KEYSTONE WOODS LAKE DAM (29-5)

2021 Dam Safety Inspection Report

Hamilton County, IN | September 2021

Inspection Date: August 3, 2021

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KEYSTONE WOODS LAKE DAM (29-5) 2021 DAM SAFETY INSPECTION REPORT

HAMILTON COUNTY, INDIANA

SEPTEMBER 2021
INSPECTION DATE: AUGUST 3, 2021

Prepared for:

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Burke Project No. 15-0171.00004

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DISCLAIMER

This report was prepared by Christopher B. Burke Engineering, LLC (Burke) for the Woodlands Home Owners Association, Inc. (WHOA) for Keystone Woods Lake Dam using available data and observed conditions. Burke is not responsible for any conditions that could not be inspected during the field examination due to excessive vegetation, inundation, or other visual obstructions.

Information describing possible solutions to problems and concerns, repairs, and emergency actions are intended for guidance only. The dam owner should obtain detailed design plans and specifications from a qualified professional engineer experienced in dam design and construction before performing any repairs or modifications to the dam or its appurtenant works. Only qualified contractors should be employed to install necessary measures.

Permits from federal, state or local agencies may be required to perform dam remedial work or repairs, depending on the magnitude of the repairs. The dam owner should seek professional assistance in determining the need for permits.

EXECUTIVE SUMMARY

Keystone Woods Lake Dam, also referred to as Woodland Addition Lake Dam, is located a half-mile east of Keystone Parkway between East 106th Street and East 116th Street in Carmel, Indiana. It is located in Section 5, Township 17N, Range 4E of the Public Land Survey System as shown on the Fishers USGS Quadrangle Map. The dam is an earthen embankment constructed across a tributary to Blue Woods Creek. The dam is collectively owned by the Woodland Home Owners Association, Inc and adjacent private properties.

According to the Indiana Department of Natural Resources (IDNR) records, Keystone Woods Lake Dam was constructed immediately downstream of Lake Woodland Dam, an unpermitted structure constructed in the late 1960's, for recreation and aesthetics. Records indicate that the embankment is approximately 14 feet high and 420 feet long, not including the auxiliary spillway. The crest is approximately 10 feet wide. The total surface area is about 53 acres which includes the upstream lake. For the purpose of this inspection report, overall spillway capacity, and recommendations, it is the opinion of Burke that the two lakes be considered one. The principal spillway is comprised of a 2.5-foot by 5-foot reinforced concrete drop inlet box with a 24-inch diameter discharge pipe. The auxiliary spillway is a 108-foot-wide open channel constructed on fill and lined with gravel and riprap.

Burke personnel performed a visual dam safety inspection of Keystone Woods Lake Dam on August 3, 2021. The inspection was performed by Jeffrey D. Fox, P.E. and Joshua L. Erwood, E.I. both having experience in dam design, construction, and inspection. The August 3, 2021 dam safety inspection revealed that the overall condition of the dam is considered "**Conditionally Poor**" based on IDNR rating criteria. Rehabilitation of the dam is needed to address surficial deficiencies and apparent lack of spillway capacity. Monitoring, maintenance, repairs, engineering analyses, and improvements are required to achieve an overall "Satisfactory" rating and improve the safety and performance of the dam. The risk of Type 1 and Type 2 dam failure is considered low to medium.

The component ratings, overall conditions rating, and recommendations to achieve a "Satisfactory" rating are summarized in the table on the next page.

Component	Rating	Recommendations	Schedule	Importance
Upstream Slope	Deficient	• Remove trees and brush from the slope and within 25 feet of the slope and abutments in accordance with the Indiana Dam Safety Inspection Manual • Replace gravel covered slope with grass, riprap or other erosion resistant material • Relocate watercraft, docks, and furniture off the dam embankment and onto natural ground • Initiate rodent control program, backfilling burrows in accordance with the Indiana Dam Safety Inspection Manual • Monitor right side wooden seawall for deflection and deterioration; notify a registered professional engineer of observed changes	• 2 years • 2 years • Immediately • Ongoing • Ongoing	• Medium • Medium • Low • Low • Low
Crest	Deficient	• Remove trees and brush from the crest in accordance with the Indiana Dam Safety Inspection Manual • Remove concrete patio in its entirety and reestablish dam crest elevation by backfilling with appropriate embankment fill or perform an engineering evaluation to confirm structural integrity of feature and potential impact on the embankment • Seed bare area near left abutment	• 2 years • 2-4 years • Within 1 year	• Medium • High • Low
Downstream Slope	Deficient	• Remove trees and brush from the slope and within 25 feet of the slope and abutments in accordance with the Indiana Dam Safety Inspection Manual • Remove landscaping, decks, steps, and other encroachments and backfill as necessary with appropriate embankment fill or perform an engineering evaluation to confirm structural integrity of feature and potential impact on the embankment • Seed sporadic bare areas on right and left sides	• 2 years • 2-4 years • 2 years	• Medium • Medium • Low
Seepage	Good	• Monitor downstream slope and around concrete patio, steps, and decks for evidence of seepage; notify a registered professional engineer of observed changes	• Ongoing	• Low
Principal Spillway	Acceptable	• Seal leaking joints in concrete inlet riser • Clean and paint metal trash rack	• 2 years • 2 years	• Low • Low
Auxiliary Spillway	Deficient	• Add appropriately sized riprap or other armoring to the spillway inlet section for erosion protection • Seed bare spots on left side • Evaluate options for removal of the large tree stump on left side and other tree stumps on right side in riprap; monitor areas adjacent to the stumps for seepage or other surficial deficiency monthly and/or after large rain events and notify a registered professional engineer of observed changes	• 2-4 years • 2 years • 2 years	• Low • Low • Low
Maintenance and Repairs	Deficient	• Perform spillway capacity analysis in accordance with current IDNR requirements • Retain a geotechnical engineer to evaluate the stability of the dam under various loading conditions • Conduct a video inspection of the principal spillway outlet pipe; subsequent inspections should be performed every six years • Multiple owners to work to resolve dam inspection recommendations	• 2 years • 2-4 years • 2 years • Ongoing	• High • High • Low • High
Overall Conditions	**Conditionally Poor**	• **See above**	• N/A	• N/A

Notes:

1. Possible Component Ratings: Good, Acceptable, Deficient, Poor
2. Possible Overall Conditions Ratings: Satisfactory, Fair, Conditionally Poor, Poor, Unsatisfactory

1.0 BACKGROUND

1.1 PROJECT LOCATION

Keystone Woods Lake Dam is an earthen embankment across a tributary to Blue Woods Creek constructed for aesthetic and recreational purposes. The dam is located in Carmel, Indiana about a half-mile east of Keystone Parkway between East 106th Street and East 116th Street. It is located in Section 5, Township 17N, Range 4E of the Public Land Survey System as shown on the Fishers USGS Quadrangle Map. The dam is collectively owned by Woodland Home Owners Association, Inc (WHOA) and adjacent private properties as referenced in a letter from the Indiana Department of Natural Resources (IDNR) dated July 31, 2020. See **Appendix 1**.

1.2 FILE REVIEW

Unless otherwise noted, information presented in this report is from the visual inspection, a review of information contained in IDNR files, Burke's files, aerial photography, topographic information, and maps publicly available through the Indiana Spatial Data Portal or Indiana Map. Primary sources of information include:

- *Woodland Addition Lake Dam Phase I Inspection Report*, prepared by GRW Engineers, Inc. for the United States Army Corps of Engineers (USACE) – Louisville District (1980)
- *Hydraulics and Hydrology for Woodland Addition Lake Dam*, prepared by Clyde E. Williams and Associates, Inc. (1983)
- *High Hazard Dam Inspection Report Keystone Woods Lake Dam,* prepared by Cosmopolitan Consulting Engineers, Inc. (2004)
- *Keystone Woods Lake Dam Inspection Biennial Inspection Report,* prepared by Fink Roberts & Petrie, Inc. (FRP) (2009, 2011)
- *Dam Inspection Report Keystone Woods Lake Dam,* prepared by VHW Engineering Company (2016)
- Dam inspection reports and correspondence prepared by IDNR from 1981 to 2015.
- *Keystone Woods Lake Dam (29-5) 2019 Dam Safety Inspection Report,* prepared by Christopher B. Burke Engineering, LLC (Burke) (2019).
- "Wabash Valley Seismic Zone". Central United States Earthquake Consortium. Accessed 23 September 2021 <https://cusec.org/wabash-valley-seismic-zone/ >.
- Gray, Walter E. and John C. Steinmetz. "Map of Indiana Showing Known Faults and Historic Earthquake Epicenters having Magnitude 3.0 and Larger". Indiana Geological Survey. Miscellaneous Map 84, revised 2015.
- "2018 National Seismic Hazard Model for the Conterminous United States, Peak Horizontal Acceleration with a 2% Probability of Exceedance in 50 Years, NEHRP Site Class D". United States Geological Survey. Accessed 23 September 2021 <https://www.sciencebase.gov/catalog>.
- "Earthquake Hazard Maps". Federal Emergency Management Agency. Accessed 23 September 2021. <https://www.fema.gov/earthquake-hazard-maps>.

1.3 HISTORY OF THE DAM

According to IDNR records, Lake Woodland Dam, located upstream of Keystone Woods Lake Dam, was constructed without permit approval in the late 1960's by developer Ralf Wolfong and his engineer Ken Thompson. Shortly after the construction of Lake Woodland Dam, Ken Thompson formed a partnership with John Schutz called Schutz & Thompson, Inc. Schutz & Thompson purchased the land south of Lake Woodland Dam to develop The Woodlands subdivision. In July 1972, Schutz & Thompson received approval from IDNR,

under Docket No. D-3086, for construction of Keystone Woods Lake Dam, referred to at that time as Woodlands Addition Lake Dam. The engineer of record was Clyde E. Williams & Associates, Inc. (CW). The dam was reportedly constructed between 1973 and 1974 without supervision from the design engineer.

The 1980 Phase 1 report outlined discrepancies between their measurements and the documents of record. The report indicated that the as-built dam crest was 1.8 feet lower than the approved design plans and that the spillways would only be able to safely pass 38% of the Probable Maximum Flood (PMF). In 1983, CW completed a hydrologic and hydraulic evaluation for modifications to the dam and spillway to address the inadequate spillway capacity noted in the Phase 1 report. Plans and technical specifications for raising the embankment crest, lowering the principal spillway crest, widening the auxiliary spillway, and lowering the auxiliary spillway crest were prepared by CW. Approval for construction of these modifications was issued by IDNR in March 1984 under Docket No. D-3086 (revised I). Construction of these modifications was apparently completed in November 1984.

The 2003 Labor Day flood event resulted in significant erosion from activation of the auxiliary spillway. Following the event, the erosion in the auxiliary spillway was backfilled with clay and armored with riprap. In a June 2005 letter to WHOA in response to receiving the 2004 biennial inspection report which documented the 2003 Labor Day flood, IDNR recommended that a new hydrologic and hydraulic analysis be performed to address variations in drainage area previously determined as well as evaluate the anticipated performance of erosion protection through the auxiliary spillway during maximum discharge. No records of these evaluations were found.

In April 2015, a sinkhole formed above the principal spillway. A subsequent video inspection of the principal spillway outlet pipe revealed a hole in the bottom of the pipe likely to have contributed to the sinkhole. Due to the emergency nature of this condition, Burke submitted a letter request to IDNR on April 10, 2015, for Construction in a Floodway Permit approval in lieu of the formal permit application. Approval from IDNR was issued on April 15, 2015, referencing CTS-3965-Basin 14-Hamilton County Unnamed Tributary Blue Woods Creek. Midwest Mole, Inc. slip-lined the 42-inch diameter corrugated metal pipe (CMP) with a 24-inch diameter HOBAS centrifugally cast fiberglass reinforced polymer mortar (CCFRPM) pipe and backfilled the sinkhole. The work was considered substantially complete on October 8, 2015.

Following the 2019 dam safety inspection, WHOA facilitated several meetings with the other dam owners to review the recommendations from the 2019 dam safety inspection. WHOA prepared a drawdown plan for the lake, which is kept on file in the clubhouse. WHOA also significantly improved the areas around the principal spillway outlet and auxiliary spillway channel in November 2019 and April 2020, removing trees, brush, and unwanted vegetation encroachments. In addition, watercraft previously stored with the auxiliary spillway channel were removed. In July 2020, Wharff Excavating, LLC installed geotextile blankets and riprap armoring to the spillway channel and side slopes. At the principal spillway outlet, the deteriorated concrete outlet channel was replaced with riprap armoring and adjacent eroded areas were repaired.

In August 2020, a portion of the timber seawall along the right side of the dam deteriorated and sloughed into the lake. The property owner, in conjunction with WHOA, contacted IDNR with their plan to replace approximately 24 feet of the seawall with new 6-inch by 6-inch treated posts similar in nature to the original wall. Due to the urgency of the repair, IDNR did not require a formal permit submittal. The work was completed by Outdoor Designs, Inc. shortly thereafter.

1.4 PREVIOUS INSPECTIONS

In accordance with Indiana Code 14-27-7.5-9, high hazard dam owners must have a licensed professional engineer inspect the dam at least one time every two years and submit a report regarding the structure's condition. Prior to enactment of the code in 2002, Keystone Woods Lake Dam was inspected by IDNR nearly every year from 1984 to 1991. IDNR then performed inspections in 1991, 1995, 1997, and 2000. The dam was inspected by Cosmopolitan Consulting Engineers, Inc. in 2004. Fink Roberts and Petrie, Inc. inspected the

dam in both 2009 and 2011. VHW Engineering Company inspected the dam in 2016. Burke performed the last inspection August 5, 2019.

Table 1: Previous Inspection Ratings (1997 - 2019)

Component	Condition Ratings Per Inspection						
	1997	2000	2004	2009	2011	2016	2019
Upstream Slope	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Good	Deficient
Crest	Deficient	Deficient	Acceptable	Acceptable	Acceptable	Deficient	Deficient
Downstream Slope	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Deficient
Seepage	Good	Good	Good	Acceptable	Acceptable	Acceptable	Good
Principal Spillway	Deficient	Deficient	Good	Acceptable	Acceptable	Acceptable	Deficient
Auxiliary Spillway	Acceptable	Acceptable	Good	Deficient	Deficient	Deficient	Deficient
Maintenance and Repairs	Deficient	Deficient	Acceptable	Acceptable	Acceptable	Acceptable	Deficient
Overall Conditions	**Conditionally Poor**	**Conditionally Poor**	**Satisfactory**	**Fair**	**Fair**	**Fair**	**Poor**

Notes:
1. Possible Component Ratings: Good, Acceptable, Deficient, Poor
2. Possible Overall Conditions Ratings: Satisfactory, Fair, Conditionally Poor, Poor, Unsatisfactory

1.5 HISTORICAL EVENTS

The 2003 Labor Day event resulted in activation of the auxiliary spillway and erosion damage downstream. There were no other major historical events or records of peak water levels or discharges at the site noted in IDNR's file.

1.6 EMERGENCY PREPAREDNESS

Keystone Woods Lake Dam is classified as a high hazard structure. Although there is mention in the 2009 inspection report by FRP of an Emergency Action Plan having been prepared, no document was found in either IDNR's file or the owner's file. However, WHOA is currently preparing an Incident and Emergency Action Plan (IEAP) for the dam, coordinating the documentation with Hamilton County Emergency Management, with an anticipated completion in 2022. The dam is accessed by foot since there are no roads leading to the dam. No auxiliary power is necessary because the dam and spillways do not have electrical components. In 2019, the owner prepared a drawdown plan which is kept in the WHOA clubhouse.

1.7 HYDROLOGY

Dams classified as high hazard by IDNR are required to safely pass the rainfall runoff from the 100% PMP event without overtopping. A PMP storm event is the Probable Maximum Precipitation that can be expected during specific storm durations. The design storm duration is generally dictated by the size of the dam's watershed. For the location and size of the Keystone Woods Lake Dam watershed, the 6-hour PMP (10 square mile basin) is 26.9 inches. Several hydrologic and hydraulic analyses have been performed with varying results due to differences in watershed size, top of dam and spillway elevations, and rainfall depths. A summary of these analyses is provided below.

The 1972 Engineer's Report for Keystone Woods Lake Dam, prepared by CW, recorded a surface area of approximately 7 acres at normal pool, at an elevation of 774.5 feet mean sea level (MSL), with a corresponding storage volume of 19.2 acre-feet. The contributing watershed was 0.76-square mile (485 acres). Flood routing calculations, performed using a 6-hour rainfall depth of 25.5 inches, resulted in a maximum pool elevation of 779.85 feet (MSL) which is 0.15-foot below the top of dam.

The 1980 Phase 1 report noted a few differences from the original design based on measurements and calculations. The Phase 1 report found the top of dam elevation to be 778.2 feet (MSL), the auxiliary spillway crest to be 774.8 feet (MSL), and the contributing drainage area to be 1.1 square miles. In addition, the Phase 1 report noted that the flood routing should have been evaluated based on a 6-hour rainfall depth of 27 inches. As a result of these differences, the Phase 1 report determined that the overall spillway capacity was inadequate, passing only 38% of the recommended design flood.

In order to address the inadequate spillway capacity determined in the Phase 1 report, CW designed modifications in 1983 that included raising the dam crest to 778.7 feet (MSL), lowering the principal spillway crest to 774.2 feet (MSL), widening the auxiliary spillway eight feet, and lowering the auxiliary spillway crest to 774.6 feet (MSL). CW used a drainage area of 0.67-square mile and a 6-hour rainfall depth of 26.9 inches to determine that the dam could pass 100% of the recommended design flood without overtopping.

It should be noted that the 2015 principal spillway repair work included slip-lining the existing 42-inch diameter CMP with a 24-inch diameter CCFRPM pipe though no hydraulic analysis appears to have been completed.

1.8 GEOLOGIC, SEISMIC AND GEOTECHNICAL CONSIDERATIONS

The following paragraph describing geologic features is from the Phase 1 report:

"The site is located within the limits of the glacial till deposited when the various ice sheets receded. In this area, these glaciers left unconsolidated deposits of granular materials up to 150-ft. thick. The deposits are mostly loam till and are part of the Trafalgar formation. The site is underlain by bedrock of the Devonian period and consists mostly of limestone and dolomite of middle Devonian age. The Fortville Fault is located approximately ten miles to the southeast and extends in the southwesterly-northeasterly direction. The dam is within Seismic Zone 2 according to the Seismic Zone Map of contiguous States. Zone 2 indicates that moderate damage may result from the expected seismic activity."

Original construction drawings for the Keystone Woods Lake Dam include five soil borings that appear to have been taken in the vicinity of the embankment as well as in the lake area. However, no geotechnical engineering evaluation of the structure's stability is known to exist. Geotechnical engineering considerations should be made in accordance with the following guidelines outlined by IDNR and USACE:

- *General Guidelines for New Dams and Improvements to Existing Dams in Indiana, 2001 edition*
- *General Design and Construction Considerations for Earth and Rock-Fill Dams (U.S. Army Corps of Engineers, Engineering and Design Manual EM 1110-2-2300), dated July 30, 2004*

According to the Federal Emergency Management Agency (FEMA), the dam is within the limits of an area where seismic design category (SDC) "A" is applicable. This category is the lowest risk and is described as an area that "very small probability of experiencing damaging earthquake effects." The USGS has determined that the 50-year two-percent probability of exceedance peak ground acceleration near Keystone Woods Lake Dam is approximately 0.1g, where "g" is standard gravity. Although the perceived seismic risk is low, the dam is in an area that could be impacted by earthquakes from the Wabash Valley Seismic Zone in southwest Indiana and southeast Illinois and the New Madrid Seismic Zone centered in southeast Missouri, according to information from the Central United States Earthquake Consortium and the USGS. Three earthquakes of magnitude 7.3 or greater occurred near New Madrid, Missouri in 1811 and 1812 which were undoubtedly felt in central Indiana.

Indiana Geological Survey (IGS) records indicate that the closest earthquakes to the dam that occurred in Indiana with magnitude 3.0 or greater were:

- Magnitude 3.2 near Shelbyville in Shelby County on May 8, 1906
- Magnitude 3.8 near Shelbyville in Shelby County on September 12, 2004
- Magnitude 3.8 near Greentown in Howard County on December 30, 2010

Several other earthquakes have occurred in Indiana and Illinois, many since the dam was constructed. The most notable is a magnitude 5.2 that occurred on April 18, 2008, near Mount Carmel, Illinois about 138 miles southwest of Keystone Woods Lake Dam. Most recently, a magnitude 3.8 earthquake occurred northeast of Montezuma, Indiana on June 17, 2021 about 68 miles southwest of Keystone Woods Lake Dam. All earthquakes noted were reported to the USGS as felt in Hamilton County. There has been no documented damage to Keystone Woods Lake Dam because of earthquakes.

1.9 DAM AND LAKE CHARACTERISTICS

Keystone Woods Lake Dam is an approximately 14-foot-tall earthen embankment that is approximately 420 feet long, not including the auxiliary spillway, and has a crest width of 10 feet. The upstream and downstream slopes are approximately 3:1 (H:V). Although original construction drawings appear to show a toe drain, no outlet was observed in the field. For reference, left and right are based on a view looking downstream. For Keystone Woods Lake Dam, left and right correspond to east and west, respectively.

The principal spillway is comprised of a 2.5-foot by 5-foot reinforced concrete drop inlet box with an approximately 70-foot long, 24-inch diameter CCFRPM outlet pipe located near the center of the dam. The outlet pipe discharges into an armored channel consisting of a short CMP section at the upstream end followed by gabion mattresses. The auxiliary spillway is a 108-foot-wide open channel constructed on fill and lined with gravel and riprap located adjacent and to the left of the principal spillway.

The total surface area of the lake is about 53 acres which includes the upstream impoundment. For the purpose of this inspection report, overall spillway capacity, and recommendations, it is the opinion of Burke that the two lakes be considered one due to the uncertainties associated with current condition of the upstream embankment as well as the hydraulic connectivity between the lakes.

1.10 DOWNSTREAM FEATURES

The valley downstream of the dam is relatively broad and flat. The channel downstream known as Blue Woods Creek goes through a wooded area between tennis courts and a community swimming pool before it is piped under Lakeshore Drive East. The creek continues through residential and industrial areas for approximately 2.7-miles until its confluence with White River. Several houses located along Blue Woods Creek are likely within the dam breach inundation area.

2.0 OBSERVED CONDITIONS

Burke personnel performed a visual dam safety inspection of Keystone Woods Lake Dam on August 3, 2021. The inspection was performed by Jeffrey D. Fox, P.E. and Joshua L. Erwood, E.I., both having experience in dam design, construction, and inspection.

The weather conditions during the inspection were mostly clear with a temperature of approximately 68 degrees Fahrenheit. The principal spillway was not engaged at the time of the inspection. The water surface elevation was measured to be about 2 inches below normal pool.

Narrative descriptions of the inspection findings are provided below. The IDNR Inspection Report Form summarizing the inspection findings and containing descriptions of the rating criteria can be found in **Appendix 2**. A copy of the IDNR Inspection Report Form from the 2019 biennial inspection report is provided in **Appendix 3**. Refer to **Appendix 4** for photographs taken the day of the inspection. **Appendix 5** contains the dam inspection checklist completed during the inspection. Refer to the Exhibits section of this report for a topographic map, an aerial map showing the location of the dam, and a map showing the approximate locations of inspection findings.

2.1 UPSTREAM SLOPE

The upstream slope is generally grass-covered but has a large area on the left side of the dam that is covered with gravel. There is a timber seawall along the upstream slope right of the principal spillway that extends roughly 4 feet above the normal pool elevation. The timber seawall appeared to have a slight deflection toward the lakeside. A rock seawall, approximately 2.5 feet above the normal pool elevation, is located near the left abutment area. There were several encroachments throughout the upstream slope such as docks, fences, watercraft, and patio furniture. In addition, a concrete patio was cut into the embankment near the principal spillway. Trees, brush, and residential landscaped areas were observed sporadically along property lines of owners along the embankment. There are two large trees in the gravel area on the left side of the embankment and another tree on the right side of the dam. There is a large bush on the left side near the waterline and one the right side of the dam. Please note that a previously observed scarp on the left side was not seen during the inspection, likely covered by the large bush. A few animal burrows about 1-inch in diameter were noted near the fence on the left side of the dam and in the gravel covered slope. A small animal run and a few burrows were found behind the timber seawall on the right side. The upstream slope was considered **"Deficient"** according to IDNR rating criteria.

2.2 CREST

Grass cover on the crest was generally adequate except for a bare area near the left abutment fence. There are two fire pits encroaching on both sides of the dam. There are trees and bushes near both right and left abutments along fences. A landscaped area and a stored canoe were observed near the fence on the left side of the embankment. The concrete patio built into the embankment right of the principal spillway has resulted in a loss of crest width and freeboard. The loss of freeboard was estimated to be about 6 to 12 inches. The crest was considered **"Deficient"** according to IDNR rating criteria.

2.3 DOWNSTREAM SLOPE

The downstream slope was adequately covered with grass except for a few minor bare spots. One bare area was 3-foot by 3-foot next to a fence on the right side. Trees and brush were observed growing on the downstream slope at two areas on the middle-left embankment. Trees and brush were also observed near the left and right abutments. Some areas were unable to be thoroughly inspected due to dense vegetation, but the slope generally appeared hummocky throughout. Several encroachments were observed on the right side of the dam including landscaping, fencing, steps, and a wood deck. A landscaped area with trees and bushes was observed near the fence on the left end. The downstream slope was considered **"Deficient"** according to IDNR rating criteria.

2.4 SEEPAGE

No seepage or wet areas were observed. It appeared that the natural ground in many areas was above normal pool. Seepage was considered **"Good"** according to IDNR rating criteria.

2.5 PRINCIPAL SPILLWAY

The visible portions of the principal spillway concrete riser structure showed minor surface deterioration, consistent with its age, with a thin layer of dried film from operation. A smaller diameter pipe was observed directly across from the outlet pipe, near the bottom of the riser, though it appears to have been capped and no longer operational. Possible seepage through the concrete structure was observed on the right side and left sides at the joints between the riser and retaining wall. Minor surface rust was observed on the inlet's metal trash rack. The principal spillway outlet and adjacent areas were recently cleared, deteriorated concrete replaced with gabion mattresses, and eroded channel downstream repaired. The metal end section has a rusted invert and a small hole on the side. The interior of the outlet pipe itself could not be thoroughly, thought, it should be noted that rathe reduction in cross sectional area of the pipe during the 2015 slip-lining work likely reduced its capacity. The principal spillway was considered **"Acceptable"** according to IDNR rating criteria.

2.6 AUXILIARY SPILLWAY

The open channel auxiliary spillway is located near the center of dam and appears to have been constructed on fill. The surface of the channel is covered in gravel and riprap which was observed to be sparse at the inlet section. There was a large tree stump left over from tree removal on the left side and a few smaller tree stumps within the riprap on the right side. A few small bare spots were observed on the left side slope at the interface with the downstream slope. As noted previously, there is uncertainty with the spillway system's (principal spillway and auxiliary spillway) ability to safely pass the runoff from the 100% PMP storm event without overtopping the embankment. The auxiliary spillway was considered **"Deficient"** according to IDNR rating criteria.

2.7 MAINTENANCE AND REPAIRS

Keystone Woods Lake Dam has seen significant improvement regarding maintenance and repairs, particularly through the auxiliary spillway and at the outlet of the principal spillway. In addition, WHOA prepared a drawdown plan for the purpose of lowering the lake for maintenance or for emergency situations. However, several natural and manmade encroachments remain that will require enhanced monitoring, additional studies, removal and/or rehabilitation. In particular, trees, brush, and landscaping located on several portions of the dam. The concrete patio cut into the embankment effectively lowers the crest elevation of the dam. Further, critical analyses are needed to determine the actual spillway capacity and factors of safety for embankment slope stability in accordance with IDNR guidelines.

Based on the 2019 dam safety inspection review letter from IDNR dated July 31, 2020, multiple properties have been identified as owning parts of the dam. When there are multiple owners of a dam, no one party has authority to conduct work, limiting the dam from receiving proper maintenance. Thus, all owners have to work together to remedy dam safety issues. Keystone Woods Lake Dam was considered to be maintained in **"Deficient"** condition according to IDNR rating criteria.

2.8 OVERALL CONDITION

The overall condition of Keystone Woods Lake Dam was considered **"Conditionally Poor"** according to IDNR rating criteria. Based on IDNR guidelines, the potential overall condition ratings include, from worst to best, Unsatisfactory, Poor, Conditionally Poor, Fair, and Satisfactory. A "Conditionally Poor" dam is one that "A potential dam safety deficiency is recognized for unusual loading conditions which may realistically occur during the expected life of the structure. Conditionally Poor may also be used with uncertainties exist as to critical analysis parameters which identify a potential dam safety deficiency; further investigations and studies are necessary". This rating primarily reflects uncertainties in spillway capacity and embankment stability as well as encroachments, both manmade and natural.

3.0 RISK OF DAM FAILURE

Burke utilized the results of the dam inspection to evaluate the potential for failure of Keystone Woods Lake Dam. There are typically two types of dam failures that could occur:

- Type 1 – component failure of a structure that does not result in a significant release from the lake
- Type 2 – uncontrolled breach failure of a structure that results in a significant release from the lake

Refer to **Appendix 6** for more details of types of failure and definitions of risk levels. Burke evaluated the risk for both types of failures.

3.1 RISK OF DAM COMPONENT FAILURE (TYPE 1)

Burke evaluated the risk for Type 1 component failure at Keystone Woods Lake Dam after the inspection was completed by considering possible failure of each component. The components that were evaluated include the upstream embankment slope, downstream embankment slope, embankment crest, principal spillway, auxiliary spillway, and dam abutments. After considering the dam's current condition and the potential maximum loadings, Burke has estimated the risk of failure for each component as shown below. The estimated risk levels are based on Burke's visual observations during the inspection and do not necessarily account for uncertainties in critical analysis parameters which could impact the risk level.

Component	Risk Level
Upstream slope	Medium
Downstream slope	Medium
Embankment crest	Medium
Principal spillway	Low
Auxiliary spillway	Medium
Dam abutments	Low

3.2 RISK OF UNCONTROLLED BREACH FAILURE (TYPE 2)

Burke evaluated the potential for an uncontrolled breach failure of Keystone Woods Lake Dam after the inspection was completed by considering possible failure modes. Embankment dams such as Keystone Woods Lake Dam generally have three potential modes of uncontrolled breach failure: 1) hydraulic failure, 2) seepage failure, and 3) structural failure. The factors that pose a risk to embankment dams and can result in dam failure can be categorized into four groups: 1) structural factors, 2) natural factors, 3) human factors, and 4) operating factors. Refer to Appendix 6 for more information about failure modes and risk factors.

At the present time, Keystone Woods Lake Dam appears to have a low to medium risk for uncontrolled breach failure. Structural factors are summarized below.

Structural factors	Risk Level	Failure Mode
Vegetation on embankment crest and slopes	Low	Structural/Seepage
Manmade encroachments on embankment	Medium	Hydraulic/Structural
Small animal burrows	Low	Seepage
Principal spillway inlet joints	Low	Seepage

Natural, human, and operating risk factors were also considered. Severe storms present a medium risk to Keystone Woods Lake Dam due to the perceived capacity of the lake and spillway system. Earthquakes present a low risk, but the dam's proximity to the Wabash Valley and New Madrid Seismic Zones should not be ignored.

It should be noted that there is always some risk for failure at all dams and that risk cannot be completely eliminated.

Natural factors	Risk Level	Failure Mode
Severe storms	Medium	Hydraulic
Earthquakes	Low	Structural

Human factors	Risk Level	Failure Mode
Vandalism	Low	Structural
Terrorism	Low	Structural

Operating factors	Risk Level	Failure Mode
Maintenance Practices	Low	Hydraulic/Structural
Access	Low	Hydraulic/Structural

4.0 RECOMMENDATIONS

This section presents Burke's recommendations for action based on the findings of the dam safety inspection, Burke's assessment of the risk of dam failure at Keystone Woods Lake Dam, and Burke's assessment of the priority for repairs of each observed deficiency. Based on inspection findings, Keystone Woods Lake Dam requires monitoring, maintenance, engineering analysis, and improvements to achieve IDNR's "Satisfactory" overall conditions rating. Burke's objective is to make engineering recommendations that minimize the risk of failure to an acceptable level. A summary of the 2021 inspection ratings and recommendations are provided in **Table 2**. **Table 3** is a summary of inspection ratings from 2000-2021.

Table 2: Inspection Ratings and Recommendations

Component	Rating	Recommendations	Schedule	Importance
Upstream Slope	Deficient	• Remove trees and brush from the slope and within 25 feet of the slope and abutments in accordance with the Indiana Dam Safety Inspection Manual	• 2 years	• Medium
		• Replace gravel covered slope with grass, riprap or other erosion resistant material	• 2 years	• Medium
		• Relocate watercraft, docks, and furniture off the dam embankment and onto natural ground	• Immediately	• Low
		• Initiate rodent control program, backfilling burrows in accordance with the Indiana Dam Safety Inspection Manual	• Ongoing	• Low
		• Monitor right side wooden seawall for deflection and deterioration; notify a registered professional engineer of observed changes	• Ongoing	• Low
Crest	Deficient	• Remove trees and brush from the crest in accordance with the Indiana Dam Safety Inspection Manual	• 2 years	• Medium
		• Remove concrete patio in its entirety and reestablish dam crest elevation by backfilling with appropriate embankment fill or perform an engineering evaluation to confirm structural integrity of feature and potential impact on the embankment	• 2-4 years	• High
		• Seed bare area near left abutment	• Within 1 year	• Low
Downstream Slope	Deficient	• Remove trees and brush from the slope and within 25 feet of the slope and abutments in accordance with the Indiana Dam Safety Inspection Manual	• 2 years	• Medium
		• Remove landscaping, decks, steps, and other encroachments and backfill as necessary with appropriate embankment fill or perform an engineering evaluation to confirm structural integrity of feature and potential impact on the embankment	• 2-4 years	• Medium
		• Seed sporadic bare areas on right and left sides	• 2 years	• Low
Seepage	Good	• Monitor downstream slope and around concrete patio, steps, and decks for evidence of seepage; notify a registered professional engineer of observed changes	• Ongoing	• Low
Principal Spillway	Acceptable	• Seal leaking joints in concrete inlet riser	• 2 years	• Low
		• Clean and paint metal trash rack	• 2 years	• Low
Auxiliary Spillway	Deficient	• Add appropriately sized riprap or other armoring to the spillway inlet section for erosion protection	• 2-4 years	• Low
		• Seed bare spots on left side	• 2 years	• Low
		• Evaluate options for removal of the large tree stump on left side and other tree stumps on right side in riprap; monitor areas adjacent to the stumps for seepage or other surficial deficiency monthly and/or after large rain events and notify a registered professional engineer of observed changes	• 2 years	• Low
Maintenance and Repairs	Deficient	• Perform spillway capacity analysis in accordance with current IDNR requirements	• 2 years	• High
		• Retain a geotechnical engineer to evaluate the stability of the dam under various loading conditions	• 2-4 years	• High
		• Conduct a video inspection of the principal spillway outlet pipe; subsequent inspections should be performed every six years	• 2 years	• Low
		• Multiple owners to work to resolve dam inspection recommendations	• Ongoing	• High
Overall Conditions	**Conditionally Poor**	• **See above**	• N/A	• N/A

Notes:

1. Possible Component Ratings: Good, Acceptable, Deficient, Poor
2. Possible Overall Conditions Ratings: Satisfactory, Fair, Conditionally Poor, Poor, Unsatisfactory

Table 3: Previous Inspection Ratings (2000 - 2021)

Component	Condition Ratings Per Inspection						
	2000	2004	2009	2011	2016	2019	2021
Upstream Slope	Acceptable	Acceptable	Acceptable	Acceptable	Good	Deficient	Deficient
Crest	Deficient	Acceptable	Acceptable	Acceptable	Deficient	Deficient	Deficient
Downstream Slope	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Deficient	Deficient
Seepage	Good	Good	Acceptable	Acceptable	Acceptable	Good	Good
Principal Spillway	Deficient	Good	Acceptable	Acceptable	Acceptable	Deficient	Acceptable
Auxiliary Spillway	Acceptable	Good	Deficient	Deficient	Deficient	Deficient	Deficient
Maintenance and Repairs	Deficient	Acceptable	Acceptable	Acceptable	Acceptable	Deficient	Deficient
Overall Conditions	**Conditionally Poor**	**Satisfactory**	**Fair**	**Fair**	**Fair**	**Poor**	**Conditionally Poor**

Notes:

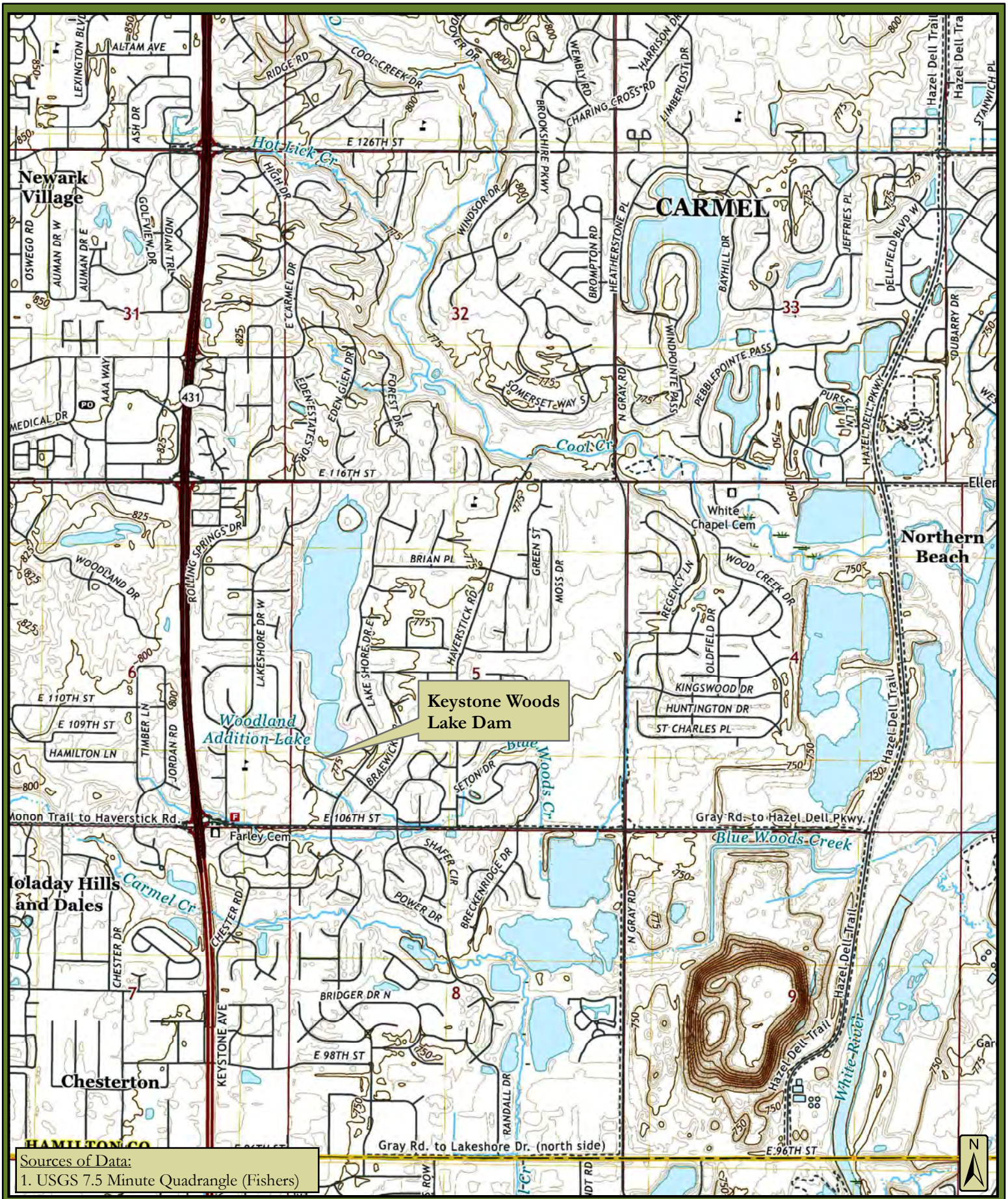
1. Possible Component Ratings: Good, Acceptable, Deficient, Poor
2. Possible Overall Conditions Ratings: Satisfactory, Fair, Conditionally Poor, Poor, Unsatisfactory

Changes in ratings from the previous inspection are noted below.

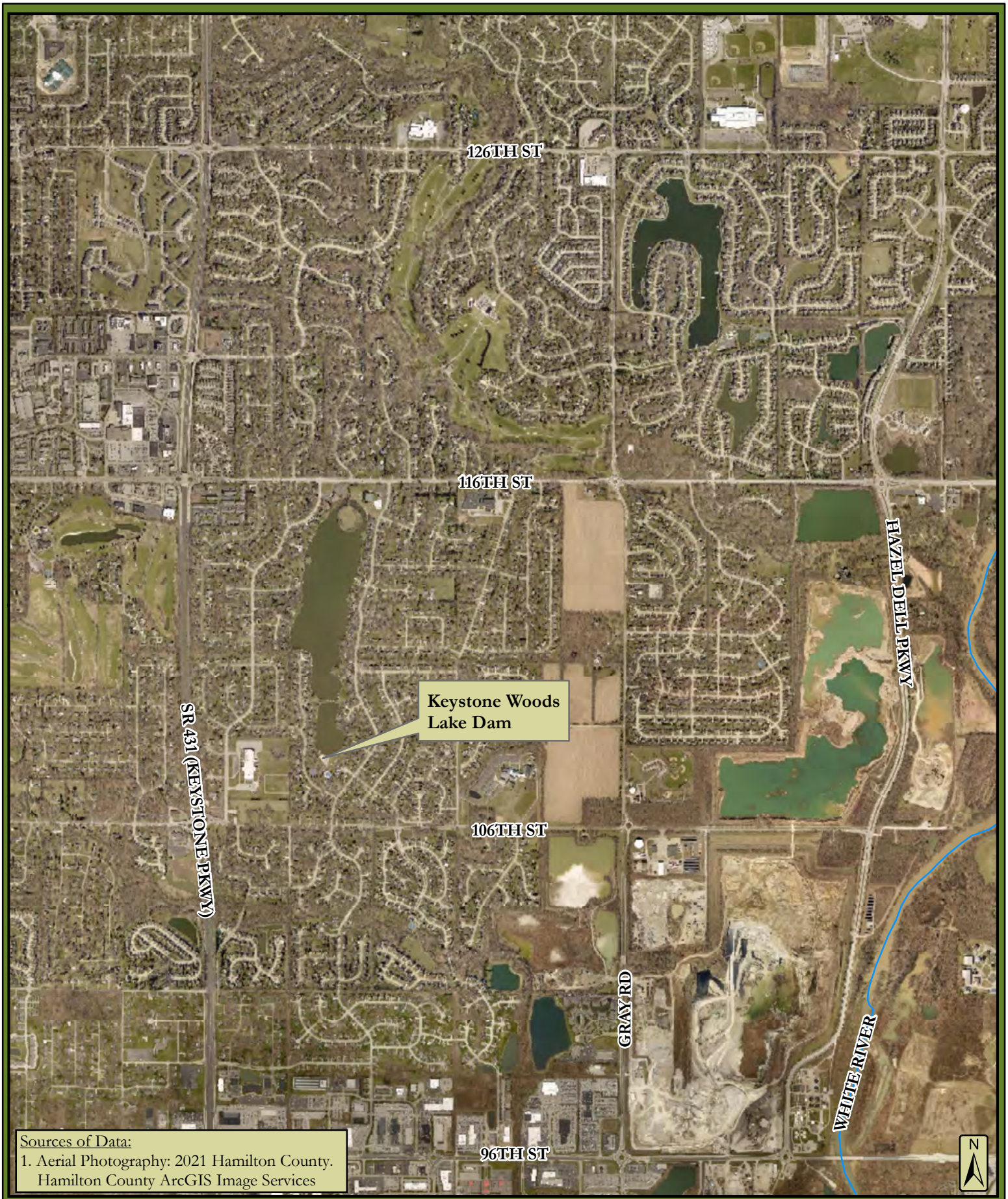
Principal Spillway – The rating was changed from "Deficient" to "Acceptable" to reflect the recent clearing and armoring improvements to the principal spillway outlet.

Overall Conditions – The rating was changed from "Poor" to "Conditionally Poor" to reflect improvements to the principal spillway outlet and auxiliary spillway channel along with the preparation of risk reduction documents including the lake drawdown plan and IEAP.

EXHIBITS



Christopher B. Burke Engineering, LLC PNC Center, Suite 1368 South 115 West Washington Street Indianapolis, Indiana 46204 (t) 317.266.8000 (f) 317.632.3306	PROJECT: **Keystone Woods Lake Dam** **2021 Safety Inspection**	PROJECT NO. **15-0171**	APPROX. SCALE **1"=2,000'**
			DATE: **8/2021**
	TITLE: **USGS Fishers Quadrangle Map**		EXHIBIT **1**



Sources of Data:
1. Aerial Photography: 2021 Hamilton County. Hamilton County ArcGIS Image Services

Christopher B. Burke Engineering, LLC
PNC Center, Suite 1368 South
115 West Washington Street
Indianapolis, Indiana 46204
(t) 317.266.8000 (f) 317.632.3306

PROJECT: Keystone Woods Lake Dam 2021 Safety Inspection		PROJECT NO. 15-0171	APPROX. SCALE 1"=2,000'
TITLE: Aerial Photograph			DATE: 8/2021
			EXHIBIT 2

Sources of Data:
1. Aerial Photography: 2021 Hamilton County. Hamilton County ArcGIS Image Services

Christopher B. Burke Engineering, LLC
PNC Center, Suite 1368 South
115 West Washington Street
Indianapolis, Indiana 46204
(t) 317.266.8000 (f) 317.632.3306

PROJECT: Keystone Woods Lake Dam 2021 Safety Inspection		PROJECT NO. 15-0171	APPROX. SCALE 1 "=100 '
			DATE: 8/2021
TITLE: Inspection Summary			EXHIBIT 3

APPENDIX 1: **IDNR LETTER TO OWNERS**

July 31, 2020

Judith Rouhselang
Woodland Home Owners Association, Inc.
10700 Lakeshore Drive East
Carmel, IN 46033

Jane B & George P Sweet
10807 Lakeview Dr
Carmel, IN 46033

Bree E & Nathan E Simmons
10803 Lakeview Dr
Carmel, IN 46033

Hassan & Christine Kassebnia,
10801 Lakeview Dr
Carmel, IN 46033

Jeffrey R & Gwen V Kempson
45 Stratford Pl
Carmel, IN 46033

Kathryn Kempson
46 Stratford Pl
Carmel, IN 46033

Christopher Lee & Carajane D Moore
50 Beechwood Ct
Carmel, IN 46033

Lynn D & Beth A Eikenberry
51 Beechwood CT
Carmel, IN 46033

Re: High Hazard Dam - 2019 Biennial Inspection Report
Keystone Woods Lake Dam
Dam ID # 29-5 - Hamilton County

Dear Dam Owners,

Over the years, Woodlands Home Owners Association (HOA), Inc. has acted much like an owner of the Keystone Woods Lake Dam's principle spillway system, and have coordinated maintenance and repairs, etc. However, based on a review of the online Hamilton County GIS parcel information, confirmation from the HOA and the engineer involved in inspection, it appears that there are multiple owners of the entirety of the dam embankment and spillway. Please see the attached aerial imagery, available at Hamilton County GIS site that shows the footprint of the dam in black line and the multiple ownership parcels. This letter is being sent to all of you as it appears you each own parts of

this dam. If you feel that you are not an owner of the dam, you may want to hire a surveyor or an engineer to perform a detailed investigation of your property's title.

Keystone Woods Lake Dam is a **high hazard** dam.

- A high hazard dam is a structure that may cause the loss of life, serious damage to homes, industrial and commercial buildings, or public utilities, or interruption of service to main highways, or railroads.
- Indiana Code 14-27-7.5-9, requires the owner(s) of a high hazard structure to have a licensed professional engineer make an engineering inspection of the high hazard structure at least one (1) time every two (2) years and submit a report of the inspection to IDNR.
- Indiana Code 14-27-7.5-7, requires the owner(s) to maintain and keep the structure in the state of repair and operating condition required by the following: the exercise of prudence; due regard for life and property; and the application of sound and accepted technical principles.
- Indiana Code 14-27-7.5-7, also requires the owner(s) to notify the department in writing of the sale or other transfer of ownership of the structure. The notice must include the name and address of the new owner(s) of the structure.

When there are multiple owners of a dam, often no one party has authority to conduct work, or remove / correct dam safety issues on all the properties that make up the dam and its footprint. All owners then have to figure out how to work together towards the resolution of all dam safety deficiencies.

The electronic report of the biennial inspection for the high hazard rated Keystone Woods Lake Dam was received in this office on November 6, 2019. Jeffrey D. Fox, P.E. – PE11100632 along with Aaron J. Fricke, P.E. – PE11100305 of Christopher B. Burke Engineering, LLC - Indianapolis, performed this biennial inspection on August 5, 2019. Your engineer rated the overall condition of the dam as "Poor CR".

The "Poor" rating for overall condition means that a potential dam safety deficiency is clearly recognized for normal loading conditions. Immediate actions to resolve the deficiency are recommended. Reservoir restrictions (such as lowered pool and other restrictions) may be necessary until the problem deficiencies are resolved.

In your report, your engineer has expressed the steps needed to correct the conditions needed to bring your overall rating to Satisfactory. Monitoring, maintenance, repairs, engineering analyses, and improvements will help to improve your rating in the future. Please refer specifically to "4.0 Recommendations" on page 9 in the report to review those recommendations. Page 3 of 6 of the Inspection Report Form included in the report also describes and explains the engineer's recommendations in more detail. We hope that you all have reviewed the document and discussed the results with your engineer. Guidance and advice given by your consulting professional engineer (firm) is most important and valuable.

As per your engineer, the level of maintenance of the dam needs significant improvement. In addition, significant rehabilitation of the dam is needed to address surficial deficiencies and apparent lack of spillway capacity. Continued neglect of maintenance and improvements may threaten the safety of the dam and safety of individuals and properties located below the dam. The next biennial inspection report should include a detailed report of the status of each of engineer recommended tasks, including the dates of completion and detailed description of work performed.

Please take necessary action to remove all manmade encroachments (concrete patio, steps, decks etc.) and also relocate watercraft, equipment and furniture from the dam and spillway.

Keystone Woods Lake Dam (#29-5)
July 31, 2020

Please note the Dam Safety Act, and particularly part (I.C. 14-27-7.5-9) requires a dam owner(s) to perform the recommended maintenance, repairs, or alterations that are necessary to remedy deficiencies in the structure or to maintain the safety of the dam. The attachment to this letter explains the importance of the recommendations and schedules presented by your engineer and the "Overall Condition Rating" system.

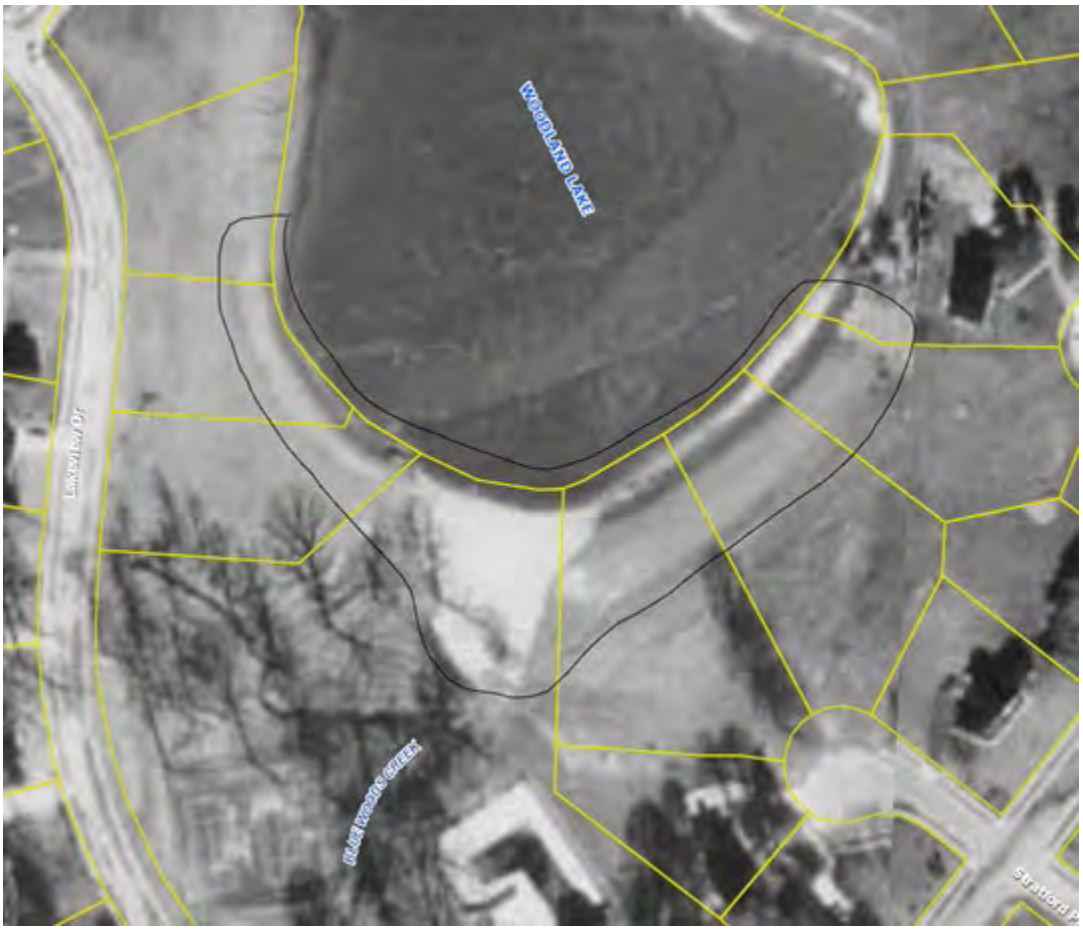
Please feel free to send me an e-mail at mmukherjee@dnr.in.gov if you have any questions regarding your dam or this inspection report. Your next biennial inspection is expected to be performed on or before August 5, 2021, and the electronic formal report in bookmarked PDF format should be submitted to this office within 60 days of the actual field inspection date.

Respectfully,

Moumita Mukherjee

Moumita Mukherjee, Ph.D., P.E.
Manager, Dams & Levee Safety Section
mmukherjee@dnr.in.gov

Attachment: General Information and Guidance
Cc: Christopher B. Burke Engineering Ltd - Indianapolis, IN
Mr. Jon Eggen, Manager, Compliance and Enforcement Section, Division of Water, DNR
Shane Booker, Director, Hamilton County Emergency Management, 18100 Cumberland Rd., Noblesville, Indiana 46060



General Information and Guidance

(A letter attachment)

The Dam Safety Act, and particularly part (I.C. 14-27-7.5-9) places requirements on a dam owner.

IC 14-27-7.5-9 - High hazard structures; inspections; report; duty to make repairs or alterations; notice of violation

Sec. 9. (a) The owner of a high hazard structure shall:

(1) Have a professional engineer licensed under IC 25-31 make an engineering inspection of the high hazard structure at least one (1) time every two (2) years;

(2) Submit a report of the inspection in a form approved by the department to the department. The report must include at least the following information:

(A) An evaluation of the structure's condition, spillway capacity, operational adequacy, and structural integrity.

(B) A determination of whether deficiencies exist that could lead to the failure of the structure, and recommendations for maintenance, repairs, and alterations to the structure to eliminate deficiencies, including a recommended schedule for necessary upgrades to the structure.

(b) If after an inspection under subsection (a) the licensed professional engineer who conducted the inspection determines that maintenance, repairs, or alterations to a high hazard structure are necessary to remedy deficiencies in the structure, ***the owner shall perform the recommended maintenance, repairs, or alterations.***

Guidance and Considerations - for Scheduled Recommended Tasks

Remember that all recommendations made by your engineer that require ***a change in the characteristics*** of the dam must be performed under the direction of the engineer and only after a Permit for Construction in a Floodway has been obtained from IDNR. Work requiring ***a change in the characteristics*** of the dam is generally, but not all inclusively, those that, (1) alter the hydraulic capacity of the spillway system, or (2) modify the stability characteristics of the embankment, or (3) lessen the safety of the dam temporarily during construction.

Normal maintenance work does not require a permit. If you feel the work recommended by your engineer may need a permit or are unsure of the need for a permit, it is suggested that you consult with this office before beginning any work

IDNR would like to follow your progress in meeting the recommended tasks and schedules. The next inspection report should discuss the status of these recommendations so that we may better understand and follow your progress.

Overall Condition Rating System – Explained:

SATISFACTORY · No existing or potential dam safety deficiencies recognized. Safe performance is expected under all anticipated loading conditions, including such events as infrequent hydrologic and/or seismic events.

FAIR · No existing dam safety deficiencies are recognized for normal loading conditions. Infrequent hydrologic and/or seismic events would probably result in a dam safety deficiency.

CONDITIONALLY POOR · A potential safety deficiency is recognized for unusual loading conditions which may realistically occur during the expected life of the structure. Conditionally poor may also be used when uncertainties exist as to critical analysis parameters which identify a potential dam deficiency. Further investigations will be necessary.

POOR · A potential dam safety deficiency is clearly recognized for normal loading conditions. Immediate actions to resolve the deficiency are recommended. Reservoir restrictions (such as lowered pool and other restrictions) may be necessary until the problem deficiencies are resolved.

UNSATISFACTORY · A dam safety deficiency exists for normal conditions. Immediate remedial action is required for problem resolution.

A "CR" after the rating explains that the rating was determined by the professional engineer consultant that performed the inspection and is not a rating determined by the Indiana DNR.

APPENDIX 2: **IDNR DAM INSPECTION REPORT FORM**

Print Form

SUGGESTED DAM INSPECTION REPORT (Refer to pages 5 and 6 for instructions.)

Name of Professional Conducting Inspection	Professional License No. (Indiana)
Jeffrey D. Fox, PE / Joshua L. Erwood, EI	PE11100632
Business Address	**Phone: (day) 317 - 266 - 8000**
115 West Washington Street, Suite 1368 South, Indianapolis, IN 46204	(evening) ___ - ___ - ___

Company Name: Christopher B. Burke Engineering, LLC

INSPECTION PREPARATION: Reviewed all pertinent technical documentation related to this dam and site in the State's and the Owner's files: Yes ☒ No ☐ Comment

MULTIDISCIPINARY:I am experienced in the technical disciplines or I am working with other professionals experienced in the technical disciplines to properly inspect this dam and appurtenant works. Technical disciplines, in additional to the general civil engineering, may include geotechnical, geological, hydrologic, structural, and mechanical. Yes ☒ No ☐ Comment

Dam Name	Quad.	Date of Inspection
Keystone Woods Lake Dam	Fishers	8 / 3 / 21

State Dam ID	Permit (if unapproved see pg. 6)	County	Sec.	T.	R.	Last Inspection
29-5	D-6308	Hamilton	5	17 N	4 E	8 / 5 / 19

Owners Name	Owner's Phone
Woodlands Homeowners Association, Inc.	( )

Address/Zip Code: 10700 Lakeshore Drive East, Carmel, Indiana 46033

Contact's Name	Contact's Phone	Spillway Width	Ft. FBD.
Judy Rouhselang	(day) 317 - 407 - 6192 (evening) ___ - ___ - ___	Top 108ft Bot. 108ft	4.1 FT

Hazard	Drainage Area	Surface Area	Height	Crest Length	Crest Width	Inlet Below Crest	Slope
High	1.1 MI^2	53 AC	14 FT	420 FT	10 FT	4.5 FT	Up 3:1 (H:V) Down 3:1 (H:V)

FIELD CONDITIONS OBSERVED

Water Level - Below Dam Crest 4.7 Ft.

Ground Moisture Condition: Dry ☒ Wet ☐ Snowcover ☐ Other

DRAWDOWN STRUCTURE

☐ Yes ☒ None

Comment: Abandoned

MONITORING ☐ Yes ☒ None [☐ Gage Rod ☐ Piezometers ☐ Seepage Weirs ☐ Survey Monuments ☐ Other]

Comments

A UPSTREAM SLOPE

GOOD	☐
ACCEPTABLE	☐
DEFICIENT	☒
POOR	☐

PROBLEMS NOTED: ☐ (A-1) None ☐ (A-2) Riprap - Missing, Sparse, Displaced, Weathered ☒ (A-3) Wave Erosion-with Scarps ☐ (A-4) Cracks-with Displacement ☐ (A-5) Sinkhole ☐ (A-6) Appears Too Steep ☐ (A-7) Depressions or Bulges ☐ (A-8) Slides ☒ (A-9) Animal Burrows ☒ (A-10) Trees, Brush, Briars ☒ (A-11) Other Encroachment / Surface Cover

Comments:

(A-3) Scarp, previously observed on left side, unable to be inspected due to large bush near waterline
(A-9) Few animal burrows observed along slope
(A-10) Trees and brush on slope and within 25 feet of toe and abutments
(A-11) Concrete patio constructed into embankment slope; watercraft, docks, and furniture on dam; portion of slope covered in small gravel

B CREST

GOOD	☐
ACCEPTABLE	☐
DEFICIENT	☒
POOR	☐

PROBLEMS NOTED: ☐ (B-1) None ☐ (B-2) Ruts or Puddles ☐ (B-3) Erosion ☐ (B-4) Cracks with Displacement ☐ (B-5) Sinkholes ☐ (B-6) Not Wide Enough ☒ (B-7) Low Area ☐ (B-8) Misalignment ☐ (B-9) Inadequate Surface Drainage ☒ (B-10) Trees, Brush, Briars ☒ (B-11) Other Bare Area

Comments:

(B-7) Concrete patio and stairs constructed into embankment slope has resulted in a loss of crest width and freeboard
(B-10) Trees, brush and landscaping on crest
(B-11) Bare area near left abutment

Spillway Width refers to the open channel (typically the emergency or auxiliary spillway) at the control section.
Ft. FBD. refers to the vertical distance from the emergency (auxiliary) spillway control section to the lowest point of the crest of the dam.
Inlet Below Crest refers to the vertical distance from the inlet of the principal spillway to the crest of the dam.

C DOWNSTREAM SLOPE

GOOD	☐
ACCEPTABLE	☐
DEFICIENT	☒
POOR	☐

PROBLEMS NOTED: ❒ (C-1) None ❒ (C-2) Livestock Damage ❒ (C-3) Erosion or Gullies ❒ (C-4) Cracks with Displacement ❒ (C-5) Sinkholes ❒ (C-6) Appears too Steep ❒ (C-7) Depression or Bulges ❒ (C-8) Slide ❒ (C-9) Soft Areas ☒ (C-10) Trees, Brush, Briars ❒ (C-11) Animal Burrows ☒ (C-12)Other Encroachment/Bare Area
Comments:

(C-10) Trees and brush on slope and within 25-feet of toe and abutments
(C-12) Landscaping, wood deck, and steps along slope particularly on right side; 3'x3' bare areas on right side

D SEEPAGE

GOOD (NONE)	☒
ACCEPTABLE	☐
DEFICIENT	☐
POOR	☐

PROBLEMS NOTED: ☒ (D-1) None ❒ (D-2) Saturated Embankment Area ❒ (D-3) Seepage Exits on Embankment ❒ (D-4) Seepage Exits at Point Source ❒ (D-5) Seepage Area at Toe ❒ (D-6) Flow Adjacent to Outlet ❒ (D-7) Seepage Clear/Muddy
[**DRAIN OUTFALLS SEEN** X No ___ Yes ❒ (D-8) Flow Clear/Muddy ❒ (D-9) Dry/Obstructed]
❒ (D-10) Other _____ Describe location of drains and indicate amount and quality of discharge.
Comments:

(D-1) No seepage was observed at the time of the inspection; no known records of observed seepage

E PRINCIPAL SPILLWAY

GOOD	☐
ACCEPTABLE	☒
DEFICIENT	☐
POOR	☐

DESCRIPTION: 5'x2.5' Concrete Riser Inlet with a 24" CCFRPM Outlet Pipe

PROBLEMS NOTED: ❒ (E-1) None ☒ (E-2) Deterioration ❒ (E-3) Separation ❒ (E-4) Cracking ☒ (E-5) Inlet, Outlet Deficiency ❒ (E-6) Stilling Basin Inadequacies ☒ (E-7) Trash Rack ☒ (E-8) Other Decreased Pipe Capacity
Comments:

(E-2) Metal end section at outlet has rusted invert and small hole on side
(E-5) Seepage observed in joints of concrete inlet riser
(E-7) Minor surface rust observed on metal trash rack
(E-8) Slip-lining work reduced outlet pipe from a 42" CMP to a 24" CCFRPM

F AUXILIARY SPILLWAY

GOOD	☐
ACCEPTABLE	☐
DEFICIENT	☒
POOR	☐

DESCRIPTION: 108' Wide Open Channel in Fill and Lined with Riprap

PROBLEMS NOTED: ❒ (F-1) None ❒ (F-2) No Auxiliary Spillway Found ❒ (F-3) Erosion-with Backcutting ❒ (F-4) Crack with Displacement ❒ (F-5) Appears to be Structurally Inadequate ☒ (F-6) Appears too Small ❒ (F-7) Inadequate Freeboard ❒ (F-8) Flow Obstructed ❒ (F-9) Concrete Deteriorated/Undermined ☒ (F-10) Other Riprap Size at Inlet, bare spots, stump
Comments:

(f-6) Uncertain spillway capacity, particularly with lowered crest section and slip-lined principal spillway oultet
(F-10) Riprap is sparse and appears too small along inlet section; few bare spots on left side; large tree stump on left side and a few in riprap on right side

G MAINTENANCE AND REPAIRS

GOOD	☐
ACCEPTABLE	☐
DEFICIENT	☒
POOR	☐

PROBLEMS NOTED: ❒ (G-1) None ❒ (G-2) Access Road Needs Maintenance ❒ (G-3) Cattle Damage ❒ (G-4) Spillway Obstruction ☒ (G-5) Brush, Weeds, Tall Grass, on Upstream Slope, Crest, Downstream Slope, Toe ☒ (G-6) Trees on Upstream Slope, Crest, Downstream Slope ☒ (G-7) Rodent Activity on Upstream Slope, Crest, Downstream Slope, Toe ❒ (G-8) Deteriorated Concrete-Facing, Outlet, Spillway ❒ (G-9) Gate and/or Drawdown Need Repair ☒ (G-10) Other Additional Investigations/Analyses
Comments:

Although maintenance and repair activities have increased in the auxiliary spillway and principal spillway outlet areas, the remaining portions of the dam need improvement. See comments for individual components. Spillway capacity and embankment stability analyses are needed.

H OVERALL CONDITIONS

Based on this inspection and recent file review, the overall surficial condition is determined to be: ❒ (H-1) Satisfactory ❒ (H-2) Fair ☒ (H-3) Conditionally Poor ❒ (H-4) Poor ❒ (H-5) Unsatisfactory

IMPORTANT: IF THIS RATING IS DIFFERENT THAN PREVIOUS IDNR RATING, PLEASE ATTACH EXPLANATION AND REASONS FOR CHANGE ON PAGE 4.

DAM NAME Keystone Woods Lake Dam STATE DAM I.D. 29-5 DATE 8/3/21

RECOMMENDATIONS AND ITEMS REQUIRING ACTION BY OWNER TO IMPROVE THE SAFETY OF THE DAM

MAINTENANCE-MINOR REPAIR-MONITORING

- [x] (1) Provide Additional Erosion Protection: Auxiliary spillway inlet section and upstream slope
- [x] (2) Mow: Continue regular mowing; vary mowing pattern to avoid rutting; mow during dry conditions
- [x] (3) Clear Trees and/or Brush From: Upstream and downstream slopes, crest, and within 25' of toe and abutments
- [x] (4) Initiate Rodent Control Program and Properly Backfill Existing Holes: Upstream slope
- [x] (5) Repair: Seal joints in concrete riser; seed bare areas
- [ ] (6) Provide Surface Drainage For:
- [x] (7) Monitor: Wooden seawall on right side for deflection and deterioration; downstream slope for seepage
- [x] (8) Other: Relocate watercraft, furniture, and other equipment off of embankment; clean and paint metal trash rack
- [x] (9) Other: Remove manmade encroachments or provide engineering evaluation of structure and potential impact

ENGINEERING-EMPLOY AN ENGINEER EXPERIENCED IN DESIGN AND CONSTRUCTION OF DAMS TO:

(Plans & Specifications must be approved by State prior to construction.)

- [ ] (10) Prepare Plans and Specifications for the Rehabilitation of the Dam:
- [ ] (11) Prepare As-Built Drawings of:
- [x] (12) Perform a Geotechnical Investigation to Evaluate the Stability of the Dam: No record of detailed analysis
- [x] (13) Perform a Hydrologic Study to Determine Required Spillway Size: Uncertainties in past analyses and modifications to dam
- [ ] (14) Prepare Plans and Specifications for an Adequate Spillway:
- [ ] (15) Set up a Monitoring Program:
- [ ] (16) Refer to Unapproved Status of Dam:
- [x] (17) Develop an Emergency Action Plan: To be completed in 2022
- [x] (18) Other: Perform a video inspection of the principal spillway outlet pipe as part of next biennial dam safety inspection
- [x] (19) Other: Multiple owners to work to resolve dam inspection recommendations

Recommended schedule for upgrades/comments (Please prioritize and note importance of each item.)

See attached table of recommendations.

Photographs [x] Attachments [x]

ENGINEER'S INSTRUCTION Instructed owner on the safety concerns with the structure and how to monitor and inspect the dam and appurtenant works in the interim period between the regulatory two-year inspections. Yes [x] No [ ]

Comment

Professional Engineer's Signature _____ Date 10/29/2021

Reviewed By Judith K. Rossbeck, Grounds Director, Woodlands HOA Date 10-29-21

Owner/Owner's Representative

Component	Recommendations	Schedule	Importance
Upstream Slope	• Remove trees and brush from the slope and within 25 feet of the slope and abutments in accordance with the Indiana Dam Safety Inspection Manual	• 2 years	• Medium
	• Replace gravel covered slope with grass, riprap or other erosion resistant material	• 2 years	• Medium
	• Relocate watercraft, docks, and furniture off the dam embankment and onto natural ground	• Immediately	• Low
	• Initiate rodent control program, backfilling burrows in accordance with the Indiana Dam Safety Inspection Manual	• Ongoing	• Low
	• Monitor right side wooden seawall for deflection and deterioration; notify a registered professional engineer of observed changes	• Ongoing	• Low
Crest	• Remove trees and brush from the crest in accordance with the Indiana Dam Safety Inspection Manual	• 2 years	• Medium
	• Remove concrete patio in its entirety and reestablish dam crest elevation by backfilling with appropriate embankment fill or perform an engineering evaluation to confirm structural integrity of feature and potential impact on the embankment	• 2-4 years	• High
	• Seed bare area near left abutment	• Within 1 year	• Low
Downstream Slope	• Remove trees and brush from the slope and within 25 feet of the slope and abutments in accordance with the Indiana Dam Safety Inspection Manual	• 2 years	• Medium
	• Remove landscaping, decks, steps, and other encroachments and backfill as necessary with appropriate embankment fill or perform an engineering evaluation to confirm structural integrity of feature and potential impact on the embankment	• 2-4 years	• Medium
	• Seed sporadic bare areas on right and left sides	• 2 years	• Low
Seepage	• Monitor downstream slope and around concrete patio, steps, and decks for evidence of seepage; notify a registered professional engineer of observed changes	• Ongoing	• Low
Principal Spillway	• Seal leaking joints in concrete inlet riser	• 2 years	• Low
	• Clean and paint metal trash rack	• 2 years	• Low
Auxiliary Spillway	• Add appropriately sized riprap or other armoring to the spillway inlet section for erosion protection	• 2-4 years	• Low
	• Seed bare spots on left side	• 2 years	• Low
	• Evaluate options for removal of the large tree stump on left side and other tree stumps on right side in riprap; monitor areas adjacent to the stumps for seepage or other surficial deficiency monthly and/or after large rain events and notify a registered professional engineer of observed changes	• 2 years	• Low
Maintenance and Repairs	• Perform spillway capacity analysis in accordance with current IDNR requirements	• 2 years	• High
	• Retain a geotechnical engineer to evaluate the stability of the dam under various loading conditions	• 2-4 years	• High
	• Conduct a video inspection of the principal spillway outlet pipe; subsequent inspections should be performed every six years	• 2 years	• Low
	• Multiple owners to work to resolve dam inspection recommendations	• Ongoing	• High
Overall Conditions	• **See above**	• N/A	• N/A

EXPLANATION FOR CHANGE IN RATINGS (Describe all repairs, upgrades or improvements made if dam conditions and rating have improved since the last inspection. Describe deteriorating conditions if ratings have worsened.)

REASONS FOR RATING CHANGE:

Principal Spillway – The rating was changed from "Deficient" to "Acceptable" to reflect the recent clearing and armoring improvements to the principal spillway outlet.

Overall Conditions – The rating was changed from "Poor" to "Conditionally Poor" to reflect improvements to the principal spillway outlet and auxiliary spillway channel along with the preparation of risk reduction documents including the lake drawdown plan and IEAP.

PREVIOUS RECOMMENDATIONS FOR MAINTENANCE, REPAIRS, AND UPGRADES:

HAVE THEY BEEN PERFORMED ☒ YES ☒ NO (If no, please explain:)

Previous Recommendations Completed:

Principal Spillway
- Trees and brush cleared around outlet
- Outlet channel armored and erosion repaired

Auxiliary Spillway
- Vegetation growing in riprap channel removed
- Relocated all watercraft, trailers and other equipment obstructing spillway
- Riprap added along channel, particularly on right side

Maintenance and Repairs
- Drawdown plan prepared
- IEAP being prepared and due to be completed in 2022
- All residential owners of dam informed of 2019 recommendations and actions needed to achieve a "Satisfactory" rating. Ongoing coordination with owners to be continued for further improvements

Other recommended actions are currently be planned and budgeted.

Supporting Documentation

Photographs ☒ Attachments ☒ Calculations ❒ Drawings ❒ Other ❒

Comments:

Keystone Woods Lake Dam 2021 Dam Safety Inspection Report

INSTRUCTIONS FOR COMPLETING DAM VISUAL INSPECTION REPORT

1. Complete all items that are applicable; if not applicable, write in "N/A". For concrete dams, complete all applicable items and use "comments" section to cover items not included in the check boxes. Also indicate that the dam is concrete in the comments section.

2. Use page 6 to determine ratings of each dam component (items A through G) and for Overall Conditions (Item H).

3. Please write legibly and concisely.

4. Inspector must be knowledgeable with the type of dam, materials, and components being inspected. If not, qualified assistance shall be engaged.

5. The inspector shall review the dam owner's and IDNR project files prior to the inspection. Previous inspection reports shall be closely reviewed for previous problems and deficiencies.

6. If the ratings of the components (items A through G) or the Overall Conditions (item H) of the dam have changed since the last inspection, please complete page 4. If a rating has improved, dam repairs, improvements, analyses, or maintenance must have been performed and documented on page 4.

7. For a dam to have a satisfactory "Overall Conditions" rating, it must have no existing or potential dam safety deficiencies recognized. Safe performance is expected under all anticipated loading conditions, including infrequent hydrologic events (PMP for high hazard dams) and seismic events. The dam owner's project files must contain hydrologic and hydraulic analyses of the dam and its spillways to verify performance. The files must also contain slope stability analyses to verify embankment stability under full reservoir conditions and rapid-draw down conditions. The dam and all of its components must meet current IDNR and design standards. "Normal" deficiencies such as minor erosion, minor seepage, or normal concrete aging may not make a dam unsatisfactory or unacceptable. For a satisfactory "Overall Conditions" rating to be assigned, items A through G generally should all have a "good" rating; however, in some cases an "acceptable" rating may be satisfactory if the "Problems Noted" are minor, or "normal" conditions, such as minor erosion rills, small puddles on crest, or if grass needs mowed, but is in good condition.

8. An inspection report form must be submitted to IDNR along with a formal technical inspection report as described in Chapter 4.0 of Part 3 of the Indiana Dam Safety Inspection Manual.

9. Please sign and date this page in the space below to verify that you have read and understand these instructions.

Inspector's Signature: _____ Date: 10/29/2021

GUIDELINES FOR DETERMINING CONDITIONS

CONDITIONS OBSERVED - APPLIES TO UPSTREAM SLOPE, CREST, DOWNSTREAM SLOPE, PRINCIPAL SPILLWAY, AUXILIARY SPILLWAY

GOOD	ACCEPTABLE	DEFICIENT	POOR
In general, this part of the structure has a good appearance, and conditions observed in this area do not appear to threaten the safety of the dam.	Although general cross-section is maintained, surfaces may be irregular, eroded, rutted, spalled, or otherwise not in new condition. Conditions in this area do not currently appear to threaten the safety of the dam.	Continued deterioration and/or unusual loading may threaten the safety of the dam.	Conditions observed in this area appear to threaten the safety of the dam. Conditions observed in this area are unacceptable.

CONDITIONS OBSERVED - APPLIES TO SEEPAGE

GOOD (NONE)	ACCEPTABLE	DEFICIENT	POOR
No evidence of uncontrolled seepage. No unexplained increase in flows from designed drains. All seepage is clear. Seepage conditions do not appear to threaten the safety of the dam.	Some seepage exists at areas other than the drain outfalls, or other designed drains. No unexplained increase in flows from designed drains. All seepage is clear. Seepage conditions observed do not currently appear to threaten the safety of the dam.	Excessive seepage exists at areas other than drain outfalls and other designed drains. Seepage needs to be evaluated. Increased flow and/or continued deterioration in seepage conditions may threaten the safety of the dam.	Excessive seepage conditions observed appear to threaten the safety of the dam and is unacceptable. Examples: 1) Designed drain or seepage flows have increased without increase in reservoir level. 2) Drain or seepage flows contain sediment. i.e., muddy water or particles in jar samples. 3) Widespread seepage, concentrated seepage or ponding appears to threaten the safety of the dam.

CONDITIONS OBSERVED - APPLIES TO MAINTENANCE AND REPAIR

GOOD	ACCEPTABLE	DEFICIENT	POOR
Dam appears to receive effective on-going maintenance and repair, and only a few minor items may need to be addressed.	Dam appears to receive maintenance, but some maintenance items need to be addressed. No major repairs are required.	Level of maintenance of the dam needs significant improvement. Major repairs may be required. Continued neglect of maintenance may threaten the safety of the dam.	Dam does not receive adequate maintenance. One or more items needing maintenance or repair has begun to threaten the safety of the dam. Level of maintenance is unacceptable.

OVERALL CONDITIONS

SATISFACTORY - No existing or potential dam safety deficiencies recognized. Safe performance is expected under all anticipated loading conditions, including such events as infrequent hydrologic and/or seismic events. Project Files contain necessary hydrologic, and other engineering calculations to verify dam safety and performance.

FAIR - No existing dam safety deficiencies are recognized for normal loading conditions. Infrequent hydrologic and/or seismic events would probably result in a dam safety deficiency.

CONDITIONALLY POOR - A potential safety deficiency is recognized for unusual loading conditions which may realistically occur during the expected life of the structure. CONDITIONALLY POOR may also be used when uncertainties exist as to critical analysis parameters which identify a potential dam safety deficiency; further investigations and studies are necessary.

POOR - A potential dam safety deficiency is clearly recognized for normal loading conditions. Immediate actions to resolve the deficiency are recommended; reservoir restrictions may be necessary until problem resolution.

UNSATISFACTORY - A dam safety deficiency exists for normal conditions. Immediate remedial action is required for problem resolution.

HAZARD CLASSIFICATIONS OF DAMS (STRUCTURE)

LOW HAZARD- A structure the failure of which may damage farm buildings, agricultural land, or local roads

SIGNIFICANT HAZARD- A structure the failure of which may damage isolated homes and highways, or cause the temporary interruption of public utility services.

HIGH HAZARD-A structure the failure of which may cause the loss of life and serious damage to homes, industrial and commercial buildings, public utilities, major highways, or railroads.

UNAPPROVED STATUS OF DAM

A dam that has been given an unapproved status (see entry for permit) means that plans, construction specifications, hydraulic analyses, and/or a geotechnical investigation on your dam, proving the safety of the structure, have not been received and approved by the Indiana Department of Natural Resources (IDNR). IDNR records indicate that no progress has been made to secure this approval. The fact that the dam is inspected under the Regulation of Dams Act (IC 14-27-7.5) in no way alters the illegal status of the structures.

If your dam is indicated to be unapproved, it is requested that your engineer contact the Indiana Department of Natural Resources,

APPENDIX 3: **PREVIOUS IDNR DAM INSPECTION REPORT FORM**

Print Form

SUGGESTED DAM INSPECTION REPORT (Refer to pages 5 and 6 for instructions.)

Name of Professional Conducting Inspection	Professional License No. (Indiana)
Jeffrey D. Fox, P.E. / Aaron J. Fricke, P.E.	PE11100632 / PE11100305
Business Address 115 West Washington Street, Suite 1368 South, Indianapolis, IN 46204	Phone: (day) 317 - 266 - 8000 (evening) ___ - ___ - ___

Company Name: Christopher B. Burke Engineering, LLC

INSPECTION PREPARATION: Reviewed all pertinent technical documentation related to this dam and site in the State's and the Owner's files: Yes ☒ No ☐ Comment

MULTIDISCIPINARY:I am experienced in the technical disciplines or I am working with other professionals experienced in the technical disciplines to properly inspect this dam and appurtenant works. Technical disciplines, in additional to the general civil engineering, may include geotechnical, geological, hydrologic, structural, and mechanical. Yes ☒ No ☐ Comment

Dam Name	Quad.	Date of Inspection
Keystone Woods Lake Dam	Fishers	8 / 5 / 19

State Dam ID	Permit (if unapproved see pg. 6)	County	Sec.	T.		R.		Last Inspection
29-5	D-6308	Hamilton	5	17	N	4	E	8 / 31 / 16

Owners Name	Owner's Phone
Woodlands Homeowners Association, Inc.	(317) 748-0295

Address/Zip Code: 10700 Lakeshore Drive East, Carmel, Indiana 46033

Contact's Name	Contact's Phone	Spillway Width	Ft. FBD.
Jim Copsey	(day) 317 - 809 - 3792 (evening) ___ - ___ - ___	Top 108ft Bot. 108ft	4.1 FT

Hazard	Drainage Area	Surface Area	Height	Crest Length	Crest Width	Inlet Below Crest	Slope
High	1.1 MI^2	53 AC	14 FT	420 FT	10 FT	4.5 FT	Up 3:1 (H:V) Down 3:1 (H:V)

FIELD CONDITIONS OBSERVED

Water Level - Below Dam Crest 4.7 Ft.

Ground Moisture Condition: Dry ☒ Wet ☐ Snowcover ☐ Other ___

DRAWDOWN STRUCTURE

☐ Yes ☒ None

Comment: Abandoned

MONITORING ☐ Yes ☒ None [☐ Gage Rod ☐ Piezometers ☐ Seepage Weirs ☐ Survey Monuments ☐ Other]

Comments ___

A UPSTREAM SLOPE

GOOD	☐
ACCEPTABLE	☐
DEFICIENT	☒
POOR	☐

PROBLEMS NOTED: ☐ (A-1) None ☐ (A-2) Riprap - Missing, Sparse, Displaced, Weathered ☒ (A-3) Wave Erosion-with Scarps ☐ (A-4) Cracks-with Displacement ☐ (A-5) Sinkhole ☐ (A-6) Appears Too Steep ☐ (A-7) Depressions or Bulges ☐ (A-8) Slides ☒ (A-9) Animal Burrows ☒ (A-10) Trees, Brush, Briars ☒ (A-11) Other Encroachment / Surface Cover

Comments:

(A-3) Scarp observed near toe of slope at left side of dam
(A-9) Few animal burrows observed along slope
(A-10) Trees and brush on slope and within 25 feet of toe and abutments
(A-11) Watercraft, docks, and furniture on dam; portion of slope covered in small gravel

B CREST

GOOD	☐
ACCEPTABLE	☐
DEFICIENT	☒
POOR	☐

PROBLEMS NOTED: ☐ (B-1) None ☐ (B-2) Ruts or Puddles ☐ (B-3) Erosion ☐ (B-4) Cracks with Displacement ☐ (B-5) Sinkholes ☐ (B-6) Not Wide Enough ☐ (B-7) Low Area ☐ (B-8) Misalignment ☐ (B-9) Inadequate Surface Drainage ☒ (B-10) Trees, Brush, Briars ☒ (B-11) Other Bare Area / Encroachment

Comments:

(B-10) Trees and brush on crest
(B-11) Bare area near left abutment; concrete patio cut into embankment

Spillway Width refers to the open channel (typically the emergency or auxiliary spillway) at the control section.
Ft. FBD. refers to the vertical distance from the emergency (auxiliary) spillway control section to the lowest point of the crest of the dam.
Inlet Below Crest refers to the vertical distance from the inlet of the principal spillway to the crest of the dam.

C DOWNSTREAM SLOPE

GOOD	☐
ACCEPTABLE	☐
DEFICIENT	☒
POOR	☐

PROBLEMS NOTED: ☐ (C-1) None ☐ (C-2) Livestock Damage ☐ (C-3) Erosion or Gullies ☐ (C-4) Cracks with Displacement ☐ (C-5) Sinkholes ☐ (C-6) Appears too Steep ☐ (C-7) Depression or Bulges ☐ (C-8) Slide ☐ (C-9) Soft Areas ☒ (C-10) Trees, Brush, Briars ☐ (C-11) Animal Burrows ☒ (C-12)Other Encroachment

Comments:

(C-10) Trees and brush on slope and within 25-feet of toe and abutments; dense trees and brush adjacent to auxiliary spillway.

(C-12) Landscaping, decks, steps, etc along slope

D SEEPAGE

GOOD (NONE)	☒
ACCEPTABLE	☐
DEFICIENT	☐
POOR	☐

PROBLEMS NOTED: ☒ (D-1) None ☐ (D-2) Saturated Embankment Area ☐ (D-3) Seepage Exits on Embankment ☐ (D-4) Seepage Exits at Point Source ☐ (D-5) Seepage Area at Toe ☐ (D-6) Flow Adjacent to Outlet ☐ (D-7) Seepage Clear/Muddy

[**DRAIN OUTFALLS SEEN** X No ___ Yes ☐ (D-8) Flow Clear/Muddy ☐ (D-9) Dry/Obstructed]

☐ (D-10) Other _____ Describe location of drains and indicate amount and quality of discharge.

Comments:

E PRINCIPAL SPILLWAY

GOOD	☐
ACCEPTABLE	☐
DEFICIENT	☒
POOR	☐

DESCRIPTION: 5'x2.5' Concrete Riser Inlet with a 24" CCFRPM Outlet Pipe

PROBLEMS NOTED: ☐ (E-1) None ☐ (E-2) Deterioration ☐ (E-3) Separation ☐ (E-4) Cracking ☒ (E-5) Inlet, Outlet Deficiency ☐ (E-6) Stilling Basin Inadequacies ☒ (E-7) Trash Rack ☒ (E-8) Other Decreased Pipe Capacity

Comments:

(E-5) Seepage observed in joints of concrete inlet riser; concrete outfall channel severely deteriorated with adjacent erosion and vegetation surrounding outlet

(E-7) Minor surface rust observed on metal trash rack

(E-8) Slip-lining work reduced outlet pipe from a 42" CMP to a 24" CCFRPM

F AUXILIARY SPILLWAY

GOOD	☐
ACCEPTABLE	☐
DEFICIENT	☒
POOR	☐

DESCRIPTION: 108' Wide Earthen Open Channel in Fill and Lined with Riprap

PROBLEMS NOTED: ☐ (F-1) None ☐ (F-2) No Auxiliary Spillway Found ☐ (F-3) Erosion-with Backcutting ☐ (F-4) Crack with Displacement ☐ (F-5) Appears to be Structurally Inadequate ☐ (F-6) Appears too Small ☐ (F-7) Inadequate Freeboard ☒ (F-8) Flow Obstructed ☐ (F-9) Concrete Deteriorated/Undermined ☒ (F-10) Other Vegetation / Inadequate Riprap Size

Comments:

(F-8) Watercraft and other equipment located within spillway channel

(F-10) Vegetation growing in riprap; riprap is sparse and appears too small

G MAINTENANCE AND REPAIRS

GOOD	☐
ACCEPTABLE	☐
DEFICIENT	☒
POOR	☐

PROBLEMS NOTED: ☐ (G-1) None ☐ (G-2) Access Road Needs Maintenance ☐ (G-3) Cattle Damage ☒ (G-4) Spillway Obstruction ☒ (G-5) Brush, Weeds, Tall Grass, on Upstream Slope, Crest, Downstream Slope, Toe ☒ (G-6) Trees on Upstream Slope, Crest, Downstream Slope ☒ (G-7) Rodent Activity on Upstream Slope, Crest, Downstream Slope, Toe ☒ (G-8) Deteriorated Concrete-Facing, Outlet, Spillway ☐ (G-9) Gate and/or Drawdown Need Repair ☒ (G-10) Other Additional Investigations/Analyses

Comments:

(G-4) Relocate watercraft and other equipment

(G-5) Remove vegetation from noted locations

(G-6) Remove trees and brush from noted locations

(G-7) Initiate rodent control program

(G-8) Repair/Replace concrete outlet deficiencies

(G-10) Inspect spillway pipe; evaluate capacity and stability

H OVERALL CONDITIONS

Based on this inspection and recent file review, the overall surficial condition is determined to be: ☐ (H-1) Satisfactory ☐ (H-2) Fair ☐ (H-3) Conditionally Poor ☒ (H-4) Poor ☐ (H-5) Unsatisfactory

IMPORTANT: IF THIS RATING IS DIFFERENT THAN PREVIOUS IDNR RATING, PLEASE ATTACH EXPLANATION AND REASONS FOR CHANGE ON PAGE 4.

DAM NAME Keystone Woods Lake Dam STATE DAM I.D. 29-5 DATE 8 / 5 / 19

RECOMMENDATIONS AND ITEMS REQUIRING ACTION BY OWNER TO IMPROVE THE SAFETY OF THE DAM

MAINTENANCE-MINOR REPAIR-MONITORING

☒ (1) Provide Additional Erosion Protection: Auxiliary spillway channel and upstream slope
☒ (2) Mow: Ongoing
☒ (3) Clear Trees and/or Brush From: Upstream and downstream slopes, crest, abutments, and spillways
☒ (4) Initiate Rodent Control Program and Properly Backfill Existing Holes: Upstream slope
☒ (5) Repair: Scarp at toe of upstream slope, concrete principal spillway outfall channel, bare area on crest
☐ (6) Provide Surface Drainage For: _____
☒ (7) Monitor: Surface rust on metal trash rack
☒ (8) Other: Relocated watercraft, furniture, and other equipment on dam and in spillway
☒ (9) Other: Remove manmade encroachments (concrete patio, decks, stairs, landscaping, etc.)

ENGINEERING-EMPLOY AN ENGINEER EXPERIENCED IN DESIGN AND CONSTRUCTION OF DAMS TO:

(Plans & Specifications must be approved by State prior to construction.)

☐ (10) Prepare Plans and Specifications for the Rehabilitation of the Dam: _____
☐ (11) Prepare As-Built Drawings of: _____
☒ (12) Perform a Geotechnical Investigation to Evaluate the Stability of the Dam: No record of detailed analysis
☒ (13) Perform a Hydrologic Study to Determine Required Spillway Size: Uncertainties in past analyses and modifications to dam
☐ (14) Prepare Plans and Specifications for an Adequate Spillway: _____
☐ (15) Set up a Monitoring Program: _____
☐ (16) Refer to Unapproved Status of Dam: _____
☒ (17) Develop an Emergency Action Plan: No record of IEAP; no drawdown plan for maintenance or emergencies
☒ (18) Other: Perform a video inspection of the principal spillway outlet pipe
☒ (19) Other: Multiple owners to work to resolve dam inspection recommendations

Recommended schedule for upgrades/comments (Please prioritize and note importance of each item.)

See attached table of recommendations.

Photographs ☒ Attachments ☒

ENGINEER'S INSTRUCTION Instructed owner on the safety concerns with the structure and how to monitor and inspect the dam and appurtenant works in the interim period between the regulatory two-year inspections. Yes ☒ No ☐

Comment

Professional Engineer's Signature _____ Date 11/5/19

Reviewed By _____ PRESIDENT 11-4-19 Date

Owner/~~Owner's~~Representative

Recommended schedule for upgrades/comments (Please prioritize and note importance of each item.)

Component	Recommendations	Schedule	Importance
Upstream Slope	• Remove trees and brush from the slope and within 25 feet of the slope and abutments in accordance with the Indiana Dam Safety Inspection Manual • Replace gravel covered slope with grass, riprap or other erosion resistant material • Relocate watercraft, docks, and furniture off the dam embankment and onto natural ground • Repair scarp near toe of slope at left side of dam and/or add erosion protection • Initiate rodent control program, backfilling burrows in accordance with the Indiana Dam Safety Inspection Manual	• 2 years • 2 years • Immediately • 2 years • 2 years	• Medium • Medium • Low • Low • Low
Crest	• Seed bare area near left abutment • Remove trees and brush from the crest in accordance with the Indiana Dam Safety Inspection Manual • Remove concrete patio in its entirety and reestablish dam crest elevation by backfilling with appropriate embankment fill	• Immediately • 2 years • 2-4 years	• Low • Medium • High
Downstream Slope	• Remove trees and brush from the slope and within 25 feet of the slope and abutments in accordance with the Indiana Dam Safety Inspection Manual • Remove landscaping, decks, steps, and other encroachments and backfill as necessary with appropriate embankment fill	• 2 years • 2 years	• Medium • Medium
Seepage	• Monitor for new seepage areas	• Ongoing	• Low
Principal Spillway	• Seal leaking joints in concrete inlet riser • Monitor surface rust on inlet metal trash rack • Replace the concrete outlet channel and repair erosion • Remove all trees and brush around outlet pipe and along concrete channel	• 2-4 years • Ongoing • 2-4 years • 2 years	• Low • Low • Medium • Low
Auxiliary Spillway	• Remove all vegetation growing in spillway channel • Relocate all watercraft, trailers and other equipment off the spillway and embankment and onto natural ground • Add appropriately sized riprap or other armoring to the spillway channel for erosion protection	• Immediately • Immediately • 2-4 years	• Low • Low • High
Maintenance and Repairs	• Perform spillway capacity analysis in accordance with current IDNR requirements • Retain a geotechnical engineer to evaluate the stability of the dam under various loading conditions • Prepare an Incident and Emergency Action Plan (IEAP) including inundation mapping • Develop a drawdown plan to be able to lower the water level if necessary for maintenance or emergencies • Conduct a video inspection of the principal spillway outlet pipe; subsequent inspections should be performed every six years • Multiple owners to work to resolve dam inspection recommendations	• 2 years • 2 years • 2-4 years • 2 years • 2-4 years • 2 years	• High • High • Medium • Low • Low • High

EXPLANATION FOR CHANGE IN RATINGS (Describe all repairs, upgrades or improvements made if dam conditions and rating have improved since the last inspection. Describe deteriorating conditions if ratings have worsened.)

REASONS FOR RATING CHANGE:

Upstream Slope – The rating was changed from "Good" to "Deficient" due to encroachments and tree growth.

Downstream Slope – The rating was changed from "Acceptable" to "Deficient" due to encroachments and tree growth.

Seepage – The rating was changed from "Acceptable" to "Good" since no seepage or wet areas were observed. The natural ground appeared to be higher than the normal pool elevation in several areas.

Principal Spillway – The rating was changed from “Acceptable” to “Deficient” due to the outlet condition, accessibility, and reduction in pipe cross sectional area from slip-lining without hydraulic analysis.

Maintenance and Repairs – The rating was changed from "Acceptable" to "Deficient" since the dam needs significant improvement.

Overall Conditions – The rating was changed from "Fair" to "Poor" due to the surficial conditions and uncertainties regarding critical analyses.

PREVIOUS RECOMMENDATIONS FOR MAINTENANCE, REPAIRS, AND UPGRADES:

HAVE THEY BEEN PERFORMED ☐ YES ☒ NO (If no, please explain:)

It does not appear that the recommendations made during the 8/31/16 inspection have been including removal of trees and brush from crest and area adjacent to auxiliary spillway, removal of small boats in auxiliary spillway, and addressing inadequate riprap in auxiliary spillway.

Supporting Documentation

Photographs ☒ Attachments ☒ Calculations ☐ Drawings ☐ Other ☐

Comments:

Keystone Woods Lake Dam 2019 Dam Safety Inspection Report

INSTRUCTIONS FOR COMPLETING DAM VISUAL INSPECTION REPORT

1. Complete all items that are applicable; if not applicable, write in "N/A". For concrete dams, complete all applicable items and use "comments" section to cover items not included in the check boxes. Also indicate that the dam is concrete in the comments section.

2. Use page 6 to determine ratings of each dam component (items A through G) and for Overall Conditions (Item H).

3. Please write legibly and concisely.

4. Inspector must be knowledgeable with the type of dam, materials, and components being inspected. If not, qualified assistance shall be engaged.

5. The inspector shall review the dam owner's and IDNR project files prior to the inspection. Previous inspection reports shall be closely reviewed for previous problems and deficiencies.

6. If the ratings of the components (items A through G) or the Overall Conditions (item H) of the dam have changed since the last inspection, please complete page 4. If a rating has improved, dam repairs, improvements, analyses, or maintenance must have been performed and documented on page 4.

7. For a dam to have a satisfactory "Overall Conditions" rating, it must have no existing or potential dam safety deficiencies recognized. Safe performance is expected under all anticipated loading conditions, including infrequent hydrologic events (PMP for high hazard dams) and seismic events. The dam owner's project files must contain hydrologic and hydraulic analyses of the dam and its spillways to verify performance. The files must also contain slope stability analyses to verify embankment stability under full reservoir conditions and rapid-draw down conditions. The dam and all of its components must meet current IDNR and design standards. "Normal" deficiencies such as minor erosion, minor seepage, or normal concrete aging may not make a dam unsatisfactory or unacceptable. For a satisfactory "Overall Conditions" rating to be assigned, items A through G generally should all have a "good" rating; however, in some cases an "acceptable" rating may be satisfactory if the "Problems Noted" are minor, or "normal" conditions, such as minor erosion rills, small puddles on crest, or if grass needs mowed, but is in good condition.

8. An inspection report form must be submitted to IDNR along with a formal technical inspection report as described in Chapter 4.0 of Part 3 of the Indiana Dam Safety Inspection Manual.

9. Please sign and date this page in the space below to verify that you have read and understand these instructions.

Inspector's Signature:  Date: 11/5/19

GUIDELINES FOR DETERMINING CONDITIONS

CONDITIONS OBSERVED - APPLIES TO UPSTREAM SLOPE, CREST, DOWNSTREAM SLOPE, PRINCIPAL SPILLWAY, AUXILIARY SPILLWAY

GOOD	ACCEPTABLE	DEFICIENT	POOR
In general, this part of the structure has a good appearance, and conditions observed in this area do not appear to threaten the safety of the dam.	Although general cross-section is maintained, surfaces may be irregular, eroded, rutted, spalled, or otherwise not in new condition. Conditions in this area do not currently appear to threaten the safety of the dam.	Continued deterioration and/or unusual loading may threaten the safety of the dam.	Conditions observed in this area appear to threaten the safety of the dam. Conditions observed in this area are unacceptable.

CONDITIONS OBSERVED - APPLIES TO SEEPAGE

GOOD (NONE)	ACCEPTABLE	DEFICIENT	POOR
No evidence of uncontrolled seepage. No unexplained increase in flows from designed drains. All seepage is clear. Seepage conditions do not appear to threaten the safety of the dam.	Some seepage exists at areas other than the drain outfalls, or other designed drains. No unexplained increase in flows from designed drains. All seepage is clear. Seepage conditions observed do not currently appear to threaten the safety of the dam.	Excessive seepage exists at areas other than drain outfalls and other designed drains. Seepage needs to be evaluated. Increased flow and/or continued deterioration in seepage conditions may threaten the safety of the dam.	Excessive seepage conditions observed appear to threaten the safety of the dam and is unacceptable. Examples: 1) Designed drain or seepage flows have increased without increase in reservoir level. 2) Drain or seepage flows contain sediment. i.e., muddy water or particles in jar samples. 3) Widespread seepage, concentrated seepage or ponding appears to threaten the safety of the dam.

CONDITIONS OBSERVED - APPLIES TO MAINTENANCE AND REPAIR

GOOD	ACCEPTABLE	DEFICIENT	POOR
Dam appears to receive effective on-going maintenance and repair, and only a few minor items may need to be addressed.	Dam appears to receive maintenance, but some maintenance items need to be addressed. No major repairs are required.	Level of maintenance of the dam needs significant improvement. Major repairs may be required. Continued neglect of maintenance may threaten the safety of the dam.	Dam does not receive adequate maintenance. One or more items needing maintenance or repair has begun to threaten the safety of the dam. Level of maintenance is unacceptable.

OVERALL CONDITIONS

SATISFACTORY - No existing or potential dam safety deficiencies recognized. Safe performance is expected under all anticipated loading conditions, including such events as infrequent hydrologic and/or seismic events. Project Files contain necessary hydrologic, and other engineering calculations to verify dam safety and performance.

FAIR - No existing dam safety deficiencies are recognized for normal loading conditions. Infrequent hydrologic and/or seismic events would probably result in a dam safety deficiency.

CONDITIONALLY POOR - A potential safety deficiency is recognized for unusual loading conditions which may realistically occur during the expected life of the structure. CONDITIONALLY POOR may also be used when uncertainties exist as to critical analysis parameters which identify a potential dam safety deficiency; further investigations and studies are necessary.

POOR - A potential dam safety deficiency is clearly recognized for normal loading conditions. Immediate actions to resolve the deficiency are recommended; reservoir restrictions may be necessary until problem resolution.

UNSATISFACTORY - A dam safety deficiency exists for normal conditions. Immediate remedial action is required for problem resolution.

HAZARD CLASSIFICATIONS OF DAMS (STRUCTURE)

LOW HAZARD- A structure the failure of which may damage farm buildings, agricultural land, or local roads

SIGNIFICANT HAZARD- A structure the failure of which may damage isolated homes and highways, or cause the temporary interruption of public utility services.

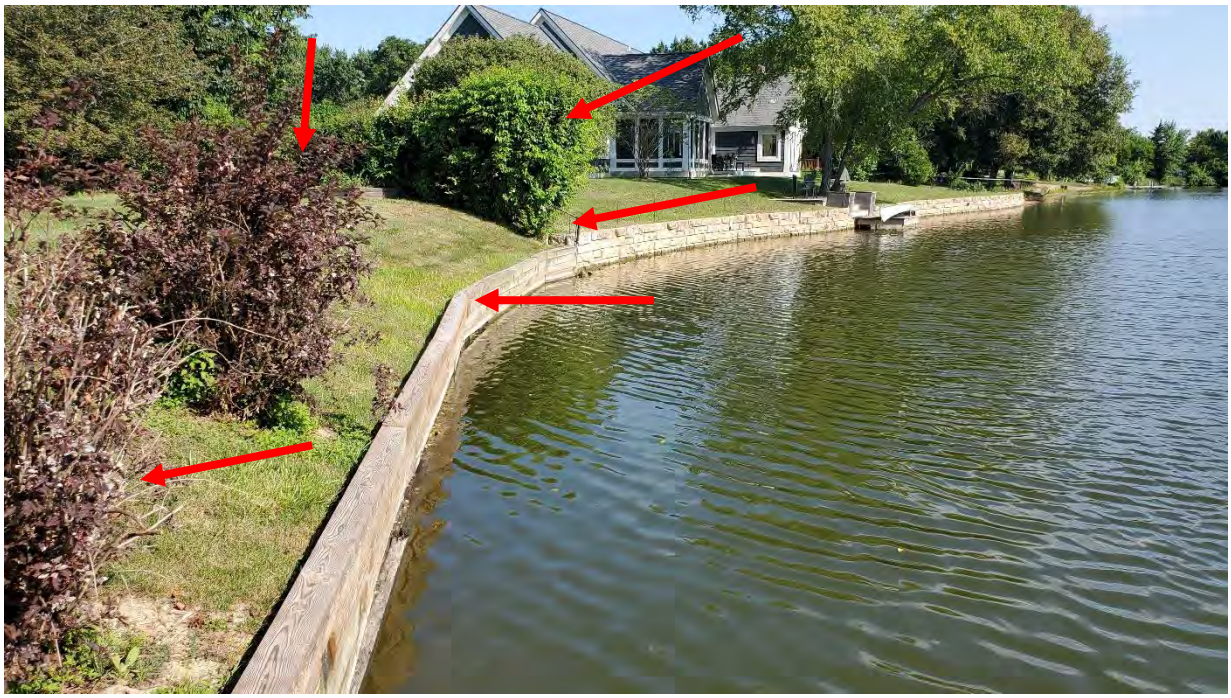
HIGH HAZARD-A structure the failure of which may cause the loss of life and serious damage to homes, industrial and commercial buildings, public utilities, major highways, or railroads.

UNAPPROVED STATUS OF DAM

A dam that has been given an unapproved status (see entry for permit) means that plans, construction specifications, hydraulic analyses, and/or a geotechnical investigation on your dam, proving the safety of the structure, have not been received and approved by the Indiana Department of Natural Resources (IDNR). IDNR records indicate that no progress has been made to secure this approval. The fact that the dam is inspected under the Regulation of Dams Act (IC 14-27-7.5) in no way alters the illegal status of the structures.

If your dam is indicated to be unapproved, it is requested that your engineer contact the Indiana Department of Natural Resources,

APPENDIX 4: **INSPECTION PHOTOGRAPHS**



Top: Upstream slope right side. Note timber seawall protection on this section with slight deflection towards lake. Also note several encroachments of fences, trees, and bushes.

Bottom: Upstream slope right side. Note timber seawall protection on this section with slight deflection towards lake. Also note several encroachments of docks, fences, landscaping, trees, and bushes.

Top: Upstream slope right side. Note small burrow and rodent run.

Bottom: Upstream slope. Note rodent burrow (typ.) located sporadically along embankment.

Top: Upstream slope left side. Note inadequate slope cover in gravel area with trees encroaching.

Bottom: Upstream slope left side. Note inadequate slope cover near toe. Brush, landscaping, and dock encroachments.

Top: Embankment crest on left abutment. Note trees, brush, landscaping, and watercraft (canoe).

Bottom: Embankment crest at left abutment fence. Note private fence across embankment and bare area.

Top: Embankment crest left side. Note trees on crest in gravel covered area.

Bottom: Embankment crest left side. Note firepit, flagpole, and tree encroachments.

Top: Embankment crest right side. Note landscaping and brush encroaching along property line.

Bottom: Embankment crest right side. Note firepit encroachment.

Top: Embankment crest right side. Note concrete patio is cut into the embankment resulting in loss of embankment height and width. Watercraft and outdoor furniture also present.

Bottom: Embankment crest right side. Note fencing and brush across embankment.

Top: Embankment crest/downstream slope from right side. Note landscaping and decking built into embankment.

Bottom: Embankment crest/downstream slope from right side. Note extended decking on embankment and tree on embankment.

Top: Downstream slope right side. Note landscaping and stairs cut into embankment slope.

Bottom: Downstream slope right side. Note fencing across embankment and bare area found by fence.

Top: Downstream slope left side. Note trees and bushes growing on and within 25 feet of embankment.

Bottom: Downstream slope from left side. Note trees and bushes growing on and within 25 feet of embankment.

Top: Principal spillway drop inlet riser with trashrack near dock. Note landscaping and watercraft encroachments along upstream slope.

Bottom: Principal spillway drop inlet interior. Note seepage around concrete joints and minor surface rust on trashrack.

Top: Principal spillway outlet channel. Note newly place riprap armoring around outfall. Note tree stumps in Auxiliary Spillway riprap.

Bottom: Principal spillway outlet and interior of 24-inch CCFRPM discharge pipe outlet.

Top: Principal spillway outlet. Note metal end section rust and hole on side.

Bottom: Principal spillway concrete outlet channel. Note newly placed riprap.

Top: Auxiliary spillway open channel. Note smaller riprap at inlet section.

Bottom: Auxiliary spillway open channel. Note stump on left side and bare spots in grassed area.

Top: Auxiliary spillway open channel. Note newly placed riprap.

Bottom: Auxiliary spillway open channel

Top: Auxiliary spillway open channel.

Bottom: Auxiliary spillway open channel at downstream end.

APPENDIX 5: **DAM INSPECTION CHECKLIST**

Dam Safety Inspection Checklist

Complete All Portions of This Section (Pre-inspection)
Date of Inspection: 8/3/2021
Name of Dam: Keystone Woods Lake Dam File Number: 29-5
EAP: (yes, no) OM&I: (yes, no)

Review Inventory - Highlight missing information (Pre -inspection)
Owner=s Name(s): Woodlands Homeowners Association, INC.
Address: 10700 Lakeshore Dr. E.
City: Carmel State: IN Zip (+4): 46033

Telephone (Home): 317-809-3797 Telephone (Work):
Contact Person: JUDITH ROURKE LANG Telephone:
Designed By: Clyde E. Williams & Associates Inc.
Constructed By: ?
Year Completed: 1974 Plans Available (Yes, No) (location): IDNR FILE
Purpose of dam:

Interview with Owner (at the site):
Owner/Representative present: (Yes, No) Name(s): Judy, Scott, Beth

Double check address, telephone #, purpose (check ->) G
How long have you owned dam - previous name/owner?

EAP/OM&I: up-dated-(yes, no) & location: - working EAP Budgeting
Operate lake drain (times per year, accessibility): - Drawdown Plan

Mowing (times per year): Regularly
Prior problems (wet areas, erosion, slides):

Repair or modification (what & when): Drawdown Plan, Riprap on Spillway by Wharff. Excavating

Failure/Incident/Breach (max. pool): Auxiliary Spillway activates in middle 8x/year

Downstream hazard status (recent changes):

Do you know the in-depth details of the construction of your dam? (If yes - ask next three questions, if no - go to Field Information Section)
Core trench material and location:
Volume of fill (earth or rock) in dam:
Foundation (earth or rock) of dam:

Field Information (while at site)
Pool Elevation (during inspection): 2" below N.P. Time: 8:30 (a.m. p.m.)
Site Conditions(temp., weather, ground moisture): 65°, Clear, Dry

Inspection Party: Jeff Fox, Josh Linard, 3 from HCA
Maximum Height: (measured or inventory appears correct)
Normal Pool Surface Area: (measured or inventory appears correct)

*SEE INSPECTION REPORT FOR RECOMMENDED ACTION. TYPICAL ALL PAGES OF CHECKLIST.

*Required Action

UPSTREAM SLOPE

Gradient: Horizontal: 3 Vertical: 1 (est, meas.)

None | Monitor | Maintenance | Engineer

☐ ***VEGETATION*** [no problem]

☑ Trees: Quantity: (<5, sparse, dense) 1-Tree on property
Diameter: (<6", 6-12", >12")
Location: (adj. to structure, entire slope, lt end, rt end, middle, see dwg) Middle LT-Stump
Notes: Middle 3 Trees ☐ ☐ ☐ ☐

☑ Brush: Quantity: (sparse, dense) Right Side / Landscaping
Location: (adj. to structure, entire slope, lt end, rt end, middle, see dwg) Middle LT
Notes: Few bushes on property ☐ ☐ ☐ ☐

☐ Ground Cover: Type: (grass, crown vetch) Other:
Quantity: (bare, sparse, adequate, dense)
Appearance: (too tall, too short, good)
Notes: Bare spot left end at property line ☐ ☐ ☐ ☐

☑ ***SLOPE PROTECTION*** [no problem, could not inspect thoroughly]

☐ None ☐ ☐ ☐ ☐

☐ Riprap: Average Diameter: ☐ ☐ ☐ ☐
(adequate, sparse, displaced, weathered, vegetation) (bedding/fabric noted - yes, no)
Notes:

☐ Wave Berm: ☐ ☐ ☐ ☐
Vegetation: (adequate, bare, sparse, improper vegetation)
Notes:

☐ Concrete Slabs: (cracked, settlement, undermined, voids, deteriorated, vegetation) ☐ ☐ ☐ ☐
Notes:

☑ Other: Seawalls on LT/RT Abutments. Pea gravel along middle ☐ ☐ ☐ ☐
Notes: LT=Rock seawall, RT=Wood seawall=Slight vertical deflection entire LT.S. right side

☐ ***EROSION*** [no problem, could not inspect thoroughly]

☐ Wave Erosion (Beaching): Scarp: Length: Height: ☐ ☐ ☐ ☐
Location: (adj. to structure, entire slope, lt end, rt end, middle, see dwg)
Notes:

☐ Runoff Erosion (Gullies): Quantity: ☐ ☐ ☐ ☐
Depth: Width: Length:
Location: (adj. to structure, entire slope, lt end, rt end, middle, see dwg)
Notes/Causes:

☐ ***INSTABILITIES*** [no problem, could not inspect thoroughly]

☐ Slides: Transverse Length: Longitudinal Length: ☐ ☐ ☐ ☐
Scarp: Width: Length:
Location: (adj. to structure, entire slope, lt end, rt end, middle, see dwg)
Crack: Width: Depth:
Notes/Causes

☐ Cracks: ☐ Transverse ☐ Longitudinal ☐ Other ☐ ☐ ☐ ☐
Quantity: Length: Width: Depth:
Location: (adj. to structure, entire slope, lt end, rt end, middle, see dwg)
Notes/Causes:

None | Monitor | Maintenance | Engineer

Required Action

Required Action

None Monitor Maintenance Engineer

☐ Cracks: ☐ Transverse ☐ Longitudinal ☐ Other ☐ ☐ ☐ ☐
Quantity: Length: Width: Depth:
Location: (adj. to structure, entire slope, lt end, rt end, middle, see dwg)
Notes/Causes:

☐ Bulges ☐ Depressions ☐ Hummocky ☐ ☐ ☐ ☐
Size: Height: Depth:
Location: (adj. to structure, entire slope, lt end, rt end, middle, see dwg)
Notes/Causes:

☐ Bulges ☐ Depressions ☐ Hummocky ☐ ☐ ☐ ☐
Size: Height: Depth:
Location: (adj. to structure, entire slope, lt end, rt end, middle, see dwg)
Notes/Causes:

☐ ***OTHER*** [no problem, could not inspect thoroughly]
☑ Rodent Burrows: (few, numerous) ☐ ☐ ☐ ☐
Location: (adj. to structure, entire slope, lt end, rt end, middle, see dwg)
Notes: RT END ABOVE WALL, Rodent path/cuts 2X

☐ Ruts: ☐ ☐ ☐ ☐
Location: (adj. to structure, entire slope, lt end, rt end, middle, see dwg)
Depth: Width Length:
Notes/Causes: (truck/auto, motorcycle, ATV, animals, pedestrian)

☑ Other: ☐ ☐ ☐ ☐
Notes: LT Abutment Seawall 1'+/-, FENCE Perpendicular to Dam Left side
- LT Fence
- RT Patio cut into slope

CREST Length:_____ Width: 10FT (est, meas.)

☐ ***VEGETATION*** [no problem]
☑ Trees: Quantity: (<5, sparse, dense) ☐ ☐ ☐ ☐
Diameter: (<6", 6-12", >12") LT Two Trees on Crest
Location: (adj. to structure, entire crest, lt end, rt end, middle, see dwg)
Notes:

☐ Brush: Quantity: (sparse, dense) Landscaping - LT END ☐ ☐ ☐ ☐
Location: (adj. to structure, entire crest, lt end, rt end, middle, see dwg)
Notes:

☑ Ground Cover: Type: (grass, crown vetch) Other: Pea gravel - LT Middle ☐ ☐ ☐ ☐
Quantity: (bare, sparse, adequate, dense)
Appearance: (too tall, too short, good)
Notes: Bare area near LT fence

☐ ***EROSION*** [no problem, could not inspect thoroughly]
☐ Runoff Erosion (Gullies): Quantity: Depth: Width: Length: ☐ ☐ ☐ ☐
Location: (adj. to structure, entire crest, lt end, rt end, middle, see dwg)
Notes/Causes:

None Monitor Maintenance Engineer

Required Action

Required Action

None Monitor Maintenance Engineer

☐ ***ALIGNMENT*** [no problem, could not inspect thoroughly]

☐ Vertical: ☐ Low Area: ☐ ☐ ☐ ☐

Location: (adj. to structure, entire crest, lt end, rt end, middle, see dwg)

Elevation Difference: Length:

Notes/Causes:

☐ ☐ ☐ ☐

☐ Horizontal:

Notes/Causes:

☐ ***WIDTH*** [no problem]

☐ Too Narrow

Location: (adj. to structure, entire crest, lt end, rt end, middle, see dwg) ☐ ☐ ☐ ☐

Notes/Causes:

☐ ***INSTABILITIES*** [no problem, could not inspect thoroughly]

☐ Cracks: ☐ Transverse ☐ Longitudinal ☐ Other ☐ ☐ ☐ ☐

Quantity: Length: Width: Depth:

Location: (adj. to structure, entire crest, lt end, rt end, middle, see dwg)

Notes/Causes:

☐ Cracks: ☐ Transverse ☐ Longitudinal ☐ Other ☐ ☐ ☐ ☐

Quantity: Length: Width: Depth:

Location: (adj. to structure, entire crest, lt end, rt end, middle, see dwg)

Notes/Causes:

☐ Bulges ☐ Depressions ☐ Hummocky ☐ ☐ ☐ ☐

Size: Height: Depth:

Location: (adj. to structure, entire crest, lt end, rt end, middle, see dwg)

Notes/Causes:

☐ Bulges ☐ Depressions ☐ Hummocky ☐ ☐ ☐ ☐

Size: Height: Depth:

Location: (adj. to structure, entire crest, lt end, rt end, middle, see dwg)

Notes/Causes:

☐ ***OTHER*** [no problem, could not inspect thoroughly]

☐ Rodent Burrows: (few, numerous) ☐ ☐ ☐ ☐

Location: (adj. to structure, entire crest, lt end, rt end, middle, see dwg)

Notes:

☐ Ruts: ☐ ☐ ☐ ☐

Location: (adj. to structure, entire crest, lt end, rt end, middle, see dwg)

Depth: Width Length:

Notes/Causes: (truck/auto, motorcycle, ATV, animals, pedestrian)

☑ Other: ☐ ☐ ☐ ☐

Notes: LT end, Canoe on property owner land
LT Middle Fire pit
RT Fire pit on owner property/Patio
RT end canoe & boat
RT end elev. garden by Fence

None Monitor Maintenance Engineer

Required Action

Required Action

DOWNSTREAM SLOPE Gradient: Horizontal: 3 Vertical: 1 (est, meas.)

None | Monitor | Maintenance | Engineer

☐ ***VEGETATION*** [no problem]

☑ Trees: Quantity: (<5, sparse, dense) ☐ ☐ ☐ ☐
Diameter: (<6", 6-12", >12")
Location: (adj. to structure, entire slope, lt end, rt end, middle, see dwg)
Notes: ↳ 1 on toe, 2 at abutment (RT)

☑ Brush: Quantity: (sparse, dense) ☐ ☐ ☐ ☐
Location: (adj. to structure, entire slope, lt end, rt end, middle, see dwg)
Notes: Landscaping/property lines

☐ Ground Cover: Type: (grass, crown vetch) Other: Sporadic bare spots ☐ ☐ ☐ ☐
Quantity: (bare, sparse, adequate, dense)
Appearance: (too tall, too short, good)
Notes: 3' x 3' bare spot RT end 10' of fence

☐ ***EROSION*** [no problem, could not inspect thoroughly]

☐ Runoff Erosion (Gullies): Quantity: Depth: Width: Length: ☐ ☐ ☐ ☐
Location: (adj. to structure, entire slope, lt end, rt end, middle, see dwg)
Notes/Causes:

☐ ***INSTABILITIES*** [no problem, could not inspect thoroughly]

☐ Slides: Transverse Length: Longitudinal Length: ☐ ☐ ☐ ☐
Scarp: Width: Length:
Location: (adj. to structure, entire slope, lt end, rt end, middle, see dwg)
Crack: Width: Depth:
Notes/Causes

☐ Cracks: ☐ Transverse ☐ Longitudinal ☐ Other ☐ ☐ ☐ ☐
Quantity: Length: Width: Depth:
Location: (adj. to structure, entire slope, lt end, rt end, middle, see dwg)
Notes/Causes:

☐ Cracks: ☐ Transverse ☐ Longitudinal ☐ Other ☐ ☐ ☐ ☐
Quantity: Length: Width: Depth:
Location: (adj. to structure, entire slope, lt end, rt end, middle, see dwg)
Notes/Causes:

☐ Bulges ☐ Depressions ☐ Hummocky ☐ ☐ ☐ ☐
Size: Height: Depth:
Location: (adj. to structure, entire slope, lt end, rt end, middle, see dwg)
Notes/Causes:

☐ Bulges ☐ Depressions ☐ Hummocky ☐ ☐ ☐ ☐
Size: Height: Depth:
Location: (adj. to structure, entire slope, lt end, rt end, middle, see dwg)
Notes/Causes:

None | Monitor | Maintenance | Engineer

Required Action

Required Action

None Monitor Maintenance Engineer

☐ ***OTHER*** [no problem, could not inspect thoroughly] ☐ ☐ ☐ ☐

☐ Rodent Burrows: (few, numerous)
Location: (adj. to structure, entire slope, lt end, rt end, middle, see dwg)
Notes:

☐ Ruts: ☐ ☐ ☐ ☐
Location: (adj. to structure, entire slope, lt end, rt end, middle, see dwg)
Depth: Width Length:
Notes/Causes: (truck/auto, motorcycle, ATV, animals, pedestrian)

☑ Other: RT property garden cut into slope ☐ ☐ ☐ ☐
Notes: RT deck on slope

☐ ***SEEPAGE*** [no problem, could not inspect thoroughly]
☐ Wet Area ☐ Flow ☐ Boil ☐ Sinkhole ☐ ☐ ☐ ☐
Flow Rate_____ Size:_____
Location:_____
☐ Aquatic Vegetation ☐ None
☐ Rust Colored Deposits ☐ None
☐ Sediment in Flow ☐ None
☐ Other:_____
Notes/Causes:_____

☐ Wet Area ☐ Flow ☐ Boil ☐ Sinkhole ☐ ☐ ☐ ☐
Flow Rate_____ Size:_____
Location:_____
☐ Aquatic Vegetation ☐ None
☐ Rust Colored Deposits ☐ None
☐ Sediment in Flow ☐ None
☐ Other:_____
Notes/Causes:_____

☐ ***EMBANKMENT DRAINS*** [none, none found, no problem, could not inspect thoroughly]
Type: ☐ Toe Drain ☐ Relief Wells ☐ Other:_____ ☐ ☐ ☐ ☐
Flow Rate:_____ Size:_____ Number:_____
Location:_____
Notes: Over on spillway inlet appears capped

☐ ***MONITORING INSTRUMENTATION*** [none, none found, no problem, could not inspect thoroughly]
☐ None Found ☐ Piezometers ☐ Weirs/Flumes ☐ Other ☐ ☐ ☐ ☐
☐ Periodic Inspections by:_____
Notes:_____

None Monitor Maintenance Engineer

Required Action

PRINCIPAL SPILLWAY

Required Action: None | Monitor | Maintenance | Engineer

☐ ***GENERAL INLET*** [no problem, could not inspect thoroughly]

☐ Anti-Vortex Plate [None] Dimensions:_____ (adequate, too small,) ☐ ☐ ☐ ☐

Type: (steel, concrete, aluminum, stainless steel, corrugated metal wood, other):_____

Deterioration: (missing sections, rusted, collapsed)_____

Notes:_____

☐ Flash Boards [None] ☐ ☐ ☐ ☐

Type: (metal, wood):_____

Deterioration:_____

Notes:_____

☑ Trashrack [None] Opening Size:_____ (adequate, too small, too large) ☐ ☐ ☐ ☐

Type: (metal bars, fence, screen, concrete, baffle, other):_____

Deterioration: (broken bars, missing sections, rusted, collapsed)_____

Notes: Not secured to top. ⇒ Minor surface rust

☐ ***INLET OBSTRUCTION*** [no problem, could not inspect thoroughly]

☐ Debris: (leaves, trash, logs, branches, ice)_____ ☐ ☐ ☐ ☐

☐ Trees: Quantity: (<5, sparse, dense) ☐ ☐ ☐ ☐

Diameter: (<6", 6-12", >12")

Location: (entire inlet, lt side, rt side, middle, see dwg)

Notes:

☐ Brush: Quantity: (sparse, dense) ☐ ☐ ☐ ☐

Location: (entire inlet, lt side, rt side, middle, see dwg)

Notes:

☐ Other:(beaver activity, trashrack opening too small, partially/completely blocked, i.e.)_____ ☐ ☐ ☐ ☐

Notes:

☐ ***INLET MATERIALS*** [no problem, could not inspect thoroughly]

☐ Metal

(loss of coating/paint, surface rust, corrosion (pitting, scaling), rusted out, pipe deformation)_____ ☐ ☐ ☐ ☐

Dimensions:_____

Location:_____

Notes/Causes:_____

☑ Concrete

(bug holes, hairline crack, efflorescence) ☐ ☐ ☐ ☐

(spalling, popouts, honeycombing, scaling, craze/map cracks) ☐ ☐ ☐ ☐

(isolated crack, exposed rebar, disintegration, other) ☐ ☐ ☐ ☐

Dimensions/Location: US RT. & D.S. LT Seepage in Joints

Notes/Causes:_____

(bug holes, hairline crack, efflorescence) ☐ ☐ ☐ ☐

(spalling, popouts, honeycombing, scaling, craze/map cracks) ☐ ☐ ☐ ☐

(isolated crack, exposed rebar, disintegration, other) ☐ ☐ ☐ ☐

Dimensions/Location:_____

Notes/Causes:_____

☐ Plastic ☐ ☐ ☐ ☐

(deterioration, cracking, deformation)_____

Dimensions:_____

Location:_____

Notes/Causes:_____

None | Monitor | Maintenance | Engineer

Required Action

Required Action

None Monitor Maintenance Engineer

☐ Earthen

☐ Ground Cover: Type: (grass, crown vetch) Other: ☐ ☐ ☐ ☐

Quantity: (bare, sparse, adequate, dense)

Appearance: (too tall, too short, good)

Notes:

☐ Erosion: (wave, surface runoff) _____ ☐ ☐ ☐ ☐

Description (height/depth/length/etc):_____

Notes:_____

_____

☐ Ruts: ☐ ☐ ☐ ☐

Location: (entire inlet, lt side, rt side, middle, see dwg)

Depth: Width Length:

Notes/Causes: (truck/auto, motorcycle, ATV, animals, pedestrian)

☐ Riprap: Average Diameter: ☐ ☐ ☐ ☐

(adequate, sparse, displaced, weathered, vegetation) (bedding/fabric noted - yes, no)

Notes:

☐ Rock-Cut (weathered, erosion) ☐ ☐ ☐ ☐

Description:_____

Notes:_____

_____

☐ Other:_____ ☐ ☐ ☐ ☐

_____

☐ ***OTHER INLET PROBLEMS*** [no problem, could not inspect thoroughly]

☐ Mis-Alignment:(pipe, chute, sidewall, headwall) ☐ Pipe Deformation_____ ☐ ☐ ☐ ☐

Location/Description:_____

Notes/Causes:_____

_____

☐ Separated Joint ☐ Loss of Joint Material ☐ ☐ ☐ ☐

Location/Description:_____

Notes/Causes:_____

_____

☐ Undermining: ☐ ☐ ☐ ☐

Location/Description:_____

Notes/Causes:_____

_____

☐ Other:_____ ☐ ☐ ☐ ☐

_____

☐ ***OPEN CHANNEL CONTROL SECTION*** [no problem, could not inspect] **Width** (est., ms.) **Brdth** (est., ms.)

Notes: ☐ ☐ ☐ ☐

☐ ***OUTLET OBSTRUCTION*** [no problem, could not inspect thoroughly]

☐ Debris: (leaves, trash, logs, branches, ice)_____ ☐ ☐ ☐ ☐

☐ Trees: Quantity: (<5, sparse, dense)_____ ☐ ☐ ☐ ☐

Diameter: (<6", 6-12", >12")

Location: (entire outlet, lt side, rt side, middle, see dwg)

Notes:

☐ Brush: Quantity: (sparse, dense) ☐ ☐ ☐ ☐

Location:(entire outlet, lt side, rt side, middle, see dwg)

Notes:

Required Action

☐ Other:(beaver activity, partially/completely blocked, i.e.)_____ ☐ ☐ ☐ ☐

_____

Notes:

None Monitor Maintenance Engineer

{Upstream Slope, Crest, Downstream Slope, Seepage, **Principal Spillway-Inlet/Outlet**, Emergency Spillway, Lake Drain}

Required Action

☑ ***OUTLET MATERIALS*** [no problem, could not inspect thoroughly]

☑ Metal (loss of coating/paint, surface rust, corrosion (pitting, scaling), rusted out, pipe deformation) End Section

Dimensions: Small Hole on Left side

Location: Metal End Section

Notes/Causes:

None ☐ Monitor ☐ Maintenance ☐ Engineer ☐

☐ Concrete

(bug holes, hairline crack, efflorescence) ☐ ☐ ☐ ☐

(spalling, popouts, honeycombing, scaling, craze/map cracks) ☐ ☐ ☐ ☐

(isolated crack, exposed rebar, disintegration, other) ☐ ☐ ☐ ☐

Dimensions/Location:

Notes/Causes:

(bug holes, hairline crack, efflorescence) ☐ ☐ ☐ ☐

(spalling, popouts, honeycombing, scaling, craze/map cracks) ☐ ☐ ☐ ☐

(isolated crack, exposed rebar, disintegration, other) ☐ ☐ ☐ ☐

Dimensions/Location:

Notes/Causes:

☐ Plastic (deterioration, cracking, deformation) ☐ ☐ ☐ ☐

Dimensions:

Location:

Notes/Causes:

☐ Earthen

☐ Ground Cover: Type: (grass, crown vetch) Other: ☐ ☐ ☐ ☐

Quantity: (bare, sparse, adequate, dense)

Appearance: (too tall, too short, good)

Notes:

☐ Erosion: (other, surface runoff) ☐ ☐ ☐ ☐

Description (width/depth/length/etc):

Notes:

☐ Ruts: ☐ ☐ ☐ ☐

Location: (entire inlet, lt side, rt side, middle, see dwg)

Depth: Width Length:

Notes/Causes: (truck/auto, motorcycle, ATV, animals, pedestrian)

☑ Riprap: Average Diameter: 6"-7" ☐ ☐ ☐ ☐

(adequate, sparse, displaced, weathered, vegetation) (bedding/fabric noted - yes, no)

Notes:

☐ Rock-Cut (weathered, erosion) ☐ ☐ ☐ ☐

Description/Notes:

☐ Other: ☐ ☐ ☐ ☐

☐ ***OTHER OUTLET PROBLEMS*** [no problem, could not inspect thoroughly]

☐ Mis-Alignment:(pipe, chute, sidewall, headwall) ☐ Pipe Deformation ☐ ☐ ☐ ☐

Location/Description:

Notes/Causes:

None Monitor Maintenance Engineer

☐ Separated Joint ☐ Loss of Joint Material ☐ ☐ ☐ ☐

Location/Description:

Notes/Causes:

☐ Undermining: ☐ ☐ ☐ ☐

Location/Description:

Notes/Causes:

☐ Other: ☐ ☐ ☐ ☐

{Upstream Slope, Crest, Downstream Slope, Seepage, **Principal Spillway-Outlet**, Emergency Spillway, Lake Drain}

Required Action

Required Action

None Monitor Maintenance Engineer

OUTLET EROSION CONTROL STRUCTURE (Stilling Basins)

☐ None ☐ ☐ ☐ ☐

☐ (endwall/headwall, plunge pool, impact basin, flip bucket, USBR, baffled chute, rock lined channel) ☐ ☐ ☐ ☐

Notes:_____

Components (baffle blocks, chute blocks, endsill)_____

☐ ***MATERIAL*** [no problem, could not inspect thoroughly]

☑ Riprap: Average Diameter: 9" ☐ ☐ ☐ ☐

(adequate, sparse, displaced, weathered, vegetation) (bedding/fabric noted - yes, no)

Notes:

☐ Concrete

(bug holes, hairline crack, efflorescence) ☐ ☐ ☐ ☐

(spalling, popouts, honeycombing, scaling, craze/map cracks) ☐ ☐ ☐ ☐

(isolated crack, exposed rebar, disintegration, other) ☐ ☐ ☐ ☐

Dimensions/Location:_____

Notes/Causes:_____

(bug holes, hairline crack, efflorescence) ☐ ☐ ☐ ☐

(spalling, popouts, honeycombing, scaling, craze/map cracks) ☐ ☐ ☐ ☐

(isolated crack, exposed rebar, disintegration, other) ☐ ☐ ☐ ☐

Dimensions/Location:_____

Notes/Causes:_____

☐ ***OTHER*** [no problem, could not inspect thoroughly] ☐ ☐ ☐ ☐

☐ Mis-Alignment:(sidewall, headwall, entire struct.)_____

Location:_____

Description:_____

Notes/Causes:_____

☐ Separated Joint ☐ Loss of Joint Material ☐ ☐ ☐ ☐

Location:_____

Description:_____

Notes/Causes:_____

☐ Undermining: ☐ ☐ ☐ ☐

Location:_____

Description:_____

Notes/Causes:_____

☑ Other: No Trespassing Signage ☐ ☐ ☐ ☐

☐ ***DRAINS*** [none, none found, no problem, could not inspect thoroughly] (See ***SEEPAGE*** Section for Toe Drains & Relief Wells)

Type: ☐ Weep Holes ☐ Relief Drains ☐ Other:_____ ☐ ☐ ☐ ☐

Flow Rate:_____ Size:_____ Number:_____

Location:_____

Notes:_____

Type: ☐ Weep Holes ☐ Relief Drains ☐ Other:_____ ☐ ☐ ☐ ☐

Flow Rate:_____ Size:_____ Number:_____

Location:_____

Notes:_____

None Monitor Maintenance Engineer

Required Action

EMERGENCY SPILLWAY

Required Action: None | Monitor | Maint. | Engineer

☐ None Found ☐ ☐ ☐ ☐

☑ ***GENERAL INLET*** [no problem, could not inspect thoroughly]

☐ Anti-Vortex Plate [None] Dimensions:_____ (adequate, too small,) ☐ ☐ ☐ ☐

Type: (steel, concrete, aluminum, stainless steel, corrugated metal wood, other):_____

Deterioration: (missing sections, rusted, collapsed)_____

Notes:_____

☐ ☐ ☐ ☐

☐ Flash Boards [None]

Type: (metal, wood):_____

Deterioration:_____

Notes:_____

☐ Trashrack [None] Opening Size:_____ (adequate, too small, too large) ☐ ☐ ☐ ☐

Type: (metal bars, fence, screen, concrete, baffle, other):_____

Deterioration: (broken bars, missing sections, rusted, collapsed)_____

Notes:_____

☑ ***INLET OBSTRUCTION*** [no problem, could not inspect thoroughly]

☐ Debris: (leaves, trash, logs, branches, ice)_____ ☐ ☐ ☐ ☐

☐ Trees: Quantity: (<5, sparse, dense) ☐ ☐ ☐ ☐

Diameter: (<6", 6-12", >12")

Location: (entire inlet, lt side, rt side, middle, see dwg)

Notes:

☐ Brush: Quantity: (sparse, dense) ☐ ☐ ☐ ☐

Location: (entire inlet, lt side, rt side, middle, see dwg)

Notes:

☐ Other:(beaver activity, trashrack opening too small, partially/completely blocked, i.e.)_____ ☐ ☐ ☐ ☐

Notes:

☑ ***INLET MATERIALS*** [no problem, could not inspect thoroughly]

☐ Metal

(loss of coating/paint, surface rust, corrosion (pitting, scaling), rusted out, pipe deformation)_____ ☐ ☐ ☐ ☐

Dimensions/Location:_____

Notes/Causes:_____

☐ Concrete

(bug holes, hairline crack, efflorescence) ☐ ☐ ☐ ☐

(spalling, popouts, honeycombing, scaling, craze/map cracks) ☐ ☐ ☐ ☐

(isolated crack, exposed rebar, disintegration, other) ☐ ☐ ☐ ☐

Dimensions/Location:_____

Notes/Causes:_____

(bug holes, hairline crack, efflorescence) ☐ ☐ ☐ ☐

(spalling, popouts, honeycombing, scaling, craze/map cracks) ☐ ☐ ☐ ☐

(isolated crack, exposed rebar, disintegration, other) ☐ ☐ ☐ ☐

Dimensions/Location:_____

Notes/Causes:_____

☐ Plastic ☐ ☐ ☐ ☐

(deterioration, cracking, deformation)_____

Dimensions/Location:_____

Notes/Causes:_____

Required Action: None | Monitor | Maintenance | Engineer

Required Action

None Monitor Maintenance Engineer

☐ Earthen

☐ Ground Cover: Type: (grass, crown vetch) Other: Some MINOR bare areas ON left side
Quantity: (bare, sparse, adequate, dense)
Appearance: (too tall, too short, good)
Notes: ☐ ☐ ☐ ☐

☐ Erosion: (wave, surface runoff) _____ ☐ ☐ ☐ ☐
Description (height/depth/length/etc): _____
Notes: _____

☐ Ruts: ☐ ☐ ☐ ☐
Location: (entire inlet, lt side, rt side, middle, see dwg)
Depth: Width Length:
Notes/Causes: (truck/auto, motorcycle, ATV, animals, pedestrian)

☑ Riprap: Average Diameter: Variable smaller at inlet ☐ ☐ ☐ ☐
(adequate, sparse, displaced, weathered, vegetation) (bedding/fabric noted - yes, no)
Notes:

☐ Rock-Cut (weathered, erosion)
Description: _____ ☐ ☐ ☐ ☐
Notes: _____

☑ Other: Tree stump left side, brush right side ☐ ☐ ☐ ☐

☐ ***OTHER INLET PROBLEMS*** [no problem, could not inspect thoroughly]

☐ Mis-Alignment:(channel, chute, sidewall, headwall) ☐ Pipe Deformation _____ ☐ ☐ ☐ ☐
Location/Description: _____
Notes/Causes: _____

☐ Separated Joint ☐ Loss of Joint Material ☐ ☐ ☐ ☐
Location/Description: _____
Notes/Causes: _____

☐ Undermining: ☐ ☐ ☐ ☐
Location/Description: _____
Notes/Causes: _____

☐ Other: _____ ☐ ☐ ☐ ☐

☐ ***OPEN CHANNEL CONTROL SECTION*** [no problem, could not inspect] **Width** (est., ms.) **Brdth** (est., ms.)
Notes: ☐ ☐ ☐ ☐

☐ ***OUTLET OBSTRUCTION*** [no problem, could not inspect thoroughly]

☐ Debris: (leaves, trash, logs, branches, ice) _____ ☐ ☐ ☐ ☐
☐ Trees: Quantity: (<5, sparse, dense) _____ ☐ ☐ ☐ ☐
Diameter: (<6", 6-12", >12")
Location: (entire outlet, lt side, rt side, middle, see dwg)
Notes:

☐ Brush: Quantity: (sparse, dense) ☐ ☐ ☐ ☐
Location:(entire outlet, lt side, rt side, middle, see dwg)
Notes:

Required Action

☐ Other:(beaver activity, partially/completely blocked, i.e.) _____ ☐ ☐ ☐ ☐
Notes:

None Monitor Maintenance Engineer

{Upstream Slope, Crest, Downstream Slope, Seepage, Principal Spillway, **Emergency Spillway-Inlet/Outlet**, Lake Drain}

Required Action

☑ ***OUTLET MATERIALS*** [no problem, could not inspect thoroughly] — None ☐ Monitor ☐ Maint. ☐ Engineer ☐

☐ Metal (loss of coating/paint, surface rust, corrosion (pitting, scaling), rusted out, pipe deformation)_____ ☐ ☐ ☐ ☐
Dimensions:_____
Location:_____
Notes/Causes:_____

☐ Concrete (bug holes, hairline crack, efflorescence) ☐ ☐ ☐ ☐
(spalling, popouts, honeycombing, scaling, craze/map cracks) ☐ ☐ ☐ ☐
(isolated crack, exposed rebar, disintegration, other) ☐ ☐ ☐ ☐
Dimensions/Location:_____
Notes/Causes:_____

(bug holes, hairline crack, efflorescence) ☐ ☐ ☐ ☐
(spalling, popouts, honeycombing, scaling, craze/map cracks) ☐ ☐ ☐ ☐
(isolated crack, exposed rebar, disintegration, other) ☐ ☐ ☐ ☐
Dimensions/Location:_____
Notes/Causes:_____

☐ Plastic (deterioration, cracking, deformation)_____ ☐ ☐ ☐ ☐
Dimensions:_____
Location:_____
Notes/Causes:_____

☑ Earthen

☑ Ground Cover: Type: (grass, crown vetch) Other: few bare spots LT side ☐ ☐ ☐ ☐
Quantity: (bare, sparse, adequate, dense)
Appearance: (too tall, too short, good)
Notes:

☐ Erosion: (other, surface runoff) ☐ ☐ ☐ ☐
Description (width/depth/length/etc):_____
Notes:_____

☐ Ruts: ☐ ☐ ☐ ☐
Location: (entire inlet, lt side, rt side, middle, see dwg)
Depth: Width Length:
Notes/Causes: (truck/auto, motorcycle, ATV, animals, pedestrian)

☑ Riprap: Average Diameter: 9" ☐ ☐ ☐ ☐
(adequate, sparse, displaced, weathered, vegetation) (bedding/fabric noted - yes, no)
Notes:

☐ Rock-Cut (weathered, erosion)
Description:_____ ☐ ☐ ☐ ☐
Notes:_____

☐ Other:_____ ☐ ☐ ☐ ☐

☐ ***OTHER OUTLET PROBLEMS*** [no problem, could not inspect thoroughly] ☐ ☐ ☐ ☐

☐ Mis-Alignment:(channel, chute, sidewall, headwall) ☐ Pipe Deformation_____
Location/Description:_____
Notes/Causes:_____

None ☐ Monitor ☐ Maintenance ☐ Engineer ☐

☐ Separated Joint ☐ Loss of Joint Material
Location/Description:_____
Notes/Causes:_____

☐ Undermining: ☐ ☐ ☐ ☐
Location/Description:_____
Notes/Causes:_____

☐ Other:_____ ☐ ☐ ☐ ☐

{Upstream Slope, Crest, Downstream Slope, Seepage, Principal Spillway, **Emergency Spillway-Outlet**, Lake Drain}

Required Action

Required Action

None Monitor Maint. Engineer

OUTLET EROSION CONTROL STRUCTURE (Stilling Basins)

☐ None ☐ ☐ ☐ ☐

☐ (endwall/headwall, plunge pool, impact basin, flip bucket, USBR, baffled chute, rock lined channel) ☐ ☐ ☐ ☐

Notes:_____

_____

Components (baffle blocks, chute blocks, endsill)_____

☐ ***MATERIAL*** [no problem, could not inspect thoroughly]

☐ Riprap: Average Diameter: ☐ ☐ ☐ ☐

(adequate, sparse, displaced, weathered, vegetation) (bedding/fabric noted - yes, no)

Notes:

☐ Concrete

(bug holes, hairline crack, efflorescence) ☐ ☐ ☐ ☐

(spalling, popouts, honeycombing, scaling, craze/map cracks) ☐ ☐ ☐ ☐

(isolated crack, exposed rebar, disintegration, other) ☐ ☐ ☐ ☐

Dimensions/Location:_____

Notes/Causes:_____

_____

(bug holes, hairline crack, efflorescence) ☐ ☐ ☐ ☐

(spalling, popouts, honeycombing, scaling, craze/map cracks) ☐ ☐ ☐ ☐

(isolated crack, exposed rebar, disintegration, other) ☐ ☐ ☐ ☐

Dimensions/Location:_____

Notes/Causes:_____

_____

☐ ***OTHER*** [no problem, could not inspect thoroughly] ☐ ☐ ☐ ☐

☐ Mis-Alignment:(sidewall, headwall)_____

Location:_____

Description:_____

Notes/Causes:_____

_____

☐ Separated Joint ☐ Loss of Joint Material ☐ ☐ ☐ ☐

Location:_____

Description:_____

Notes/Causes:_____

_____

☐ Undermining: ☐ ☐ ☐ ☐

Location:_____

Description:_____

Notes/Causes:_____

_____

☐ Other:_____ ☐ ☐ ☐ ☐

_____

☐ ***DRAINS*** [none, none found, no problem, could not inspect thoroughly] (See ***SEEPAGE*** Section for Toe Drains & Relief Wells)

Type: ☐ Weep Holes ☐ Relief Drains ☐ Other:_____ ☐ ☐ ☐ ☐

Flow Rate:_____ Size:_____ Number:_____

Location:_____

Notes:_____

_____

_____

Type: ☐ Weep Holes ☐ Relief Drains ☐ Other:_____ ☐ ☐ ☐ ☐

Flow Rate:_____ Size:_____ Number:_____

Location:_____

Notes:_____

_____

_____

None Monitor Maintenance Engineer

Required Action

{Upstream Slope, Crest, Downstream Slope, Seepage, Principal Spillway, **Emergency Spillway-Outlet Erosion Control Structure**, Lake Drain}

LAKE DRAIN

Required Action: None | Monitor | Maint. | Engineer

☐ ***GENERAL***

☐ None Found ☑ Does not have one – copper at Principal Spillway ☐ ☐ ☐ ☐

☐ Type of Lake Drain (isolated control/intake tower, valve vault w/ outlet conduit, valve in riser/drop inlet, siphon) ☐ ☐ ☐ ☐

Notes:_____

☐ Operated During Inspection (yes, no)_____ ☐ ☐ ☐ ☐

Notes:_____

☐ ***ACCESS TO VALVE/SLUICE GATE*** [no problem, could not inspect thoroughly] ☐ ☐ ☐ ☐

☐ Type (not accessible, from shore, boat, walkway, other)_____

Notes:_____

☐ Walkway/Platform:_____

☐ Concrete Deterioration ☐ Cracks (platform, piers, end supports, railing) ☐ ☐ ☐ ☐

Location:_____

Notes:_____

☐ Wood Deterioration ☐ ☐ ☐ ☐

Notes:_____

☐ Metal Deterioration ☐ ☐ ☐ ☐

(minor, moderate, extensive, other)_____

Notes:_____

☐ ***LAKE DRAIN COMPONENTS*** [no problem, could not inspect thoroughly]

☐ Concrete Structure ☐ ☐ ☐ ☐

Location:_____

Description: (deterioration, misalignment, cracks):_____

Notes/Causes:_____

☐ Valve Control (Operating Device)

☐ No Operating Device ☐ No Stem ☐ Bent/Broken Stem ☐ Other ☐ ☐ ☐ ☐

Notes/Operability:_____

☐ Valve / Sluice Gate ☐ ☐ ☐ ☐

☐ Metal Deterioration: (surface rust, minor, moderate, extensive, other)_____

Location:_____

Flow Rate:_____

Notes/Causes:_____

☐ Misalignment ☐ ☐ ☐ ☐

Notes/Causes:_____

☐ Leakage - Flow Rate:_____ ☐ ☐ ☐ ☐

Notes/Causes:_____

☐ Valve / Sluice Gate ☐ ☐ ☐ ☐

☐ Metal Deterioration: (surface rust, minor, moderate, extensive, other)_____

Location:_____

Flow Rate:_____

Notes/Causes:_____

☐ Misalignment - Notes/Causes:_____ ☐ ☐ ☐ ☐

☐ Leakage - Flow Rate:_____ ☐ ☐ ☐ ☐

Notes/Causes:_____

Required Action: None | Monitor | Maintenance | Engineer

Required Action

None Monitor Maintenance Engineer

☐ Outlet Conduit

☐ Metal:(loss of coating/paint, surface rust, corrosion (pitting, scaling), rusted out) ☐ ☐ ☐ ☐
Location:_____
Notes/Causes:_____

☐ Concrete (bug holes, hairline crack, efflorescence) ☐ ☐ ☐ ☐
(spalling, popouts, honeycombing, scaling, craze/map cracks) ☐ ☐ ☐ ☐
(isolated crack, exposed rebar, disintegration, other) ☐ ☐ ☐ ☐
Dimensions/Location:_____
Notes/Causes:_____

☐ Plastic:(deterioration, cracking)_____ ☐ ☐ ☐ ☐
Location:_____
Notes/Causes:_____

☐ Conduit Deformation ☐ Mis-Alignment: ☐ ☐ ☐ ☐
Location:_____
Notes/Causes:_____

☐ Separated Joint ☐ Loss of Joint Material ☐ ☐ ☐ ☐
Location/Description:_____
Notes/Causes:_____

☐ Undermining: ☐ ☐ ☐ ☐
Location/Description:_____
Notes/Causes:_____

☐ Vegetation (trees, brush)_____ ☐ ☐ ☐ ☐
Notes:_____

☐ Other:_____ ☐ ☐ ☐ ☐
Notes:_____

☐ Energy Dissipator

☐ Type (endwall, plunge pool, impact basin, stilling basin, rock-lined channel, none) ☐ ☐ ☐ ☐
Notes:_____

☐ Riprap: Average Diameter: ☐ ☐ ☐ ☐
(adequate, sparse, displaced, weathered, vegetation) (bedding/fabric noted - yes, no))
Notes:

☐ Concrete (bug holes, hairline crack, efflorescence) ☐ ☐ ☐ ☐
(spalling, popouts, honeycombing, scaling, craze/map cracks) ☐ ☐ ☐ ☐
(isolated crack, exposed rebar, disintegration, other) ☐ ☐ ☐ ☐
Dimensions/Location:_____
Notes/Causes:_____

☐ Mis-Alignment:_____ ☐ ☐ ☐ ☐
Location/Description:_____
Notes/Causes:_____

☐ Separated Joint ☐ Loss of Joint Material ☐ ☐ ☐ ☐
Location/Description:_____
Notes/Causes:_____

☐ Undermining: ☐ ☐ ☐ ☐
Location/Description:_____
Notes/Causes:_____

Required Action

☐ Other:_____ ☐ ☐ ☐ ☐
Notes:_____

None Monitor Maintenance Engineer

APPENDIX 6: **EMBANKMENT DAM FAILURE MODES AND RISK FACTORS**

Failure Modes of Embankment Dams

IDNR classifies dam failures in two categories: Type 1, component failure of a structure that does not result in a significant reservoir release; and, Type 2, uncontrolled breach failure of a structure that results in a significant reservoir release.

Type 1 failures include localized seepage and structural failures of dam components that do not breach the dam into the reservoir. Type 1 failures are generally local failures of a dam feature, such as an embankment slide that does not breach the crest, a spillway structural failure, a piping condition in its early stage of formation, a trash rack failure, or settlement on an earth dam embankment that does not extend to the water level. Type 1 failures are critical, require immediate attention, and may lead to a Type 2 failure. However, they do not result in a significant release of reservoir water and generally do not pose an immediate dam safety risk.

Type 2 failures are failures that do result in a significant release of the reservoir and may eventually result in a dam breach with total release of the reservoir. There are three general categories of Type 2 failures: (1) hydraulic failures, (2) seepage failures, and (3) structural failures. Type 2 failures often result from Type 1 failures that were improperly corrected or were ignored.

Embankment dams have three potential modes for Type 2, uncontrolled breach failure:

1. hydraulic failure (dam overtopping, wave erosion, dam toe erosion, severe erosion)
2. seepage failure (pervious reservoir rim or bottom, pervious foundation, pervious dam, leaking conduits, cracks in dam, piping through dam or along conduits, inappropriate vegetation, windblown trees, animal burrows)
3. structural failure (dam and foundation slides, dam failure, dam settlement, spillway cracks or failure)

The presence of any of these conditions poses a degree of risk for dam failure, however, failure typically will not occur until the conditions become severe enough to allow water to flow out of the reservoir in an uncontrolled manner. Therefore, when the dam deficiencies are minor and do not threaten the stability or safety of the dam, the risk of dam failure is low. If the deficiencies are serious and do pose a likely threat to the dam safety, the risk of dam failure is high.

Risk Factors that can Cause Dam Failure

The factors that pose a risk to embankment dams can be categorized into four groups:

1. structural factors (design, construction, and condition of embankment, foundation, abutments, and spillways)
2. natural factors (earthquakes, storms, floods, landslides, sedimentation)
3. human factors (vandalism, terrorism, mistakes, operational mismanagement)
4. operating factors (poor maintenance practices, lack of operator training, poor access, lack of proper inspection program, reliability of electrical and mechanical equipment)

For purposes of this report, the potential risk of dam failure is defined as follows:

Low risk – the dam or its appurtenant works has a minor deficiency that does not pose an imminent threat to the dam safety. However, if left unattended, these deficiencies may progress and ultimately lead to a dam failure.

Low risk conditions should be monitored and/or repaired within 4 years. If the deficiency is minor and is progressing very slowly, it may be appropriate to monitor the condition, and reassess it every year. In some cases, it may be appropriate to complete the repairs immediately and be done with it. If the dam is a high hazard dam, a shorter time limit for performing low risk repairs may be warranted to ensure that the work will be completed before the next formal technical safety inspection. Repairs or correction of low-risk deficiencies are typically a low priority. A minor deficiency with a low risk of dam failure may be assigned a medium priority repair schedule if the deficiency makes it impossible or difficult to perform a visual inspection. An example of this is excessive vegetation of the embankment; the excessive vegetation may present a low risk of dam failure, but because it prevents a proper visual inspection, removal of the brush may be assigned a medium or high priority.

Medium risk - the dam or its appurtenant works has a deficiency that lies between minor and serious. Medium risk conditions should be corrected as soon as possible, but no later than 3 years. Corrective repairs may need to be performed sooner if the deficiency is progressing rapidly. Repairs or correction of medium risk deficiencies are typically a medium priority.

High risk – the dam or its appurtenant works has a severe deficiency that poses an imminent threat to the dam safety. The dam will fail if the deficiency is not corrected. High risk conditions must be corrected within 1 year. Repairs or correction of high-risk deficiencies are typically a high priority.

The risk assessment should always be tempered with the potential downstream safety hazards. A minor deficiency on a low hazard dam may have a lower priority for repair than the same deficiency on a high hazard dam

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