LAKE LANSING LEVEL CONTROL STRUCTURE
ALTERNATIVE ANALYSIS

Ingham County, Michigan

Prepared For:
Ingham County

Prepared By:

Spicer group

December 2023
Project No. 134489SG2023

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TABLE OF CONTENTS

INTRODUCTION 1

LOCATION AND DESCRIPTION OF STRUCTURE 1

PROJECT BACKGROUND AND HISTORY 2

PROJECT PURPOSE AND SCOPE 2

METHOD OF ANALYSIS 3

DATA COLLECTION / DOCUMENT REVIEW 3

FIELD DATA AND EXISTING CONDITIONS 3

Results of Field Work 4

Surveying Methods 4

Elevation Summary 4

CONCEPTUAL DESIGN ALTERNATIVES 5

HYDROLOGIC AND HYDRAULIC ANALYSIS 5

PRELIMINARY ESTIMATES OF COST 5

IDENTIFY PROPOSED SOLUTION 5

HYDRAULIC ANALYSIS AND RESULTS 6

NARRATIVE 6

ASSUMPTIONS, VARIABLES, AND COEFFICIENTS 6

Boundary Conditions 6

Manning's Roughness Coefficients 6

Expansion Coefficients 7

Contraction Coefficients 7

Weir Discharge Coefficients 7

HYDROLOGIC AND HYDRAULIC RESULTS 7

CAPACITY ELEVATION SUMMARY ANALYSIS 8

Existing Conditions 8

STRUCTURE ELEVATIONS 8

ALTERNATIVE ANALYSIS 9

EXISTING CONDITIONS AND MODEL VERIFICATION 9

CONCEPTUAL DESIGN ALTERNATIVES ANALYSIS 9

Alternative I 9
Alternative II 10
Alternative III 10
Alternative IV 11
Alternative V 11
Alternative VI 12

CONCLUSIONS AND RECOMMENDATIONS 13

CONCLUSIONS 13
EGLE Permitting 13
Court Ordered Lake Level 13
Remote Monitoring 13
Operations and Maintenance 14

APPENDICIES

APPENDIX A
Historic and Background Information
1974 Pre-Improvement Photographs
1975 Dam Improvement Plans
1980 Post-Improvement Photographs
1986 Intake Pipe Photographs
2022 Dam Inspection Report
2020 Dam Inspection Report
Existing Condition Plan, Profile and Cross Section Drawings
APPENDIX B
Site Inspection Photographs
APPENDIX C
Alternative Analysis Drawings
APPENDIX D
Hydrologic and Hydraulic Modeling Information
APPENDIX E
Preliminary Estimate of Costs

INTRODUCTION

LOCATION AND DESCRIPTION OF STRUCTURE

Lake Lansing is located in the northern portion of Meridian Charter Township in Ingham County, Michigan. The lake level is maintained by a concrete spillway structure with stop logs and through a lift gate installed in line with a 24-inch drawdown pipe. The lake level control structure is under the jurisdiction of the Ingham County Drain Commissioner, Patrick E. Lindemann (ICDC). The original structure was constructed in the 1920s and the spillway was reconstructed to its current configuration as part of an improvement project completed in the fall of 1976. The design plans for the improvement project dated October 1975 are attached in Appendix A. Historic photos from 1974 and 1980 are included in Appendix A, showing the control structure before and after the 1975 reconstruction project.

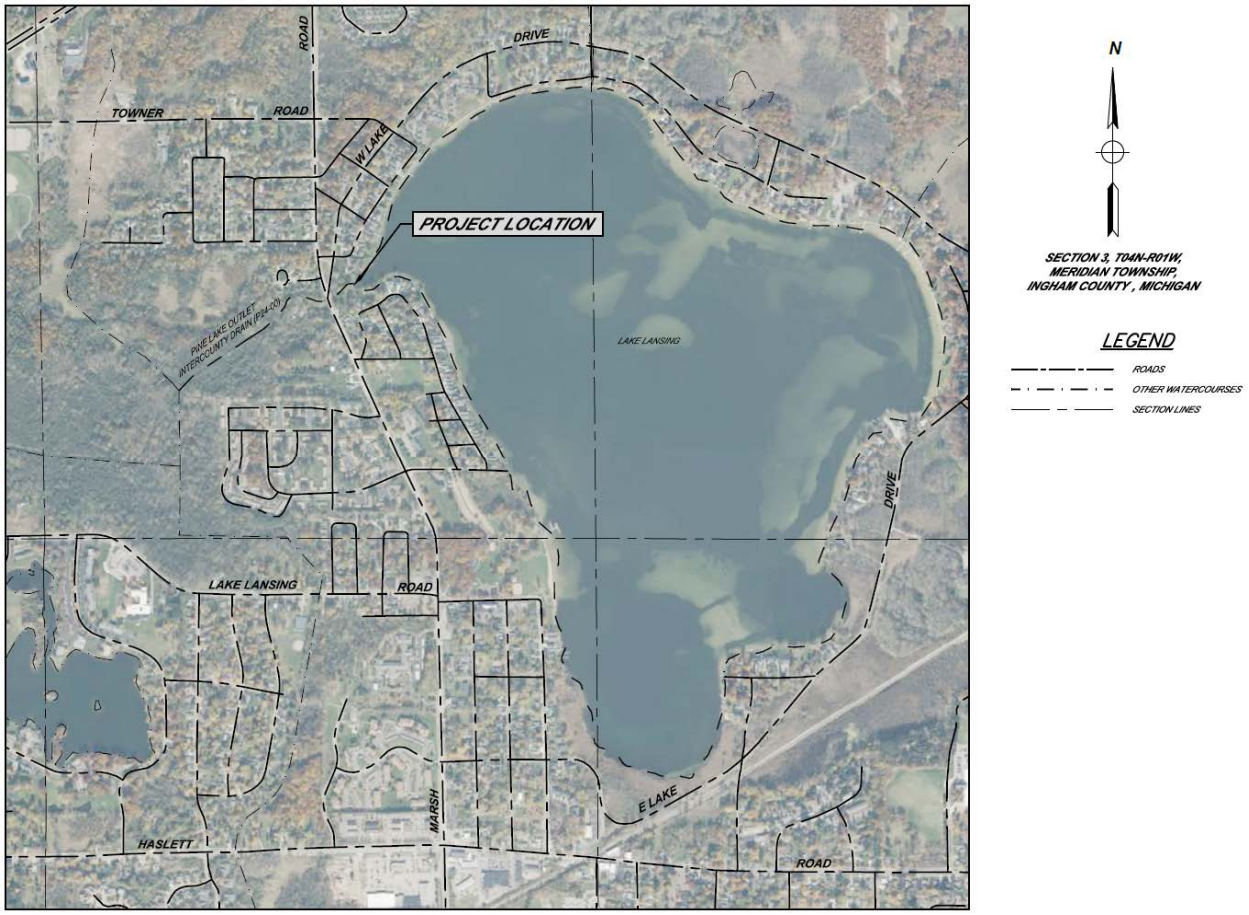

Figure 1. Lake Lansing Level Control Structure Location Map

PROJECT BACKGROUND AND HISTORY

Lake Lansing is a 453-acre lake that provides recreational opportunities for residential properties around the lake as well as the surrounding community. Lake Lansing Park South is a county owned park that offers park amenities and beach access for the community with over 180,000 visitors in 2020, according to the county parks master plan. Public access for boating and ice fishing is provided through a County owned public boat launch on the north side of the lake which saw over 150,000 users in 2020. Michigan State University's sailing center as well as the privately held Lansing Sailing Club are located around the lake.

The drainage area served by the lake level control structure is approximately 3.6 square miles in size, draining lands from Ingham and Clinton Counties. Flow from the lake discharges through the Pine Lake Outlet Intercounty Drain and Mud Lake Outlet Drain before reaching the Red Cedar River.

During regular inspections by ICDC staff in 2022 and as noted in the "Lake Lansing Dam Inspection Report" dated 12/29/2022, the lift gate installed in line with the 24-inch drawdown pipe had become inoperable. The 2022 inspection report recommended replacement of the control structure, pipe, slide gate, and related support structures. In June of 2023, Ingham County published a request for proposals seeking professional engineering services for a Lake Lansing Dam Improvement Project. The 2022 dam inspection report and the 2020 dam inspection report, which noted the gate was operable but had seepage, can be found in Appendix A.

The excerpt below from the 1986 Triennial Inspection provides a summary of the history of the current lake level control structure completed by SEG Engineers & Consultants, Inc.:

> *SEG is not cognizant of all the historical information regarding the events of the dam prior to 1970, except to state that the initial dam was constructed to maintain an unspecified lake level. In the late 1960's SEG (formally John R. Snell Engineers, Inc.) inspected the dam with specific intentions to review the dam's spillway condition as part of a study to establish a legal lake level and dredge the lake. The inspection revealed that the spillway was severely cracked and that a hole had developed in the spillway. In 1975 SEG was authorized to prepare construction plans and specifications to correct the spillway problems by rebuilding the spillway, complete with stilling basin. The spillway reconstruction also included the construction of a valved drawdown pipe, steel sheet piling and legal lake level control boards. Construction of the modifications was completed in the fall of 1976.*

Additionally, as documented in the 1986 inspection report, the intake pipe constructed in 1976 had broken free of its anchor points and floated upward. A recommended plan to correct the failure was provided showing what is believed to be the current day concrete structure under the dock section. This is the same location where the staff gauge is affixed to read the current lake level. The entirety of the 1986 inspection report can be found in Appendix A.

PROJECT PURPOSE AND SCOPE

The purpose of this study and report is to provide an alternatives analysis for improvements to the Lake Lansing level control structure following the recommendations provided in the 2022 Lake Lansing Dam Inspection Report. The goal is to address the noted draw down pipe and slide gate condition, review and recommend work related to other condition related deficiencies found during our inspection, model and provide discussion on the available capacity of the lake level control structure and make overall recommendation to provide a reliable and safe operation of the control structure. This study and report include research of existing documentation, topographic site survey, site inspection, existing condition

drawings, a hydrologic and hydraulic analysis, and an alternatives analysis for improvements to the lake level control structure.

METHOD OF ANALYSIS

DATA COLLECTION / DOCUMENT REVIEW

Spicer Group requested all available plans, reports, and other documents of significance pertaining to the Lake Lansing level control structure from the Ingham County Drain Commissioner's (ICDC) Office and the Michigan Department of Environment, Great Lakes, and Energy (EGLE) through Dam Safety Unit of the Water Resources Division. Information collected from the ICDC and EGLE were in the form of both electronic records and paper files. Paper files from both organizations were scanned into electronic file formats for review.

Construction records and historic photographs were obtained through the document review process showing the control structure before and after improvements made to the structure in the 1970s. This allowed for a better understanding of the history, design, function, and operation of the structure. Previous regular inspection reports performed under the Inland Lake Levels part (Part 307) of the Natural Resource and Environmental Protection Act (NREPA), and under previous state statutes, were located and date back to 1986.

The slide gate on the drawdown pipe was noted as inoperable in the 2022 inspection report. Inspection reports prior to 2022 note that the slide gate operated without issue but allows for some seepage when sediments are lodged in the seat of the gate. It was noted that this was due to a lack of screening at the upstream end of the drawdown pipe since the 2010 inspection report. The drawdown pipe condition has been reported as poor since the 2007 inspection report, noting corroded holes in the intake pipe. Report recommendations for a more accessible drawdown control chamber were made since the 2013 inspection report due to the residential deck encroachment and large manhole cover over the structure that requires two people to remove. Further recommendations for remote lake level reading equipment have been made since the 2013 inspection report.

The Federal Emergency Management Agency (FEMA) performed a flood insurance study in 2011. Results of this study were used during the hydrologic and hydraulic modeling phase of this report.

Geographic information system (GIS) data was provided by the ICDC and the State of Michigan GIS Open Data portal including existing parcel outline and ownership data, street centerlines, aerial imagery, and topographic data derived from aerial flown LiDAR data collection.

Several meetings were conducted with project stakeholders and community members which provided substantial information relevant to the development of this report and the subsequent recommendations. The Lake Lansing Advisory Committee of Meridian Township and the Lake Lansing Property Owners Association were two groups that were met with regularly to provide status and receive feedback regarding the study. Additionally, Michigan State Representative, Penelope Tsernoglou held a town hall meeting with residents throughout the community to hear updates and provide feedback regarding the study.

FIELD DATA AND EXISTING CONDITIONS

A dam safety engineer from Spicer Group performed an inspection of the Lake Lansing Dam and the immediate downstream reach of the Pine Lake Outlet Intercounty Drain. Photographs were taken as part of this investigation and can be found in Appendix B. Subsequently, a topographical survey was completed for the project area. The survey provided existing centerline/flow line elevations, open channel cross-sections, a detailed survey of the existing dam, and a survey of relevant portions of the Marsh Road culvert

downstream. Crews surveyed these locations and collected data on the North American Datum of 1983 (NAD ’83) and the North American Vertical Datum of 1988 (NAVD '88).

Results of Field Work

The inspection of the lake level control structure was performed by Spicer Group staff according to the guidelines of Part 307 of NREPA on September 9, 2023. The following inspection elements were notable at the time of the inspection.

Stop logs are placed within the spillway structure and sealed with expanding foam and sheets of rubber to provide a seal around the boards. The ICDC maintenance staff provided the comment that this is required to keep the boards in place and provide a reasonable seal to hold the lake level.

The 24-inch diameter corrugated metal pipe is filled with sediment at the upstream end and is visibly corroded. The slide gate along the drawdown pipe remains inoperable as observed in the 2022 inspection report. The structure and slide gate are beneath a private deck, covered over with the storage of miscellaneous items. The slide gate is difficult to access through the residential deck and heavy structure lid. Consistent with the 2022 inspection report, minor cracking and spauling in the concrete structure was observed; however, the structure is in good condition. The private dock from the shore on the north side to the end of the drawdown pipe has failed, broken free of its connection to the shore, and is unsafe for use.

Active erosion downstream of the water level control structure was not observed. The absence of soil on the south side of the stilling basin is a concern. The south side of the spillway does not have a sheet pile or concrete wall consistent with the north side of the structure. However, through historic record research, a concrete cutoff is shown to exist to the south of the dam, though is not visible at ground level. Riprap on south side of stilling basin is recommended. Excessive vegetation and trees were found growing along the south side of the spillway and should be removed as a maintenance measure.

Surveying Methods

The two-man field crew utilizing GPS collection equipment spent two days on site, surveying the lake level control structure and Pine Lake Outlet Intercounty Drain downstream of the lake.

The topographic survey results are detailed in an existing condition drawing that can be found in Appendix A. This drawing includes plan, profile and cross section sheets of the control structure and the Pine Lake Outlet Intercounty Drain from the downstream side of the spillway, through the Marsh Road crossing to a point 1,000 feet downstream of Marsh Road. GIS basemap information was added to the existing condition drawings to provide existing contextual data.

Elevation Summary

The following is a summary and analysis of the current lake level structure elevations compared to the 2003 court ordered lake levels.

Court ordered summer level (Mar-Nov 14):	852.29 feet above sea level*
Court ordered winter level (Nov 15-Feb):	851.72 feet above sea level*
Date of Survey-September 29, 2023	
Surveyed water surface elevation:	851.76 feet NAVD88
Surveyed top of stop log elevation (summer level):	851.70 feet NAVD88
Surveyed weir elevation (winter level):	850.93 feet NAVD88
Staff gauge reading at time of survey:	852.38 feet above sea level*

*The vertical datum in the lake level court order references 'feet above sea level' which does not directly convert to the North American Vertical Datum of 1988 (NAVD88) used by the ICDC. The lake levels ordered in 2003 modify the lake levels ordered in 1975. The 2003 order set two separate lake levels to be maintained throughout the year, as opposed to the three lake levels set in the 1975 order. The elevation of the lake level set in 2003 matched two of the lake levels set in the 1975 order. The difference between surveyed board/weir elevations (NAVD88) and the court ordered levels for summer and winter is 0.59 feet and 0.79 feet respectively.

CONCEPTUAL DESIGN ALTERNATIVES

Design alternatives were developed based on comments from the community leaders, survey data, field verification, modeling results, previous dam improvement projects, comments from community stakeholders, and other recommendations. SGI reviewed previous reports and available research documents for Lake Lansing to assist with alternative design.

Many previous dam inspection reports recommend the replacement of the drawdown pipe, and the 2022 inspection found the slide gate on the drawdown pipe inoperable. Several options exist to address the improvement to the lake drawdown pipe. Additionally, other maintenance and recommended improvements are outlined to take advantage of the economies of scale of performing multiple work items as part of a larger project.

HYDROLOGIC AND HYDRAULIC ANALYSIS

A steady state hydraulic model was created in HEC-RAS to understand the existing hydraulic capacity of the lake level control structure. This model was prepared using surveyed cross sections collected as part of this study amended with 2010 LiDAR data, field observations, aerial photography, and flow rates obtained from the Michigan Department of Environment, Great Lakes and Energy (EGLE). A model was created to simulate existing conditions on the lake based on collected survey data, field observations, and the outputs from the most recent FEMA flood insurance study for Lake Lansing.

PRELIMINARY ESTIMATES OF COST

A Preliminary Estimate of Cost (PEC) was developed for each of the design alternatives to provide planning guidance and relative cost magnitude difference for each alternative. To develop the PEC, a list of general project scope items was generated for each design alternative. After identifying high-level proposed scopes, quantities were estimated based on the existing site conditions. Lump sum prices were developed for each task based on experience with similar projects.

IDENTIFY PROPOSED SOLUTION

The method for determining our recommended solution was based on the results of the previously described analyses and from discussions with various project stakeholders. The basis for our design includes the following considerations:

1. Condition of the drawdown pipe and slide gate.
2. Ability to increase the flow through the lake level control structure during times of high water to promptly maintain the legally established lake levels.
3. Operational efficiency and safety.
4. Risk and liability.
5. Environmental permitting.
6. Project cost.

HYDRAULIC ANALYSIS AND RESULTS

NARRATIVE

Hydrologic flows to Lake Lansing were provided by EGLE Hydrologic Studies and Floodplain Management Unit through request record 20230530. The flowrates provided are illustrated below and were calculated for runoff from 3.6 square miles of contributing drainage area. These flow rates mirrored the FEMA 2011 Flood Insurance Study for the Pine Lake Outlet and Lake Lansing.

Table 1 - EGLE Discharges for the Pine Lake Outlet at Lake Lansing Dam, Dam ID 1957

Discharge Frequency	Design Storm	Discharge (cfs)
50%	2 Year	20
20%	5 Year	35
10%	10 Year	55
4%	25 Year	90
2%	50 Year	130
1%	100 Year	135
0.5%	200 Year	140
0.2%	500 Year	145

These discharge rates are flows after being routed through the Lake Lansing impoundment and control structure. These discharge rates were input into a HEC-RAS one dimensional hydraulic model to evaluate structure hydraulics and overall capacity.

ASSUMPTIONS, VARIABLES, AND COEFFICIENTS

Boundary Conditions

The downstream boundary condition of the Lake Lansing Dam hydraulic model was determined utilizing the 100-year 24-hour floodplain surface water elevation at cross section E for the Pine Lake Outlet Drain, which aligns with Sta. 0+00 of the hydraulic model. The regulated elevation established in the flood insurance study is 849.2 ft. Elevations are constant until Lake Lansing Road.

The upstream boundary condition of the model was set with a starting water surface elevation of 851.70 ft which represents the top of the lake level control board installed in the overflow weir during the summer lake level. A second scenario was run without stoplogs with a starting water surface elevation of 850.93 ft, representing the concrete weir crest.

Manning's Roughness Coefficients

Manning's Roughness Coefficients were developed by Spicer Group, Inc. based on field observations. These estimates considered that roughness varies with flood stages, depending on such factors as the width-to-depth ratio of the stream, vegetation in the channel and overbanks, and the materials of the channel bed. Following is a general description of the channel and overbank characteristics as found on the project source along with their respective Manning's Roughness Coefficients:

Main Channels

Clean, straight, full, no rifts or deep pools 0.032

Floodplains

Brush

Light brush and trees 0.040 - 0.080

Trees

Heavy stand of timber, a few down trees, little undergrowth, flood stage below branches 0.100 – 0.160

Expansion Coefficients
The expansion coefficients used in this model follow the basic recommendations made by the United States Army Corp of Engineers (USACE), Hydrologic Engineering Center and EGLE. They are as follows:

Natural stream/river	0.3
Bridge Sections	0.5

Contraction Coefficients
The contraction coefficients used in this model follow the basic recommendations made by the United States Army Corp of Engineers (USACE), Hydrologic Engineering Center and EGLE. They are as follows:

Natural stream/river	0.1
Bridge Sections	0.3

Weir Discharge Coefficients
A coefficient of 3.0 was used in the weir equation for calculating overtopping of the bridge and the bridge approaches.

HYDROLOGIC AND HYDRAULIC RESULTS
The 100-year 24-hour design storm estimated the lake level to be 853.2 feet with the 24-inch diameter gate closed flowing over the concrete weir crest. The Letter of Map Revision (Case No. 12-05-0030)) to flood insurance study 26065CV000A reports the 1% percent annual chance elevation to be 852.7 feet, therefore the model meets FEMA letter of map revision requirements and validates as a duplicate effective model. FEMA requirements are to be within 0.5 feet of the existing regulated floodplain elevation. Note that FEMA regulates floodplain elevations to the tenth of a foot.

The existing maximum capacity of the lake level control structure without overtopping was determined to be between the 10-year 24-hour and 25-year 24-hour storm events. This is a configuration of winter level (without boards) with the low-flow gate open. The definition of overtopping in the context of this analysis is any water surface elevation where flow from the lake occurs outside of the spillway itself. Please note that this analysis is limited to the vicinity of the lake level control structure site. The concrete cutoff wall north of the water level control structure is the first overtopping point at elevation 852.30 feet.

This overtopping point is 0.98 feet below the modeled 100-year 24-hour surface water elevation during the summer level (with boards) with the low-flow gate closed and is 0.51 feet below water surface for the same storm event at the winter level (without boards) with the low-flow gate open. To summarize, the 100-year 24-hour storm was modeled to overtop the dam between 6-12 inches. The FEMA reported 100-year floodplain elevation is 0.40 feet over this overtopping point.

During the winter level (without boards), the existing capacity of the structure is approximately 50-80 cfs before overtopping depending on low-flow gate position. During the summer level (with boards), the capacity of the structure is 15-40 cfs before overtopping depending on low-flow gate position. According to the EGLE provided flow rates and based on the results of our hydraulic model of the lake level control structure, a maximum of a 10-year 24-hour duration storm event can be conveyed during the winter level and a maximum of a 5-year 24-hour duration storm event can be managed during the summer level.

The following items should be noted regarding the results of the hydraulics analysis:

1. The flowrates utilized were based on FEMA FIS model and provided by EGLE through the flood flow discharge request.
2. The model results show that the structure cannot pass a 25-year 24-hour storm event without overtopping.

3. The ICDC staff have not indicated that there has been historic overtopping of the lake level control structure.
4. Testimony from residents around the dam in the community has not expressed that the dam overtops regularly.

HEC-RAS modeling results are compiled in Appendix D for four scenarios depicting the two court ordered lake levels with and without the low-flow gate opened.

CAPACITY ELEVATION SUMMARY ANALYSIS

The following tables summarize the water surface elevations modeled for the various given scenarios. There is a reference made to the "Depth of flow overtopping structure" which is a reporting of how high the water surface elevation was modeled over the lowest structural element of the dam where the flow can no longer be contained within the spillway itself, which is the northern concrete cutoff wall. Please note that this analysis is limited to the vicinity of the lake level control structure site.

Existing Conditions

Elevations during winter levels - no boards in spillway				
24-hour Design Storm Bulletin 71 Rainfall Depths	High Water Elevation with Gate Closed (ft NAVD 88)	Depth of flow overtopping structure (ft)	High Water Elevation with Gate Open (ft NAVD 88)	Depth of flow overtopping structure (ft)
50-year Storm	853.21	0.91	852.73	0.43
100-year Storm	853.22	0.92	852.81	0.51
200-year Storm	853.23	0.93	852.91	0.61
500-year Storm	853.25	0.95	852.96	0.66

Elevations during summer levels - with boards in spillway				
24-hour Design Storm Bulletin 71 Rainfall Depths	High Water Elevation with Gate Closed (ft NAVD 88)	Depth of flow overtopping structure (ft)	High Water Elevation with Gate Open (ft NAVD 88)	Depth of flow overtopping structure (ft)
50-year Storm	853.27	0.97	853.21	0.91
100-year Storm	853.28	0.98	853.22	0.92
200-year Storm	853.28	0.98	853.23	0.93
500-year Storm	853.29	0.99	853.25	0.95

STRUCTURE ELEVATIONS

Elevations adjacent to the lake level control structure

Weir crest elevation: 850.93 feet NAVD88
Lake level control board elevation: 851.70 feet NAVD88
Top of lake level control structure: 853.17 feet NAVD88
Concrete cutoff wall elevation (north): 852.30 feet NAVD88
Timber seawall elevation (south): 852.80 feet NAVD88

ALTERNATIVE ANALYSIS

EXISTING CONDITIONS AND MODEL VERIFICATION

After the existing document review, field investigation, preliminary modeling, preparation of preliminary plan, profile and cross section drawings, alternatives were analyzed. This analysis included studying the benefits and detriments related to the existing draw down pipe and slide gate, safety and operations, hydraulic capacity, cost, and current condition of different level control structure elements. The detailed alternative analysis can be found below.

CONCEPTUAL DESIGN ALTERNATIVES ANALYSIS

The current project proposes several different design alternatives that have been considered and evaluated in the process of determining the best design to cost effectively address the existing draw down pipe and slide gate, allow safe and reliable operation of the lake level control structure, and address any condition related concerns. The following is a list of alternatives considered. These alternatives have been analyzed on an individual basis for comparative purposes.

Alternative I: Do nothing
Alternative II: Abandon existing drawdown pipe and slide gate control structure in-place
Alternative III: Remove and replace drawdown pipe and slide gate control structure
Alternative IV: Remove and replace drawdown pipe and slide gate control structure, replace primary stoplogs
Alternative V: Modify spillway to provide low flow gate, abandon existing drawdown pipe in-place
Alternative VI: Increase spillway capacity

A brief description of each design alternative, its positive and negative effects, and estimated cost is provided below. Note, the costs presented below are preliminary planning level estimates of probable construction and project soft costs, excluding costs for environmental permitting and floodplain study. These estimates are developed without preliminary engineering design within the limited scope of this study and report. Inflation of 10% has been added to these costs to reflect a construction cost approximately 18 months beyond the conclusion of this study, to June of 2025. Overall plan view drawings showing the improvements of each alternative can be found in Appendix C.

Alternative I
Do nothing

Currently, the inoperable drawdown slide gate is secured in the closed position. If the slide gate were to fail in an open state, the lake would drawdown to an elevation of 847.94 feet, approximately 3.8 feet lower than the surveyed lake level. A drawdown of this amount would require emergency response to close the failed slide gate. There would likely be regulatory implications from EGLE due to impacts to riparian habitat and due to transport of sediments downstream from the unpermitted drawdown. Additionally, restoring the lake back afterward becomes a complex permitting project. This would also be a clear violation of the current lake level order.

This alternative would leave the existing drawdown pipe and inoperable slide gate structure in place. The only option for controlling lake level would be to add or remove the primary boards manually within the spillway, which can be an unsafe practice during times of high water. This alternative would not address the noted concerns with the lake level control structure's condition, operations, or safety. This scenario has a lesser hydraulic capacity than the structure would have at full operation. There is a risk of flooding and harmful impact to properties around the lake without the ability to open the drawdown gate.

The presentation of this alternative is to provide context for the risks and liabilities of moving forward without a project. We do not recommend this alternative.

Alternative II
Abandon existing drawdown pipe and slide gate control structure in-place
This alternative would bulkhead the existing ends of the drawdown pipe, both at the lake side and stilling basin side and fill the existing drawdown pipe and slide gate structure will flowable fill concrete. This would allow the drawdown pipe to be abandoned in-place. Repairs to the existing stone-cobble wall and steel sheet piling would need to be performed in the locations of the current drawdown pipe penetrations.

This alternative would mitigate one concern outlined in Alternative I regarding an unplanned drawdown of the lake due to a failed slide gate; however, it would provide a diminished capacity at the outlet structure (similar to Alternative I) because the only option for controlling lake level would be to add or remove boards manually within the spillway. In a scenario where the lake level was too high, the only option for the ICDC would be to allow the water to flow over the weir without the drawdown pipe and slide gate to assist. There is a risk of flooding and harmful impact to properties around the lake with the removal of the low-flow pipe and slide gate. This alternative would not address matters of operational safety of the lake level control structure as manual operation of boards would be required.

This alternative would reduce the overall structure capacity which will have a negative impact on the ICDC's ability to maintain the court ordered lake level. Please note, a floodplain study has not been performed as part of this report and removal of available capacity within the lake level control structure would negatively impact the mapped floodplain and flood insurance requirements around the lake. It should be noted that regulatory agencies would likely not permit a construction project only to abandon the low-flow drawdown pipe. We included this alternative as a response to questions and feedback from community stakeholders regarding removal of the drawdown pipe alone. We do not recommend this alternative.

Total Estimated Project Cost: $300,000

Alternative III
Remove and replace drawdown pipe and slide gate control structure
This alternative would remove the existing drawdown pipe and slide gate control structure and replace it with a new reinforced concrete drawdown pipe and bypass control structure. The bypass control structure would be fitted with a device that could allow for incremental drawdown of the lake level, as needed to maintain the court ordered lake level. The spillway and weir configuration, including the main primary boards to control winter and summer levels, would be un-modified in this alternative.

At the time of construction of improvements to the structure in the late 1970s, the stone-cobble wall was existing and left in place. Due to the age and condition of the stone-cobble wall on the north side of the spillway, a replacement of that wall is proposed in this alternative. Additionally, miscellaneous crack repair, and cleaning and recoating of exposed steel sheet pile is included in this alternative to extend the longevity of the spillway structure that was constructed in 1976. The residential deck over the slide gate control structure and dock over the intake pipe would be removed during construction.

This alternative would address the condition concerns related to the drawdown pipe and slide gate, as well as condition issues related to the stone and cobble wall and 1976 improvements. Operational safety is improved with new controls within a replaced drawdown pipe and bypass control structure; however, manual operation of the primary boards in the spillway would be necessary to set the winter and summer levels.

There is an opportunity to increase overall capacity in the structure with this alternative by increasing the size of the low-flow pipe. This would not provide increased passive capacity in the spillway, but it would

provide additional capacity through operation of the control structure if needed. Increasing the 24-inch low flow pipe to a 48-inch pipe would provide a capacity between a 50- and 100-year storm. The construction of a larger low-flow drawdown pipe could pose harmful impacts to property owners downstream and increased peak flows downstream of the lake should be evaluated with this alternative. Increasing the capacity of the structure will likely necessitate a flood study to receive regulatory approval for construction.

Total Estimated Project Cost: $900,000 - $950,000*
*Does not include cost for permitting and flood study.

Alternative IV
Remove and replace drawdown pipe and slide gate control structure, replace primary stoplogs
This alternative would be similar in scope to Alternative III but would include additional modifications to the spillway to retrofit a system of primary boards that could be installed and removed from the embankment beside the lake level control structure. A crank style system would raise and lower the boards within a frame over the spillway providing more reliability and safety in the operation and maintenance of the court ordered lake level. Replacement of the stone-cobble wall, crack and corrosion work, and removal of the deck and dock structures is also included in this alternative.

This alternative would address the condition concerns as noted in Alternative III. Operational safety would be fully addressed as both the drawdown and primary board operations could be performed from outside of the spillway of the level control structure.

There is an opportunity to increase overall capacity in the structure with this alternative by increasing the size of the low-flow pipe. This would not provide increased passive capacity in the spillway, but it would provide additional capacity through operation of the control structure if needed. Increasing the 24-inch low flow pipe to a 48-inch pipe would provide a capacity between a 50- and 100-year storm. The construction of a larger low-flow drawdown pipe could pose harmful impacts to property owners downstream and increased peak flows downstream of the lake should be evaluated with this alternative. Increasing the capacity of the structure will likely necessitate a flood study to receive regulatory approval for construction.

Total Estimated Project Cost: $1,060,000 - $1,110,000*
*Does not include cost for permitting and flood study.

Alternative V
Modify spillway to provide low flow gate, abandon existing drawdown pipe in-place
This alternative would remove the use of a drawdown pipe and gate structure and modify the spillway to provide a low flow gate to retain the ability and function to draw down the lake. The additional capacity and ability to lower the lake level with the 1976 addition of the drawdown pipe allowed for lake level control without pulling the primary boards. This alternative would consolidate the controls and operation of the structure to one location. The spillway would be modified to include a low flow gate across its length at a lower elevation with removable boards to set lake level, and the drawdown pipe would be abandoned in-place. The spillway would require modification to be made 1 to 2 feet lower than it is today, in order to install new control gates. In this configuration, operators would be located safely away from the spillway to operate the structure. The primary boards could be operated separately from the low flow gate, depending on the need to release water from the lake. This alternative would likely require dredging of lake bottom material in order to maintain a clear opening to the low flow gate.

The previously outlined work items in Alternative IV addressing the stone-cobble wall replacement, crack and corrosion work, and removal of the residential deck and dock would be included in this alternative.

This alternative would address all the condition related concerns as noted in previous alternatives. Operational safety would be fully addressed as both the drawdown and primary board operations could be performed from outside of the spillway of the level control structure.

Capacity would increase relative to the existing condition capacity of the lake level control structure. The low flow weir could be designed 1 to 2 feet lower to increase the capacity of the structure to a desired level of service. The construction of spillway with an increased capacity could pose harmful impacts to property owners downstream and increased peak flows downstream of the lake should be evaluated with this alternative. Increasing the capacity of the structure will likely necessitate a flood study to receive regulatory approval for construction.

Total Estimated Project Cost: $1,500,000*
*Does not include cost for permitting and flood study.

Alternative VI
Increase spillway capacity
This alternative would triple the spillway length from 10.3 feet to 30 feet to provide 100-year storm capacity in the spillway alone. The improvement of capacity at the spillway could pose harmful impacts to property owners downstream and increased peak flows downstream of the lake should be evaluated with this alternative. Increasing the capacity of the structure will likely necessitate a flood study to receive regulatory approval for construction.

The hydraulic modeling analysis results show that a 10-year 24-hour duration storm event can be managed without boards (winter level) and less than the 5-year 24-hour duration storm event can be managed with boards (summer level). This lake level control structure is not regulated as a dam by EGLE under Dam Safety regulations and therefore does not have a mandated capacity enforced by EGLE. The cost of this alternative would be significant.

Total Estimated Project Cost: $4,000,000+*
*Does not include cost for permitting and flood study.

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

In choosing a final design alternative for the Lake Lansing level control structure environmental, economic, constructability, legal, and social issues were considered.

At this time, we recommend replacement of the drawdown pipe and gate system as well as a replacement of the primary stoplog configuration at the lake level control structure as outlined above in Alternative IV. This would include a solution to address major deficiencies noted in past inspection reports regarding the inoperable slide gate, provide improvements to reduce operational cost and improve operational safety, replace ageing elements of the structure constructed prior to the 1976 project, and address condition related work items to extend the overall usable life of the remaining structural elements through vegetation management, corrosion removal, and concrete crack repair.

EGLE Permitting

Construction within the lake on the lake level control structure will likely require permitting through EGLE for impacts to lakes, streams, wetlands, and floodplains. The most notable permitting impact will come through a review of the floodplain and permitting of any capacity changes to the structure. A flood study will likely be required according to FEMA letter of map change standards to update floodplain boundaries as part of a project to change the capacity at the lake level control structure. In a scenario where capacity increases, floodplain elevations on the lake could potentially go down and floodplain elevations downstream of the lake could potentially go up. The reverse would also be true and a study of these floodplain elevations would be required to justify the project to regulators.

Court Ordered Lake Level

The ultimate configuration of the dam will dictate how quickly the ICDC can respond to and operate the structure to maintain the lake level. Though operational functions of the structure have been recommended in this report, the current court order remains in place to govern the lake level. There is no datum referenced in the 2003 order that can be translated to NAVD88 which can cause confusion on the current lake level and whether the lake level is being maintained. A revised Circuit Court Order could address the elevations to provide for a modern datum. Lastly, the Circuit Court Order should be updated to allow for seasonal variation. In most instances, it is not possible to maintain a static level therefore the Order should include language to address seasonal variation such as during period of drought and during high flow events, i.e., large storm events or spring runoff.

Remote Monitoring

An element of the operational cost of the lake level control structure is the periodic documentation of the lake level elevation. Typically, this is performed following a property owner's concern or request, or as part of the regular operation and inspection of the lake level control structure. Remote read water level sensors with data logging capabilities are commonly installed in dam and lake level control structures applications. This would allow observation and documentation of the lake level to be performed quickly within an application or webpage as opposed to necessitating a visit to the site by ICDC staff members. A typical cost to purchase a water level sensor complete with solar power and cellular data capabilities is $2,000. A recuring cost of approximately $300 per year should be expected to maintain a connection and access to live data. Other subscription-based options for approximately $2,000 per year include the sensor, cellular connection, data storage, live web access to data, data alerts, maintenance, upgrades and equipment replacement.

Monitoring the water level at the control structure would be the primary location for a level sensor. Following discussions with ICDC maintenance staff, we would recommend a second water level sensor be

installed downstream of the lake just south of Lake Lansing Road east of the dead end of Sherbrook Way on the Pine River Outlet Intercounty Drain, at a location that is commonly monitored during times of lake drawdown to avoid inadvertent flooding.

Operations and Maintenance

If the design of improvements to the Lake Lansing lake level control structure are pursued, we recommend that a comprehensive operations and maintenance manual be included in the scope and requirements of the consultant performing the design. Any manufactured items/products installed on the structure will likely include a maintenance approach that is recommended by the manufacturer, that can inform the maintenance needs for that given item/portion of the structure.