EVERGREEN METROPOLITAN DISTRICT
Water and Wastewater
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September 16, 2019

Ms. Anna Mauss, PE
Colorado Water Conservation Board
1313 Sherman Street, #718
Denver, CO 80203

Re: Loan Feasibility Study Grant for Evergreen Dam Rehab
Grant Contract Number POGG1, PDAA, 201900002360
Letter of Intended Next Steps

Dear Ms. Mauss:

This letter is intended to provide you with the District's best estimate of our next steps for the Dam Rehabilitation Project. It was determined the gate leaf must be replaced and we plan this replacement in 2019. While the remainder of the project is budgeted for 2020, we are waiting until a new agreement is worked through and entered into with the City and County of Denver before moving forward with this project. The Board of Directors may be interested in a loan through the Colorado Water Conservation Board once we are ready to move forward.

Please do not hesitate to contact me if you have any questions.

Thank you.

Sincerely,

David W. Lighthart
General Manager
DWL/str

GEI Consultants

Consulting Engineers and Scientists

Condition Assessment Report

Evergreen Dam Outlet Works

Evergreen, Colorado

Submitted to:
Evergreen Metro District
P.O. Box 3819
Evergreen, CO 80437-3819

Submitted by:
GEI Consultants, Inc.
4601 DTC Boulevard, Suite 900
Denver, CO 80237
303-662-0100

June 2019
Project 1804163

Courtney Mattson, P.E.
Project Engineer

Chad Masching, P.E.
Project Manager

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Appendices

1. Introduction and Background

1.1 Project Description and Operational History

Evergreen Dam is located on Bear Creek, at the intersection of Bear Creek Road/Colorado Route 74 and Colorado Route 73, in Evergreen, Colorado. The dam is a concrete gravity structure, originally constructed between 1925 and 1926 and impounds Evergreen Lake. The dam and lake are owned by Denver Mountain Parks, serving as a recreational asset as well as water supply for the Evergreen Metropolitan District (Evergreen Metro). Evergreen Metro operates the dam under a long-term leasing agreement with Denver Mountain Parks. The dam is on the state historic register and is under the jurisdiction of the Colorado Department of Water Resources, State Engineer's Office, Dam Safety Branch (SEO Dam Safety).

The dam is 41 feet tall, with a spill section set at El. 7071. Currently, the dam operates as a flow-through reservoir, with lake inflows either cascading over the spillway or being utilized by Evergreen Metro through their 16-inch diameter raw water intake located at the left abutment of the dam. This raw water intake was constructed in 1966 and penetrates the dam at El. 7065.7. Additionally, the dam was constructed with a 42-inch diameter outlet works conduit monolithically cast into the left abutment non-spill section of the dam. This outlet works has not been functional for decades, and the inability to draw Evergreen Lake down in an emergency situation has been a recurring noted deficiency during dam safety inspections by SEO Dam Safety. Additionally, Evergreen Metro cannot adequately comply with senior water right calls from downstream users due to this issue. The overflow section of the dam has concrete spalling issues, typically at construction joints at the crest and downstream face. The downstream face cannot be inspected nor repairs made to the concrete due to the inability to draw the lake level below the crest.

GEI Consultants, Inc. (GEI) contracted with Evergreen Metro to perform a condition assessment of the Evergreen Lake Dam Outlet Works and to develop feasibility level alternatives for rehabilitating the outlet works or providing an alternative means for drawing down the lake. This condition assessment is being completed with a partial funding match from the Colorado Water Conservation Board.

Components of the Evergreen Dam outlet works relevant to this study include the upstream intake gate and trashrack, the cast iron and riveted steel pipe outlet conduit, the downstream terminal vault and the outlet discharge. The system is shown on the Evergreen Dam outlet works site plan (Figure 1).

The 1925 construction drawings and 1966 Evergreen water system drawings were used as references and are included in Appendix A. The Engineer's Inspection Reports (EIR) performed in 2012 and 2013 reference 1995 as the last outlet inspection.

1.2 Project Objectives and Purpose

The approach of the outlet works assessment was designed to evaluate the condition of the upstream and downstream components and provide general recommendations for rehabilitation of the outlet works system.

1.3 Project Team

GEI performed inspection services with support from Evergreen Metro staff and Inland Marine Services. GEI's team consisted of:

- Chad Masching, P.E. – Project Manager
- Courtney Mattson, P.E. – Inspection Engineering and Documentation
- Sarah Skigen-Caird – Permitting Assistance
- Paul Eggers, P.E. – Quality Assurance Review

Evergreen Metro performed duties including removal of the terminal vault roof for inspection access, cleaning debris from the terminal vault, placing a tap on the downstream outlet works to identify if the system was pressurized, and coordinating with the diving contractor.

Evergreen Metro contracted directly with Inland Marine Services to provide dive inspection and sediment removal services at the upstream gate.

1.4 Mobilizations

Several mobilizations to the Evergreen Dam were required to complete the outlet works inspection. A timeline of key mobilizations and associated tasks are summarized in the following:

- 10/29/2018 to 11/02/2018 – Downstream vault access and debris removal
- 11/14/2018 – Wet tap of 16-inch line
- 02/11/2019 to 02/27/19 – Upstream debris removal
- 03/05/2019 – Upstream gate removal

All mobilizations occurred with the spillway overflowing the dam crest under normal operating conditions. The following sections describe the procedures and results associated with each task of the outlet works inspection.

2. Downstream Inspection

The downstream outlet works sediment removal and inspections were completed between October 29, 2018 to November 14, 2018. The downstream terminal vault is located below a pedestrian pathway that leads up to the dam crest. The corrugated metal roof of the vault was previously covered with gravel to allow pedestrian access over the vault. Evergreen Metro staff closed the path to pedestrians on October 29, 2018 and began removing the gravel fill over the corrugated metal roof. The roof was not original to the structure. Approximately 6-inches of gravel fill was removed to allow access into the vault. Once the vault roof was opened, Metro District staff conducted air monitoring to verify that hazardous atmospheric conditions were not present within the vault space. The vault did not contain any air quality issues.

The vault initially required pumping to remove water from inside the structure. The structure contained a weep hole below the tailwater level of Bear Creek, directly below the dam. A patch was applied over this weep hole to allow complete dewatering of the structure. Once the vault was dewatered, it was noted that the interior of the structure was covered with silt and sediment assumed to be from high tailwater inflows into the vault during major spill discharges. In addition to silt and sediment, the floor of the vault was covered with rotten timber beams that had previously supported the roof. When the corrugated metal roof was constructed, structural channels were constructed to span between the walls of the vault to support the corrugated metal roof.

An additional vault constructed in 1966 adjacent to the outlet works vault was opened but was not included in this condition assessment. The lake outlet vault was modified in 1966 to tie in a 16-inch line to the 42-inch outletworks conduit. The water treatment plant vault is located north of the lake outlet vault.

2.1 Lake Outlet Vault Inspection

GEI completed visual observations of the valve vault before and after debris was removed. During our inspection, it was noted that the original construction drawings included three 30-inch diameter tee connections to the outlet conduit within the vault. Our inspection confirmed the presence of two 30-inch tees within the vault. Both of these tee connections were installed to stick up vertically. A ½-inch thick steel bulkhead was constructed on top of the upstream tee, apparently as part of the original construction. On the second tee, a 4-foot tall, 30-inch by 16-inch tee was constructed on top of the outlet tee section. This tee was constructed as part of the 1966 modifications and was galvanized steel. A ½-inch thick 30-inch bulkhead (also apparently part of the original construction) was bolted to the top of this tee. A 16-inch diameter galvanized steel pipe was connected to this tee extension and exited through the north wall of the outlet vault, with a centerline approximately 63-inches above the centerline of the outlet works conduit. In the smaller vault adjacent to the outlet works terminal vault, a valve was constructed on this pipe prior to connecting with the 16-inch diameter water treatment plant raw water line at a Tee. This valve was assumed to be in the closed position, but the position was not verified.

An additional 24-inch diameter tee connection was constructed downstream of the 30-inch diameter tees. This third connection was installed horizontally, with the pipe penetrating through the south wall of the outlet works vault and terminating at a blind flange within the tailwater below the dam. The flange was mostly covered by sediment within the tailwater. However, Evergreen Metro staff exposed the top of the penetration for documentation.

Downstream of the tee connections, the 42-inch diameter outlet pipe reduces down to 36-inches for a 36-inch diameter gate valve. The gate valve was manufactured by Ludlow and was in the closed position. The operating stem of the valve extends through the vault roof. However, the operator at ground surface was non-functional and was only supported by decayed timbers.

The 42-inch and 24-inch outlet conduits were backfilled with concrete up to the springline of the pipe, which appears to have been cast integral to the floor of the vault structure. With the exception of the galvanized steel portions of the outlet conduit, the pipes appear to be coated with a coal tar enamel. No testing of the coatings was completed.

Based on micrometer measurements of the riveted lap joints, the outlet conduits have the following thicknesses:

- 42-inch diameter conduit – 0.5-inches
- 42- to 36-inch diameter reducer – 0.325-inches
- 24-inch diameter conduit – 0.25-inches

Longitudinal rivets were installed in a single row along the springline of the 42-inch conduit and along the quarter sections of the 42-inch to 36-inch diameter reducer. Rivets are also present at the tee junction of each 30-inch line, vertical up the 30-inch tee on the northside of the pipe, at the 24-inch line tee junction and around the collar of the 42-inch to 36-inch diameter reducer. In general, the rivets were measured to be 1.75-inches wide and 0.625-inch high.

Downstream of the 36-inch diameter valve, a 36-inch by 42-inch expansion occurs in the outlet conduit. The conduit penetrates the downstream (east) wall of the vault and discharges to Bear Creek.

The outfall present on the east side of the vault was observed to be constructed of a reinforced concrete pipe extending approximately 2 feet long into Bear Creek. It is assumed that the conduit transitions from cast-iron to concrete at some point through the outlet vault. The invert of the pipe was within 1 foot of the observed creek bottom and could not be inspected.

2.1.1 16" Line Wet Tap

As part of the condition assessment, GEI needed to verify if the outlet conduit was pressurized in order to assess if it was safe to remove one of the 30-inch diameter tee bulkheads off of the outlet conduit to perform an internal inspection of the outlet conduit. A wet tap of the outlet conduit was required to verify if the pipe was pressurized. It was agreed by GEI and Evergreen Metro staff that the best location for this wet tap would be through the 16-inch diameter galvanized steel pipe connecting to Evergreen Metro's raw water intake. Evergreen Metro procured a saddle to complete a ¾-inch diameter wet tap. Once the pipe was tapped, it was observed that the tap was pressurized. Evergreen Metro installed a pressure gage at the end of the tap and recorded 9 pounds per square inch (psi), which is approximately equal to the static head of the lake. Evergreen metro connected a hose to the tapped connection and ran water through the hose for several hours to determine if the pressure would dissipate. After the pressure did not decrease, it was determined that either the outlet gate was full or partially opened or that there was a break in the outlet conduit upstream of the valve vault. Due to this condition, GEI and Evergreen Metro decided that it would not be possible to dewater and inspect the upstream conduit as part of this condition assessment without closing the upstream gate.

2.2 Summary

The downstream outlet works vault was originally observed to be in a poorly maintained condition, with sediment and debris covering much of the outlet conduit. After the vault was cleaned by Evergreen Metro, the outlet conduit itself was observed to be in satisfactory condition. Portions of the external coating were missing, but large scale corrosion or pitting was not documented. Because the outlet works conduit was constructed with concrete up to the springline of the conduit, it will be difficult to modify the conduit to accommodate additional valve configurations beyond what currently exists. The interior of the conduit was not able to be assessed due to the fact that the conduit was pressurized. Measurements taken of the outlet vault during the condition assessment are documented in Figures 2 and 3, and inspection photographs are in Appendix B.

3. Upstream Inspection

Sediment and debris removal and gate inspection at the upstream end of the outlet works were completed by Inland Marine Services from February 11 to March 3, 2019. All depth measurements were taken from the water surface with an estimated relative elevation (El) of 7071, which is also the spillway crest elevation.

3.1 Permitting for Sediment Displacement

In order to perform visual observations of the upstream gate, accumulated sediment on the upstream face of the dam adjacent to the outlet works gate and trashrack had to be removed. GEI coordinated with the US Army Corps of Engineers to determine permitting requirements for the maintenance activities. Only a formal notification was required.

Denver Mountain Parks was also notified of the planned maintenance activities.

3.2 Sediment Displacement and Debris Removal

In order to displace sediment from the upstream side of the dam to the downstream dam tailwater, Inland Marine first established a silt curtain within the southern area of the tailwater. HDPE conduit was fused and strung along the left abutment of the dam to the lake, and a flexible hose with a valve installed near the end was extended into the lake. The HDPE conduit crossed to the south side of Bear Creek, and a valve was constructed at the end of the pipe. A flexible hose extended from the valve to the tailwater within the curtained area. A hole was cut into the upstream ice at the lake for diver access. Sediment displacement was completed by creating a siphon to suck water and sediment from the lake side of the dam to the tailwater side of the dam. After initial sediment displacement, it was noted that some turbidity sediment was escaping through the silt curtain, so siphon activities were stopped. Inland Marine installed a second, deeper silt curtain and resumed silt displacement after the second curtain was installed. GEI performed periodic observations of the silt displacement.

The sediment was initially 18-feet above the invert of the outlet conduit when divers first entered the lake. In addition to sediment, two large metal debris items were removed. The sediment mostly consisted of fine-grained soil with branches, pine cones, and other organic material intermixed within the silt matrix. This material was easily displaced through the siphon for the top several feet before becoming more densely compacted. The divers used a combination of small garden tools and compressed air to break up the dense soil material so that it could pass downstream through the siphon.

Small rocks and boulders were encountered below the dense soil at a depth of 24.5 feet (El 7046.5) on the exterior of the trashrack. The boulders were too large to be moved by the divers without additional equipment. Inland Marine focused their efforts on removing the sediment and silt material remaining within the interior of the trashrack. The top of the trashrack was cut to allow diver access, and the sediment removal progressed until the divers exposed the gate and a concrete floor at the bottom of the trashrack.

3.3 Trashrack

The 1925 construction drawings describe the trashrack or 'screen' as a 'semi-circular type with 4-inch openings horizontal and vertical; screen bars to be of 1-1/4 (inch) diameter steel rods securely fastened thru semicircular rings at top and bottom.' Based on steel bar samples removed by the divers, portions of the trashrack steel bars have been reduced to ¾-inches thick in areas. The trashrack extends approximately 3.5 feet into the lake from the concrete headwall of the left abutment. The horizontal distance between the two points where the trashrack meets the wall was measured at 5.8 feet, meaning that the trashrack is essentially semi-circular. The apex of the trashrack was measured 12 feet from the concrete floor. The vertical bars of the trashrack were observed by divers to be cast into the concrete floor and had a clear opening of approximately 2.5 inches. The trashrack is bolted to the concrete headwall at four locations with two semi-circular horizontal bars spaced at about 3.5 feet from each other, approximately 2 feet above the concrete floor.

The top of the trashrack bend at the top to close the fabrication. The divers cut the topmost bars and removed them to gain access behind the trashrack. Based on diver observations, the trashracks currently hold back approximately 6 feet of large diameter rock from falling onto the upstream gate.

3.4 Gate and Stem

Following the removal of sediment and debris, a gate inspection was conducted in which the divers recorded video and took measurements of the gate assembly. The divers observed that the gate was opened approximately 7.5 inches. The gate frame was observed to be bolted to the dam on the left and right sides of the gate. However, the lower sill of the gate frame appears to have been cast into the concrete slab at the bottom of the trashrack enclosure. The outlet pipe was observed to contain loose silt, and the outlet conduit invert was approximately flush with the concrete sill. The dive team confirmed that there were no additional items of debris or sediment preventing the gate from being moved to the closed position. Observations established that the gate stem has three stem guides securing it to the left abutment at depths of 2-, 10- and 18- feet below the water surface (El 7071). There were also two stem couplings present at depths of 6 and 26 feet, respectively. The stem circumference was measured to be 7.9 inches (2.5-inch diameter) at a depth of approximately 3 feet, and 9.5 inches (3.0-inch diameter) at a depth of 18 feet, just below the level of the silt prior to the sediment displacement operations. The corrosion above the silt line was noted to be greater than below the silt. Based on these observations, it is likely that the upper gate stem lost at least 0.5-inches of steel thickness due to corrosion.

Following discussion with GEI about the unknown condition of the gate leaf, Evergreen Metro elected to have Inland Marine remove it from the upstream outlet works for above water inspection. During the final mobilization on March 5 divers removed a section of the gate stem approximately 6-feet long, from below the third stem guide at a depth of 18-feet. Evergreen Metro then removed the remaining (~6-feet) lower gate stem and gate leaf with a truck-mounted crane by pulling it upward out of the guides that secured it to the left abutment. Following the removal of the gate leaf the divers repaired the opening in the trashrack.

3.5 Summary

The upstream outlet works assembly was found to be in poor condition. The gate operator was not functional, and the gate stem above the initial sediment line had a thick coating of rust and scale. After removal of a portion of the corrosion, the gate stem above the sediment line and trashrack below the silt line show signs of approximately 0.5-inch of section loss due to corrosion. Although the amount of rock and debris present on the upstream side of the trashrack can attest to the current strength of the steel, future performance cannot be estimated. A material assessment of the cast iron gate leaf was not performed. Upon visual inspection, the gate leaf does have some pitting, but it has not undergone the same amount of corrosion as the steel members.

The interior condition of the conduit was unable to be evaluated during this investigation, and it is likely to contain sediment due to the gate being maintained in partially opened for a period of time. Documentation of the upstream gate inspection and a summary of sediment removal are found in Figures 4 and 5. Inspection photographs are in Appendix B.

4. Assessment of Alternatives

Based on our review of the current condition of the Evergreen Dam outlet works, GEI has evaluated potential alternatives to replace or rehabilitate the outlet works to restore operation of low level outlet. We divided the assessment into 4 components of the outlet works system, which include the upstream control, conduit, and downstream control and vault. Each alternative is discussed in further detail below.

No alternatives which included coring through the existing dam were considered, it was assumed that the existing outlet works conduit could be rehabilitated based on observations.

Once Evergreen Metro has the ability to isolate the outlet works from the upstream, a future inspection will need to take place to assess the interior condition of the 42-inch diameter conduit. GEI believes some form of rehabilitation will be warranted to extend the future performance life of the line. Two of the most common options for in-place pipeline rehabilitation are to line the existing conduit with a smaller diameter pipe, or to construct a Cured-In-Place Pipe (CIPP) liner.

4.1 Upstream Rehabilitation

GEI has identified 3 rehabilitation alternatives for the upstream gate. These alternatives include: 1) Repairing the upstream gate and replacing the operating works and trashrack; 2) Replacing the existing gate and replacing the operating works and trashrack; and 3) Utilizing the existing 16-inch water treatment plant intake for downstream releases. Pros and cons of these options are discussed below:

4.1.1 Upstream Alternative 1: Repair Existing Gate

This option includes sandblasting and re-coating the existing outlet works gate removed in February. The gate would be refurbished and shop coated with an epoxy resin or other appropriate coating. A new gate stem and electric operator would be procured and installed. The existing trashrack would be replaced with a new fabricated structure and installed by divers. Removal of large rocks surrounding the existing trashrack would be required.

Pros

- Less underwater construction effort
- Utilizes "historic" infrastructure
- Less overall cost
- Assumed to meet SEO drawdown criteria with improvements to the downstream facilities

Cons

- Potentially less watertight than a new gate
- Relies on structural integrity of a 94-year-old gate
- Requires excavation of riprap and debris and construction of a new trashrack “in the wet” with divers

4.1.2 Upstream Alternative 2: Replace Existing Gate

This option includes procurement and installation of a new fabricated stainless steel gate, gate stem and electric operator with divers. The existing trashrack would be replaced with a new fabricated structure and also installed by divers. Removal of large rocks surrounding the existing trashrack would be required.

Pros

- New gate designed to current safety standards
- Can be designed as a flow throttling gate
- New corrosion resistant materials or coating (long gate life)
- New operator and stem would be from same gate provider
- Assumed to meet SEO drawdown criteria with improvements to the downstream facilities

Cons

- Requires excavation of riprap and debris and new trashrack by underwater construction
- Requires demolition of the concrete slab below the trashrack
- Difficult underwater construction
- Potential for non-watertight installation due to underwater construction
- Highest overall cost

4.1.3 Upstream Alternative 3: Utilize Existing 12-inch Intake

This option includes utilizing the existing 12-inch raw water intake for the water treatment plant to make lake releases.

Pros

- Existing infrastructure can be utilized at the intake
- Lowest overall cost

Cons

- Likely does not meet SEO drawdown criteria
- Limited depth of lake drawdown
- Complicated delivery between WTP and required releases - introduces a system vulnerability

4.2 Conduit Rehabilitation

GEI has identified 3 rehabilitation alternatives for the outlet conduit. These alternatives include: 1) Inspecting and relining the existing 42-inch diameter conduit; 2) Constructing a Cured-In-Place Pipe (CIPP) lining through the existing 42-inch diameter conduit; and 3) Utilizing the existing 16-inch water treatment plant intake for downstream releases. Pros and cons of these options are discussed below:

4.2.1 Conduit Alternative 1: Relining Existing Conduit

For this alternative, the outlet works first needs to be inspected after installation of the upstream gate. If the conduit is determined to be structurally adequate, the steel shell would likely be sandblasted and lined with a polyurethane or epoxy lining system.

Pros

- Utilizes existing penetration through dam
- Conduit has been subject to full hydrostatic pressure of lake (i.e. the pipe has been tested)
- Potentially can utilize the 16-inch line from second tee at the Outlet Works vault to feed WTP from lower level and allow WTP operation at lower lake levels

Cons

- Unknown condition of conduit interior
- Likely requires relining
- 94-year old infrastructure

4.2.2 Conduit Alternative 2: CIPP Line Existing Conduit

This alternative employs a trenchless construction method that sliplines an existing pipe with a resin to coat the interior of the existing 42-inch diameter conduit.

Pros

- Utilizes existing penetration through dam
- Conduit will meet hydrostatic pressure demand of all operating conditions
- Cost-effective

Cons

- Difficult to transition between upstream gate and pipe lining with CIPP lining system
- Likely requires replacement of downstream piping within vault for valve connections

4.2.3 Conduit Alternative 3: Utilize WTP Intake Pipe

This alternative utilizes the existing 12 to 16 inch WTP intake pipe system to make deliveries to Bear Creek.

Pros

- Existing infrastructure is utilized

Cons

- Likely does not meet SEO drawdown criteria
- Limited depth of lake drawdown
- Complicated delivery between WTP and required releases - introduces a system vulnerability

4.3 Downstream Rehabilitation: Vault

4.3.1 *Vault Rehabilitation*

GEI has identified 2 rehabilitation alternatives for the outlet works downstream vault. These alternatives include: 1) Rehabilitating the existing vault; and 2) Replacing the existing vault. Pros and cons of these options are discussed below:

4.3.1.1 Vault Alternative 1: Repair Existing Vault

The concrete at the base of the vault likely needs to be selectively demolished to replace the existing valve. We recommend utilizing hydrodemolition techniques, which uses a high pressure water jet to remove concrete, if demolition is required. The vault roof should also be replaced, access into the vault improved, and ventilation improvements considered.

Pros

- Existing structure is utilized resulting in a lower cost
- Good overall concrete condition

Cons

- Requires new roof and access
- Existing vault has weep hole connection to Bear Creek. Potential for vault to "float" if this weep hole is plugged. Potential for submerged valves and sediment in if weep hole is not plugged
- Conduits are partially encased in concrete, making rehabilitation difficult
- Valve configuration will be tight for addition of replacement energy dissipation valves for lake releases
- Bear Creek thalweg is above 24-inch and 42-inch conduit inverts

4.3.1.2 Vault Alternative 2: Demolish and Replace Vault

This alternative would include demolition and replacement of the existing vault structure.

Pros

- Structure can be sized to fit required energy dissipation valves

Cons

- Expensive construction
- Requires demolition of historic structure

4.4 Downstream Rehabilitation: Downstream Release Control

GEI has identified 5 rehabilitation alternatives for the outlet works downstream vault. These alternatives include: 1) Utilizing the upstream gate for flow throttling; 2) Replacing the existing 36-inch valve; 3) Constructing a new 24-inch valve; 4) Utilizing the existing 16-inch low level tap in the outlet works vault for stream discharges; and 5) Utilizing the 16-inch WTP conduit. Pros and cons of these options are discussed below:

4.4.1 Downstream Alternative 1: Utilize Upstream Gate for Flow Throttling

The existing gate valve would be removed and replaced with a straight pipe section or butterfly valve. The 16-inch connection to the WTP intake conduit would be removed, non-pressurized releases would be made through the outlet conduit to Bear Creek. Energy dissipation at Bear Creek or a flap gate may be required to prevent silt from building up within the conduit.

Pros

- Likely will meet SEO drawdown criteria
- Non-pressurized conduit through dam
- Low overall cost

Cons

- Upstream gate replacement is required with a gate capable of flow throttling
- Less expensive downstream valve criteria
- Conduit cannot be utilized for WTP flows in addition to releases
- No flow metering capabilities

4.4.2 Downstream Alternative 2: Replace Existing 36-inch Valve

The existing gate valve would be removed and replaced with a new knife gate valve capable of throttling flow. The 16-inch connection to the WTP intake conduit could still be utilized for delivering water to the WTP through the low level outlet. Energy dissipation at Bear Creek or a flap gate may be required to prevent silt from building up within the conduit.

Pros

- Utilizes existing piping
- Likely meets SEO drawdown criteria

Cons

- Difficult to design for flow metering capabilities
- Discharges to Bear Creek below crown of pipe (potential for sediment)
- Likely requires energy dissipation structure

4.4.3 Downstream Alternative 3: Construct New 24-inch Valve on Tee within Vault

The existing bulkhead on the 24-inch Tee connection to the outlet works would be removed and a new flow throttling valve would be installed on the 24-inch conduit. Releases to Bear Creek would be made through this conduit.

Pros

- Utilizes existing piping
- Lower cost valve than 36-inch

Cons

- No flow metering capabilities

- Discharges to Bear Creek below crown of pipe (potential for sediment)
- May require energy dissipation structure
- Potentially does not meet SEO drawdown criteria
- Valve likely required outside of vault (exposed to spillway discharges)

4.4.4 Downstream Alternative 4: Utilize Existing 16-inch Valve from Vault

The existing 16-inch Tee within the Outlet Works vault would be utilized to provide discharges to Bear Creek. The pipe would be reconfigured near the smaller valve vault adjacent to the Outlet Works vault.

Pros

- Potential for flow metering capabilities
- Ability to discharge to Bear Creek at a higher level than existing WTP piping

Cons

- Potential for 42-inch outlet conduit to fill with sediment without cleanout potential
- May require a small energy dissipation structure
- Does not meet SEO drawdown criteria

4.4.5 Downstream Alternative 5: Utilize 16-inch line from WTP

The existing WTP intake pipe would be utilized to provide releases to Bear Creek in addition to feeding the WTP. A new discharge pipe would be connected to the existing conduit at the WTP valve vault adjacent to the Outlet Works vault.

Pros

- Ability to discharge to Bear Creek at a higher level than existing piping

Cons

- May require an energy dissipation structure
- Potential loss of pressure for WTP intake
- Does not meet SEO drawdown criteria

Based on our review of project conditions, GEI has prepared our condition assessment report with the following feasibility level alternatives:

Alternative 1: Replace the existing gate with a new fabricated gate capable of flow throttling. Excavate the debris upstream of the gate intake and replace the trashrack. Assess the internal condition of the existing outlet works conduit after gate installation, selecting to either reline the existing conduit or construct a CIPP liner within the existing conduit. Perform selective demolition in the vault structure and rehabilitate. Consider a downstream gate knife gate valve to replace the existing downstream valve. The downstream valve would not be required if releases are controlled from the upstream gate. Downstream energy dissipation may be required.

Alternative 2: Rehabilitate the existing gate and replace the gate stem and operator. Excavate the debris upstream of the gate intake and replace the trashrack. Assess the internal condition of the existing outlet works conduit after gate installation, selecting to either reline the existing conduit or construct a CIPP liner within the existing conduit. Perform selective demolition in the vault structure and rehabilitate. Identify an appropriate throttling valve and replace the existing valve. Construct downstream energy dissipation.

For either of these alternatives, a second valve could be connected either to the 24-inch or 16-inch conduits for smaller releases to Bear Creek.

The alternatives which include utilizing the existing 12- to 16-inch diameter WTP intake were evaluated but were not considered feasible because they will not meet SEO drawdown criteria and may impact Evergreen Metro's ability to meet plant intake requirements. No alternatives which included coring through the existing dam were fully developed, as the existing outlet works conduit is assumed to be adequate after inspecting and applying a new lining or constructing an internal CIPP liner.

5. Construction Cost Estimate

5.1 Cost Analysis

This cost analysis has been prepared to assist in selection of a preferred design alternative, to identify key cost areas of the design, and to assist in design decisions and considerations in future design developments.

This cost estimate has been developed using Association for the Advancement of Cost Engineering (AACE) Guidelines, Class 4 Cost Estimate. A summary of the AACE class limits of accuracy is summarized in Table 1 below.

Table 1 - AACE Accuracy Matrix for Estimating Classes

ESTIMATE CLASS	*Primary Characteristic*	*Secondary Characteristic*			
	LEVEL OF PROJECT DEFINITION Expressed as % of complete definition	END USAGE Typical purpose of estimate	METHODOLOGY Typical estimating method	EXPECTED ACCURACY RANGE Typical variation in low and high ranges [a]	PREPARATION EFFORT Typical degree of effort based on project cost [b]
Class 5	0% to 2%	Concept Screening	Capacity Factored, Parametric Models, Judgment, or Analogy	L: -20% to -50% H: +30% to +100%	1
Class 4	1% to 15%	Study or Feasibility	Equipment Factored or Parametric Models	L: -15% to -30% H: +20% to +50%	2 to 4
Class 3	10% to 40%	Budget Authorization, or Control	Semi-Detailed Unit Costs with Assembly Level Line Items	L: -10% to -20% H: +10% to +30%	3 to 10
Class 2	30% to 70%	Control or Bid/Tender	Detailed Unit Cost with Forced Detailed Take-Off	L: -5% to -15% H: +5% to +20%	4 to 20
Class 1	50% to 100%	Check Estimate or Bid/Tender	Detailed Unit Cost with Detailed Take-Off	L: -3% to -10% H: +3% to +15%	5 to 100

Notes: [a] The state of process technology and availability of applicable reference cost data affect the range markedly. The ± value represents typical percentage variation of actual costs from the cost estimate after application of contingency (typically at a 50% level of confidence) for given scope.

[b] If the range index value of "1" represents 0.005% of project costs, then an index value of 100 represents 0.5%. Estimate preparation effort is highly dependent upon the size of the project and the quality of estimating data and tools.

This cost estimate reflects the designs concepts presented in this Condition Assessment and related quantities, with pricing in 2019 dollars.

5.2 Cost Summary

Table 2 contains our opinion of probable construction cost for Alternative 1 – Gate Replacement. Table 3 contains our opinion of probable construction cost for Alternative 2 – Gate Rehabilitation. The lump sum item prices are based on qualitative estimates of the work required and the corresponding cost. Estimated unit prices and costs for the listed work items were derived from the following sources: 1) published and non-published bid price data for similar work from similar projects; 2) R.S. Means Heavy Construction Cost Data for 2019; 3) Engineering News Record; 4) GEI's experience on related construction work; and 5) price quotes from material suppliers and contractors.

Table 2 – Opinion of Probable Construction Cost with Gate Replacement and Upstream Control

No.	Construction Item	Estimated Quantity	Units	Estimated Unit Cost	Estimated Total Cost
1	**Upstream Demo (Rocks and Debris, Trashrack)**				
	Rock/Debris Dredging & Trashrack Demo with Divers	1	LS	$85,000	$ 85,000
				Estimated Sub Total	$ 85,000
2	**New Trashrack**				
	Procure Fabricated Trashrack	1	LS	$15,000	$ 15,000
	Install Trashrack with Divers	1	LS	$30,000	$ 30,000
				Estimated Sub Total	$ 45,000
3	**New Upstream Gate Assembly**				
	42"x42" Stainless Steel Gate, Stem and Electric Operator	1	LS	$60,000	$ 60,000
	Install Gate with Divers	1	LS	$58,000	$ 58,000
				Estimated Sub Total	$ 118,000
4	**Conduit Assessment**				
	Inspection and Assessment	1	LS	$20,000	$ 20,000
				Estimated Sub Total	$ 20,000
5	**Conduit Lining (Assume sandblast and high solids PE lining system)**				
	Sandblast and Apply High Solids PE Lining System	115	LF	$600	$ 69,000
				Estimated Sub Total	$ 69,000
6	**Vault Improvements**				
	Allowance for New Roof, Ventilation, Ladder	1	LS	$40,000	$ 40,000
				Estimated Sub Total	$ 40,000
7	**Replace Downstream Control Valve with Non-Throttling Butterfly Valve**				
	Procure and Install 36" BFV with Electric Operator	1	EA	$45,000	$ 45,000
	Procure and Install New Downstream Pipe Extension	1	EA	$30,000	$ 30,000
				Estimated Sub Total	$ 75,000
8	**Construct Downstream Energy Dissipation**				
	Allowance for Energy Dissipation and Stream Improvements	1	LS	$25,000	$ 25,000
				Estimated Sub Total	$ 25,000
				Estimated Base Construction Costs	**$ 457,000**
9	**Mobilization and Demobilization @ 10%**	-	-	-	$ 45,700
	Contingencies (10% of BCS + Mobilization)	-	-	-	$ 50,270
	Engineering Fees & Permitting @ 15%	-	-	-	$ 68,550
	OPINION OF PROBABLE CONSTRUCTION COSTS				**$ 621,520**

Table 3 – Opinion of Probable Construction Cost with Gate Rehabilitation and Downstream Control

No.	Construction Item	Estimated Quantity	Units	Estimated Unit Cost	Estimated Total Cost
1	**Upstream Demo (Rocks and Debris, Trashrack)**				
	Rock/Debris Dredging & Trashrack Demo with Divers	*1*	*LS*	*$85,000*	$ 85,000
				Estimated Sub Total	$ 85,000
2	**New Trashrack**				
	Procure Fabricated Trashrack	*1*	*LS*	*$15,000*	$ 15,000
	Install Trashrack with Divers	*1*	*LS*	*$30,000*	$ 30,000
				Estimated Sub Total	$ 45,000
3	**Repair Upstream Gate Assembly**				
	Rehab. Existing Gate, New Stem and Electric Operator	*1*	*LS*	*$40,000*	$ 40,000
	Install Gate with Divers	*1*	*LS*	*$15,000*	$ 15,000
				Estimated Sub Total	$ 55,000
4	**Conduit Assessment**				
	Inspection and Assessment	*1*	*LS*	*$20,000*	$ 20,000
				Estimated Sub Total	$ 20,000
5	Conduit Lining (Assume sandblast and high solids PE lining system)				
	Sandblast and Apply High Solids PE Lining System	115	*LF*	*$600*	$ 69,000
				Estimated Sub Total	$ 69,000
6	**Vault Improvements**				
	Allowance for New Roof, Ventilation, Ladder	*1*	*LS*	*$40,000*	$ 40,000
				Estimated Sub Total	$ 40,000
7	**New Downstream Control Valve**				
	Procure and Install 36" Knife Gate Valve w/ Elect. Operator	*1*	*EA*	*$75,000*	$ 75,000
	Procure and Install New Downstream Pipe Extension	*1*	*EA*	*$30,000*	$ 30,000
				Estimated Sub Total	$ 105,000
8	**Construct Downstream Energy Dissipation**				
	Allowance for Energy Dissipation and Stream Improvements	*1*	*LS*	*$25,000*	$ 25,000
				Estimated Sub Total	$ 25,000
		Estimated Base Construction Costs			**$ 424,000**
9	**Mobilization and Demobilization @ 10%**	-	-	-	$ 42,400
	Contingencies (10% of BCS + Mobilization)	-	-	-	$ 46,640
	Engineering Fees & Permitting @ 15%	-	-	-	$ 63,600
	OPINION OF PROBABLE CONSTRUCTION COSTS				**$ 576,640**

6. Recommendations

Based on GEI's observations of the existing outlet works system, rehabilitation of the system is possible. Either of the two selected alternatives will provide Evergreen Metro with the ability to operate the outlet works to provide required releases for Evergreen Lake. Replacement of the upstream gate with a new throttling gate will provide a reduction of risk of gate failure over the life of the dam. However, installation of a new gate carries additional difficulty and risk during construction than rehabilitating the existing gate. Evergreen Metro must also consider if there is a need to utilize the outlet works for WTP intake flows and balance the upfront construction costs and risks with long term performance risks.

7. Limitations of Liability

This report presents observations made, conclusions drawn and opinions formed from a visual inspection of this project and a review of pertinent documents relating to the construction and historic operation of this project. The purpose of this condition assessment report has been to assess the system in order to provide general recommendations for its safety and rehabilitation. Reuse of this report for any other purposes, in part or in whole, is at the sole risk of the user.

In the context intended above, the term "safety" is interpreted to be restricted specifically to major structural and control features of the project in regard to their adequacy against possible catastrophic failure due to natural or operational events. No consideration is given herein to those public safety aspects related to voluntary occupancy or use of project features in such manner as to result in personal mishaps.

GEI Consultants, Inc. desires that it be clearly understood that the conclusions regarding the condition and safety of the outlet works are not guaranteed but do represent our best judgment. Inevitably, such judgment must be recognized to be affected to an uncertain degree by the practical limitations that affect all similar evaluations, relative principally to approximate knowledge of the existing properties of the facilities and the uncertainties that are known to exist in estimating margins of safety.

8. References

(City and County of Denver, 1925) City and County of Denver, "Plans for the Evergreen Dam." September 1, 1925.

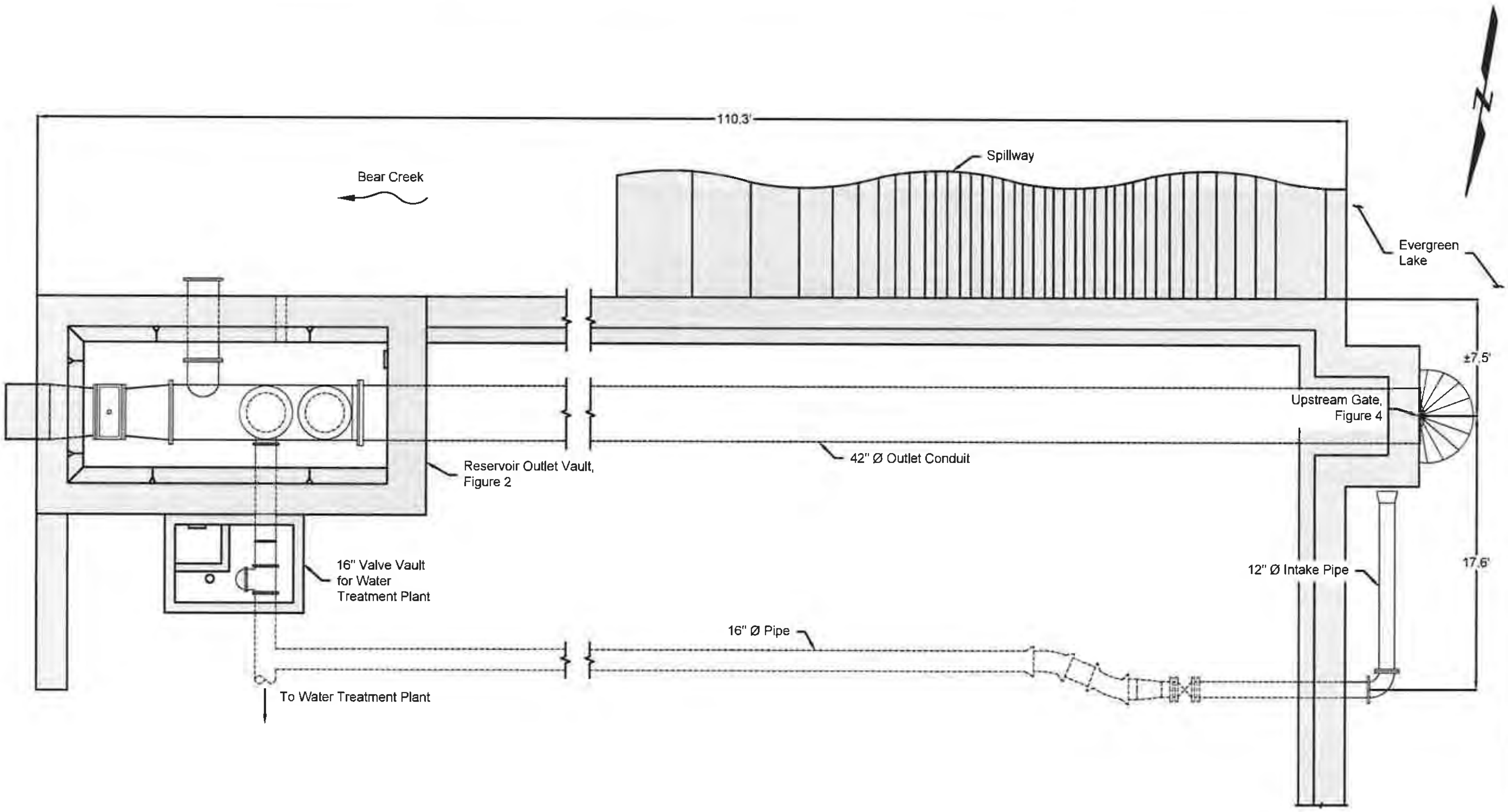
(City and County of Denver, 1979) City and County of Denver Department of Public Works, "Modification to Evergreen Dam, Project No. 78-102." March 1979.

(EIR, 2012) Gregory Hammer, P.E., Department of Natural Resources, Division of Water Resources. "Engineer's Inspection Report" August 17, 2012.

(EIR, 2013) Chad Masching, GEI Consultants, Inc. "Engineer's Inspection Report." September 25, 2013.

(Rea 1963) Dale H Rea. Consulting Engineer. "Public Service Company of Colorado, Evergreen Water System." November 29, 1963. As Constructed: April 14, 1966.FF

Figures



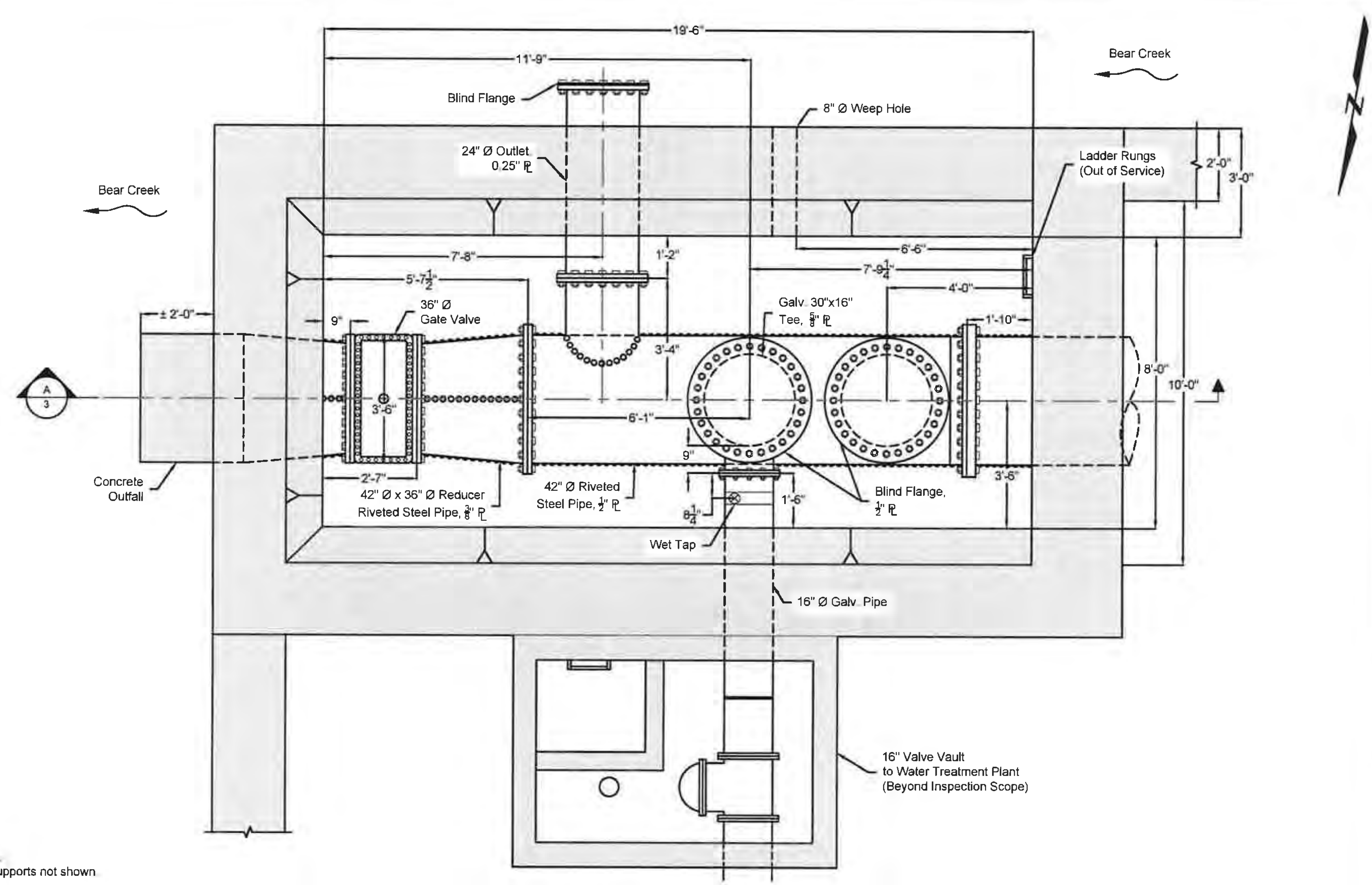
NOTE:

1. Pedestrian path, steps and surface grading not shown.

0 10 20

SCALE: 1" = 10'

Evergreen Dam Outlet Works Assessment Evergreen, CO	GEI Consultants	EVERGREEN DAM OUTLET WORKS SITE PLAN
Evergreen Metro District	Project 1804163	June 2019 Fig. 1



NOTE:
1. Roof supports not shown

0 4 8
SCALE: 1/4" = 1'-0"

Evergreen Dam Outlet Works Assessment
Evergreen, CO

Evergreen Metro District

GEI Consultants

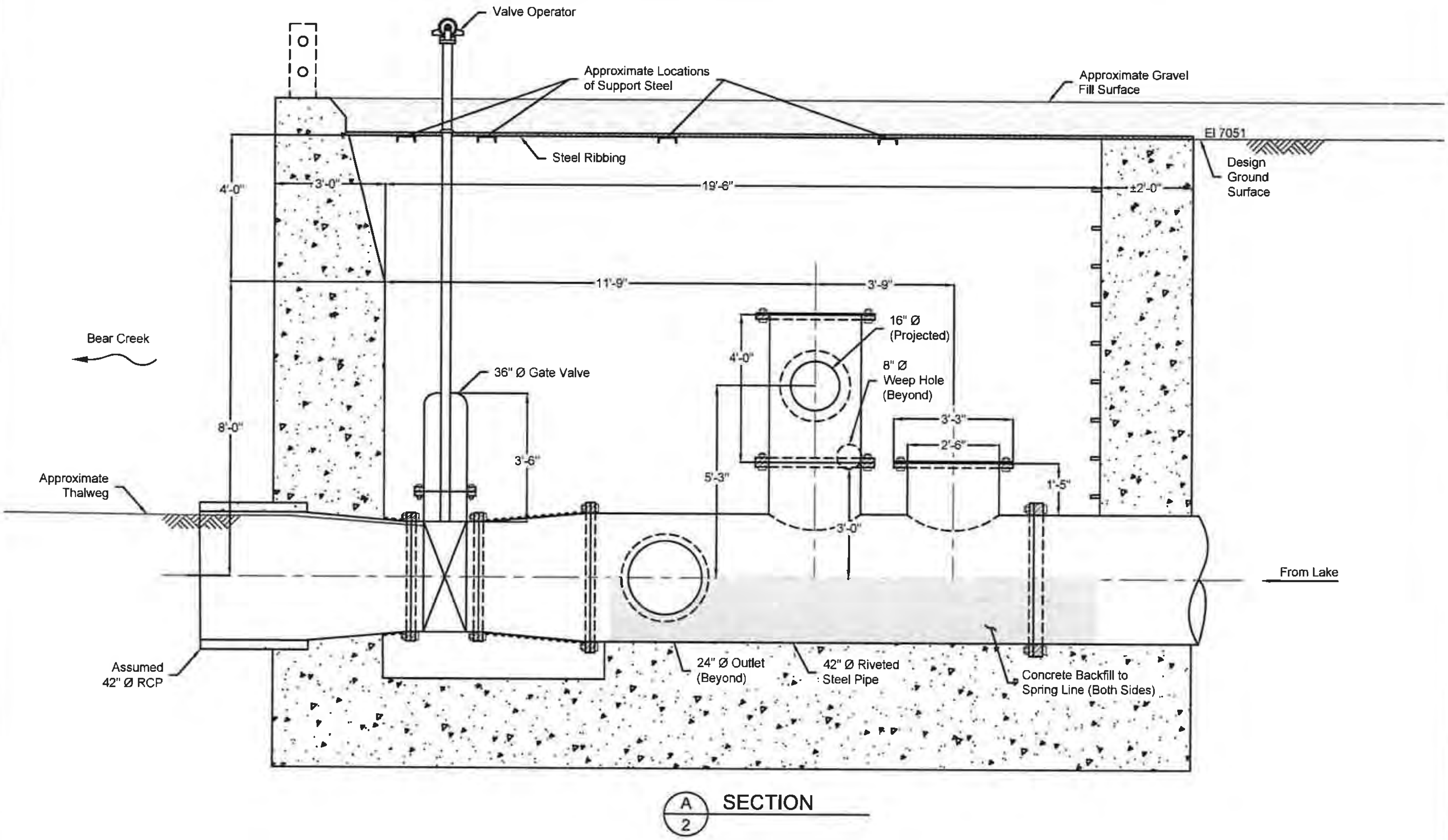
Project 1804163

RESERVOIR OUTLET VAULT

June 2019

Fig. 2

\\den1v-fs02\ P:\1804163 - Evergreen Dam Outlet Works\CAD\Design\Working\Fig 2-3 - Downstream Evergreen OW.dwg - 4/24/2019

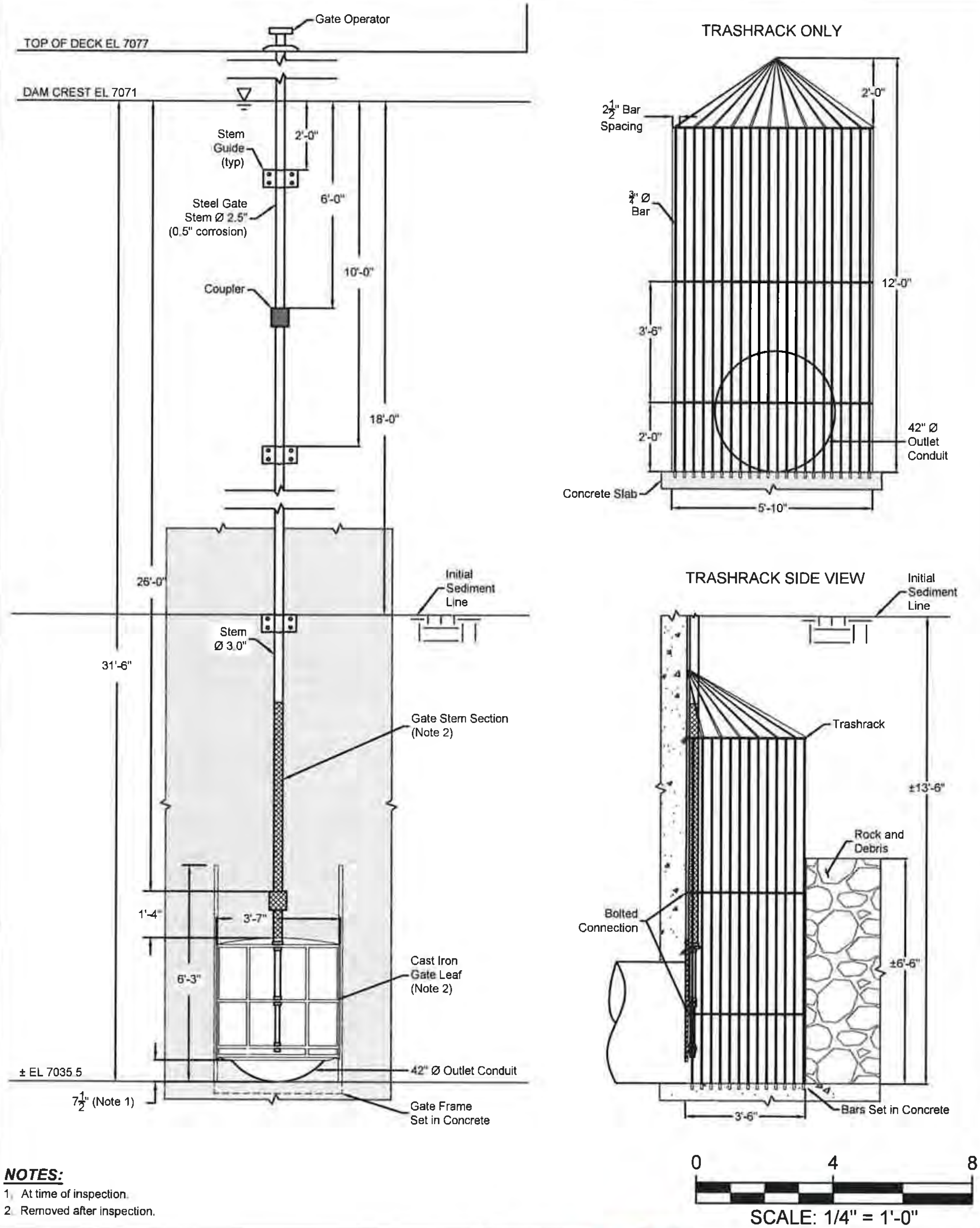


0 1/8" 1/4" 1/2"

SCALE: 1/4" = 1'

Evergreen Dam Outlet Works Assessment Evergreen, CO	GEI Consultants	RESERVOIR OUTLET VAULT SECTION
Evergreen Metro District	Project 1804163	June 2019 Fig. 3

\\den1v-fs02\ P:\1804163 - Evergreen Dam Outlet Works\CAD\Design\Working\Fig 2-3 - Downstream Evergreen OW.dwg - 4/24/2019

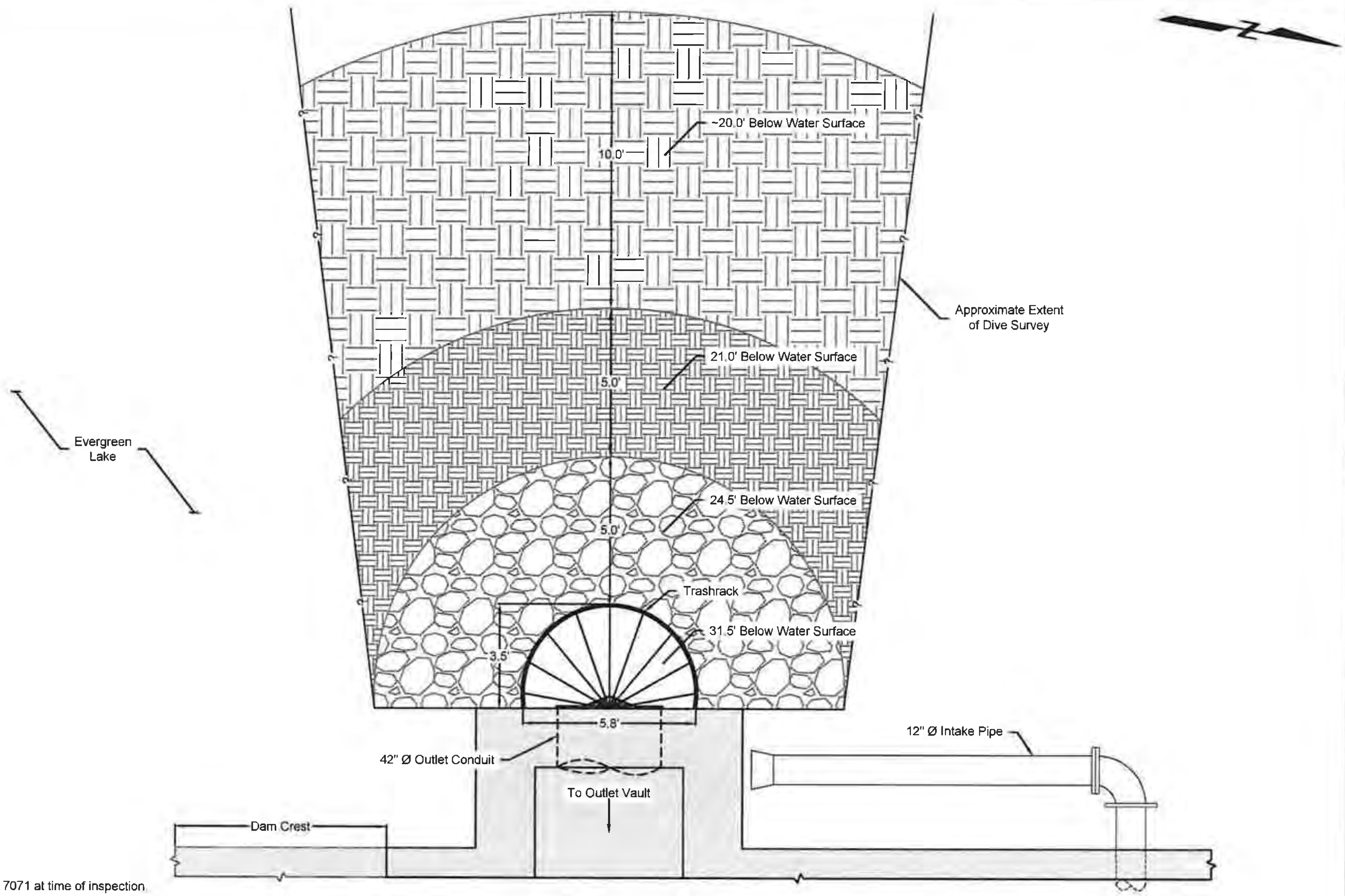


NOTES:

1. At time of inspection.
2. Removed after inspection.

Evergreen Dam Outlet Works Assessment Evergreen, CO	GEI Consultants	UPSTREAM GATE INSPECTION	
Evergreen Metro District	Project 1804163	June 2019	Fig. 4

\\den1v-fs02\ P:\1804163 - Evergreen Dam Outlet Works\CAD\Design\Working\Fig 4 - Upstream Evergreen OW.dwg - 4/24/2019



NOTE:

1. Water surface ± EL 7071 at time of inspection.

0 5 10

SCALE: 1" = 5'

Evergreen Dam Outlet Works Assessment Evergreen, CO	GEI Consultants	UPSTREAM DEBRIS REMOVAL SUMMARY OF WORK
Evergreen Metro District	Project 1804163	June 2019 Fig. 5

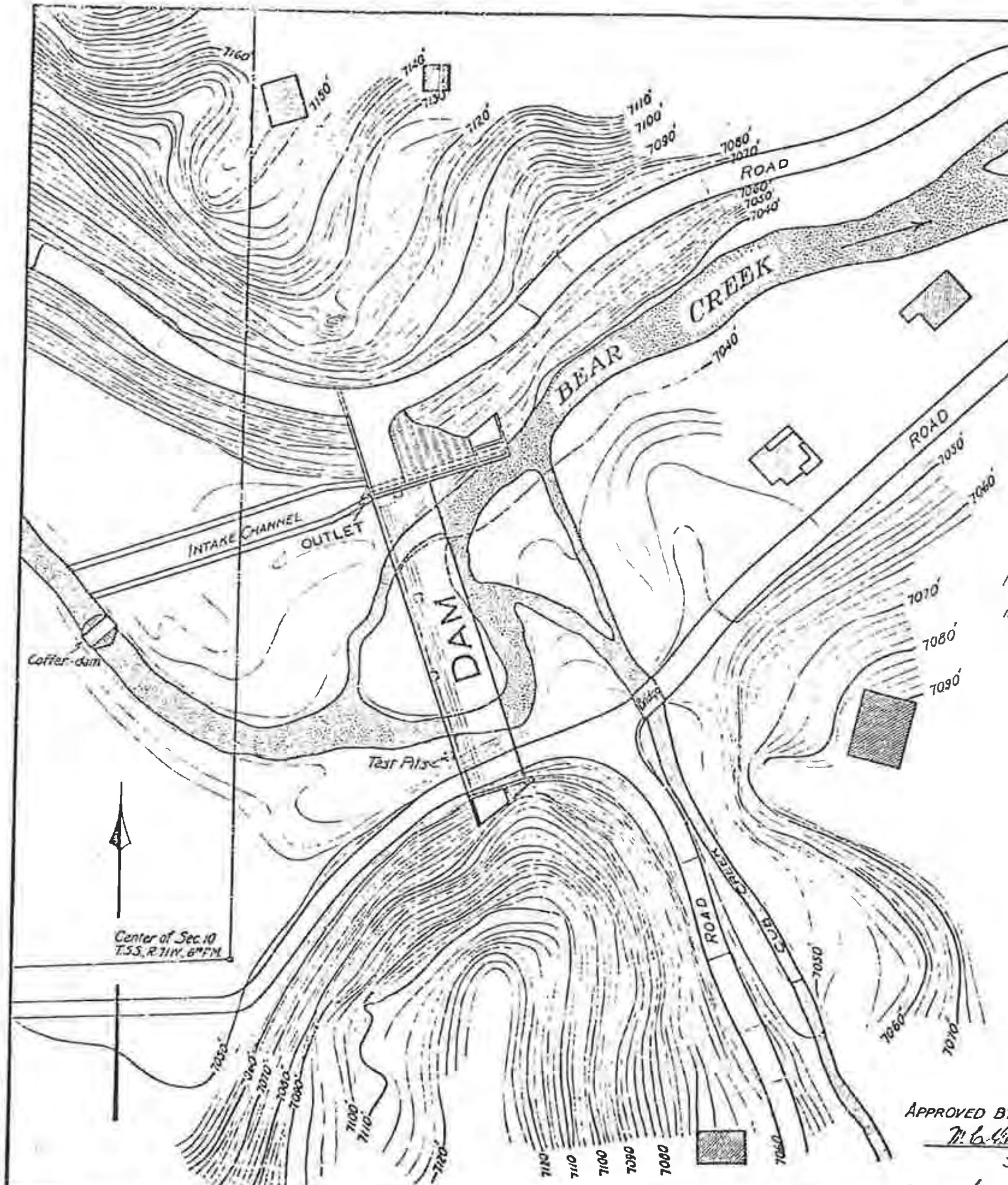
\\den1v-fs02\ P:\1804163 - Evergreen Dam Outlet Works\CAD\Design\Working\Fig 5 - Upstream Evergreen OW Sediment.dwg - 4/24/2019

Appendix A

Supporting Project Drawings and Inspection Reports

1925 – Evergreen Dam Construction

1966 – Evergreen Water System



CERTIFICATE OF APPOINTMENT

I, the undersigned, Manager of Improvements and Parks, certify that Albion K. Vickery is hereby appointed Engineer to have responsible charge of the construction of the Evergreen Dam in accordance with the Plans and Specifications prepared by George M. Bull.

Denver, Colorado Sept. 1st 1925.

Mgr. of Improvements and Parks.

CERTIFICATE OF ADOPTION

I, the undersigned, Manager of Improvements and Parks, certify that the Plans and Specifications, accompanying this certificate prepared by George M. Bull, have been accepted and adopted by the City and County of Denver for the construction of the Evergreen Dam.

Denver, Colorado Sept. 1st 1925.

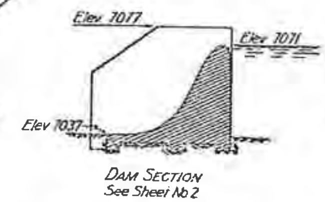
Mgr. of Improvements and Parks.

CERTIFICATE OF IDENTIFICATION

I, the undersigned, certify that I am the Engineer employed to make these Plans and Specifications, that they were made under my direction and are to be used for the construction of the Evergreen Dam.

Denver, Colorado Sept. 1st 1925.

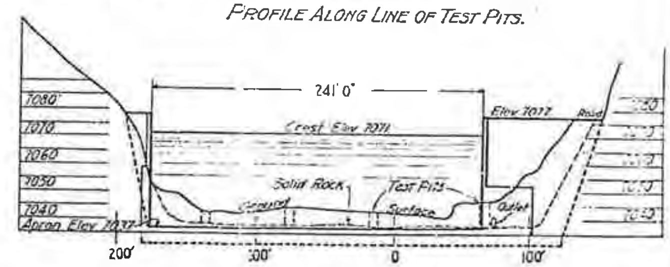
Engineer.



DAM SECTION
See Sheet No 2

Note:
The design of this structure is adapted to the installation of a concrete roadway in accordance with preliminary plans by HERBERT S. CROCKER.

PROFILE ALONG LINE OF TEST PITS.



PLANS FOR THE

EVERGREEN DAM

LOCATED ON BEAR CREEK IN THE MOUNTAIN PARKS OF THE

CITY AND COUNTY OF DENVER

IN 3 SHEETS — SHEET NO. 1.

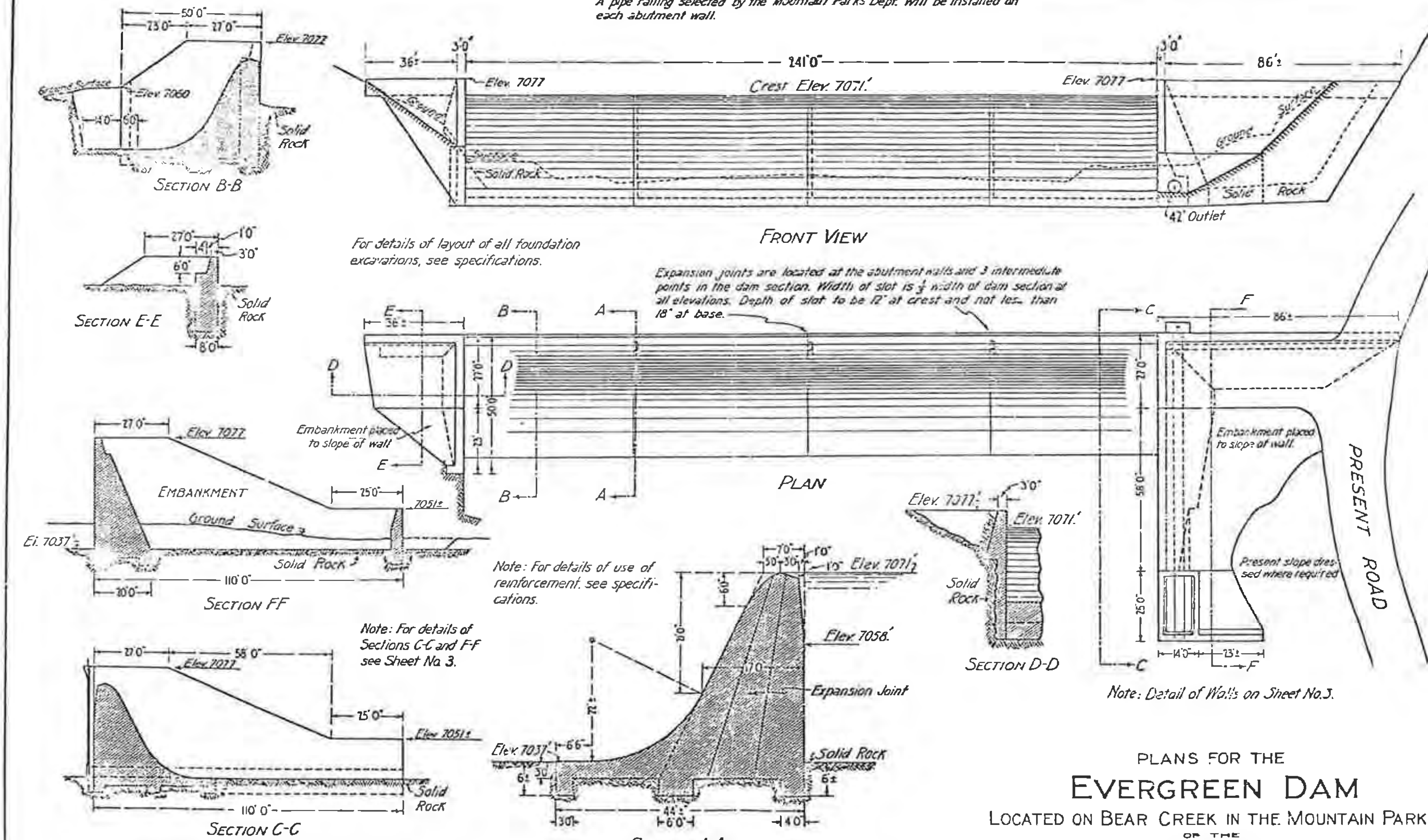
GENERAL LAYOUT

FOR CONCRETE MASONRY TYPE DAM

0 100
SCALE 1" = 40'.

APPROVED BY
State Engineer.
DATE August 18th 1926

September 1, 1925.



A pipe railing selected by the Mountain Parks Dept. will be installed on each abutment wall.

For details of layout of all foundation excavations, see specifications.

Expansion joints are located at the abutment walls and 3 intermediate points in the dam section. Width of slot is 1/3 width of dam section at all elevations. Depth of slot to be 12" at crest and not less than 18" at base.

Note: For details of use of reinforcement, see specifications.

Note: For details of Sections C-C and F-F see Sheet No. 3.

Note: Detail of Walls on Sheet No. 3.

Should solid but pervious rock be encountered in the foundation bed of the dam, a drainage system shall be installed in the foundation to suit conditions as found.

Certificates of Appointment of Engineer and Adoption of Plans on Sheet No. 1

Chas. D. Vaile
Mgr. of Improvements and Parks

Approved by M. C. Hinderlider
State Engineer

Date August 11, 1926

Certificate of Identification of Plans on Sheet No. 1.

Engineer

PLANS FOR THE

EVERGREEN DAM

LOCATED ON BEAR CREEK IN THE MOUNTAIN PARKS OF THE

CITY AND COUNTY OF DENVER

IN 3 SHEETS —— SHEET NO. 2

CONCRETE STRUCTURE DETAILS FOR CONCRETE MASONRY TYPE DAM

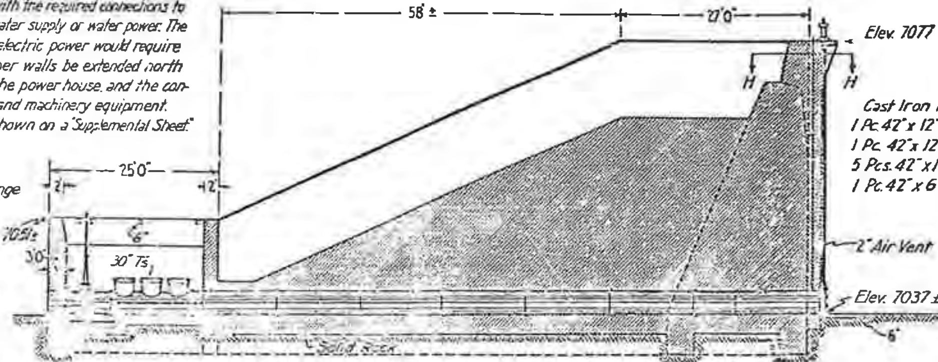
0 10' 20' 30' 40'
SCALE 1/16" = 1'

September 1, 1925

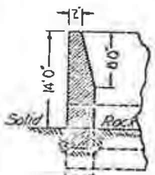
C-195

Note: This sheet contains the complete plans for the Reservoir Outlet with the required connections to tap the Reservoir for water supply or water power. The installation of hydro-electric power would require that the outlet chamber walls be extended north for a foundation for the power house, and the construction of a house and machinery equipment. These details will be shown on a "Supplemental Sheet."

1-36" Valve with flange connections.



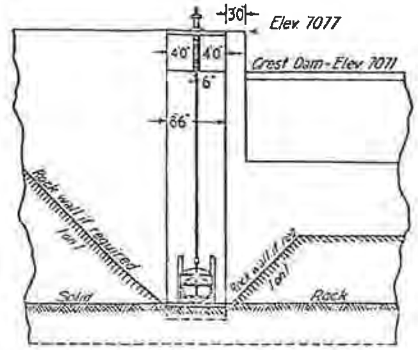
Section X-X



Section F-F

Copper Bearing Steel Pipe all ⅜" thick -
1-Flange-ended 42" x 12' with 3-30" T outlets
1-42" x 36" x 3'0" reducer with flange ends.
1-42" x 36" x 5'0" flange on 36" end only.

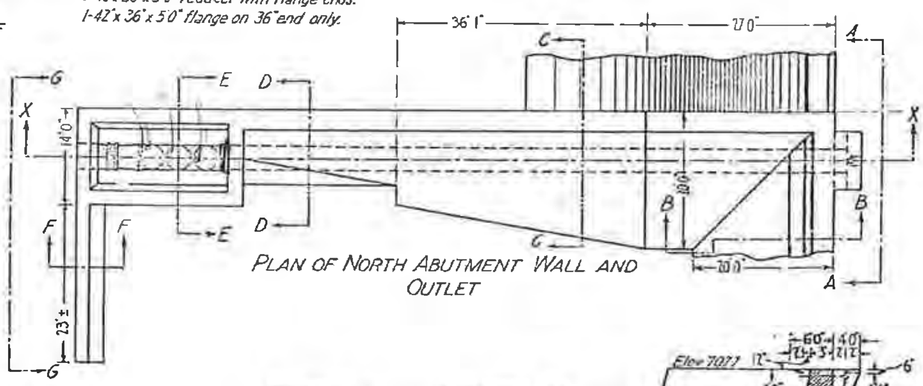
42" sluice-gate with rising stem.



Section A-A

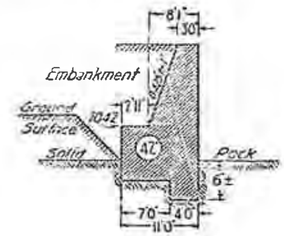
Screen

Screen to be semi-circular type with 4" openings horizontal & vertical; screen bars to be of 1¼" steel rods securely fastened thru semi-circular rings at top and bottom.



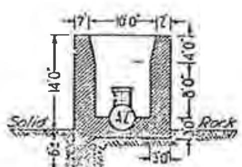
Plan of North Abutment Wall and Outlet

Section H-H

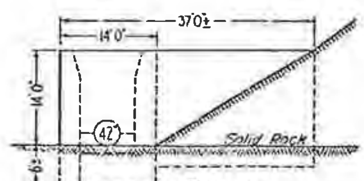


Section D-D

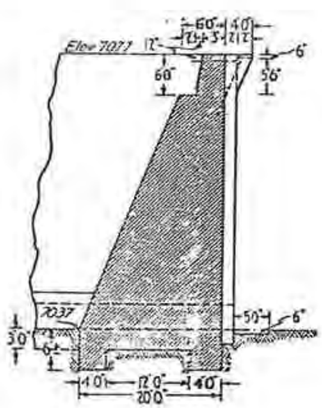
Section C-C



Section E-E



Section G-G



Section B-B

Certificate of Identification of Plans on Sheet No. 1

G. M. Bull
Engineer

Certificates of Appointment of Engineer and Adoption of Plans on Sheet No. 1

Chas. D. Vail
Mgr. of Improvements and Parks

Approved by M. C. Hinderlider
State Engineer

Date August 18th 1926

Plans for the

Evergreen Dam

Located on Bear Creek in the Mountain Parks of the

City and County of Denver

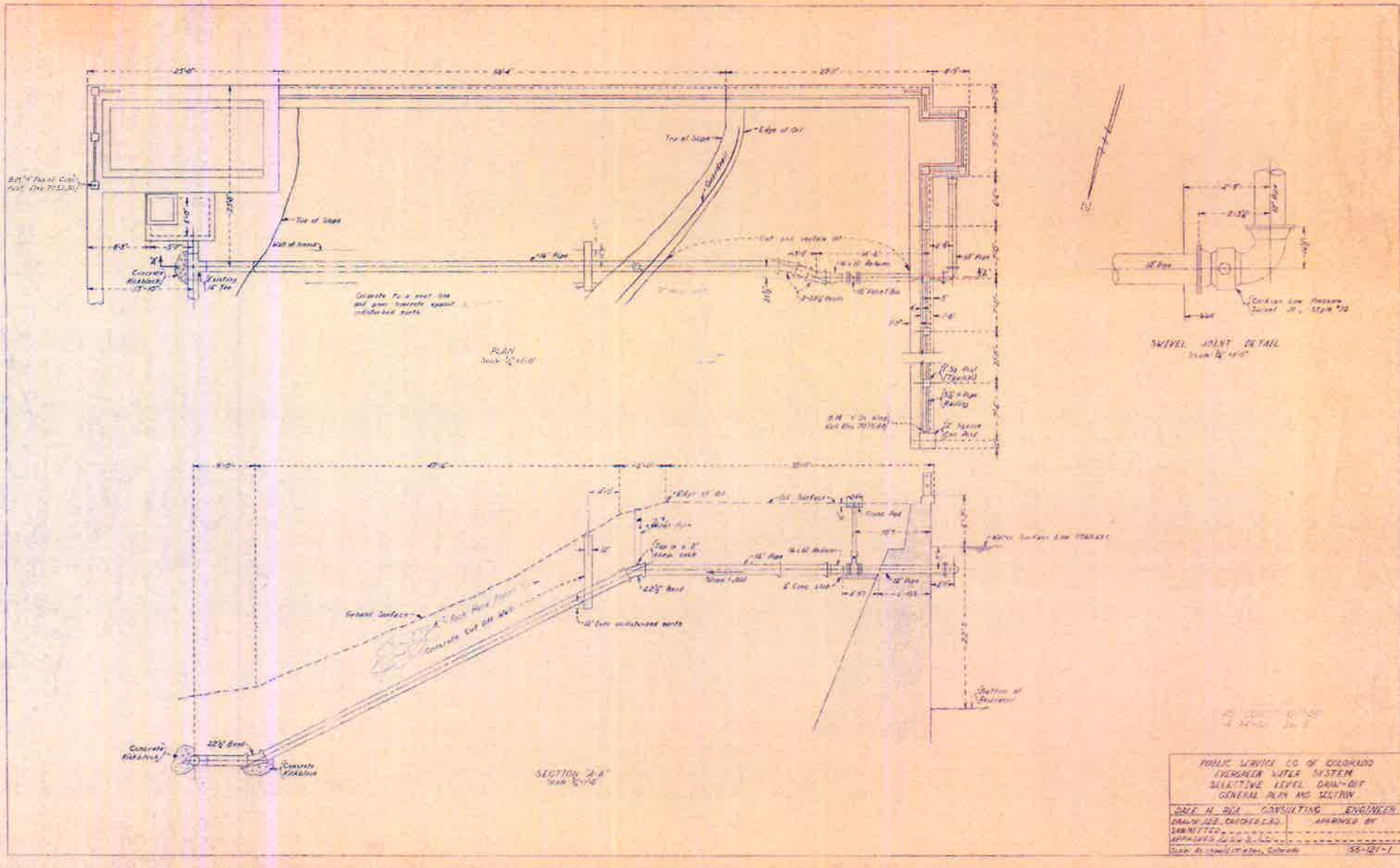
In 3 Sheets —— Sheet No. 3

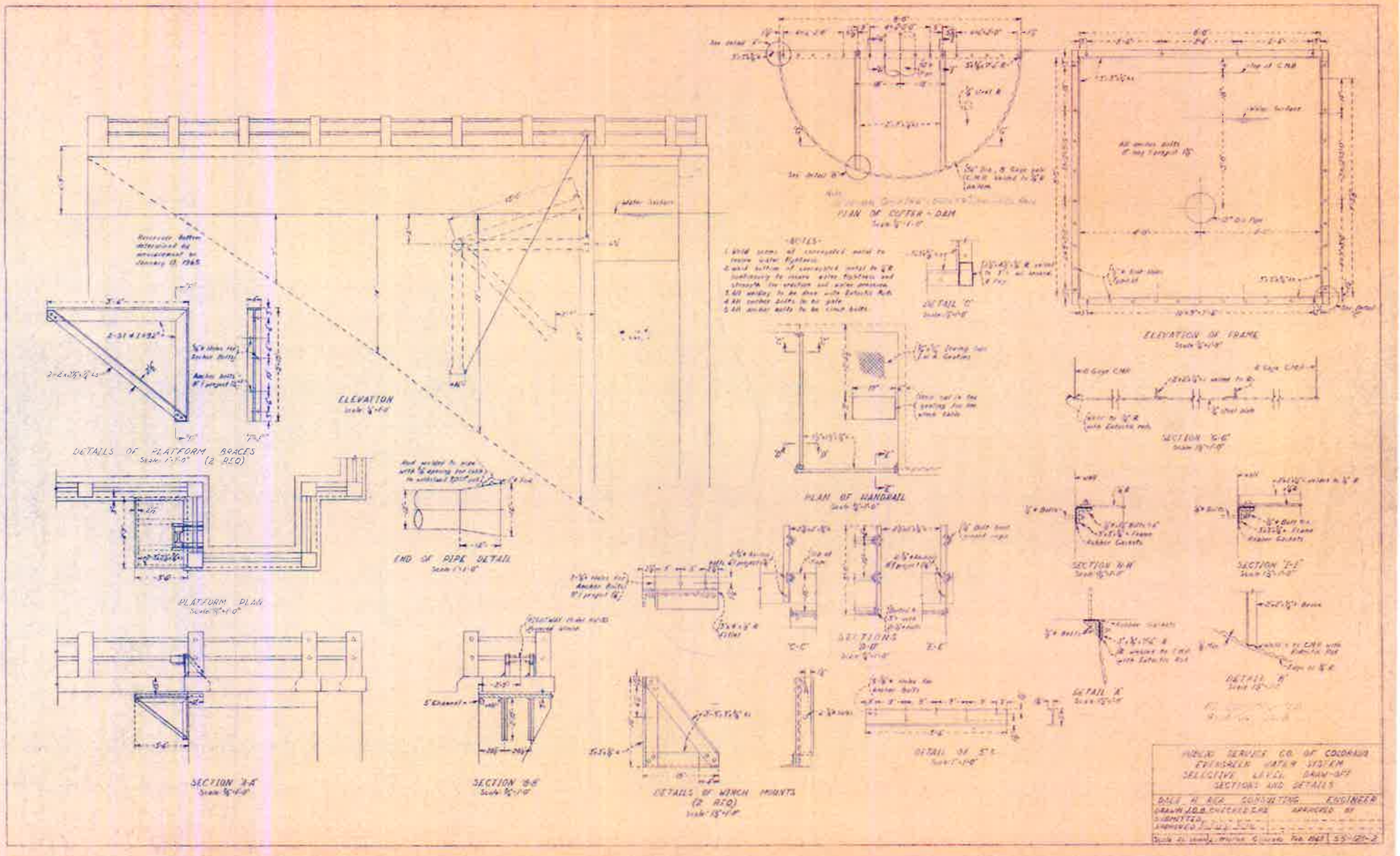
Outlet Details
For Concrete Masonry Type Dam

0 5' 10' 15' 20'
Scale 1/8" = 1'

September 1, 1925.

C-195


PLAN
SECTION "A-A"
SWIVEL JOINT DETAIL
Top of Slope
Edge of Cut
Wall of Trench
Concrete Kickblock
Existing 16" Tee
16" Pipe
22½° Bend
Ground Surface
Bottom of Reservoir
PUBLIC SERVICE CO. OF COLORADO
EVERGREEN WATER SYSTEM
SELECTIVE LEVEL DRAW-OFF
GENERAL PLAN AND SECTION
DALE H. REA CONSULTING ENGINEER
APPROVED BY
55-121-1



ELEVATION
DETAILS OF PLATFORM BRACES (2 REQ)
PLATFORM PLAN
SECTION "A-A"
SECTION "B-B"
END OF PIPE DETAIL
DETAILS OF WINCH MOUNTS (2 REQ)
PLAN OF COFFER - DAM
NOTES
DETAIL "C"
PLAN OF HANDRAIL
SECTIONS
DETAIL OF 5" C
ELEVATION OF FRAME
SECTION "G-G"
SECTION "H-H"
SECTION "I-I"
DETAIL "K"
DETAIL "H"
PUBLIC SERVICE CO. OF COLORADO
EVERGREEN WATER SYSTEM
SELECTIVE LEVEL DRAW-OFF
SECTIONS AND DETAILS
DALE H. RICK CONSULTING ENGINEER
DRAWN
CHECKED
APPROVED BY
SUBMITTED
APPROVED
Feb. 1965
55-121-2

Appendix B

Field Inspection Photos

Photo 1: Evergreen Metro workers expose steel ribbing roof of the reservoir outlet vault. In the foreground the 16-inch water treatment plant valve vault is also open.
Date: 10-29-2018 Source: C. Mattson (GEI)

	Photo 2: View of 30-inch tee within the outlet vault after most of the rotten wooden timbers have been removed. Date:10-29-2018 Source: C. Mattson (GEI)
	Photo 3: View of 24-inch drain line that runs south out of the vault. Date:10-29-2018 Source: C. Mattson (GEI)

Photo 4: View of gate valve in the outlet vault.
Date:10-29-2018
Source: C. Mattson (GEI)

Photo 5: West view of south side of outlet vault after debris removal.
Date:11-02-2018
Source: G. Jeffrey (Evergreen Metro)

Photo 6: West view of 16-inch line.
Date:11-02-2018
Source: G. Jeffrey (Evergreen Metro)

Photo 7: East view of 30-inch tee with gate valve stem in background.
Date: 11-02-2018 Source: G. Jeffrey (Evergreen Metro)

Photo 8: View of 30-inch tee from above.
Date: 11-02-2018 Source: G. Jeffrey (Evergreen Metro)

Photo 9: East view of 16-inch line on south side of vault.
Date: 11-02-2018 Source: G. Jeffrey (Evergreen Metro)

Photo 10: West view of south side of vault.
Date: 11-02-2018 Source: G. Jeffrey (Evergreen Metro)

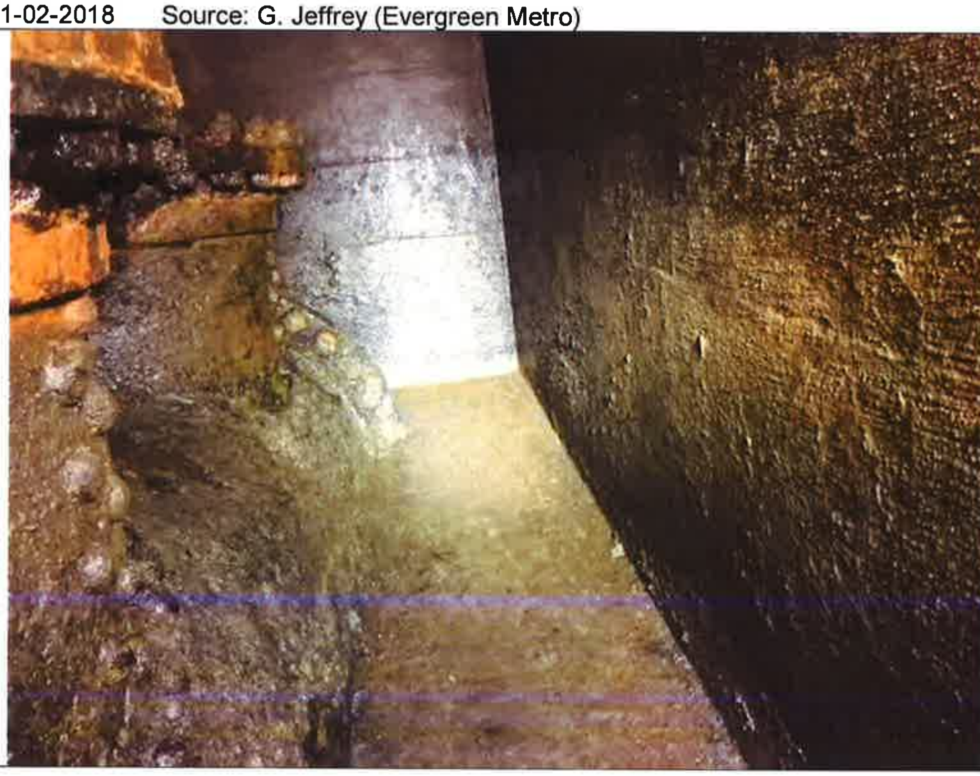


Photo 11: West view of north side of vault.
Date: 11-02-2018 Source: G. Jeffrey (Evergreen Metro)

Photo 12: Wet tap gage on 16-inch line.
Date: 11-15-2018 Source: G. Jeffrey (Evergreen Metro)

Photo 13: Steel ribbing over vault with steel beam support members running north-south. Valve operator is located above the vault, behind the ladder on the eastside of the vault.
Date: 12-07-2018 Source: C. Masching (GEI)

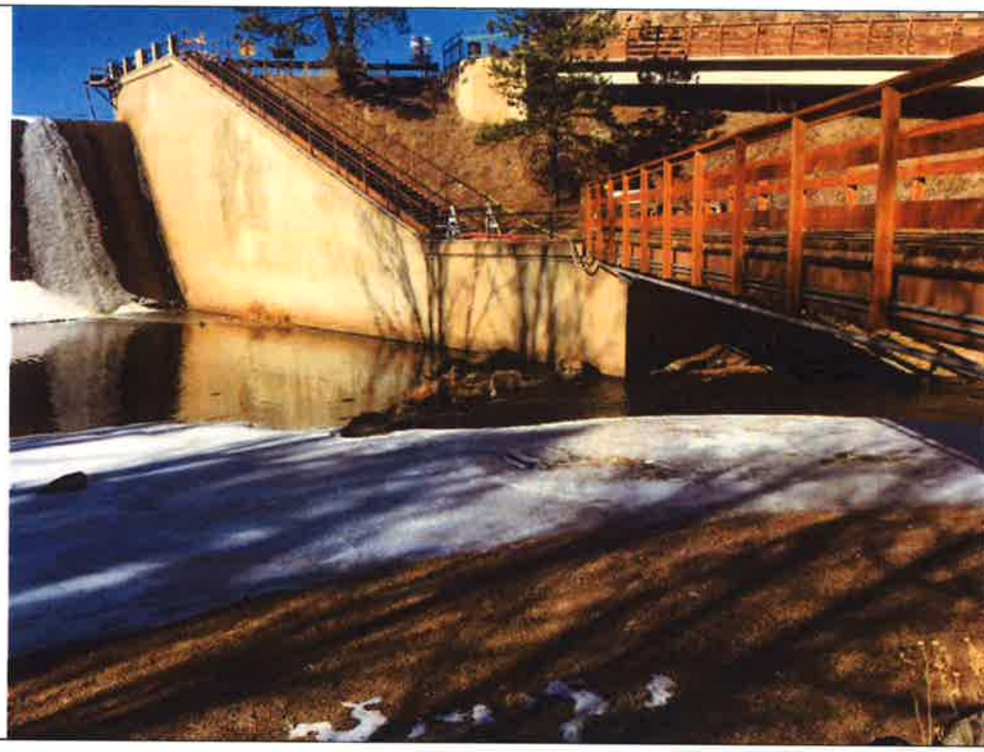


Photo 14: Left abutment and pedestrian bridge. Notice sediment at crest of outfall pipe.
Date: 12-07-2018 Source: C. Masching (GEI)

Photo 15: Flange on 42-inch conduit line located furthest west in vault.
Date: 12-07-2018
Source: C. Masching (GEI)

Photo 16: 30-inch blind flange with concrete fill to spring line of 42-inch conduit.
Date: 12-07-2018 Source: C. Masching (GEI)

Photo 17: Bottom of fabricated 30-inch x 16-inch tee with concrete fill to spring line.
Date: 12-07-2018
Source: C. Masching (GEI)

Photo 18: 30-inch by 16-inch tee installed in 1966 for water treatment plant modifications (looking west). Tee is tilted 1.5-inches north.
Date: 12-07-2018
Source: C. Masching (GEI)

Photo 19: 42-inch to 36-inch reducer conduit and gate valve.
Date: 12-07-2018
Source: C. Masching (GEI)

Photo 20: Gate valve mechanism above cover.
Date: 12-07-2018
Source: C. Masching (GEI)

Photo 21: Manufacturer label on valve cover ("Ludlow").
Date: 12-07-2018
Source: C. Masching (GEI)

Photo 22: Steel members installed to support steel ribbing roof.
Date: 12-07-2018
Source: C. Masching (GEI)

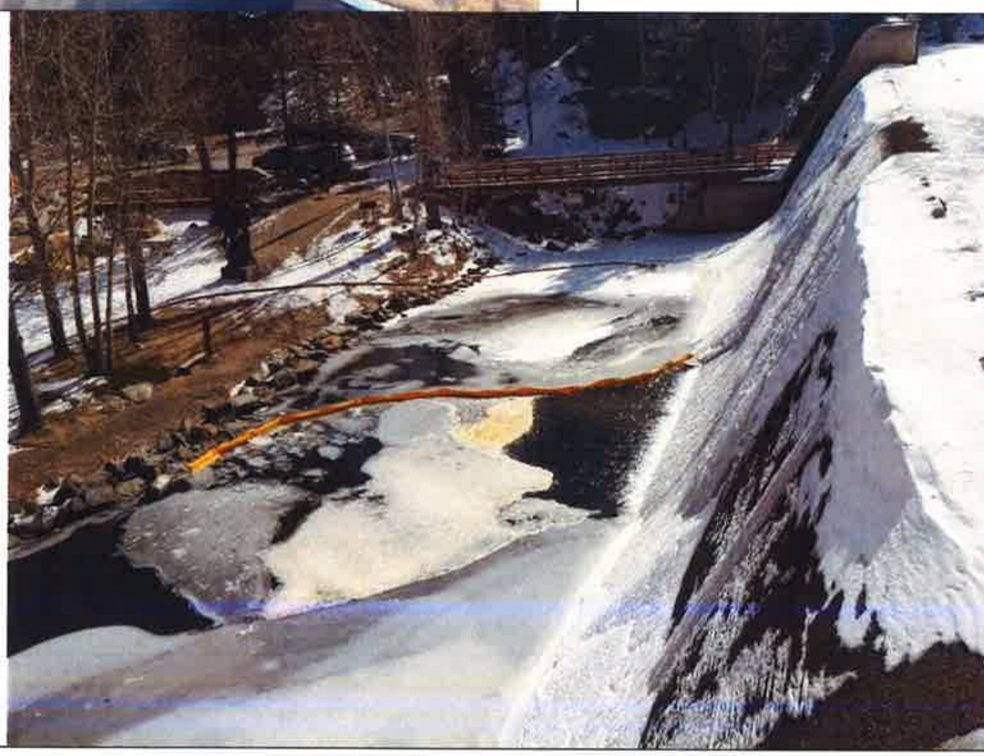


Photo 23: Sediment transport hose and turbidity curtain in southern portion of downstream pool.
Date: 02-12-2019 Source: C. Mattson (GEI)

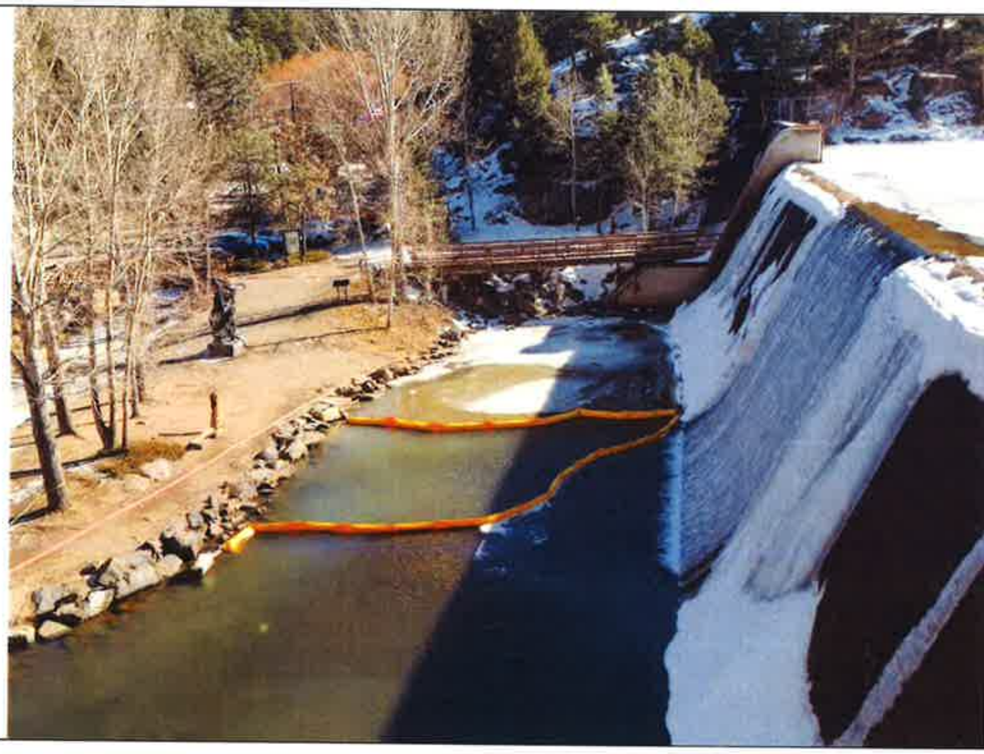


Photo 24: Sediment transport system after the installation of second turbidity curtain.
Date: 02-15-2019 Source: C. Mattson (GEI)

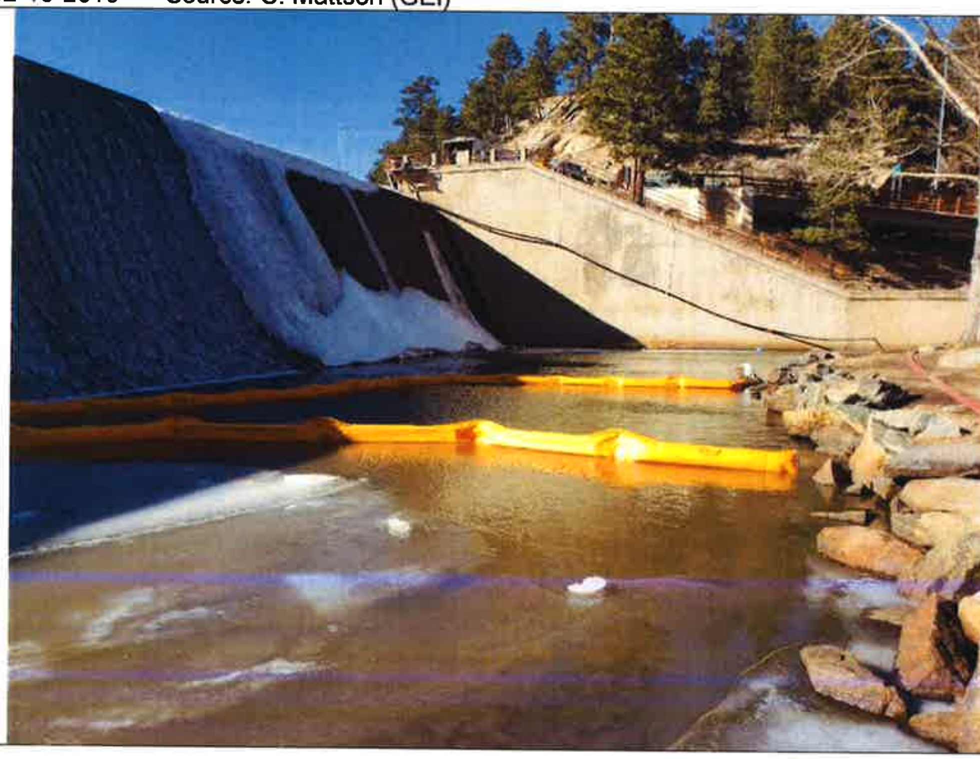


Photo 25: Turbidity curtains and sediment transport pipe on left abutment looking north.
Date: 02-15-2019 Source: C. Mattson (GEI)

Photo 26: Sediment transport system from pedestrian bridge looking southwest.
Date: 02-27-2019 Source: C. Masching (GEI)

Photo 27: Diver entering water upstream of Evergreen Dam.
Date: 02-27-2019
Source: C. Masching (GEI)

Photo 28: Additional view of diver entering water upstream of Evergreen Dam.
Date: 02-27-2019
Source: C. Masching (GEI)

Photo 29: Location of 24-inch line blind flange outside of vault before removal of debris.
Date: 10-29-2018 Source: C. Mattson (GEI)

Photo 30: Arrow pointing to blind flange of 24-inch line after sediment removal by Evergreen Metro.
Date: 03-05-2019 Source: C. Mattson (GEI)

Photo 31: Removal of upstream gate leaf.
Date: 03-05-2019
Source: C. Masching (GEI)

Photo 32: Additional view of gate leaf removed using truck-mounted crane.
Date: 03-05-2019
Source: C. Masching (GEI)

Photo 33: Piece of gate stem and coupler removed from upstream gate assembly.
Date: 03-21-2019
Source: G. Jeffrey (Evergreen Metro)

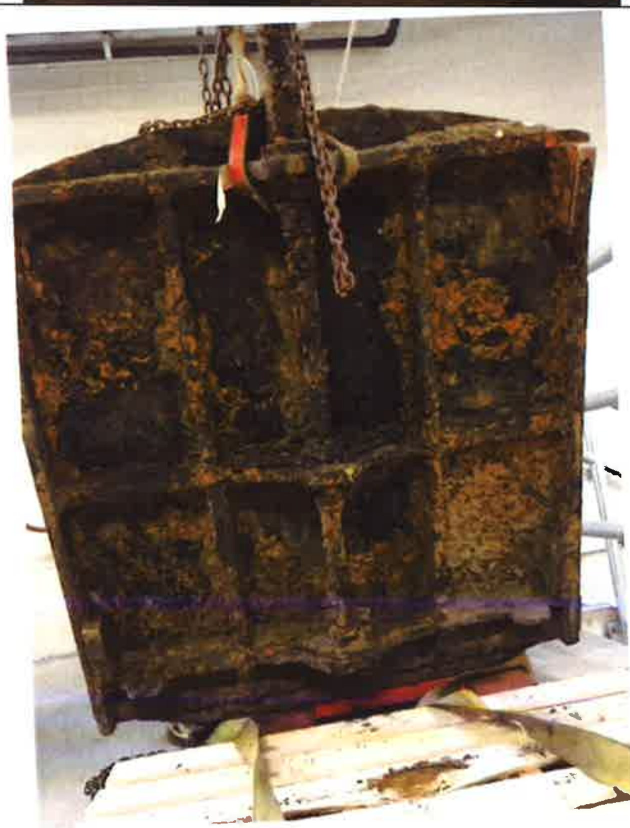


Photo 34: Upstream side of gate leaf.
Date: 03-21-2019
Source: G. Jeffrey (Evergreen Metro)

	Photo 35: Downstream side of gate leaf. Date: 03-21-2019 Source: G. Jeffrey (Evergreen Metro)
	Photo 36: Coupler pins. Date: 03-21-2019 Source: G. Jeffrey (Evergreen Metro)