Houston Engineering Inc.

Fargo, ND | HEI No. 8675_001
October 31, 2017

PELICAN RIVER DAM CONCRETE SPILLWAY ASSESSMENT REPORT

Pelican Rapids, Minnesota

PELICAN RIVER DAM CONCRETE SPILLWAY ASSESSMENT REPORT

Pelican Rapids, Minnesota

October 31, 2017

Prepared for:
City of Pelican Rapids and Minnesota Department of Natural Resources – Dam Safety Division

Prepared by:
Houston Engineering, Inc.

HoustonEngineering Inc.

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision, and that I am duly Licensed Engineer under the laws of the State of Minnesota.

Houston Engineering, Inc.
1401 21st Ave. N
Fargo, ND 58102
Phone # 701.237.5065

Luke J. Beckermann
MN #53505

10/31/2017
Date

TABLE OF CONTENTS

1 INTRODUCTION 1
2 HISTORY 1
3 INSPECTION 2
4 SUMMARY OF FINDINGS 3
5 RECOMMENDATIONS 8
5.1 REPAIR 8
5.2 REPLACE 9
5.3 GATES 9
6 CONCLUSION 9

APPENDICES

Appendix A Photos
Appendix B Braun Report 2-14-2017
Appendix C Core & Repair Locations
Appendix D Detailed Opinion of Probable Costs

TABLES

Table 1: Repair of Spillway Structure
Table 2: Replacement of Spillway Structure
Table 3: Repair of Spillway Structure with Gravity Block Retaining Wall
Table 4: Replacement of Spillway Structure with Gravity Block Retaining Wall

1 INTRODUCTION

In the summer of 2016, the City of Pelican Rapids retained Houston Engineering, Inc. (HEI) to conduct an assessment of a rock masonry retaining wall that had failed at the Pelican Rapids Dam.

The assessment was published in a report titled “Pelican River Dam Rock Masonry Wall Failure Assessment Report” dated March 9, 2017. During the inspection of the rock wall on November 3, 2016, it was found that concrete components of the spillway were showing extreme deterioration. Due to the amount of flow through the spillway, it was not possible to do a complete inspection. The deterioration that was evident above the existing water line and at the ends of the chute indicated that enough deterioration had occurred to warrant a more in-depth inspection in order to properly determine if the structure could be repaired or if a complete replacement would be needed.

The City executed an agreement with the Minnesota DNR for cost sharing on the spillway assessment, and HEI was retained to provide a report on the spillway.

This report covers the spillway inspection, its condition and options for repair or replacement, and the associated costs. These costs are then summarized with the cost for the gravity wall alternative discussed in the March 9, 2017, assessment.

2 HISTORY

The Pelican Rapids concrete spillway structure was originally constructed between 1914 and 1915. Before this construction, the spillway consisted of a timber structure. Original plans for the concrete spillway were not found; however, a more in-depth look at the history of the spillway and dam was provided in the Pelican River Dam Rock Masonry Wall Failure Assessment Report. In 1987 and 1988, the dam underwent major rehabilitation in which the spillway stoplogs were replaced with a sluicegate, cavities in the spillway floor were repaired, a portion of the spillway was resurfaced for aesthetics, and the downstream footing of the spillway was extended. The plans for this rehabilitation are available; however, most of the spillway geometry/dimensioning were not included in the plans.

Photo 2-1 Pelican Rapids Spillway

3 INSPECTION

Before inspection of the structure could be completed, the structure needed to be dewatered and dry to allow access. The City started diverting flows through the power house the week of August 7th. As flows were diverted and maintained through the power house, several sink holes formed around the power house. Once the sinkholes stabilized, greater flows were diverted. Flows eventually dissipated, and the chute was ready for inspection August 25th. The power house will need to be inspected further at a later date to determine why the sinkholes formed, and possible remedial actions may be explored.

The inspection of the spillway was completed August 28th by Luke Beckermann and Jeremy McLaughlin. In the inspection, a ladder was used to access the structure and reach all areas of the inside of the structure. However, access to the downstream apron was limited due to the high tailwater.

The inspection of the concrete spillway included a detailed visual and hands-on inspection of the concrete floor and walls. The visual portion of the inspection consisted of visually determining areas of spalling, pitting, cracking, or discoloration of the concrete. All of these concerns can be an indication of degradation of the concrete. The hands-on inspection included sounding the concrete with hammers. Dull or hollow sounding concrete typically indicates degradation of the concrete. This generally indicates that there are either voids in the concrete or the concrete is not bonded to the reinforcement.

Photos of any areas showing wear or deterioration were taken. HEI employed Braun Intertec to perform several cores and Ground Penetrating Radar (GPR) to help identify the quality of the concrete and any potential voids in or below the existing concrete. During the inspection, HEI marked out areas of the structure where cores should be taken. These locations included two bottom slab cores and four wall cores at various locations. Core locations are shown in Appendix C of this report.

The cores were broken to determine the concrete strength, and the results were summarized in the attached report by Braun Intertec (see Appendix B). Cores of the concrete can also determine voids and further degradation of the concrete that cannot always be determined with visual and hands-on inspection. GPR can help in determining both the thickness of the concrete in addition to reinforcement depth and spacing. The results of the core sampling and GPR are presented in the report by Braun Intertec and will be summarized in the following section.

4 SUMMARY OF FINDINGS

On-Site Inspection

It became evident during the inspection that certain areas of the structure were in need of repair, while others were in relatively good condition considering the age of the structure. The wingwalls on the downstream end of the structure exhibited extreme deterioration. There were several areas where concrete had completely spalled off and the reinforcement was exposed. The entire bottom slab of the structure exhibited extreme degradation for about 19’ directly upstream of the baffle block. This portion of the bottom slab appeared to have been poured on top of another slab of concrete that it was not bonded to (this could not be verified in the field and no plans were available that indicated the concrete slab arrangement). The bottom slab also had several holes and pitting in the concrete around the baffle block. Several of the holes had exposed reinforcement.

Photo 4-1 Pitting near Baffle Block

Photo 4-2 Wingwall Deterioration

On the walls, there was an area approximately 2’ high, which started about 4’ up from the bottom slab, where the concrete was discolored and sounded delaminated. This 2-foot high portion of the walls appeared to be in the area of the normal water line and continued approximately 23’ downstream from the upstream ends of the walls. Outside of this 2-foot section of delaminated concrete on the walls, there were various small areas of concrete that would need repairs. These areas consisted of cracks of various sizes, small spalls, and other various signs of distress. In order to properly account for these areas, an estimate of 20% of the remaining concrete was assumed to be in poor condition (based on test areas conducted in the field). In addition, there was an approximately 1-foot-wide area of concrete on the north wall, starting at the bottom slab and continuing to the top of the wall, that exhibited extreme delamination. This area was approximately 11’ upstream of the baffle block.

Photo 4-3 Deterioration near north waterline

Photo 4-4 Deterioration near south waterline

The two steel beams supporting the concrete walking path across the spillway exhibited corrosion and section loss. The steel beams were 8” deep with 4” flanges spaced at 2’-8” O.C.

Several of the described deficiencies above are shown in additional photos in Appendix A.

Additional Testing

Braun Intertec performed concrete cores on site on August 29th, 2017. Concrete cores and breaks confirmed what was expected from the visual and hands-on inspection.

Existing Concrete Strength

Of the six core breaks, five of the six broke at a strength at or above 3800 psi. Only one of the cores, Core 5 (see Appendix C), broke at a lower strength of 2600 psi. This core had the most apparent degradation and broke through the area of degradation. Core 5 was taken on the south wall in an area that was discolored and sounded delaminated.

Existing Concrete Thicknesses

Concrete cores revealed a high level of variability in concrete thickness. Although the concrete walls measured 1’-10” at the top, only one of the wall cores indicated a thickness comparable to the measured thickness. Three of the four wall cores showed the walls being between 8” and 10” thick (see core locations in Appendix C). Because of the variability in concrete core thickness and variation from the measured thickness at the top of walls, Braun recommended the use of a GPR to accurately determine the actual thickness of the concrete. The GPR was inconclusive in finding concrete thickness. The report

by Braun discussed that as the cores were taken, once the drill got through the concrete, they reached what appeared to be a flowable fill material that was too soft and impeded the advancement of the core bit. The material could not be removed by hand. It is expected, though unclear, that the material behind the walls is close enough in density to concrete that the GPR could not obtain an accurate reading on thickness. Based on the cores, it appears that the walls were of varying thickness and likely were not poured using formwork on the exterior. This makes it difficult to determine overall structure integrity; however, due to the relatively high strength of the existing concrete and the fact that it does not appear to exhibit any signs of inadequate strength, it is assumed that the existing concrete thickness is adequate. It was not in the scope to complete a detailed structural analysis of the walls and floor.

Gates

It was also discussed with City employees that new gates should be installed in the structure that would control the flow of water through the spillway. The existing gates open from the bottom up and are of timber construction. The original system was designed in 1987 and doesn't operate adequately according to City Staff. As part of the overall structure repair, it is recommended that the gates be replaced with a more current and user friendly system for the City to operate.

Photo 4-5 Timber Gate

Photo 4-6 Timber Gate Seal

5 RECOMMENDATIONS

5.1 REPAIR

Spillway concrete repair for this structure would consist of using concrete jackhammers and removing the concrete until “sound”, or solid concrete, is found. The depth varies with location, and it is often difficult to estimate the depth of repair that will be needed. Visual inspection of the cores allows us to determine how much of the concrete in that specific location is deteriorated. We can then estimate for other locations how much concrete will need to be removed. We estimated that most areas will be able to be remedied with 4” or less of concrete removal. However, during repairs, an engineer should be on site to determine the depth to which the concrete needs to be removed. This is determined by continuing to sound the concrete as it is removed to determine when sound concrete is encountered. Once sound concrete is encountered, the areas would be repaired and filled to the original concrete surface using shotcrete.

In the repair option, both the north and south wingwalls on the downstream end of the structure and the 19’ stretch of the bottom slab that exhibited extreme delamination would be completely removed and replaced. The holes and pits in the remainder of the bottom slab would also be repaired by removing any delaminated concrete and filling the holes with concrete. In addition, the 2-foot stretch of concrete around the normal water line as well as approximately 20% of the walls outside of the 2-foot sections would be removed down to sound concrete and repaired as described above. Additionally, the outer skimcoat layer of concrete would be removed on the entire structure, and a skimcoat or staining would be completed for aesthetic purposes.

The steel beams supporting the walkway over the spillway would also be replaced. The walkway over the spillway would need to be removed and replaced as well.

Estimating the remaining service life of a structure after this type of repair is difficult. Often, a new structure would be estimated to last somewhere between 50 to 75 years. If the repair option as described above was completed, we could assume the overall service life of the structure could be extended by about 20 years. Since the original structure was built nearly 100 years ago, it is difficult to estimate the remaining life of the non-repaired concrete. Additional maintenance and repairs would be expected on the rest of the structure during the remaining service life.

The repair option would be expected to cost approximately $215,000. This price would be in addition to either of the rock wall repair alternatives. The detailed opinion of cost can be seen in Appendix D.

5.2 REPLACE

In this option, the structure would be completely removed and replaced with a structure similar in geometry and dimensions. This option is significantly more intensive, as it would require dewatering, including coffer dams, temporary shoring, and much more preparation work before the structure could be replaced. This option would also require more time to complete. A new structure could be assumed to have a design life of 75 years or greater.

The replace option would be expected to cost approximately $365,000. This price would be in addition to either of the rock wall alternatives. The detailed opinion of cost can be seen in Appendix D.

5.3 GATES

In either the repair or the replace option, the timber gate in the structure could be replaced with a stop log-type closure or a weir-type gate. The stop log-type gate functions by manually inserting or removing aluminum stop logs from channels on the walls. The stop logs could be designed to be put in place or removed from the walkway over the spillway. The drawback of this style of gate is that the stop logs would have to be manually put in place or removed. This type of gate would cost approximately $20,000.

The second option would be to install an aluminum weir type gate. This type of gate is very similar in function to the existing gate, except instead of a pulley system to raise and lower the gate, a hydraulic power system is used to raise and lower the gate. The hydraulic power system can be used to raise or lower the gate to the desired level. A weir type gate is shown in the images in Appendix A. This type of gate would be far more user friendly and easier to operate. A gate of this type would cost approximately $138,000.

Total Project Costs for the spillway repair or replacement are included in Appendix D.

6 CONCLUSION

As discussed, the spillway is in need of repair or replacement due to extreme deterioration of the concrete. HEI recommends repairs for the rock retaining wall and that the spillway be repaired or replaced as part of the project to ensure the spillway continues to function as intended. Costs to fix the

rock wall and spillway are included in the tables in Appendix D. It is important to point out that these costs do not address the sink holes that developed at the power house during the reservoir drawdown to inspect the spillway.

The City has retained HEI to assess the problem at the power house. This assessment will be completed when the water in the pump house can be lowered for inspection. The costs for the pump house repairs would need to be added to the costs in the table.

As mentioned in the previous rock wall report, the Minnesota DNR is also interested in talking to the City regarding removal of the Pelican River Dam. As discussed before, one of the benefits of this alternative is the 50% cost sharing that the State expects from the City on other alternatives could be waived. This alternative could be investigated before proceeding with the repair or replacement of the existing structure to determine feasibility and the best course of action.

APPENDIX A

Photos

Photo A-1 Pitting near Baffle Block with Exposed Reinforcement

Photo A-2 Wingwall Deterioration with Exposed Reinforcement

Photo A-3 Wingwall Deterioration with Exposed Reinforcement

Photo A-4 Typical Spalling and Cracking

Photo A-5 Sounding Concrete, Overall Structure Condition

Photo A-6 Typical Concrete Deterioration

Photo A-7 Weir Style Gate

APPENDIX B

Braun Report 2-14-2017

Braun Intertec Corporation
3900 Roosevelt Road, Suite 113
Saint Cloud, MN 56301

Phone: 320.253.9940
Fax: 320.253.3054
Web: braunintertec.com

September 15, 2017 Project B1708679

Jeremy McLaughlin, PE
Houston Engineering, Inc.
1401 21st Avenue North
Fargo, ND 58102

Re: Coring and GPR Scanning Letter
Pelican Rapids Dam Spillway
Pelican Rapids, Minnesota

Dear Mr. McLaughlin:

Braun Intertec Corporation is pleased to submit this letter summarizing our recent Coring and Ground Penetrating Radar (GPR) scanning performed at the Pelican Rapids Dam Spillway in Pelican Rapids, Minnesota.

Background

It is our understanding that Houston Engineering, Inc. (HEI) is working with the City of Pelican Rapids to design modifications to the spillway. To aid in their design HEI asked that we perform coring and GPR scanning to aid in evaluating the existing condition of the concrete.

Scope of Services

Coring and Compressive Strength Testing

HEI marked six (6) locations on the walls and floor of the spillway. We visited the site and performed 4" diameter cores at each location. Upon completion of the cores the holes were patched with non-shrink grout. Cores were returned to our West Fargo laboratory and then delivered to HEI's office where they were measured and photographed by HEI. After observations were complete the cores were trimmed to 8" lengths and prepared for compressive strength testing in accordance with ASTM C42. After moisture conditioning for 5 days the samples were tested in accordance with ASTM C39.

GPR Scanning

Upon completion of the coring and observation of the cores, HEI noted that the core thickness did not align well with their measurements of the wall thickness measurements at the top of the wall and indicating that the wall may be shallower at the base than it was at the top. We returned to the site to perform GPR scanning to evaluate the wall thickness variability. In addition we scanned to see if we could observe a rebar pattern within the walls and floor. Multiple scans were performed in a vertical and horizontal orientation to locate the position of reflections typically associated with reinforcing.

Results and Discussion

While we were coring, the concrete appeared relatively consistent throughout much of the length. In most of the cores the maximum aggregate size was noted at between 1 and 2 inches. The top portion of the cores were in variable condition, with those advanced below the apparent water line having little to no delamination and degradation visible in them. Cores taken above the apparent water line had variable depths of delamination, porosity and degradation visible in them, up to 6 inches deep. The backfill for the wall appeared to consist of a flowable fill material that we could not penetrate with the core machine as it was too soft, crumbling and impeding the advancement of the core bit. The material could not be pulled out by hand.

Each of the cores were tested for compressive strength and the results of the testing are attached to this letter. In general the cores broke at strengths exceeding 3800 pounds per square inch (psi) with the exception of Core #5 that broke at 2600 psi. Of all the cores, number 5, was the one that had the most apparent degradation of the concrete, up to 6 inches, and it broke through the degraded area.

We returned to the site to use GPR to evaluate the thickness of the concrete walls. A GPR system operates by transmitting electromagnetic pulses into the subsurface and recording subsequent reflections from targets of varying electrical properties. The variable electrical properties typical delineate variable density materials which can be used to identify changes from concrete to soil. In the case of the spillway, we were unable to identify a consistent pattern that could be used to identify the wall thickness. We anticipate this may have been a result of the fill material behind the walls not having a sufficiently different density to be distinguishable from the concrete.

We also tried to identify patterns in the reinforcement. In general, reflections typically representative of reinforcing were observed at a depth of 3 to 3 1/2 inches below the surface of the concrete. Horizontal rebar in the walls was at variable spacing between 6 and 12 inches, with 8 to 10 inches common. A single vertical rebar was noted on the north wall, approximately 3 feet west of the weir. On the south wall we noted apparent vertical rebar spaced at 1 to 3 feet apart from the east end to about 6 feet west; continuing west, vertical rebar was not noticed for about 8 feet and then was noted at spacing's of 1 to 2 feet continuing to the west side of the concrete walk. Vertical rebar was not observed in the south wall west of the concrete walk. The size of the rebar is not determinable using GPR technology.

General

In performing its services, Braun Intertec used that degree of care and skill ordinarily exercised under similar circumstances by reputable members of its profession currently practicing in the same locality. No warranty, express or implied, is made.

If you have any questions or concerns, please do not hesitate to contact Ezra Ballinger at 701.205.2515.

Sincerely,

BRAUN INTERTEC CORPORATION

Justin Miller
Associate Principal/Operations Supervisor

Ezra Ballinger, PE
Principal/Senior Engineer

Attachments:

Coring Results (2 pages)

Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C42 (Core Compression)

Date:	September 5, 2017	**Project Number:**	B1708679
Client:	Houston Engineering	**Project Description:**	
		Pelican Rapids Dam Coring	

Sample Data

Core Number:	1	2	3
Location:	North Wall	Floor East	S Wall East
Date Cored:	08/29/17	08/29/17	08/29/17

Laboratory Data

Date Tested:	09/05/17	09/05/17	09/05/17
Test Age (Days)			
Received Length (in.):	8.25	9.375	16.5
Core Length (in.) before Capping:	8.10	8.08	8.11
Core Length (in.) after Capping:	8.31	8.20	8.23
Diameter (in.):	4.02	4.02	4.01
Weight (lbs.)	8.32	8.32	8.40
L/D Ratio:	2.07	2.04	2.05
Area (sq. in.):	12.69	12.69	12.63
Density (lbs./ft^3)	140	140	142

Test Results

L/D Ratio	2.07	2.04	2.05
L/D Correction Factor:	1.00	1.00	1.00
Ultimate Load (lbs.):	51,655	71,220	67,660
Corrected Comp. Strength (psi):	**4070**	**5610**	**5360**
Fracture Type:	**4**	**2**	**2**

Sample Location and Comments

Average Compressing Strength :		psi	
Notes:	No Degradation Noted	No Degradation Noted	No Degradation Noted/ Top 4.5" Cut off Due to Rebar

Remarks

Condition samples were tested in (dry/wet):	Dry
Nominal size of aggregate (in.):	
Sample(s) with rebar present:	None
Specified compressive strength (psi):	

Direction of load application on the core with respect to the horizontal plane of concrete as placed:
90 DEGREES

cc:

Reviewed By:

Braun Intertec Corporation

Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C42 (Core Compression)

Date:	September 5, 2017	**Project Number:**	B1708679
Client:	Houston Engineering	**Project Description:**	
		Pelican Rapids Dam Coring	

Sample Data

Core Number:	4	5	6
Location:	S Wall Center	S Wall West	Floor West
Date Cored:	08/29/17	08/29/17	08/29/17

Laboratory Data

Date Tested:	09/05/17	09/05/17	09/05/17
Test Age (Days)			
Received Length (in.):	10	11.5	17.25
Core Length (in.) before Capping:	8.08	8.09	8.07
Core Length (in.) after Capping:	8.22	8.19	8.18
Diameter (in.):	4.01	4.01	4.01
Weight (lbs.)	8.35	8.25	8.51
L/D Ratio:	2.05	2.04	2.04
Area (sq. in.):	12.63	12.63	12.63
Density (lbs./ft^3)	141	139	144

Test Results

L/D Ratio	2.05	2.04	2.04
L/D Correction Factor:	1.00	1.00	1.00
Ultimate Load (lbs.):	73,235	32,910	48,090
Corrected Comp. Strength (psi):	**5800**	**2610**	**3810**
Fracture Type:	**3**	**4**	**4**

Sample Location and Comments

Average Compressing Strength :		psi	
Notes:	A Little Degraded in Top 1"	Degradation Noted in Top 6"	No Drgradation Noted/ Top 6" Broke Off During Coring

Remarks

Condition samples were tested in (dry/wet): Dry
Nominal size of aggregate (in.):
Sample(s) with rebar present: None
Specified compressive strength (psi):
Direction of load application on the core with respect to the horizontal plane of concrete as placed:
90 DEGREES

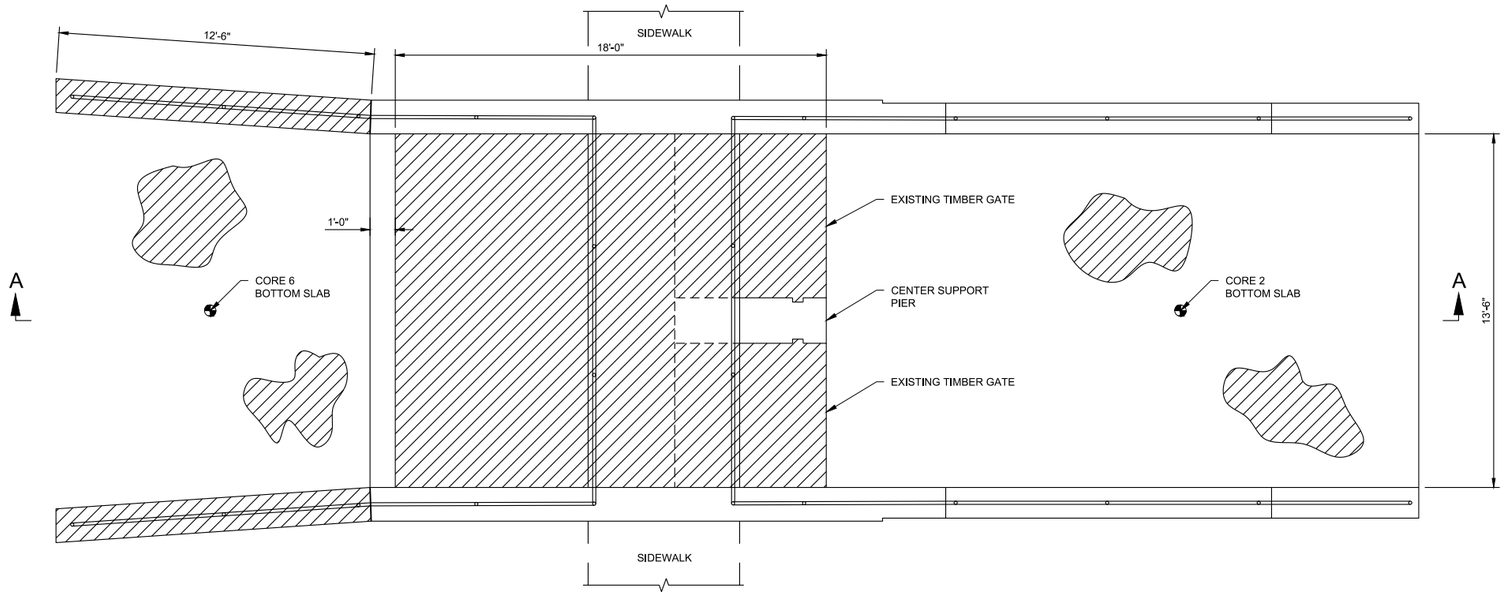
cc:

Reviewed By:

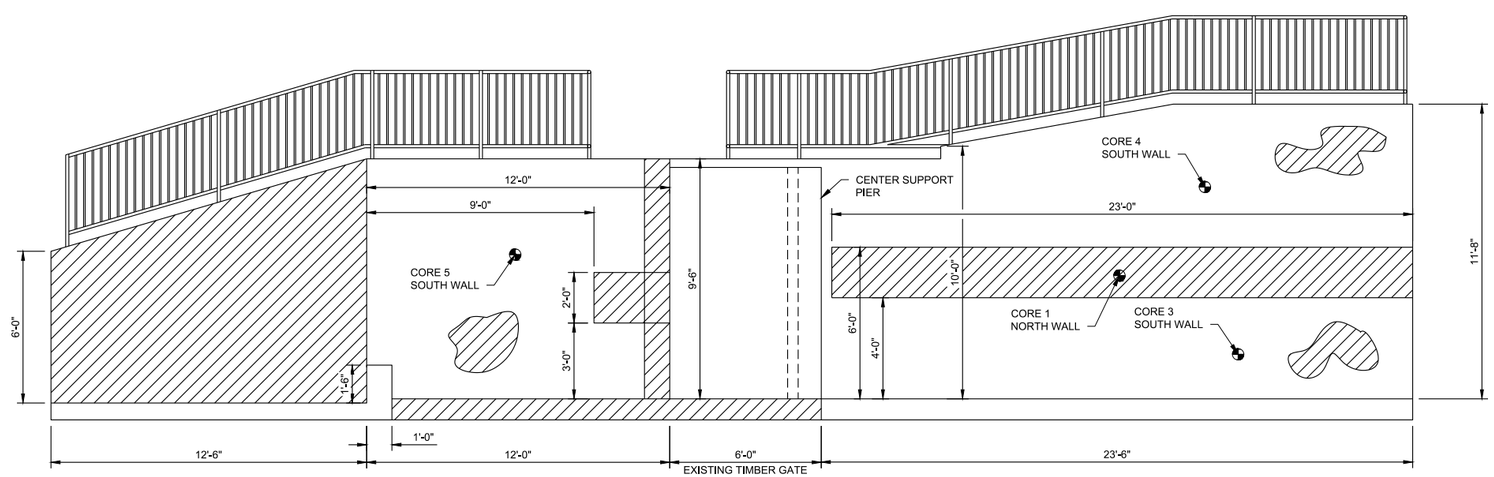
Braun Intertec Corporation

APPENDIX C

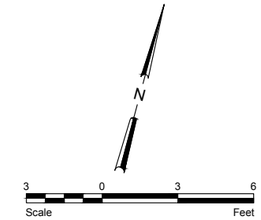
Core & Repair Locations



1 PLAN VIEW



A-A SECTION VIEW



LEGEND

DETERIORATED CONCRETE

CORE LOCATIONS

NOTE:

ADDITIONAL CONCRETE REMOVAL IS ANTICIPATED OUTSIDE OF THE AREAS SHOWN. APPROXIMATELY 20% OF CONCRETE NOT SHOWN AS DETERIORATED WILL REQUIRE CONCRETE REPAIR.

CONCRETE REMOVAL:

WALLS: 15 CY *

BOTTOM SLAB: 10 CY *

* INCLUDES ADDITIONAL 20% DETERIORATED CONCRETE.

No.	Revision	Date	By

PRELIMINARY
Not for Construction

Houston Engineering Inc.

Fargo
P: 701.237.5065
F: 701.237.5101

Drawn by	Date
SMH	9-13-17
Checked by	Scale
TJB,RRS	AS SHOWN

PELICAN RAPIDS DAM REPAIR
CITY OF PELICAN RAPIDS
PELICAN RAPIDS, MINNESOTA

REPAIR

PROJECT NO. 8675-001

SHEET
1 of 1

H:\Fargo\JBN\8600\8675\8675-001 Pelican Rapids Dam\CAD\Pelican Dam Layout.dwg-Layout-9/19/2017 3:10 PM-(jrenner)

APPENDIX D

Detailed Opinion of Probable Costs

Table 1: Repair of Spillway Structure

Item	Unit	Quantity	Unit Price	Amount
Removal of Concrete	LSUM	1	$20,000	$20,000
Removal of Steel Beams	LSUM	1	$2,500	$2,500
Removal of Gate	LSUM	1	$1,500	$1,500
Temporary Shoring	LSUM	1	$20,000	$20,000
Shotcrete Repair	CY	10	$1,400	$14,000
Replace Wingwalls	CY	10	$2,500	$25,000
Replace Concrete Bottom Slab	CY	10	$2,000	$20,000
Replacement of Steel Beams	LF	28	$300	$8,400
Replacement of Railing	LF	30	$210	$6,300
Skimcoat	LSUM	1	$10,000	$10,000
Stop Log Gate*				$20,000
20% Contingency				$29,540
Construction Total				**$177,240**
Bid Documents and Contractor Procurement				$13,000
Construction Management				$19,000
Administration				$5,000
Repair Total				**$214,240**

Table 2: Replacement of Spillway Structure

Item	Unit	Quantity	Unit Price	Amount
Removal of Existing Structure	LSUM	1	$25,000	$25,000
Replacement of Structure	LSUM	1	$160,000	$160,000
Replacement of Railing	LF	63	$210	$13,230
Temporary Shoring and Dewatering	LSUM	1	$30,000	$30,000
Stop Log Gate*				$20,000
20% Contingency				$49,646
Construction Total				**$297,876**
Bid Documents and Contractor Procurement				$35,000
Construction Management				$27,000
Administration				$5,000
Repair Total				**$364,876**

*If Weir Type Gate is preferred instead of Stop Log Gate, add an additional $138,000 to total

Table 3: Repair of Spillway Structure with Gravity Block Retaining Wall

Repair of Spillway Structure	$214,240
Gravity Block Retaining Wall**	$637,798
TOTAL PROJECT PROBABLE COST	**$852,038**

Table 4: Replacement of Spillway Structure with Gravity Block Retaining Wall

Replacement of Spillway Structure	$364,876
Gravity Block Retaining Wall**	$637,798
TOTAL PROJECT PROBABLE COST	**$1,002,674**

**See the March 9, 2017, report for details