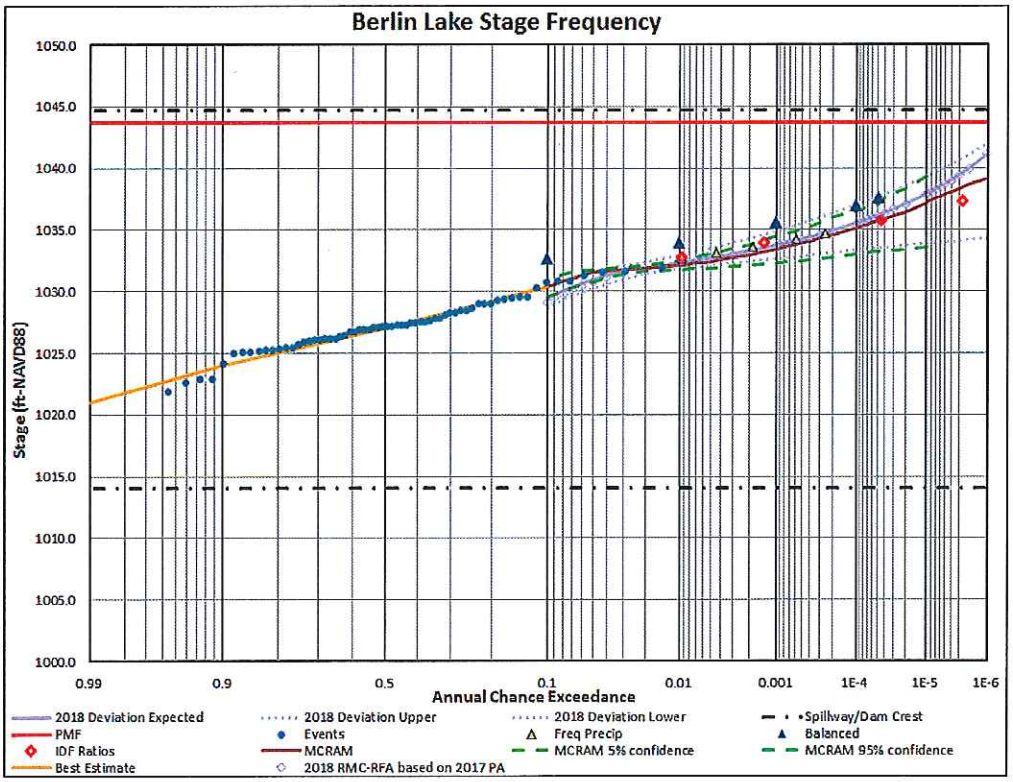

Figure 5. Berlin Lake Stage (Elevation) Frequency Plot

d. Potential Failure Analysis. The First Periodic Assessment of Berlin (conducted in 2017) revealed four risk driving failure modes, with the corresponding critical pool levels, as shown in Table 2.

Table 2. Berlin Failure Modes

Potential Failure Mode	Short Description	Pool Level (ft) (NAVD88) (Critical Hydrologic Loading)
1	Overwash of embankment	1044.4 (PMF)
3	Concentrated leak erosion (CLE) along right abutment spillway contact	≥ 1032.7 (TAS*)
24	Crest gate failure due to trunnion pin friction	≥ 1032.7 (TAS*)
25	Monolith instability due to hydraulic loading	≥ 1032.7 (TAS*)

* Top of Active Storage (TAS)

(1) The First Periodic Assessment report recommended a change in dam safety action classification (DSAC) from 3 to 4 for Berlin based on an evaluation of the risk-driving PFMs. The estimated loss-of-life consequences associated with the risk-driving potential failure modes (PFMs) assumed cascading failure of both Berlin Dam and Milton Dam, which is situated downstream of Berlin. Based on a briefing of the periodic assessment in February 2018, the Dam Safety Oversight Group (DSOG) voted to change Berlin from DSAC 3 to DSAC 5 based on low likelihood of failure, conservatism in the estimated consequences (i.e., cascading failures assumed), and the lack of a compelling case that there was substantial uncertainty associated with or imminent concerns with the dam's condition. The District has not yet received the final DSAC memo.

(2) Under the current WCP, maximum summer conservation pool is held from May 1 to June 25 and the deviation would extend maximum summer conservation pool to August 1. In addition, implementation of the deviation could result in the reservoir remaining above maximum winter conservation pool from mid-March through late-October, whereas current operations result in reservoir levels above winter pool from mid-March through the end of September. Therefore, there is the potential that the dam could be exposed to the critical hydrologic loadings on a slightly more frequent basis than assumed during the periodic assessment.

(3) PFM 1 would require hydrologic loading associated with the inflow design flood (IDF), which consists of the probable maximum flood (PMF). The IDF considered three types of storms:

- Type I – Winter/spring storm accompanied by snowmelt
- Type IV – Decadent tropical storm in late summer/early fall

- Type V – Summer convectional storm (most critical)

(4) The Type V storm was found to be the critical event for the IDF. Based on the First Periodic Assessment Report, "The IDF routing was not sensitive to the antecedent pool (el. 1014 ft – 1032 ft NAVD88) for this dam as all HEC HMS antecedent scenarios resulted in similar ranges of peak pool elevations for all three gate operation scenarios and unit hydrograph peaking conditions". Therefore, the deviation should have no effect on the estimated annual probability of failure (APF) of PFM 1. Since the peak pool would not change due to the deviation, the consequences of failure for PFM 1 would not change.

(5) PFMs 3, 24, and 25 would require hydrologic loading at or in excess of top of active storage (TAS), el. 1032.7 ft (NAVD88). The periodic assessment ascribed an annual chance of exceedance (ACE) of 0.02 (1/50) for this pool. The probabilities of failure for these PFMs are dominated by the low probabilities of failure once the critical hydrologic loading occurs. The deviation would presumably result in a slightly higher ACE for the TAS pool and therefore, slightly higher probabilities of failure for these PFMs. The loss-of-life consequences associated with these three PFMs would not change as a result of the deviation since the critical reservoir level and potential inundation associated with dam failure, though possibly occurring more frequently, would not change.

(6) In conclusion, the deviation would result in slightly higher APFs for three of the risk-driving potential failure modes (PFMs 3, 24, and 25). The corresponding increase in probability of failure has not been quantified. However, it is expected to be relatively minor. The consequences of failure are not expected to increase as a result of the deviation. However, the slightly higher probability of failure could be a consideration in future DSAC determinations.

e. Flood Threat. There is an increased risk of higher pools & spillway flow by holding more water in the reservoir when it would typically be used for flood storage. At summer pool Berlin Lake can only hold 2.35" of runoff before reaching spillway flow. If a storm total producing over 2.5" of runoff passes over Berlin Lake, the reservoir will rise to full pool and will experience uncontrolled spillway flow. Intentionally holding additional water within the reservoir entering hurricane season will affect how the reservoir operates. With the reduction in storage, the reservoir will have to be more aggressive in releases to bring the reservoir level below the guide curve in order to prepare for the next possible runoff event. This would translate into higher flow pulses immediately following an event, which wouldn't exceed the established channel capacity (1,000 cfs at MJ Kirwan and 2,600 cfs at Lake Milton) but would likely impact those within the floodplain downstream. One example being the Riverview Golf Course in Braceville, OH, which is affected when the combined releases from MJ Kirwan and Berlin/Milton exceed 1,800 cfs. In 2015 the Riverview Golf Course contacted both Representative Tim Ryan and Senator Sherrod Brown regarding flooding at their facility.

The District prepared responses to these requests and would anticipate additional requests if pulse releases from Berlin were more significant than the 2015 releases.

f. Berlin Lake's downstream channel capacity is 3,400 cfs, whereas the channel capacity downstream of Lake Milton is only 2,600 cfs. Therefore if the flow from each reservoir is at channel capacity and if Lake Milton is at summer pool, it would only take three and a half days for Lake Milton to rise three feet from summer pool to the spillway, resulting in uncontrolled spillway flow downstream of Lake Milton. Uncontrolled spillway flow may result in downstream flooding. At this time there aren't any mitigation options for the proposed loss of flood control storage. Similarly if there are operational restrictions at Lake Milton, such as functionality of the gate valves resulting in a reduced capacity to discharge downstream, it will add an additional layer of complexity during a high water event.

7. Pertinent Information. Given the current scope and budget associated with this proposed deviation, in depth computations in regards to predicted maximum pool elevation and downstream river stages are not available. Berlin Lake would still be operated to reduce flooding impacts at National Weather Service established flood gages downstream on the Mahoning River. Figure 1 shows the 30 year average pool elevation under the operation of the current WCP.

8. Review. Reduced downstream summer flows expected with the proposed deviation could exacerbate already poor water quality conditions along the 71-mile long regulated reach of the Mahoning River downstream of Berlin Dam, which could increase incidences of noncompliance with the Clean Water Act (exceedances of state water quality standards). This risk will be mitigated by increasing water quality monitoring and adjusting the discharge if/when deviations from water quality standards occur.

9. Coordination. On July 10, 2017 the District met with key watershed stakeholders. The purpose of this meeting was to talk about the future of Berlin Lake, where reservoir users could speak freely with downstream users; where public citizens, business owners, and agencies could discuss their needs for the watershed. On October 18, 2017, Berlin Lake's Acting Resource Manager, Doug Krider, attended the Berlin Lake Association fall meeting in which he provided the membership with a status update on the 2018 Deviation. On May 17, 2018, District Commander COL Lloyd and other District employees provided an update on the deviation request to the Berlin Lake Association at their regularly scheduled membership meeting.

10. Comments. Refer to Appendix A of enclosed Environmental Assessment dated June 2018 for comments received.

11. Discussion. While the duration of this 2018 Planned Deviation request is only four months, the District reviewed the Ohio River Basin (ORB) Pilot Study in regards to climate change. Based on that study, temperatures within the Ohio River Basin are expected to increase one-half degree per decade from 2011-2040 and one degree per

decade from 2041-2099. Annual maximum stream flow for the Upper Ohio River basin may increase by up to 35% through 2099. Annual minimum stream flow is not projected to change significantly. March mean stream flow for the Upper Ohio River basin may increase by up to 25% through 2099. October minimum stream flow may decrease by up to 15% through 2099.

a. Overall, the qualitative tools and available literature indicate that March mean stream flow and annual maximum stream flow will likely increase creating greater challenges for flood risk reduction, especially in the spring flood season. Decreases in October minimum stream flow and increasing variability in stream flow will likely create greater challenges for ecosystem restoration (and perhaps by extension, water quality), especially in the fall low flow season.

b. In the context of a planned deviation request for Berlin Lake to hold pool higher in July and August, the potential impacts to ecosystem restoration most likely outweigh any potential impacts to flood risk reduction. Additional analysis is needed to determine if there are ecosystem benefits or losses to storing additional water in Berlin Lake through the summer season to augment flows in the fall. For more information on flood seasonality, refer to the Berlin Lake flood seasonality analysis.

c. In summary, the District is requesting approval from Division to temporarily deviate from Berlin Lake's WCP from June 25, 2018 or thereafter to October 13, 2018 by holding the pool to the proposed WCP outlined in Figure 1, provided that the downstream minimum flow target is met at Leavittsburg, OH.

12. Point of contact for the Pittsburgh District is Jeanine Hoey, Chief of Engineering and Construction Division, (412) 395-7289.

BUILDING STRONG and Taking Care of People!

Encls

JOHN P. LLOYD
Colonel, Corps of Engineers
District Engineer

CELRP-EC
SUBJECT: Request for Deviation from the Approved Water Control Plan at Berlin Lake, OH

District Recommendations

- **Recommendation** X **YES** ____ **NO**

  Comments: None

  District Water Control Manager Chad Katz

- **Recommendation** X **YES** ____ **NO**

  Comments: NONE

  Chief Engineering and Construction Division [signature]

- **Recommendation** X **YES** ____ **NO**

  Comments: NONE for Kathy M. Griffin

  Operations (if needed) Olga M Beddingfield

- **Recommendation** X **YES** ____ **NO**

  Comments: NONE

  Planning (if needed) [signature]

- **Recommendation** X **YES** ____ **NO**

  Comments: NONE

  Environmental [signature]

- **Recommendation** ____ **YES** ____ **NO**

  Comments: No legal objection.

  Legal [signature] 5 JUL 18