# Safety Inspection of Union Street Dam

**The City of Traverse**
**City Engineering Office**
**400 Boardman Avenue, 2nd Floor**
**Traverse City, Michigan 49684**

**STS Project No. 200802039**
**September 15, 2008**

**Prepared by:**
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# 1.0 Title Sheet

| | |
|---|---|
| Name of the Dam: | Union Street Dam |
| Inventory Identification Number: | 0511 |
| County: | Grand Traverse |
| Watercourse: | Boardman River |
| Owner/Operator: | City of Traverse<br>Public Services Department<br>625 Woodmere Avenue<br>Traverse City, Michigan 49686 |
| Contact Person: | Mr. Robert E. Cole, P.E.<br>Director of Public Services<br>(231) 922-4910 |
| Hazard Potential Classification: | High |
| Name of Inspectors: | STS<br><br>Michael D. Carpenter, P.E.<br>Richard J. Anderson, P.E. |
| Date of Inspection: | June 17, 2008 |
| Engineer in Charge of Inspection: | Michael D. Carpenter, P.E.<br>Senior Project Engineer<br>STS<br>1050 Wilson Street<br>Marquette, Michigan 49855<br>(906) 226-4963 |

STATE OF MICHIGAN
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# 2.0 Introduction

STS was contracted by the City of Traverse to perform a physical inspection of Union Street Dam. The purposes of this study were to:

- evaluate the current physical condition of the dam,
- identify any deficiencies that, if left uncorrected, could lead to failure of the dam,
- develop recommendations for repair,
- identify required on-going monitoring,
- identify additional field investigations or studies required to bring the dam into compliance with State of Michigan dam safety requirements.

The Union Street Dam (ID No. 0511) is a low-head, high hazard dam located on the Boardman River approximately 1.5 miles upstream of Traverse Bay in Grand Traverse County. The dam is regulated under Part 315, Dam Safety, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (Act 451), Sections 31501 through 31529.

Our scope of work consisted of performing a visual inspection of the dam, a diving inspection of the submerged portion of the upstream and downstream structures, and preparing a report that summarizes our findings, recommendations for repair, and opinions of probable cost for engineering and construction.

All references to “right” and “left” within this report are with respect to looking in the downstream direction.

# 3.0 Conclusions and Recommendations

Overall, the dam is well-maintained and in generally good condition and the structures appear to be stable. However, the spillway capacity and freeboard are in question for the current hazard rating of the dam.

During the diving inspection, a failure of the joint between sections of corrugated metal pipe (CMP) in Outlet Pipe No. 10[1] of the principal spillway was discovered. The CMP joint failure was located approximately 10 feet downstream from the slide gate and was approximately 24 inches long at the invert of the pipe. A small sand boil was observed moving embankment material into the pipe. Left untreated, the boil could progress leading to the development of a sinkhole. The decision was made to keep slide gate No. 10 closed until repairs could be made. Two days later, the diver returned to the site to install a neoprene seal and expansion band over the failed joint. This repair successfully sealed the failed joint.

An approximately 3-inch wide gap was observed between the upstream sheet piling and the upstream, right end of the concrete approach wall to the auxiliary spillway inlet. There was a minor amount of settlement of the ground surface behind this gap, indicating some ground loss has occurred. Although this is not considered a dam-safety concern, the gap should be monitored. If additional ground loss occurs, the gap should be repaired.

No other conditions were observed which were considered an imminent threat to dam safety. However, the following conditions were identified which should be addressed within the timeframes listed:

## 3.1 Immediate (by end of 2008)

The only immediate deficiency identified was the failure of Outlet Pipe No. 10, as noted above, which was repaired immediately following the inspection. No other deficiencies were identified that require immediate attention.

## 3.2 Short-Term (within 1 to 2 years)

1. Construct a properly engineering toe drain just upstream of the principal spillway outlet headwall. The toe drain should be composed of properly-graded granular materials to prevent piping of material into the drain. A slotted PVC collector pipe encased in drainage stone should be used to convey collected water to the spillway tailrace. The use of filter socks or fabric-wrapped stone is not recommended for toe drains. A Toe Drain Concept Sketch is included in Appendix B.

2. Trees and woody vegetation on embankment dams have been demonstrated to pose a threat to long-term integrity, particularly when they die off. As roots decay, they leave passages for seepage and piping to initiate. Under windstorms, uprooted trees can scar the embankment, and intercept the phreatic

[1] Principal spillway CMP pipes are numbered 1 through 10 as viewed from left to right, looking downstream.

surface, leading to progressive slope failure. The trees and woody shrubs located on the upstream slope near the left and right abutments should be removed. In addition, the large trees located on the downstream slope groins on either side of the principal spillway should be removed. In addition to removing the trunks, the roots should be grubbed out and the voids filled with compacted soil. Upon removal of the trees, place additional topsoil, seed and mulch on the downstream slope.

3. Evaluate the project spillway capacity for the 200-year design inflow, which takes into account the capability of removing stoplogs and the head loss due to the trash racks (including some amount of clogging). The modeling should be conducted to include tailwater effects, exit losses, and entrance losses caused by the stoplog weir and trashracks. We also recommend that the top of the dam be surveyed to confirm the elevation of the entire crest length.

4. Update the Operations and Maintenance Plan to include procedures required to operate and maintain the spillway during a flood event.

5. Install a staff gage on the dam to monitor reservoir elevation. The staff gage should be set to National Geodetic Vertical Datum (NGVD 1929).

### 3.3 Long-Term (within 5 years)

1. The principal spillway CMP outlet pipes have reached the end of their design life. The typical design life of CMP outlet pipes for this application is 30 to 50 years. The CMP outlets at Union Street Dam are more than 60 years old. The asphaltic lining has deteriorated and many of the expansion bands are missing and gasket material is being lost. Because the CMP pipes have retained their shape, we recommend that the CMP outlets be slip-lined with either a heat-cured epoxy liner (Insitu-form or equal) or a smooth-lined pipe be installed and grouted into place. The slip-lining system needs to be properly designed so that there is no net loss in principal spillway capacity. Damaged surface concrete at the base of the concrete inlet structures should also be repaired during the slip-lining program.

   Rather than extending the life of the current spillway outlet pipes, consideration should also be given to alternate, passive spillway systems which do not require the use of gates to regulate flows and maintain pool level. These include a labyrinth spillway, chute spillway, or possibly a “natural” spillway system. A natural system involves constructing a series of cascading boulder-lined pools which mimic a natural-flowing stream. A natural system could be designed to be a water recreation park or kayak park. The costs of all these alternate concepts are likely to be significantly higher than maintaining the existing spillway pipes. For any alternate spillway system, consideration must also be given to maintaining the invasive species barrier.

2. The water main on top of the dam consists of old bell-and-spigot tile pipe and sits exposed on the top of the dam. Failure of this pipe would result in pressurized water impinging on erodible embankment soils. Significant damage to the embankment could occur before City crews shut off the water. Although this pipe does not currently represent a significant hazard to dam safety, the City should consider relocating this main, or sleeving it within a protective casing above or below ground.

# 4.0 Project Information

## 4.1 Available References

The following references were provided by the City and were used as a reference for this Project Information section and this report:

1. U.S. Army Corps of Engineers Detroit District and Engineering Consulting and Technology, Inc. (2008) Boardman River Feasibility Study – Preliminary Evaluation of Existing Structures – DRAFT, January.

2. Previous Inspection Reports under the Authority of DEQ Part 315:
    a. September 2005 prepared by James Caughlin, P.E.
    b. August 2002 prepared by James Pawloski, P.E., MDEQ
    c. February 2000 prepared by James Pawloski, P.E., MDEQ
    d. 1996 (not available for review)
    e. December 1991 prepared by James Pawloski, P.E., MDEQ

3. Donahue and Associates (1981) National Dam Safety Inspection Report, May 1981 (not available for review).

4. Kiser-Johnson, Co (2000) Underwater Inspection – Union Street Dam, Principal and Auxiliary Spillway, October 17th.

5. Robert F. Anderson (1996) Underwater Inspection Report – Union Street Dam, December.

6. Letter from Mr. Richard M. Raetz, Gosling Czubak Associates to Mr. Bill Strom, City of Traverse, re. Installation of Piezometers at Union Street Dam, dated May 23, 1986.

7. Grand Traverse County, Boardman River HEC-RAS GIS H&H Report (on CD), dated April 2008.

8. City of Traverse, Union Street Dam, Emergency Action Plan, dated August 22, 2008.

9. City of Traverse, Union Street Dam, Operation and Maintenance Plan, Not Dated.

The above references, with the exception of those cited as “not available,” were reviewed prior to inspection for comparison between current and past conditions. These references were also used to help generate the following project description and historical information, as noted.

No original design calculations or analyses were available for review. No subsurface exploration information was available but a limited number of engineering plans were available from the owner for review. Installation logs from four driven well points installed by Gosling Czubak Associates during May 1985 were available. The well points are no longer in service and are not currently monitored by the City.

## 4.2 Project History and Purpose

Union Street Dam was originally constructed in 1867 to provide mechanical power for a flour mill (no longer present). Modifications were made in 1955 and 1965 to provide better control of the level of Boardman Lake. A fish ladder was constructed in 1987. The dam currently serves to provide lake level control for Boardman Lake and prevents upstream passage of invasive species into the Boardman River. The dam also provides river crossing for a 12-inch diameter cast iron water main which is located on the surface of the dam crest. A City pedestrian walkway traverses the crest of the dam. A walkway and fishing platforms are present along the downstream toe of the dam. The dam site is used for fishing access to the river.

## 4.3 Project Description

The Union Street Dam consists of an approximately 250-foot-long earthen embankment. Within the embankment are two spillways and a fish ladder. Selected project drawings are included in Appendix B.

The right (principal) spillway consists of a concrete overflow section with five, 10.5-foot-wide bays. Each bay is connected to two 48-inch-diameter corrugated metal pipe (CMP) outlets (10 total) that extend 81 feet through the embankment and exit at the downstream toe through a concrete headwall structure. Each pipe is internally coated with asphalt. Expansion-type band clamps are used at some of the joints inside the CMP's. A concrete apron extends approximately 24 feet downstream of the headwall. The spillway apron has a short sheet pile cutoff at the downstream end to protect against undermining. Each outlet pipe has a slide gate at the upstream end with a rising stem operator. City staff uses a portable electric drill to open or close the slide gates. Wooden stoplogs at the upstream end of each of the five bays are used to control the normal water surface in Boardman Lake, which has a surface area of approximately 350 acres. Steel bar trashracks cover the inlet to each bay.

The left (auxiliary) spillway consists of a concrete inlet box 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 into a separate channel which connects to the Boardman River downstream.

A 6-foot-wide concrete fish ladder connects to the inlet structure of the auxiliary spillway and outlets to the Boardman River left of the principal spillway. The fish ladder has a series of weir-controlled steps to provide upstream and downstream fish passage from Boardman Lake to tailwater level in the river.

The embankment dam is a homogeneous earthfill structure with a maximum structural height, as measured from the crest to the top of the spillway apron of 21.5 feet. The height of the dam, as defined by Part 315 for the purpose of establishing required spillway capacity, is the difference in elevation between the design flood elevation to the toe of the streambed at the downstream toe of the dam, is approximately 20.5 feet.

The embankment has a crest width that varies from 25 to 75 feet. The upstream slope varies from approximately 10H:1V to 6H:1V. The downstream slope varies from approximately 5H:1V to 2H:1V. A steel sheet pile cutoff wall extends along the entire upstream edge of the dam from the left abutment to the right abutment and ties to and extends under the principal and auxiliary spillway intake structures.

Although no formal normal water level has been established for Boardman Lake, the reservoir has historically been maintained by the City between elevation 589 and 590 feet. The normal tailwater elevation is 583 feet, which provides a normal hydraulic head difference of 6 to 7 feet. According to the project drawings, the minimum crest elevation ranges from approximately 593 to 594 feet, which provides a freeboard at normal pool of approximately 4 feet.

# 5.0 Field Inspection

Messrs. Michael D. Carpenter, P.E. and Richard J. Anderson, P.E. inspected the Union Street Dam on June 17, 2008. At the time of inspection, the weather was light rain with temperatures in the low 60's. Visible portions of the project were inspected, including the embankment, spillway inlet and outlet structures, spillway gates and operators, retaining walls, and fish ladder. In addition, a dive inspection was performed by Seaview Diving Contractors, Inc. of Seymour, Wisconsin under subcontract to STS. The diver inspected the below-water structures along the upstream and downstream face of the dam, along the downstream end of the spillway apron for signs of signs of scour or undermining, and an internal inspection of the ten primary spillway conduits. Messrs. Timothy Lodge, Robert Cole, and Ken Gregory of the City of Traverse were present during the inspection to answer questions and provide additional information as needed. In addition, City Public Services Department staff assisted with operation of each of the spillway slide gates during inspection. A visual inspection checklist was completed during the inspection and is included in Appendix E. Photographs documenting the condition of the above-water structures are included in Appendix C. A copy of the dive inspection report and DVD are included in Appendix F.

**Embankment**

Overall, the embankment appears to be in good condition. The crest elevation undulates slightly (Photos 1 and 4). There are no visible signs of vertical settlement, lateral movement, or cracking, with the exception of a minor 3 to 4 inch deep dip in the crest just right of outlet pipe No. 10 adjacent to the water main (Photo 5). The settlement appears to be due to surface runoff from the right abutment. A bituminous concrete walkway allows pedestrian access across the embankment. There is also a wooden split rail fence along the downstream side of the walkway (Photos 2 and 3). A city water main extends across the top of the dam. It spans the intake to the auxiliary spillway and rests on the surface of the embankment dam.

A steel sheet pile wall runs along the upstream face of the dam between the right approach wall for the auxiliary spillway and the left wall of the primary spillway inlet structure (Photo 6). The retaining wall continues right of the right wall of the primary spillway inlet structure to the right abutment. The project drawings show the sheet pile wall is continuous under the primary spillway inlet structure and functions as a seepage cutoff wall. The wall is in good condition with no evidence of bowing or tilting. The waler located near the top of the wall tieback is in good condition. The drawings do not indicate the presence of a tieback system. The underwater diving inspection indicated that the condition of the sheet piling below water is very good. A small gap is present between the upstream sheet piling and the upstream, right end of the concrete approach wall to the auxiliary spillway inlet. Photo 21 shows the gap and resulting ground loss at this location.

The upstream slope between the crest and the sheet pile wall is fairly uniform, well-vegetated and exhibits no signs of settlement, sloughing, sliding, or seepage. The downstream slope at the primary spillway is fairly steep, but exhibits no signs of settlement, sloughing, or sliding. The grass cover is fair with the exception of areas under

large trees growing on the slope at the left and right sides (Photos 7 and 8). The downstream embankment slope to the left of the primary spillway up to the auxiliary spillway is much flatter, well-vegetated, and exhibits no signs of settlement, sloughing or sliding. There is minor seepage evident in several locations exiting from the top of the primary spillway outlet headwall (Photo 10). The downstream toe of slope at the contact with the sidewalk is also wet and spongy. Seepage was also observed exiting from the toe of slope between the spillway headwall and the fish ladder above the riprap (Photo 11). There was no evidence of movement of soil out of the slope at any of these seepage locations. Flow quantity at each was estimated to be less than 1 gpm.

Several large trees are growing on the embankment. These include a large cottonwood adjacent to the right abutment (Photo 12), a large pine tree on the downstream slope near the right groin (Photo 7), a large stump and a tree on the downstream slope near the left groin (Photo 8), several trees on the upstream slope at the left (Photo 13) and right side of the embankment, and several smaller ornamental trees on the downstream slope between the fish ladder and the auxiliary spillway (Photo 9).

**Principal Spillway**

The concrete inlet structure for the principal spillway is in good condition. The concrete headwall and piers are in good condition with no signs of cracking or significant surface deterioration. The timber stoplogs are also in good condition. The trash racks are all in good condition. The underwater diving inspection found the below water concrete to be in overall good condition with some minor zebra mussel coverage. Some minor cracking of the concrete was observed, but there was no evidence of concrete spalling, surface deterioration, or undermining below water. All of the gates and hoists were run through their full range of operation and functioned smoothly with no binding (Photo 14).

During the inspection, STS did a dewatered inspection of inlet Bay 2 (to Outlet Pipes 3 and 4) (Photo 15). Some minor loss of concrete was found on the floor of Bay 2. One area was approximately 12” x 18” x 4” deep. The second area was 18” x 24” x 5” deep. The slide gate functioned well with no binding. There was some minor bending noted on the bottom of the gate guides on the sides and bottom. Loss of gasket material was noted inside Outlet Pipe 4 at the first joint approximately 10 feet downstream from the slide gate. Tree root material was also observed penetrating through the gap between the outlet pipe joints at this location.

The interior of all ten outlet pipes was inspected during the dive inspection. All of the conduits were found to be 48 inches in diameter and none were reported to be blocked or out of round. Some minor delamination of the asphaltic coating was observed and several of the internal expansion clamps were found to be missing. In Outlet Pipe No. 10, a 2-foot long gap was observed at the invert of the pipe between joints located approximately 10 feet back from the slide gate. A small sand boil was observed moving fill material into the pipe. Two days later, the diver returned to the site to install a neoprene seal over the failed joint in Pipe No. 10.

The diver also inspected the submerged portion of the headwall at the downstream toe and the spillway apron. Both were found to be in good condition. No undermining or erosion was found downstream of the spillway apron.

**Auxiliary Spillway**

The concrete inlet structure to the auxiliary spillway is in generally good condition. The concrete comprising the side walls, head wall, and left and right approach walls are in good condition with no signs of cracking, displacement or surface deterioration. The trash racks are all in good condition (Photo 16). The underwater diving inspection found the below water concrete to be in overall good condition with some minor zebra mussel coverage. Some minor cracking of the concrete was observed, but there was no evidence of concrete spalling, surface deterioration, or undermining below water. The stoplog piers and stoplogs are in good condition (Photo 17). The headwall at the outlet end downstream is in good condition (Photo 18). The tailrace area shows no signs of scour or undermining. The side slopes are protected by concrete slabs which show some evidence of minor erosion near the ground surface.

**Fish Ladder**

The fish ladder was constructed in 1987 and is in excellent condition. The concrete walls showed no signs of cracking, displacement, or surface deterioration (Photos 19 and 20). During the diving inspection, some undermining below the outlet into Boardman River was reported. The erosion extended approximately 2 feet under the entire width of the fishway.

# 6.0 Structural Stability

No settlement, movement, or cracking was noted in any of the project structures observed which would suggest an issue with stability. The principal and auxiliary spillways are integral with the embankment and as such, are not separate water retaining structures.

Previous slope stability analysis and computed factors of safety versus are not available for the embankment. However, given the very broad crest width as compared to the dam height, and the lack of visible evidence of slope movement, slope stability is not presently considered an issue.

Minor seepage was observed exiting the embankment from several locations along the top of the primary spillway outlet headwall and along the left bank above the riprap between the primary spillway and the fish ladder. There was no evidence of soil movement out of the seeps or loss of ground that would be indicative of piping. Review of the project drawings indicate a homogenous earth embankment with no internal drainage system. In addition, the spillway outlet headwall has no weep holes and the drawings show no indication of free draining backfill. The seepage observed is likely the expression of the phreatic surface exiting the downstream toe of the dam. Without an internal drainage system, the phreatic surface will tend to back up upstream of the spillway headwall, resulting in the seepage observed. It is our opinion that there is no immediate issues with regard to piping or slope stability. However, if left untreated, seepage can increase over time leading to piping of material from the embankment. We recommend that a toe drain system be installed to intercept and lower the phreatic surface that is being backed up upstream of the headwall. This recommendation has been made in past inspection reports.

# 7.0 Hydrology and Hydraulics

## 7.1 Hydrology

For a high hazard dam less than 40 feet in height, as measured from the 200-year design flood elevation to the lowest downstream toe elevation, the State of Michigan requires a total spillway capacity capable of passing the 200-year flood, or the flood of record, whichever is greater. The Hydrologic Studies Unit of the Michigan Department of Environmental Quality (MDEQ) estimates the drainage area to be 283 square miles and has estimated various discharge frequencies for the Union Street Dam, which are summarized in Table 7.1. A copy of the Request Record from the MDEQ containing estimated design flood flows is included in Appendix D. Discharge frequencies were also provided in the U.S. Army Corps of Engineers (USACE) HEC-RAS model and in the 2005 Safety Inspection Report. These values are also included in Table 7.1

**Table 7.1 - Summary of Discharge Frequencies**

| Discharge Frequency | 2008 MDEQ Flow (cfs) | Army Corps of Engineers Flow (cfs) (ref. 7) | 1981 Donahue Report Flow (cfs) (ref. 2a) |
|---|---|---|---|
| 10 year return | 1,200 | 1,300 | |
| 50 year return | 1,700 | 1,600 | |
| 100 year return | 1,800 | 1,800 | |
| 200 year return | 2,000 | 1,900 | 2,000 |
| 500 year return | 2,400 | 2,100 | |

## 7.2 Hydraulics

Discharge rating tables or curves were unavailable for this inspection. However, some spillway rating data is included within the 2008 USACE HEC-RAS model and within previous inspection reports. In addition, the Federal Emergency Management Agency (FEMA) map of the dam site is available and is included in Appendix D. Table 7.2 summarizes the available spillway rating data for the Union Street Dam.

**Table 7.2 - Spillway Rating Table**

| Reference | Reservoir Elevation (ft, NGVD) | Spillway Flow (cfs) |
|---|---|---|
| 2008 USACE HEC-RAS Model | 592.5 | 2,100 |
| 2008 USACE HEC-RAS Model | 591.5 | 1,900 |
| 2008 USACE HEC-RAS Model | 591.1 | 1,800 |
| 1981 Donahue & Associates Report | Unknown elev. (1-foot of freeboard) | 2,000 |
| 1991 Safety Inspection Report | Unknown elev. (zero freeboard) | 2,200 |
| FEMA Flood Map | 592 | 1,800* |

* - FEMA uses a 100-year flood flow to estimate inundation limits – this value was assumed using the value presented in Table 7.1

Note that the USACE model assumes that all the stop logs have been removed to accommodate the flood scenarios. Also, since the 1981 Donahue & Associates report was unavailable, the operational assumptions related to the stop logs is unknown. Because of the unknowns associated with reservoir pool versus spillway flows, the adequacy of the project freeboard cannot be assessed with the information available. Furthermore, the spillway rating curve under various stoplog removal scenarios (ranging from left in place, to partial removal, to full removal), is currently unknown. We recommend that spillway capacity during flood conditions be evaluated taking into account various scenarios of stoplog removal, potential trashrack clogging and head loss. We also recommend that the top of the dam be surveyed to confirm the elevation of the entire crest length.

# 8.0 Operation and Maintenance

Operation and maintenance of the dam is the responsibility of the Department of Public Services, City of Traverse. Routine observations are made on a weekly basis by City Public Services staff. A written operation and maintenance (O&M) plan exists and was reviewed as part of this inspection.

The O&M plan contains adequate information regarding the maintenance of the dam and appurtenant structures. However, the plan does not adequately address the operation of the dam under flood conditions. We recommend adding the following operational items to the plan:

- Identify the staffing needs required to be on-site during flood events
- Define what constitutes a flood event (currently defined as a rain event of 1 inch or more)
- Develop procedures to safely remove the stoplogs during a flood event
- Provide procedures to keep the trash racks clean during a flood event
- Install a staff gage to judge the effect of floods on reservoir elevation

# 9.0 Emergency Action Plan

The City has an Emergency Action Plan (EAP) for the project and STS reviewed the EAP as part of the inspection. The EAP was found to be complete and appropriate for the Union Street Dam.

# 10.0 Cost Estimates

Concept-level opinions of probable cost for the recommendations provided in Section 3.0 are summarized in the table below.

**Table 10.1 - Concept-level Opinions of Probable Cost**

| Recommendation | Estimated Cost | Comments |
|---|---|---|
| **Immediate (by end of 2008)** | | |
| Repair CMP No. 10 leak | $1,500 to $2.000 | Repaired during inspection |
| **Short Term (next 1 to 2 years)** | | |
| Toe drain installation | $50,000 to $80,000 | Includes design, construction engineering, and construction |
| Remove Trees | None | No materials. Labor provided by Parks department staff |
| Develop spillway rating curve, evaluate freeboard adequacy, and stoplog operational requirements | $10,000 to $15,000 | Does not include design or construction of new stoplog handling system, if required |
| Update O&M Plan | None | To be completed by City staff |
| Install staff gage | <$500 | Installed by City staff |
| **Long Term (within 5 years)** | | |
| Reline spillway CMP outlets | $300,000 to $400,000 | Includes engineering and construction |
| New chute or labyrinth spillway | $1,000,000 to $1,500,000 | Including design, construction engineering, and construction |
| Relocation of water main | $50,000 to $100,000 | To be completed by City staff |

These opinions are based upon 2008 unit costs for similar projects and engineering judgment based on experience with similar projects. They are not based on any actual designs, engineering analysis, quantity calculations, or contractor bids. Actual costs will vary based on design, permit conditions, contractor's perceived risk, site access, weather, and market conditions. No warranty concerning the accuracy of these costs are expressed or implied.

# Appendices

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Appendix B – Project Drawings:

Toe Drain Concept Sketch

1986 Fish Passage Design Drawings (2)

1965 Auxiliary Spillway Reconstruction Drawings (3)

1955 Armco Gate Details

1955 Primary Spillway Design Drawings (4)

1931 Old Mill Substructure and Flume Drawings (2)

Appendix C – Photographs (21)

Appendix D – Hydrological Data

MDEQ Flood Discharge Request Record

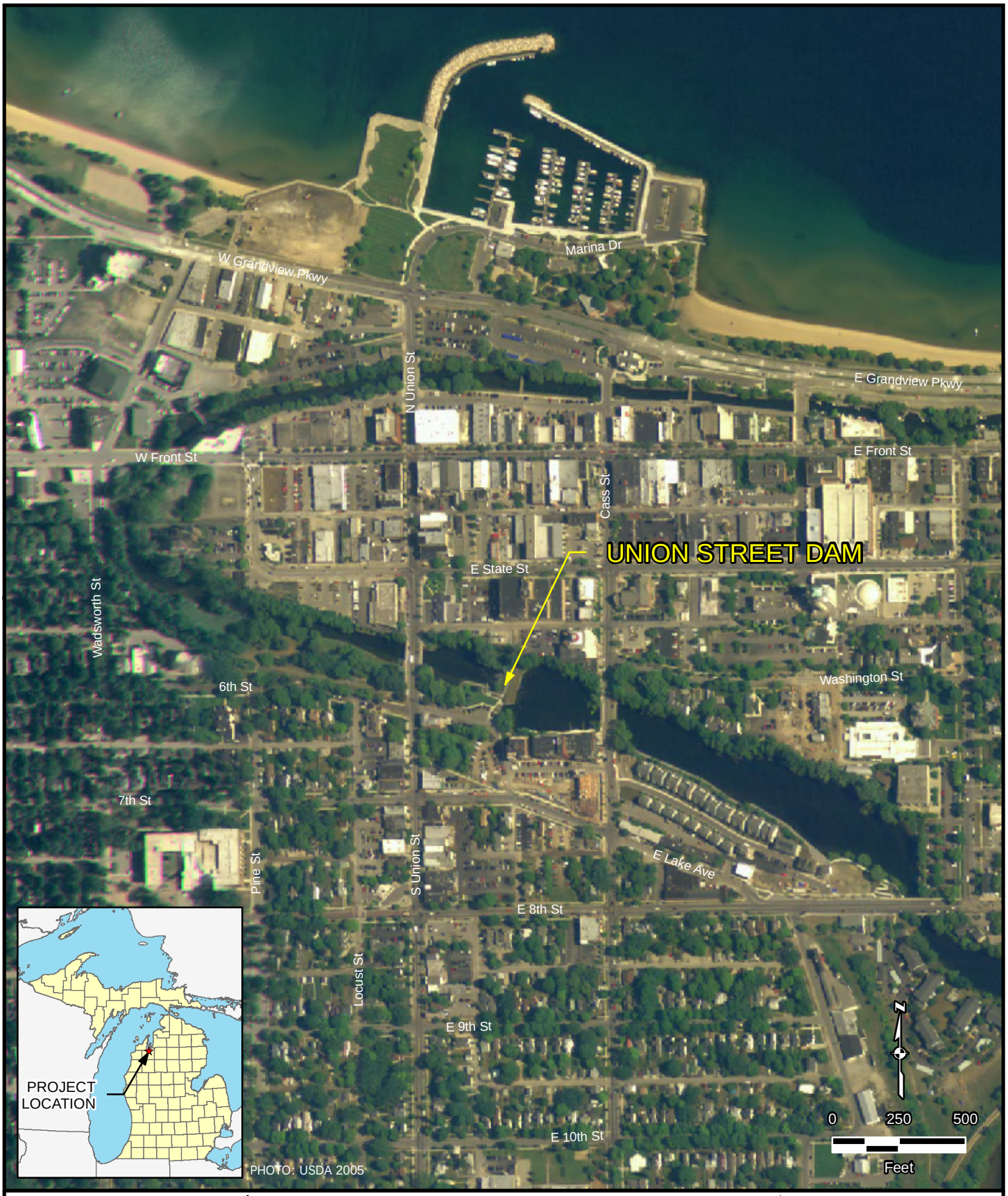
FEMA Flood Map

Appendix E – Dam Inspection Checklist

Appendix F – Diving Inspection Report and DVD

# Appendix A

Project Location Map

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SITE LOCATION MAP
UNION STREET DAM
TRAVERSE CITY, MICHIGAN

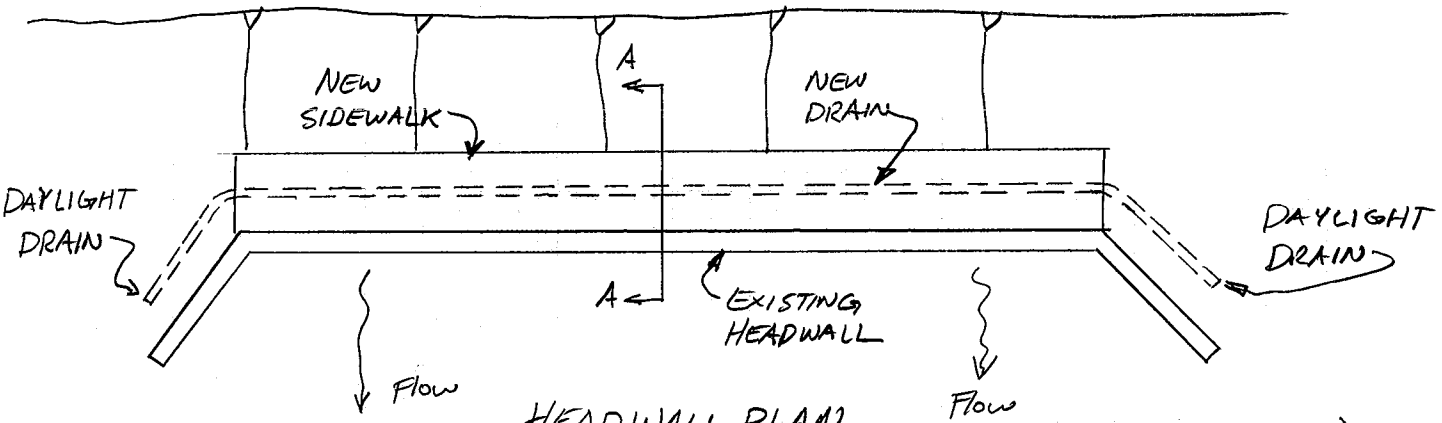
| | | |
|---|---|---|
| Drawn: | SJE | 7/28/2008 |
| Approved: | MDC | 7/28/2008 |
| Scale: | AS SHOWN | |
| PROJECT NUMBER | 200802039 | |
| FIGURE NUMBER | 1 | |

# Appendix B

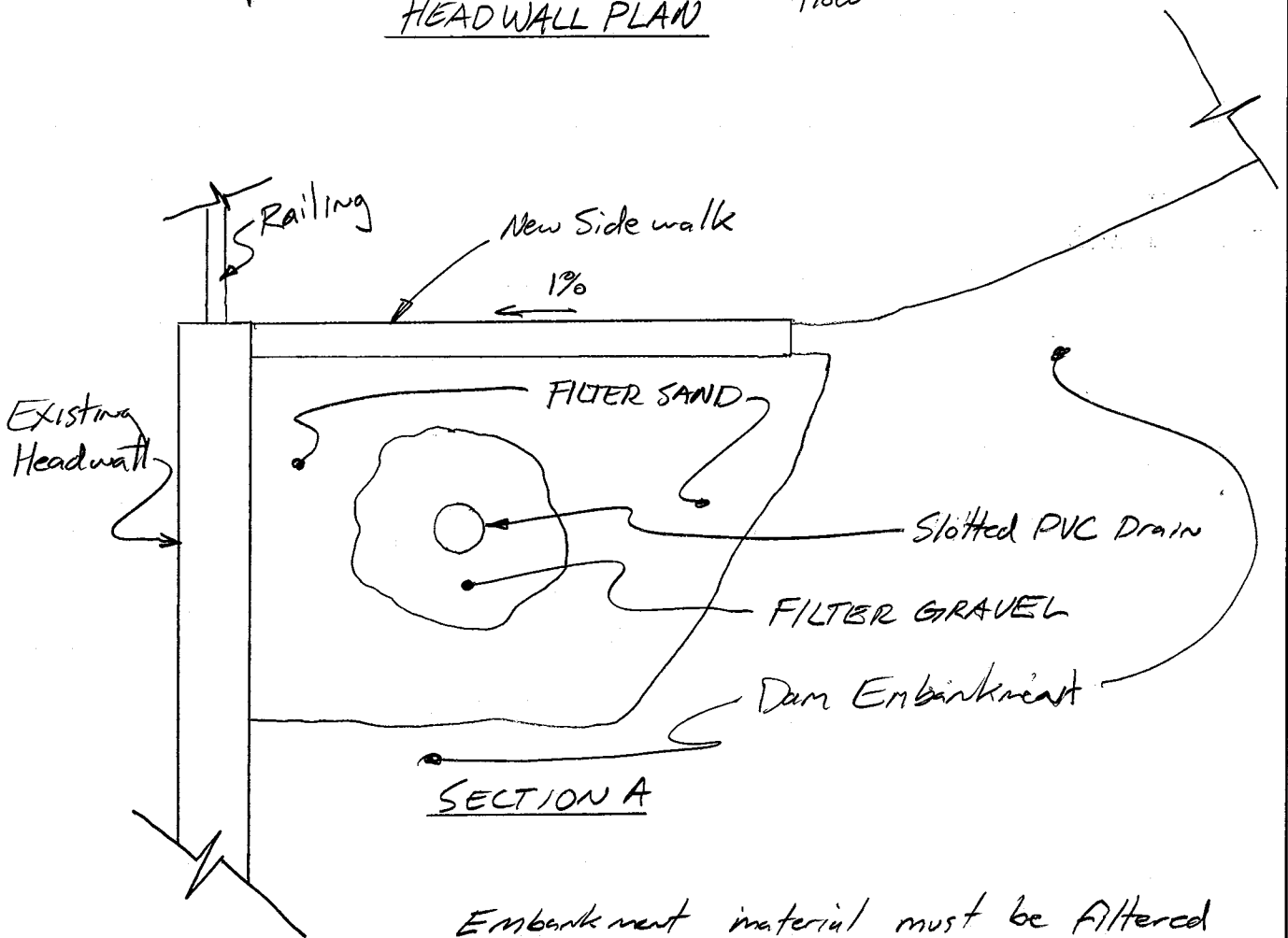
Project Drawings:

- Toe Drain Concept Sketch
- 1986 Fish Passage Design Drawings (2)
- 1965 Auxiliary Spillway Reconstruction Drawings (3)
- 1955 Armco Gate Details
- 1955 Primary Spillway Design Drawings (4)
- 1931 Old Mill Substructure and Flume Drawings (2)

| STS Consultants Ltd. CALCULATION SHEET | PROJECT: Union Street Dam | | | | STS JOB NO. 200802039 | |
|---|---|---|---|---|---|---|
| | SUBJECT: Toe Drain Concept Sketch | | | | SHEET NO. 1 OF 1 | |
| | ORIGINATED BY: MDC | DATE: 7/25/08 | CHECKED BY: | DATE: | CALC. NO. | REV. NO. |

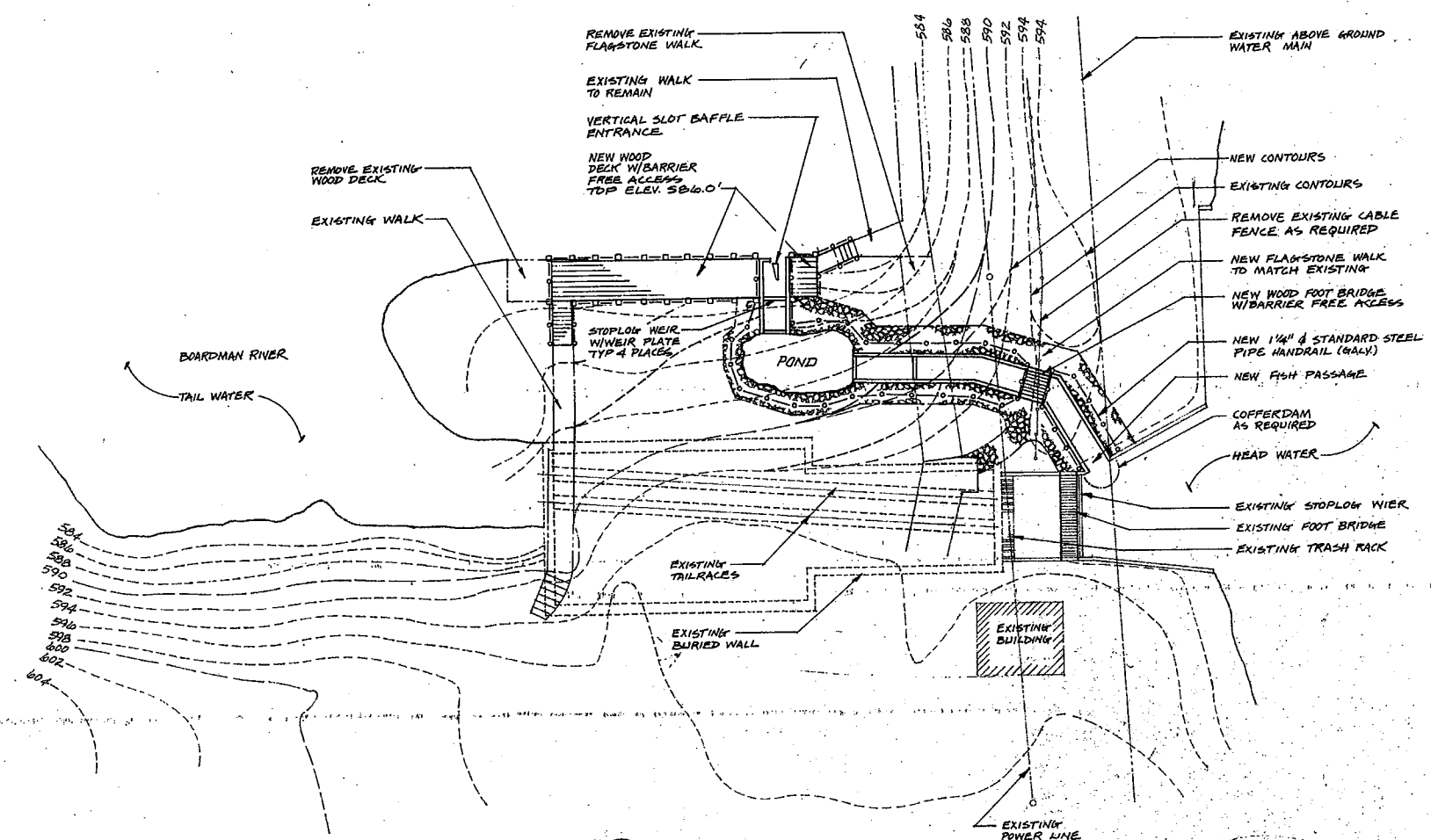



HEADWALL PLAN

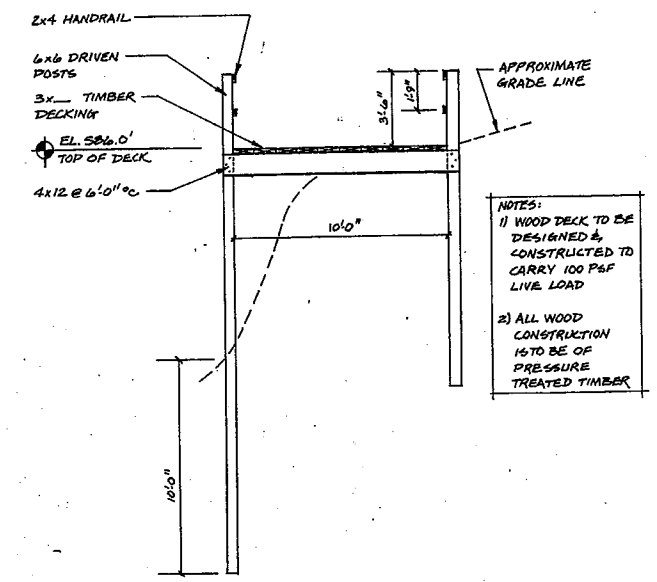



SECTION A

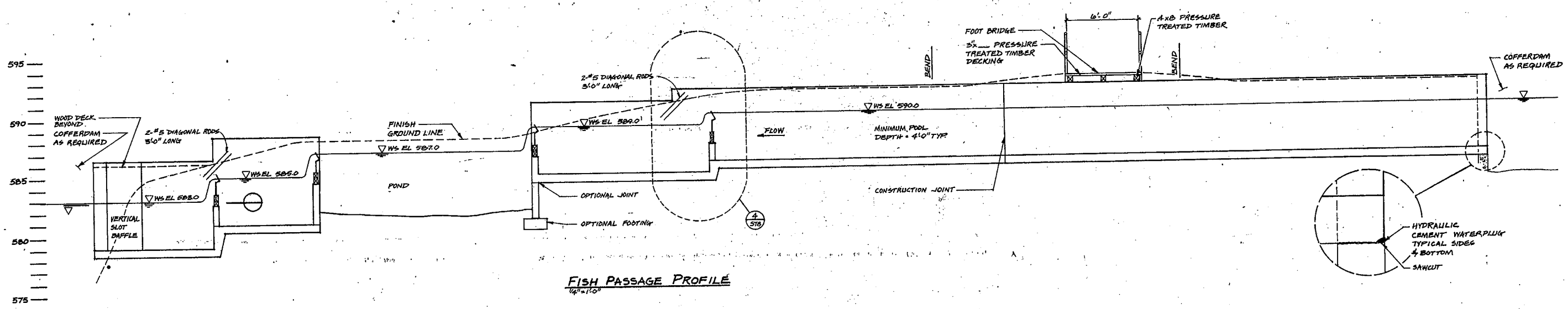
Embankment material must be filtered by Filter Sand, Filter Sand must be filtered by Filter Gravel, & Filter Gravel must be filtered by the screened/slotted PVC drain.




SITE PLAN
1" = 20'-0"




TYPICAL SECTION - WOOD DECK
¼" = 1'-0"




FISH PASSAGE PROFILE
¼" = 1'-0"

| | | | | | |
|---|---|---|---|---|---|
| JOB NO. T3-86B | ▲ - DENOTES SCREENED 30% | | | | DRWG. NO. |
| SCREEN | ▲ | | | | ST7 |
| AUDIT | TBS | CSE | CSN | | |
| OVERLAY | TBS | CSE | CSN | | |

TRAVERSE CITY, MICHIGAN
UNION STREET DAM FISH PASSAGE

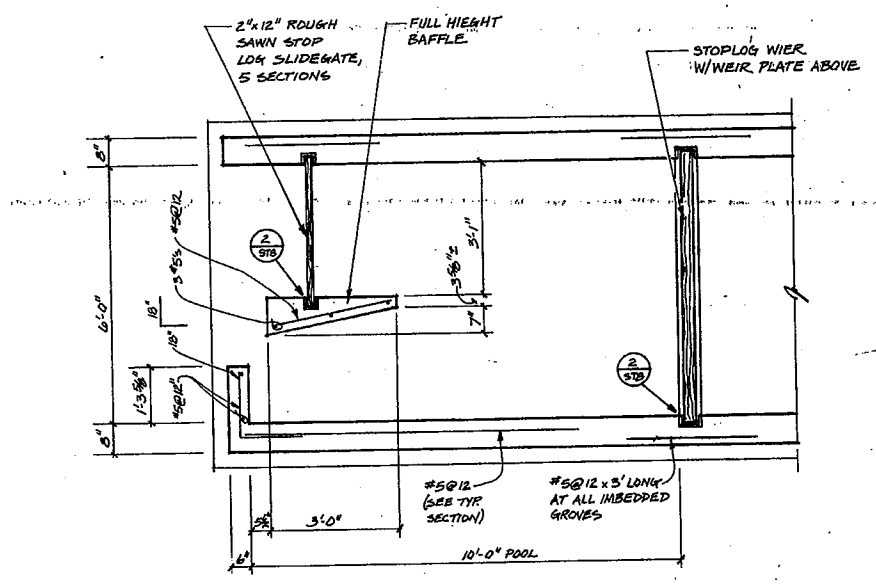
PLANS AND PROFILE

SCALE: AS NOTED
DATE: SEPT. 1986

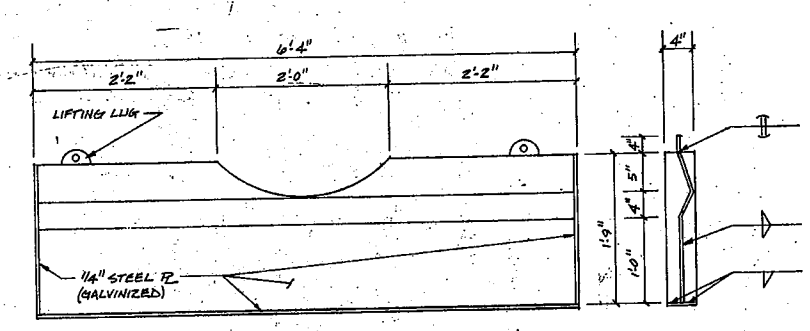
DESIGNED
DRAWN DGM
TRACED
CHECKED
APPROVED TLH

MEAD AND HUNT, INC.
CONSULTING ENGINEERS
MADISON, WISCONSIN

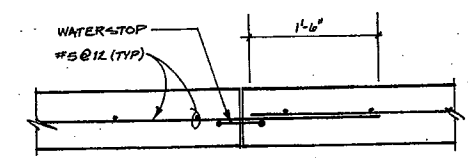
A7567-ST7
JOB NO. T3-86B



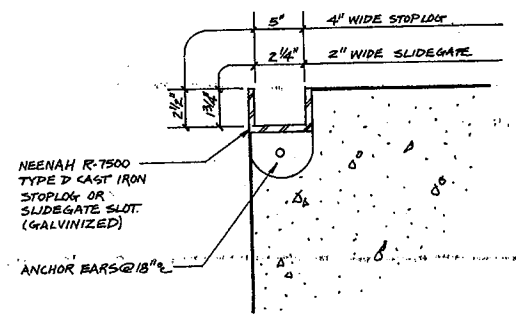

1 / ST7 VERTICAL SLOT WEIR
1/2" = 1'-0"



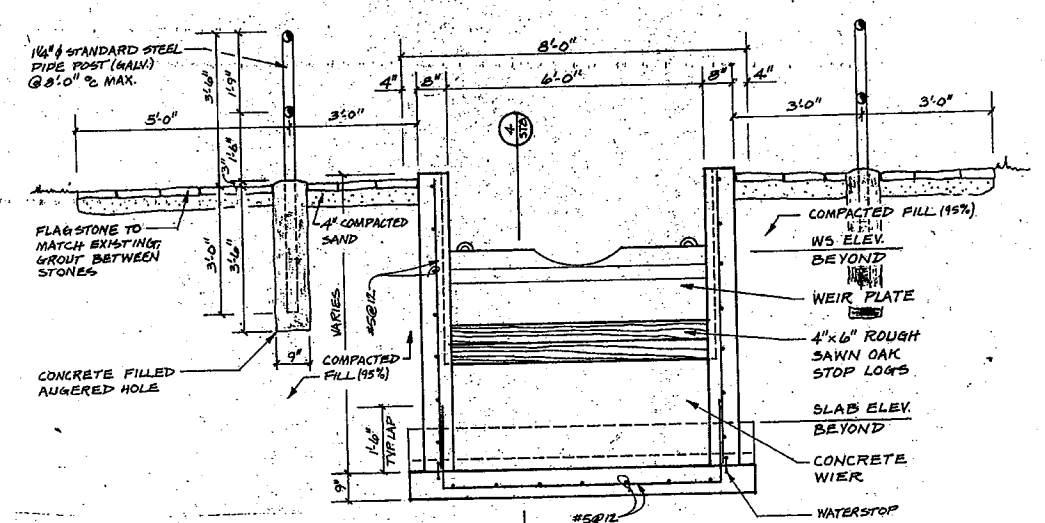

TYPICAL WIER PLATE DETAIL
1" = 1'-0"



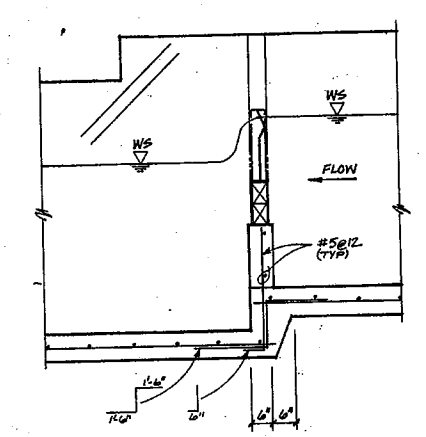

TYPICAL WALL & SLAB CONSTRUCTION JOINT
NO SCALE




2 / ST8 STOPLOG & SLIDEGATE SLOT DETAIL
NO SCALE




3 / ST7 TYPICAL SECTION
1 1/2" = 1'-0"




4 / ST8 SECTION
1 1/2" = 1'-0"

▲ - DENOTES SCREENED 30%

| JOB NO | T3-865 | | |
|---|---|---|---|
| SCREEN | TBS | PSI | PSI |
| AUDIT | TBS | PSI | PSI |
| OVERLAY | TBS | PSI | PSI |

DRWG NO -

TRAVERSE CITY, MICHIGAN
UNION STREET DAM FISH PASSAGE

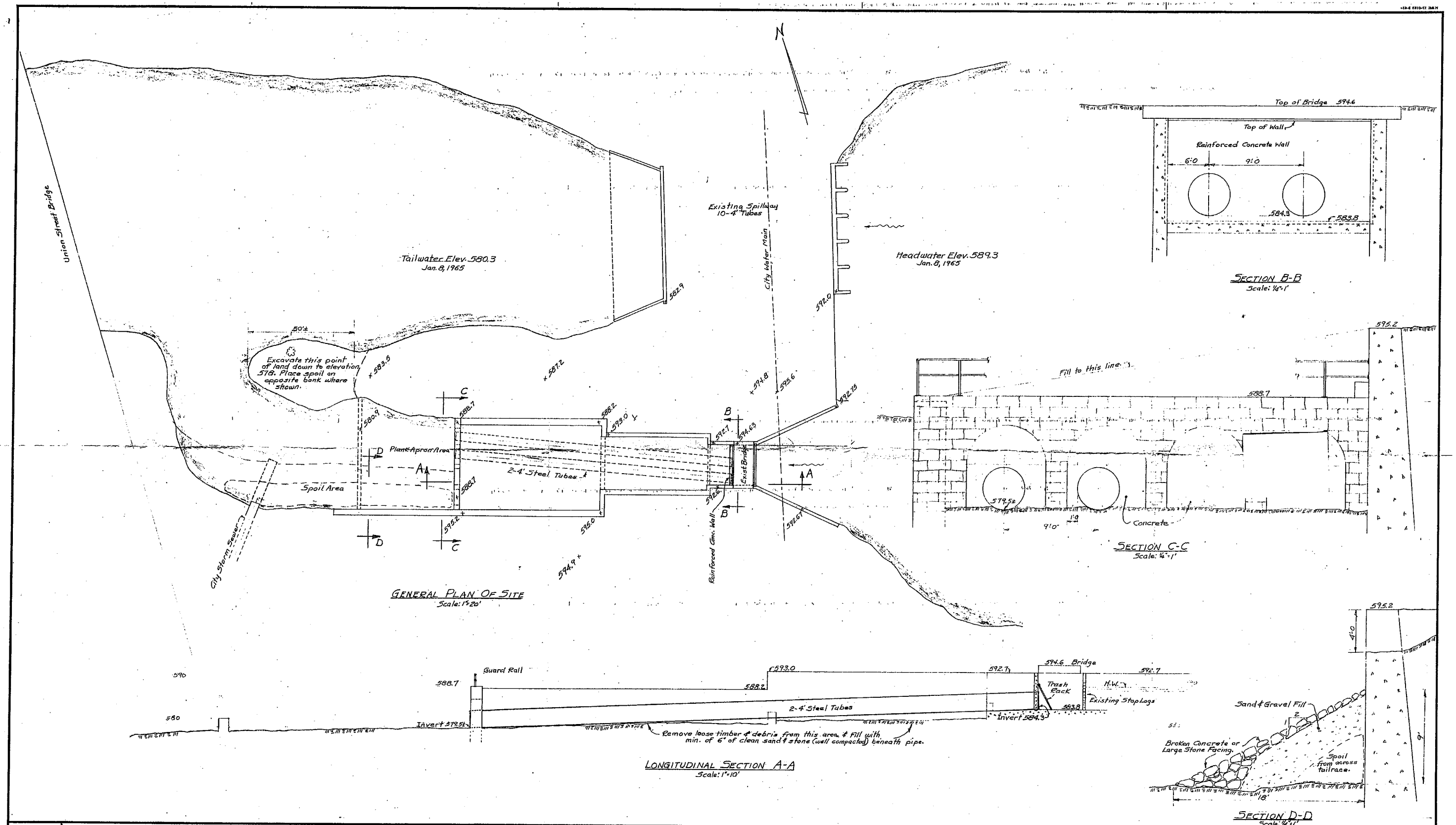
DETAILS

SCALE: AS NOTED
DATE: SEPT. 1986

DESIGNED TLK
DRAWN DGM
TRACED
CHECKED
APPROVED TLH

MEAD AND HUNT, INC.
CONSULTING ENGINEERS
MADISON, WISCONSIN

A7567-ST8
JOB NO T3-865



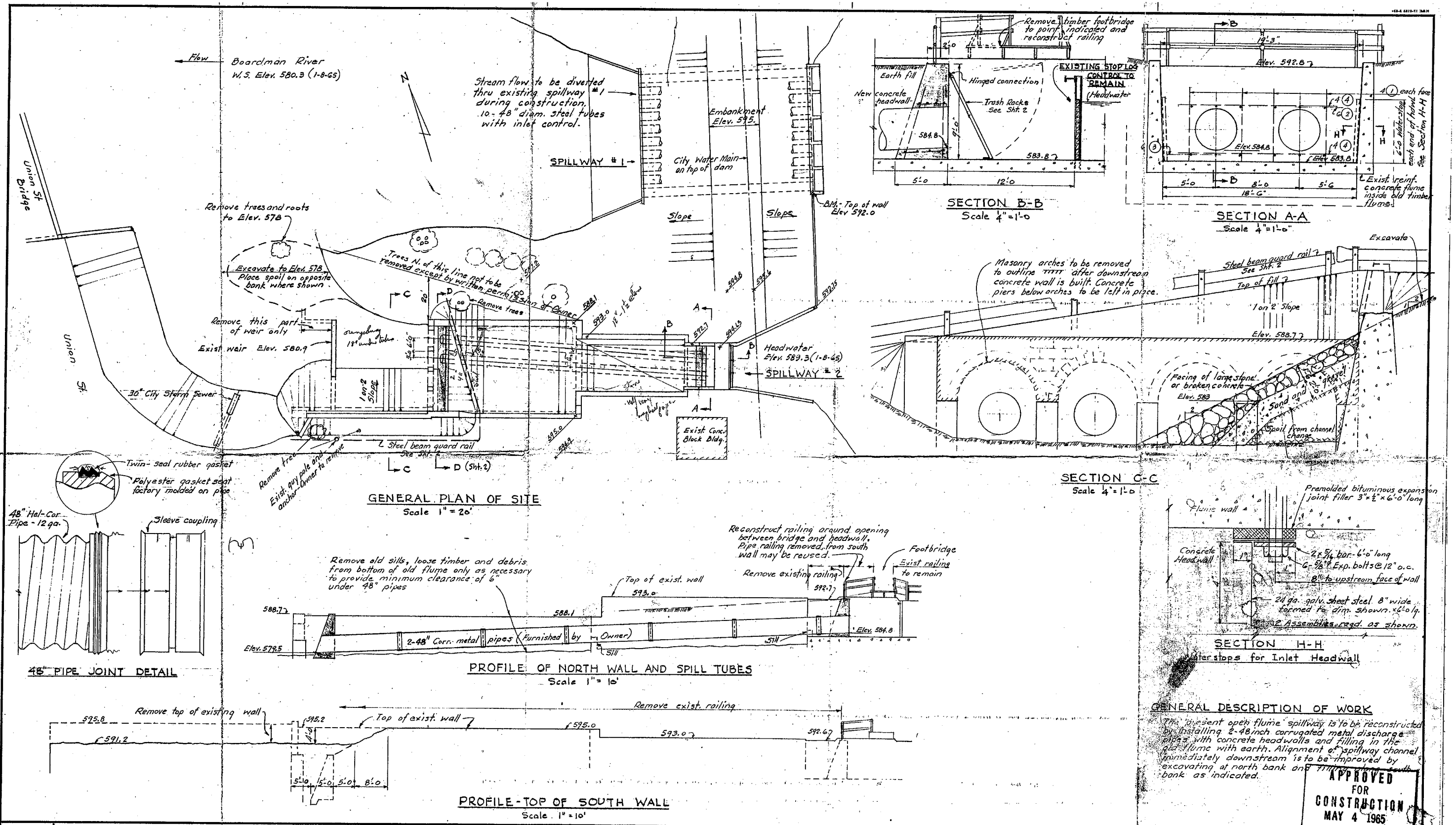

| DRAWING NO. | REFERENCE DRAWINGS | REV. | DATE | DESCRIPTION | BY | APP. |
|---|---|---|---|---|---|---|

DR. W. D. Potter DATE 1-20-65
OK. SECTION HEAD
APP. DIVISION HEAD
APP. DEPARTMENT HEAD
APP.

**CONSUMERS POWER CO.**
ELECTRIC AND GENERAL ENGINEERING DEPARTMENT
JACKSON, MICHIGAN

RECONSTRUCTION OF SPILLWAY
UNION STREET DAM
TRAVERSE CITY, MICH.

SCALE As Shown
JOB 188-277-8
DRAWING NO. M3049-F104
SHEET
REV.




## GENERAL DESCRIPTION OF WORK

The present open flume spillway is to be reconstructed by installing 2-48 inch corrugated metal discharge pipes with concrete headwalls and filling in the old flume with earth. Alignment of spillway channel immediately downstream is to be improved by excavating at north bank and filling along south bank as indicated.

APPROVED FOR CONSTRUCTION MAY 4 1965

| DRAWING NO. | REFERENCE DRAWINGS | REV. | DATE | DESCRIPTION | BY | APP. |
|---|---|---|---|---|---|---|

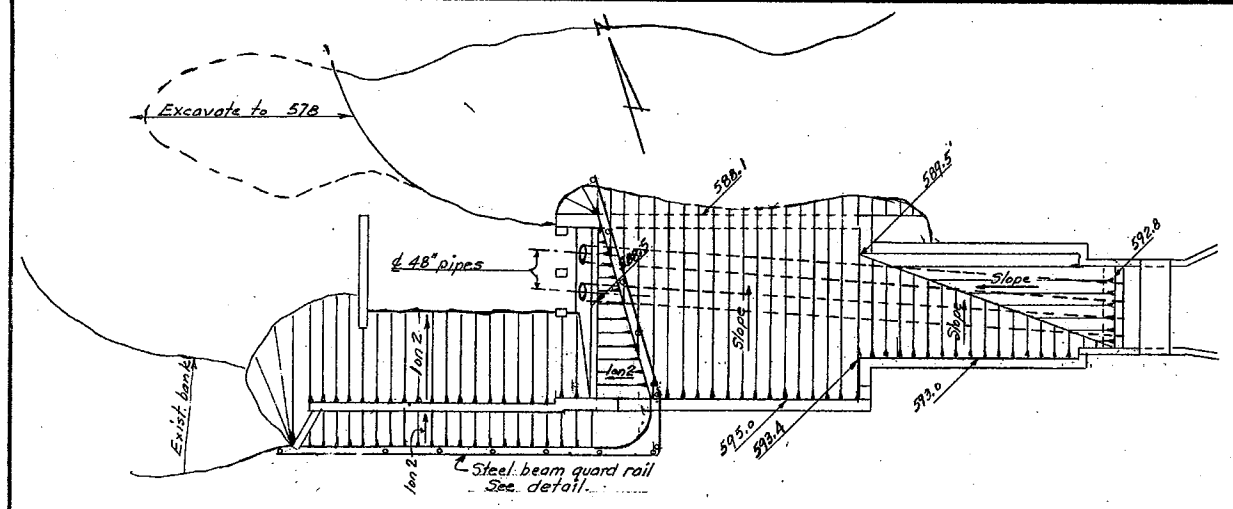
DR. R.E.E. DATE 4-19-65
CK. W.D.P. 4-29-65
SECTION HEAD
APP.
DIVISION HEAD
APP. W.S. Harvey 5/3/65
DEPARTMENT HEAD
APP. M.W. Belfour 5/3/65

**CONSUMERS POWER CO.**
ELECTRIC AND GENERAL ENGINEERING DEPARTMENT
JACKSON, MICHIGAN

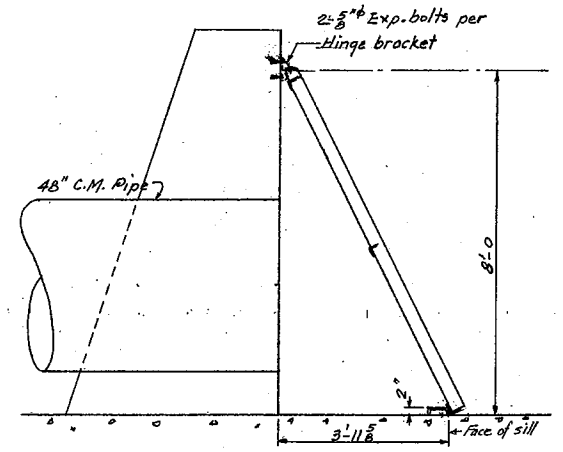
UNION STREET DAM
TRAVERSE CITY MICHIGAN
RECONSTRUCTION OF SPILLWAY #2

SCALE As Shown
JOB 188.277-8
DRAWING NO. M3049-F105
SHEET 1
REV.

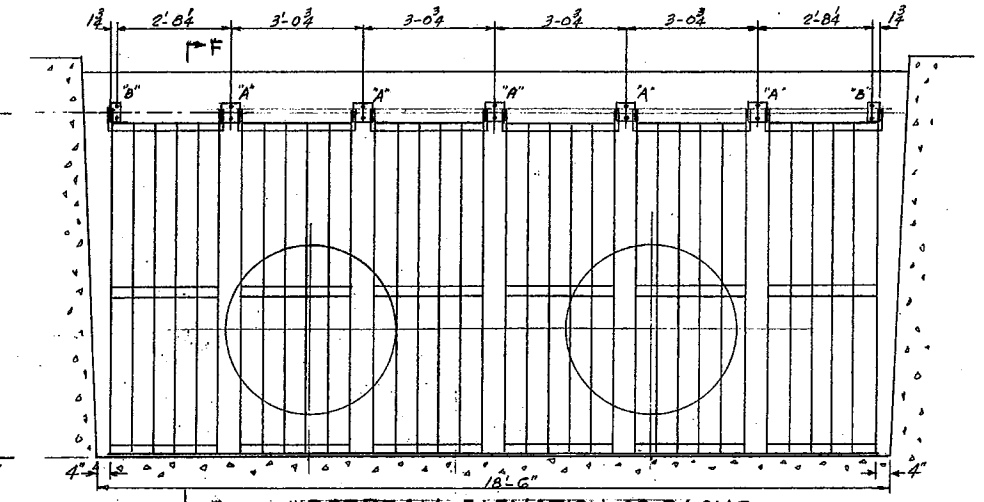
DWG. NO. M.3049-F105 Sh. 2



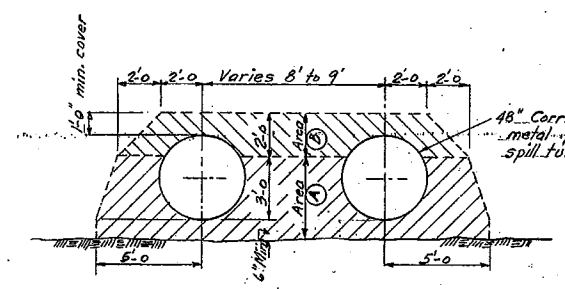

GRADING PLAN
Scale 1" = 20'




SECTION F-F




UPSTREAM ELEVATION OF RACKS
Scale 1/2" = 1'-0




BACKFILL SPECIFICATIONS

See Sketch Above

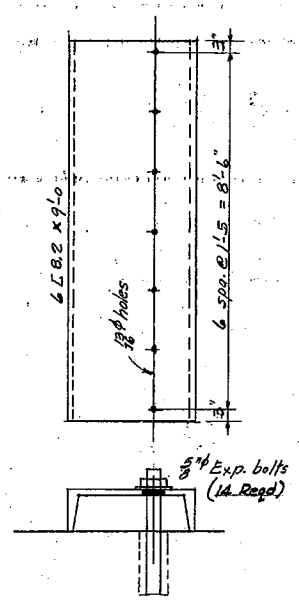
Area (A) - Backfill shall be sand or gravel containing not more than 10% silt and clay, free from stones or lumps larger than 3", cinders and appreciable amounts of organic material. Backfill shall be placed in 6" layers kept at same level on both sides of pipe. Each layer shall be thoroughly compacted using approved power tampers or heavy hand equipment, before placing next layer.

Area (B) - Material same as specified for Area (A). Placing in layers and tamping will not be required.

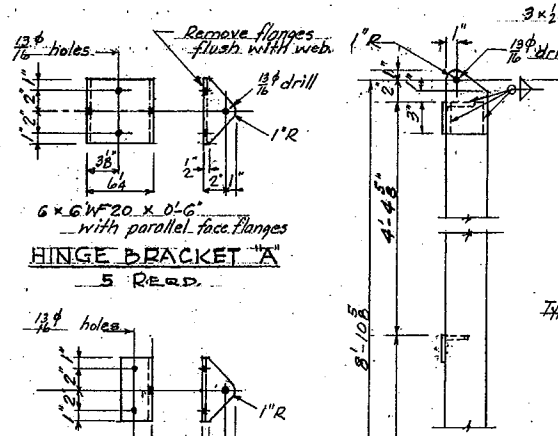
Other Areas - Fill shall be sound material such as sand, gravel or clay containing not more than 20% silt or 5% organic material. (Material may contain rock and broken concrete or masonry if distributed so as to eliminate voids in fill. Fill shall be spread in 12" layers by bulldozing and compacted by normal movement of equipment, leaving no uncompacted areas.

Fill shall be finished to smooth uniform slopes and to the elevations shown on Grading Plan.

Pipes shall be laid to a uniform grade and alignment on a 6" (minimum) layer of compacted material as specified for Area (A).

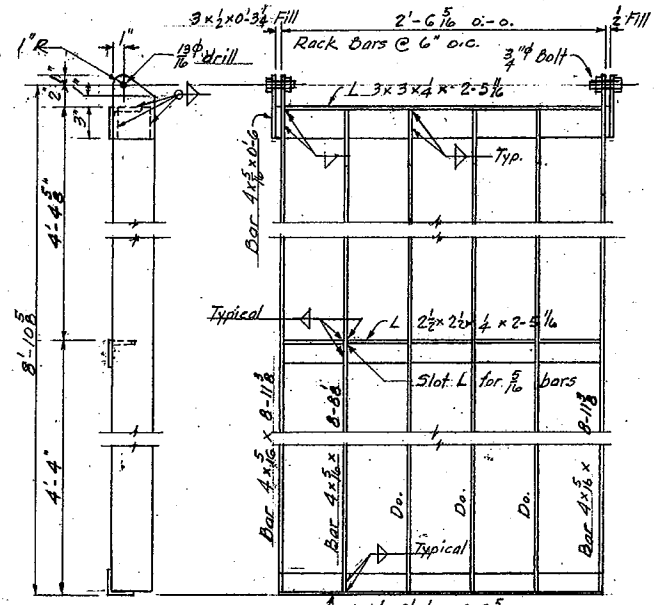



RACK SILL
2 REQD.




HINGE BRACKET "A"
5 REQD.

HINGE BRACKET "B"
2 REQD.



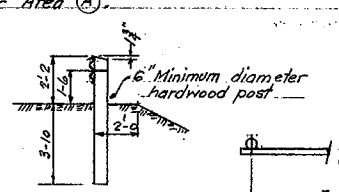

RACK SECTION
6 REQD.

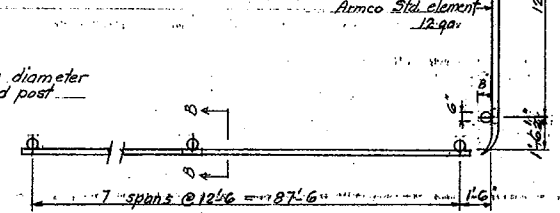
REINFORCING BAR LIST

| ITEM | SIZE | LENGTH | NO. REQD | WEIGHT | REMARKS |
|---|---|---|---|---|---|
| 1 | 6 | 7'-0 | 16 | 170 | Straight |
| 2 | 6 | 2'-9 | 12 | 50 | " |
| 3 | 6 | 4'-0 | 12 | 70 | " |
| 4 | 6 | 16'-0 | 16 | 390 | " |
| Total | | | | 680 | |

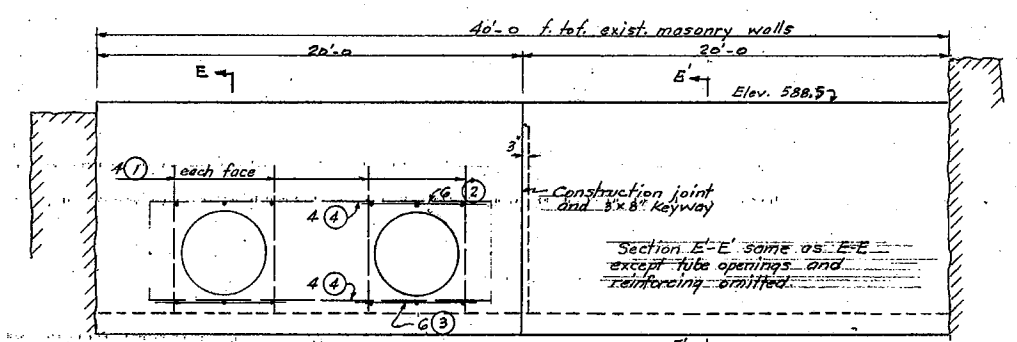
BILL OF MATERIALS

| QUANT. | DESCRIPTION | FURN. BY |
|---|---|---|
| 14 pcs | 48" Armco Hel-Con Pipe 12 ga. - 20' long 10 Pcs. with gasket seat both ends 4 Pcs. with gasket seat one end. | Owner (Delivered to site) |
| 24 pcs. | Armco Twin-Seal Rubber Gasket 48" | |
| 12 pcs. | Armco Sleeve Cplg. for 48" pipe | |
| 680 Lbs. | Reinforcing Steel | Contractor |
| 65 CY | 3000# Concrete - | Contractor |
| 450 CY | Sand - gravel fill | Contractor |
| 1900 CY | Earth fill | |
| 120 CY | Rip - rap | |
| 2050 Lbs. | Steel Trash Racks. | Contractor |
| 155 Lin. Ft. | Steel Beam Guard Rail - Armco. | Contractor |
| 15 Pcs. | 6" Min. diam. x 6' Guard Rail Post Oak or other approved hardwood | Contractor |
| 2 Each | Water Stops as per Section H-H | Contractor |
| 340 Lbs | 2 - Outlet Screens and Guides | Contractor |

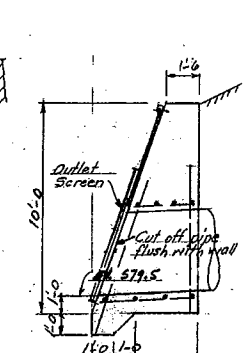


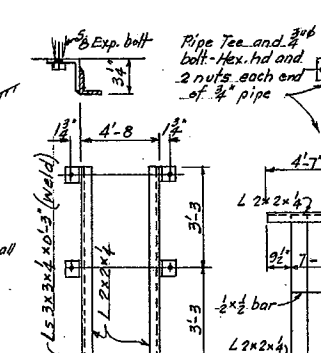

STEEL BEAM GUARD RAIL
Scale 1/4" = 1'-0



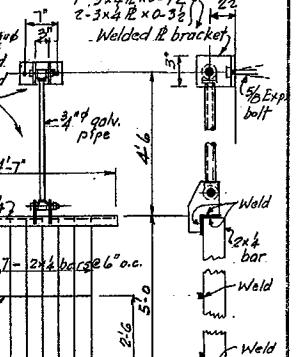

DOWNSTREAM HEADWALL - SECTION D-D
Scale 1/4" = 1'-0




SECTION E-E




GUIDES




OUTLET SCREEN - 2 REQD.

| DRAWING NO. | REFERENCE DRAWINGS | REV. | DATE | DESCRIPTION | BY | APP. |
|---|---|---|---|---|---|---|

CH. R.E.E. DATE 4-20-65
CK. W.D.P. SECTION HEAD 4-29-65
APP. DIVISION HEAD
APP. DEPARTMENT HEAD

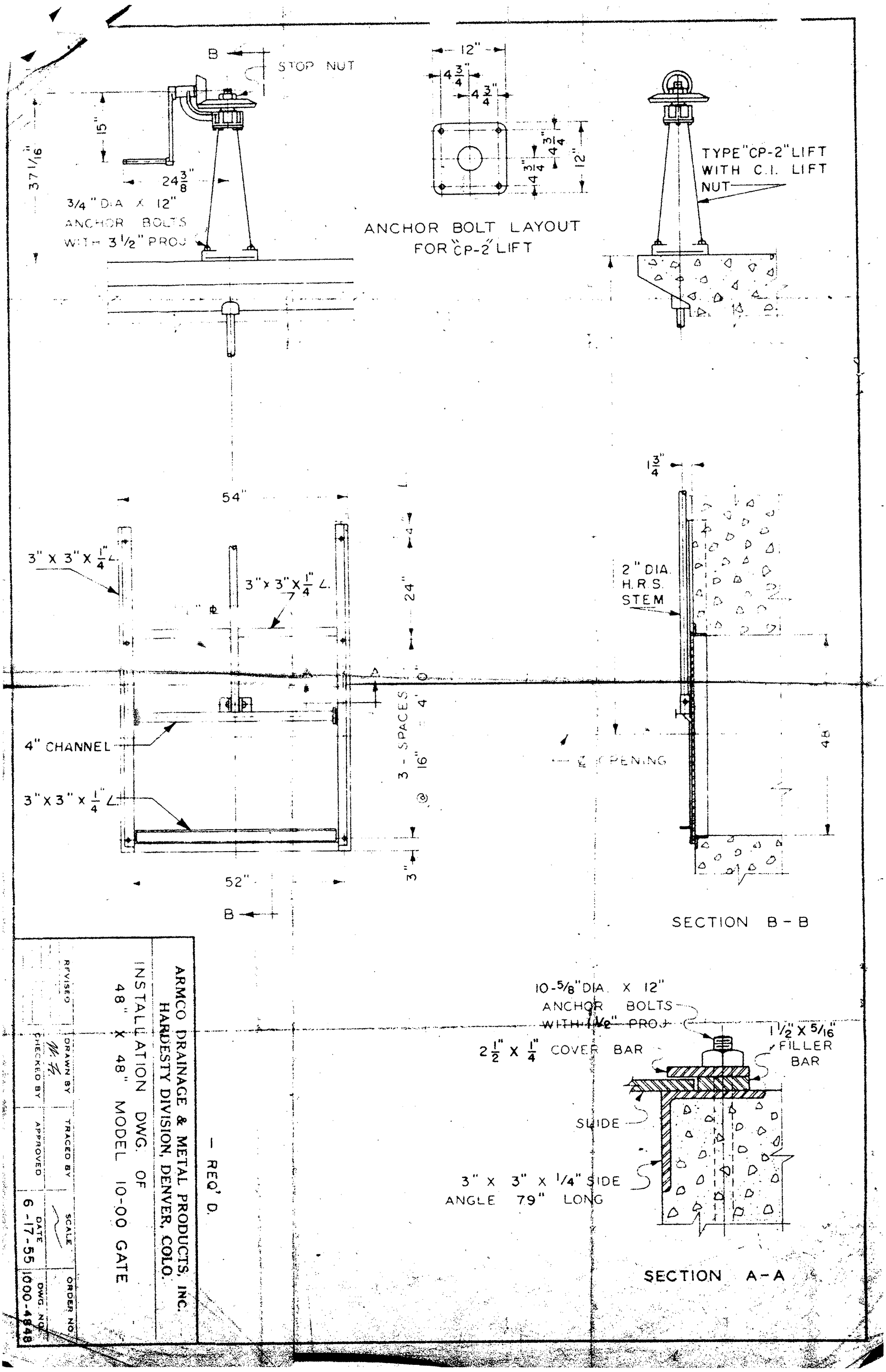
CONSUMERS POWER CO.
ELECTRIC AND GENERAL ENGINEERING DEPARTMENT
JACKSON, MICHIGAN

UNION STREET DAM
TRAVERSE CITY MICHIGAN
RECONSTRUCTION OF SPILLWAY # 2

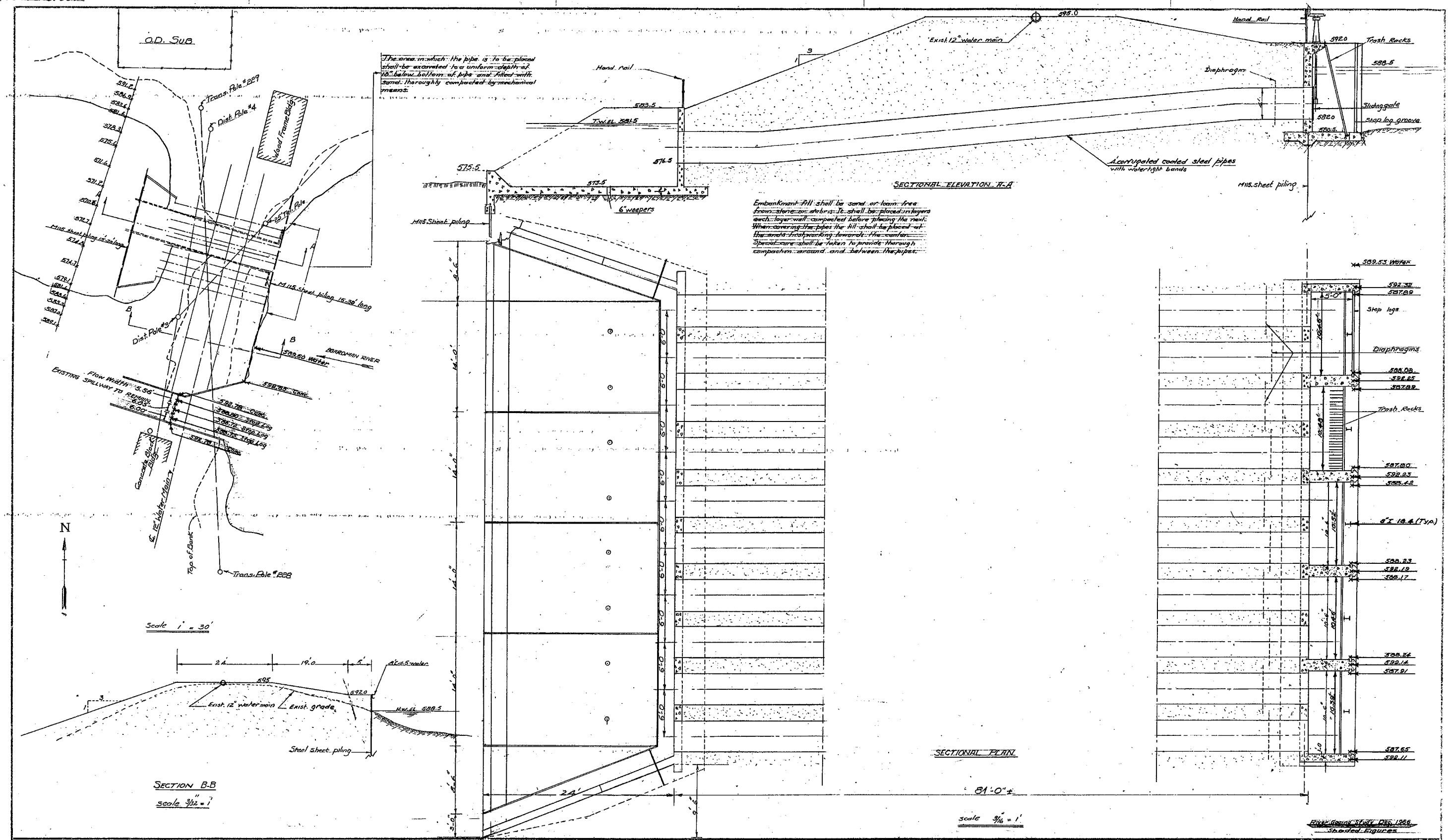
SCALE As Shown | JOB 188-277-8 | DRAWING NO. M 3049 - F105 | SHEET 2 | REV.

M

O.K. TO FILE


B
STOP NUT
15"
37 1/16"
24 3/8"
3/4" DIA X 12" ANCHOR BOLTS WITH 3 1/2" PROJ
12"
4 3/4"
4 3/4"
4 3/4"
4 3/4"
12"
ANCHOR BOLT LAYOUT FOR "CP-2" LIFT
TYPE "CP-2" LIFT WITH C.I. LIFT NUT
54"
3" X 3" X 1/4" ∠.
3" x 3" X 1/4" ∠.
24"
4"
3 - SPACES @ 16" = 4'-0"
4" CHANNEL
3" X 3" x 1/4" ∠.
3"
52"
B
1 3/4"
2" DIA. H.R.S. STEM
℄ OPENING
48"
SECTION B - B
10-5/8" DIA. X 12" ANCHOR BOLTS WITH 1 1/2" PROJ
2 1/2" X 1/4" COVER BAR
1 1/2" X 5/16" FILLER BAR
SLIDE
3" X 3" X 1/4" SIDE ANGLE 79" LONG
SECTION A-A
— REQ'D.
ARMCO DRAINAGE & METAL PRODUCTS, INC.
HARVESTY DIVISION, DENVER, COLO.
INSTALLATION DWG. OF
48" X 48" MODEL 10-00 GATE
REVISED
DRAWN BY
CHECKED BY
TRACED BY
APPROVED
SCALE
DATE 6-17-55
ORDER NO.
DWG. NO. 1000-4848

DRAWING NO 713049-E101 SH.1




| DRAWING NO. | REFERENCE DRAWINGS | REV. | DATE | DESCRIPTION | BY | APP. |
|---|---|---|---|---|---|---|
| | | | | | | |

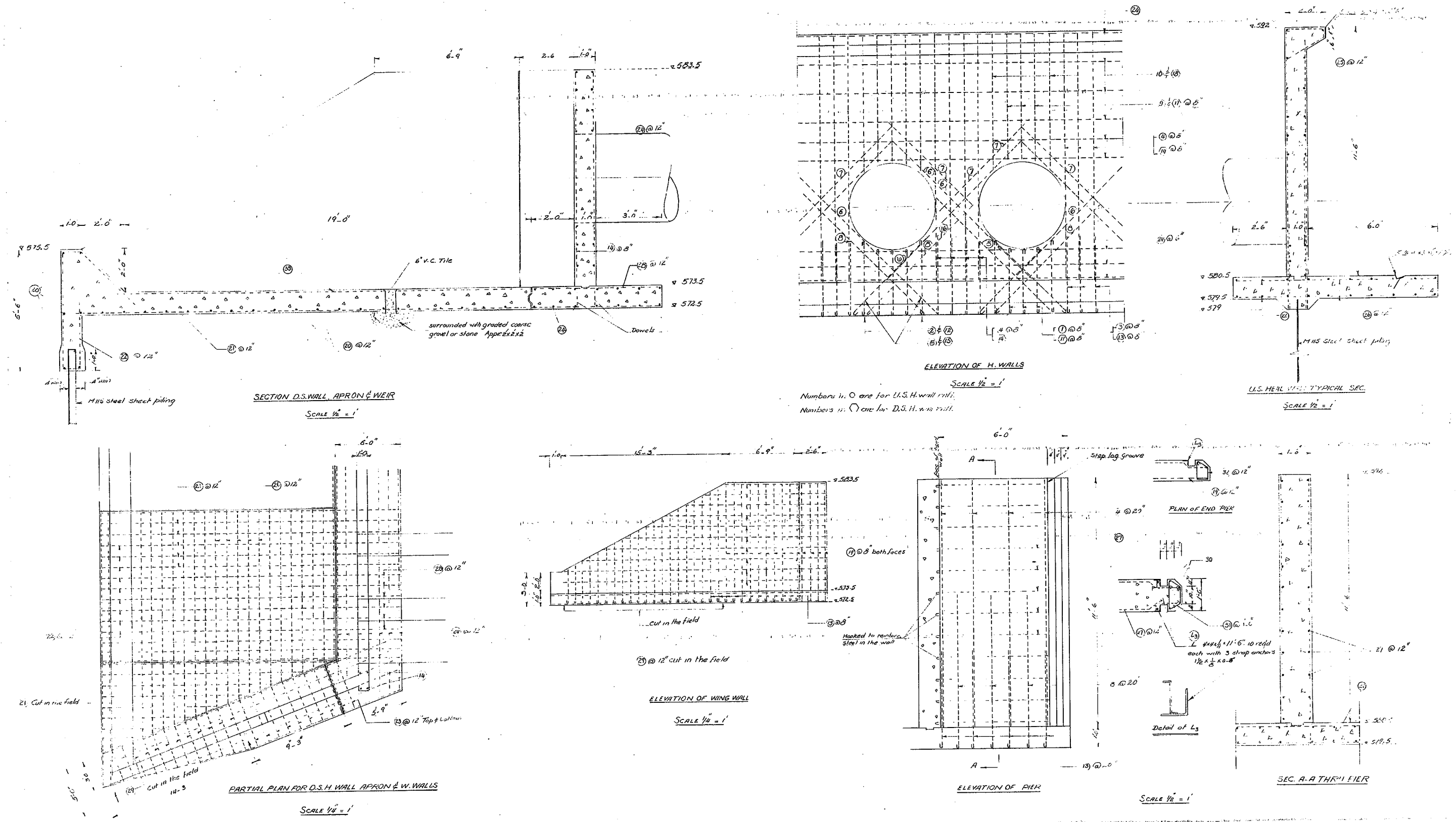
DR. W.D.P. / K.R. DATE 6/7/65
INSP. DATE 8/16/65
TRC. DATE
CK. W.D.P. DATE 8/18/65
APP. DATE 8/18/65

**CONSUMERS POWER CO.**
GENERAL ENGINEERING DEPARTMENT
JACKSON, MICHIGAN

UNION STREET DAM
TRAVERSE CITY MICHIGAN
NEW SPILLWAY

SCALE As shown | DRAWING NO. 713049-E101 | REV. | SHEET 1
JOB

| DATE | STARTED | BY | AP | | A | | C | | E | | G |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | B | | D | | F | | H |




K. RIAD 7/28/55
M.S.A. 8/16/55
W.D.R. 8/12/55
E. L. Sayles 8/16/55

CONSUMERS POWER CO.
GENERAL ENGINEERING DEPARTMENT
JACKSON, MICHIGAN

UNION STREET DAM
TRAVERSE CITY MICHIGAN
HEAD WALLS & APRON CONCRETE DETAILS
As Noted
M3049-F101

DWG. NO. M3049 F101 SH3

## BAR SCHEDULE

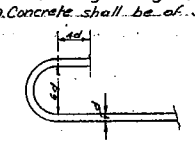
| ITEM | SIZE | LENGTH | QUANTITY | WEIGHT | REMARKS |
|---|---|---|---|---|---|
| 1 | 6 | 4_2 | 60 | 375 | Hooked on both ends |
| 2 | 6 | 4_6 | 40 | 270 | do |
| 3 | 6 | 4_8 | 80 | 560 | Hooked on one end (dowels) |
| 4 | 6 | 11_4 | 128 | 2170 | Str. |
| 5 | 6 | 5_2 | 40 | 310 | Hooked on one end (Skew dowels) |
| 6 | 6 | 9_0 | 80 | 1080 | Str. |
| 7 | 6 | 6_0 | 80 | 720 | do |
| 8 | 6 | 7_8 | 76 | 875 | Hooked on one end |
| 9 | 6 | 5_9 | 60 | 518 | Str. |
| 10 | 6 | 6_2 | 40 | 372 | do |
| 11 | 6 | 5_2 | 60 | 465 | Hooked on both ends |
| 12 | 6 | 5_6 | 40 | 330 | do |
| 13 | 6 | 4_2 | 200 | 1250 | Hooked on one end (dowels) |
| 14 | 6 | 9_10 | 144 | 2130 | Str. |
| 15 | 6 | 4_8 | 40 | 280 | Hooked on one end (Skew dowels) |
| 16 | 6 | 8_0 | 40 | 480 | do |
| 17 | 6 | 2_10 | 60 | 255 | Str. |
| 18 | 6 | 3_3 | 40 | 195 | do |
| 19 | 4 | 6_6 | 24 | 104 | Hooked on one end |
| 20 | 6 | 13_9 | 108 | 2225 | do |
| 21 | 6 | 20_0 | 80 | 2400 | do |
| 22 | 6 | 13_0 | 80 | 1560 | As shown |
| 23 | 4 | 4_6 | 44 | 133 | Str. |
| 24 | 4 | 22_0 | 204 | 3000 | do |
| 25 | 4 | 4_0 | 63 | 168 | As shown |
| 26 | 4 | 9_3 | 126 | 780 | Str. |
| 27 | 4 | 6_11 | 120 | 560 | As shown |
| 28 | 4 | 5_9 | 126 | 482 | Str. |
| 29 | 4 | 20_0 | 45 | 600 | do |
| 30 | 4 | 11_4 | 24 | 182 | do |
| 31 | 2 | 3_8 | 48 | 30 | Bend in field |
| 32 | 2 | 3_0 | 24 | 12 | do |
| 33 | | | 1500 S.F. | 870 | Welded wire mesh 66-44 |

## BILL OF MATERIALS

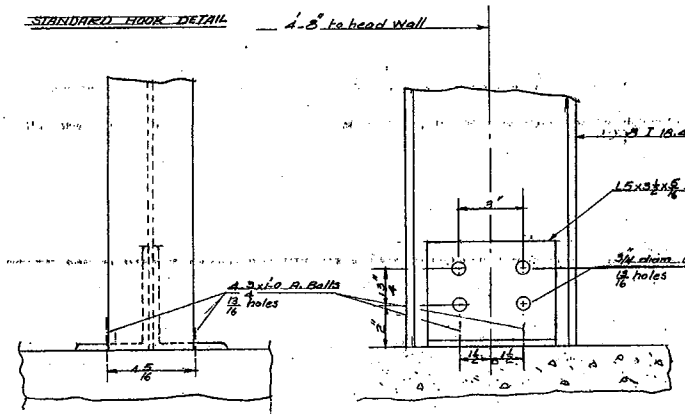
| ITEM | QUANTITY | DESCRIPTION | REMARKS |
|---|---|---|---|
| 1 | 200 C.Y. | 3000 LBS CONCRETE | |
| 2 | 55 T. | M115 STEEL PILING | 15_30 LONG |
| 3 | 18820 LBS | NO 6 BARS | |
| | 6010 LBS | NO 4 BARS | |
| | 50 LBS | NO 2 BARS | |
| 4 | 10 | ARMCO MOD. 10 GATES | INCL. CP.2. LIFT |
| 5 | 800 FT. | 4" DIAM. COR. PIPES | COATED |
| 6 | 30 SECTIONS | 5 BARS EACH | TRASH RACKS |
| 7 | 2,225 T. | MISC. STEEL | L1, L2, L3, BL, PL, P2, C1 |
| 8 | 1500 S.F. | REINFORCING | W.W. MESH 66_44 |
| 9 | 130 LFT. | HAND RAIL | 1 1/2"_2 RAIL |
| 10 | 2.6 | 3x8x11.0 TREATED FIR | STOP LOGS |

## CONCRETE SPECIFICATIONS

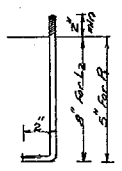
1. Concrete may be job mixed or ready mixed at the option of the contractor.
2. Cement shall be std. Portland Cement free from lumps or warehouse set.
3. Fine aggregate shall consist of sand or stone screenings that are clean, hard, strong, durable, uncoated & free from injurious amounts of dust, clay, organic matter or other deleterious substances.
4. Coarse aggregate shall consist of crushed stone or gravel having clean hard, strong, durable, uncoated pieces free from injurious amounts of organic matter.
5. Water shall be clean, free from oil, acid, strong alkali or veg. matter.
6. The concrete mix shall be designed to produce a min. compressive strength of 3000 psi. at 28 days. Consistency shall be such that concrete will work into corners & around reinforcing steel readily.
   Vibrators may be used if approved by owners representative.
7. Job mixed concrete shall be mixed in a mixer of approved type for a period of not less than 2 minutes after all materials are in mixer.
8. Under no circumstances shall concrete be placed after it has attained its initial set.
9. Forms shall be true to line & grade, adequately braced & mortar tight and shall be left in place not less than 5 days after placement of concrete. Concrete surfaces shall be kept continuously moist for at least ten days using approved methods.
10. Concrete shall be of such consistency & so placed that it will not segregate.



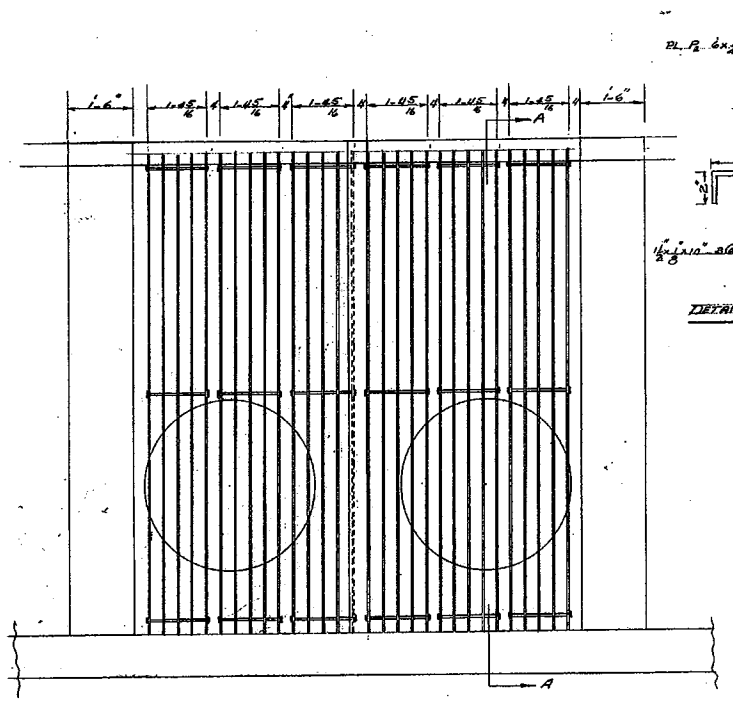

STANDARD HOOK DETAIL



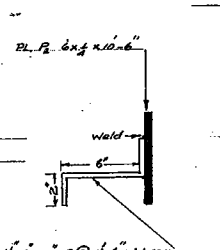

VERTICAL BEAM ANCHOR DETAIL
Scale 1" = 1'



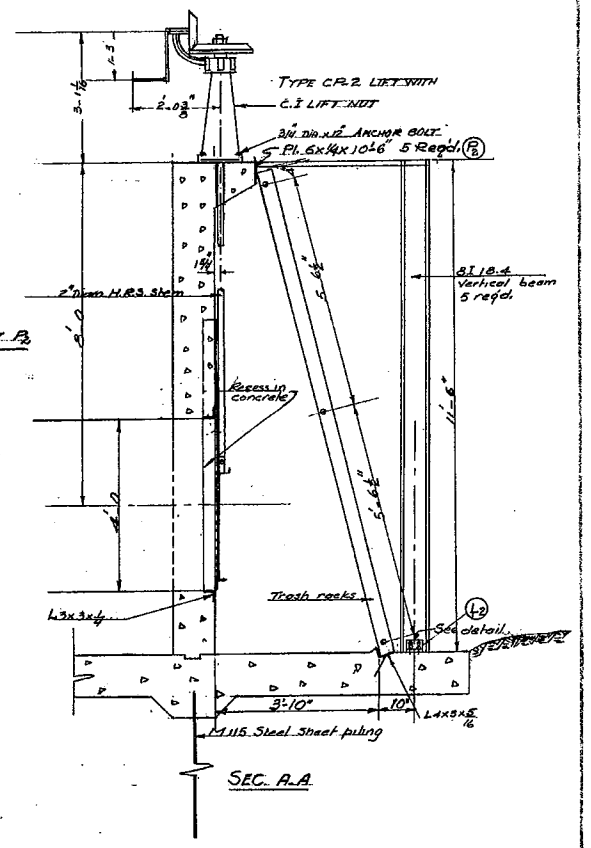

ANCHOR BOLT DETAIL



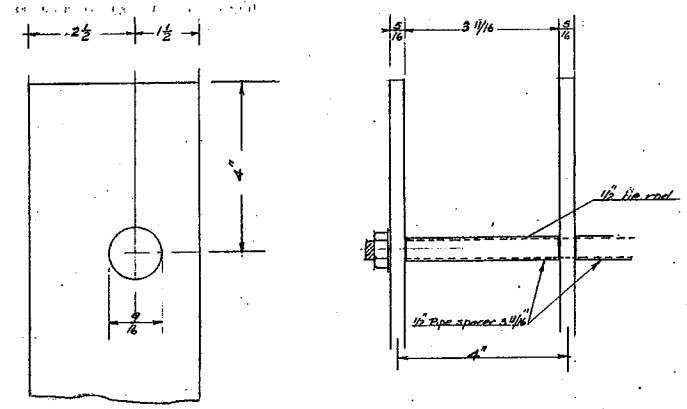

TRASH RACKS - U.S. ELEVATION
Scale 1/2" = 1'



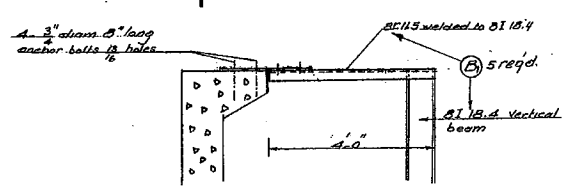

DETAIL OF PLATE P2

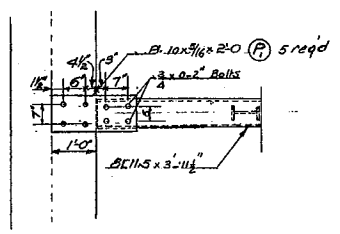



SEC. A-A

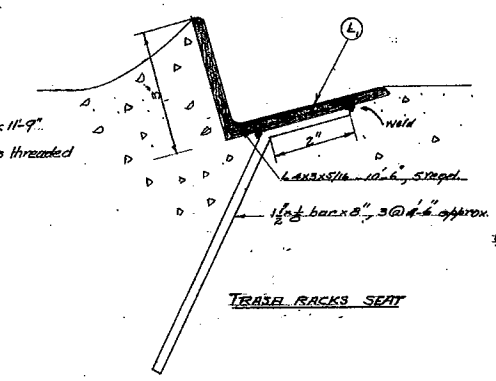



TRASH RACKS DETAILS




UPPER SUPPORT FOR VERTICAL BEAM
Scale 1/2" = 1'




TRASH RACKS SEAT

### PAINT NOTE

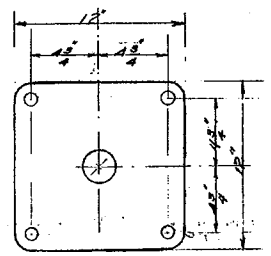
All steel members shall have 1 shop coat of 20% red lead in oil and one finish coat of Sutox 1½ Sutox 1300

### ANCHOR BOLTS SCHEDULE

| ITEM | QUAN. | DESCRIP. | REMARKS |
|---|---|---|---|
| 1 | 20 | 3/4 x 0-9" | P1, See detail |
| 2 | 20 | 3/4 x 1-6" | L2, See detail |
| 3 | 66 | 5/8 x 0-8" | For Hand railing |

### MACHINE BOLTS

40 _ 3/4 x 0-2" for L2 with nuts & washers.
41 _ 1" x 0-1 3/4" for C1 with nuts & washers




ANCHOR BOLT LAYOUT
FOR C.P.2 LIFT

### TRASH RACKS

Trash racks are in sections - 5 bars 4'-4" x 11'-9" with ½" x 3 1/16 pipe spacers and ½" x 18" tie rods threaded 1/2 - 13 N.C. one inch long each end.

| DRAWING NO. | REFERENCE DRAWINGS | REV. | DATE | DESCRIPTION | BY | APP. |
|---|---|---|---|---|---|---|

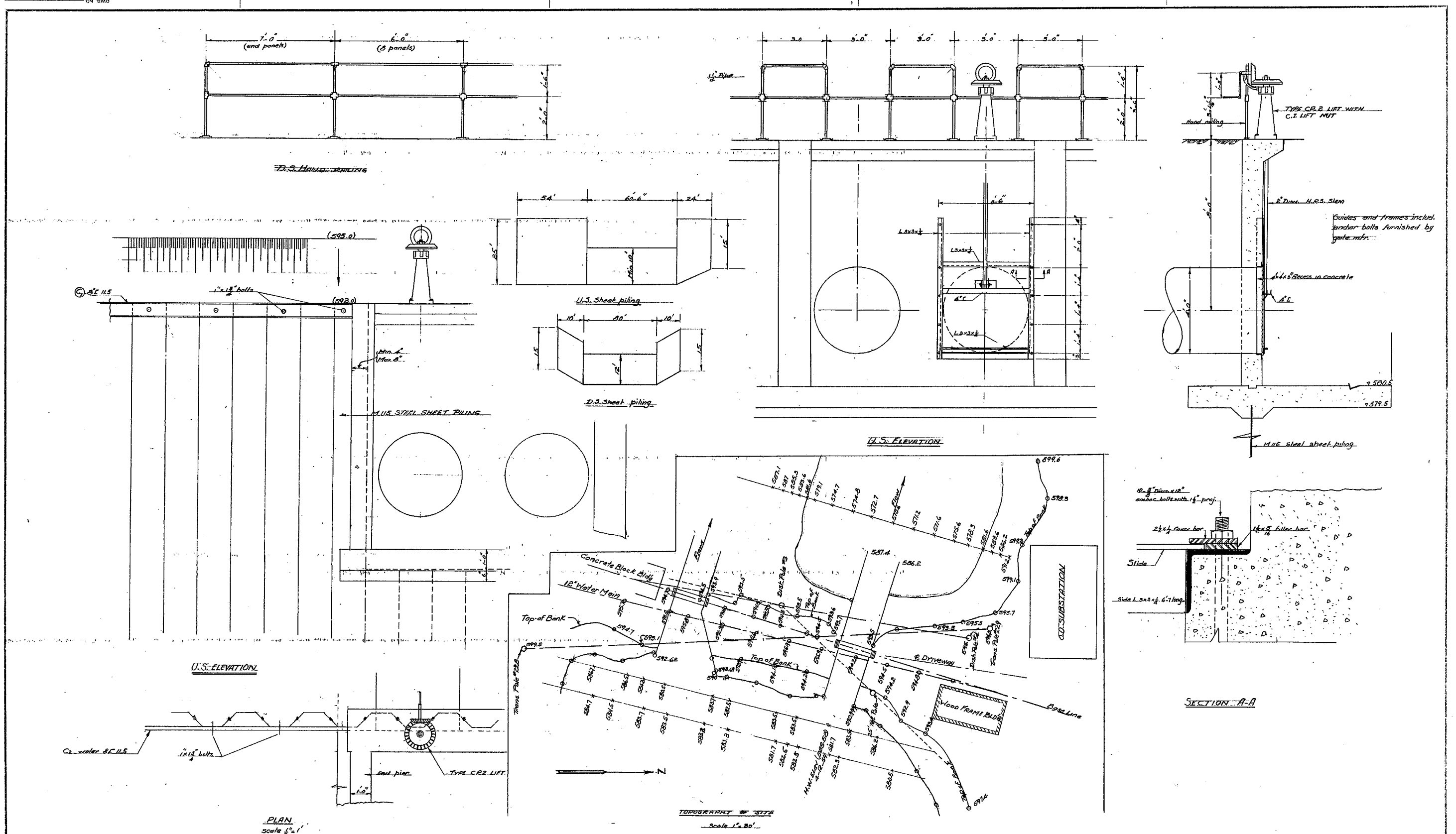
DR. K. RIAD DATE 7/30/55
INSP. MSM DATE 8/16/55
TRD. DATE
OK. W.D.P. DATE 8/16/55
APP. DATE 8/16/55

**CONSUMERS POWER CO.**
GENERAL ENGINEERING DEPARTMENT
JACKSON, MICHIGAN

UNION STREET DAM
TRAVERSE CITY MICHIGAN
MISC. DETAILS

SCALE As shown
JOB
DRAWING NO. M3049-F101
REV.
SHEET 3

DATE STARTED BY AP




| DRAWING NO. | REFERENCE DRAWINGS | REV. | DATE | DESCRIPTION | BY | APP. |
|---|---|---|---|---|---|---|

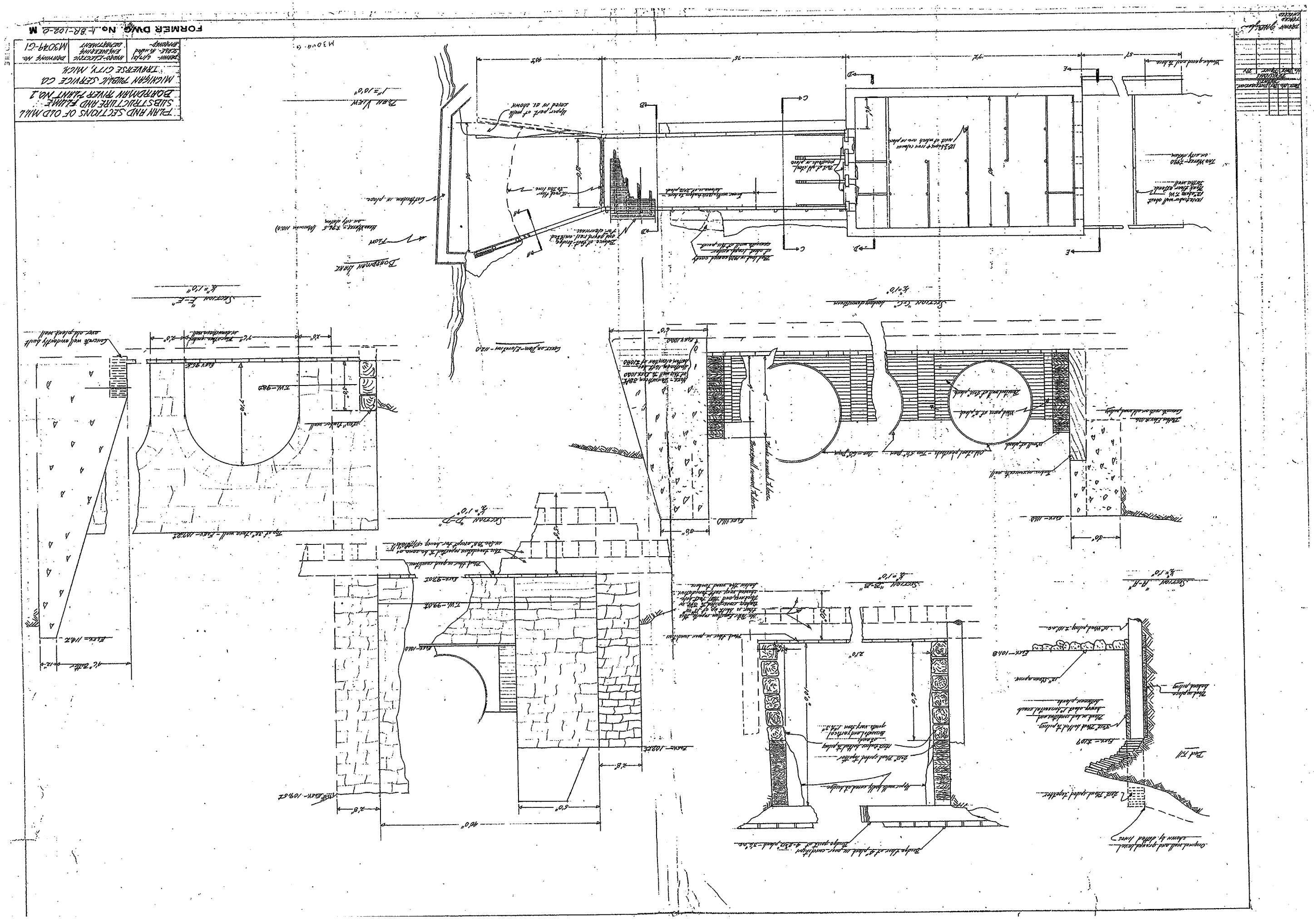
DR. K. Riad DATE 8/8/55
INSP. MJL DATE 8/16/55
TRD. DATE
CK. W.D.R. DATE 8/16/55
APP. E.V. Sayles DATE 8/16/55

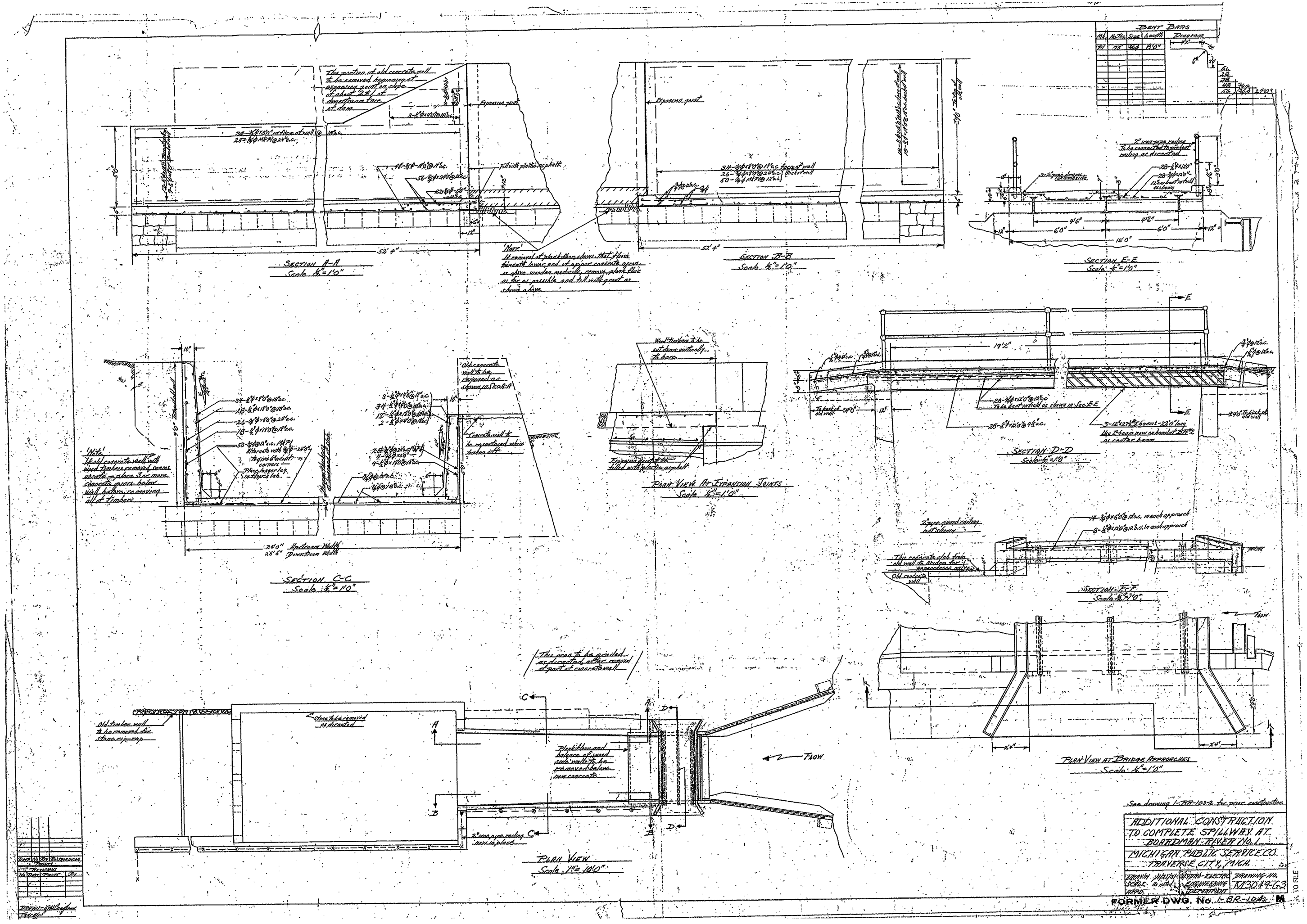
**CONSUMERS POWER CO.**
GENERAL ENGINEERING DEPARTMENT
JACKSON, MICHIGAN

UNION STREET DAM
TRAVERSE CITY MICHIGAN
MISC. DETAILS

SCALE As shown
JOB
DRAWING NO. M3049-F101
REV.
SHEET 4

DATE STARTED BY AP


PLAN AND SECTIONS OF OLD MILL
SUBSTRUCTURE AND FLUME
BORDMAN RIVER PLANT NO. 1
MICHIGAN PUBLIC SERVICE CO.
TRAVERSE CITY, MICH.
DRAWN - 6/17/51
SCALE - AS NOTED
APPROVED -
HYDRO-ELECTRIC ENGINEERING DEPARTMENT
DRAWING NO. M3049-G1
FORMER DWG. No. 1-BR-102-0 M
Plan View
Bordman Lake
Flow
Section "E-E"
Section "C-C"
Section "D-D"
Section "B-B"
Section "A-A"
Pad Fill


BENT BARS
Mk. No. Req. Size Length Diagram
B7 26 3/4 8'0"
The portion of old concrete wall to be removed beginning at expansion joint on slope of about 2:1, at downstream face of dam
Expansion joint
3-1"Ø x 10'0" @ 18" o.c.
34-1"Ø x 10'0" surface of wall @ 18" o.c.
25-3/4"Ø x 14'7" @ 24" o.c.
48-3/4"Ø-11'0" @ 18" o.c.
56-3/4"Ø x 24'0" @ 18" o.c.
Fill with plastic asphalt
52'4"
SECTION A-A
Scale 1/4"=1'0"
'Note'
If removal of plank lining shows that floor beneath lower end of upper concrete apron is above wooden mudsills, remove plank floor as far as possible and fill with grout as shown above.
31-3/4"Ø x 8'0" @ 11" o.c. face of wall
26-3/4"Ø x 8'0" @ 22" o.c. backwall
50-3/4"Ø x 14'7" @ 12" o.c.
3/4"Ø @ 12" o.c.
52'4"
SECTION B-B
Scale 1/4"=1'0"
2" iron pipe railing. To be erected flat to form joint overlap as directed
28-3/4"Ø x 12'0"
28-3/4"Ø x 12'0"
12" x 6" bent to fit old anchorage
6'0"
12'0"
SECTION E-E
Scale 1/4"=1'0"
'Note'
If old concrete wall with wood timbers removal seems unsafe - place 3 or more concrete piers below wall before removing all of timbers
37-3/4"Ø x 8'0" @ 18" o.c.
18-3/4"Ø x 18'0" @ 18" o.c.
26-3/4"Ø x 16'0" @ 24" o.c.
18-3/4"Ø x 11'0" @ 18" o.c.
50-3/4"Ø 12" o.c. 14'7"
Wire ties with 3/8"Ø-24" corners
Place hooper leg in floor slab
24'0" Upstream Width
25'5" Downstream Width
SECTION C-C
Scale 1/4"=1'0"
Old concrete wall to be removed as shown on Sec. A-A
3-3/4"Ø x 10'0" @ 18" o.c.
34-3/4"Ø x 10'0" @ 18" o.c.
17-3/4"Ø x 12'0" @ 18" o.c.
2-3/4"Ø x 10'0" @ 18" o.c.
Trench wall to be repaired where broken off
Wood timbers to be cut down vertically to here
Expansion joint to be filled with plastic asphalt
PLAN VIEW AT EXPANSION JOINTS
Scale 1/4"=1'0"
19'2"
28-3/4"Ø x 12'0" @ 12" o.c.
To be bent as shown in Sec. E-E
28-3/4"Ø x 12'0" @ 9" o.c.
3-12" x 27 lb. I-beams - 22'0" long
Use I-beam now on hand at Bent 12 as center beam
To back of old wall
2'0" To back of old wall
SECTION D-D
Scale 1/4"=1'0"
2" pipe guard railing not shown
14-3/4"Ø x 6'0" @ 12" o.c. in each approach
8-3/4"Ø x 10'0" @ 12" o.c. in each approach
This concrete slab forms old wall to broken for appearance only
Old concrete wall
SECTION F-F
Scale 1/4"=1'0"
Flow
PLAN VIEW AT BRIDGE APPROACHES
Scale 1/4"=1'0"
This item to be provided as directed, either cement or part of concrete wall
Old timber wall to be removed for stone rip-rap
Stone to be removed as directed
Plank lining and balance of wood side wall to be removed before new concrete
Flow
2" iron pipe railing now in place
PLAN VIEW
Scale 1"=10'0"
See drawing 1-BR-103a for pier construction
ADDITIONAL CONSTRUCTION TO COMPLETE SPILLWAY AT BOARDMAN RIVER No. 1
MICHIGAN PUBLIC SERVICE CO.
TRAVERSE CITY, MICH.
DRAWN
SCALE
DATE
ENGINEERING DEPARTMENT
DRAWING NO. M30A9-G3
FORMER DWG. No. 1-BR-104a
TO FILE

# Appendix C

Photographs (21)

Photo 1 - 6-18-08 - View of dam crest and upstream slope, looking right. The inlet to the fish passage and auxiliary spillway can be seen.

Photo 2 - 6-18-08 - Downstream slope of embankment, looking right.

Photo 3 - 6-18-08 - Pedestrian path along crest of embankment, looking right.

Photo 4 - 6-18-08 - View of low point in dam crest, looking left.
Low point is at the location of the auxiliary spillway and fish passage structures.

Photo 5 - 6-18-08 - View of small depression upstream of water main right of spillway pipe No. 10.

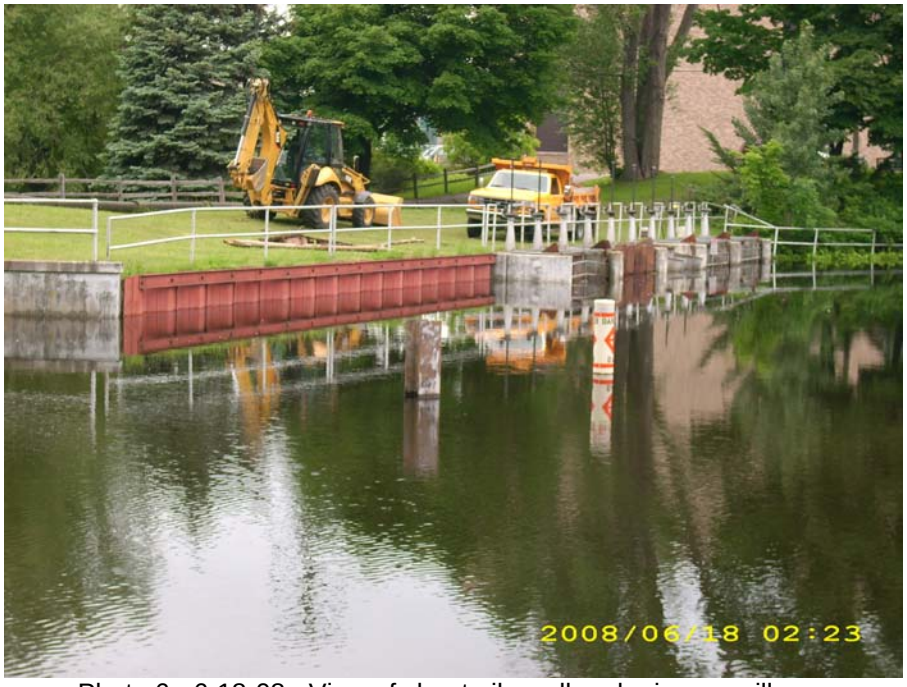



Photo 6 - 6-18-08 - View of sheet pile wall and primary spillway.

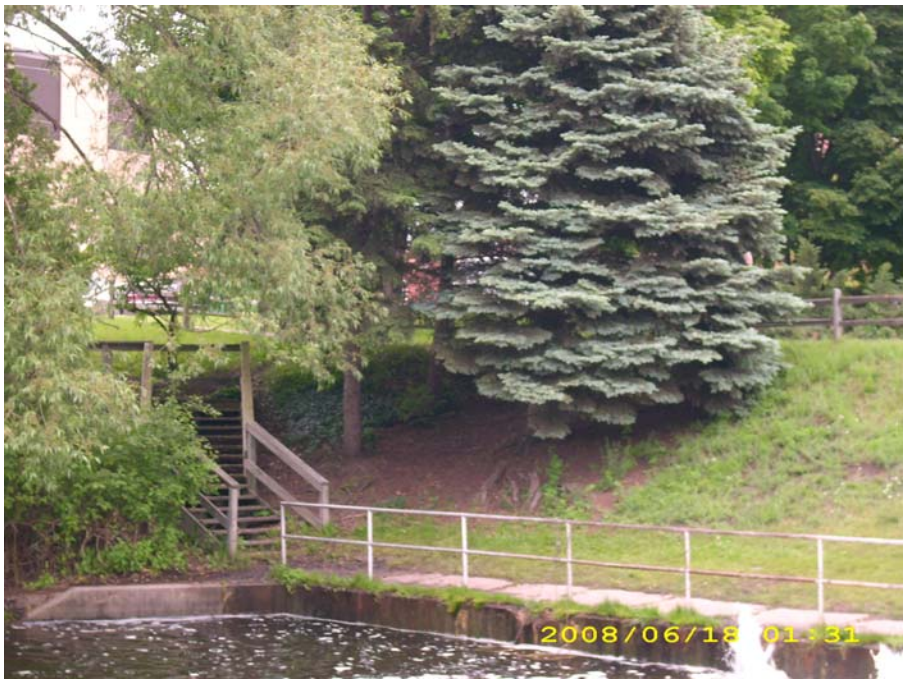



Photo 7 - 6-18-08 - Large trees growing on downstream slope of the embankment dam.
Note lack of grass growing below pine tree.

Photo 8 - 6-18-08 - Large trees, shrubs, and stump (not seen)
present at left side of main embankment dam.

Photo 9 - 6-18-08 - View looking upstream of the downstream slope of the embankment dam between primary and auxiliary spillways.

Photo 10 - 6-18-08 - View of primary spillway outlet headwall. Note seepage along walkway.

Photo 11 - 6-18-08 - View of active seepage at the groin between the primary spillway embankment and the shallow-sloped auxiliary spillway embankment.

Photo 12 - 6-18-08 - Cottonwood tree located on right abutment.

Photo 13 - 6-18-08 - View of upstream side of left abutment. Note tree at edge of concrete retaining wall.

Photo 14 - 6-18-08 - View of primary spillway inlet structures. Note variable trash rack systems. Also note gate operators and their position - some are open and some are closed.

Photo 15 - 6-18-08 - View looking downstream in Bay 2 (pipes 3 and 4). Leaks in stoplogs prevented complete dewatering. Note slide gates at inlets to pipe.

Photo 16 - 6-18-08 - View of auxiliary spillway inlet.

Photo 17 - 6-18-08 - View of stoplogs and piers of auxiliary spillway.

Photo 18 - 6-18-08 - Outlet of auxiliary spillway.

Photo 19 - 6-18-08 - View of fish ladder structure looking downstream.

Photo 20 - 6-18-08 - Outlet of fish ladder.  Some undermining noted at this outlet.

Photo 21 - 9-4-08 View of gap between sheet piling and concrete training wall.
Note resulting ground loss behind sheet piling.

# Appendix D

Hydrological Data

MDEQ Flood Discharge Request Record

FEMA Flood Map

Department of Environmental Quality

Michigan.gov

# Land and Water Management Division

## Flood Discharge Request Record 20080188-1

6/17/2008

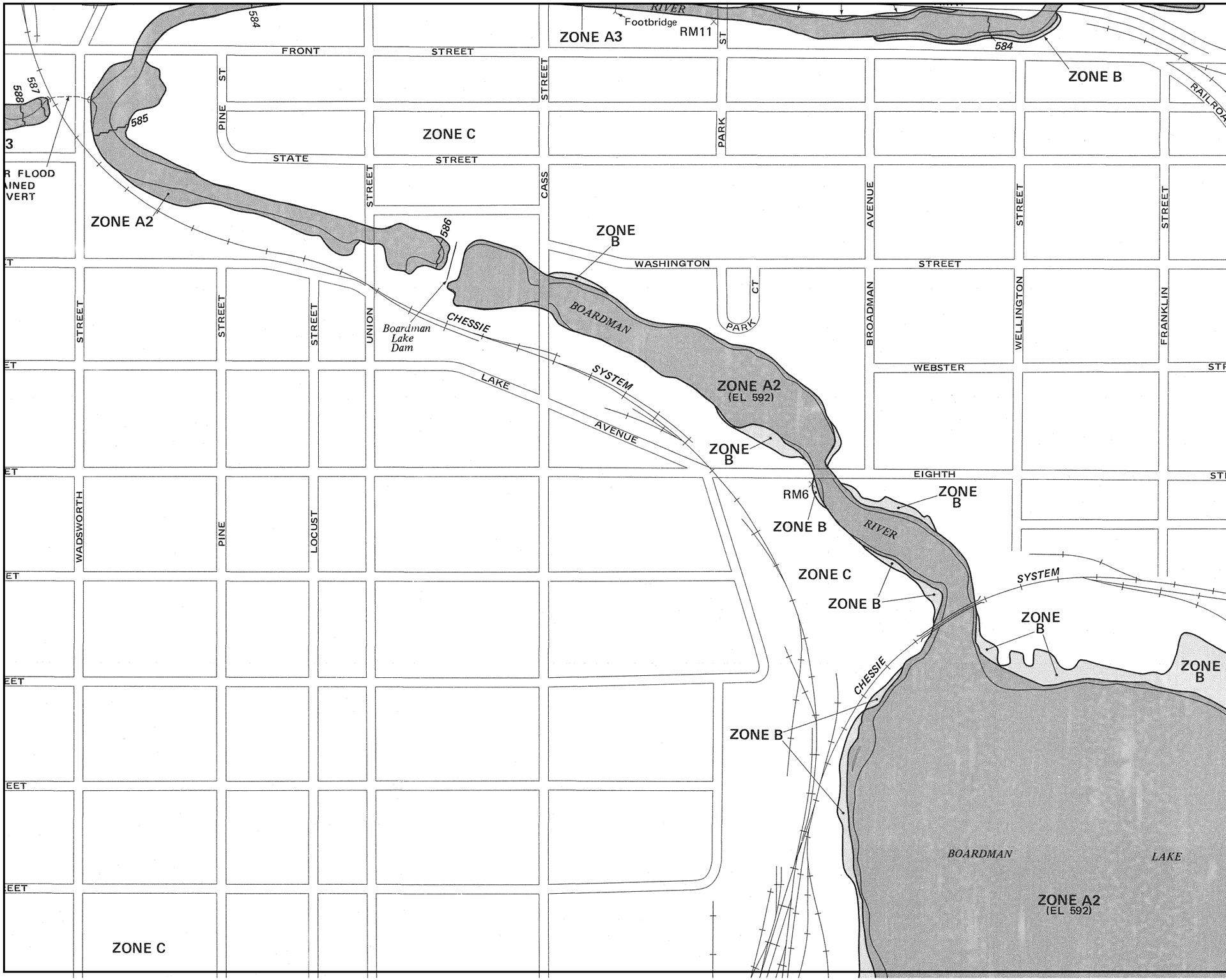


## Discharge Information

| | | | |
|---|---|---|---|
| Watercourse: | BOARDMAN RIVER | | |
| Location: | Union Street Dam | Drainage Area: | 283.16 $mi^2$ |
| Basin Name: | 09 - Boardman | Contributing Area: | 225.37 $mi^2$ |
| County: | Grand Traverse | Tn/Rng/Sec: | 27N11W/03 |
| Township: | City of Traverse City | Latitude: | 44.76166943 |
| Quad Name: | Traverse City SE | Longitude: | -85.62243614 |
| Quad ID: | K20SE | | |
| Requested By: | Prein & Newhof | Received Date: | 5/27/2008 |
| Request Type: | Dam | Issued Date: | 6/5/2008 |
| File Number: | 20080188-1 | Reference Number: | 511 |

| Discharge Frequencies: | | Volume Frequencies: | |
|---|---|---|---|
| 10%: | 1200 cfs | | |
| 2%: | 1700 cfs | | |
| 1%: | 1800 cfs | 1%: | |
| 0.5%: | 2000 cfs | 0.5%: | |
| 0.2%: | 2400 cfs | | |

Access to the Flood Flow Database is provided as a service to allow you to check the status of your flood flow requests or to view discharges from previous requests for preliminary design purposes. The discharges values are only valid for the original requestor and for one year after the original request date. To obtain discharge information from the Land and Water Management Division's Hydrologic Studies Unit (HSU), a flood flow discharge request form may be submitted electronically to the HSU. A written or email response to your request will be returned to you and must accompany your permit application.




APPROXIMATE SCALE

400 0 400 FEET

CITY OF
# TRAVERSE CITY, MICHIGAN
GRAND TRAVERSE COUNTY

PANEL 2 OF 5

(SEE MAP INDEX FOR PANELS NOT PRINTED)

**COMMUNITY-PANEL NUMBER**
**260082 0002 B**

**EFFECTIVE DATE:**
**DECEMBER 15, 1982**

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

# Appendix E

Dam Inspection Checklist

Inventory No. _____

Sheet _____ of _____

# VISUAL INSPECTION CHECKLIST

1. Name of Dam: Union Street Dam.
2. Inventory No.:
3. Hazard Category: Low
4. Size Classification:
5. Owner: City of TC

"Lay Park"

6. Date Inspected: 6/17/08
7. Pool Elevation: — no staff gage
8. Tailwater Elevation: — "
9. Purpose of Dam: Recreation - Lamprey control - Historical - supports water line -
10. Weather: 60°F Overcast some rain.

Directions: Mark an "X" in the "YES" or "NO" / column.
If item does not apply, write "N/A" in "REMARKS" columns.
Use "OTHER COMMENTS" space to amplify "REMARKS"

| ITEM | YES | NO | REMARKS |
|---|---|---|---|
| RESERVOIR | | | |
| | | | |
| 1. Any Upstream Development? Sabin Boardman + BB. | X | | Inventory No. |
| 2. Any Upstream Impoundments? Boardman Lk. | X | | |
| 3. Shoreline Slide Potential? None - developed | | X | |
| 4. Significant Sedimentation? None | | X | |
| 5. Any Trash Boom? No. | | X | |
| 6. Any Ice Boom? | | X | |
| 7. Operating Procedure Changes? | | X | Park maintains / exercises gates every 6 months |
| | | | |
| DOWNSTREAM CHANNEL | | | |
| | | | |
| 1. CHANNEL | | | |
| a. Eroding or Backcutting? | | X | |
| b. Sloughing? | | X | |
| c. Obstructions? | | X | |
| d. Bridging? | | X | |
| 2. DOWNSTREAM FLOODPLAIN | | | |
| a. Occupied Housing? | X | | |
| b. Farming? | | X | |
| c. Recreation Areas? | X | | |
| d. Changed Hazard Potential? | | X | |
| e. New Development? | | | Unknown |
| | | | |
| INSTRUMENTATION | | | |
| | | | |
| 1. Are there | | | |
| a. Piezometers? | | X | |
| b. Weirs? | | X | |
| c. Settlement Pins? | | X | |
| d. Observation Wells? | | X | |
| e. Other? | | X | |
| 2. Are readings | | | |
| a. Available? | | X | |
| b. Plotted? | | X | |
| c. Taken Periodically? | | X | |
| | | | |
| | | | |
| | | | |

Inventory No. _____

Sheet _____ of _____

| ITEM | YES | NO | REMARKS |
|---|---|---|---|
| SPILLWAYS 10 primary gated 48" Ø pipes | | | TYPE: 48" Ø CMP |
| 2 ungated 48" Ø pipes | | | No gates on left 2 pipes |
| | | | |
| 1. CREST | | | TYPE: |
| a. Any Settlements? | | X | |
| b. Any Misalignments? | | X | |
| c. Any Cracking? | | X | |
| d. Any Deterioration? | | X | |
| e. Exposed Reinforcement? | | X | |
| f. Erosion? | | X | |
| g. Silt Deposit Upstream? | | X | |
| 2. CONTROL STRUCTURES | | | TYPE: |
| a. Mechanical Equipment Operable? | X | | |
| b. Are Gates Maintained? | X | | Every 6 months |
| c. Will Flashboards Trip Automatically? NA | | | |
| d. Are Stanchions Trippable? NA | | | |
| e. Are Gates Remotely Controlled? | | X | |
| 3. STILLING BASIN | | | TYPE: Apron slab |
| a. Any Cracking? | | | See Dive inspection |
| b. Any Deterioration | | | |
| c. Erosion? | | | |
| d. Exposed Reinforcement? | | | |
| e. Seepage at Lift Lines or Joints? | | | |
| 4. ENERGY DISSIPATORS | | | TYPE: None |
| a. Any Deterioration | | | |
| b. Erosion? | | | |
| c. Exposed Reinforcement? | | | |
| 5. METAL APPURTENANCES | | | |
| a. Corrosion? | | X | |
| b. Breakage? | | X | |
| c. Secure Anchorages? | X | | |
| 6. EMERGENCY SPILLWAY NA | | | TYPE: NA |
| a. Adequate Grass Cover? | | | |
| b. Clear Approach Channel? | | | |
| c. Erodible Downstream Channel? | | | |
| d. Erodible Fuse Plug? | | | |
| e. Stable Side Slope? | | | |
| 7. AIR BUBBLES | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

Other Comments:

Inventory No. _____

Sheet _____ of _____

| ITEM | YES | NO | REMARKS |
|---|---|---|---|
| FILL DAMS | | | TYPE: |
| | | | |
| 1. CREST | | | Inventory No. |
| a. Any Settlement? Undulating crest. | | X | Paved pathway |
| b. Any Misalignment? | | X | |
| c. Any Cracking? | | X | |
| d. Adequate Freeboard? | X | | Fetch: 100 yds |
| 2. UPSTREAM SLOPE | | | |
| a. Adequate Slope Protection? | X | | Type: Concrete wall or SSP |
| b. Any Erosion or Beaching? | | X | |
| c. Trees Growing on Slope? | X | | At left abutment and right abutment. |
| d. Deteriorating Slope Protection? | | X | |
| e. Visual Settlements? | | X | One spot right of pipe 10 ± @ water pipe |
| f. Any Sinkholes? | | X | |
| 3. DOWNSTREAM SLOPE | | | |
| a. Adequate Slope Protection? | X | | Type: Concrete walls. |
| b. Any Erosion? | X | X | Some at grow between |
| c. Trees Growing on Slope? | X | | spillway + highway - Minor. |
| d. Animal Burrows? | | X | See photos |
| e. Sinkholes? | | X | |
| f. Visual Settlement? | | X | |
| g. Surface Seepage? | X | | Just above concrete retaining wall @ |
| h. Toe Drains Dry? NA | | | |
| i. Relief Wells Flowing? NA | | | |
| j. Slides or Slumps | | X | |
| 4. ABUTMENT CONTACTS | | | |
| a. Any Erosion? | | X | |
| b. Seepage Present? | | X | |
| c. Boils or Springs Downstream? | | X | |
| 5. FOUNDATION | | | Type: |
| a. If Dam Founded on Permafrost NA | | | |
| (1) Is Fill Frozen? | | | |
| (2) Are Internal Temperatures | | | |
| Monitored? | | | |
| b. If Dam Founded on Bedrock | | X | Type: |
| (1) Is Bedrock adversely bedded? | | | |
| (2) Does Bedrock contain Gypsum? | | | |
| (3) Weak Strength Beds? | | | |
| c. If Dam Foundation Overburden | | | Type: Glacial till |
| (1) Pipable? | X | | |
| (2) Compressive? | | X | |
| (3) Low Shear Strength? | | X | |

Other Comments:

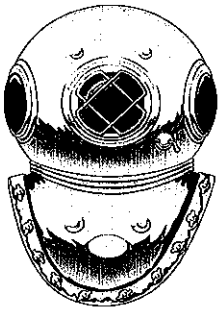
# Appendix F

Diving Inspection Report and DVD

# Seaview

## DIVING CONTRACTORS, INC.

- Marine Construction
- Diving Services
- Potable Water
- Wastewater Diving
- Nuclear Diving
- Underwater Cutting
- Underwater Welding
- Video Inspections
- Pipe Penetrations
- Concrete Restoration
- Dam Repairs
- Hydrographic Surveys
- Zebra Mussel Control



*Commercial Diving Report*

www.seaviewdiving.com

N8867 County Road Y Seymour, WI 54165 920-833-7601 (Fax 920-833-7701)

# Seaview Diving Contractors, Inc.

**Pipelines * Construction * Burning & Welding * Salvage * Inspections * U/W Video * Concrete Repairs**

**N8867 County Road Y**
**Seymour, Wisconsin 54165**
**920-833-7601**
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**www.seaviewdiving.com**

**DATE:** Tuesday June 24, 2008

**SUBJECT:** Commercial dive team to perform dam inspections for STS in Traverse City, Michigan on Tuesday, June 17 and Wednesday, June 18, 2008.

**FOR:** STS
Attn. Rick Anderson
2821 Dairy Drive Suite 5
Madison, WI 53718

**BY:** Seaview Diving Contractors, Inc.
N8867 County Road Y
Seymour, WI 54165
(920) 833-7601

**JOB#:** 2820

**PO #:** 200802039

**PREPARED BY:** Steve Haney
Commercial Diver

On Tuesday June 17th and Wednesday June 18th, 2008 Seaview Diving Contractors, Inc. reported for work with a three-man dive crew in Traverse City, Michigan. The scope of the job was to perform a video inspection on The Union Street Dam, and The Brown Bridge Dam.

**Union Street Dam**

On Tuesday morning Seaview met with our STS contact, Rick Anderson, and discussed how the inspection would be performed. After a dive station was mobilized, a commercial diver entered the water on the upstream side of the dam. The diver began the inspection by the fish ladder, and worked his way from left to right periodically testing the strength of the concrete with a chipping hammer. The diver reported the concrete to be in overall good condition with some zebra mussel coverage. Some minor cracks were found, (this can be seen in the video document provided.) Nothing seriously detrimental such as concrete spauling or rotting was discovered. The diver then surveyed the sheet piling and noted that it was in very good condition. After working his way over to the gate area the diver examined the trash racks, the gates, and the concrete bulkheads. The trash racks had some debris build up, but were in good working order. The diver reported that the gates appeared to be in sound condition with no major discrepancies, and the concrete bulkheads were in good condition as well. The diver also stated that no undermining was found through out the course of the upstream inspection. The upstream inspection was temporally put on hold when the diver reached the live gates. After relocating over to the far left wall the diver examined the concrete by the spillway. The concrete was found to be in overall adequate condition, one small crack was found about 50 feet downstream on the far left wall. Moving in a clockwise direction the diver examined the spillway area reporting the stop logs were uncompromised and in good condition. The diver inspected the wall all the way around back to the fish ladder and relayed topside that the concrete was in good condition. After exiting the water the diver then moved to the downstream side. Starting by the fish ladder the diver discovered an area that was undermined approximately 5 feet wide by 2 feet deep. (This can also be seen via the video document provided.) The diver then proceeded to inspect the ten discharge pipes. We found these pipes to be corrugated and 48 inches in diameter. Most of the discrepancies found were minor such as coating delamination, and deteriorated expansion clamps. The discharge pipes were found to be sediment free, and the concrete in between the pipes was in good condition. ***The only major damage found was located in the 10th discharge pipe where a 2 foot breach about 10 feet from the end of the pipe was discovered. Sand was seen seeping in (please refer to the video document.)*** After inspecting the discharge pipes the diver moved downstream to check for undermining and reported that none was found. We then moved back upstream to conclude that part of the inspection. The diver stated that everything else on the upstream side was in good condition. The diver then exited the water and the Union Street Dam inspection was completed. ***On Thursday June 19th Seaview returned to install a neoprene seal over the compromised area in pipe #10. This seal was tightly secured by two expansion clamps***

***that were carefully placed. After the installation was complete we video inspected the repair and found it to successfully seal the breached area.***

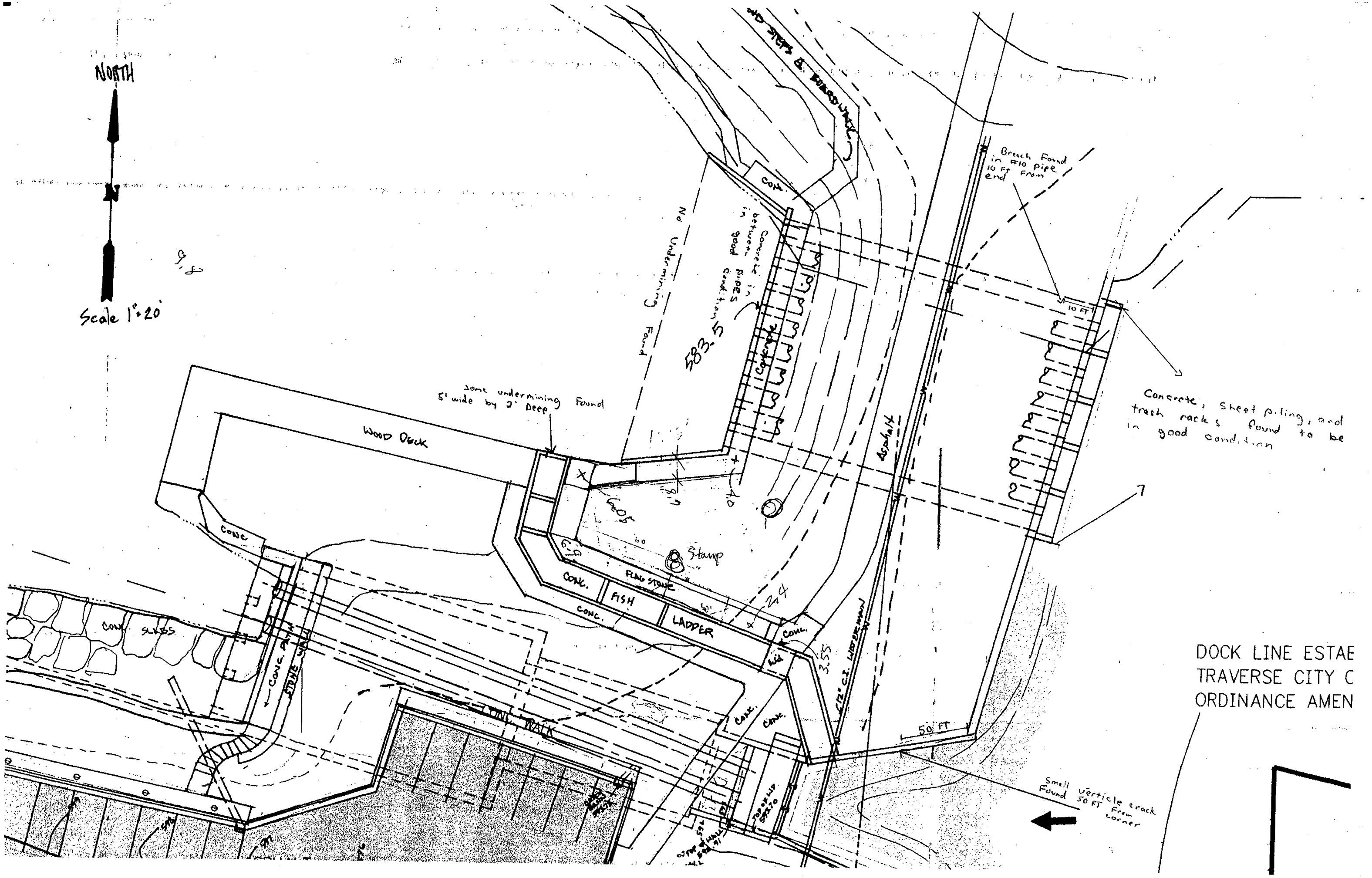
**Brown Bridge Dam**

On Wednesday, June 18th Seaview again met with Rick Anderson to conduct a video inspection on the Brown Dam in Traverse City. After a dive station was set up, a commercial diver entered the water on the upstream side. Moving left to right the diver inspected the concrete and the trash racks. The diver found the concrete to be in good condition as he tested it with a chipping hammer. ***Extensive zebra mussel coverage existed on the trash racks covering approximately 60% of the racks.*** Some minor cosmetic discrepancies were found on the concrete above the surface of the water, where a spray on shotcrete had started to peal away. On the second trash rack in the far right corner a small void was found where some aggregate was exposed, but the concrete still appeared to be sound. The diver stated that no undermining was found, and the overall condition of the dam on the upstream side was very good. The diver then exited the water briefly, but re-entered after the logway gate was closed. He noted that all the concrete was in good condition with some zebra mussel coverage spread out sporadically. Some of the coating on the gate had pealed away but the gate was in good working order. The inspection on the upstream side was concluded and the diver relocated to the downstream side. The diver entered the water on the right side and worked his way left checking for undermining and concrete defects. Again the diver utilized a chipping hammer to periodically test the concrete strength. It was noted that the concrete around the two spillways was in excellent condition, and no undermining was found. After surveying the spillway area the diver moved downstream to inspect the left side wall, the concrete was found to be in good condition. Some of the shotcrete was breaking away above the water surface, but was not an area of concern. The diver then moved away from the wall to inspect the concrete apron. Although most of the apron was covered with rip-rap rock the diver found an exposed area on the right side and verified the concrete was in good condition, and no undermining existed. After examining the entire Brown Bridge Dam we determined the overall condition was very good. The inspection was concluded and the diver exited the water.

**Recommendations**

Although the overall condition of these dams was good Seaview Diving Contractors, Inc. recommends that annual inspections be performed. With heavy rainfall and the ice conditions in winter damage can occur quickly. Seaview would also recommend that the repair made in pipe #10 on the Union Street Dam be inspected in the near future to insure a proper seal is still obtained.

Seaview Diving Contractors, Inc. thanks you for the opportunity to service you underwater needs. Please call us at (920) 833-7601 with any questions or concerns you may have.


NORTH
N
Scale 1"=20'
9.8
Breach Found in #10 pipe 10 ft from end
10 FT
Concrete, sheet piling, and trash racks found to be in good condition
Concrete in between pipes in good condition
No Undermining Found
583.5
Concrete
Some undermining Found 5' wide by 2' Deep
WOOD DECK
Asphalt
Stamp
FLAG STONE
CONC.
FISH
LADDER
CONC.
CONC.
CONC.
CONC. SLABS
CONC. PATH
STONE WALL
CONC. WALK
CONC.
CONC.
3.55
12" C.I. WATERMAIN
50 FT
Small verticle crack Found 50 FT from corner
DOCK LINE ESTAE
TRAVERSE CITY C
ORDINANCE AMEN