March 15, 2013

Mr. Daniel Richardson
Construction and Acquisition
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Bloomington, MN 55437-1458

Dear Mr. Richardson:

Subject: Union Street Dam
Inspection Services
Task 5.1 – Inspection Report
Task Order No. F12PD00574

The following documents the site visit, inspection, and stop log replacement for Union Street Dam in Traverse City, Michigan. The inspection report presents findings of inspection and summary of work completed during inspection. A separate hydraulic analysis report summarizing findings of the dam’s potential for passage by invasive see lamprey is being submitted as part of the Task Order.

Introduction

Union Street Dam is located in downtown Traverse City, Michigan and forms an impoundment of the Boardman River. There is an ongoing environmental restoration project on the Boardman River removing several dams upstream of Union Street Dam. The Union Street Dam will remain as an important sea lamprey control structure. The United States Fish and Wildlife Service (USFWS) is undertaking an inspection and analysis of Union Street Dam to evaluate the dam’s effectiveness as a lamprey control structure.

Lamprey essentially have two potential paths for escapement upstream of Boardman Dam. Upstream passage could be obtained by:

1. Passage through openings larger than 0.5” in the embankment, spillway, or fish passage structures.
2. Passage over stoplogs when the tailwater is less than 18” from the top of stoplogs in the spillway or fish passage structures.

The inspection report evaluates potential Path 1. The hydraulic analysis report evaluates potential Path 2.
Project Description

The Union Street Dam was constructed in 1867 to provide mechanical power for a flour mill. Modifications were made to the dam in 1955 and 1965 to provide improved control of pool levels in Boardman Lake. A fish passage was added to the project in 1987. The current purpose of the dam is to maintain pool level control of Boardman Lake and to provide a barrier to passage of invasive species up the Boardman River.

The Union Street Dam is a 250-foot long embankment dam. The dam contains three water passing structures, a principal spillway, auxiliary spillway, and fish passage. Figure 1 provides a plan view of the dam. (Refer to Photos 1, 2, and 3.)

The principal spillway consists of a concrete inlet structure with five, 10.5-foot wide bays. (Refer to Photo 4.) Each bay contains two 48-inch diameter corrugated metal (CMP) pipe outlets that extend approximately 80 feet through the embankment and exit through a concrete headwall structure located at the downstream toe of the embankment. Each pipe is internally coated with asphalt. A concrete apron extends approximately 24 feet downstream of the headwall structure. The design drawings indicate a sheet pile wall at the downstream end of the apron to protect against scour and undermining of the apron. Each pipe outlet is equipped with a slide gate and actuator at the inlet structure. The actuators can be operated using portable power equipment or manual wheels. Each inlet is protected with sloping steel bar trashracks. Wooden stop logs are placed at the upstream end of each inlet bay to maintain pool levels in Boardman Lake. The principal spillway pipe outlets/gates are numbered 1 through 10, with #1 being the southernmost gate/pipe outlet.

The auxiliary spillway consists of a concrete inlet structure with three stoplog bays (5.6 feet, 6.0 feet, and 6.0 feet wide). Two 48 inch diameter CMP’s extend approximately 130 feet through the embankment and outlet through a headwall into a side channel with concrete protected side slopes, before reentering the main channel of the Boardman River. The inlet structure is equipped with three sets of wooden stop logs used to maintain the pool level in Boardman Lake. Sloping steel bar trashracks are attached to the headwall of the pipe inlet. The inlet pipes are not equipped with closure gates.

The fish passage consists of a 6-foot wide concrete channel. The entrance to the passage is in the auxiliary spillway inlet bay, upstream of the auxiliary spillway stoplogs. The outlet is through a headwall on the south bank of the Boardman River, just downstream of the principal spillway outlets. The fish passage has a series of pools created by steel weir plates, supported by short concrete walls.

The available drawings indicate that the embankment is a homogenous earthfill structure with a maximum height of approximately 21.5 feet (measured from the crest to the principal spillway apron). The embankment has a variable crest width, ranging from 25 feet to 75 feet. Upstream slopes range from 10H:1V to 6H:1V, while downstream slopes range from 5H:1V to 2H:1V. The drawings indicate an upstream sheet pile cutoff extending the entire length of the embankment. The cutoff is shown tying into and extending under the concrete spillway structures. An asphalt concrete pedestrian walking path and associated split rail fence traverses the crest of the dam. A 12-inch diameter cast iron City water main is also supported on the surface of the embankment crest and spans the inlet bay to the auxiliary spillway. Walking paths and fishing platforms are located along the downstream toe of the dam. A canoe/kayak portage path is located along the south abutment of the dam.
The project is accessible via foot, car, or truck from both the north and south abutments. There is a pedestrian bridge over the auxiliary spillway inlet that prevents large equipment access to the main embankment from the south abutment. Large equipment can access the main embankment from the north abutment.

**Site Visit and Inspection**

On July 24, 2012, representatives from the USFWS (Daniel Richardson and Greg Klingler), Stanley Consultants (Bill Holman), and AMI Consulting Engineers (Chad Scott) met at the Union Street Dam to discuss plans for the inspection of the dam structures, as well as the replacement of existing, deteriorated stoplogs located at the intakes for the principal and auxiliary spillways. The above water inspection was completed by Bill Holman. AMI divers completed the underwater inspection using video and voice to document the inspection and maintain communication with Bill Holman and Chad Scott during the entire inspection. The AMI divers also assisted USFWS personnel with the removal and replacement of the stop logs at the principal and auxiliary spillway inlets. The following paragraphs present the results of the above and underwater inspections and stop log replacement efforts and provide recommendations for future work to maintain the integrity of the Union Street Dam for continued use as an invasive species barrier.

The weather at the time of the inspection was partly cloudy and warm. Site photos taken during the inspection and stoplog replacement operations are provided in Attachment 1. A copy of the AMI dive inspection report and DVD are provided in Attachment 2.

The inspection included the following structures that comprise the dam:
- Embankment and abutments.
- Auxiliary spillway.
- Principal spillway.
- Fish passage.

**Embankment and Abutments**

The earthen embankment and abutments are generally in good condition. There is no evidence of significant settlement or lateral movement on the embankment slopes or crest. Cracking or other indications of potential slope instability or movement were not observed. Given the broad crest width relative to the height of the embankment and lack of evidence of movement or instability, stability is not a concern with this earthen structure.

A majority of the embankment and abutments have a good vegetative cover that protects against surface erosion. There were areas under trees and near pedestrian paths where the vegetation cover was absent. These areas could be susceptible to erosion during high runoff events or embankment overtopping. There were minor areas of surface erosion observed in some of the areas lacking vegetative cover, likely due to pedestrian traffic and surface run-off. (Refer to Photos 38 and 39.)

Several trees and bushes were observed on the embankment slopes. Trees and brush should be removed as they create potential hazards for embankment seepage and weakening. Trees and brush also provide an obstacle to the inspection of the embankment surfaces. (Refer to Photo 9.)
Seepage was observed at the downstream toe of the embankment above the principal spillway headwall. Ponded water on the sidewalk as well as staining of the headwall was evidence of continued seepage. (Refer to Photos 10 and 11.) It is likely that seepage passing through the homogeneous earth embankment is being blocked by the downstream principal spillway headwall, causing the seepage to surface above the wall. There was no evidence of soil movement or “piping” at these locations and seepage volumes are small. These areas should continue to be monitored for changes in seepage conditions and consideration should be given to constructing a seepage collection system to safely collect and convey away the seepage. It should be noted that the construction drawings do not indicate weep holes in the headwall or a toe drain system as part of the embankment construction.

There is a sheet pile retaining wall along a portion of the upstream face of the embankment. The sheet pile is in good condition above and below water, with no evidence of significant movement or corrosion. An exception is at the south end of the sheet pile wall, where the wall meets the concrete approach wall of the auxiliary spillway inlet bay. The sheet pile has deflected away from the wall resulting in a 2 inch +/- gap at this location. It appears that a piece of wood has been wedged into this gap to close the opening and limit soil loss from behind the wall. There has been some loss of soil from behind the sheet pile and adjacent concrete wall. (Refer to Photos 5 and 6.) This gap should be permanently sealed to limit future loss of soil and a potential for increased seepage.

There is a 12-inch diameter cast iron water main supported on the surface of the embankment crest. Failure of this pipe would pose a risk to the integrity of the embankment. Release of pressurized water from a broken pipe would lead to erosion of the embankment, potentially resulting in significant damage to the embankment. The pipe does not create an immediate hazard to the dam; however, its relocation should be considered for the long-term safety of the dam. (Refer to Photos 7 and 8.)

Potential passages for invasive species were not observed during the embankment and abutment inspections. The seepage exiting along the toe of the embankment is evidence of water movement through the embankment; however, the small quantity of seepage observed indicates seepage paths much smaller than the 0.5 inch required for invasive species passage.

**Auxiliary Spillway**

The concrete walls for the auxiliary spillway intake bay are in very good condition, with no evidence of significant cracking, erosion, deterioration, tilting, or movement observed. (Refer to Photos 13 and 14.) Some minor cracking was observed in the inlet walls. The diver indicated that the concrete floor of the inlet, where visible, was intact and in good condition. The existing stop logs were in poor condition and not able to be sealed when attempts were made to dewater the intake bay. (Refer to Photo 16.) The diver observed 3 to 4 feet of silt, sand, pebbles, cobbles, and boulders along the upstream face of the stop logs.

The steel bar trashracks were in good condition. (Refer to Photo 15.) The coating system was in fair condition with no significant corrosion of the bars observed. The headwall and inlet to the CMP pipes also appeared to be in good condition with no significant spalling or loss of concrete.

The auxiliary spillway outlet headwall was in good condition with no evidence of tilting, movement, or significant cracking. There was no loss of concrete from around the CMP in the headwall. (Refer to Photo 18.) It appeared the apron was intake below the outlet and scour or erosion did not appear to be a problem. The sloped sidewalls of the outlet channel were in poor condition. Many of the concrete
slabs had shifted or broken, with voids visible behind some wall sections. (Refer to Photos 19, 20, and 21.) This condition could allow the soil behind the walls to continue to erode, with potential failure of the erosion protection system and the banks they protect.

The auxiliary spillway inlet is integral with the embankment; therefore, sliding and overturning stability of the structure is not a concern.

Potential passages (greater than 0.5”) for invasive species may have existed through the deteriorated stoplog system. There were no potential passages observed in or around the concrete portions of the structure.

Principal Spillway

The concrete inlet structures for the principal spillways are generally in good condition with no significant spalling, cracking, or deterioration observed. (Refer to Photos 22 and 23.) The underwater inspection identified exposed aggregate due to surface scour of the cement paste along the base of the inlets. Typically the paste loss appeared on the order of 1/2”, with deeper scour observed along the edges of the base slab and in front of some of the slide gates. Much of the concrete originally cast against the steel angles supporting the steel bar trashracks had been scoured away. However, the angles are anchored into the base and remain securely attached. The depth of the scour observed is not considered to be significant compared to the 12-inch thickness of the base indicated on the construction drawings. The depth of scour should be monitored for future significant change during future inspections.

The diver noted small holes in the concrete near the top of pipe outlet #5 and one hole near the base of pipe outlet #7. No flow was noted through the holes, and the size of the holes is not large enough to impact the integrity of the gate/structure. Small areas of honeycomb were observed at the top right hand side of gate #6 and top right and left hand corners of gate #10. These areas should be monitored for future deterioration.

The slide gates for the 10 outlets were in good condition. Each gate was operated during the inspection and stoplog maintenance work and was observed to operate smoothly. (Refer to Photo 24.) Five of the gates completely sealed upon closing. Five gates (#3, #5, #7, #8, and #10) were observed to have 1/8” to 1/4” gaps at the bottom of the gate when closed. In some cases this may have been the result of sticks or debris stuck in the invert of the gate guide. The diver observed that the bolts attaching the middle gate operator stem guide to the inlet structure had sheared off on five of the gates (#1, #2, #3, #5, and #7). The guide was resting on top of the gate at each of these locations. The gates are able to operate without the middle guide; however, there is increased risk of bending the operating stem without this middle guide in-place. The noted some loose bolts on the #10 gate frame, lower left side.

The diver observed the bottom 4 to 5 feet of the stoplogs to be in poor condition. It appeared these logs may have been original. Years of sedimentation, and rocks of varying size had built up against the upstream face of the stoplogs. (Refer to Photo 29.)

The downstream headwall and pipe outlets are in good condition, with no evidence of movement or tilting. The concrete was observed to be in good condition without significant cracking or spalling. The diver observed small holes in the concrete adjacent to a couple of the pipe outlets; however, these were small and not a concern to the long-term integrity of the structure. The diver found the apron to
be in good condition with no evidence of significant spalling, cracking, settlement, or undermining. Significant scour was not observed along the downstream edge of the apron.

All 10 of the outlet pipes were inspected in 2008. None of the pipes were found to be blocked or out of round. Some delamination/loss of asphaltic coatings was observed. Several internal expansion clamps were found missing. In pipe outlet #10, a 2-foot long gap was observed with sand intruding into the pipe. This was repaired after the inspection with a neoprene seal. Outlet pipe #4 had lost a gasket at a joint near the inlet and a tree root was observed penetrating into the pipe. The pipe outlets at the time of the 2008 inspection were in fair condition. These outlets had exceeded their intended design life, and replacement should be considered as part of long-term maintenance of the dam. A failure of the pipe may lead to erosion of embankment material and significant damage to the embankment structure.

The principal spillway inlets are integral with the embankment, therefore sliding and overturning stability of these structures is not a concern.

Potential passages (greater than 0.5”) for invasive species may have existed through the deteriorated stoplog system. There were no potential passages observed in or around the concrete portions of the structure.

**Fish Passage**

The fish passage is a relatively new structure (1987) and the concrete is in very good to excellent condition. (Refer to Photos 31, 32, 33 and 34.) There was no evidence of movement, significant cracking, or spalling observed. During the underwater inspection, 1/4” to 1/2” gaps were observed between the steel weir plates and the concrete walls they were supported on at three of the passage weirs. (Refer to Photos 35, 36, and 37.) A large hammer was used to better seat the gate; however, some gap remained. These gaps were large enough to serve as potential passage for lamprey. It is recommended that seals be added to the base of the steel weir plates.

The diver observed significant scour in front of and beneath the fish passage outlet. The undermining was measured at 1 foot deep and extending approximately 6 feet back under the slab. This is greater than measured during the 2008 inspection, so the condition may be worsening. It is recommended that the scour/undermining be repaired before settlement and/or cracking of the fish passage outlet occurs.

The fish passage structure is integral with the embankment, therefore sliding and overturning stability of the structure is not a concern.

**Stoplog Replacement**

An excavation contractor, Molon, was retained to assist USFWS personnel and the diver with the removal and replacement of stoplogs for the principal and auxiliary spillway inlet structures. The contractor used a large excavator to lift and replace steel bar trashracks and move sediment, debris, cobbles and boulders away from the upstream face of the existing stoplogs. (Refer to Photos 25 and 26.) The excavator was also used to assist with the placement of site fabricated plywood covers for the auxiliary pipe inlets. (Refer to Photo 17.) Consideration should be given to installing slide gates for the auxiliary spillway outlet pipes to assist with future maintenance and repair operations and provide redundancy should the stoplog system fail.
As the stoplogs were removed, they were inspected. If stoplogs were found to be damage, deteriorated or excessively worn, they were replaced with new, site fabricated timber stoplogs. (Refer to Photos 28, 29, and 30.) In general, the inspection indicated the lower stoplogs were in poor condition, with significant deterioration and wear.

Once removed, the diver used a vacuum and pressurized water jet to clean the inlet structure sills for inspection and placement of the new stoplogs. (Refer to Photo 27.) In general, the sill for the principal spillway stoplogs were found to be in good condition and once cleaned, the new stoplogs placed. The bottom stoplogs for the auxiliary spillway were attached to the inlet invert with three bolts embedded in the concrete. The deteriorated logs were broken and removed from the bolts. The concrete surface was cleaned, the new stoplogs fitted with holes to fit over the bolts remaining in the concrete sill, and installed.

The diver assisted USFWS personnel with the installation of new stoplogs, checking for proper seal as they were installed. The trashracks were replaced when stoplog installation was complete.

**Recommendations**

The above and underwater inspection did not identify potential invasive passages greater than 1/2” through the earthen embankment or concrete structures. However, several areas of potential passages greater than 1/2” were identified in the wood stoplog systems for the principal and auxiliary spillways and within the fish passage. Many of the old, potentially original wood stoplogs had experienced significant erosion and degradation. This had resulted in opening between the stoplogs that may have provided potential passage of lamprey. All of the deteriorated stoplogs were replaced as part of the inspection. The steel weir plates in the fish passage did not seat well on the concrete walls that supported them. Gaps were observed at this interface. Placement of flexible seals along this joint should serve to seal potential passages for lamprey.

In addition to identification of potential invasive species passages through the dam structure, the inspection identified several items that should be addressed as part of short and long-term maintenance to maintain the service life and structural integrity of the dam structures. The following provide recommendations for each structure. Each recommendation is assigned a “measure of need” for resolving the observed deficiency to assist with planning. In terms of scheduling the repairs, the following guideline is suggested:

- Low – long-term maintenance.
- Medium – within five years.
- High – within one year.

**Embankment**

- Remove trees and bushes (high).
- Repair surface erosion and restore missing vegetation (high).
- Move or provide secondary containment for City water main (medium).
- Install toe drainage/seepage collection system behind downstream principal spillway headwall (medium).
- Permanently seal gap between sheet pile wall and auxiliary spillway inlet bay wall (high).
Principal Spillway
- Reinstall middle gate stem guides on Gates #1, #2, #3, #5, and #7 (high).
- Tighten bolts on Gate #10 frame (high).
- Monitor concrete conditions observed adjacent to Gates #5, #6, #7, and #10 (low).
- Replace or line 60-year-old CMP outlets (medium).

Auxiliary Spillway
- Remove debris from base slab between stoplogs and headwall (low).
- Add gates to pipes to allow closure for future maintenance and flow control (low).
- Replace channel bank erosion protection downstream of outlet (medium).

Fish Passage
- Install flexible seals on base of steel weir plates (high).
- Repair scour/undermining at fish passage outlet (high).

Engineers Opinion of Probable Construction Cost (EOPCC)
The EOPCC’s are based on quantities developed from the inspection, available project drawings and attached sketches. An amount of 25% has been included to account for the level of design and unforeseen site conditions. The costs have been separated by task as described previously in this report. A breakdown of these costs is included in Attachment 3.

Please contact me if you have any further questions.

Sincerely,

Stanley Consultants, Inc.

Bill Holman, P.E.
Senior Project Manager

Attachments
FIGURE 1 - PROJECT SITE MAP

UNION STREET DAM

U.S. FISH AND WILDLIFE SERVICE
TRAVERSE CITY, MICHIGAN
ATTACHMENT 1

PHOTOGRAPHS
Photo 1: View of upstream face of dam.  
Note equipment for support of underwater inspection and stop log repairs.

Photo 2: View of upstream face of dam.  
Note principal spillway intake structure (right), sheet pile wall (center) and auxiliary spillway bay (left).
Photo 3: View of downstream face of dam. Note principal spillway (left) and auxiliary spillway (right).

Photo 4: View along upstream face of dam looking north. Note sheet pile wall and principal spillway intake structure.
Photo 5: Gap in sheet pile wall, auxiliary spillway intake wall connection. Notice ground loss behind sheet pile wall.

Photo 6: Ground loss behind concrete wall near connection with upstream sheet pile wall.
Photo 7: View of dam crest looking north. Note water main and paved pedestrian path. Note trees on downstream (left) slope.

Photo 8: View of auxiliary spillway intake bay and dam crest looking north. Note water main and entrance to fish passage.
Photo 9: View of downstream embankment slope. Note trees and bushes on embankment.

Photo 10: View of principal spillway outlets. Note seepage on sidewalk at toe of embankment.
Photo 11: Sidewalk at downstream toe of embankment.
Note seepage.

Photo 12: Diver entering tailrace to inspect principal spillway outlets, apron, and retaining walls.
Photo 13: View of auxiliary spillway intake bay. Note stop log frame and trash racks.

Photo 14: View of south wall of auxiliary spillway intake bay. Note good condition of wall. Note trees on embankment.
Photo 15: Auxiliary spillway trash racks.
Note general good condition.

Photo 16: Auxiliary spillway stop logs.
Note seepage between and around stop logs.
Photo 17: Installing plywood closures over auxiliary spillway inlets to allow underwater inspection and stoplog repair.

Photo 18: Auxiliary Spillway outlet. Note broken concrete along north (left) bank.
Photo 19: Auxiliary Spillway outlet.
Note broken concrete along north (left) and south (right) banks.

Photo 20: Failed auxiliary spillway tailrace wall.
Note voids behind wall.
Photo 21: Failed auxiliary spillway tailrace wall.

Photo 22: View of principal spillway intake structure. Note chain link cover/fall protection.
Photo 23: View of principal spillway intake structure. Note trash racks, removable chain link cover/fall protection and gate actuators.

Photo 24: Closing a principal spillway gate with portable equipment.
Photo 25: Using excavator to move sand, gravel, and cobbles away from principal spillway stop logs.

Photo 26: Using excavator to remove principal spillway trash racks.
Photo 27: Using vacuum equipment and compressed air to clean inverts of principal spillway intakes.

Photo 28: Principal intake stoplogs. Note deterioration and erosion of stoplogs.
Photo 29: Principal intake stop logs. 
Note deterioration and erosion of stop logs.

Photo 30: New lumber for fabricating replacement stop logs for intakes.
Photo 31: View of fish passage looking upstream. Note very good condition of concrete.

Photo 32: View of fish passage looking downstream. Note very good condition of concrete.
Photo 33: Diver installing stop logs at fish passage entrance to allow inspection.

Photo 34: View of fish passage with stop logs in place. Note very good condition of concrete.
Photo 35: Steel fish passage weir plate. 
Note poor seal at base of weir and significant seepage.

Photo 36: Steel fish passage weir plate. 
Note poor seal at base of weir and significant seepage.
Photo 37: Diver inspecting fish passage weirs. Note seepage at base of steel weir plate.

Photo 38: North abutment and downstream embankment slope. Note lack of vegetation cover, trees, and surface erosion from foot traffic.
Photo 39: Upstream portage landing on south abutment. Note lack of vegetation cover and erosion from foot traffic. Note trees and bushes.
ATTACHMENT 2

UNDERWATER INSPECTION
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**Purpose of Inspection**

AMI Consulting Engineers, P.A. (AMI) was contacted by Stanley Consultants to perform an underwater inspection and assist with stop log removal on the two spillways and one fish ladder on the Traverse City Lamprey Barrier, located in Traverse City, Michigan. The purpose of the inspection was to confirm existing construction, determine existing conditions, and determine if voids or gaps of sufficient size to allow for the passage of Lamprey past the barrier are present. An excavator and operator were brought to the site to assist the U.S. Fish and Wildlife construction group in the removal of the stop logs prior to the arrival of the dive team.

**Procedures Used for Inspections**

The AMI Engineering dive team consisted of one professional engineer diver and two additional divers/tenders. Surface supplied diving techniques were utilized during all phases of the inspection process to meet OSHA, US Coast Guard, and Association of Commercial Diving International Standards to ensure proper safety was incorporated at all times. The divers used an underwater helmet mounted video camera to document the existing condition of the dock wall for future review by AMI and Stanley.

The diver performed a Level I underwater inspection of the dam surfaces as directed by Stanley Consultants which included a visual inspection below the waterline looking for any damage, deterioration, or defects to the spillways and fish ladder structures.

**Site Conditions**

The excavator and operator mobilized to the site on July 23, 2012 and began work with the U.S. Fish and Wildlife staff on July 24th, 2012 removing stop logs. The dive team mobilized to the site on July 24th and began work on July 25th, 2012. Upon arrival to the site, the AMI dive team began inspections of the North spillway gates. Immediately upon entering the water, it was apparent that the U.S. Fish and Wildlife construction staff would need assistance in the removal of the stop logs due to excessive years of sedimentation and the presence of rock of varying size in front of the stop logs. The bottom sets of stop logs looked original to the dam and were in poor condition. AMI worked with the construction staff to remove the stop logs on all gates throughout the entire project and utilized the excavator and a jetting and lifting pump to move the material from in front of the gates to prepare the concrete sills to receive the new stop logs and get proper bottom seal. All north spillway and south spillway logs were removed. Additionally the AMI dive team assisted the construction staff in the reinstallation of all stop logs and trash racks, insuring complete and proper seal. After each section of stop logs was removed, the two gates were inspected and any deficiency was noted and recorded. The remainder of this report documents the deficiencies found during the inspection.
North Spillway

General Notes on Gates

All bottom 4 to 5 feet of stop logs appeared very old and possibly never replaced. Bottom levels of stop logs deteriorated. There was 2 to 5 feet of material that has built up in front next to stop logs. Size of material ranged from small pebbles to large 12 to 24 inch stone mixed with a sand/silt material. See Video "General Condition 1".

Upstream concrete bases have minor scour on concrete over flat surfaces. Surfaces look like washed aggregate finish with paste washed away up to 1/2 inch. Some minor areas were present where it appeared it was scoured exceeding this value near the corners next to the gates, but this depressed areas could have also been poured uneven during the original construction. No major concerns of loss or cracks were noted on the concrete. See Video "General Condition 2".

Areas of minor scour were also present around both sides of the trash rack lower seat angle which was imbedded in the concrete during the original construction. It appears some of the concrete on both sides has been scoured from around the angles. Although there was some minor scour present, all angles were still fully attached to the concrete base. See Video "General Condition 2".

The middle stem guide bolts are sheared off on half the gates. Stem guides have fallen to top of gate. See Video "Stem Guide".

The downstream apron and outfall pipes were in good condition with stone and light debris over the entire apron area. See Video "Downstream Apron".

Trash racks were reinstalled on all gates. See Video "Trash Rack".

New stop logs were installed on all gates. See Video "Stop Log Install".

Gate #1
Upstream: Good Condition – Middle stem guide bolts broken and stem guide fallen to top of gate. Stop Logs: Old timbers removed and new timbers replaced successfully. Downstream: Good Condition
Downstream Apron: Good Condition

Gate #2
Upstream: Middle stem guide bolts broken and stem guide fallen to top of gate. Stop Logs: Old timbers removed and new timbers replaced successfully. Downstream: Good Condition Downstream Apron: Good Condition
Gate #3
Upstream: Middle stem guide bolts broken and stem guide fallen to top of gate. Bottom of gate was not sealed fully. A 1/8 to 1/4 inch gap was present and was allowing a minor flow to occur. Stop Logs: Old timbers removed and new timbers replaced successfully. Downstream: Good Condition Downstream Apron: Good Condition

Gate #4
Upstream: Good Condition Stop Logs: Old timbers removed and new timbers replaced successfully. Downstream: Good Condition Downstream Apron: Good Condition

Gate #5
Upstream: Middle stem guide bolts broken and stem guide fallen to top of gate. Bottom right corner of gate was not sealed fully. A 1/8 to 1/4 inch gap was present and was allowing a minor flow to occur. Stop Logs: Old timbers removed and new timbers replaced successfully. Downstream: Good Condition - Two minor small holes in the concrete near the top of the steel pipe. Downstream Apron: Good Condition

Gate #6
Upstream: Good Condition - Small honeycomb area in concrete just above the top right hand side of the gate. Stop Logs: Old timbers removed and new timbers replaced successfully. Downstream: Good Condition Downstream Apron: Good Condition

Gate #7
Upstream: Middle stem guide bolts broken and stem guide fallen to top of gate. Bottom of left side gate tight, 1/8 to 1/4 inch gap in middle, 1/4 inch gap right side allowing flow under gate. Small sticks in gap at bottom of gate present most likely are causing the gap. Stop Logs: Old timbers removed and new timbers replaced successfully. Downstream: Good Condition - One minor small hole near bottom of steel pipe in concrete. Downstream Apron: Good Condition

Gate #8
Upstream: Small amounts of sticks and debris present causing small gap at bottom of gate to remain open. Gap 1/4 inch on left side to 1/2 inch on the right side. Stop Logs: Old timbers removed and new timbers replaced successfully. Downstream: Good Condition Downstream Apron: Good Condition
Gate #9
Upstream: Good condition. Minor concrete scour near bottom right side, just below gate.
Stop Logs: Old timbers removed and new timbers replaced successfully.
Downstream: Good Condition
Downstream Apron: Good Condition

Gate #10
Upstream: Good condition. Minor area of white, soft concrete with some minor honeycombing at the top right and left hand corner above the gate on the concrete.
Steel gate guide bolts loose on the left side near the bottom of the gate. Small leak at bottom of gate as gate not fully sealed. Less than 1/4 inch gap present. Minor concrete scour along bottom just below gate. See Video "Gate 10".
Stop Logs: Old timbers removed and new timbers replaced successfully.
Downstream: Good Condition
Downstream Apron: Good Condition

Fish Passage Inspection
On the day of inspection, four fish passage stop log areas were inspected. No stop logs were in place only the concrete base. Weir plates were directly on concrete in only three places of the fish passage. Three of the weir plates were not seated properly with 1/4 to 1 1/2 inch gaps between the concrete and weir plate allowing water to pass through between. New seals are needed to keep system working properly. See Video "Fish Passage Inspection".

A couple stop logs were found at the very end of the fish ladder before it drains into the lower end of the river. The stop logs were not full seated and purposely appeared to be placed in an elevated position. This section did not match any of our reference drawings. Concrete along the entire fish passage was in good condition with no major defects noted during the time of inspection. Only minor scour of the surface paste on the downstream side below the weir plate was present in a few spots.

Minor Scour was present just below the fish ladder concrete at the end of the fish ladder. Scour was 1 foot deep and extended under the slab back approximately 6 feet.

South Spillway
Removal of three sets of stop logs on the spillway was accomplished after removal of trash racks and stoppage of water through the 4 foot diameter pipes. Removal of 3 to 4 feet of large to small rock, pebbles and silt in front of the stop logs was accomplished first with an excavator. Diver utilized jetting and lifting equipment to finish removal of sedimentation. After removal of all the top stop logs, it was noted the last stop log was attached to the base by three bolts which were cast into the concrete. Diver removed
the final timber and nuts off the bolts and cleaned the cast in seat along the bottom. The new bottom timbers were notched to go over the existing bolts and seated in the bottom and then the remainder of the new stop logs was reinstalled. See Video "Spillway Stop Log". Rocks and minor debris remained in the downstream side of the stop logs and eventually should be cleaned out and removed.

**Recommendations**

After reviewing all of the data and assessing the existing site conditions, AMI Consulting Engineers makes the following recommendations to correct the deficiencies that remained upon our departure date:

**North Spillway:** Reinstall middle stem guides to concrete on those that have sheared off and fallen to top of gates on gates #1, #2, #3, #5, and #7. Tighten bolts on gate guide on left side of gate #10.

**Fish Ladder:** Remove existing steel weirs plates and reinstall with new flexible seals between weir plate and/or lower timber or concrete.

**South Spillway:** Clean debris in area between stop logs, trash racks and culverts. Add steel gates as a way to secure flow through culverts for future maintenance and flow control.

Respectfully Submitted,

Chad W. Scott, P.E.
Principal
## UNION STREET DAM INSPECTION
### PRELIMINARY COST ESTIMATE

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Quantity</th>
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**Estimated Total Cost** $615,800