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Ms. Debbie Bluso-Rogers
Administrator
Richfield Joint Recreation District
4410 West Streetsboro Road
Richfield, Ohio 44286

September 1, 2016
2016257.00

RE: Dam Structural Concrete Conditions Assessment – Upper Hilaka Lake Dam

Dear Ms. Bluso-Rogers:

Below is a summary of GPD's findings from our site visit that took place between June 2 and June 14, 2016. Alek Babel and Micah Nine, of GPD Group, visited the Upper Hilaka Lake Dam to gather information with the intent to assess the condition of the concrete portions of the dam.

SCOPE OF WORK

The scope of work includes the following:

- Conduct a field inspection and concrete structure assessment of the visible surfaces
- Obtain concrete core samples, including petrographic analysis and report of the concrete conditions
- Prepare a structural condition assessment report with summary of results and recommendation for rehabilitation or replacement

LIMITATIONS

The observations provided in this report were generally non-destructive in nature, and limited to portions of the dam that were accessible and could be visually observed. Three (3) concrete core samples were taken for analysis, but a full petrographic analysis was conducted on one sample only; the other two were examined for physical integrity. Concrete core samples may not be representative of concrete throughout the entire structure. The scope of services did not include an exhaustive technical investigation. No special testing and/or engineering calculations were performed. Only the dam components listed in this report were observed during the site visit.

GENERAL DAM OVERVIEW

The Upper Hilaka Lake Dam is a cast in place concrete dam installed in 1926. The dam is approximately 30.5' high and 520' long. The dam is ODNR jurisdictional as a Class II Dam

based on downstream hazard conditions. The latest ODNR Dam Safety Inspection Report (File number: 1115-002, dated April 23, 2014) indicates that no investigation or engineering action was required, but monitoring of deteriorating concrete on the spillway and monitoring of observed seepage is required. Original drawings for the dam were not available, but drawings indicating repairs had been proposed in 1979.

OBSERVATIONS

- The concrete “cut off” wall which extends to the west from the main spillway appears to be generally sound, considering the age of the dam. There are a number of vertical cracks which are indicative of shrinkage cracking due to the lack of control joints in the wall. The portions of the wall that are exposed to the retained lake show some signs of spalling.

- The concrete spillway condition varies from generally sound to poor. The sloped and vertical surfaces of the concrete spillway show signs of previous repair. Some of the repairs appeared to be delaminating from the original substrate. There are some surface spalls, and cracking throughout. A concrete core was taken from the spillway surface for petrographic analysis.

- The two buttress walls were in poor condition. The walls showed signs of previous repairs which appeared to have debonded over time from the original substrate. Embedded steel wire mesh showed signs of corrosion and there was extensive erosion and spalling of the concrete. A concrete core was taken from the eastern most buttress wall and examined for physical characteristics such as cracking.

- The apron at the bottom of the dam appeared to be generally sound. There was some areas of surface delamination. Some surface erosion has occurred, and standing water was present in some areas at the time of our visit. A concrete core was taken from the apron and examined for physical characteristics.

- The side walls showed some cracking and spalling, but appeared to be generally sound. Near the spillway elevation, more cracking and spalling was observed.

- The top of the spillway showed signs of surface distress. There appeared to be repair concrete present, which appeared to be debonded from the original substrate. Some erosion of the original concrete was present.

- The backside of the spillway wall appeared to be generally sound. Approximately 6 feet of soil/sediment was removed from the upstream side of the dam to allow access for observation. There was some cracking, but little surface delamination as indicated by the sounding tests performed.

ASSESSMENT AND RECOMMENDATIONS

Considering the age of the dam, it appears to be in fair condition. The problems with the concrete observed during the site visits are typical for a structure of the age, use, and exposure. Areas of concrete that are potentially exposed to flowing water and freeze-thaw cycles exhibited higher levels of distress than concrete that is generally not exposed to these conditions.

The concrete “cut off” wall to the west of the main spillway appears to be in good condition. Cracking in this portion of the dam is indicative of shrinkage cracking. There is some spalling present below the spillway elevation, which may be indicative of freeze-thaw damage. There is some delamination and surface spalling above the spillway present, but this damage is superficial and minor in nature. At this time, we would recommend continued observation of the “cut off” wall concrete for additional signs of distress, with no immediate repairs being required. If repairs to the main spillway concrete are performed, repair of spalls and cracks should be considered as added scope. As the spalling below the spillway elevation appears to be freeze-thaw induced, we would suggest that the lake be drawn down every fall to reduce the impact of freeze-thaw on the lower portions of the wall.

The spillway concrete showed varying surface conditions. There were areas where previous repairs were made, with some of the repair work showing signs of debonding from the concrete substrate. Other areas appeared to be generally sound. There were some signs of seepage through cracks in the spillway. Petrographic analysis of a core sample taken through the spillway showed few signs of erosion, and low levels of chlorides. GPD recommends that the sloped and vertical surfaces of the spillway downstream of the lake be repaired. Repair would require removal of the existing surface concrete down to sound concrete, with a repair wire mesh & mortar applied to the prepared surface.

The top of the spillway wall showed signs of freeze-thaw damage to the substrate concrete and to previous repairs. Some portions of the top of the spillway have old repairs still in place, but through hammer sounding of the concrete, appear to be debonding from the substrate. GPD recommends that the top portion of the dam spillway be repaired. Similar to the face of the spillway wall, the existing surface would be removed down to sound concrete, and a repair wire mesh & mortar would be applied to the prepared surface. Further, we recommend that the cracks through which water is seeping be repaired and monitored for further seepage.

The two buttress walls of the spillway are in poor condition. Previous surface repairs were in very poor condition, with large areas of repaired concrete debonding from the original substrate. Spalling occurs throughout the buttress walls, and there is corroded wire mesh exposed. A core sample through one of the buttress walls shows signs of freeze-thaw damage, as well as signs of moisture intrusion through the entire width of the wall. GPD recommends that the buttress walls be removed and replaced with new reinforced concrete walls of adequate design. The existing concrete shows signs of freeze-thaw damage down to approximately 4-5” below the surface. Removal of this concrete alone could expose concrete sound enough to apply repair material. However, a repair of this depth would likely necessitate reinforcing being added to the repair, which would be embedded into the existing substrate. Due to the age of the existing concrete, embedding reinforcing into the

existing concrete and bonding it to new concrete would likely create a cathodic cell, and damage to the repair due to corrosion would be accelerated. Our recommendation to remove the whole buttress walls minimizes the risk of recurring repairs being required.

The wing walls of the spillway appear to be generally sound. There are some areas of surface delamination that were detected through hammer sounding, as well as some cracking and spalling, especially near the top of the spillway. GPD recommends that the areas of delaminated concrete be removed, and the surface repaired. Further, spalls near the top of the spillway should be repaired, as well as cracks where seepage is present.

The apron slab below the spillway shows signs of surface deterioration, likely due to erosion. However, sounding by chain showed most of the apron appears to be sound. There is one large area showing signs of delaminated surface concrete. GPD recommends that this area be repaired, with the delaminated concrete being removed down to sound concrete and a repair mortar being applied to the prepared surface.

The upstream side of the spillway appeared to be generally sound. Sounding of the surface with a chain showed little delamination of the surface, while there were some cracks present, which could be areas where seepage occurs. If other repairs are being executed, GPD would recommend that the cracks on the upstream side of the spillway wall be repaired.

GPD has prepared an opinion of costs for the recommended concrete repair work. Due to the uncertain nature of surface preparation, certain assumptions have been made in preparing the estimate.

Assumptions include:

- This is an opinion of cost solely for the rehabilitation of select portions of the concrete dam; no assessment or costs have been attributed to the earthen dam, steel bridge, lake drain, or lake sediment.
- No repair work done to the cut-off wall
- In the main spillway, 4” of surface concrete will be removed and repaired
- In the apron, 4” of concrete will be removed and repaired
- The two buttress walls will be completely removed and replaced
- On the side walls, only the large spalls will be repaired

Also, due to the nature of the site, and the possibility that additional concrete will have to be removed to attain a sound surface, the opinion of cost is listed as a range of values

The opinion of cost is not a bid, and is not based upon a detailed rehabilitation design. The opinion of cost should be considered an order of magnitude estimate to assist with planning.

CONCRETE REHABILITATION OPINION OF COSTS – UPPER HILAKA LAKE DAM

WORK ITEM:	Cost
Main Spillway/Side wall spalls	$ 20,000-40,000
Settling Basin	$ 30,000-50,000
Buttress Walls	$ 60,000-100,000
Scaffolding	$ 3,000-6,000
Sub-Total	$ 113,000-196,000
Engineering Design (~15%)	$ 17,000-30,000
Construction Mobilization & General Conditions (~10%)	$ 12,000-20,000
Construction Contingency (~25%)	$ 29,000-50,000
Total Budget	$ 171,000 – 296,000

The recommendations listed can be performed to slow the rate of deterioration of the concrete dam structure. However, GPD cannot guarantee that further deterioration will not take place.

Design of rehabilitation repair is not within the scope of this evaluation. This report presents areas to consider and potential repair options. Construction Documents are required to address all aspects of layout, site improvement, materials and design element selection.

The evaluation of this structure requires that certain assumptions are made about the existing condition of the concrete. Considering that some of these assumptions cannot be verified without expending additional sums of money and/or destroying otherwise serviceable portions of the structure, GPD Group cannot be held responsible for conditions that could not reasonably be determined during this study, or which have not been discovered within the scope of this evaluation.

RECOMMENDED NEXT STEPS

- Engineering/design and construction plans for the concrete dam rehabilitation.
- Remove or replace the bridge over dam.
- Coordinate with ODNR; meet protocol for rehabilitation criteria.
- Complete the concrete dam rehabilitation and update the ODNR Dam Safety Inspection Report; conduct annual maintenance and inspections thereafter. Continue to monitor dam conditions annually.
- Annually drain down lake to a defined winter pool elevation (to prevent further freeze/thaw deterioration of concrete).
- Perform a lake management study, including sediment dredge limits for optimum lake function, restore the upper sediment trap function, and restore lake perimeter condition (select planting, control invasive species, and select clearing for lines of sight to the lake).

CONCLUSION

The upper Hilaka Lake Dam is generally in fair condition, considering its age. However, there are areas of the concrete structure that are in need of repair. The spillway is in need of surface repair, with cracks showing signs of seepage also needing to be repaired. The top of the spillway needs surface repair, with existing repair concrete being removed. The wing walls are in fair condition, with some surface repair required, and spalling at the top of the spillway needing repairs. Some cracks showing signs of seepage should be repaired. The surface of the apron is in fair condition, with some surface repairs required. The buttress walls are in poor condition, and should be replaced.

The opinion of cost presented in this report, represents the order of magnitude range in cost for design and construction of concrete rehabilitation for select portions of the concrete dam. Additional upgrades/replacement of features adjacent to the lake dam should be considered by separate assessment not included in this scope.

We thank you for the opportunity to offer our services for the concrete condition assessment of the upper Hilaka Lake Dam.

Sincerely,
GPD Group

Alek Babel, PE
Structural Engineer

Matthew A. Lascola, P.E., LEED-AP
Project Manager

Attachment:

- RJRD Upper Dam Condition Assessment Laboratory Studies of Two Concrete Cores by Wiss, Janney, Elstner Associates, Inc. Dated August 1, 2016

APPENDIX: REPRESENTATIVE PHOTOS OF THE UPPER HILAKA LAKE DAM:

Photo 1 Description: Concrete "Cut Off" wall. A representative photo of the lake side of the concrete cut off wall showing cracking indicative of shrinkage cracks (CR) due to no control joints in the wall as well as spalling(SP) near the spillway elevation.	
Photo 2 Description: Concrete "Cut Off" wall. A representative photo of the lake side of the concrete cut off wall, with the entire concrete portion of wall above the spillway elevation. Wall shows signs of vertical cracks indicative of shrinkage cracking due to no control joints in the wall.	
Photo 3 Description: Main Spillway – Lower half of westernmost cell. The vertical and sloping surface of the spillway showing surface spalls, delamination, and some cracking.	

Photo 4 Description: Main Spillway – Upper half of westernmost cell. The sloping surface of the spillway showing surface spalls, delamination, and a large horizontal crack across the cell.	
Photo 5 Description: Main Spillway – Lower half of center cell. The vertical and sloping surface of the spillway showing surface pitting and cracks as well as a prior repair showing signs of delamination and debonding from the original substrate.	
Photo 6 Description: Main Spillway – Upper half of center cell. The sloping surface of the spillway showing surface pitting as well as a prior repair showing signs of delamination and debonding from the original substrate.	

Photo 7 Description: Main Spillway – Lower half of easternmost cell. The vertical and sloping surface of the spillway showing surface delamination and spalling. Seepage is visible in this portion of the spillway.	
Photo 8 Description: Main Spillway –Center portion of easternmost cell. The vertical and sloping surface of the spillway showing surface delamination of a prior repair and spalling. Seepage is visible in this portion of the spillway.	
Photo 9 Description: Main Spillway – Upper half of easternmost cell. The sloping surface of the spillway showing surface pitting.	

Photo 10 Description: Main Spillway – Top of spillway. The top surface of the spillway shows signs of freeze thaw damage, with repair material debonding from the original substrate and damage to the original concrete. The vertical surface shows signs of surface pitting and erosion.	
Photo 11 Description: Main Spillway – West Buttress Wall. The bottom portion of the west buttress wall shows signs of delamination and spalling. The original concrete substrate is heavily distressed.	
Photo 12 Description: Main Spillway – West Buttress Wall. The middle portion of the west buttress wall shows signs of spalling and cracking. The original concrete substrate is heavily distressed.	

Photo 13 Description: Main Spillway – West Buttress Wall. The upper portion of the west buttress wall shows signs of spalling and cracking. The original concrete substrate is heavily distressed.	
Photo 14 Description: Main Spillway – West Buttress Wall. The bottom portion of the west buttress wall shows signs of delamination and spalling. The original concrete substrate is heavily distressed.	
Photo 15 Description: Main Spillway – West Buttress Wall. The upper portion of the west buttress wall shows signs of spalling and cracking. The original concrete substrate is heavily distressed.	

Photo 16 Description: Main Spillway – East Buttress Wall. The bottom portion of the east buttress wall shows signs of delamination and spalling. The original concrete substrate is heavily distressed. Wire mesh reinforcing is exposed.	
Photo 17 Description: Main Spillway – East Buttress Wall. The upper portion of the east buttress wall shows signs of pitting and spalling. The original concrete substrate is heavily distressed.	
Photo 18 Description: Main Spillway – East Buttress Wall. The bottom portion of the east buttress wall shows signs of delamination and spalling. The original concrete substrate is heavily distressed. Wire mesh reinforcing is exposed.	

Photo 19 Description: Main Spillway – East Buttress Wall. The upper portion of the east buttress wall shows signs of pitting and spalling. The original concrete is heavily distressed.	
Photo 20 Description: Main Spillway – West Wing Wall. The lower portion of the west wing wall showing some delamination and seepage cracks.	
Photo 21 Description: Main Spillway – West Wing Wall. The upper portion of the west wing wall showing some delamination, cracks and spalls. Note the larger spall at the intersection with the spillway.	

Photo 22 Description: Main Spillway – East Wing Wall. The lower portion of the east wing wall showing some delamination and seepage cracks.	
Photo 23 Description: Main Spillway – East Wing Wall. The upper portion of the east wing wall showing some delamination, cracks and spalls. Note the larger spall at the intersection with the spillway.	
Photo 24 Description: Main Spillway – Apron. The southeast corner of the apron shows signs of deterioration, and sounding with a chain indicates delamination.	

Photo 25 Description: Main Spillway – Apron. The northwest corner of the apron in the easternmost cell shows signs of deterioration. Note the water from seepage. Sounding with a chain indicates delamination.	
Photo 26 Description: Main Spillway – Upstream Surface. The upstream surface of the spillway appeared to be generally sound, with some cracking present. Clays were present on the upstream side of the dam up to near the spillway elevation.