CITY OF GRAND LEDGE
SEVEN ISLANDS DAM REPAIR OPTIONS

NOVEMBER 2014
PROJECT NO. 13008.00

Eng.
Engineering & Surveying

4063 Grand Oak Drive, Suite A109
Lansing, Michigan 48911

Prein&Newhof

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City of Grand Ledge
Seven Islands (Mudges) Dam
Repair Options

Introduction

History

The Seven Islands / Mudges / Island Park Dam (Dam) spans the Grand River in the City of Grand Ledge, and was constructed in 1921 to raise the water level on the Grand River. The Dam consists of two main components: the long spillway, a concrete structure over which the water flows; and a gate structure, made up of seven 6-foot wide gates that can be raised or lowered to control the water level behind or upstream of the Dam. Note that the City's Island Park and downtown are upstream of the Dam.

The Dam is approximately 310 feet long, including a fish ladder on the south river bank. The main spillway is approximately five to six feet high and 220 feet long, constructed as a timber crib filled with rocks and capped with concrete. A gate control structure, approximately 75 feet long, abuts the north river bank, housing a series of seven rectangular slide gates.

The gates and the gates' support structure are failing, endangering persons occupying the area immediately downstream.

Over the years, additions to the Dam have included the construction of the weir boards to raise the water level (late 1950s) and the fish ladder (1981). The weir boards are replaced regularly, when the gates are opened to lower the water level.

The Dam has been inspected on a regular basis, the most recent report completed in December 2002. The report pointed out significant deficiencies in the gate structure and the individual gates. Cracks in the spillway were observed, and they have been patched with hydraulic cement.

Eng., Inc. has been working with the City (City Council, Public Service, and Joint Planning Committee) to address concerns about the deteriorating condition of the gates and the ability of the Dam to hold back water. Other concerns are the condition of the spillway, erosion of the north bank, access, and safety of the gate structure. Eng. presented five options to the Mayor and City Council in July of 2013 (see attached letter in Appendix A, dated July 18, 2013). Based on several meetings and discussions, Eng. was asked to further evaluate and prepare a report on Options 1, 2 and 3 which are found later in this document. Options 4 and 5 that were considered and rejected were:

4. Remove the Dam completely. The river level would be permanently lowered and allowed to stabilize. The disadvantages of this approach were considered to be unacceptable for several reasons.

5. Do nothing. This option was also considered to be unacceptable due to the continued deterioration of the gates and safety concerns.

Follow-up Activities

In July of 2014, Eng. had the opportunity to evaluate the condition of the spillway. For options that include retaining the spillway, its condition would have a significant impact on the cost and/or expected life.

During previous inspections, we noted that the toe of the spillway had been undermined due to turbulence, and broken off in many places. Our concern was that the undermining had extended under the main structure. To check that possibility, Eng. proposed a dye test when the water level was low enough, and not flowing over the spillway. Then, any flow not going through the gates could be observed by placing fluorescein dye upstream, behind the spillway.

On July 3, 2014, together with Public Service staff, the dye test was completed. Dye was observed downstream at the joint between the spillway and the fish ladder. No other dye was observed flowing below the spillway, indicating that the main structure is not being undercut. The failure of that joint can be repaired.

Dye Test completed July 3, 2014

During the drawdown, Eng. and Public Service staff inspected the spillway structure. Previous repairs remain intact and no new cracks were observed.

Temporary Repairs

When the gates were raised (open) for the drawdown, Public Service staff became concerned about the possibility of the gates not holding together when lowered. Replacement gates were constructed and installed. In addition, a drive was constructed on the north side for equipment to access the gates. Fencing was installed to prevent trespassers from climbing on the gate structure.

Temporary Repairs: Replacement Gates and Fencing

Options

The following options, repeated here and numbered as presented in July 2013, are based on these criteria:

- The fish ladder is structurally sound, has no safety issues and can remain in place.
- The main spillway is stable and can be left in place.

Option 1: Replace the gate structure and repair the spillway. This option includes new gates and supports, bank restoration, site access improvements, new catwalk and gate lifting mechanism. We recommend that the toe of the spillway be repaired at the same time to address the areas where the apron have broken off and settled.

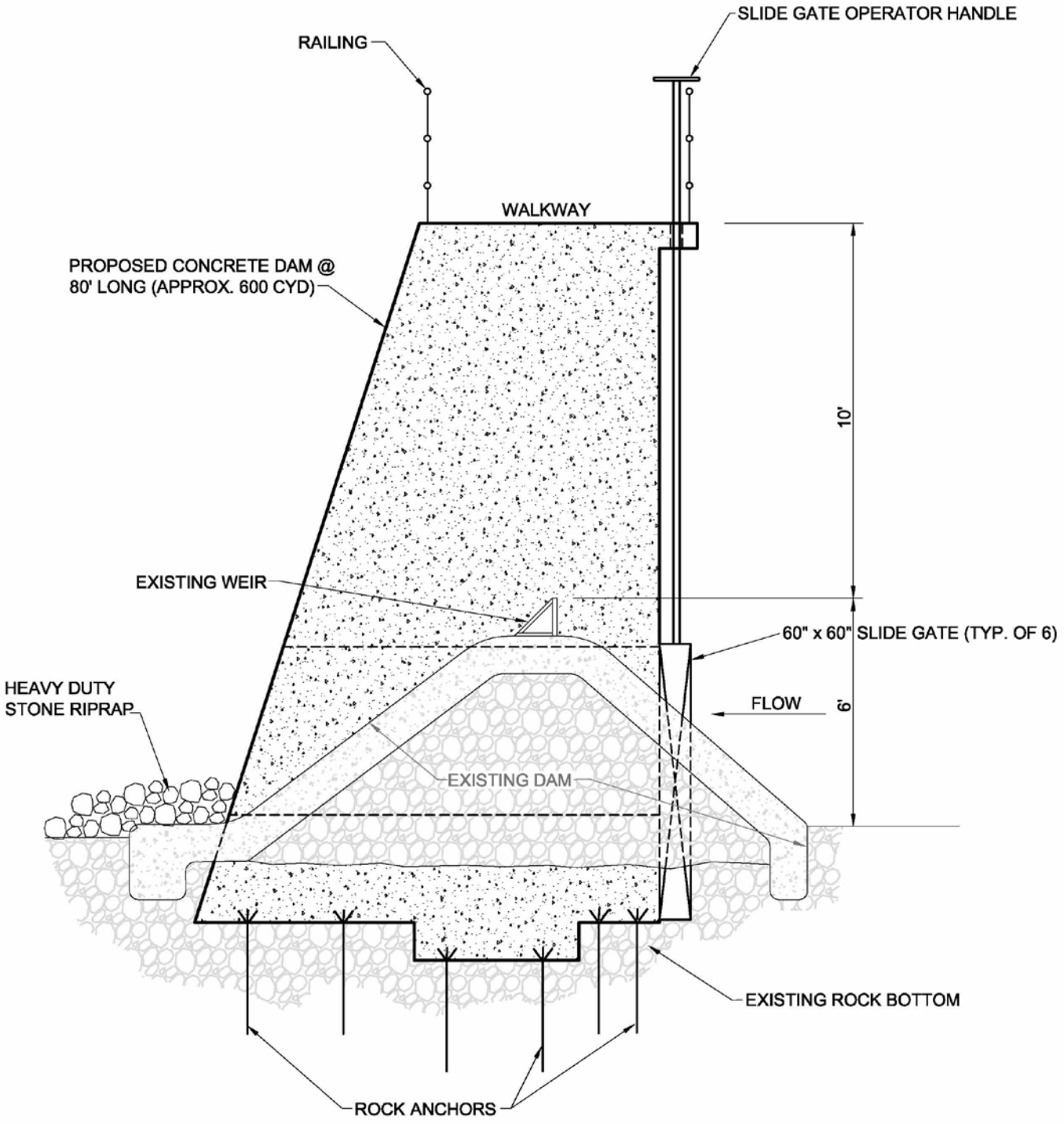
Option 1 consists of an entirely new dam connecting to the existing spillway, constructed by pouring an overlapping structure over the spillway. The dam would extend northeasterly and tie into the north bank.

The existing gates would be replaced with six (6) 5-foot by 5-foot gates with handwheel operators. An overhead crane is an option with gravity closure. The walkway would be integrated with the concrete dam by safety rails.

Option 1 is shown in Figures 1A and 1B on the following pages. Note that this option would provide the ability to open gates to periodically lower the water level during low-flow periods for various maintenance activities while maintaining the upstream water level for recreation activities.

The estimated cost of Option 1 is itemized in the following table:

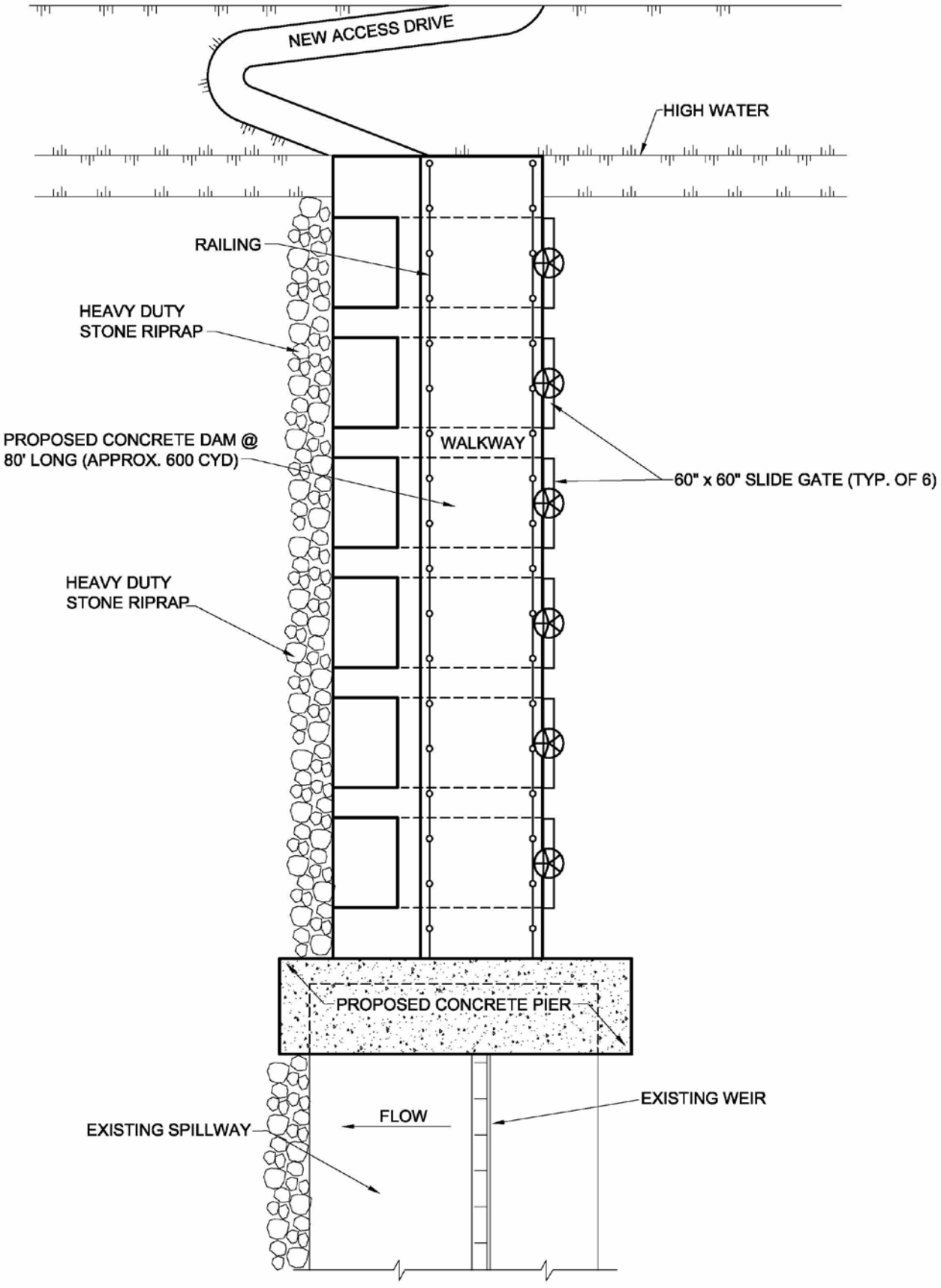
OPTION 1: Replace the gate structure and repair the spillway			
Work Item	**Units**	**Unit Cost**	**Total Cost**
Mobilization / Demobilization	1	$50,000	$50,000
Access Roads	1	$40,000	$40,000
River Access	1	$30,000	$30,000
Install and Remove Cofferdam	1	$100,000	$100,000
Removal and Disposal of Existing Gate Structure	1	$230,000	$230,000
Place Concrete	600 cyds	$600	$360,000
Rock Excavation	1	$50,000	$50,000
Rock Anchors, Reinforcing Steel	1	$50,000	$50,000
60 x 60 Gates	6	$30,000	$180,000
Restoration	1	$25,000	$25,000
Rock for Spillway Toe	300 cyds	$175	$52,500
Subtotal			**$1,167,500**
Engineering, Legal, Contingencies, Permitting			$347,500
OPTION 1 TOTAL			**$1,515,000**



DAM SECTION

1/4"=1'-0"

Eng. Engineering & Surveying 4063 Grand Oak Drive, Suite A109 Lansing, Michigan 48911 PROJECT NO.: 13008	Prein&Newhof	**OPTION 1** **GATED CONCRETE EXTENSION** **SEVEN ISLANDS (MUDGE'S) DAM IMPROVEMENTS** **CITY OF GRAND LEDGE, MICHIGAN**	**FIGURE 1A**



DAM PLAN

NO SCALE

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OPTION 1
GATED CONCRETE EXTENSION

SEVEN ISLANDS (MUDGE'S) DAM IMPROVEMENTS
CITY OF GRAND LEDGE, MICHIGAN

FIGURE 1B

Option 2 (as originally proposed)**: *Remove the gate structure and replace with a rock-lined channel. This option would divert the flow that currently goes over the spillway through a new channel. This option would eliminate the need for new permanent access on the north side, the type of construction would include bank restoration. Gates and new catwalk would not be included.***

Advantages include savings over Option 1 (above), although further study is needed to estimate the amount. Disadvantages are not being able to draw down the river level for shoreline maintenance or construction and a lower permanent water level. For the channel to carry water, it would have to be constructed lower than the existing spillway.

As we evaluated Option 2 as originally proposed, we realized that diverting flow through a separate channel would require lowering water levels to unacceptable levels. For this report, Option 2 has been revised to a new dam structure that would allow water to flow over at flood stage.

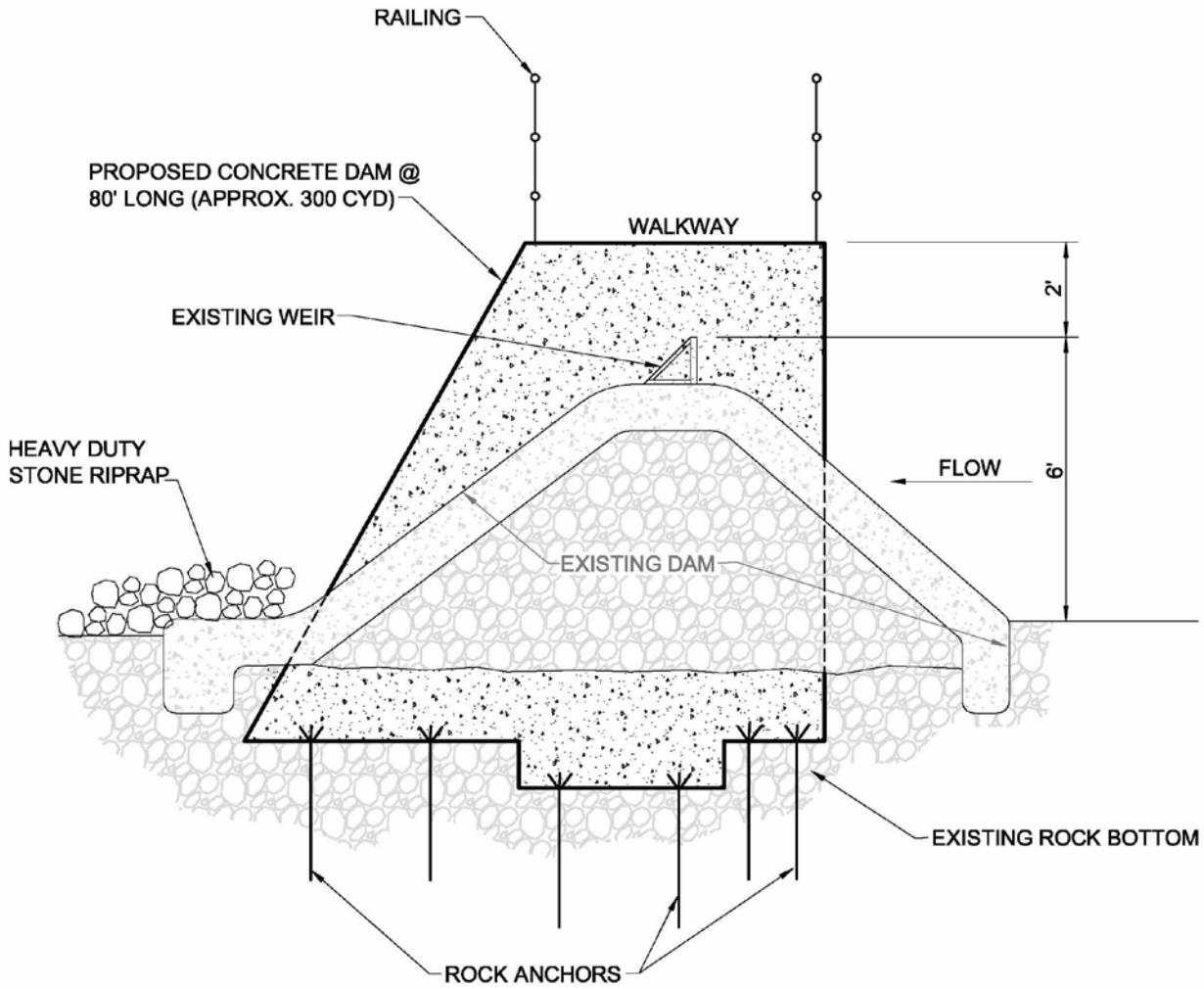
Option 2 (revised)**: *Construct a new dam structure that will allow water to flow over at flood stage.***

During normal river stages, water would flow over the spillway as it currently does. As in Option 1, the toe of the spillway would be reinforced.

The concepts can be found in figures 2A and 2B, following this page.

The estimated cost is itemized in the following table:

OPTION 2: Remove the gate structure and replace with a rock-lined channel			
Work Item	**Units**	**Unit Cost**	**Total Cost**
Mobilization / Demobilization	1	$50,000	$50,000
Access Roads	1	$40,000	$40,000
River Access	1	$30,000	$30,000
Install and Remove Cofferdam	1	$100,000	$100,000
Removal and Disposal of Existing Gate Structure	1	$230,000	$230,000
Place Concrete	300 cyds	$600	$180,000
Rock Excavation	1	$50,000	$50,000
Rock Anchors, Reinforcing Steel	1	$50,000	$50,000
Restoration	1	$25,000	$25,000
Rock for Spillway Toe	300 cyds	$175	$52,500
Subtotal			**$807,500**
Engineering, Legal, Contingencies			$239,500
OPTION 2 TOTAL			**$1,047,000**



DAM SECTION

1/4"=1'-0"

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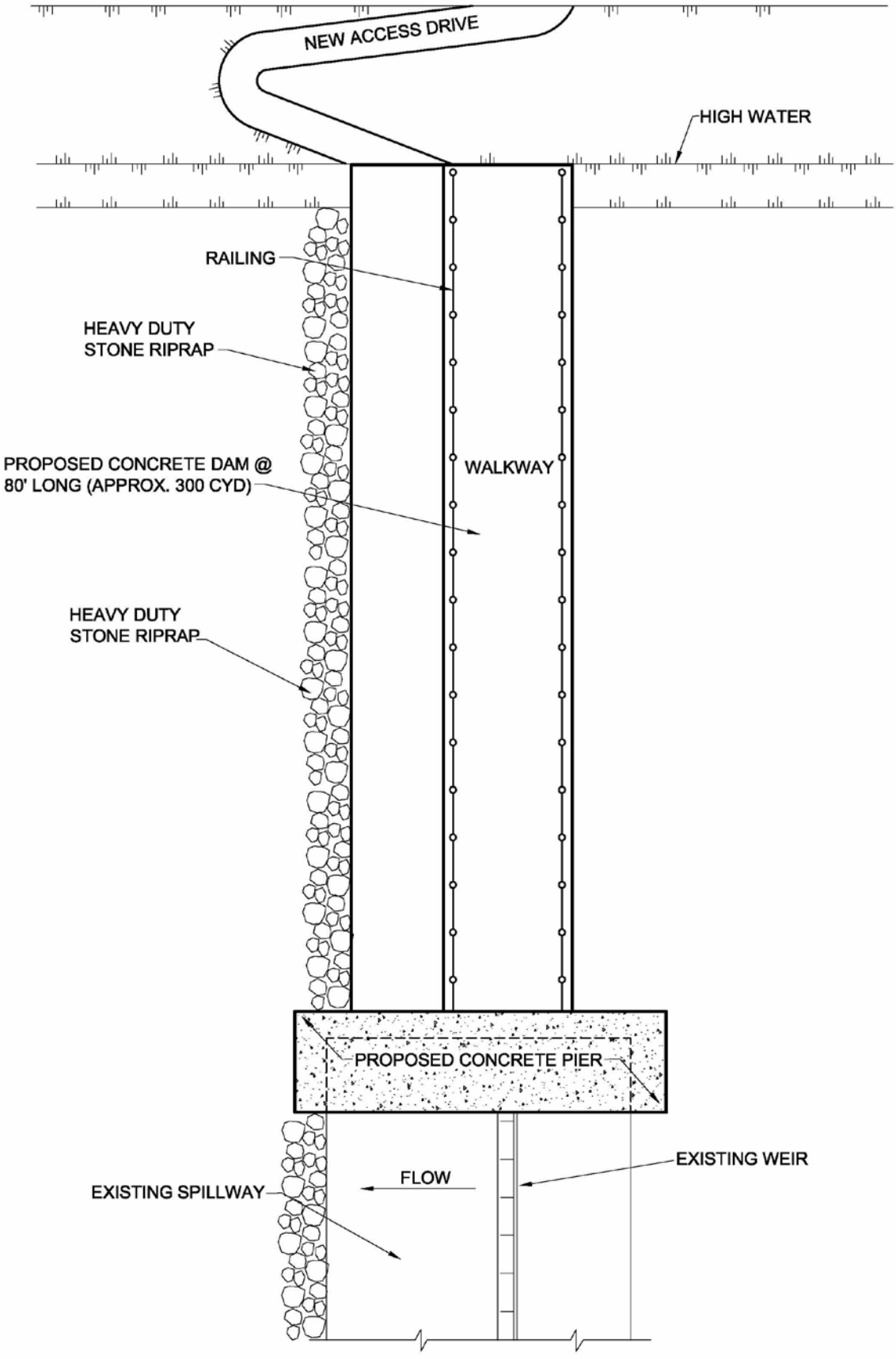
OPTION 2
CONCRETE EXTENSION ONLY

SEVEN ISLANDS (MUDGE'S) DAM IMPROVEMENTS
CITY OF GRAND LEDGE, MICHIGAN

FIGURE 2A



DAM PLAN

NO SCALE

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4063 Grand Oak Drive, Suite A109
Lansing, Michigan 48911
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OPTION 2
CONCRETE EXTENSION

SEVEN ISLANDS (MUDGE'S) DAM IMPROVEMENTS
CITY OF GRAND LEDGE, MICHIGAN

FIGURE 2B

Option 3: Remove the Dam completely, maintaining upstream water levels. The Dam could be removed and replaced with a series of channels and pools which would maintain the water elevation upstream and gradually step down to the downstream elevation. This would take place over several hundred feet and be designed so as not to impede fish movement.

Advantages include a more natural river flow and potentially an attractive improvement. The main disadvantage to this is cost.

Please note that we believe that Option 3 has the best likelihood of the three options to obtain grant funding, which may offset the higher cost.

Eng. previously prepared a Power Point presentation on this option. Please see Appendix B for the proposed layout and the example on the Shiawassee River.

The proposed costs for Option 3 are itemized in the following table:

OPTION 3: Remove the dam completely, maintaining upstream water levels			
Work Item	**Units**	**Unit Cost**	**Total Cost**
Mobilization / Demobilization	1	$35,000	$35,000
Access Roads	1	$40,000	$40,000
River Access	1	$30,000	$30,000
4x3x2 Rock/Stone	4,420 cyds	$175	$773,500
Cobble Fill	21,500 cyds	$8	$172,000
Bank Riprap (MDOT Heavy)	7,240 cyds	$50	$362,000
Restoration	1	$25,000	$25,000
Subtotal			**$1,437,500**
Engineering, Legal, Contingencies			$428,500
OPTION 3 TOTAL			**$1,866,000**

APPENDIX A

Presentation to the Mayor and City Council in July of 2013

Eng™
Engineering & Surveying

4063 Grand Oak Drive
Suite A109
Lansing, MI 48911

T: 517.887.1100
F: 517.887.6335
engdot.com

Gregory L. Minshall, PE
Michael J. Dyer, PE
Brian J. Cenci, PE

June 7, 2013
Revised July 18, 2013

The Honorable Mayor Kalmin Smith
City Council
City of Grand Ledge
200 E. Jefferson
Grand Ledge, MI 48837

RE: Seven Islands Dam Study
Project No. 13008.00

Dear Mayor Smith and Members of the City Council:

We have completed Task 1 of the Seven Islands Dam Study. We met twice with representatives of the Michigan Department of Environmental Quality (DEQ), and the Michigan Department of Natural Resources (DNR): once at their offices and once on-site. City staff were in attendance at both meetings.

The first meeting took place with Lucas Trumble and Tom Kolhoff of DEQ. City staff included Larry LaHaie and Chad Brunton. We discussed issues of regulatory compliance. The DEQ representatives confirmed that due to the size of the impoundment (surface area of the water held back by the dam), the structure is not regulated as a dam. Proposed repair design and construction would not need to meet current dam safety requirements. Please note that if the gates are left in place or replaced with new gates, there are safety issues for staff access to and operation of the gates that should be addressed.

The second meeting took place on-site with Scott Hanshue of DNR Fisheries to discuss the impacts of dam modifications on fish migration. The City was represented by Larry LaHaie, Chad Brunton and Jon Bayless.

Based on our discussions with DEQ, the City has several options with respect to repair or reconstruction of the dam. We discuss some options below.

1. Replace the gate structure and repair the spillway. This option includes new gates and supports, bank restoration, site access improvements, new catwalk and gate lifting mechanism. We recommend that the toe of the spillway be repaired at the same time to address the areas where the apron have broken off and settled.

There is no indication that there is flow under the spillway, which would undermine the structure. It would be prudent to evaluate whether or not there is bypass flow if this option is selected to make sure that all repairs are included.

To replace the gates, the flow should be modeled to determine the optimal number and size of the new gates. There are currently seven gates, more than are needed to draw down the river.

Advantages include maintaining the current water level while having new gates for draw-down when needed. Safety would be significantly improved for staff access and operation.

The main disadvantage is cost. This level of effort was estimated at $1,150,000 in 2002.

2. Remove the gate structure and replace with a rock-lined channel. This option would divert the flow that currently goes over the spillway through a new channel.

   This option would eliminate the need for new permanent access on the north side, the type of construction would include bank restoration. Gates and new catwalk would not be included.

   Advantages include savings over Option 1 (above), although further study is needed to estimate the amount.

   Disadvantages are not being able to draw down the river level for shoreline maintenance or construction and a lower permanent water level. For the channel to carry water, it would have to be constructed lower than the existing spillway.

3. Remove the dam completely, maintaining upstream water levels. The dam could be removed and replaced with a series of channels and pools which would maintain the water elevation upstream and gradually step down to the downstream elevation. This would take place over several hundred feet and be designed so as not to impede fish movement.

   Advantages include a more natural river flow and potentially an attractive improvement. There is a better chance of obtaining grant funds from multiple sources for this option.

   The main disadvantage to this is cost. Even with additional grant opportunities, this is likely to be the most costly option.

4. Remove the dam completely. This option would involve removing the gate structure and at least part of the spillway. The north bank would be stabilized. The river level would be permanently lowered and allowed to naturally stabilize.

The advantages to this option are a minimal cost with opportunities for grant assistance and it would restore the river to its natural state (prior to earlier dam constructions).

Disadvantages include a lower water level which would inhibit boat access. The riverboat would not be able to operate. The resulting mud flats would be unsightly until natural vegetation is established (this could be mitigated by a natural plant installation plan).

5. The last option is to do nothing. As time passes, the holes in the iron gates will increase in size and their ability to maintain water levels will decrease. If this option is selected or becomes a default due to lack of funds, we recommend:
   A. Barricade and add warning signs to the gate structure to keep people off.
   B. Add signs warning people not to fish below the gates due to safety concerns.

We are not including the option of repairing the existing gates and concrete. Based on our latest site visit and inspection, we believe the concrete is too deteriorated and gates too corroded to repair. The "c" channels that the gates are in are not adequately anchored. Repair attempts would not be a cost effective approach to addressing the dam.

We will be happy to meet with you to discuss options and the next steps, if any.

Sincerely,

Eng., Inc.

Gregory L. Minshall, PE
President

APPENDIX B

Proposed layout (Option 3) and example on the Shiawassee River

Grand Ledge Dam Improvements

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Grand Ledge Dam Improvements

Proposed Dam Improvements Conceptual Layout

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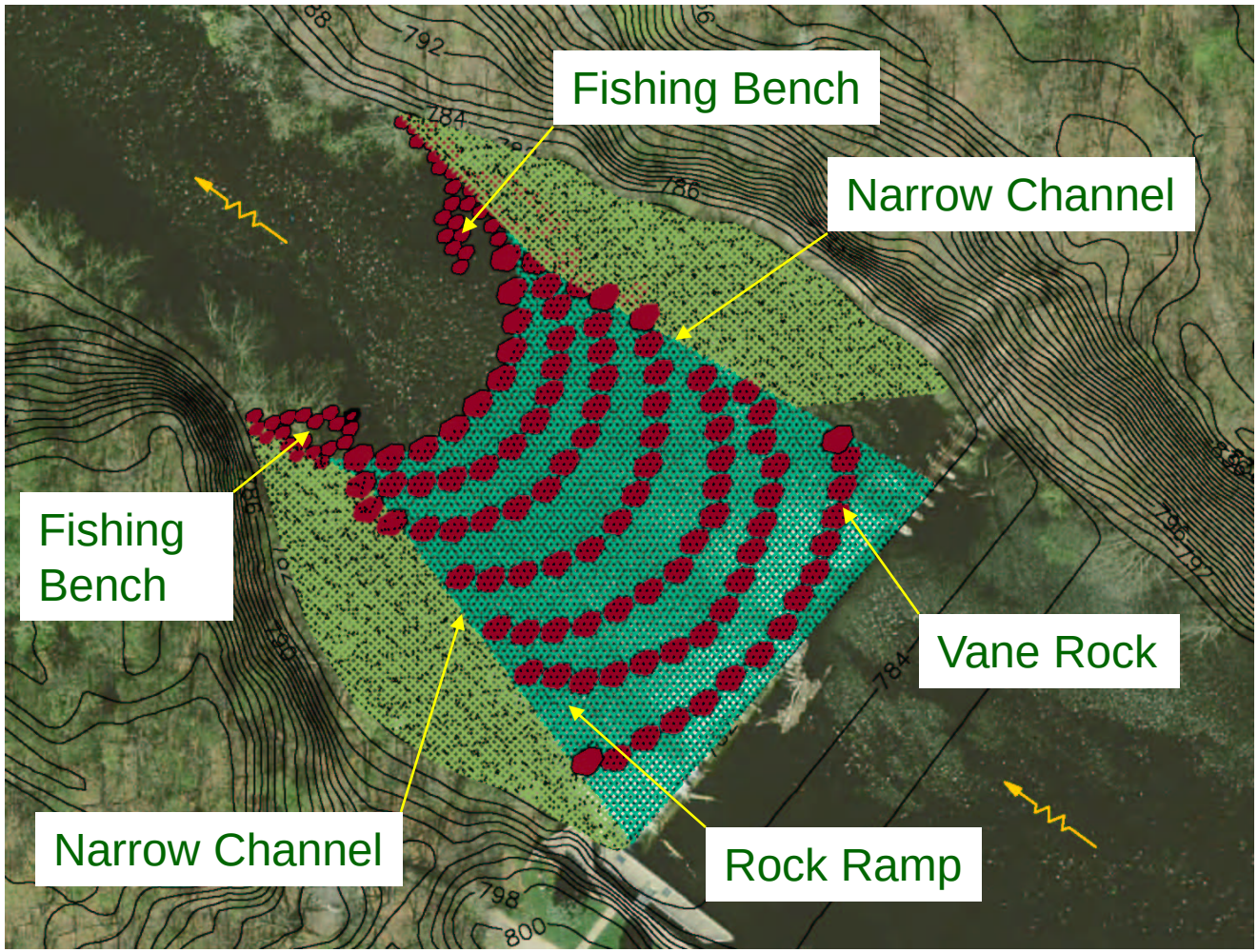
Grand Ledge Dam Improvements



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Grand Ledge Dam Improvements

Before

Village of Chesaning – Shiawassee River Dam Location

(Prior to dam improvements)

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Grand Ledge Dam Improvements

Actual

Village of Chesaning – Shiawassee River Dam Location

(Completed dam improvements. Project done by Wade Trim)

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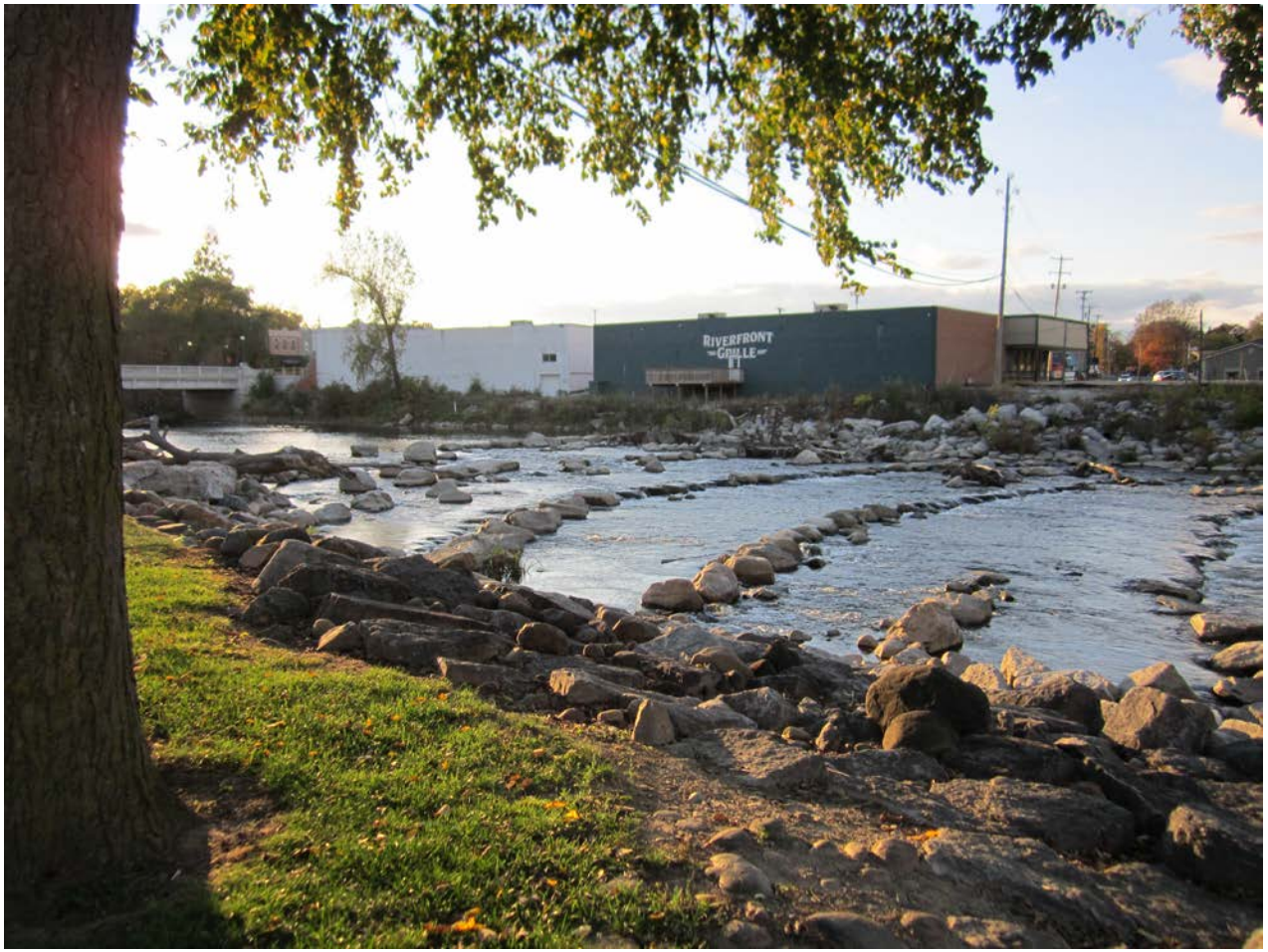
Grand Ledge Dam Improvements



Looking southwest along east bank of the Shiawassee River

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Grand Ledge Dam Improvements

Looking northwest along east bank of the Shiawassee River

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Grand Ledge Dam Improvements

Looking southeast along west bank of the Shiawassee River

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Grand Ledge Dam Improvements

Looking northeast along west bank of the Shiawassee River

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Grand Ledge Dam Improvements

Looking southeast along west bank of the Shiawassee River

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Grand Ledge Dam Improvements

Looking southwest along east bank of the Shiawassee River

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Recommendations

Based on the criteria established for this report, options for the Dam repair / replacement range from an estimated low of $1,047,000 to a high of $1,866,000. Since these estimates are very preliminary, the reader should consider some factor of safety; however, they give an order of magnitude of the cost of a project.

If the ability to lower the water level behind the Dam is considered a critical element, then Option 1 meets that requirement and financing alternatives should be pursued. We do not recommend investing in a design until a funding source is identified.

If that ability is not essential, then Options 2 and 3 should be considered. Even with the significant cost difference, we recommend Option 3 over Option 2 for the following reasons:

- Option 3 has more and better outside financing opportunities (grants).
- Option 3 provides better water quality and fish passage.
- Option 3 results in better recreational opportunities.
- Option 3 allows for the removal of the fish ladder.