Ohio Department of Natural Resources

JOHN R. KASICH, GOVERNOR — DAVID MUSTINE, DIRECTOR

Theodore R. Lozier • Chief

Division of Soil & Water Resources

April 22, 2011

David Payne, Chief
Division of Parks and Recreation
2045 Morse Rd., Building C-3
Columbus, Ohio 43229-6693

RECEIVED
MAY 17 2011
DEPT. OF NATURAL RESOURCES
DIVISION OF ENGINEERING

RE: Buckeye Lake Dam
File Number: 9723-004
Licking and Fairfield Counties

Dear Mr. Payne:

Thank you for allowing Peter George and Dena Barnhouse of the Division of Soil & Water Resources to conduct a safety inspection of Buckeye Lake Dam on June 24 & 25, 2010. I have enclosed a copy of the safety inspection reports of West Bank & North Bank for your use and review. The inspection was conducted under the provisions of Ohio Revised Code Section 1521.062 to evaluate the condition of the dam and its appurtenances. I have the responsibility to ensure that human life, health, and property are protected from catastrophic dam failures. Conducting periodic safety inspections and working with dam owners to maintain and improve the overall condition of Ohio dams are vital aspects of achieving this purpose.

List in the reports are several requirements that must be performed to improve the safety and overall condition of the dam. I must approve any plans for modifications or repairs to the dam. Following the approval of the engineered plans, all necessary repairs must be implemented under the supervision of a registered professional engineer. Please coordinate the repair of the dam through the Divisions of Engineering and Soil & Water Resources.

To gain information that will help improve the inspection program, a short survey has been enclosed with Tim Waln's copy of the report. Please complete the survey and return it in the self-addressed envelope provided. Your feedback is important.

Please note the ORC section 1521.062 requires a dam owner to notify me in writing of a change in ownership of a dam prior to the change of the property.

Your cooperation in improving the overall condition of this dam is appreciated. Please contact Peter George at 614/265-6725, if you have any questions.

Sincerely,

Theodore R. Lozier, P.E., Chief
Division of Soil & Water Resources

TRL:pg

cc: Tim Waln, Park Manager, Buckeye Lake State Park
Hung Thai, P.E., Program Manager, Division of Engineering
Peter George, P.E., Project Manager, Division of Soil & Water Resources

Enclosures

DAM SAFETY INSPECTION REPORT

Buckeye Lake Dam –West Bank
File Number: 9723-004
Class I
Fairfield County, Walnut Township
Inspection Date: June 24, 2010

In accordance with Ohio Revised Code Section 1521.062, the owners of dams must monitor, maintain, and operate their dams safely. Negligence of owners in fulfilling these responsibilities can lead to the development of extremely hazardous conditions to downstream residents and properties. In the event of a dam failure, owners can be subject to liability claims.

The Chief of the Division of Water has the responsibility to ensure that human life, health, and property are protected from the failure of dams. Conducting periodic safety inspections and working with dam owners to maintain and improve the overall condition of Ohio dams are vital aspects of achieving this purpose.

Representatives of the Chief conducted this inspection to evaluate the condition of the dam and its appurtenances under authority of Ohio Revised Code Section 1521.062. In accordance with Ohio Administrative Code Rule 1501:21-21-03, the owners of dams must implement all remedial measures listed in the enclosed report.

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Section 1

DIVISION OF SOIL & WATER RESOURCES
DAM SAFETY INSPECTION SITE VISIT
WEST BANK OF BUCKEYE LAKE DAM
FILE NUMBER: 9723-004

LOCATION:	Fairfield County, Walnut Township
DATE:	Thursday, June 24, 2010
TIME:	8:00 a.m.
INSPECTORS:	Peter George, P.E., Project Manager Dena Barnhouse, P.E., Project Manager
OTHERS PRESENT:	Tim Waln, Park Manager
SITE CONDITIONS:	It was sunny and about 70 degrees Fahrenheit. The ground surface was dry.
PHOTOGRAPHS:	Digital photographs were taken and are on file at this office and included in this report.

INSPECTION PURPOSE AND AUTHORITY:

This inspection was conducted under the provisions of Ohio Revised Code (ORC) Section 1521.062 to evaluate the condition of the dam and its appurtenances. The Dam Safety Engineering Program has the responsibility to ensure that human life, health, and property are protected from catastrophic dam failures.

DESCRIPTION:

The inspection of the West Bank began at an approximate station of 10+00 (residential address of 12472) and ended at an approximate station of 64+00 (residential address of 13322). This is the area from Leibs Island to Mud Island. The stationing is referenced from the plans titled "Buckeye Lake State Park Embankment Mapping" dated April 1990, by Dodson-Lindblom Associates, Inc. A visual inspection was performed from the centerline of the dam to the stone and masonry wall located on the upstream slope and on the downstream slope. The visual inspection included observation of structures such as the stone and masonry wall, sidewalks, trees, decks, and docks to observe the affects on the dam.

The observed portion of the stone wall located on the upstream slope was deteriorated. There were several areas with displaced stones and several areas where the wall was leaning toward the lake. A portion of the stone and masonry wall had been capped with concrete.

The downstream slope contains residential houses. On the average, houses along the downstream slope are spaced approximately 10 to 15 feet apart. Basements and foundations extend into the downstream slope almost to the centerline of the dam. Large trees (30+ inches in diameter) were noted along the downstream slope. Trees on the downstream slope are on private property and not numbered.

Several trees varying in diameter from 0.5 foot to 3.0 feet were noted all along the West Bank. Also, some trees had been removed and depressions remained on the embankment in these locations. Trees along the upstream slope have an aluminum numbered tag. Some numbers have been referenced in the observations.

It was impossible to inspect many areas of the dam due to decks, patios, landscaping, and other structures located on the state's portion of the dam.

OBSERVATIONS:

Station 10+00 to 11+00:
A low area/sink hole approximately 1 foot in diameter was noted near station 10+65. A sinkhole was noted near station 10+90 behind the concrete wall, which was not noted in 2005 safety inspection.

Station 11+00 to 12+00:
A large tree still existed near station 11+90. The upstream stone wall was leaning towards lakeside. A low area at station 11+28 was noted adjacent to the upstream stone-wall and measured 5 feet x 2 feet. ***A digital photo was taken of this area and is included in this report.***

Station 12+00 to 13+00:
A low area next to the stone wall was noted at station 12+75. The area was approximately 18 inches in diameter and 4 inches deep. Two trees noted on the 1990 drawings had been removed.

Station 13+00 to 14+00:
Three trees that were noted on the 1990 Dodson–Lindblom plans had been removed.
Condition in this area appears unchanged.

Station 14+00 to 15+00:
The upstream embankment behind the stone wall was 0.5 foot lower than the top of the wall between stations 14+25 and 14+65. A tree along the wall had been removed. Condition in this section appears unchanged.

Station 15+00 to 16+00:
Near station 15+05, a 2-foot depression was noted next to the wall. Brick pavers were noted along the upstream slope. The embankment around the perimeter of the pavers was low. At house number 12530, a low area was noted adjacent to the wall. Sidewalk elevation is below top of wall elevation. ***A digital photo of this area was taken and is included in this report.***

Station 16+00 to 17+00:
A new house had been constructed on the downstream slope. One digital photo was taken along the downstream slope. Upstream wall is leaning towards lake and 18 inches of undermining was noted at the waterline. ***Two digital photos were taken and are included in this report.***

Station 17+00 to 18+00:
A wet area approximately 4 feet in diameter that had been observed 12 to 15 feet beyond the downstream toe near station 18+00 in 2005 was dry during this inspection. According to the plans, a tree had been located in this area. A low area was noted adjacent to the wall that measured 7-inches deep, 30-inches wide, and 10-feet long. ***One digital photo was taken in this area and is included in this report.***

Station 18+00 to 19+00:
Between station 18+00 and 18+50, a new house had been constructed on the downstream slope. Two trees near station 18+50 had been removed. A new tree was noted during the 2010 inspection on the upstream slope. Park manager informed property owner that tree must be removed.

Station 19+00 to 20+00:
A 4-inch-diameter water well was noted on the downstream slope. Iron deposits were noted on the well casing. During the 2010 inspection, the outside of the well casing was wet. A tree had been removed at station 19+25. A drain had been added on the downstream slope. Slope appeared dry. ***Three digital photos were taken along the downstream slope during this inspection.***

Station 20+00 to 21+00:
At station 20+50 (house number 12636), the resident stated that considerable fill material had been placed in front of their house to raise the elevation of the upstream portion of the slope in 2000. A tree had been removed near station 20+25 and the stump had been removed by the 2010 inspection. A 24-inch-diameter depression was observed near station 20+50. The downstream slope was dry. ***A digital photo was taken of this area and is included in this report.***

Station 21+00 to 22+00:
During the 2010 dam inspection the fill behind the upstream slope masonry wall was 7 inches below the top, 18 inches out from wall, and 10 feet in length. Tree tag nos. 16 and 17 still existed on the upstream slope.

Station 22+00 to 23+00:
A tree was noted at station 22+90 during the 2005 inspection. During the 2010 inspection, the tree tag no.18 had been removed and the upstream slope had been covered with patio pavers. ***A digital photo was taken of this area and is included in this report.***

Station 23+00 to 24+00:
A tree had been removed near station 23+45. Tree tag no. 19 still existed during the 2010 inspection. ***A digital photo was taken of this area and is included in this report.***

Station 24+00 to 25+00:
A large deck covered the upstream slope from station 24+60 to 24+85. A concrete cap was noted on the upstream stone wall. During the 2010 inspection a sink hole was noted that measured 5 inched deep, 7 feet long, and 8 inches wide.

Station 25+00 to 26+00:
Along this section of the downstream slope, two trees had been removed near station 25+50. Two trees tag nos. 21 & 22 still exist on the upstream slope. No change during the 2010 inspection.

Station 26+00 to 27+00:
A tree tagged no. 24 had been removed at station 26+25. Fill was 3 inches below the stone wall.

Station 27+00 to 28+00:
A low area that was 1.0 foot in diameter and 0.5 foot low was observed near station 27+50 and adjacent to the stone wall. A concrete wall observed on the downstream slope at station 27+75 was leaning away from the dam. In was noted during the 2010 inspection that tree tag no. 26 still exists and the 2005 observations were unchanged.

Station 28+00 to 29+00:
The upstream slope is covered with concrete pavers. We were unable to inspect the upstream slope. ***A digital photo was taken of the pavers on the upstream slope.*** No seepage was noted on the downstream slope

Station 29+00 to 30+00:
A low area 6 inches below the top of the wall was noted near station 29+50. Two trees tag nos. 30 & 31 were noted on the upstream slope.

Station 30+00 to 31+00:
Near station 30+50, a low area was noted approximately 1 foot in diameter and 6 to 8 inches deep. Another low area, noted at station 30+75, was 7 feet from the upstream wall, approximately 3 feet in diameter, and 14 inches deep. ***A digital photo was taken of this area and is included in this report.***

Station 31+00 to 32+00:
Near station 31+75, a hole less than 1 foot in diameter was observed next to the stone and masonary wall. Sinkholes less than 0.5 foot in diameter were observed near station 31+25. Rodent burrows were noted on the downstream slope. Tree tag no. 35 was noted on the upstream slope.

Station 32+00 to 33+00:
A 2-foot-diameter low area was noted along this section of the upstream embankment next to the stone wall. Tree tag no. 36 was observed on the upstream slope. ***A digital photo was taken of this area and is included in this report.***

Station 33+00 to 34+00:
Tree tag no. 37 was observed. Three new trees had been planted along the crest/upstream slope in this section since the last inspection dam safety inspection.

Station 34+00 to 35+00:
Trees tag nos. 38, 39, and 40 were observed along the upstream slope. ***A digital photo was taken of this area and is included in this report.***

Station 35+00 to 36+00:
A new house had been constructed along the downstream slope. Trees tag nos. 41 and 42 were noted on the upstream slope of the embankment. At approximate station 35+60, the elevation of the upstream embankment was a 0.5 foot below the top of the stone wall. Sinkholes were observed near station 35+85 in the upstream embankment adjacent to the stone wall. ***A digital photo was taken of this area and is included in this report.***

Station 36+00 to 37+00:
Fill on the upstream slope was approximately 6-inches lower than the stone wall. Voids were observed under the concrete slab on the downstream slope near station 36+25. A wet area approximately 25 feet beyond the downstream toe was observed. The area measured 14 feet by 10 feet and had aquatic vegetation and standing water. ***A photo was taken on the wet area.*** Trees tag nos. 43 and 44 were noted on the upstream.

Station 37+00 to 38+00:
Trees tag nos. 45, 46, and 47 were noted on the upstream slope. Trees were also noted on the downstream slope. Decks covered a large portion of the upstream slope.

Station 38+00 to 39+00:
Four trees tag nos. 48, 49,50, and 51 were noted along this section. A concrete slab near station 38+50 prevented a close inspection of the entire upstream slope. The downstream slope contained a vertical wall. The downstream slope and toe were dry.

Station 39+00 to 40+00:
Trees and docks lined this section of the upstream slope. This station of the upstream slope has been modified/excavated to install a deck with pavers. ***Digital photos were taken of this area and have been included.***

Station 40+00 to 41+00:
A resident located near station 40+00 (house number 12938) stated that the area near the stone wall (upstream embankment) drops in elevation every year. Also, the resident stated that material is added each year to retain the elevation of the stone wall. Trees tag nos. 52, 53, and 54 were observed. Downstream slope and toe were dry.

Station 41+00 to 42+00:
Near station 41+45, a tree had been removed. The upstream stonewall was leaning towards the lake approximately 3 inches from the original centerline.

Station 41+00 to 42+00:
A small sinkhole was noted along the upstream slope at approximate station 41+50. The sidewalk contained a 2-inch crack and fill along the upstream slope was 6 inches below top of the stone wall.

Station 42+00 to 43+00:
Trees and a deck were noted on the slope. Trees tag nos. 56, 57, and 58 still exist in this section. Fill was approximately 8 inches below the top of the wall. ***A digital photo was taken of this area and is included in this report.***

Station 43+00 to 44+00:
Fill was approximately 8 inches below the upstream wall. A 2-inch hole approximately 12 inches deep and 18 inches from the stone wall was observed. ***A digital photo was taken of this area.***

Station 44+00 to 45+00:
A new house was constructed at station 44+00. A low area, 18 inches deep, was noted along the stone wall. A tree had been removed near station 44+50. Trees tag nos. 60 & 61 were noted in this section.

Station 45+00 to 46+00:
Two trees had been planted in this area since our last dam safety inspection. A deck was located along much of this section of the upstream slope. A depression was noted along the stone wall at station 45+75. The fill along the upstream slope was 3 inches below the stone wall.

Station 46+00 to 47+00:
One tree tag no. 66 was noted along this station. Sinkholes less than 0.5 foot in diameter were observed adjacent to the stone wall at station 46+50.

Station 47+00 to 48+00:
A sinkhole was observed along the stone wall at station 47+25. A number of trees were noted in this area. Trees tag nos. 67, 68, 69, and 70 were noted along this section.

Station 48+00 to 49+00:
A large tree was noted on the downstream slope at station 49+00. A deck covered a large portion of the upstream slope. Trees tag nos. 71, 72, and 73 were noted in this section.

Station 49+00 to 50+00:
A deck covered a large portion of this area. An addition had been added to the house at station 49+25. Trees tag nos. 74, 75, and 76 were noted in this section.

Station 50+00 to 51+00:
A depression 0.5 foot deep was observed along the stone wall at station 50+25. A tree had been removed near station 50+50. Two survey monuments were observed on the downstream slope near station 50+80. Trees tag nos. 77 & 78 were noted in this section. There is no house located on the downstream slope. ***A digital photo was taken of this area and is included in this report.***

Station 51+00 to 52+00:
A recently constructed sidewalk was observed. The older portion of the sidewalk that leads to the stone wall had collapsed. A large tree tag no. 79 was noted in this section. Near station 51+50 on the downstream slope a large tree was noted. ***A digital photo was taken of this area and is included.***

Station 52+00 to 53+00:
One large tree tag no. 80 was noted on the upstream portion of the embankment. Fill material along the upstream slope was 3 inches below the top of the stone wall. Area was unchanged from last inspection.

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Station 53+00 to 54+00:
Decks covered over half of this station. Two trees tag nos. 81 and 82 were noted on the upstream slope. The downstream slope was dry.

Station 54+00 to 55+00:
Near station 54+50, the stone wall was observed to be tilting towards the lake. A depression was noted at station 54+75 on the downstream slope. Trees tag nos. 83 and 84 were noted along this section.

Station 55+00 to 56+00:
At an approximate station of 55+50, a depression of 0.5 foot deep was observed along the stone wall. Fill material was approximately 6-inches below the top of the stone wall. Four trees tag nos. 85, 86, 87, and 88 were noted along the upstream slope.

Station 56+00 to 57+00:
A 2-foot-diameter by 8-inch-deep depression was noted at station 57+75 adjacent to the stone wall. This section contained voids less than 0.5 foot in diameter along the stone wall. Three large trees tag nos. 89, 90, and 91 were noted along this portion of the upstream slope. Fill material was 3 inches below the top of the stone wall.

Station 57+00 to 58+00:
A 2-foot-diameter by 10-inch-deep depression was observed near station 57+85. Another low area approximately 1 foot in diameter was observed near station 57+75. Trees tag nos. 92 & 94 were located along this section. Tree tag no. 93 had been removed.

Station 58+00 to 59+00:
Fill was 6 inches below the top of the stone wall. A large tree tag no. 95 was noted in this section. A sinkhole near station 58+68, that was 13-inches in diameter and 3-feet deep was observed adjacent to the upstream stone wall. ***A digital photo was taken of this sinkhole and has been included in this report.***

Station 59+00 to 60+00:
The upstream embankment contained low areas all along the stone wall. A section of the stone wall was broken and displaced near station 59+40. The sidewalk (station 59+10) that extended from the crest to the stone wall was broken and displaced.

Station 59+00 to 60+00:
Trees tag nos. 96 and 97 were located along this section. Fill material was 8 inches below the top of the stone wall. ***Digital photographs were taken of this area and are included in the report.***

Station 60+00 to 61+00:
Three trees tag nos. 98, 99, and 100 were noted on the upstream slope. The upstream embankment contained a low area (0.5 foot deep) near the stone wall at an approximate station of 60+15. ***A digital photo was taken of this area and is included in this report.***

Station 61+00 to 62+00:
A large tree approximately 6-feet in diameter and tag no. 101 was noted along the upstream slope. Large decks prevented a close inspection of the upstream slope.

Station 62+00 to 63+00:
Trees and decks were noted along this section upstream slope. A close inspection could not be performed.

Station 63+00 to 64+00
No trees were observed along this section. A portion of the sheet-pile wall had been replaced.

Station 64+00 to 65+00
No problems were noted. New sheet piling had been installed along the upstream slope. ***A digital photo was taken at this station and included in the report.***

DISCUSSION:

Trees should not be permitted on embankment surfaces. Extensive root systems can provide seepage paths for water. Trees that blow down or fall over can leave large holes in the embankment surface that will weaken the embankment and can lead to increased erosion. Tree growth adjacent to concrete walls and structures may eventually cause damage to the concrete and should be removed. Stumps and root balls of cut trees should be removed so vegetation can be established and the surface mowed. All woody material (roots) must be removed and the cavity filled with well-compacted fill material and grass vegetation established. *A number of new trees had been planted along the upstream slope, since the last dam safety inspection.*

Houses, docks, gazebos, and other structures should not be built into a dam. A house foundation in the downstream embankment reduces the seepage path and removes valuable fill material. Other excavations into the embankment for construction of docks, gazebos, light poles, garages, patios, and other structures also reduce the safety of the dam and make proper inspection very difficult, if not impossible. All of these issues create stability problems for the embankment that could lead to dam failure.

Depressions are sunken areas of the embankment surface. They may be created during construction, or may be caused by decay of buried organic material (tree roots), internal erosion of the embankment, or settlement (consolidation) of the embankment or its foundation. Internal erosion and excessive settlement can lead to dam failure.

The location of a number of the low areas and their proximity to the stone and masonry wall indicates that loss of embankment fill due to erosion has taken place in a number of areas. Continued loss of this earthfill could lead to failure of the wall and the dam.

Seepage of earthen dams is a concern that should always be monitored. Seepage from the dam must be controlled to prevent stability and maintenance problems. The location of a number of the low areas and their proximity indicates that internal erosion has taken place in a number of areas. Internal erosion that is not corrected will weaken the embankment and could possibly lead to failure of the embankment.

When the dam was originally constructed, both the West & North Embankments would have had typical embankment cross-sections and it would be easy to recognize the areas that need to be inspected and maintained. However, since construction, many modifications have taken place that make the extent of the dam less obvious. These modifications include constructing houses on the downstream slope, planting trees and shrubs, and installing boat lifts. The OMI manual must provide specific instructions for inspecting the entire dam, especially the downstream slope.

In 1997, Paul C. Rizzo Associates, Inc., completed the "Buckeye Lake Dam Stability Study". Included in this site visit are sections 5.0 Evaluation of Dam Safety Issues and 6.0 Conclusions, which outline what is needed to bring the dam into safety standards to pass the required 100% of the Probable Maximum Flood (PMF).

REQUIREMENTS:

1. This dam must have an operation, maintenance, and inspection manual (OM&I) and an emergency action plan (EAP) in accordance with OAC Rule 1501:21-21-04. Prepare an OM&I and an EAP including an inundation map. Guidelines for the preparation of these documents can be downloaded from the Division of Water's web site, or a copy can be mailed to you upon request.

2. The dam's discharge/storage capacity must be sufficient to safely pass the required design flood. Prepare plans and specifications as necessary to increase the discharge/storage capacity to pass the required design flood. In accordance with OAC Rule 1501:21-13-02, the minimum design flood for Class I dams is 100% of the Probable Maximum Flood or the critical flood.

3. Repair the stone wall along the entire West Bank from Mud Island to Leibs Island. Also, repair the noted sinkholes and low areas with compacted clay material and establish a dense grass cover. Remedial measures must be taken immediately to stabilize the largest hole observed at station 53+80. See the "Ground Cover" fact sheet included in this section for additional information.

4. Monitor the depressions (low areas) along the upstream portion of the embankment for additional signs of settlement until repairs can be made.

5. Remove the trees and root systems along the upstream portion of the embankment. Replace the voids in the embankment with compacted fill material and establish a dense grass cover. See the "Trees and Brush" fact sheet included in this section for additional information.

6. Remove all landscaping and structures from the entire dam. This will facilitate proper inspection and maintenance of the earthfill embankment. See the "Trees and Brush" fact sheet included in this section for additional information.

Dena C. Barnhouse 4-5-11

Dena Barnhouse, P.E. Date
Project Manager
Dam Safety Engineering Program
Division of Soil & Water Resources

Peter George 4/5/2011

Peter George, P.E. Date
Project Manager
Dam Safety Engineering Program
Division of Soil & Water Resources

Paul C. Rizzo Associates, Inc.
CONSULTANTS

May 5, 1997

Project No. 95-1590

Mr. Gary Harsanye, P.E.
Ohio Department of Natural Resources
Division of Engineering
1889 Fountain Square Court, Building F-3
Columbus, Ohio 43224-1331

TRANSMITTAL
BUCKEYE LAKE DAM STABILITY STUDY
BUCKEYE LAKE STATE PARK
FAIRFIELD, LICKING, AND PERRY COUNTIES, OHIO
DNR 736 730-96-034

Dear Mr. Harsanye:

Paul C. Rizzo Associates, Inc. respectfully submits the Buckeye Lake Dam Stability Study (Study), DNR 736 730-96-034 for the Buckeye Lake Dam located in the Buckeye Lake State Park, Fairfield, Licking, and Perry Counties, Ohio. In accordance with Section B, Design Service of our Contract, ten copies of the Study are enclosed for your distribution and use.

Paul C. Rizzo Associates appreciates this opportunity to work with the Ohio Department of Natural Resources (ODNR) Division of Engineering on this project. We look forward to our continuing our association with the ODNR. If you have any questions or require additional information, please do not hesitate to contact us.

Very truly yours,
Paul C. Rizzo Associates

Paul C. Rizzo, Ph.D., P.E.
President

Richard A. Isaac, P.E.
Project Manager

PCR/RAI/and/mfs
Enclosures

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NEWARK, DE COLUMBUS, OH MT. PLEASANT, SC COVINGTON, KY

REPORT

BUCKEYE LAKE DAM STABILITY STUDY
BUCKEYE LAKE STATE PARK
FAIRFIELD, LICKING, AND PERRY COUNTIES, OHIO
DNR 736 730-96-034

PROJECT NO. 95-1590
MAY 1997

PREPARED FOR:
OHIO DEPARTMENT OF NATURAL RESOURCES
COLUMBUS, OHIO

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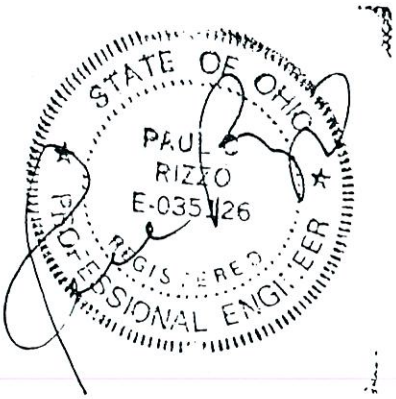

5.0 EVALUATION OF DAM SAFETY ISSUES

This Section deals with three primary issues related to the long term safety of Buckeye Lake Dam. While these issues have an indirect impact on stability, more importantly, they have a direct impact on piping, overtopping and/or the behavior of the new and existing retaining walls. Hence, there is a need to address these issues during and subsequent to Phase III remediation.

5.1 TREES AND LANDSCAPING ON THE DAM CREST

The crest of the Dam has been "abused" by allowing trees, some having diameters in excess of 30 inches, to grow on the crest and downstream slope. Trees have a direct impact on dam safety from the perspective that root structure provides pathways for piping to develop and overturned trees can cause large voids to develop, leading to overtopping during rain events with high pool levels. Consequently, we have the following recommendations pertaining to trees, landscaping, and hardscaping.

1. All trees and stumps, regardless of diameter, that are rooted in the crest or in the downstream slope should be removed. Stumps should be removed and roots should be "chased" to a point where the diameter is less than two inches and removed. Root grindings and cuttings should be removed from the stump excavation to the maximum degree practical. The stump excavation should be backfilled with clay compacted to 95 percent of the maximum dry density as determined by the Standard Proctor Method and within two percent of the optimum moisture content on the wet side.

2. Small diameter trees having a maximum diameter on the order of two (2) inches measured at a height of 54 inches can be placed and maintained in planters that do not allow roots to penetrate into the Dam crest or downstream slope. Plantings on the crest and downstream slope should be limited to grass and small flowers. Shrubbery and small bushes and trees should be prohibited.

3. A ten foot wide clear buffer zone on the upstream side of the crest and parallel to the sheet pile wall should be cleared and maintained free of all hardscaping except for the following permissible materials:

   - o Un-cemented stone chips
   - o Grass and flowers
   - o Sand and gravel
   - o Concrete pavers (less than 2' by 2')
   - o Wood mulch
   - o Landscape timbers

Wood decks, concrete paving, brick paving, and asphalt paving are not permissible materials in the buffer zone.

All utility conduits set in the buffer zone should be encased in concrete. All water spouting should be constructed to drain to the downstream side of the Dam in such a manner that erosion does not occur. No penetrations or attachments to the new or existing wall should be allowed. All existing attachments to the existing wall should be removed and all penetrations should be sealed.

5.2 BOAT DOCKS

We have observed a large number of boat docks on the upstream side of the Dam. Some of these are on piles and others are of cantilever construction. In addition, we noticed that some docks are of suspended cantilever design with one end of the dock attached to the existing sheetpile wall. Also, we observed a boat house, lifting davits and various types of boat lifts either partially supported by the existing wall or supported on foundations embedded in the crest of the Dam. We believe that none of these features was contemplated in the original design of the existing wall or Dam. As these features are a potential threat to dam safety, most should be removed and replaced with designs that are not a threat to dam safety. In addition, new and/or replacement boat docks will hinder the ability to effectively and economically perform future inspections, routine maintenance and repairs to the new sheetpile wall and Dam. We have the following specific comments regarding docking systems:

5.2.1 Pile-Supported Docks

Pile Supported Docks are acceptable so long as they do not attach to the existing or new sheetpile wall and no piles are driven into the Dam. Stairs or ramps leading between the dock and the crest should not be attached to or penetrate through the sheetpile wall. Pile-Supported Docks should be by permit only as issued by the ODNR.

5.2.2 Floating Docks

Floating Docks are acceptable so long as they do not attach to the existing or new sheetpile wall. Stairs or ramps leading between the dock and the crest should not be attached to or penetrate through the sheetpile wall. Floating Docks should be by permit only as issued by the ODNR.

5.2.3 Lifting Davits

Lifting Davits with foundations embedded in the crest should be prohibited. Temporary lifting Davits installed offshore of the existing or new sheetpile wall are acceptable so long as they do not attach to the existing or new sheetpile wall. Lifting Davits should be by permit only as issued by the ODNR.

5.2.4 Non-Suspended Cantilever Docks

Non-Suspended Cantilever Docks are docks which have a pair of anchor blocks embedded in the Dam crest and a structural steel frame that cantilevers out over the sheetpile wall into the Lake. Lifting hoists are occasionally installed at the offshore end or along the sides of the structural steel cantilever. Also, some of the cantilevers are supported with a pile strut driven into the Lake bottom to resist a portion of the vertical load and decrease the cantilever moment.

We have studied the design of this type of dock and have the following comments and recommendations:

1. From a foundation engineering perspective, and excluding considerations of dam safety, this type of dock is technically feasible. We would note that, depending on the length of the cantilever, the location of the lifting hoists, the size of the boat, and the use (or non-use) of a vertical pile strut, it may be necessary to found the anchor blocks on piles. We suspect that none of the existing Cantilever Docks include pile-supported anchor blocks.

2. From a dam safety perspective, we view Non-Suspended Cantilever Docks with anchor blocks embedded in the crest as an "abuse" of the Dam much like a house on the downstream slope, trees, etc. Therefore, this type of dock with its

concrete anchor block foundations embedded in the crest is unacceptable. We list below the following specific reasons:

- The anchor block encroaches on the integrity of the Dam. The interface between the concrete and the surrounding earth provides a preferred pathway for seepage and piping to occur.

- Docks and foundations can cause difficulty in performing inspections, maintenance, and remedial and emergency repairs of the sheet pile wall.

- Many of the existing anchor block foundations attach to the existing sheetpile wall, thus imparting a load to the wall for which it was not designed. Also, the blocks tend to increase the lateral earth pressure acting on the sheetpile wall, thus increasing the stresses in the wall and increasing the load in the tie-back anchors. These blocks should be removed and the excavation backfilled with impervious soil compacted to 95 percent of the maximum dry density as determined with the Standard Proctor method and within two percent of the optimum moisture content on the wet side.

- Even if new blocks were to be constructed away from the new wall and on piles, the potential for piping, increased lateral earth pressures and increased anchor forces still exist. Furthermore, the installation of piles, either by driving or pre-drilling, can affect the integrity of the new wall and the Dam. Piling also increases the potential for piping at depths below the normal Lake level.

3. It is our conclusion that while Non-Suspended Cantilever Docks are technically acceptable from a foundation engineering perspective, particularly with pile supported anchor blocks, they are not acceptable from a dam safety perspective. Existing docks of this type should be removed from the Dam and no new cantilever docks should be permitted.

5.2.2 Floating Docks

Floating Docks are acceptable so long as they do not attach to the existing or new sheetpile wall. Stairs or ramps leading between the dock and the crest should not be attached to or penetrate through the sheetpile wall. Floating Docks should be by permit only as issued by the ODNR.

5.2.3 Lifting Davits

Lifting Davits with foundations embedded in the crest should be prohibited. Temporary lifting Davits installed offshore of the existing or new sheetpile wall are acceptable so long as they do not attach to the existing or new sheetpile wall. Lifting Davits should be by permit only as issued by the ODNR.

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We have studied the design of this type of dock and have the following comments and recommendations:

1. From a foundation engineering perspective, and excluding considerations of dam safety, this type of dock is technically feasible. We would note that, depending on the length of the cantilever, the location of the lifting hoists, the size of the boat, and the use (or non-use) of a vertical pile strut, it may be necessary to found the anchor blocks on piles. We suspect that none of the existing Cantilever Docks include pile-supported anchor blocks.

2. From a dam safety perspective, we view Non-Suspended Cantilever Docks with anchor blocks embedded in the crest as an "abuse" of the Dam much like a house on the downstream slope, trees, etc. Therefore, this type of dock with its

5.2.5 Suspended Cantilever Docks

The Suspended Cantilever Docks generally consist of a deck with the shore end supported on the existing wall (and presumably on the new wall) and the offshore end supported by a suspension cable tied to a vertical column inserted into the crest of the Dam. As the shore end of this type of dock is supported on the wall and the vertical column penetrates the Dam, we recommend that this type of dock be removed and prohibited in the future.

5.2.6 Boat Houses

Boat houses should be considered on a case-by-case basis, recognizing all of the prohibitions and restrictions previously recommended. Quite frankly, we have difficulty imagining how a boat house could be designed considering all of the above. Nevertheless, we would reserve judgment until an actual design is presented to the ODNR for permitting. Indeed , boat houses that penetrate or cut into the Dam embankment or attach to the sheetpile wall should be removed and not permitted in the future.

5.3 New and Remodeled Structures on the Downstream Slope

As discussed in the context of this Report, we view the construction of homes and buildings on the downstream slope and on the crest as an "abuse" of the Dam. Our stability analysis indicates that the this type of construction impacts on the safety of the Dam. but admittedly, the margin of safety against catastrophic stability failure for the as-built construction for both the "Before" and "After" cases is satisfactory.

However, the most critical aspect of construction of these homes on the downstream slope and crest is the period of time when the excavation is open and the basement walls are being constructed. It is during this period of time that the Dam is most vulnerable to a breach and/or piping. The entire Lake is in jeopardy, and therefore, construction should be allowed to proceed only under the following conditions:

1. Local authorities should be encouraged to designate the slope and crest on the Dam as a Special Zone with respect to Building Permits and Building Regulations. Local building inspection agencies should expect to incur increased costs to monitor the construction in this Special Zone.

2. All new construction on the slope and on the crest, other than landscaping, should require a Special Building Permit based on drawings and specifications prepared and stamped by a registered professional geotechnical engineer knowledgeable and experienced in Dam construction, deep excavations, slope stability, and sheeting and shoring.

3. All new excavations on the downstream slope and on the crest, other than that associated with landscaping, should be temporarily shored using a design prepared and stamped by a registered professional geotechnical engineer.

4. New foundations and basement walls should be cast in place reinforced or reinforced concrete masonry units with vertical reinforcing steel placed in the voids and horizontal reinforcing placed in the mortar joints between courses. Foundations and basement walls should be designed by a registered professional geotechnical engineer knowledgeable and experienced in Dam construction, deep excavations, slope stability, and sheeting and shoring.

5. All excavation work and below-grade construction should be under the supervision of a registered professional geotechnical engineer following a Construction Quality Assurance (CQA) Plan approved by the local building authorities. The monitoring should be on a full time basis during the time that the excavation is open. The CQA Plan should include an emergency response plan in the event that breaching or piping begins to occur or if a storm is predicted that will cause the Lake level to rise significantly.

6. During construction of a basement excavation and basement walls, sand or sand bags should be stockpiled on site as part of an emergency response plan to mitigate the potential for a gross breach and/or piping failure.

6.0 CONCLUSIONS

Considering the results of the work performed to date by others, the 1996 field investigation and laboratory testing program, an extensive analysis of the properties of the Embankment Fill and Foundation Till, and a comprehensive stability analysis, we conclude the following:

- Based on the field observations, the relatively low head, the long seepage paths, the age of the Dam and the laboratory testing program, specifically, the properties of the soils comprising the Embankment Fill, we conclude that while there may be occasional zones of localized seepage, there is no evidence to indicate that raising the crest a few feet or a higher Lake level associated with temporary storage of the PMF will lead to a catastrophic piping failure.

- Raising the Dam crest a few feet and postulating a higher Lake level to temporarily store a PMF will not lead to stability failure of the downstream slope of the Dam. This conclusion also applies to those sections of the Dam where the downstream slope has been violated with the emplacement of a structure.

- The stability of the downstream slope of the Dam (with or without an emplaced structure) with the raised crest, postulated PMF and downstream flooding is marginally impacted, but still safe. This same conclusion applies under a postulated earthquake condition.

- The factors of safety against stability failure reported herein are substantially higher than those reported by Dodson-Lindblom Associates (DLA, 1987) and W.S. Gardner and Associates (WSGA, 1995). As all of WSGA's work is based on soil properties and assumptions regarding the phreatic surface reported by DLA; one would expect their results to be practically the same as reported by DLA. Our factors of safety are higher for the following reasons:

- Based on new laboratory test data, coupled with a reinterpretation of previous data, we find the shear strength available to resist catastrophic failure of the Embankment Fill and the Foundation Till to be higher than considered in earlier analysis.

- Based on new data obtained during this investigation from sealed Piezometers and from laboratory tests to measure permeability, we estimate that the phreatic surface will be substantially lower under the postulated PMF condition than considered in previous analysis.

We observe that the Dam has been "abused" from the perspective that the downstream toe has been excavated and replaced with structures and large trees have been permitted to grow on the crest and on the slopes. We have extensive experience evaluating the stability and safety of dams throughout the United States and, we find the "abuses" to the Buckeye Lake Dam to be some of the worst ever witnessed. We make a series of recommendations pertaining to these "abuses" as well as the matter of boat docks on the upstream side of existing and new sheet pile walls. We also conclude and advise that while the popular Non-Suspended Cantilever Docks are technically acceptable from a foundation engineering perspective, particularly with pile supported anchor blocks, they are not acceptable from a dam safety perspective. Existing docks of this type should be removed from the Dam and no new Cantilever Docks should be permitted.

Finally, we conclude that there is no reason, from a geotechnical engineering perspective, why the proposed Phase III Remediation Plan should not proceed following the normal practice of engineering and construction for dams, including a comprehensive quality control/quality assurance program.

Respectfully submitted,
Paul C. Rizzo Associates

Dr. Paul C. Rizzo, P.E.
Principal-in-Charge

Richard A. Isaac, P.E.
Project Manager

PCR/mfs

Section 2

Photograph No. 1:

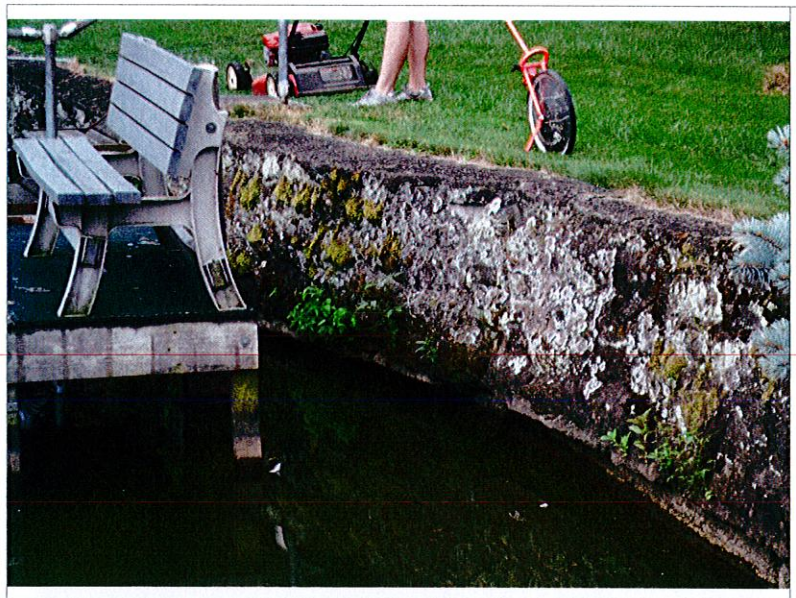
Stations: 11+00 to 12+00

Photograph No. 2:

Stations: 15+00 to 16+00

Photograph No. 3:

Stations: 16+00 to 17+00



Photograph No. 4:

Stations: 16+00 to 17+00

Photograph No. 5:

Stations: 17+00 to 18+00

Photograph No. 6:

Stations: 19+00 to 20+00

Photograph No. 7:

Stations: 19+00 to 20+00

Photograph No. 8:

Stations: 19+00 to 20+00

Photograph No. 9:

Stations: 20+00 to 21+00

Photograph No. 10:

Stations: 22+00 to 23+00

Photograph No. 11:

Stations: 23+00 to 24+00

Photograph No. 12:

Stations: 28+00 to 29+00

Photograph No. 13:

Stations: 30+00 to 31+00

Photograph No. 14:

Stations: 32+00 to 33+00

Photograph No. 15:

Stations: 34+00 to 35+00

Photograph No. 16:

Stations: 35+00 to 36+00

Photograph No. 17:

Stations: 36+00 to 37+00

Photograph No. 18:

Stations: 36+05 to 37+00

Photograph No. 19:

Stations: 36+10 to 37+00

Photograph No. 20:

Stations: 39+00 to 40+00

Photograph No. 21:

Stations: 39+01 to 40+00

Photograph No. 22:

Stations: 41+00 to 42+00

Photograph No. 23:

Stations: 41+00 to 42+00

Photograph No. 24:

Stations: 41+05 to 42+00

Photograph No. 25:

Stations: 42+00 to 43+00

Photograph No. 26:

Stations: 50+00 to 51+00

Photograph No. 27:

Stations: 51+00 to 52+00

Photograph No. 28:

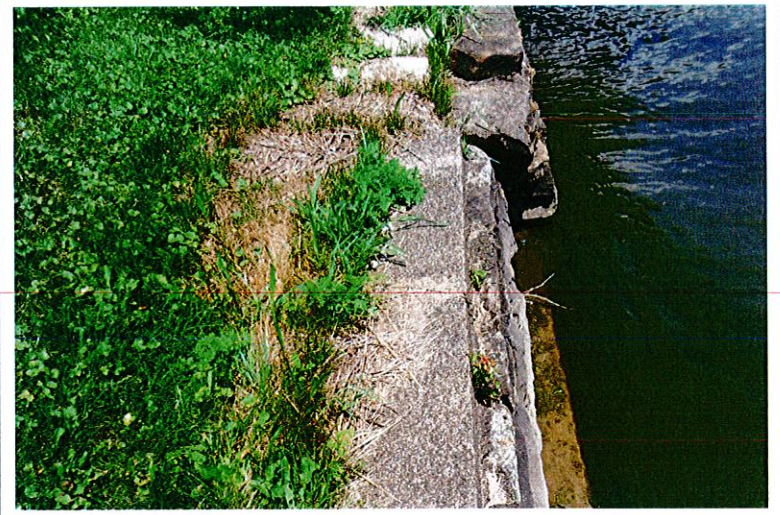
Stations: 58+00 to 59+00

Photograph No. 29:

Stations: 59+00 to 60+00

Photograph No. 30:

Stations: 59+00 to 60+00



Photograph No. 31:

Stations: 59+05 to 60+00

Photograph No. 32:

Stations: 60+00 to 61+00

Photograph No. 33:

Stations: 64+00 to 65+00

Dam Classification Checklist

Name of Dam: Buckeye Lake Dam
File Number: 9723-004
County: Fairfield & Licking
Date: June 24 & 25, 2010
Engineer: PMG

The classification of a dam is based on three factors: the dam's height, storage capacity, and potential downstream hazard. The height of the dam is the vertical distance from the crest to the downstream toe. The storage capacity is the volume of water that the dam can impound at the top of dam (crest) elevation. The downstream hazard consists of roads, buildings, homes, and other structures that would be damaged in the event of a dam failure. Potential for loss of life is also evaluated. Various dam failure scenarios must be considered, and they include failures when the dam is at normal pool level and failures during significant flood events. Each of the three factors is evaluated, and the final classification of the dam is based on the highest individual factor. Class I is the highest and Class IV is the lowest. The classification of a dam can change based on future development along the downstream channel.

This checklist is intended to establish or verify the appropriate classification in accordance with the Ohio Administrative Code – it does not necessarily show all potential hazards or the full extent of inundation. In addition, elevations are estimated.

HEIGHT CLASSIFICATION

Dam Height = 14.5 feet

____	> 60' - Class I
____	> 40' - Class II
____	> 25' - Class III
X	≤ 25' - Class IV

STORAGE CLASSIFICATION

Stor. Capacity (top of dam)= 20000 acre-feet

X	> 5000 acre-feet - Class I
____	> 500 acre-feet - Class II
____	> 50 acre-feet - Class III
____	≤ 50 acre-feet - Class IV

EXEMPT~NON-REGULATED

____	Height ≤ 6 feet
____	Storage ≤ 15 acre-feet
____	6 ft. < Height < 10 ft. & Stor. ≤ 50 ac-ft

Height Class: IV

Storage Class: I

Hazard Class (see next page): I

Estimated Population at Risk: (none 1-5 6-15 **16+**)

Final Class: I

Class Changed (Yes, **No**)

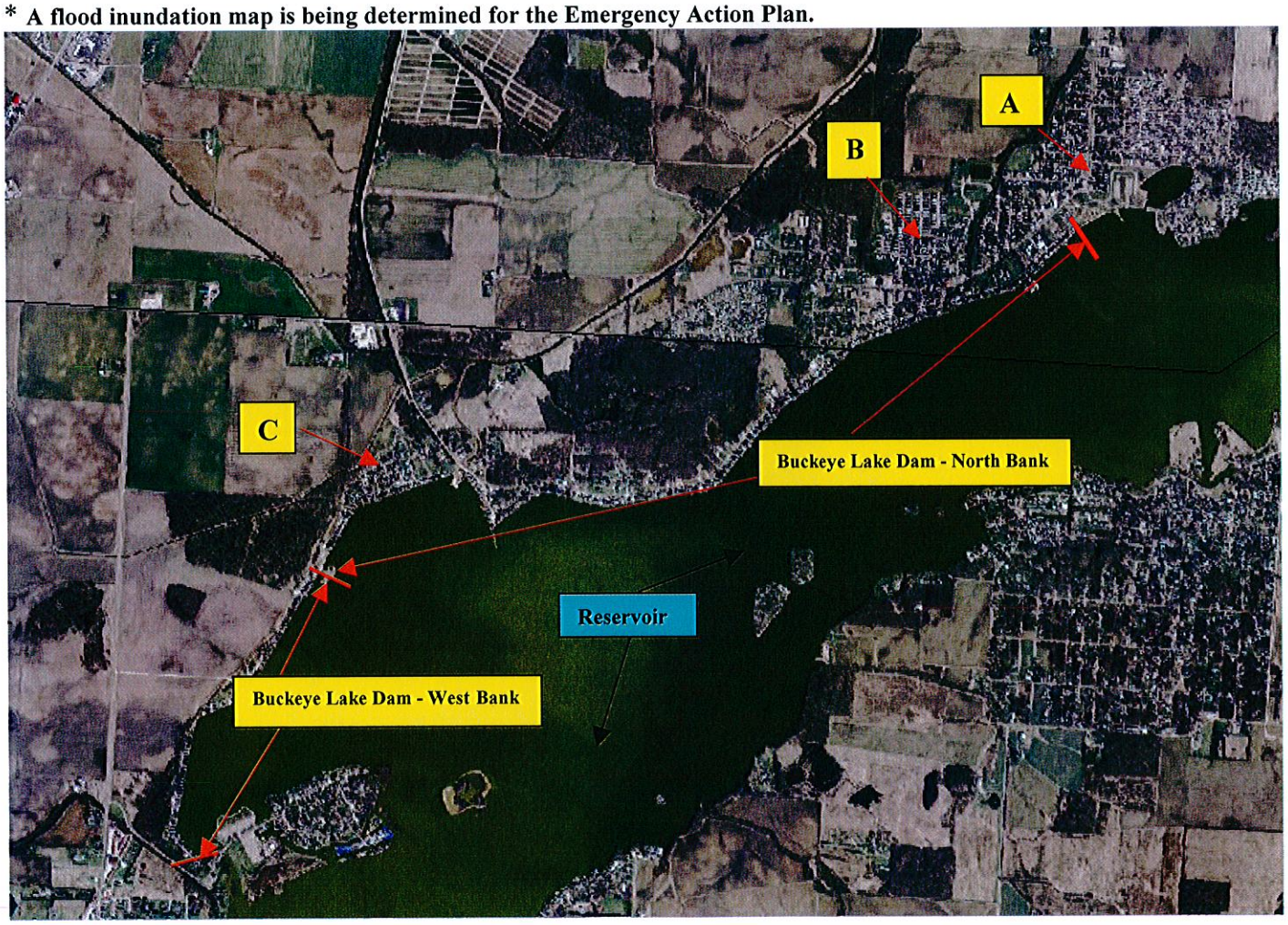
POTENTIAL DOWNSTREAM HAZARD

I	II					III		IV	-	-			
Probable loss of human life	Loss of public water supply or wastewater treatment facility, release of health hazardous waste	Flooding of structure or high-value property	Damage to high-value or Class I, II, III dam or levee	Damage to major road (US or state route), disruption of only access to residential or critical facility area	Damage to railroad or public utility	Damage to rural building, not otherwise high-valued property, or Class IV dam or levee	Damage to local road (county and township)	Loss restricted mainly to the dam or agricultural /rural land	No hazard to structure noted	*No hazard assessment; further investigation needed*	Distance downstream of reservoir to affected structure (feet)	Vertical distance from base of affected structure to adjacent grade (feet)	
											-	-	Reservoir
				A							50	1	S. R. 79
B	B	B			B	B	B				5	1-3	Village of Buckeye Lake
C	C	C			C	C	C				5	1-3	Lakeside Community

This checklist is intended to establish or verify the appropriate classification in accordance with the OAC – it does not necessarily show all potential hazards or the full extent of inundation.

Sketch of Developments Downstream of Dam

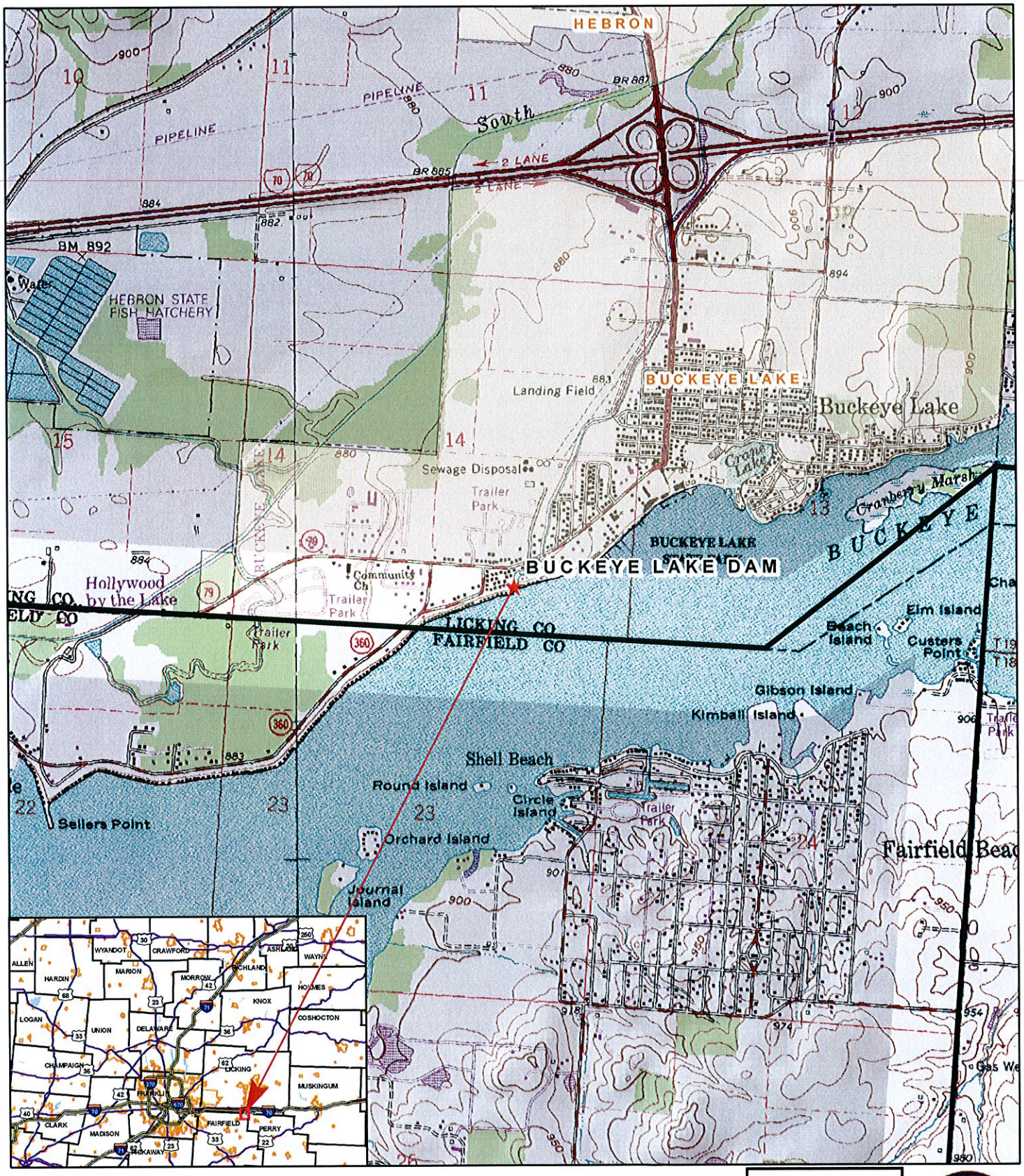
*** A flood inundation map is being determined for the Emergency Action Plan.**



Section 3

LOCATION MAP

BUCKEYE LAKE DAM - 9723-004



N
W E
S

Azimuth 315 degrees

Altitude 30.0000 degrees

Miles
0 0.1 0.2 0.4 0.6 0.8 1

Legend
- Dams
- Cities
- County Boundary
- Quad Boundary

DIVISION OF WATER

Feb 28, 2007

Dam Inventory Sheet

Name: BUCKEYE LAKE DAM
Reservoir:
File No: 9723-004
National #: OH00474
Permit No.: N/A
Class (Ht-Vol): I (IV - I)

Owner Information

Owner: ODNR, Division of Parks & Recreation
Address: 2045 Morse Road, Bldg. C
City: Columbus **State:** OH **Zip:** 43229-6693
Contact: **Phone No.:** 740/467-2690
Owner Type: Public, State
Multi-Dams: Yes: 59, Class I:39
Parcel No.:

Location Information

County: Licking
Township: Union
Stream: Tributary To South Fork Licking River
Nearest Affected Community: Buckeye Lake
Community's Distance from Dam (miles): 0.1
USGS Quad.: Thornville
Latitude Deg.: 39 **Min.:** 55 **Sec.:** 40
Longitude Deg.: 82 **Min.:** 29 **Sec.:** 18
USGS Basin No.: 05040006

Design/Construction Information

Designed By: State Of Ohio
Constructed By: State Of Ohio
Completed: 1832 **Plan Available:** YES **At:** ODNR, DIVISION OF WATER
Failure/Incident/Breach:

Structure Information

Purpose: Recreation, Public
Type of Impound.: Dam And Spillway
Type of Structure: Earthfill
Drainage Area (sq. miles): 44.1 **or (acres):** 28224

Embankment Data

Length (ft): 21700
Height (ft): 14.5
Top Width (ft): 3
Upstream Slope: 1H:1V
Downstream Slope: 2H:1V
Volume of Fill (cub. yds.): 375000

Spillway Outlet Works Data

Lake Drain: TWO 60-INCH DIAMETER CONCRETE PIPES
Principal: 33.5-FT WEIR WITH AMIL GATE
Emergency: 472-FT CONCRETE OGEE WEIR
Maximum Spillway Discharge (cfs): 20700 **Design Flood:** 1.0 **Flood Capacity:** .50

Dam Reservoir Data	Elevation (ft-MSL)*	Area (acres)	Storage (acre-feet)
Top of Dam:	894.4	3030	20000
Emergency Spillway:	892.2		
Principal Spillway:	891.75	2800	14000
Streambed:	879.9		
Foundation:			

*Elevations are not necessarily related to a USGS benchmark

Inspection Information

Inspection History: 6/24/2010 PMG
5/4/2005 PMG
4/14/2000 PMG
6/6/1986

Phase I: 7/7/1978
Other Visits:
Inspection Year: 2009-2010 C - Special Trip
EAP Disc.: $0.00
DNRP Cond.Disc.: $0.00

Operation Information/Remarks

Emergency Action Plan: Yes **Format:** EPP **OMI:**
Last Entry: 7/26/2010

Dam Safety Inspection Checklist

Complete All Portions of This Section (Pre-inspection)

Name of Dam: Buckeye Lake Dam - WEST BANK
Date of Inspection: JUNE 24, 2010
File Number: 9723-004
Class: I
Design Flood: 1.0 Flood Capacity: .50

Licking County Required Action

None	Mon.	Maint.	Eng.
☐	☐	☐	☒

Interview with Owner (at the site):

Owner/Representative present: (Yes, No) Name(s): Mr. Tim Waln
Owner's Name(s): ODNR, Division of Parks & Recreation
Address: 2045 Morse Road, Bldg. C, ,
City: Columbus State: OH Zip (+4): 43229-6693
Contact Person: Tim Waln Telephone: 740/467-2690
Email Address: Tim.waln@dnr.state.oh.us
Purpose of dam: Recreation, Public

Owner Dam Safety Program

Emergency Action Plan
EAP (document): Yes EAP is currently in draft form and an inundation map is being developed Up-to-date? (yes, no) ☐ ☐ ☐ ☒
Exercised: No
Downstream development: Houses around the dam are reconstructed and new homes are built often.
Security: Park rangers patrol dam on bikes once per week.

Operation, Maintenance, and Inspection
OMI (document): DRAFT FORM Up-to-date? (yes, no) ☐ ☐ ☐ ☒
Operation of drains/gates
All operable? (yes, no) Valves are operated once per year.

Normal rate of drawdown: 3 feet in November Emerg. rate of drawdown: NO
Accessibility for operation: CREST OF DAM - NEXT TO EMERGENCY SPILLWAY

Maintenance
Frequency of mowing: OFTEN DURING SUMMER MONTHS, PUBLIC ACCESS AREAS, MUD ISLAND, SELLER POINT
Other maintenance: FILL RODENT BURROWS, TREE REMOVAL, FILL SINK HOLES, CLEAN TRASHRACK GATES FOR PRINCIPAL SPILLWAY

Inspection
Frequency and thoroughness of day-to-day & routine inspections: Bike patrol is a routine visual inspection. No day to day inspection. Downstream residents contact park office if they see a problem.
Frequency and thoroughness of event-driven inspections: CHECK SPILLWAYS
Problems found during inspections: DEBRIS UNDER ANVIL GATE

Field Information

Pool Elevation (during inspection): Normal Pool Elevation Time: 8:00 (a.m) p.m.)
Site Conditions(temp., weather, ground moisture): 75°, OVERCAST, DRY
Inspection Party: PETER GEORGE, DENA BURKHOUSE, TIM WALN
Maximum Height: 14.5 Feet (measured or inventory appears correct)
Normal Pool Surface Area: 2800 Acres (measured or inventory appears correct)

DAM SAFETY INSPECTION REPORT

Buckeye Lake Dam – North Bank
File Number: 9723-004
Class I
Fairfield County, Walnut Township
Licking County, Union Township
Inspection Date: June 25, 2010

In accordance with Ohio Revised Code Section 1521.062, the owners of dams must monitor, maintain, and operate their dams safely. Negligence of owners in fulfilling these responsibilities can lead to the development of extremely hazardous conditions to downstream residents and properties. In the event of a dam failure, owners can be subject to liability claims.

The Chief of the Division of Water has the responsibility to ensure that human life, health, and property are protected from the failure of dams. Conducting periodic safety inspections and working with dam owners to maintain and improve the overall condition of Ohio dams are vital aspects of achieving this purpose.

Representatives of the Chief conducted this inspection to evaluate the condition of the dam and its appurtenances under authority of Ohio Revised Code Section 1521.062. In accordance with Ohio Administrative Code Rule 1501:21-21-03, the owners of dams must implement all remedial measures listed in the enclosed report.

Table of Contents

Section 1

DIVISION OF SOIL & WATER RESOURCES
DAM SAFETY INSPECTION SITE VISIT
NORTH BANK OF BUCKEYE LAKE DAM
FILE NUMBER: 9723-004

LOCATION:	Fairfield County, Walnut Township Licking County, Union Township
DATE:	Friday, June 25, 2010
TIME:	8:00 a.m.
INSPECTORS:	Peter George, P.E., Project Manager Dena Barnhouse, P.E., Project Manager
OTHERS PRESENT:	Tim Waln, Park Manager
SITE CONDITIONS:	It was sunny and about 70 degrees Fahrenheit. The ground surface was dry.
PHOTOGRAPHS:	Digital photographs were taken and are on file at this office and included in this report.

INSPECTION PURPOSE AND AUTHORITY:

This inspection was conducted under the provisions of Ohio Revised Code (ORC) Section 1521.062 to evaluate the condition of the dam and its appurtenances. The Dam Safety Engineering Program has the responsibility to ensure that human life, health, and property are protected from catastrophic dam failures.

DESCRIPTION:

The inspection of the North Bank began at an approximate station of 65+00 and ended at an approximate station of 213+00. This inspection included the area of North Bank that had been repaired near Mud Island to the parking lot west of Crane Lake. The stationing is referenced from the plans titled "Buckeye Lake State Park Embankment Mapping" dated April 1990, by Dodson-Lindblom Associates, Inc. A visual inspection was performed from the centerline of the dam to the sheet-pile retaining wall located on the upstream slope and along the downstream slope. The visual inspection included observation of structures such as: elevation of the fill material behind the sheet-pile retaining wall, sidewalks, trees, decks, and docks to observe the affects on the upstream portion of the dam. A detailed inspection of the sheet-pile retaining wall was not performed.

Several trees varying in diameter from 0.5 foot to 4.0 feet were noted all the North Bank. Also, some trees had been removed and depressions remain on the embankment in these locations. Some relatively new trees had been planted along the upstream slope.

The downstream slope contains residential houses. On the average houses along the downstream slope are spaced approximately 10 to 15 feet apart. Basements and foundations extend into the downstream slope almost to the centerline of the dam. Large trees (30+ inches in diameter) were noted along the downstream slope. Construction of new homes were observed in a few locations.

It was impossible to inspect many areas of the dam due to decks, patios, landscaping, and other structures.

OBSERVATIONS:

Station 65+00 to 66+00:
No problems noted. Upstream slope has a gravel bedding. Park Manager Tim Waln stated that barges get loaded and unloaded in this area.

Station 66+00 to 67+00:
No problems noted. This section contain monitoring wells.

Station 67+00 to 68+00:
Upstream slope sheet piling wall replacement ended at station 67+62.50. A deck was noted on the remainder of this section. A tree approximately 8 inches in diameter was observed. No tree tag was observed.

Station 68+00 to 69+00:
Two large diameter trees and **two new trees** were noted along this section of the upstream slope. The fill material was nearly even with the sheet-pile retaining wall located along the upstream slope. A house is located in the downstream slope. A steel cap had been welded to the top of the sheet-pile retaining wall. The large trees were tagged 106 and 107.

Station 69+00 to 70+00:
Two large diameter trees were noted along this section of the upstream slope and were tagged 108 and 109. The fill material was nearly even with the sheet-pile retaining wall located along the upstream slope. A new house was being constructed on the downstream slope. ***A digital photograph was taken of this area and is included in the report.***

Station 70+00 to 71+00:
Two 10-inch diameter trees were noted along the upstream slope. The fill material was nearly even with the sheet-pile retaining wall located along the upstream slope. One tree had been removed.

Station 71+00 to 72+00:
Fill material along the upstream slope was even with the top of the sheet-pile retaining wall. Two small trees were noted on the downstream slope.

Station 72+00 to 73+00:
The fill material was level with the top of the sheet-pile retaining wall. One tree tagged 117 was noted on the upstream slope.

Station 73+00 to 74+00:
Two large trees were tagged nos. 118 and 119 were noted along the upstream slope. Fill material was level with the upstream slope sheet-pile wall.

Station 74+00 to 75+00:
A large tree was noted along the upstream slope. The fill material was level with the top of the sheet-pile retaining wall.

Station 75+00 to 76+00:
Two large trees were noted on the upstream slope and two large trees were noted on the downstream slope. The fill material was even with the top of the sheet-pile retaining wall.

Station 76+00 to 77+00:
One large tree tagged no. 123 was noted on the upstream slope near the crest. No trees were noted along the downstream slope. The fill material was even with the top of the sheet-pile retaining wall.

Station 77+00 to 78+00:
A large tree tagged no. 126 was noted along the crest. The sheet-pile retaining wall cap was eliminated near station 77+50. The fill material was 3 to 4 inches below the top of the sheet-pile retaining wall.

Station 78+00 to 79+00:
One large tree tagged no. 127 was noted along the upstream slope. Fill material was 2 inches below the top of the sheet-pile retaining wall. No trees were noted along the downstream slope.

Station 79+00 to 80+00:
Five large trees nos. 128, 129, 130, 131, and 132 were noted along the upstream slope. Fill material was level with the top of the sheet-pile retaining wall.

Station 80+00 to 81+00:
Two large trees tagged nos. 133 & 134 were noted along the upstream slope. Fill material was even with the top of the sheet-pile retaining wall. Approximately 8 large trees were observed on the downstream slope. Downstream slope was dry.

Station 81+00 to 82+00:
One large tree tagged no. 136 was noted along the upstream slope. A 1-foot-diameter depression was noted near station 81+75. Fill material was approximately 4 to 6 inches below the top of the sheet-pile retaining wall.

Station 82+00 to 83+00:
Two large trees were noted along the downstream slope. A new sidewalk was noted in this area. Fill material along the sheet-pile retaining wall was nearly even with the top.

Station 83+00 to 84+00:
Two large trees were noted along the upstream slope. No tags could be located on the trees. Fill material along the upstream slope sheet-pile retaining wall was approximately 3 inches below the top.

Station 84+00 to 85+00:
A large tree tagged no. 141 was noted along the upstream slope. Fill material was even with the top of the sheet-pile retaining wall located along the upstream slope. Houses were noted in the downstream slope.

Station 85+00 to 86+00:
Fill material was nearly level with the sheet-pile retaining wall located along the upstream slope. Two large trees tagged nos. 142 & 143 were noted along the crest. A steel cap was noted on the top of the sheet-pile retaining wall near station 86+00. A digital photo of this section was taken.

Station 86+00 to 87+00:
Two depressions that were approximately 2.5 feet in diameter that were noted in the previous inspection near the crest had been filled in. **A new tree was noted on the upstream slope.** The fill was approximately 4 to 5 inches below the top of the retaining wall.

Station 87+00 to 88+00:
Two large trees tagged nos. 147 & 148 were noted along the upstream slope. A depression that was 5 feet in diameter and approximately 4 inches deep was observed again during this inspection. The fill material was approximately 6 inches below the top of the sheet-pile retaining wall. Downstream slope was dry during this inspection.

Station 88+00 to 89+00:
An 18-inch-diameter depression (existing tree location) was located near station 88+25 upstream of the sidewalk. Two large trees tagged nos. 149 & 150 and one small tree were noted along the upstream slope. The fill material was 4 to 6 inches below the top of the sheet-pile retaining wall.

Station 89+00 to 90+00:
At approximate station 89+10 is where the embankment was upgraded during the installation of the emergency spillway system. The sidewalk located on the crest was 8 inches lower than the upstream slope. One tree tagged no. 151 was noted along this section.

Station 90+00 to 91+00:
This section was repaired during the installation of the emergency spillway. Downstream slope contained six trees. ***A digital photo was taken of this area and is included in this report.***

Station 91+00 to 92+00:
This section was repaired during the installation of the emergency spillway. The concrete in the emergency spillway was in good condition. Silt had collected in the bottom of the spillway and vegetation was noted. Vegetation was also growing in concrete cold joints. Lake drain valve fence enclosure had ice damage. ***A digital photo was taken of this area and is included in this report.***

Station 92+00 to 93+00:
This section was repaired during the installation of the emergency spillway.

Station 93+00 to 94+00:
Two large trees tagged nos. 155 & 156 and **two new trees** were noted along the upstream slope. One tree was noted on the downstream. The fill material was 6 inches below the top of the sheet-pile retaining wall. The sidewalk was 4 to 5 inches lower than the upstream slope.

Station 94+00 to 95+00:
Two large trees tagged nos. 157 & 158 were noted on the upstream slope and one tree was noted on the downstream slope. The fill material was 6 inches below the top of the sheet-pile retaining wall. **Two new trees were noted on the upstream slope.**

Station 95+00 to 96+00:
A 10-inch diameter tree was noted on the upstream slope. A tag number could not be located. The fill material was 6 to 9 inches below the top of the sheet-pile retaining wall.

Station 96+00 to 97+00:
Two large trees tag nos. 160 & 161 were noted on the upstream slope near station 96+75. One small tree was noted on the crest. Fill material was 4 to 6 inches below the top of the sheet-pile retaining wall. A soft area, located near station 96+35, measured 12 inches in diameter and 3 inches deep. One large tree was noted on the downstream slope. At station 96+20, a low area 5 feet in diameter and 6 inches deep was noted.

Station 97+00 to 98+00:
One large tree tag no. 162 was noted on the upstream slope and one tree was noted on the downstream slope. A low area near station 97+60 was noted that was approximately 6 feet in diameter, 3 to 4 inches deep and 12 feet from the sheet-pile retaining wall. The fill material was approximately 6 to 8 inches below the top of the sheet-pile wall. A new sidewalk had been added to this section as well as new landscaping.

Station 98+00 to 99+00:
Two large trees tag nos. 167 & 168 were noted along the upstream slope. Fill material was 6 to 8 inches below the top of the sheet-pile retaining wall. Dense brush was noted on the downstream slope.

Station 99+00 to 100+00:
Two large trees tag nos. 170 & 171 and shrubs were noted on the upstream slope. The fill material was 2 to 4 inches below the top of the sheet-pile retaining wall.

Station 100+00 to 101+00:
Four large trees tag nos. 172, 173, 174, and 175 were noted along this area. The fill material was approximately 8 to 10 inches below the top of the sheet-pile retaining wall.

Station 101+00 to 102+00:
Two trees tag nos. 176 & 177 were noted along this section. The upstream slope was hummocky and the fill material was approximately 12 inches below the top of the sheet-pile retaining wall. Fill material with dense grass replaced the deteriorated concrete block wall.

Station 102+00 to 103+00:
Two large trees tag nos. 178 & 179 were noted along the upstream slope. The fill material was 6 inches below the top of the sheet-pile retaining wall. The sidewalk was uneven and sloped towards the downstream slope. Near station 102+00, a 12-inch-tall steel I-beam had been welded to the top of the sheet-pile retaining wall.

Station 103+00 to 104+00:
One large tree tag no. 180 was noted along the crest. The fill material varied between 4 to 6 inches below the top of the sheet-pile retaining wall. A 12-inch-tall steel I-beam was noted on the top of the sheet-pile wall.

Station 104+00 to 105+00:
Two large trees tag nos. 181 & 182 were noted on the upstream slope. Fill material along the upstream slope was below the top of the 12-inch-tall steel I - beam.

Station 105+00 to 106+00:
Three large trees tag nos. 183, 184, & 185 were noted along the upstream slope. Fill material sloped up to the same elevation as the top of the I-beam elevation and sloped down to the crest. The sidewalk was 8 to 10 inches below the upstream slope elevation.

Station 106+00 to 107+00:
Two large trees tag nos. 186 & 187 were noted on the upstream slope. Three small trees were noted on the downstream slope. Fill material was below the top of the sheet-pile retaining wall. The sidewalk was sloped toward the downstream slope.

Station 107+00 to 108+00:
Fill material was 10 inches below the top of the sheet-pile retaining wall. The downstream slope was bare and lacked vegetal cover. A large tree still exists near station 107+50.

Station 108+00 to 109+00:
Two large trees tag nos. 188 & 189 were noted on the upstream slope and one large tree was noted on the downstream slope. Fill material was 10 inches below the top of the steel I-beam that had been placed on top of the sheet-pile retaining wall.

Station 109+00 to 110+00:
Two trees tag nos. 190 & 191 were noted along the upstream slope. Fill material was 10 inches below the top of the steel I-beam that had been placed on top of the sheet-pile retaining wall. The downstream slope had been landscaped with rock. The downstream slope lacked grass cover.

Station 110+00 to 111+00:
Trees tog nos. 192, 193, & 194, were noted along the upstream slope. Fill material was 4 inches below the top of the 10-inch-tall steel I-beam that was attached on the top of the sheet-pile retaining wall. The downstream slope lacked adequate grass cover.

Station 111+00 to 112+00:
According to the park manager, a new sheet-pile retaining wall starts at an approximate station 111+65. A deck covers a large portion of the upstream slope.

Station 112+00 to 113+00:
No trees were noted on the upstream slope or downstream slope. The fill material was approximately 8 inches below the sheet-pile retaining wall. A brick patio was noted along the upstream slope.

Station 113+00 to 114+00:
Three trees tag nos. 198, 199, & 200 were noted along the upstream slope. Two large trees were noted on the downstream slope to the left of residence 3709. The fill material was 4 to 6 inches below the top of the sheet-pile wall.

Station 114+00 to 115+00:
Two trees tag nos. 201 & 202 were noted along the upstream slope. The fill material was 8 inches below the top of the sheet-pile retaining wall.

Station 115+00 to 116+00:
One tree tag no. 202 was noted along the upstream slope and two trees were noted on the downstream slope. Fill material was 6 to 8 inches below the sheet-pile retaining wall.

Station 116+00 to 117+00:
A tree tag no. 203 was noted near the crest and three trees were noted on the downstream slope. The fill material was 4 inches below the top of the sheet-pile retaining wall. The sidewalk was approximately 4 inches lower than the upstream slope. House number 3765 had been removed.

Station 117+00 to 118+00:
No trees were noted along the upstream slope. The fill material in this area was a couple of inches below the top of the sheet-pile retaining wall. The downstream slope lacked grass cover.

Station 118+00 to 119+00:
A low area/depression was noted approximately 10 feet from the sheet-pile retaining wall. The area was 14 feet long, 2 feet wide and 4 inches low. The sidewalk had sunken approximately 4 inches lower than the upstream slope. One tree was noted on the downstream slope.

Station 119+00 to 120+00:
A 8-foot by 8-foot area approximately 6 inches low was noted approximately 15 feet from the sheet-pile retaining wall. The fill material was approximately 3 to 4 inches below the sheet-pile retaining wall. ***A digital photo was taken of this area and is included in this report.***

Station 120+00 to 121+00:
One large tree tag no. 205 was noted on the upstream. The fill material along the wall was 8 inches below the top of the sheet-pile retaining wall.

Station 121+00 to 122+00:
A large tree tag no. 206 and a new tree were noted near the crest. One tree was noted on the downstream slope. Fill material was approximately 4 inches below the top of the sheet-pile retaining wall.

Station 122+00 to 123+00:
Two large trees tag nos. 207 & 208 were noted on the upstream slope and one tree was noted on the crest. One tree was noted on the downstream slope. Fill material was 6 inches below the top of the sheet-pile retaining wall. Sidewalk was damaged by tree roots. ***A digital photo was taken of this area and is included in this report.***

Station 123+00 to 124+00:
A large tree tag no. 209 was noted on the upstream slope near the crest and a large tree had been removed near the sheet-pile wall. Fill material varied 4 to 6 inches below the top of the sheet-pile retaining wall.

Station 124+00 to 125+00:
A large tree tag no. 210 and a new tree were noted on the upstream slope. The fill material was even with the top of the sheet-pile retaining wall.

Station 125+00 to 126+00:
Two trees tag nos. 214 & 215 were noted along the upstream slope. The fill material was approximately 4 inches below the top of the sheet-piling wall. House number 3913 had been removed. The retaining wall on the downstream slope was leaning.

Station 126+00 to 127+00:
One large tree tag no. 216 was noted along the upstream slope. Four large trees were noted on the downstream slope. A low area/depression that was approximately 65 feet long, 6 feet wide and 8 inches deep was noted along the upstream slope. The fill material was approximately 8 inches below the top of the sheet-pile wall. ***A digital photo was taken of this area and is included in this report.***

Station 127+00 to 128+00:
Three large bushes were noted on the upstream slope and six large trees were noted on the downstream slope. A sinkhole 8 inches in diameter was noted near station 127+75, approximately 11 feet from the sheet-pile wall. The house between 127+50 and 128+00 had been removed.

Station 128+00 to 129+00:
Four trees tag nos. 227, 218, 219, & 220 were noted on the upstream slope. The fill material was 2 to 3 inches below the top of the sheet-pile wall. Dense brush was noted on the downstream slope.

Station 129+00 to 130+00:
Three trees tag nos. 221, 222, & 223 were noted on the upstream slope. The fill material was nearly level with the sheet-pile retaining wall. Two trees were noted on the downstream slope.

Station 130+00 to 131+00:
The sidewalk was 3 to 4 inches below the upstream slope elevation. No trees were noted on the upstream or downstream slope.

Station 131+00 to 132+00:
One large tree tag no. 225 was noted on the upstream slope and four trees were noted on the downstream slope. The fill material was 8 inches below the top of the sheet-pile retaining wall.

Station 132+00 to 133+00:
Two large trees tag nos. 226 & 227 were noted on the crest and four large trees were noted on the downstream slope. The fill material was approximately 8 inches below the top of the sheet-pile retaining wall. The sidewalk was 8 inches below the upstream slope & sheet-pile wall.

Station 133+00 to 134+00:
Two large trees tag nos. 229 & 230 were noted on the upstream slope. A soft area that was approximately 3 feet by 2 feet was noted 14 feet from the sheet-pile retaining wall on the upstream slope. A portion of the old stone-wall was exposed on the crest. Fill material was 8 inches below the top of the sheet-pile retaining wall. The sidewalk was 6 to 8 inches lower than the upstream slope. A sink-hole 8 inches in diameter and 6 inches deep was noted adjacent upstream portion of the sidewalk. House nos. 4079 & 4082 were in close proximity to this sink-hole. ***A digital photo was taken of this area and is included in this report.***

Station 134+00 to 135+00:
A large tree tag no. 231 was noted on the upstream slope and four trees were noted on the downstream slope. The fill material was approximately 3 inches below the top of the sheet-pile retaining wall. The sidewalk was lower than the upstream slope elevation and tilted toward the downstream slope.

Station 135+00 to 136+00:
Two larges trees tag nos. 232 & 233 were noted on the upstream slope. The fill material was approximately 2 to 3 inches below the top of the sheet-pile retaining wall. The sidewalk was 6 to 8 inches lower than the upstream slope elevation and was tilted toward the downstream slope. Landscaping had been added to this section of the upstream slope.

Station 136+00 to 137+00:
One tree tag no. 234 was noted on the upstream slope. The fill material was approximately 3 inches below the top of the sheet-pile retaining wall. The sidewalk was 6 to 8 inches lower than the upstream slope and tilted toward the downstream slope.

Station 137+00 to 138+00:
One large tree tag no. 235 was noted along the upstream slope and three trees were noted on the downstream slope. The fill material had been to the upstream slope approximately 20 feet out from the sheet-pile wall. ***A digital photo was taken of this area and is included in this report.***

Station 138+00 to 139+00:
Two large trees tag nos. 237 & 238 were noted along the downstream slope. The fill material was approximately 4 inches below the top of the sheet-pile retaining wall.

Station 139+00 to 140+00:
Two trees tag nos. 239 & 240 were noted on the upstream slope. The fill material was 2 to 3 inches below the top of the sheet-pile retaining wall. Sidewalk was lower than the crest.

Station 140+00 to 141+00:
The fill material was level with the sheet-pile retaining wall. The sidewalk had sunken 2 to 3 inches below the upstream slope elevation. Landscaping and flower bed had been added to upstream slope.

Station 141+00 to 142+00:
One tree tag no. 241 was noted on the upstream slope and one tree on the downstream slope. Fill material was level with the top of the sheet-pile retaining wall. The sidewalk was 2 to 3 inches lower than the upstream slope elevation.

Station 142+00 to 143+00:
One large tree was noted on the upstream slope. The fill material was approximately 3 to 4 inches below the sheet-pile retaining wall.

Station 143+00 to 144+00:
One tree tag no. 243 was noted on the upstream slope and one tree was noted on the downstream slope. The fill material was 3 inches below the top of the sheet-pile retaining wall.

Station 144+00 to 145+00:
Two trees tag nos. 244 & 245 were noted on the upstream slope and a tree was noted on the downstream slope. Fill material was approximately 4 inches below the top of the sheet-pile retaining wall.

Station 145+00 to 146+00:
One large tree tag no. 246 was noted on the upstream slope and two trees were noted on the downstream slope. Fill was 3 inches below the top of the sheet-pile wall.

Station 146+00 to 147+00:
Two large trees tag nos.247 & 248 were noted on the upstream slope. One large tree was noted on the downstream slope. The fill material was level with the top of the sheet-pile retaining wall.

Station 147+00 to 148+00:
Two large trees tag nos. 249 & 250 were noted along the upstream slope. The fill material was approximately 4 inches below the top of the sheet-pile retaining wall. Houses were located in the downstream slope.

Station 148+00 to 149+00:
Fill material was 6 to 8 inches below the top of the sheet-pile retaining wall. One tree was noted on the downstream slope.

Station 149+00 to 150+00:
Fill material was nearly level with the top of the sheet-pile retaining wall. This section of the upstream slope was well maintained.

Station 150+00 to 151+00:
Two large trees tag nos. 254 & 255 were noted on the upstream slope. The fill material and the sidewalk was nearly level with the top of the sheet-pile retaining wall.

Station 151+00 to 152+00:
Two large trees tag nos. 256 & 257 were noted along the upstream slope. Fill material was level with the top of the sheet-pile retaining wall. **Bushes had been added in front of house number 4307.**

Station 152+00 to 153+00:
A low area was noted near station 152+25 along the upstream slope that measured 3 feet by 3 feet and 4 inches deep. One tree had been removed and one tree tag no. 258 remained on the upstream slope. Only one tree was noted on the downstream slope. The steel I-beam located on top of the sheet-pile retaining wall had been removed near station 153+00. Seepage on the downstream slope was estimated at less than 1 gallon per minute. ***Digital photos were taken of this area and are included in this report.***

Station 153+00 to 154+00:
Two large trees tag nos. 259 & 260 were noted on the upstream slope and one large tree was noted on the downstream slope. Fill material was level with the top of the sheet-pile wall.

Station 154+00 to 155+00:
A low area on the crest was noted that measured 50 feet long, 10 feet wide and 5 inches deep. Two large trees were noted along the upstream slope, and two large trees were noted on the downstream slope. **This section has state access. The house number adjacent to this area was 4333.**

Station 155+00 to 156+00:
Two trees tag nos. 261 & 262 were noted near the crest, and **one tree had recently been planted near station 155+85.** One tree was noted on the downstream slope near the crest.

Station 156+00 to 157+00:
Fill material was nearly level with the sheet-pile retaining wall. A new sidewalk had been installed along with bushes.

Station 157+00 to 158+00:
Four trees tag nos. 265, 266, 267, & 268 were noted along the upstream slope, and two large trees were noted on the downstream slope. The fill material was approximately 10 inches below the top of the sheet-pile retaining wall.

Station 158+00 to 159+00:
The fill material was approximately 8 inches below the top of the sheet-pile retaining wall. At station 158+50 on the downstream slope, a seepage area with an approximate size of 50 feet by 10 feet was noted. The seepage area contained iron deposits and vegetation. House 4393 had been removed and the landscaping sidewalk was 12 inches above the top of the sheet-pile wall.
A digital photo was taken of this area and is included in this report.

Station 159+00 to 160+00:
Three trees tag nos. 269, 270, & 271 were noted on the upstream slope, and four trees were noted on the downstream slope. Fill material was 6 inches below the top of the sheet-pile retaining wall.

Station 160+00 to 161+00:
One tree was removed from the upstream slope. A low area was noted on the upstream slope in close proximity to the sheet-pile retaining wall had been filled in.

Station 161+00 to 162+00:
The fill material was 2 to 3 inches below the top of the sheet-pile retaining wall. Landscape had been added to this section of the upstream slope.
A digital photo was taken of this area and is included in this report.

Station 162+00 to 163+00:
The fill material was 2 inches below the top of the sheet-pile retaining wall. Patios cover almost this entire section of the upstream slope.
A digital photo was taken of this area and is included in this report.

Station 163+00 to 164+00:
A depression was noted near station 163+25 and 13.2 feet from the upstream sheet-pile retaining wall. The depression was 16 inches in diameter and 16 to 21 inches deep. Fill material was 4 inches below the sheet-pile retaining wall. A digital photo of this area was taken.

Station 164+00 to 165+00:
The fill material was 2 to 3 inches below the top of the sheet-pile retaining wall. A low area near station 164+75 was approximately 3 feet in diameter. Landscaping covered the upstream slope.

Station 165+00 to 166+00:
Two large trees tag nos. 274 & 275 were noted on the upstream slope. Fill material was 2 to 4 inches below the top of the sheet-pile retaining wall. One tree was noted on the downstream slope.

Station 166+00 to 167+00:
Fill material was 3 inches below the sheet-pile wall. Shrubs were noted on the upstream slope.

Station 167+00 to 168+00:
The fill material behind the wall varied between 2 to 4 inches below the top of the sheet-pile retaining wall.

Station 168+00 to 169+00:
The fill material behind the wall varied between 3 to 4 inches below the top of the sheet-pile retaining wall. Sidewalk is below grade and tilts towards upstream slope. ***A digital photo was taken of this area and is included in this report.***

Station 169+00 to 170+00:
The sidewalk was approximately 6 inches lower than the fill elevation along the upstream slope.

Station 170+00 to 171+00:
Fill material was nearly level with the sheet-pile retaining wall.

Station 171+00 to 172+00:
Four large trees tag nos. 277, 278, 279, & 280 were noted along the upstream slope. One tree was noted on the downstream slope.

Station 172+00 to 173+00:
No problems were noted.

Station 173+00 to 174+00:
Upstream slope fill elevation was level with the top of the wall. One tree was noted on the downstream slope.

Station 174+00 to 175+00:
It appeared that the trees noted on the original plan sheets had been removed. Fill was level with the top of the sheet-pile wall. The downstream slope was dry.

Station 175+00 to 176+00:
One large tree tag no. 284 was noted on the upstream slope midway between the crest and sheet-pile retaining wall. Two unmarked trees were noted on the upstream slope along with one large bush. Fill was level with the sheet-pile wall.

Station 176+00 to 177+00:
Two large diameter trees (no tag nos.) were noted on the upstream slope. The sidewalk was 3 to 4 inches lower than the crest elevation. Fill was level with the top of the sheet-pile wall.

Station 177+00 to 178+00:
One large tree (no tag no.) was noted on the upstream slope. A large tree had been removed from the downstream slope. Fill level was level with the top of the sheet-pile wall.

Station 178+00 to 179+00:
A 4-foot-diameter low area/depression approximately 4 inches deep was noted near station 178+10. The fill material was level with the top of the sheet-pile retaining wall.

Station 179+00 to 180+00:
The fill material behind the wall was level with the top of the sheet-pile retaining wall. Trees noted on the downstream slope were close to the crest.

Station 180+00 to 181+00:
Two trees that were noted on the 1990 plan sheets had been removed from the upstream slope. Fill material was level with the sheet-pile wall.

Station 181+00 to 182+00:
This section is natural ground. Trees were noted near the sheet-pile retaining wall. Fill was level with the sheet-pile wall.

Station 182+00 to 183+00:
This section is natural ground. Trees were noted near the sheet-pile retaining wall.

Station 183+00 to 184+00:
This section is natural ground.

Station 184+00 to 185+00:
This is the principal spillway section. The fence around the spillway amil gate was damaged and the trashrack grate was missing bolts. The concrete was in good condition. ***Seven digital photos were taken of this area and are included in this report.***

Station 185+00 to 186+00:
The principal spillway repair extended to station 185+50. The existing sheet-pile retaining wall was approximately 12 inches lower than the repaired section of the principal spillway. No trees were noted along this section.

Station 186+00 to 187+00:
Four large trees tag nos. 290, 291, 293, and 294 were noted along this section of the upstream slope. The sidewalk along the crest was 3 inches lower than the upstream slope elevation and sloped towards the downstream slope.

Station 187+00 to 188+00:
Four large trees tag nos. 295, 296, 297, & 298 were noted on the upstream slope midway between the crest and sheet-pile retaining wall. The sidewalk was approximately 10 inches below the upstream slope elevation. Fill material was 2 to 4 inches below the sheet-pile retaining wall.

Station 188+00 to 189+00:
Two trees tag nos. 299& 300 were noted along the upstream slope. Fill material was approximately 3 inches below the top of the sheet-pile retaining wall. Patios and landscaping covered the upstream slope.

Station 189+00 to 190+00:
Two trees tag nos. 301 &302 were noted along the upstream slope of this section. Fill material was 3 inches below the top of sheet-pile retaining wall.

Station 190+00 to 191+00:
A low area/depression approximately 3 feet in diameter and 6 inches deep was noted near station 190+15. Two large trees tag nos. 303 & 304 were noted on the upstream slope. Fill was level with upstream sheet-pile wall.

Station 191+00 to 192+00:
A large tree tag no. 305 was noted on the upstream slope, and one large tree was noted on the downstream slope. Fill material was level with the upstream sheet-pile wall.

Station 192+00 to 193+00:
One tree tag no. 306 was noted on the upstream slope of this section.

Station 193+00 to 194+00:
Three trees tag nos. 307, 308, & 309 were noted along this section of the upstream slope. A low-area that measured 6 feet by 5 feet and 6 inches deep was observed near station 193+50. Fill material was level with the sheet-pile wall.

Station 194+00 to 195+00:
Two large trees tag nos. 310 & 311 were noted along this section of the upstream slope. Tree tag no. 312 had been removed. The fill material along the upstream slope was nearly level with the sheet-pile retaining wall.

Station 195+00 to 196+00:
Four large trees tag nos. 313, 314, 315, and 316 were noted along the upstream slope. The fill material along the upstream slope was nearly level with the sheet-pile retaining wall.

Station 196+00 to 197+00:
One large tree tag no. 317 was noted along the upstream slope. Tree tag no. 318 had been removed. The fill material along the upstream slope was nearly level with the sheet-pile retaining wall.

Station 197+00 to 198+00:
No problems noted.

Station 198+00 to 199+00:
An 18-inch-diameter depression was noted on the upstream slope. It was approximately 8 inches deep. One large tree was noted in this section of the upstream slope but no tag could be located.

Station 199+00 to 200+00:
Two large trees were noted on the downstream slope. The yacht club and a boat storage facility are located in this area.

Station 200+00 to 201+00:
This section, according to park officials, failed in the 1960's. A low area on the upstream slope was noted near station 200+75 and measured 2 feet in diameter by 6 inches deep. Fill material was 2 to 4 inches below the sheet-pile wall.

Station 201+00 to 202+00:
The fill material was approximately 6 inches below the top of the sheet-pile retaining wall.

Station 202+00 to 203+00:
No problems were noted along this section.

Station 203+00 to 204+00:
The fill material varied from 4 to 6 inches along the sheet-pile retaining wall near station 203+50.

Station 204+00 to 205+00:
A 1-foot-diameter low area was noted near station 204+25. No other problems were noted along this section of the upstream slope. No change in this section.

Station 205+00 to 206+00:
The old stone wall was exposed upstream of the sheet-pile retaining wall.

Station 206+00 to 207+00:
A crack in the sidewalk, located on the crest, began near station 206+25 and extended 75 feet. The crack varied from 0.4 inch to 2.0 inches in width and was approximately 8 inches deep in some locations. The upstream slope and crest were covered in concrete.

Station 207+00 to 208+00:
The upstream slope and crest were covered in concrete. No close observations could be performed.

Station 208+00 to 209+00:
The upstream slope and crest were covered in concrete. No close observations could be performed.

Station 209+00 to 210+00:
The upstream slope and crest were covered in concrete. No close observations could be performed. Riprap was noted upstream of the sheet-pile wall. Some brush was noted in the riprap.

Station 210+00 to 211+00:
Concrete covered the upstream slope. No close observations could be performed.
A digital photo was taken of this area and is included in this report.

Station 211+00 to 212+00:
The upstream slope and crest were covered in concrete. No problems were noted.
A digital photo was taken of this area and is included in this report.

Station 212+00 to 213+00:
This section of the dam is where the north embankment ties into natural ground. The upstream slope and crest are covered in concrete. No problems were noted.
A digital photo was taken of this area and is included in this report.

Station 213+214:
The crest is covered with a concrete sidewalk. No problems were noted.

DISCUSSION:

Embankment station 203+00 to 204+00 was repaired by the ODNR, Division of Engineering in 1998. This area along the upstream slope appeared to be in good condition. Fill had settled along the wall.

Trees should not be permitted on embankment surfaces. Extensive root systems can provide seepage paths for water. Trees that blow down or fall over can leave large holes in the embankment surface that will weaken the embankment and can lead to increased erosion. Tree growth adjacent to concrete walls and structures may eventually cause damage to the concrete and should be removed. Stumps and root balls of cut trees should be removed so vegetation can be established and the surface mowed. All woody material (roots) must be removed and the cavity filled with well-compacted fill material and grass vegetation established.

Houses, docks, gazebos, and other structures should not be built into a dam. A number of residents commented about water seeping from their basement walls that face the lake. A house foundation in the downstream embankment reduces the seepage path and removes valuable fill material. Other excavations into the embankment for construction of docks, gazebos, light poles, garages, patios, and other structures also reduce the safety of the dam and make proper inspection very difficult, if not impossible. All of these issues create stability problems for the embankment that could lead to dam failure.

Depressions are sunken areas of the embankment surface. They may be created during construction, or may be caused by decay of buried organic material (tree roots), internal erosion of the embankment, or settlement (consolidation) of the embankment or its foundation. Internal erosion and excessive settlement can lead to dam failure.

The location of a number of the low areas and their proximity to the stone and masonry wall indicates that loss of embankment fill due to erosion has taken place in a number of areas. Continued loss of this earthfill could lead to failure of the wall and the dam.

Seepage of earthen dams is a concern that should always be monitored. Seepage from the dam must be controlled to prevent stability and maintenance problems. The location of a number of the low areas and their proximity indicates that internal erosion has taken place in a number of areas. Internal erosion that is not corrected will weaken the embankment and could possibly lead to failure of the embankment. See the "Seepage Through Earthen Dams" fact sheet included in this section for additional information.

When the dam was originally constructed, both the West & North Embankments would have had typical embankment cross-sections and it would be easy to recognize the areas that need to be inspected and maintained. However, since construction, many modifications have taken place that make the extent of the dam less obvious. These modifications include constructing houses on the downstream slope, planting trees and shrubs, and installing boat lifts. The OMI manual must provide specific instructions for inspecting the entire dam, especially the downstream slope.

In 1997, Paul C. Rizzo Associates, Inc., completed the "Buckeye Lake Dam Stability Study". Included in this site visit are sections 5.0 Evaluation of Dam Safety Issues and 6.0 Conclusions, which outline what is needed to bring the dam into safety standards to pass the required 100% of the Probable Maximum Flood (PMF).

REQUIREMENTS:

1. This dam must have an operation, maintenance, and inspection manual (OM&I) and an emergency action plan (EAP) in accordance with OAC Rule 1501:21-21-04. Prepare an OM&I and an EAP including an inundation map. Guidelines for the preparation of these documents can be downloaded from the Division of Water's web site, or a copy can be mailed to you upon request.

2. Investigate the integrity of the sheet-pile retaining wall above and below the normal pool level. Repair the sheet-pile retaining wall as necessary. Replenish the fill material behind the sheet-pile retaining wall to a consistent elevation along the north embankment.

3. Reestablish the crest elevation, repair the noted low areas/depressions, and establish a dense grass cover where needed. See the "Ground Cover" fact sheet included in this section for additional information.

4. Monitor the depressions (low areas) along the upstream portion of the embankment for additional signs of settlement until repairs are made and following the repairs.

5. Remove the trees and root systems along the upstream slope and the crest. Repair the voids in the embankment with compacted fill material and establish a dense grass cover. See the "Trees and Brush" fact sheet included in this section for additional information.

6. Remove all landscaping and structures from the entire dam. This will facilitate proper inspection and maintenance of the earthfill embankment. See the "Trees and Brush" fact sheet included in this section for additional information.

7. Prevent the planting of new trees and shrubs on the upstream slope.

Dena Barnhouse, P.E. Date
Project Manager
Dam Safety Engineering Program
Division of Soil & Water Resources

Peter George, P.E. Date
Project Manager
Dam Safety Engineering Program
Division of Soil & Water Resources

Paul C. Rizzo Associates, Inc.
CONSULTANTS

May 5, 1997

Project No. 95-1590

Mr. Gary Harsanye, P.E.
Ohio Department of Natural Resources
Division of Engineering
1889 Fountain Square Court, Building F-3
Columbus, Ohio 43224-1331

TRANSMITTAL
BUCKEYE LAKE DAM STABILITY STUDY
BUCKEYE LAKE STATE PARK
FAIRFIELD, LICKING, AND PERRY COUNTIES, OHIO
DNR 736 730-96-034

Dear Mr. Harsanye:

Paul C. Rizzo Associates, Inc. respectfully submits the Buckeye Lake Dam Stability Study (Study), DNR 736 730-96-034 for the Buckeye Lake Dam located in the Buckeye Lake State Park, Fairfield, Licking, and Perry Counties, Ohio. In accordance with Section B, Design Service of our Contract, ten copies of the Study are enclosed for your distribution and use.

Paul C. Rizzo Associates appreciates this opportunity to work with the Ohio Department of Natural Resources (ODNR) Division of Engineering on this project. We look forward to our continuing our association with the ODNR. If you have any questions or require additional information, please do not hesitate to contact us.

Very truly yours,
Paul C. Rizzo Associates

Paul C. Rizzo, Ph.D., P.E.
President

Richard A. Isaac, P.E.
Project Manager

PCR/RAI/and/mfs
Enclosures

300 OXFORD DRIVE, MONROEVILLE, PA 15146-2347
PHONE (412) 856-9700 FAX (412) 856-9749

NEWARK, DE COLUMBUS, OH MT. PLEASANT, SC COVINGTON, KY

REPORT

BUCKEYE LAKE DAM STABILITY STUDY
BUCKEYE LAKE STATE PARK
FAIRFIELD, LICKING, AND PERRY COUNTIES, OHIO
DNR 736 730-96-034

PROJECT NO. 95-1590
MAY 1997

PREPARED FOR:
OHIO DEPARTMENT OF NATURAL RESOURCES
COLUMBUS, OHIO

PAUL C. RIZZO ASSOCIATES
LIONMARK CORPORATE CENTER
4605 HILTON CORPORATE DRIVE
COLUMBUS, OH 43232
TELEPHONE: (614) 868-5011
TELEFAX: (614) 868-5047

5.0 EVALUATION OF DAM SAFETY ISSUES

This Section deals with three primary issues related to the long term safety of Buckeye Lake Dam. While these issues have an indirect impact on stability, more importantly, they have a direct impact on piping, overtopping and/or the behavior of the new and existing retaining walls. Hence, there is a need to address these issues during and subsequent to Phase III remediation.

5.1 TREES AND LANDSCAPING ON THE DAM CREST

The crest of the Dam has been "abused" by allowing trees, some having diameters in excess of 30 inches, to grow on the crest and downstream slope. Trees have a direct impact on dam safety from the perspective that root structure provides pathways for piping to develop and overturned trees can cause large voids to develop, leading to overtopping during rain events with high pool levels. Consequently, we have the following recommendations pertaining to trees, landscaping, and hardscaping.

1. All trees and stumps, regardless of diameter, that are rooted in the crest or in the downstream slope should be removed. Stumps should be removed and roots should be "chased" to a point where the diameter is less than two inches and removed. Root grindings and cuttings should be removed from the stump excavation to the maximum degree practical. The stump excavation should be backfilled with clay compacted to 95 percent of the maximum dry density as determined by the Standard Proctor Method and within two percent of the optimum moisture content on the wet side.

2. Small diameter trees having a maximum diameter on the order of two (2) inches measured at a height of 54 inches can be placed and maintained in planters that do not allow roots to penetrate into the Dam crest or downstream slope. Plantings on the crest and downstream slope should be limited to grass and small flowers. Shrubbery and small bushes and trees should be prohibited.

3. A ten foot wide clear buffer zone on the upstream side of the crest and parallel to the sheet pile wall should be cleared and maintained free of all hardscaping except for the following permissible materials:

o	Un-cemented stone chips	o	Concrete pavers (less than 2' by 2')
o	Grass and flowers	o	Wood mulch
o	Sand and gravel	o	Landscape timbers

Wood decks, concrete paving, brick paving, and asphalt paving are not permissible materials in the buffer zone.

All utility conduits set in the buffer zone should be encased in concrete. All water spouting should be constructed to drain to the downstream side of the Dam in such a manner that erosion does not occur. No penetrations or attachments to the new or existing wall should be allowed. All existing attachments to the existing wall should be removed and all penetrations should be sealed.

5.2 BOAT DOCKS

We have observed a large number of boat docks on the upstream side of the Dam. Some of these are on piles and others are of cantilever construction. In addition, we noticed that some docks are of suspended cantilever design with one end of the dock attached to the existing sheetpile wall. Also, we observed a boat house, lifting davits and various types of boat lifts either partially supported by the existing wall or supported on foundations embedded in the crest of the Dam. We believe that none of these features was contemplated in the original design of the existing wall or Dam. As these features are a potential threat to dam safety, most should be removed and replaced with designs that are not a threat to dam safety. In addition, new and/or replacement boat docks will hinder the ability to effectively and economically perform future inspections, routine maintenance and repairs to the new sheetpile wall and Dam. We have the following specific comments regarding docking systems:

5.2.1 Pile-Supported Docks

Pile Supported Docks are acceptable so long as they do not attach to the existing or new sheetpile wall and no piles are driven into the Dam. Stairs or ramps leading between the dock and the crest should not be attached to or penetrate through the sheetpile wall. Pile-Supported Docks should be by permit only as issued by the ODNR.

5.2.2 Floating Docks

Floating Docks are acceptable so long as they do not attach to the existing or new sheetpile wall. Stairs or ramps leading between the dock and the crest should not be attached to or penetrate through the sheetpile wall. Floating Docks should be by permit only as issued by the ODNR.

5.2.3 Lifting Davits

Lifting Davits with foundations embedded in the crest should be prohibited. Temporary lifting Davits installed offshore of the existing or new sheetpile wall are acceptable so long as they do not attach to the existing or new sheetpile wall. Lifting Davits should be by permit only as issued by the ODNR.

5.2.4 Non-Suspended Cantilever Docks

Non-Suspended Cantilever Docks are docks which have a pair of anchor blocks embedded in the Dam crest and a structural steel frame that cantilevers out over the sheetpile wall into the Lake. Lifting hoists are occasionally installed at the offshore end or along the sides of the structural steel cantilever. Also, some of the cantilevers are supported with a pile strut driven into the Lake bottom to resist a portion of the vertical load and decrease the cantilever moment.

We have studied the design of this type of dock and have the following comments and recommendations:

1. From a foundation engineering perspective, and excluding considerations of dam safety, this type of dock is technically feasible. We would note that, depending on the length of the cantilever, the location of the lifting hoists, the size of the boat, and the use (or non-use) of a vertical pile strut, it may be necessary to found the anchor blocks on piles. We suspect that none of the existing Cantilever Docks include pile-supported anchor blocks.

2. From a dam safety perspective, we view Non-Suspended Cantilever Docks with anchor blocks embedded in the crest as an "abuse" of the Dam much like a house on the downstream slope, trees, etc. Therefore, this type of dock with its

concrete anchor block foundations embedded in the crest is unacceptable. We list below the following specific reasons:

- The anchor block encroaches on the integrity of the Dam. The interface between the concrete and the surrounding earth provides a preferred pathway for seepage and piping to occur.

- Docks and foundations can cause difficulty in performing inspections, maintenance, and remedial and emergency repairs of the sheet pile wall.

- Many of the existing anchor block foundations attach to the existing sheetpile wall, thus imparting a load to the wall for which it was not designed. Also, the blocks tend to increase the lateral earth pressure acting on the sheetpile wall, thus increasing the stresses in the wall and increasing the load in the tie-back anchors. These blocks should be removed and the excavation backfilled with impervious soil compacted to 95 percent of the maximum dry density as determined with the Standard Proctor method and within two percent of the optimum moisture content on the wet side.

- Even if new blocks were to be constructed away from the new wall and on piles, the potential for piping, increased lateral earth pressures and increased anchor forces still exist. Furthermore, the installation of piles, either by driving or pre-drilling, can affect the integrity of the new wall and the Dam. Piling also increases the potential for piping at depths below the normal Lake level.

3. It is our conclusion that while Non-Suspended Cantilever Docks are technically acceptable from a foundation engineering perspective, particularly with pile supported anchor blocks, they are not acceptable from a dam safety perspective. Existing docks of this type should be removed from the Dam and no new cantilever docks should be permitted.

5.2.2 Floating Docks

Floating Docks are acceptable so long as they do not attach to the existing or new sheetpile wall. Stairs or ramps leading between the dock and the crest should not be attached to or penetrate through the sheetpile wall. Floating Docks should be by permit only as issued by the ODNR.

5.2.3 Lifting Davits

Lifting Davits with foundations embedded in the crest should be prohibited. Temporary lifting Davits installed offshore of the existing or new sheetpile wall are acceptable so long as they do not attach to the existing or new sheetpile wall. Lifting Davits should be by permit only as issued by the ODNR.

5.2.4 Non-Suspended Cantilever Docks

Non-Suspended Cantilever Docks are docks which have a pair of anchor blocks embedded in the Dam crest and a structural steel frame that cantilevers out over the sheetpile wall into the Lake. Lifting hoists are occasionally installed at the offshore end or along the sides of the structural steel cantilever. Also, some of the cantilevers are supported with a pile strut driven into the Lake bottom to resist a portion of the vertical load and decrease the cantilever moment.

We have studied the design of this type of dock and have the following comments and recommendations:

1. From a foundation engineering perspective, and excluding considerations of dam safety, this type of dock is technically feasible. We would note that, depending on the length of the cantilever, the location of the lifting hoists, the size of the boat, and the use (or non-use) of a vertical pile strut, it may be necessary to found the anchor blocks on piles. We suspect that none of the existing Cantilever Docks include pile-supported anchor blocks.

2. From a dam safety perspective, we view Non-Suspended Cantilever Docks with anchor blocks embedded in the crest as an "abuse" of the Dam much like a house on the downstream slope, trees, etc. Therefore, this type of dock with its

5.2.5 Suspended Cantilever Docks

The Suspended Cantilever Docks generally consist of a deck with the shore end supported on the existing wall (and presumably on the new wall) and the offshore end supported by a suspension cable tied to a vertical column inserted into the crest of the Dam. As the shore end of this type of dock is supported on the wall and the vertical column penetrates the Dam, we recommend that this type of dock be removed and prohibited in the future.

5.2.6 Boat Houses

Boat houses should be considered on a case-by-case basis, recognizing all of the prohibitions and restrictions previously recommended. Quite frankly, we have difficulty imagining how a boat house could be designed considering all of the above. Nevertheless, we would reserve judgment until an actual design is presented to the ODNR for permitting. Indeed , boat houses that penetrate or cut into the Dam embankment or attach to the sheetpile wall should be removed and not permitted in the future.

5.3 New and Remodeled Structures on the Downstream Slope

As discussed in the context of this Report, we view the construction of homes and buildings on the downstream slope and on the crest as an "abuse" of the Dam. Our stability analysis indicates that the this type of construction impacts on the safety of the Dam. but admittedly, the margin of safety against catastrophic stability failure for the as-built construction for both the "Before" and "After" cases is satisfactory.

However, the most critical aspect of construction of these homes on the downstream slope and crest is the period of time when the excavation is open and the basement walls are being constructed. It is during this period of time that the Dam is most vulnerable to a breach and/or piping. The entire Lake is in jeopardy, and therefore, construction should be allowed to proceed only under the following conditions:

1. Local authorities should be encouraged to designate the slope and crest on the Dam as a Special Zone with respect to Building Permits and Building Regulations. Local building inspection agencies should expect to incur increased costs to monitor the construction in this Special Zone.

2. All new construction on the slope and on the crest, other than landscaping, should require a Special Building Permit based on drawings and specifications prepared and stamped by a registered professional geotechnical engineer knowledgeable and experienced in Dam construction, deep excavations, slope stability, and sheeting and shoring.

3. All new excavations on the downstream slope and on the crest, other than that associated with landscaping, should be temporarily shored using a design prepared and stamped by a registered professional geotechnical engineer.

4. New foundations and basement walls should be cast in place reinforced or reinforced concrete masonry units with vertical reinforcing steel placed in the voids and horizontal reinforcing placed in the mortar joints between courses. Foundations and basement walls should be designed by a registered professional geotechnical engineer knowledgeable and experienced in Dam construction, deep excavations, slope stability, and sheeting and shoring.

5. All excavation work and below-grade construction should be under the supervision of a registered professional geotechnical engineer following a Construction Quality Assurance (CQA) Plan approved by the local building authorities. The monitoring should be on a full time basis during the time that the excavation is open. The CQA Plan should include an emergency response plan in the event that breaching or piping begins to occur or if a storm is predicted that will cause the Lake level to rise significantly.

6. During construction of a basement excavation and basement walls, sand or sand bags should be stockpiled on site as part of an emergency response plan to mitigate the potential for a gross breach and/or piping failure.

6.0 CONCLUSIONS

Considering the results of the work performed to date by others, the 1996 field investigation and laboratory testing program, an extensive analysis of the properties of the Embankment Fill and Foundation Till, and a comprehensive stability analysis, we conclude the following:

- Based on the field observations, the relatively low head, the long seepage paths, the age of the Dam and the laboratory testing program, specifically, the properties of the soils comprising the Embankment Fill, we conclude that while there may be occasional zones of localized seepage, there is no evidence to indicate that raising the crest a few feet or a higher Lake level associated with temporary storage of the PMF will lead to a catastrophic piping failure.

- Raising the Dam crest a few feet and postulating a higher Lake level to temporarily store a PMF will not lead to stability failure of the downstream slope of the Dam. This conclusion also applies to those sections of the Dam where the downstream slope has been violated with the emplacement of a structure.

- The stability of the downstream slope of the Dam (with or without an emplaced structure) with the raised crest, postulated PMF and downstream flooding is marginally impacted, but still safe. This same conclusion applies under a postulated earthquake condition.

- The factors of safety against stability failure reported herein are substantially higher than those reported by Dodson-Lindblom Associates (DLA, 1987) and W.S. Gardner and Associates (WSGA, 1995). As all of WSGA's work is based on soil properties and assumptions regarding the phreatic surface reported by DLA; one would expect their results to be practically the same as reported by DLA. Our factors of safety are higher for the following reasons:

- Based on new laboratory test data, coupled with a reinterpretation of previous data, we find the shear strength available to resist catastrophic failure of the Embankment Fill and the Foundation Till to be higher than considered in earlier analysis.

- Based on new data obtained during this investigation from sealed Piezometers and from laboratory tests to measure permeability, we estimate that the phreatic surface will be substantially lower under the postulated PMF condition than considered in previous analysis.

We observe that the Dam has been "abused" from the perspective that the downstream toe has been excavated and replaced with structures and large trees have been permitted to grow on the crest and on the slopes. We have extensive experience evaluating the stability and safety of dams throughout the United States and, we find the "abuses" to the Buckeye Lake Dam to be some of the worst ever witnessed. We make a series of recommendations pertaining to these "abuses" as well as the matter of boat docks on the upstream side of existing and new sheet pile walls. We also conclude and advise that while the popular Non-Suspended Cantilever Docks are technically acceptable from a foundation engineering perspective, particularly with pile supported anchor blocks, they are not acceptable from a dam safety perspective. Existing docks of this type should be removed from the Dam and no new Cantilever Docks should be permitted.

Finally, we conclude that there is no reason, from a geotechnical engineering perspective, why the proposed Phase III Remediation Plan should not proceed following the normal practice of engineering and construction for dams, including a comprehensive quality control/quality assurance program.

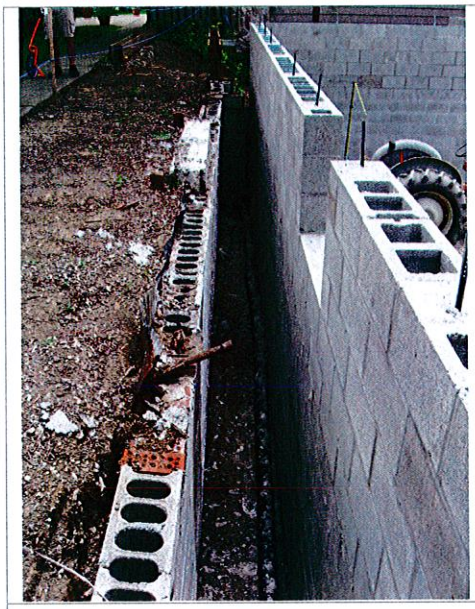
Respectfully submitted,
Paul C. Rizzo Associates

Dr. Paul C. Rizzo, P.E.
Principal-in-Charge

Richard A. Isaac, P.E.
Project Manager

PCR/mfs

Section 2



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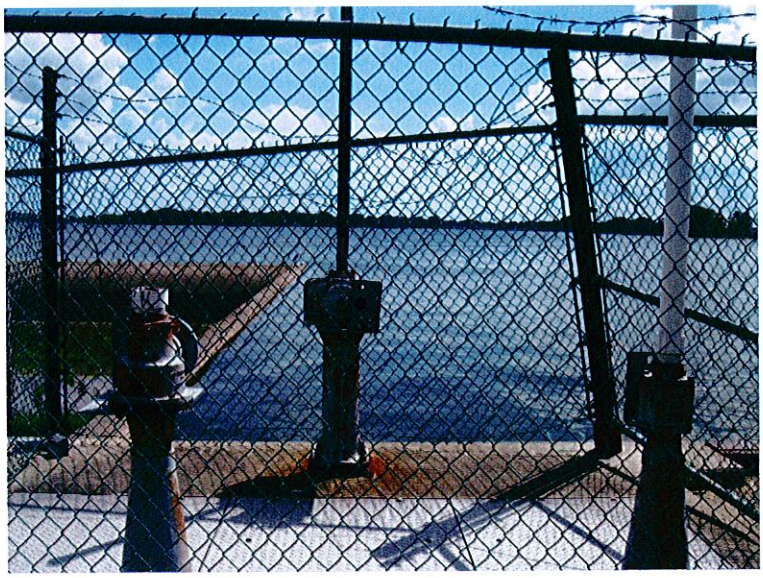

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Photograph No. 38:

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Photograph No. 39:

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Photograph No. 40:

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Photograph No. 42:

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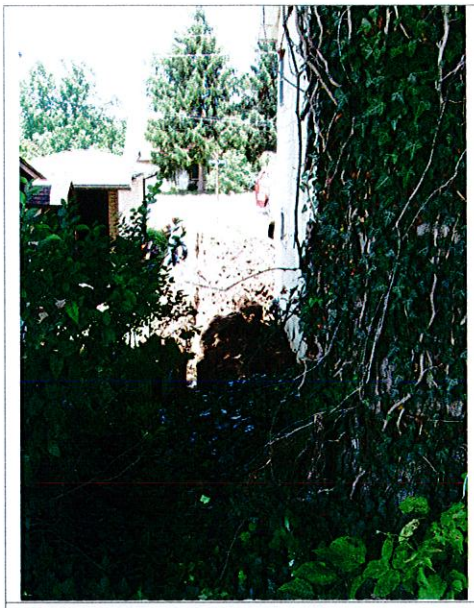

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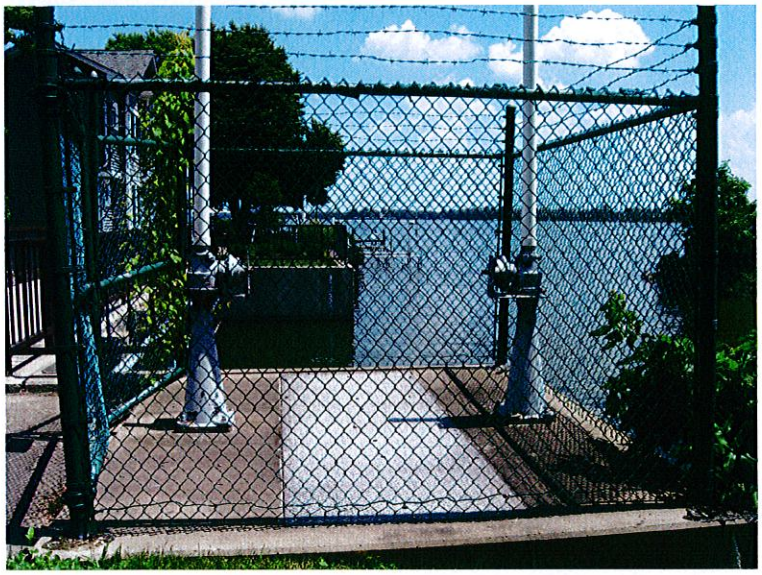

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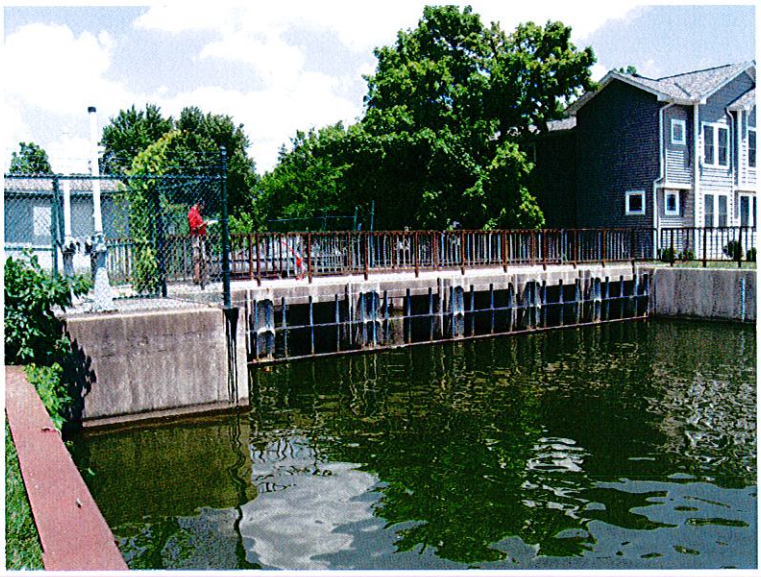

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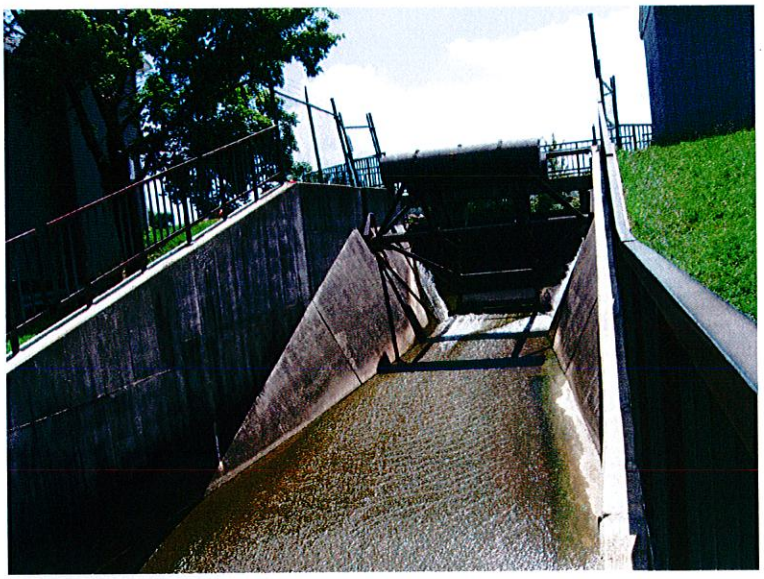

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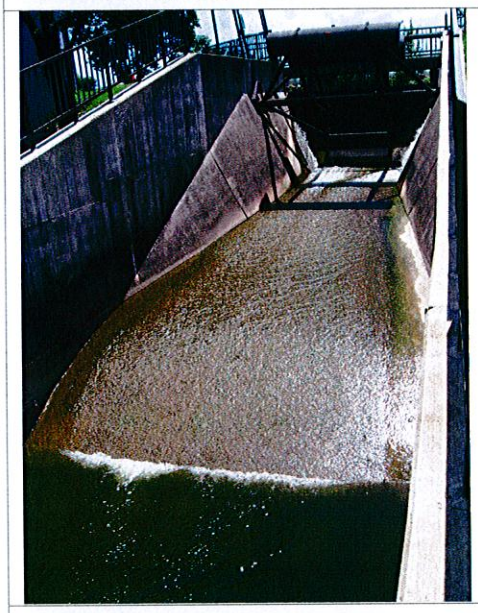

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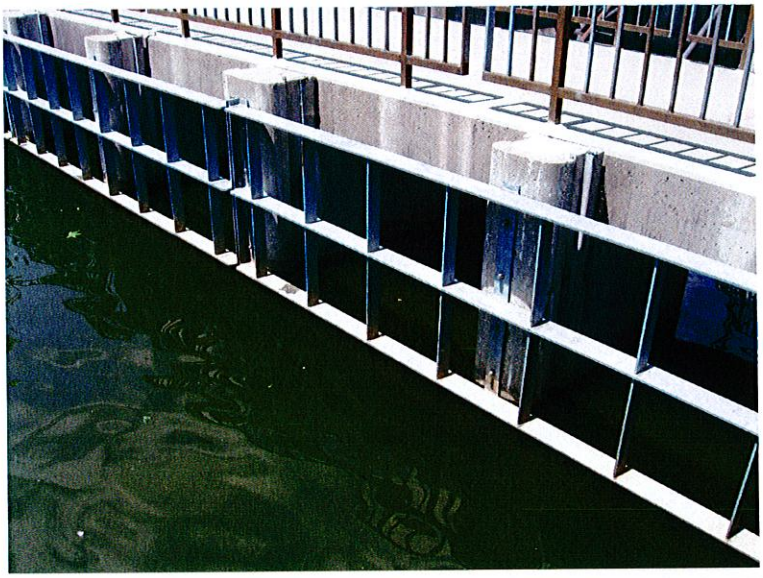

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Photograph No. 62:

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Dam Classification Checklist

Name of Dam: Buckeye Lake Dam | File Number: 9723-004
County: Fairfield & Licking | Date: June 24 & 25, 2010 | Engineer: PMG

The classification of a dam is based on three factors: the dam's height, storage capacity, and potential downstream hazard. The height of the dam is the vertical distance from the crest to the downstream toe. The storage capacity is the volume of water that the dam can impound at the top of dam (crest) elevation. The downstream hazard consists of roads, buildings, homes, and other structures that would be damaged in the event of a dam failure. Potential for loss of life is also evaluated. Various dam failure scenarios must be considered, and they include failures when the dam is at normal pool level and failures during significant flood events. Each of the three factors is evaluated, and the final classification of the dam is based on the highest individual factor. Class I is the highest and Class IV is the lowest. The classification of a dam can change based on future development along the downstream channel.

This checklist is intended to establish or verify the appropriate classification in accordance with the Ohio Administrative Code – it does not necessarily show all potential hazards or the full extent of inundation. In addition, elevations are estimated.

HEIGHT CLASSIFICATION
Dam Height = 14.5 feet

	> 60' - Class I
	> 40' - Class II
	> 25' - Class III
X	≤ 25' - Class IV

STORAGE CLASSIFICATION
Stor. Capacity (top of dam)= 20000 acre-feet

X	> 5000 acre-feet - Class I
	> 500 acre-feet - Class II
	> 50 acre-feet - Class III
	≤ 50 acre-feet - Class IV

EXEMPT~NON-REGULATED

	Height ≤ 6 feet
	Storage ≤ 15 acre-feet
	6 ft. < Height < 10 ft. & Stor. ≤ 50 ac-ft

Height Class: IV
Storage Class: I
Hazard Class (see next page): I
Estimated Population at Risk: (none 1-5 6-15 **16+**)
Final Class: I

Class Changed (Yes, **No**)

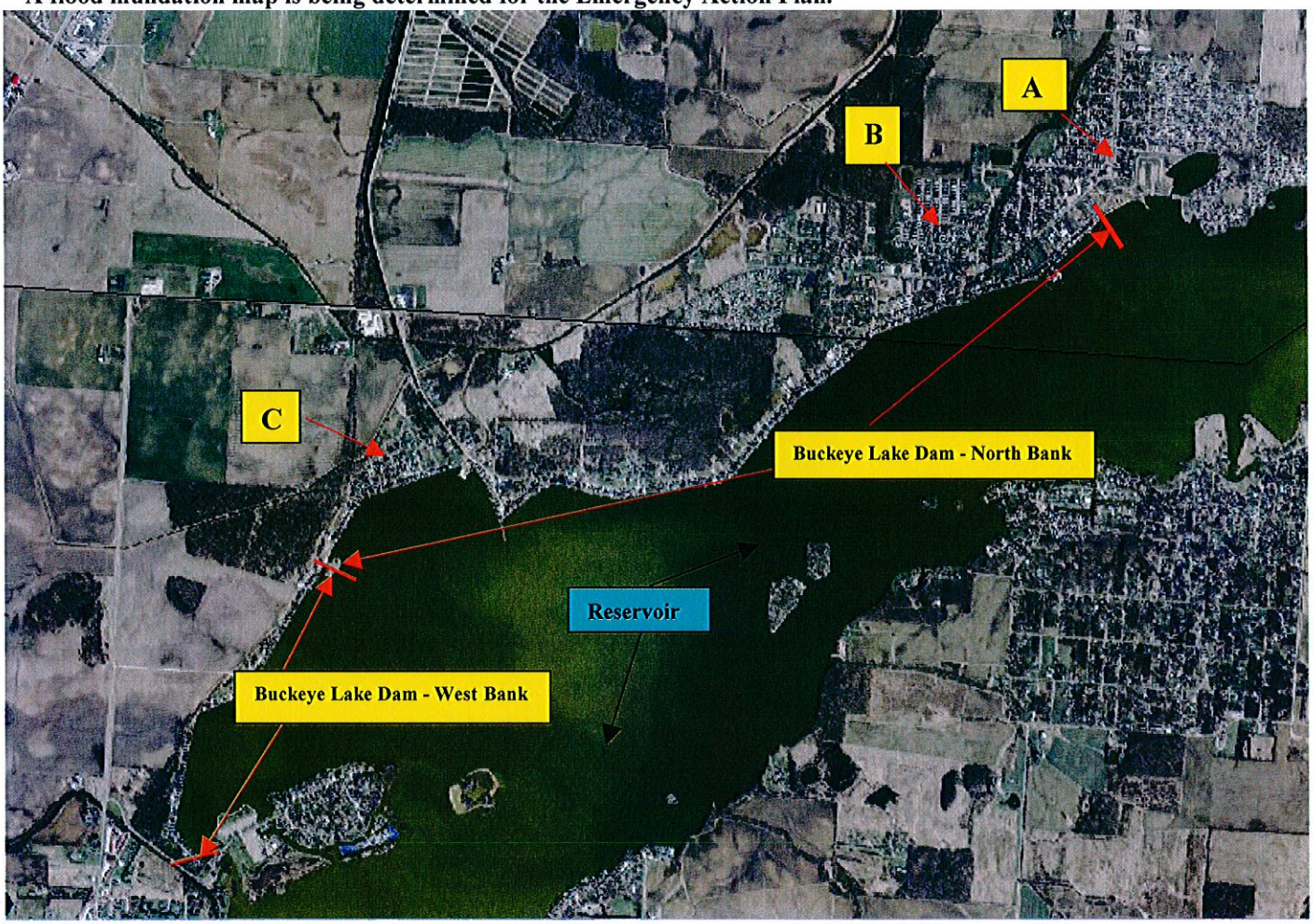
POTENTIAL DOWNSTREAM HAZARD

I	II					III		IV	-	-			
Probable loss of human life	Loss of public water supply or wastewater treatment facility, release of health hazardous waste	Flooding of structure or high-value property	Damage to high-value or Class I, II, III dam or levee	Damage to major road (US or state route), disruption of only access to residential or critical facility area	Damage to railroad or public utility	Damage to rural building, not otherwise high-valued property, or Class IV dam or levee	Damage to local road (county and township)	Loss restricted mainly to the dam or agricultural /rural land	No hazard to structure noted	*No hazard assessment; further investigation needed*	Distance downstream of reservoir to affected structure (feet)	Vertical distance from base of affected structure to adjacent grade (feet)	
											-	-	Reservoir
				A							50	1	S. R. 79
B	B	B			B	B	B				5	1-3	Village of Buckeye Lake
C	C	C			C	C	C				5	1-3	Lakeside Community

This checklist is intended to establish or verify the appropriate classification in accordance with the OAC – it does not necessarily show all potential hazards or the full extent of inundation.

Sketch of Developments Downstream of Dam

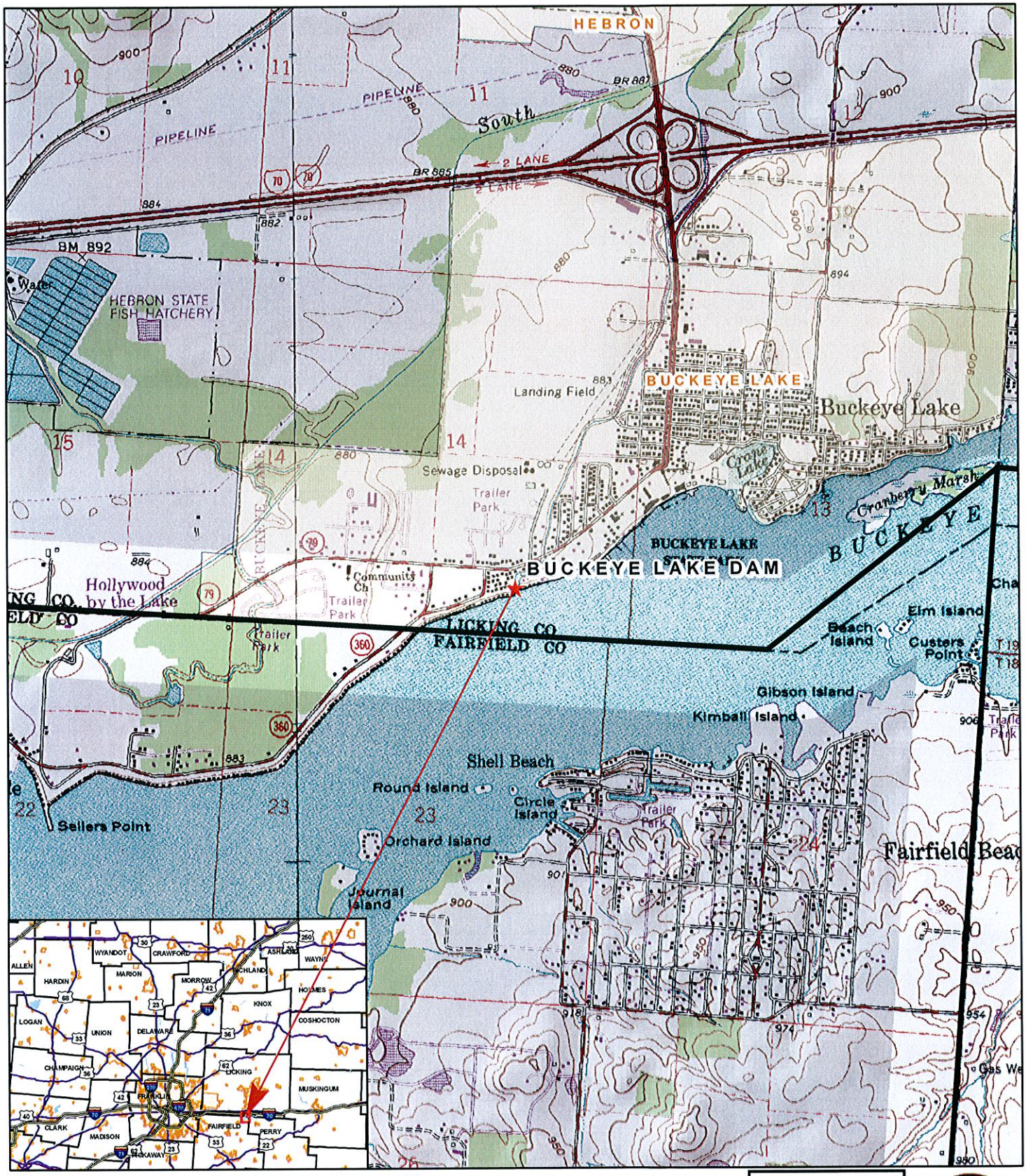
*** A flood inundation map is being determined for the Emergency Action Plan.**



Section 3

LOCATION MAP

BUCKEYE LAKE DAM - 9723-004



N
W E
S

Azimuth: 315 degrees

Altitude: 30.0000 degrees

Miles

0 0.1 0.2 0.4 0.6 0.8 1

Legend

- Dams
- Cities
- County Boundary
- Quad Boundary

DIVISION OF WATER

Feb 28, 2007

Dam Inventory Sheet

Name: BUCKEYE LAKE DAM
File No: 9723-004
National #: OH00474
Reservoir:
Permit No.: N/A
Class (Ht-Vol): I (IV - I)

Owner Information

Owner: ODNR, Division of Parks & Recreation
Owner Type: Public, State
Address: 2045 Morse Road, Bldg. C
Multi-Dams: Yes: 59, Class I:39
Parcel No.:
City: Columbus **State:** OH **Zip:** 43229-6693
Contact: **Phone No.:** 740/467-2690

Location Information

County: Licking **Latitude Deg.:** 39 **Min.:** 55 **Sec.:** 40
Township: Union **Longitude Deg.:** 82 **Min.:** 29 **Sec.:** 18
Stream: Tributary To South Fork Licking River
Nearest Affected Community: Buckeye Lake
Community's Distance from Dam (miles): 0.1
USGS Quad.: Thornville **USGS Basin No.:** 05040006

Design/Construction Information

Designed By: State Of Ohio
Constructed By: State Of Ohio
Completed: 1832 **Plan Available:** YES **At:** ODNR, DIVISION OF WATER
Failure/Incident/Breach:

Structure Information

Purpose: Recreation, Public
Type of Impound.: Dam And Spillway
Type of Structure: Earthfill
Drainage Area (sq. miles): 44.1 **or (acres):** 28224

Embankment Data

Length (ft): 21700 **Upstream Slope:** 1H:1V
Height (ft): 14.5 **Downstream Slope:** 2H:1V
Top Width (ft): 3 **Volume of Fill (cub. yds.):** 375000

Spillway Outlet Works Data

Lake Drain: TWO 60-INCH DIAMETER CONCRETE PIPES
Principal: 33.5-FT WEIR WITH AMIL GATE
Emergency: 472-FT CONCRETE OGEE WEIR
Maximum Spillway Discharge (cfs): 20700 **Design Flood:** 1.0 **Flood Capacity:** .50

Dam Reservoir Data

	Elevation (ft-MSL)*	Area (acres)	Storage (acre-feet)
Top of Dam:	894.4	3030	20000
Emergency Spillway:	892.2		
Principal Spillway:	891.75	2800	14000
Streambed:	879.9		
Foundation:			

*Elevations are not necessarily related to a USGS benchmark

Inspection Information

Inspection History: 6/24/2010 PMG
5/4/2005 PMG
4/14/2000 PMG
6/6/1986

Phase I: 7/7/1978
Other Visits:

Inspection Year: 2009-2010 C - Special Trip

DNRP EAP Disc.: $0.00
Cond.Disc.: $0.00

Operation Information/Remarks

Emergency Action Plan: Yes **Format:** EPP **OMI:**
Last Entry: 7/26/2010

Dam Safety Inspection Checklist

Complete All Portions of This Section (Pre-inspection)

Name of Dam: Buckeye Lake Dam - NORTH BANK
Date of Inspection: JUNE 25, 2010
File Number: 9723-004
Class: I Design Flood: 1.0 Flood Capacity: 50

Licking County Required Action — None ☐ Mon. ☐ Maint. ☐ Eng. ☒

Interview with Owner (at the site):

Owner/Representative present: (Yes, No) Name(s): Mr. Tim Waln
Owner's Name(s): ODNR, Division of Parks & Recreation
Address: 2045 Morse Road, Bldg. C, ,
City: Columbus State: OH Zip (+4): 43229-6693
Contact Person: Tim Waln Telephone: 740/467-2690
Email Address: Tim.Waln@dnr.state.oh.us
Purpose of dam: Recreation, Public

Owner Dam Safety Program

Emergency Action Plan
EAP (document): Yes EAP is currently in draft form Up-to-date? (yes, no) ☐ ☐ ☐ ☒
Exercised: NO and an inundation map is being developed
Downstream development: Houses around the dam are reconstructed and new homes are built often.
Security: Park rangers patrol dam on bikes once per week.

Operation, Maintenance, and Inspection
OMI (document): DRAFT FORM Up-to-date? (yes, no) ☐ ☐ ☐ ☒
Operation of drains/gates
All operable? (yes, no) LAKE drain valves were operated last year.

Normal rate of drawdown: 3 feet in November Emerg. rate of drawdown: No
Accessibility for operation: CREST OF DAM - NEXT TO EMERGENCY SPILLWAY
Maintenance
Frequency of mowing: OFTEN DURING SUMMER MONTHS, PUBLIC ACCESS AREAS, MUD ISLAND SELLERS POINT
Other maintenance: Fill Rodent burrows, tree removal, fill sink holes, clean trashrack gates for principal spillway.
Inspection
Frequency and thoroughness of day-to-day & routine inspections: Bike patrol is a routine visual inspection. No day to day inspection is performed. Downstream residents contact park office if they see a problem.
Frequency and thoroughness of event-driven inspections: SPILLWAYS are checked
Problems found during inspections: Debris under anvil gate

Field Information

Pool Elevation (during inspection): Normal Pool Elevation Time: 8:00 (a.m.) p.m.)
Site Conditions(temp., weather, ground moisture): 75°, clear, dry
Inspection Party: PETER GEORGE, DENA BARNHOUSE, TIM WALN
Maximum Height: 14.5 Feet (measured or inventory appears correct)
Normal Pool Surface Area: 2800 Acres (measured or inventory appears correct)
