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September 9, 2021

To:

Brian Grennell, Cultural Resources Management Coordinator
State Historic Preservation Office
300 North Washington Square
Lansing, MI 48913

From:

Robb Roos, Project Manager and Senior Environmental Analyst
Mike Madson, Cultural Resources Specialist
Angela Julin, Cultural Resources Specialist

Subject:
Four Lakes Task Force: Secord Dam Rehabilitation
Secord Dam, Gladwin County, Michigan

Dear Mr. Grennell:

With this letter Four Lakes Task Force (FLTF) provides your office information on the efforts to stabilize the Secord Dam in Gladwin County, Michigan. The Secord Dam is located on the Tittabawassee River, a tributary of the Saginaw River, and is approximately 41 river miles upstream of the City of Midland in Gladwin County, Michigan (see Figures 1 and 2). The facility is owned and operated by the FLTF which is the Part 307 delegated authority for Gladwin County. Construction of the dam was completed in 1925 to provide storage and headwater control for the purpose of hydroelectric power generation.

From left to right (when looking downstream), the project consists of an approximately 650-foot-long left embankment with a minimum dam crest elevation (El.) of 757.82 feet; a 25-foot-wide powerhouse containing one turbine generating unit with a rated capacity of 1.2 MW with an operating head of 46.5 feet, a 46.3-foot-wide gated spillway with two Tainter gates, and an approximately 350-foot-long right embankment. Normal headwater and tailwater pools at the dam are El. 750.8 and 704.3, respectively. All elevations presented in this summary are in National Geodetic Vertical Datum of 1929 (NGVD29). The primary goal of the Secord Dam Rehabilitation Project is to construct improvements in accordance with the State of Michigan Department of Environment, Great Lakes, and Energy (EGLE) requirements and restore the legal Secord Lake level.

Merjent, Inc. is a subcontractor to FTLF's consultant Spicer Group. In April 2021, Merjent archaeologists initiated an archaeological survey of the Secord Dam, and the results of that survey are pending. An architectural history review was not part of the initial scope; however, consideration of Secord Dam's structural components is now of interest to parties consulting with the FLTF, most notably the Natural Resources Conservation Service (NRCS). Recently, NRCS advised FLTF to communicate with your office on the measures being taken to stabilize failed dams across the FLTF area of concern, including interim and long-term proposed rehabilitation measures at the Secord Dam. The proposed rehabilitation efforts for the Secord Dam are depicted

on the Secord Dam Conceptual Design, which is provided as **Appendix A**. These plans depict the proposed work that is discussed within the narrative sections of this report.

Secord Spillway

The reinforced concrete spillway structure is a hollow reinforced concrete barrel arch and ogee shaped rollway spanning to buttress pier supported structure with two Tainter gate bays (see Photos 1 and 2). The left Tainter gate is approximately 20.5-feet-wide by 10-feet-high and the right Tainter gate is approximately 23.8-feet-wide by 10-feet-high separated by a 2-foot-wide center pier. The spillway ogee crest is at approximate El. 742.8 feet. The gates are operated by a hydraulic hoist with the operators located directly adjacent to the hoist above each gate on an elevated platform. The hydraulic gate chain and single cable hoist systems were installed in 2019, replacing the original electric hoist and trolley system.

Photo 1. Secord Dam Overview, May 2021.

Photo 2. Secord Dam Spillway

Secord Dam Powerhouse

The powerhouse consists of a reinforced concrete substructure and brick superstructure with one vertical Francis unit. The powerhouse is 25-feet wide (left to right) and 36.5-feet long (see Photos 3 and 5). A 1.2 MW vertical Francis style unit is installed in an open pit layout. A vertical trumpet-shaped draft tube is installed in the lower portion of the powerhouse, allowing discharge of the outflow into the spillway stilling pool. The stilling poll is formed by a downstream wall which also functions as the flip bucket. The original water diversion for the construction occurred by use of the lower now inactive portion of the structure, which now houses the draft tube cone. This area once had three intake openings to the upstream which was used as the diversion watercourse while the embankments were built. The powerhouse substructure is built of reinforced concrete and is integral with the spillway structure located to its right. Both structures are founded on glacial till using a base slab ribbed in two directions. The slab also has an upstream and downstream cutoff wall integral with the slab. The powerhouse measures approximately 50.75 feet by 21 feet in plan and is 57 feet in height.

Secord Dam Embankments

The left and right embankments are approximately 650 feet and 350 feet long, respectively, with a maximum structural height of 56 feet near the powerhouse and spillway (see Photos 3-5). The original embankments were reportedly constructed of a mix of clay and poorly graded sand, and are founded on native soils consisting of interbedded layers of clay and silty sand with some gravel overlying glacial till. The upstream and downstream slopes were constructed at 2.5H:1V and 2H:1V, respectively. In 2005, the embankment crest was re-established to the design elevation of 757.8 feet. Portions of both embankments immediately adjacent to the powerhouse and spillway contain an upstream seepage cutoff wall consisting of hot rolled ball and socket interlocked steel sheeting installed into foundation soils with a reinforced concrete cap. The seepage cutoff wall has a top elevation of approximately 753.8 feet and extends approximately 96 feet left of the powerhouse and 82 feet right of the spillway. In 2008, leakage along the abutment/sheeting contact was repaired. Both embankments also contain lateral finger drains that extend under the downstream embankment shell at the embankment/foundation contact and discharge into a drainage ditch located at the downstream toe. A toe berm was reportedly constructed on the left embankment downstream slope to improve stability and address seepage. No record of these repairs were found. There is no record of improvements or repairs made to the right embankment.

Photo 3, Secord Powerhouse and Left Embankment, August 2019.

Photo 4. Secord Dam Left Embankment, 2021.

Photo 5. Aerial Drone Imagery of Secord Dam, 2020.

Secord Dam Stabilization
Following the May 19, 2020, storm event, significant downstream erosion damage occurred at the Secord Dam. In order to prevent similar dam failure events, most notably as seen at the Edenville Dam, the following rehabilitation measures are proposed:

- Provide an updated earth and concrete structure that will have a 75 (+) year design service life.
- Provide temporary cofferdams and diversion structures to have the ability to safely pass base river flows plus flood flows (assumed 100-year storm event) without failing during construction.
- Rehabilitation designs to meet current industry standards of engineering practice and the design standards for high hazard dams in accordance with the State of Michigan EGLE.
- Restoring hydropower generation will not be part of the rehabilitation plans and was not included in our costs.
- Upgrade the total spillway capacity to pass at a minimum the ½ PMF in accordance with State of Michigan EGLE requirements.
- Transform the powerhouse to a gated low-level outlet structure using the intake, scroll case, a fixed Francis wheel and draft tube to release 100 to 200 cfs baseflows during low flow winter months.

SUMMARY OF DAM REPAIRS AND FLOOD CAPACITY UPGRADES

Primary Spillway Modifications
The existing Tainter gate spillway will be partially demolished and the two (2) Tainter gates will be replaced with hydraulically operated crest gates at sill El. 734.8 to increase the spillway capacity. The left crest gate (Bay No. 1) will be 18-feet-wide by 16-feet-high and the right crest gate (Bay No. 2) will be 21-feet-wide by 16-feet-high. The automated hydraulically operated crest gates will be designed to open and close with minimal human intervention during normal operation or during flood events. In the event of loss of power or control the gates can be depressurized and they will automatically lower to full discharge condition. The hydraulic gate operators will be supported on a new, reinforced concrete center pier. The upstream portions of the barrel arches below El. 734.8 will remain and the crest gates and their anchorage embedment's will be founded on mass concrete. A reinforced concrete stepped chute will convey water that discharges over the crest gates down to a new reinforced concrete stilling basin. Both the left and right spillway walls will be extended downstream and raised to provide adequate flow clearance and accommodate flattening of the flanking embankments.

Auxiliary Spillway
A new 130-foot-wide pin flashboard overflow spillway will be constructed across the top of the left embankment at El. 748.5 with steel pipe pins embedded in concrete holding timber flashboards that extend up to El. 752.0 to maintain the normal summer pool at El. 750.8. The pin-flashboards will be designed to fail when overflow greater than 1.5 feet water head over the top of the boards reaches El. 753.5. This release will provide additional spillway capacity during the ½ PMF + design storm. The overflow spillway will discharge into a concrete chute and 130-foot wide USBR Type III stilling basin to dissipate and transfer flow into the downstream discharge channel. Downstream of the stilling basin, flows will be conveyed downstream of the left embankment,

approximately 600 feet back into the Tittabawassee River just upstream of Secord Dam Road via a riprap-lined discharge channel. A concrete-lined stepped drop structure will be constructed at the terminus of the discharge channel at the riverbank of Tittabawassee River. Steel sheet piling will be provided along the upstream side of the auxiliary discharge channel from the end of the stilling basin downstream to the stepped drop structure as an added measure to protect the left embankment toe from possible erosion and undermining in the event of high flows within the auxiliary discharge channel.

Powerhouse Modifications to Provide a Low-Level Outlet

As highlighted by the ongoing ice issues experienced at Secord Dam during the winter of 2020 / 2021, it is crucial to develop a reliable low-level outlet to pass base flows in the winter at Secord Dam to minimize active daily ice management. For the long-term reconstruction, we are proposing to retrofit the existing powerhouse to pass base flows (100 to 200 cfs) through the powerhouse in accordance with the 95% exceedance base flows estimated by the State of Michigan Department of Environmental Quality Flood discharge database. This will be accomplished by removing the existing generator, turbine shaft, wicket gates and ancillary mechanical and electrical equipment, installing a bulkhead over the runner pit and fixing the runner into place. By lowering the concrete sill upstream of the existing head gate and installing an upstream vertical slide gate to control in-flow, the powerhouse water passages will be converted into a low-level outlet to pass base flows. The low-level outlet conceptual design was developed by GEI, Essex and SGI.

The proposed low-level outlet design consists of the following elements:

- Cut down the barrel arch upstream of the powerhouse intake to El. 723.8 and fill the hollow structure below the barrel arch with mass concrete.
- Construct a new reinforced concrete cap at the intake elevation just upstream of the existing head gate. The total impoundment drawdown potential is from El. 750.8 to El. 723.8.
- Remove the existing trash rack and provide a replacement trash rack upstream of its current location.
- Construct a new vertical slide gate(s), gate (bulkhead) guide slots, operating deck, and hoist system at spillway operator deck level upstream of the existing head gate.
- Remove and upgrade the existing steel head gate.
- Remove generator, turbine shaft and wicket gates.
- Construct a new bulkhead over the top of the runner pit in the powerhouse floor slab.
- Remove the existing timber headgates.
- The upstream slide gates will be used to throttle base flows to pass the 200 to 400 cfs.
- The upstream bulkhead and headgate will allow for full de-watering for maintenance and inspections of the downstream water passages.
- Leave the runner in place and affix (weld) to the new bulkhead to provide horizontal to vertical flow energy dissipation.
- Construct a new tailrace weir wall to maintain higher tailwater immediately downstream of the draft tube bays.
- The new upstream slide gates will be used to throttle base flows to pass approximately 100 to 200 cfs of flow.
- The upstream bulkhead and head gate will allow for full de-watering for maintenance and inspections of the downstream water passages.

EMBANKMENT MODIFICATIONS

The upstream and downstream slopes will be flattened, and the crest widened to a minimum width of 15 feet to provide adequate stability in accordance with EGLE requirements under normal and flood pool loading criteria. A new permanent hot rolled steel sheet pile cutoff wall with interlock sealants will be constructed along the upstream edge of the dam crest and extend through the embankment fill and foundation overburden soils and be founded into the clayey glacial till to provide a seepage cutoff. A reverse filter and toe drain, comprised of filter sand and drainage stone, will be incorporated into the downstream fills to provide improved internal drainage and filter protection against internal erosion in the event of seepage through the sheet pile cutoff.

Embankment Fill

New embankment fill placed on maximum 2.5H:1V slopes will be used to reconstruct the embankment sections upstream and downstream of the newly constructed concrete core wall between each end of the new auxiliary spillway and the existing buried barrel arch spillway abutment walls. The embankment fill will consist of material either salvaged from on-site excavations or imported from approved off-site sources, as required. All cobbles greater than 4 inches in diameter will be screened out. New embankment fill material will be comprised of semi-pervious granular material (Unified Soil Classification System soil types: SP-SM, SM, and SC-SM) and will be compatible with the remaining, existing embankment fill in terms of filter criteria. Embankment fill will be placed in loose horizontal lifts not exceeding 12 inches and compacted in a controlled manner to a minimum of 95 percent of maximum dry density determined by the standard Proctor (ASTM D698) with appropriate moisture control measures.

Reverse Filter and Toe Drain

A reverse filter toe drain consisting of filter sand and drainage stone will be constructed at downstream slope and toe of the left and right embankments to mitigate against seepage and internal erosion of the embankment and foundation soils. The reverse filter and drain will generally consist of 18 inches of fine filter (Michigan Department of Transportation (MDOT) 2NS natural sand) and 24 inches of coarse filter (MDOT 29A stone). Depending upon their condition upon excavation, the existing finger drains will either be extended and conveyed downstream to daylight at the toe or be terminated within and seepage collected in the drainage stone layer. The seepage will be collected in a minimum 8-inch diameter slotted drainpipe surrounded by coarse filter material. The purposes are: 1) to provide an outlet to convey seepage toward the outlet to keep the phreatic surface from rising within the reverse filter, and 2) to collect and direct seepage flow entering the reverse filter to the downstream weir box so the flow rate and potential fines movement can be collected and monitored.

Rip-rap and Bedding

Rip-rap placed on the upstream side of the auxiliary spillway approach apron, and upstream and downstream embankment slopes will consist of a hard, durable, non-weathered, angular stone in accordance with MDOT standard specifications. Rip-rap placed downstream of the stilling basin and in the auxiliary spillway discharge channel will consist of MDOT heavy rip-rap. Bedding material will consist of imported granular material in accordance with MDOT specifications placed over MDOT 29A crushed stone. The 29A stone should be placed on natural 2NS sand placed over native soil subgrades. For accessible rip-rap and bedding subgrades, the bedding material can be placed on non-woven geotextile.

SECORD DAM ARCHITECTURAL HISTORY

Frank Wixom founded the Tittabawassee Power Company in 1906 with a vision to dam the Tittabawassee and Tobacco River to provide cheap electricity to farmers and the local community and to create a recreational area for the greater region. Although the initial plans were not financially feasible at the time for Wixom's power company, the Wolverine Power Company was formed in 1923, with Wixom as president. Sponsored by Wolverine Power Company, construction of the Secord Dam, designed by consulting engineers Holland, Ackerman & Holland, was completed in 1925 to provide storage and headwater control for the purpose of hydroelectric power generation. Original plan drawings and a photograph taken during construction of the dam are provided as Figure 3 and Photo 6.

The powerhouse structure was built first, and water diverted through it, at which time the right half of the river was coffer-damned, and then the spillway structure was built. The lower portion of the powerhouse was used as the diversion structure. Once the concrete powerhouse and spillway structure were completed, construction of the embankment dam was undertaken. In 1947, an engine fire destroyed the powerhouse and it was rebuilt. A photo collage, presented as Photo 7, is provided below.

FLTF maintains a collection of historic photos taken during the construction of the Secord Dam, as well as sheets of construction plans and improvements (1920s), as-builts (1930s), and common lifecycle modifications (into the 2000s).

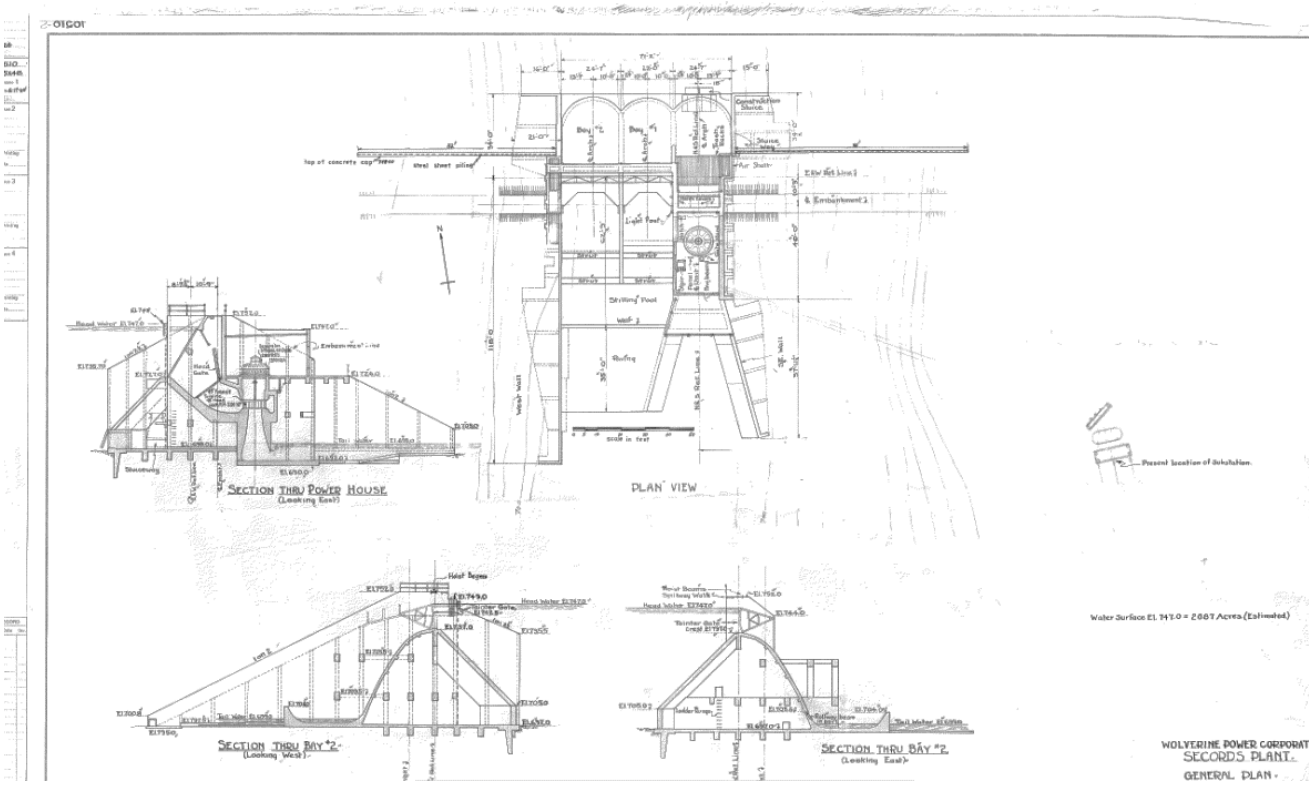


Figure 3. Original Plan Drawings of the Secord Dam, April 1924.

SECORD FROM UP STREAM APRIL 30, 1925

Photo 6. Secord Dam during construction, April 1925.

Photo 7. Secord Dam fire destruction, 1947.

Secord Dam as a Cultural Resource

To understand the eligibility of the Secord Dam as a cultural resource, all built components of the dam were considered. This includes the concrete spillway, water-retaining, or water conveyance structures described in this report. These primarily consist of the gated spillway (comprised of sidewalls, center piers, rollway, stilling basin, and crest gates) and powerhouse (side walls, intake, scroll case, draft bay, stilling basin). None of these elements have previously been evaluated for inclusion on the National Register of Historic Places (NRHP). Spillway construction began in September 1923, followed by the powerhouse. Once the counter forte spillway structures were built, embankment dams were built using the native Michigan sand-clay materials for the fill, founded on the hardpan glacial till of the region.

The Site Safety Inspection Report 2012 indicated that the design was "very advanced for reinforced concrete design for its time". They also noted that the integration of hydraulic considerations into the design was "also very far advanced of the general knowledge of the field for the type of structure. These considerations allow the structures to age much better than similar structures in similar environments around the country."

A second opinion of this record was requested in August 2021 from Paul D. Drew, Senior Water Resources Engineer for GEI Consultants. Per this communication, Mr. Drew noted that although this was mentioned within the 2012 Site Safety Inspection Report it appears to be exaggerated. He stated that the design was "very similar to other dams by this designer across the Midwest with similar vintage". There are no additional notes on file indicating the design was any different than the three other dams along the Tittabawassee and Tobacco Rivers. A complete offering of Mr. Drew's research on the design is provided below:

> *The cantilever training wall, barrel arch, rollway slab and buttress dam design used for the powerhouse and spillway at Secord Dam by Holland and Ackerman circa 1923 to 1925 was common for the time in the upper Midwest when dam materials were relatively expensive, Portland cement supplies relatively scarce, and skilled labor plentiful and inexpensive.*
>
> *It is an exaggeration to say the design was "advanced for its time". Rather, it is quite typical of other similar hydropower and dam structures constructed by this and several other designers for economic reasons. There were more than 100 Ambursen type (patented dam design 1912) and dozens of Holland and Ackerman style slab and buttress dams constructed for navigation, flood control and hydropower from the 1900's to 1930's when this style of reinforced concrete slab and buttress dams on competent foundation design was more commonly used.*
>
> *That said, except for common freeze thaw deterioration observed today due to the use of concrete without air entrainment in the 1920 and lack of periodic maintenance over the years to remove and replaced deteriorated concrete, the current condition and lack of evidence of structural distress shows the structural designers possessed a good understanding of the hydraulic and earth pressures imparted on the dam and pressures imparted on competent foundation.*
>
> *Post WW-II, this style of dam fell out of favor in the industry due to fragility and several foundation sliding failures (Stoney River Dam in WV on clay shale, Waco Dam on weak shales in TX, etc.). After the 1930's, concrete dams were designed to be more massive to avoid concrete structural frame failures when there in movement between walls and*

buttresses and have more ductility to resist flood and earthquake loading. Many of these slab and arch buttress dams have had their hollow between buttress piers filled in with concrete to avoid numerous failure modes.

Prior to 2019, gate operations were handled by a human operator, due to the means of opening and closing a gate. The gate used a chain hoist on a trolley system, where the operator was required to set the chain on the hoist drum and be in attendance to push the start and stop buttons on the gate hoist.

According to historic documentation on file with the FLTF, modifications to the dam began in 1935 with the installation of steel sheet pile cutoff walls. In 1947, a fire destroyed the powerhouse and it was rebuilt. In the mid-1990s, the area downstream of the stilling basin was rip-rapped. In 1996, a significant concrete repair was completed with an overlay of the west spillway training wall, with a small amount of concrete rehabilitation completed on the rollaway slab at the crest. The most significant modifications occurred in 2012 when the spillway was resurfaced. Post-construction, modifications were performed on the Secord Dam following every significant flood. Structural repairs included continuous concrete repair on the structures, as well as gate repairs. All pre-disaster modifications were performed by Wolverine Power Company, followed by Boyce Hydro.

Photo 8. Spillway Resurfacing, 2012.

There are more than 50 hydroelectric dams in Michigan, which provide approximately 1.5% of Michigan's energy. Four of these facilities are listed on the NRHP. The Cooke Dam, constructed on the Au Sable River in 1911, is listed due to the presence of associated outbuildings, including a powerhouse, substation, storage shed, and Classic-Revival style Attendant's House. The Croton Dam on the Muskegon River is listed on the NRHP as it attracted international attention in

1907 due to the 110,000-volt transmission line, which was the highest in use at that time. The Five Channels Dam, constructed in 1912, is listed on the NRHP as a District known for its associated 45-acre worker's camp, which is also listed on the NRHP as an archaeological site. The Hardy Dam was constructed in 1931 and, at the time, was one of the largest earthen dams in the United States. Two additional dams are listed as Michigan State Historic Sites, including the Rugg Pond Dam constructed in 1904 on the Rapid River, which was constructed with materials delivered via wagon and listed Ernest Hemingway as a notable guest. The Mio Dam on the Au Sable River was constructed in 1916 and is unique for its conduit spillways underneath the powerhouse foundation, which paved the way for design innovations in icy rivers.

Of the hydroelectric dams in Michigan, most were constructed in the second quarter of the 20th century. To determine the presence of distinguishing features that might inform the significance of the Secord Dam, Merjent reviewed four other dams designed by Holland, Ackerman, and Holland, all constructed between 1922 and 1927. These dams include the Chalk Hill Dam, the Victoria Dam, the Union City Dam, and the Quaker Mill Dam (see Table 2 below).

TABLE 2.

List of notable Holland, Ackerman and Holland Dams

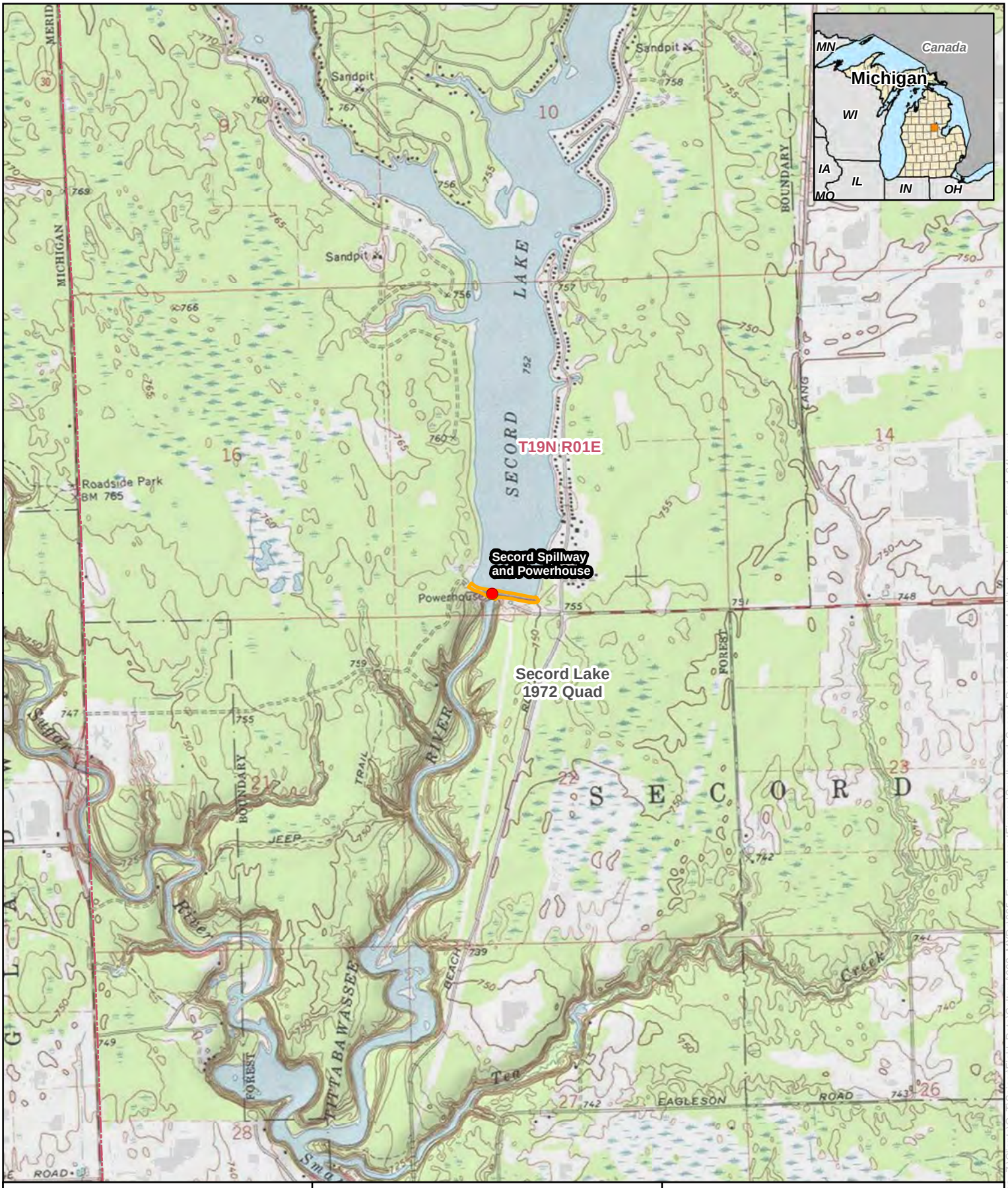
Dam Nam	State	Contractor	Power Company	Features
Union City Dam	Michigan	Benjamin Douglas Company	"municipality-owned"	Tainter Gates (5)
Quaker Mill Dam	Iowa	Unknown	Iowa Electric Company	One Tainter Gate
Secord Dam	Michigan	Holland, Ackerman, and Holland	Wolverine Power Company	Tainter Gates (2)
Chalk Hill Dam	Wisconsin	Siems, Helmer, Shaffner, Inc.	Northern Electric Company	Tainter Gates (11)
Victoria Dam	Michigan	Price Brothers Company	Copper Range Company	No Tainter gates

Other properties designed by Holland, Ackerman and Holland, exhibit unique architectural elements such as stained glass within the powerhouse (Chalk Hill Dam) or sweeping arches (Victoria Dam). The Quaker Mill Dam; demolished in 2017, was previously listed on the NRHP due to a few unique characteristics, namely a monumental concrete fishway and a single Tainter gate with a manually operated hoist. While both the Chalk Hill Dam and the Tobacco River Spillway are hollow, the hollow nature of the Chalk Hill Dam was utilized to access the powerhouse, which is not present at the Secord Dam. The Chalk Hill Dam was also distinctive due to a large concrete fishway, its size (early 300 feet wide), and the decorative elements within the powerhouse (see Photo 9). Other than some being hollow and/or having multiple Tainter gates, unique architectural features and associated structures set these facilities apart from the Secord Dam.

Photo 9. Chalk Hill spillway (left) and powerhouse (right).

When considering the eligibility of the Secord Dam, the National Register Criteria for Evaluation were considered (36 C.F.R. § 60.4). It is of our opinion that the Secord Dam is not eligible for inclusion on the NRHP, either in and of itself or as a contributing property of a historic district. While the dam property, including the powerhouse and spillway have remained intact, continual repairs have modified the original structures. Regardless of impacts to the structural characteristics, the Secord Dam lacks unique architectural elements present among other dam spillways, powerhouses, or embankments (particularly those listed on the NRHP with associated powerhouses or other notable engineering elements), it is our professional opinion that the Secord Dam does not meet the criteria established by the Secretary of the Interior as detailed in 36 C.F.R. § 60.4.

FIGURES



merjent

0 1,000 2,000 Feet

1:24,000

For Environmental Review Purposes Only

N W E S

Figure 1: 24k Topo
Secord Dam
Gladwin County, Michigan

- Secord Spillway
- Embankment
- Quad Map Boundary
- Township Boundary
- County Boundary

Source: Z:\Clients\Q_T\SpicerField_Data\Cultural\002_MXDs\005_Embankment\Figures\Smallwood_Secord_Projects\Secord_Architectural_History_Figure1_24k.mxd

Date: (6/26/2021)

0 100 200 Feet

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N W E S

For Environmental Review Purposes Only

Figure 2: 2020 Aerial Map
Secord Dam
Gladwin County, Michigan

Secord Spillway
Section Boundary
Embankment

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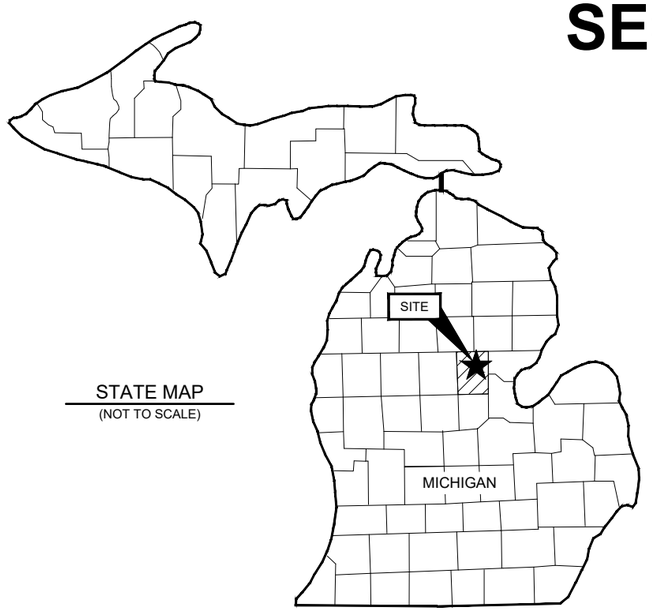
Date: (8/26/2021)

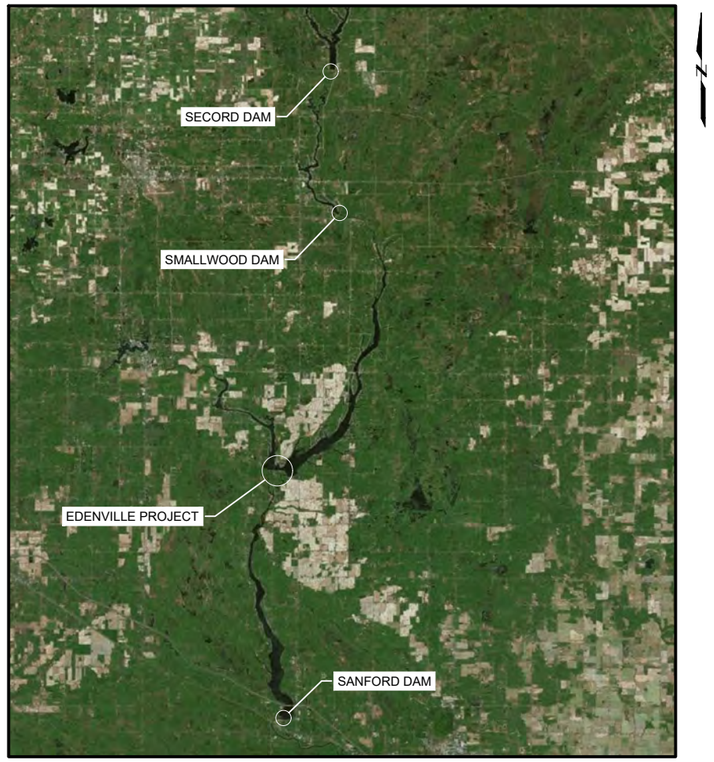
APPENDIX A

SECORD DAM CONCEPTUAL DESIGN

GLADWIN COUNTY, MICHIGAN
FOUR LAKES TASK FORCE
FERC PROJECT NO. 10809



STATE MAP
(NOT TO SCALE)



SOURCE:
AERIAL IMAGE TAKEN FROM GOOGLE EARTH

SITE LOCATION
(NOT TO SCALE)

SITE AERIAL
(NOT TO SCALE)

SHEET INDEX

SHEET NO.	DRAWING NO.	TITLE
1	G-01	COVER SHEET AND SITE LOCATION
2	G-02	GENERAL NOTES AND LEGEND
3	C-01	SITE PLAN - EXISTING CONDITIONS
4	C-02	OUTLET WORKS - EXISTING CONDITIONS PLAN
5	C-03	OUTLET WORKS - TEMPORARY COFFERDAMS PLAN
6	C-04	OUTLET WORKS - DEMOLITION PLAN
7	C-05	OUTLET WORKS - DEMOLITION SECTION
8	C-06	OUTLET WORKS - MODIFICATIONS PLAN VIEW
9	C-07	POWERHOUSE - MODIFICATIONS SECTION
10	C-08	PRIMARY SPILLWAY - MODIFICATIONS SECTION
11	C-09	PRIMARY SPILLWAY - CREST GATE DETAILS
12	C-10	RIGHT EMBANKMENT - EXISTING SITE PLAN AND ELEVATION PROFILE
13	C-11	RIGHT EMBANKMENT - MODIFICATIONS PLAN
14	C-12	LEFT EMBANKMENT - EXISTING SITE PLAN AND ELEVATION PROFILE
15	C-13	LEFT EMBANKMENT - MODIFICATIONS PLAN
16	C-14	RIGHT EMBANKMENT - MODIFIED SECTIONS
17	C-15	LEFT EMBANKMENT - MODIFIED SECTIONS
18	C-16	RIGHT AND LEFT EMBANKMENTS - MODIFICATION DETAILS
19	C-17	AUXILIARY SPILLWAY - PROPOSED PLAN VIEW
20	C-18	AUXILIARY SPILLWAY - PROPOSED SPILLWAY CROSS SECTION
21	C-19	AUXILIARY SPILLWAY TERMINAL STRUCTURE - PROPOSED PLAN AND SECTION

PREPARED FOR:

FOUR LAKES TASK FORCE
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PREPARED BY:

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GEI PROJECT NO. 2002879

NO.	DATE	ISSUE/REVISION	APP
0	XX/XX/XX	CONCEPTUAL DESIGN SUBMITTAL	--

DRAFT

DWG. NO. G-01

SHEET NO. 1

1. GENERAL

SPACIAL DATUM INFORMATION

- VERTICAL: NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD29).
- HORIZONTAL: NORTH AMERICAN DATUM OF 1983 (NAD83), MICHIGAN STATE PLANE, CENTRAL ZONE.
- A CONVERSION OF +5.8' IS REQUIRED WHEN CONVERTING VERTICAL DAM DATUM TO NGVD29 (E.G., HEADWATER ELEVATION AT DAM DATUM IS 745.0' AND AT NGVD29 DATUM IS 750.8').
- A CONVERSION OF -0.512' IS REQUIRED WHEN CONVERTING VERTICAL NGVD29 DATUM TO NAVD88 DATUM.
- CONTROL MONUMENTS ON-SITE SHALL BE REFERRED TO CONFIRM HORIZONTAL AND VERTICAL MEASUREMENTS.

BASEMAP DATA

- SITE TOPOGRAPHY AND AERIAL IMAGE OBTAINED DRONE FLIGHT PERFORMED BY SPICER GROUP IN 2020.
- COVER SHEET AERIAL IMAGES OBTAINED FROM GOOGLE EARTH REPRESENT CONDITIONS IN JUNE, 2018.
- OBTAINED FROM BOYCE HYDRO:
  - ORIGINAL CONSTRUCTION DRAWINGS
  - EXHIBIT F LICENSE DRAWINGS

DESIGN PARAMETERS

- NORMAL RESERVOIR ELEVATION 750.8' (+0.3' / -0.4')
- WINTER RESERVOIR OPERATIONS: MINIMUM 747.8' (+0.7')
- ORDINARY HIGH WATER MARK ELEVATION 704.3 (±0.5')

DESIGN REFERENCE STANDARDS

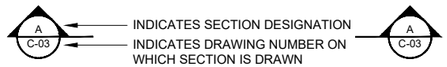
- (USBR, 1987) UNITED STATES DEPARTMENT OF THE INTERIORER, BUREAU OF RECLAMATION, "DESIGN OF SMALL DAMS", 1987.
- (USACE, 1995) UNITED STATES ARMY CORPS OF ENGINEERS, ENGINEERING AND DESIGN, "CONSTRUCTION CONTROL FOR EARTH AND ROCK-FILL DAMS", EM 1110-2-1911, 1995.
- (ACI, 2001) AMERICAN CONCRETE INSTITUTE, "CONTROL OF CRACKING IN CONCRETE STRUCTURES" (ACI 224), 2001.
- (USACE, 2004) UNITED STATES ARMY CORPS OF ENGINEERS, ENGINEERING AND DESIGN, "GENERAL DESIGN AND CONSTRUCTION CONSIDERATIONS FOR EARTH AND ROCK-FILL DAMS", EM 1110-2-2300, 2004.
- (ACI, 2006) AMERICAN CONCRETE INSTITUTE, "CODE REQUIREMENTS FOR ENVIRONMENTAL ENGINEERING CONCRETE STRUCTURES" (ACI 350), 2006.
- (ACI, 2011) AMERICAN CONCRETE INSTITUTE, "BUILDING CODE REQUIREMENTS FOR STRUCTURAL CONCRETE" (ACI 318), 2011.
- (FERC, 2016) FEDERAL ENERGY REGULATORY COMMISSION, ENGINEERING GUIDELINES FOR EVALUATION OF HYDROPOWER PROJECTS (MOST RECENT VERSIONS)

ABBREVIATIONS

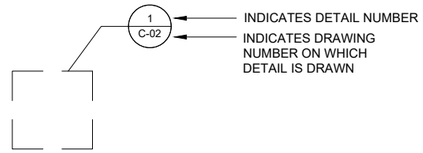
BO = BOTTOM OF
C = CENTER LINE
MM = MOVEMENT MONUMENT
CONC = CONCRETE
CONT = CONTINUOUS
CTRD = CENTERED
D/S = DOWNSTREAM
EO = EDGE OF
EX = EXISTING
EF = EACH FACE
EL = ELEVATION (FEET)
HW = HEADWATER
MAX = MAXIMUM
OC = ON CENTER
OCEW = ON CENTER EACH WAY
OHWM = ORDINARY HIGH WATER MARK
PL = PLATE
PMF = PROBABLE MAXIMUM FLOOD
SDF = SPILLWAY DESIGN FLOOD
SSP = STEEL SHEET PILE
STD = STANDARD
STIFF = STIFFENER
TBD = TO BE DETERMINED
TO = TOP OF
TW = TAILWATER
TYP = TYPICAL
UON = UNLESS OTHERWISE NOTED
U/S = UPSTREAM
VIF = VERIFY IN FIELD
WL = WETLAND
W/ = WITH

SECTION AND DETAIL LEGEND

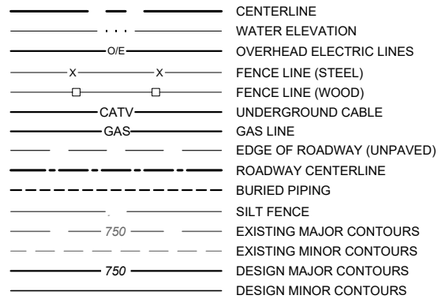
SECTION



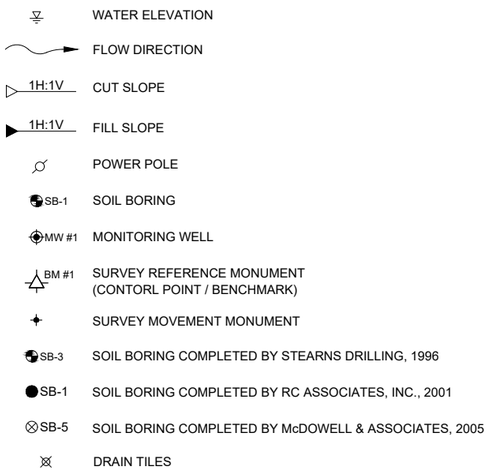
DETAIL



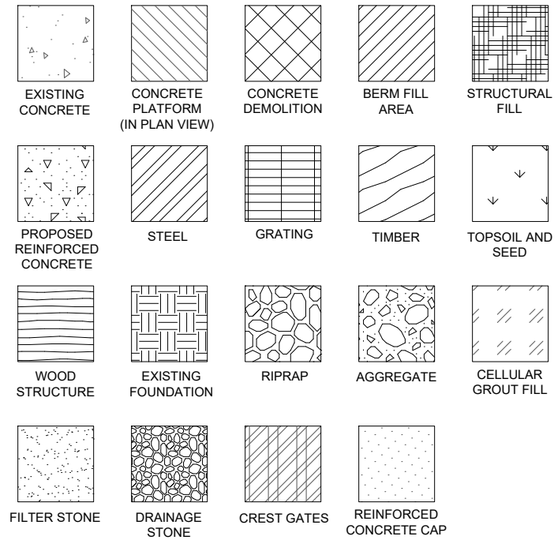
LINETYPE LEGEND



SYMBOLS LEGEND



HATCH LEGEND



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Attention:

0 1"

If this scale bar does not measure 1" then drawing is not original scale.

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Checked:	P. DREW
Drawn:	A. SAMPSON
Approved By:	B. WALTON

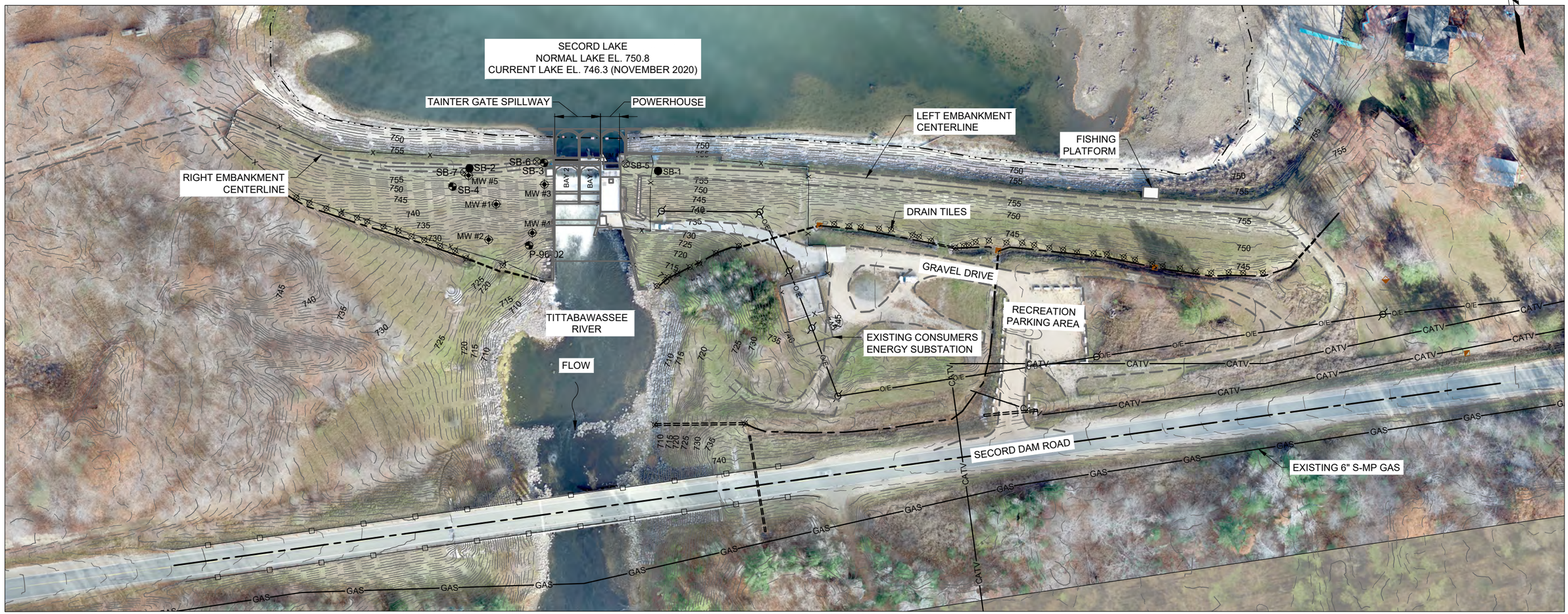
Four Lakes Task Force
FERC Project No. 10809
GEI Project 2002879

Secord Dam Conceptual Design
Gladwin County, Michigan

GENERAL NOTES AND LEGEND

DWG. NO. G-02

SHEET NO. 2



LINETYPE LEGEND

- CENTERLINE
- WATER ELEVATION
- OVERHEAD ELECTRIC LINES
- FENCE LINE (STEEL)
- FENCE LINE (WOOD)
- UNDERGROUND CABLE
- EDGE OF ROADWAY (UNPAVED)
- ROADWAY CENTERLINE
- BURIED PIPING
- GAS LINE
- EXISTING MAJOR CONTOURS
- EXISTING MINOR CONTOURS

SYMBOLS LEGEND

- SB-3 — SOIL BORING COMPLETED BY STEARNS DRILLING, 1996
- SB-1 — SOIL BORING COMPLETED BY RC ASSOCIATES, INC., 2001
- SB-5 — SOIL BORING COMPLETED BY McDOWELL & ASSOCIATES, 2005
- DRAIN TILES
- FLOW DIRECTION
- MW #1 — MONITORING WELL
- BM #1 — SURVEY REFERENCE MONUMENT

EXISTING CONDITIONS SITE PLAN

0 50 100
SCALE, FT

SURVEY CONTROL MONUMENT LOCATIONS

ID	ELEVATION	COMMENT
BM #1	758.45	EXISTING BENCHMARK CAP IN NORTHEAST CORNER OF SPILLWAY WALKWAY.

NOTES:
1. Vertical datum: National Geodetic Vertical Datum of 1929 (NGVD29)
2. Spatial datum: North American Datum of 1983 (NAD83), Michigan State Plane, Central Zone

Attention:
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SITE PLAN - EXISTING CONDITIONS

DWG. NO. C-01
SHEET NO. 3

SECORD LAKE
NORMAL LAKE EL. 750.8
CURRENT LAKE EL. 746.3 (NOVEMBER 2020)

PHOTO 1

SYMBOLS LEGEND

SB-3	SOIL BORING COMPLETED BY STEARNS DRILLING, 1996
SB-1	SOIL BORING COMPLETED BY RC ASSOCIATES, INC., 2001
SB-5	SOIL BORING COMPLETED BY McDOWELL & ASSOCIATES, 2005
	DRAIN TILES
MW #1	MONITORING WELL
BM #1	SURVEY REFERENCE MONUMENT

LINETYPE LEGEND

- CENTERLINE
- WATER ELEVATION
- O/E — OVERHEAD ELECTRIC LINES
- X — X — FENCE LINE (STEEL)
- EDGE OF ROADWAY (UNPAVED)
- BURIED PIPING
- 750 — EXISTING MAJOR CONTOURS
- EXISTING MINOR CONTOURS

PRIMARY SPILLWAY 24.6' + 22' + 24.6' | POWERHOUSE | 16' | 15'

BAY 2 | BAY 1 | BARREL ARCH 31' | U/S BARREL ARCH (TYP)

RIGHT U/S CUTOFF WALL 82'

LEFT U/S CUTOFF WALL 96'

U/S EDGE OF CREST 1.5' + 1.5'

EXISTING BRIDGE DECK

BM #1 — SAVE OFFICIAL BENCHMARK

SB-6 | SB-3 | SB-5 | SB-2 | SB-7 | SB-1 | MW #5 | SB-4 | MW #3 | MW #1 | MW #4 | P-96-02

RIGHT EMBANKMENT CENTERLINE

LEFT EMBANKMENT CENTERLINE

ROLLWAY 23.8' + 20.5'

CREST & ROLLWAY 31'

PIER

STRUT

STRUT

POWERHOUSE

STAIRCASE

STILLING BASIN 33.7'

APRON

POWERHOUSE ENTRY POINT

BAFFLE

POWERHOUSE ACCESS ROAD

APRON 36'

POWERHOUSE TRAINING WALL

PHOTO 1

DITCH CENTERLINE

19.8'

TITTABAWASSEE RIVER

FLOW

29.9'

9.1'

8.7'

750 | 755 | 745 | 740 | 735 | 730 | 725 | 720 | 715 | 710

O/E

OUTLET WORKS - EXISTING PLAN VIEW

0 10 20
SCALE, FT

Attention:	NO.	DATE	ISSUE/REVISION	APP
0 1" — If this scale bar does not measure 1" then drawing is not original scale.	0	xx/xx/xxxx	CONCEPTUAL DESIGN SUBMITTAL	--

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GEI Project 2002879

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Gladwin County, Michigan

OUTLET WORKS - EXISTING CONDITIONS PLAN

DWG. NO. C-02

SHEET NO. 4

SECORD LAKE
NORMAL LAKE EL. 750.8
CURRENT LAKE EL. 746.3 (NOVEMBER 2020)

N

SB-6
SB-3
SB-2
SB-7
MW #5
RIGHT EMBANKMENT CENTERLINE
SB-4
MW #3
MW #1
MW #4
MW #2
P-96-02
BM #1
SB-5
SB-1
LEFT EMBANKMENT CENTERLINE
POWERHOUSE ACCESS ROAD
DITCH CENTERLINE
TITTABAWASSEE RIVER
FLOW

750 755 745 740 735 730 725 720 715 710

SYMBOLS LEGEND

SB-3	SOIL BORING COMPLETED BY STEARNS DRILLING, 1996
SB-1	SOIL BORING COMPLETED BY RC ASSOCIATES, INC., 2001
SB-5	SOIL BORING COMPLETED BY McDOWELL & ASSOCIATES, 2005
	DRAIN TILES
MW #1	MONITORING WELL
BM #1	SURVEY REFERENCE MONUMENT

LINETYPE LEGEND

- CENTERLINE
- WATER ELEVATION
- O/E — OVERHEAD ELECTRIC LINES
- X — X — FENCE LINE (STEEL)
- EDGE OF ROADWAY (UNPAVED)
- BURIED PIPING
- 750 — EXISTING MAJOR CONTOURS
- EXISTING MINOR CONTOURS

OUTLET WORKS - PLAN VIEW

0 10 20
SCALE, FT

Attention:
0 1"
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NO.	DATE	ISSUE/REVISION	APP
0	xx/xx/xxxx	CONCEPTUAL DESIGN SUBMITTAL	--

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OUTLET WORKS - TEMPORARY COFFERDAMS PLAN

DWG. NO. C-03
SHEET NO. 5

SECORD LAKE
NORMAL LAKE EL. 750.8
CURRENT LAKE EL. 746.3 (NOVEMBER 2020)

A
C-05

EXISTING UPSTREAM ARCHES
BELOW EL. 734.8 TO REMAIN

UPSTREAM EXTENT OF DEMOLITION

DEMOLISH EXISTING HANDRAIL

DEMOLISH EXISTING CONCRETE DECK

REMOVE EXISTING BRIDGE DECK

REMOVE HOIST BEAMS

DEMOLISH EXISTING TAINTER GATES

LOWER
CREST &
DEMOLISH
ROLLWAY

EXISTING PIER TO REMAIN

DEMOLISH STRUTS

RESURFACE
STILLING
BASIN

DEMOLISH END SILL

DOWNSTREAM EXTENT
OF DEMOLITION

DEMOLISH

A
C-05

TITTABAWASSEE RIVER

FLOW

N

LINETYPE LEGEND

- CENTERLINE
- WATER ELEVATION
- OVERHEAD ELECTRIC LINES
- FENCE LINE (STEEL)
- FENCE LINE (WOOD)
- EDGE OF ROADWAY (UNPAVED)
- BURIED PIPING
- EXISTING MAJOR CONTOURS
- EXISTING MINOR CONTOURS

HATCH LEGEND

GRATING

CONCRETE
DEMOLITION

SYMBOLS LEGEND

- DRAIN TILES
- FLOW DIRECTION

OUTLET WORKS - DEMOLITION PLAN VIEW

0 10 20
SCALE, FT

NO.	DATE	ISSUE/REVISION	APP
0	xx/xx/xxxx	CONCEPTUAL DESIGN SUBMITTAL	--

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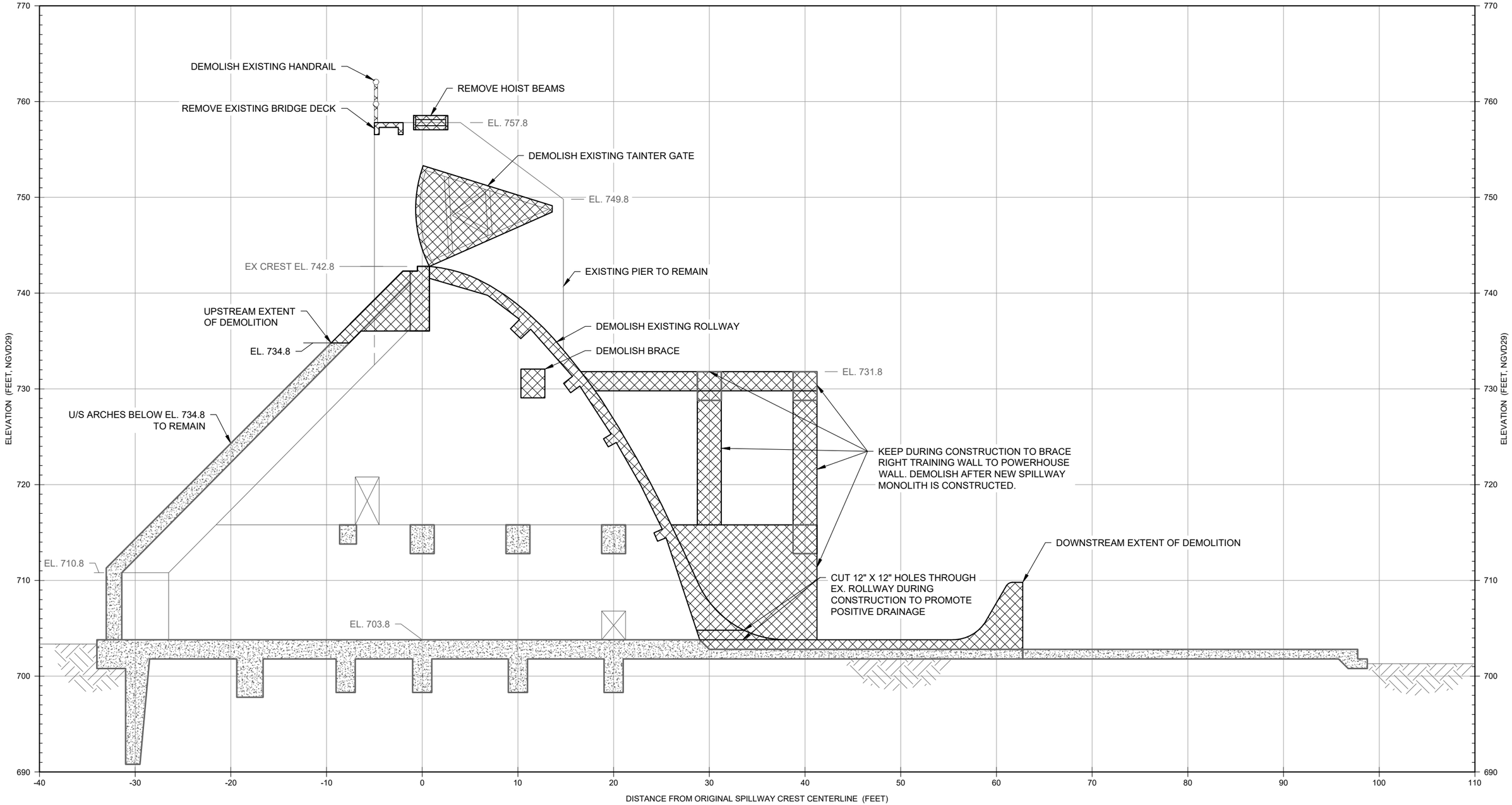
Gladwin County, Michigan

OUTLET WORKS - DEMOLITION PLAN

DWG. NO. C-04

SHEET NO. 6



A / C-04 SECTION
SPILLWAY DEMOLITION

SCALE, FT 0 5 10

HATCH LEGEND

CONCRETE DEMOLITION | EXISTING CONCRETE | EXISTING FOUNDATION

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OUTLET WORKS - DEMOLITION SECTION

DWG. NO. C-05
SHEET NO. 7

SECORD LAKE
NORMAL LAKE EL. 750.8
CURRENT LAKE EL. 746.3 (NOVEMBER 2020)

C C-08

B C-07

BAY 2

BAY 1

6.8'

NEW PREFABRICATED WALKWAY

RAISE AND EXTEND WALL TO SUPPORT WALKWAY

UPSTREAM EDGE OF CREST

HYDRAULIC CYLINDERS

NEW CREST GATE (FULL CLOSED POSITION)

NEW CREST GATE (FULL OPEN POSITION)

EXTEND & WIDEN CONCRETE PIER TO MOUNT GATE HYDRAULICS

EMBANKMENT CREST EL. 758.0

15'

EDGE OF EMBANKMENT CREST

GATE 21'

GATE 18'

STEPPED CONCRETE CHUTE 24'

3' STEPS (TYP)

NO MODIFICATIONS TO POWERHOUSE

RAISE TRAINING WALL

RESURFACE CONCRETE APRON 42.2'

RAISE AND EXTEND TRAINING WALL

RIPRAP PROTECTION UP TO EL. 728±

CONSTRUCT NEW END SILL 12.4'

34.2'

TITTABAWASSEE RIVER

FLOW

29.9'

22'

2.5H:1V

750

755

LINETYPE LEGEND

- CENTERLINE
- WATER ELEVATION
- O/E — OVERHEAD ELECTRIC LINES
- X — X — FENCE LINE (STEEL)
- FENCE LINE (WOOD)
- EDGE OF ROADWAY (UNPAVED)
- BURIED PIPING
- 750 — EXISTING MAJOR CONTOURS
- EXISTING MINOR CONTOURS

HATCH LEGEND

RIPRAP, CREST GATES, GRATING

SYMBOLS LEGEND

- DRAIN TILES
- FLOW DIRECTION

OUTLET WORKS - MODIFICATIONS PLAN VIEW

0 10 20
SCALE, FT

NO.	DATE	ISSUE/REVISION	APP
0	xx/xx/xxxx	CONCEPTUAL DESIGN SUBMITTAL	--

Attention: If this scale bar does not measure 1" then drawing is not original scale. (0 — 1")

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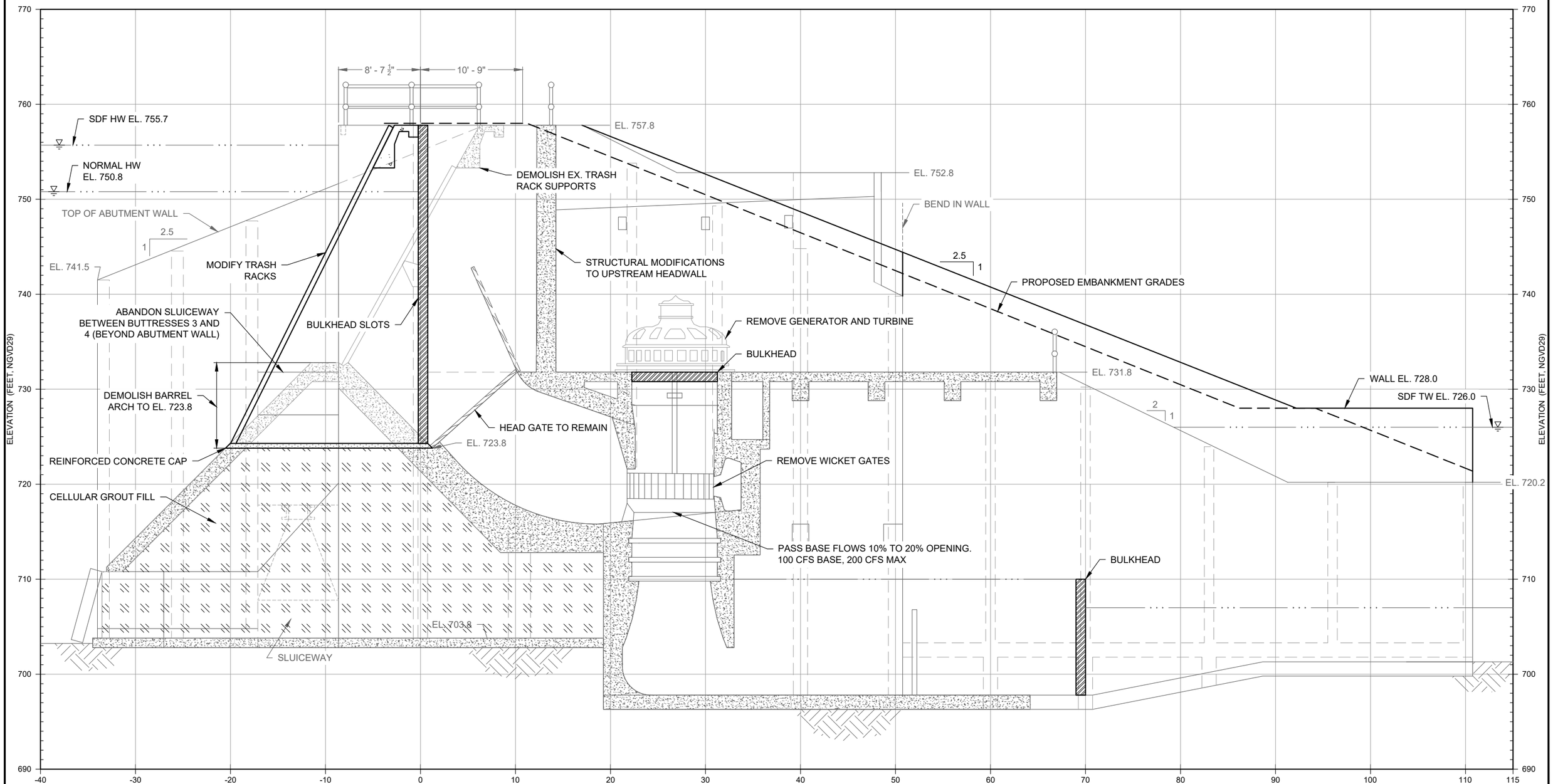
OUTLET WORKS - MODIFICATIONS PLAN VIEW

DWG. NO. C-06

SHEET NO. 8



B
C-06
SECTION
POWERHOUSE

SCALE, FT

HATCH LEGEND

EXISTING CONCRETE | EXISTING FOUNDATION | REINFORCED CONCRETE CAP | CELLULAR GROUT FILL | TIMBER

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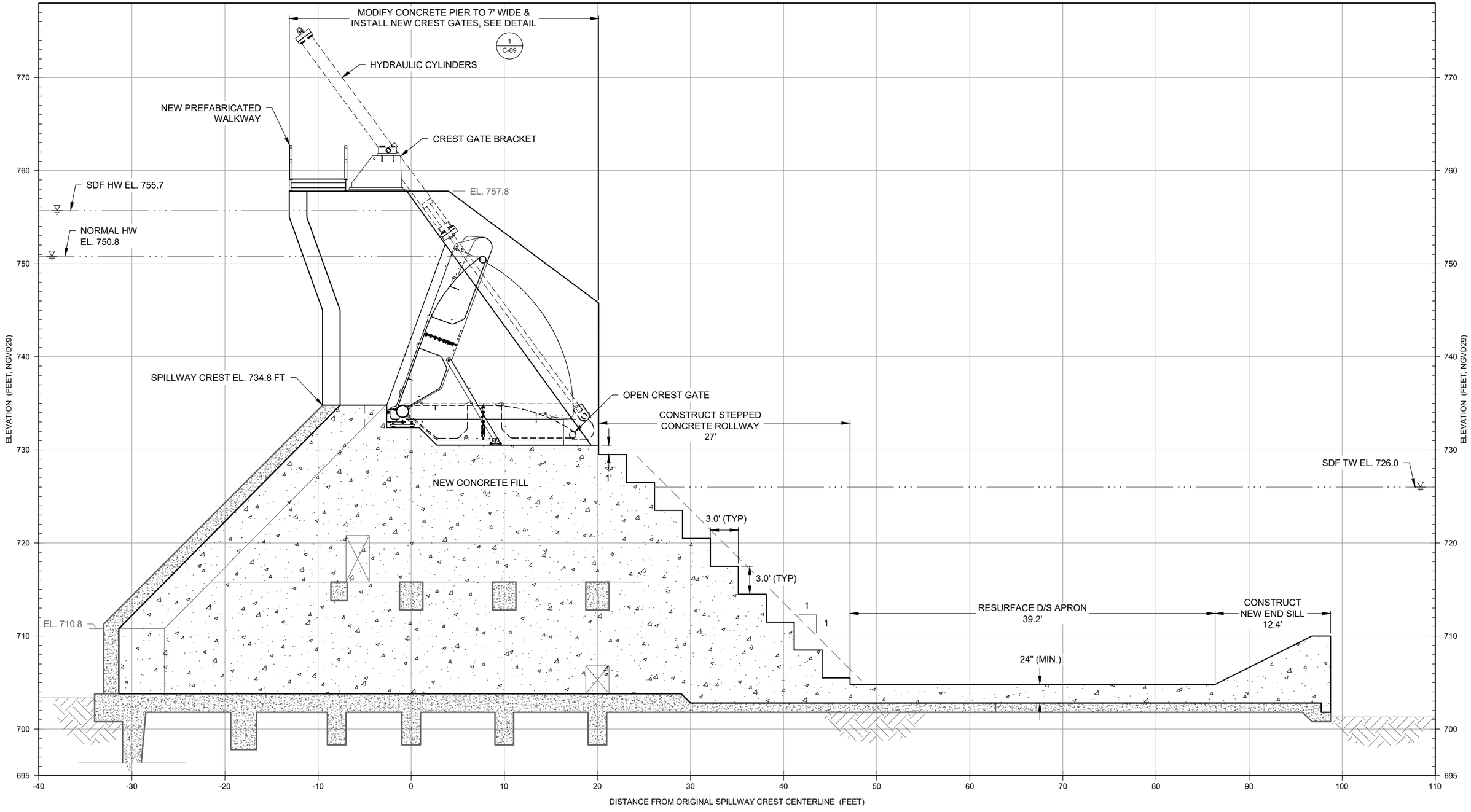
Gladwin County, Michigan

POWERHOUSE - MODIFICATIONS SECTION

DWG. NO. C-07
SHEET NO. 9



C-06 SECTION BAY 2 SPILLWAY

SCALE, FT 0 5 10

HATCH LEGEND

PROPOSED REINFORCED CONCRETE

EXISTING CONCRETE

EXISTING FOUNDATION

Attention:

0 1"

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NO.	DATE	ISSUE/REVISION	APP
0	xx/xx/xxxx	CONCEPTUAL DESIGN SUBMITTAL	--

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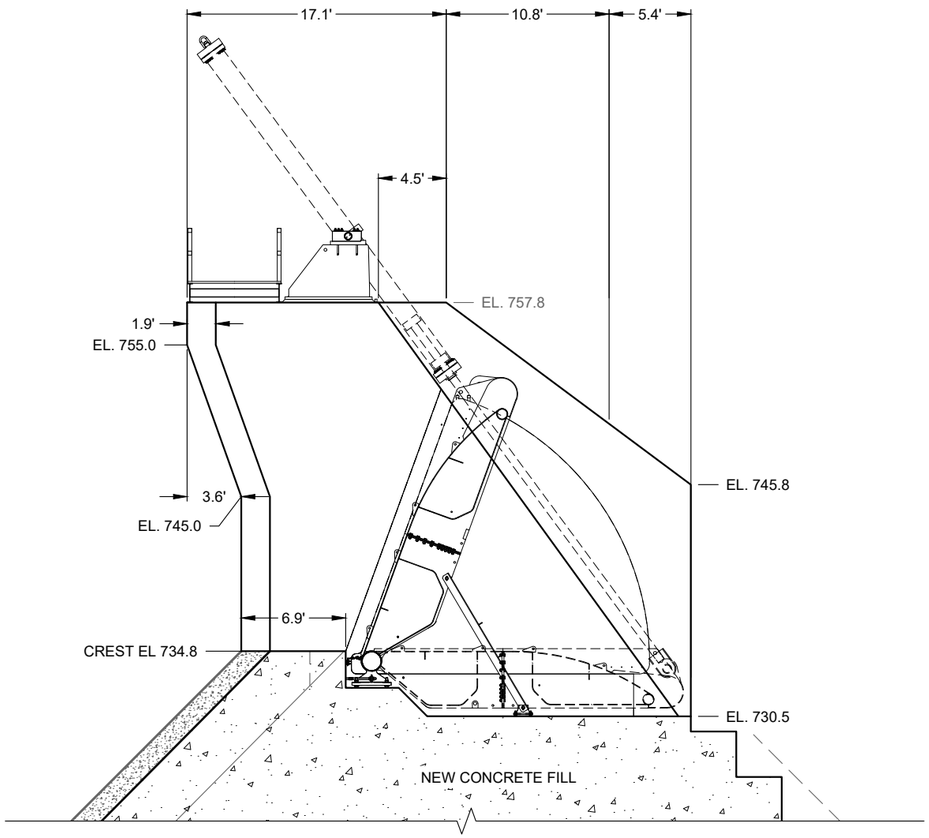
Gladwin County, Michigan

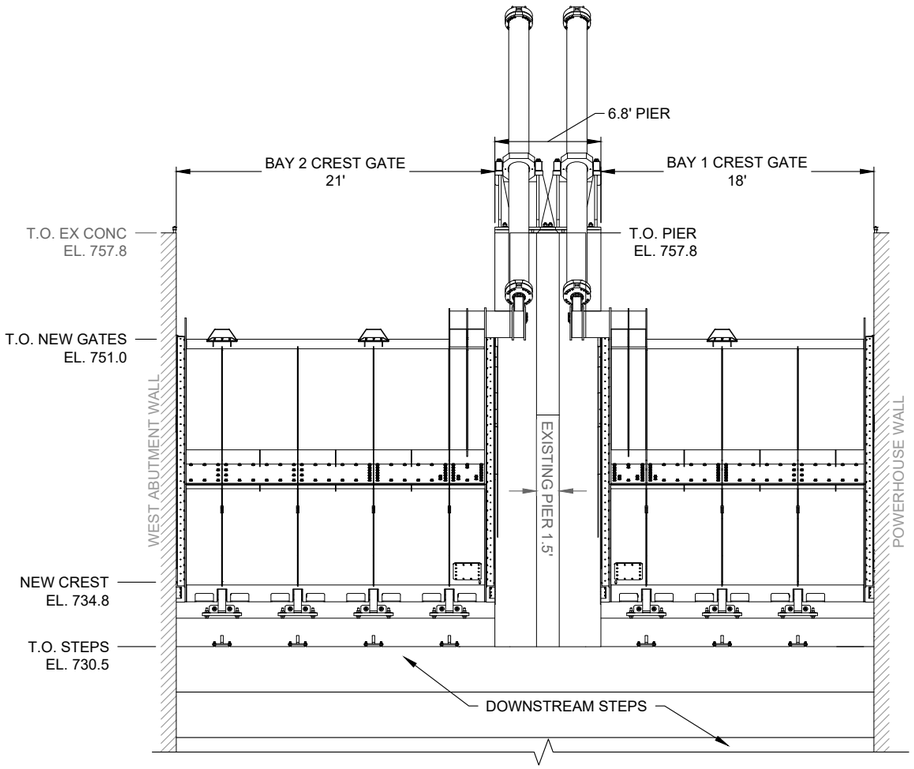
PRIMARY SPILLWAY - MODIFICATIONS SECTION

DWG. NO. C-08

SHEET NO. 10



SECTION



DOWNSTREAM ELEVATION
(LOOKING UPSTREAM)

1 / C-08 DETAIL
PIER-MOUNTED CREST GATE

0 5 10
SCALE, FT

HATCH LEGEND

PROPOSED REINFORCED CONCRETE

EXISTING CONCRETE

NO.	DATE	ISSUE/REVISION	APP
0	xx/xx/xxxx	CONCEPTUAL DESIGN SUBMITTAL	--

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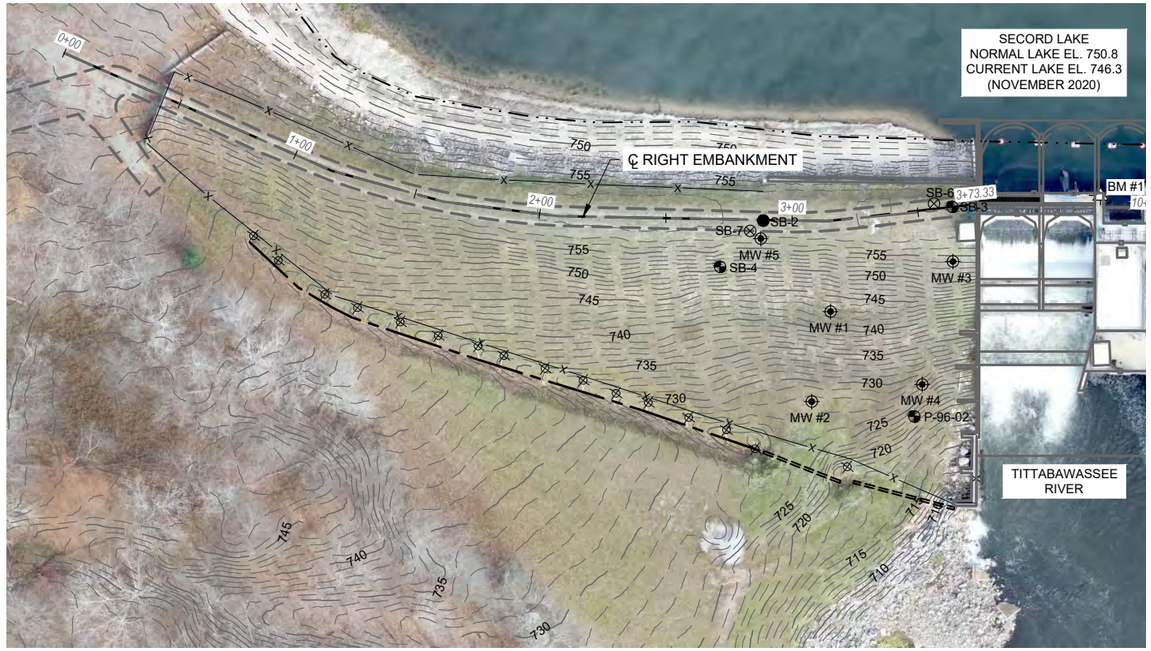
Gladwin County, Michigan

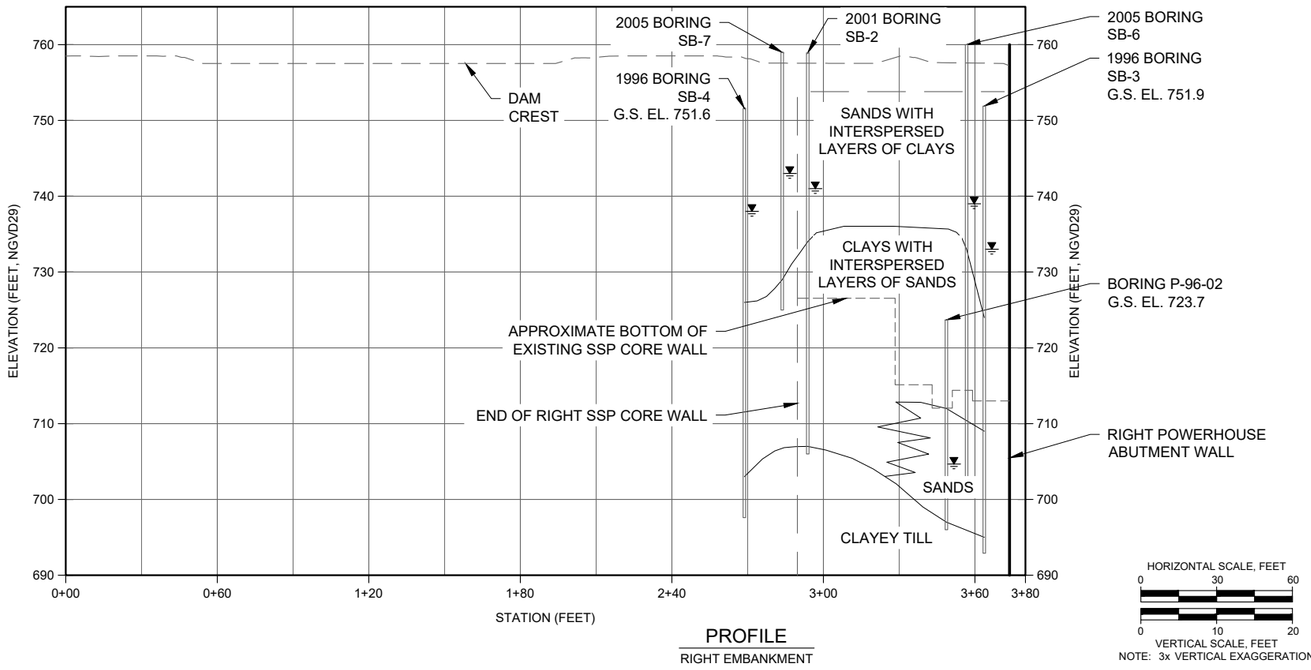
PRIMARY SPILLWAY - CREST GATE DETAILS

DWG. NO. C-09
SHEET NO. 11



RIGHT EMBANKMENT EXISTING CONDITIONS PLAN

0 30' 60'
SCALE, FT



PROFILE
RIGHT EMBANKMENT

HORIZONTAL SCALE, FEET
0 30 60
0 10 20
VERTICAL SCALE, FEET
NOTE: 3x VERTICAL EXAGGERATION

LINETYPE LEGEND

- CENTERLINE
- WATER ELEVATION
- FENCE LINE (STEEL)
- FENCE LINE (WOOD)
- EDGE OF ROADWAY (UNPAVED)
- ROADWAY CENTERLINE
- BURIED PIPING
- 750 EXISTING MAJOR CONTOURS
- EXISTING MINOR CONTOURS
- EXISTING SURFACE ELEVATION
- SSP CORE WALL EXTENTS

SYMBOLS LEGEND

- SB-3 SOIL BORING COMPLETED BY STEARNS DRILLING, 1996
- SB-1 SOIL BORING COMPLETED BY RC ASSOCIATES, INC., 2001
- SB-5 SOIL BORING COMPLETED BY McDOWELL & ASSOCIATES, 2005
- DRAIN TILES
- MW #1 MONITORING WELL
- BM #1 SURVEY REFERENCE MONUMENT

NOTES:

1. RIGHT EMBANKMENT SOIL PROFILE DEVELOPED FROM SECORD SUPPORTING TECHNICAL INFORMATION DOCUMENT, FEBRUARY 2006.

NO.	DATE	ISSUE/REVISION	APP
0	xx/xx/xxxx	CONCEPTUAL DESIGN SUBMITTAL	--

Attention: 0 1" — If this scale bar does not measure 1" then drawing is not original scale.

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Checked:	P. DREW
Drawn:	A. SAMPSON
Approved By:	B. WALTON

Four Lakes Task Force
FERC Project No. 10809

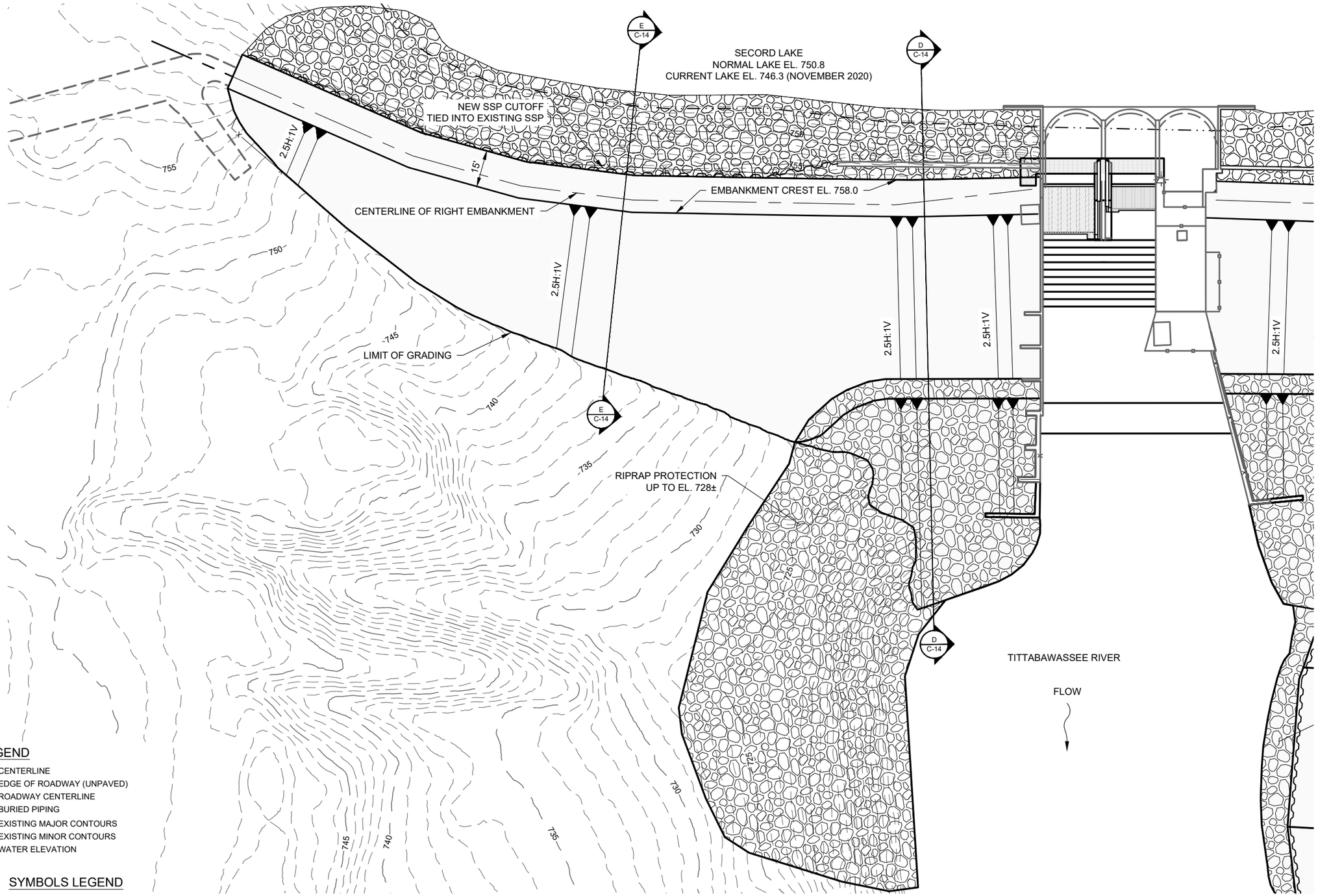
GEI Project 2002879

Secord Dam Conceptual Design
Gladwin County, Michigan

RIGHT EMBANKMENT - EXISTING SITE PLAN AND ELEVATION PROFILE

DWG. NO. C-10

SHEET NO. 12



LINETYPE LEGEND

- CENTERLINE
- EDGE OF ROADWAY (UNPAVED)
- ROADWAY CENTERLINE
- BURIED PIPING
- 750 — EXISTING MAJOR CONTOURS
- EXISTING MINOR CONTOURS
- WATER ELEVATION

HATCH LEGEND

RIPRAP

BERM FILL AREA

SYMBOLS LEGEND

1H:1V — CUT SLOPE

1H:1V — FILL SLOPE

RIGHT EMBANKMENT MODIFICATIONS PLAN

0 20 40

SCALE: 1" = 20'

NO.	DATE	ISSUE/REVISION	APP
0	xx/xx/xxxx	CONCEPTUAL DESIGN SUBMITTAL	--

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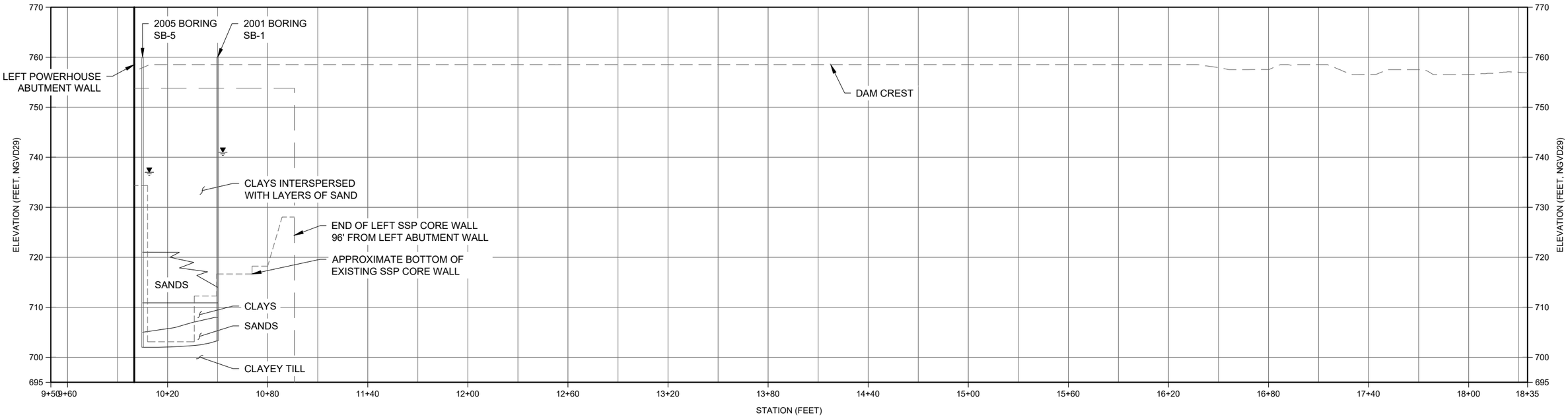
RIGHT EMBANKMENT - MODIFICATIONS PLAN

DWG. NO. C-11

SHEET NO. 13

LEFT EMBANKMENT EXISTING CONDITIONS PLAN

SCALE, FT: 0, 30', 60'



LINETYPE LEGEND

- CENTERLINE
- WATER ELEVATION
- FENCE LINE (STEEL)
- FENCE LINE (WOOD)
- EDGE OF ROADWAY (UNPAVED)
- ROADWAY CENTERLINE
- BURIED PIPING
- EXISTING MAJOR CONTOURS (750)
- EXISTING MINOR CONTOURS
- EXISTING SURFACE ELEVATION
- SSP CORE WALL EXTENTS

SYMBOLS LEGEND

- SB-3 — SOIL BORING COMPLETED BY STEARNS DRILLING, 1996
- SB-1 — SOIL BORING COMPLETED BY RC ASSOCIATES, INC., 2001
- SB-5 — SOIL BORING COMPLETED BY McDOWELL & ASSOCIATES, 2005
- DRAIN TILES
- MW #1 — MONITORING WELL
- BM #1 — SURVEY REFERENCE MONUMENT

PROFILE
LEFT EMBANKMENT

HORIZONTAL SCALE, FEET: 0, 30, 60
VERTICAL SCALE, FEET: 0, 10, 20
NOTE: 3x VERTICAL EXAGGERATION

NOTES:

1. LEFT EMBANKMENT SOIL PROFILE DEVELOPED FROM SECORD SUPPORTING TECHNICAL INFORMATION DOCUMENT, FEBRUARY 2006.

NO.	DATE	ISSUE/REVISION	APP
0	xx/xx/xxxx	CONCEPTUAL DESIGN SUBMITTAL	--

Attention: If this scale bar does not measure 1" then drawing is not original scale. (0, 1")

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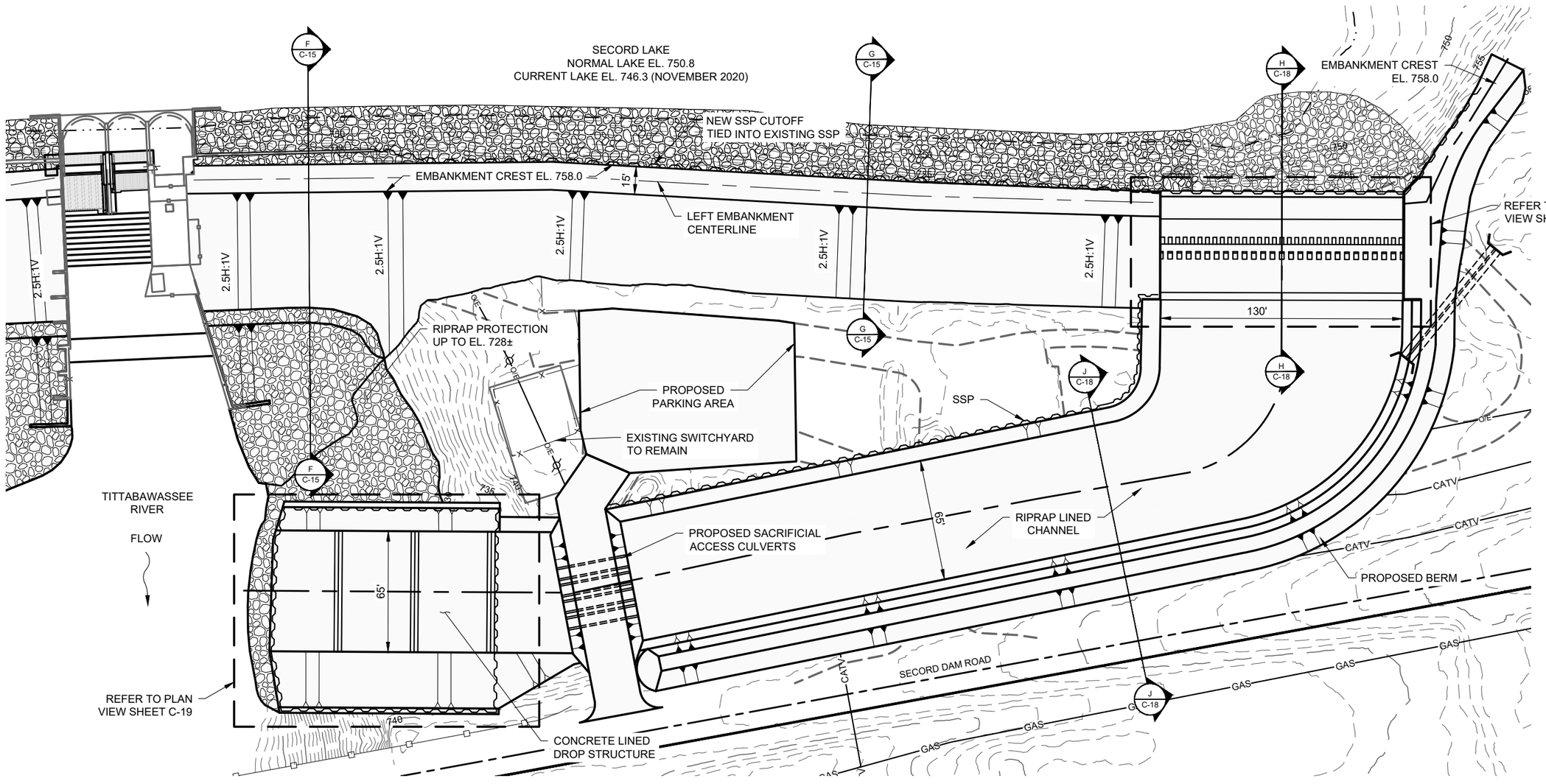
LEFT EMBANKMENT - EXISTING SITE PLAN AND ELEVATION PROFILE

DWG. NO. C-12

SHEET NO. 14



AUXILIARY SPILLWAY PLAN

0 30 60
SCALE, FEET

LINETYPE LEGEND

- CENTERLINE
- EDGE OF ROADWAY (UNPAVED)
- ROADWAY CENTERLINE
- BURIED PIPING
- 750 EXISTING MAJOR CONTOURS
- EXISTING MINOR CONTOURS
- WATER ELEVATION

HATCH LEGEND

RIPRAP

BERM FILL AREA

SYMBOLS LEGEND

1H:1V CUT SLOPE

1H:1V FILL SLOPE

NO.	DATE	ISSUE/REVISION	APP
0	xx/xx/xxxx	CONCEPTUAL DESIGN SUBMITTAL	--

Attention: 0 1" If this scale bar does not measure 1" then drawing is not original scale.

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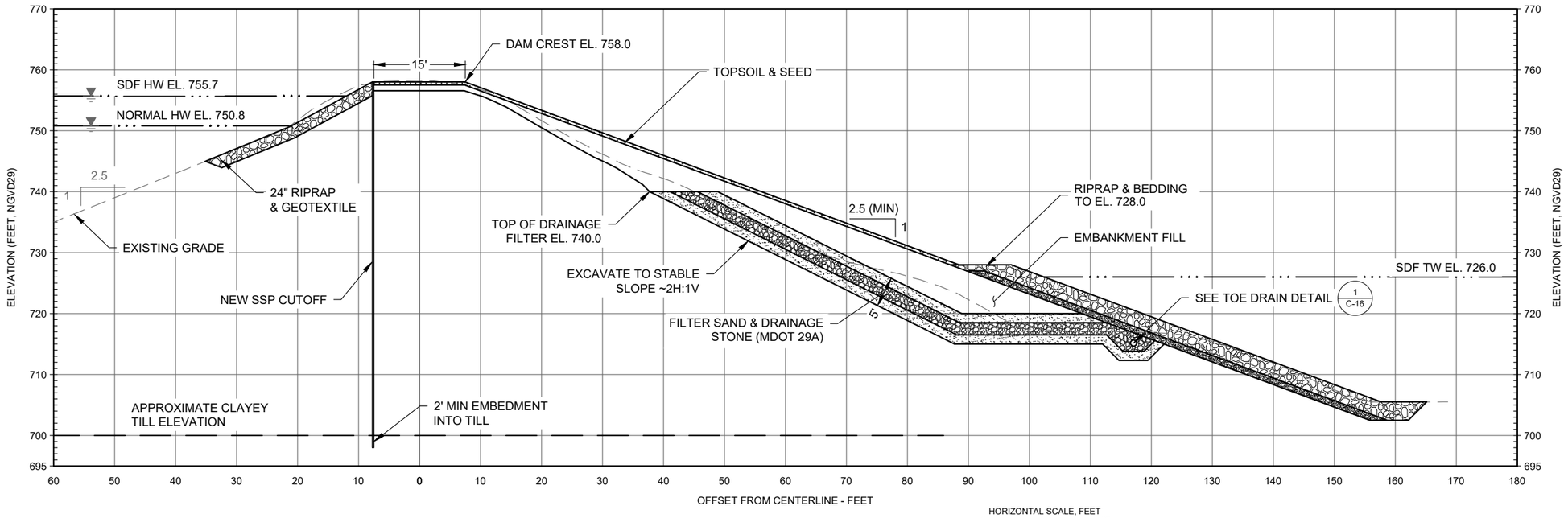
LEFT EMBANKMENT - MODIFICATIONS PLAN

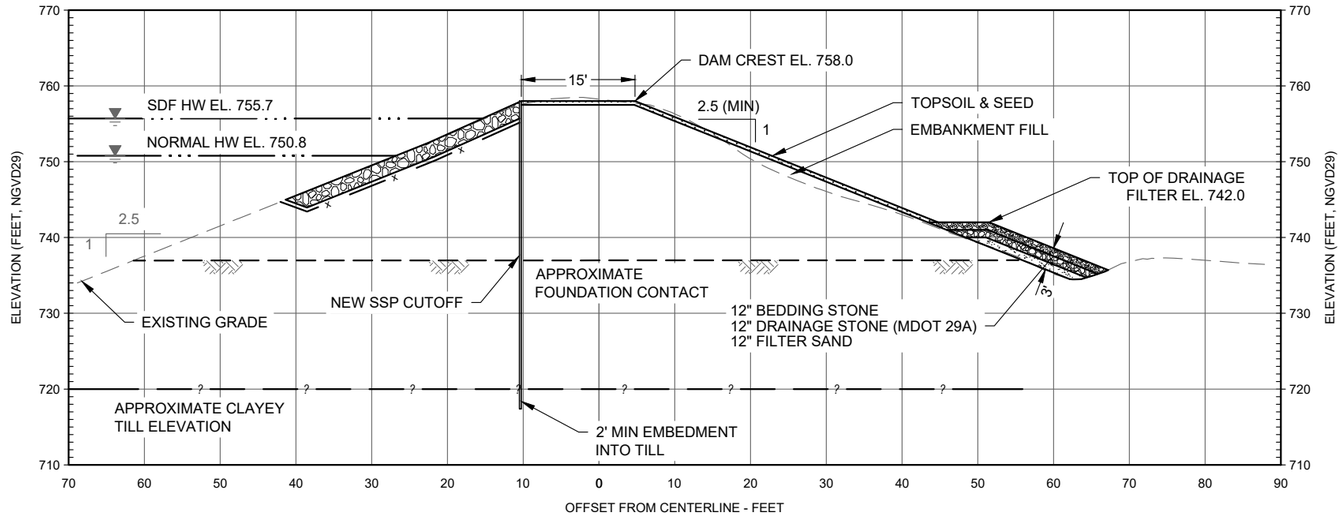
DWG. NO. C-13

SHEET NO. 15



D C-11 SECTION
RIGHT EMBANKMENT

HORIZONTAL SCALE, FEET
0 10 20
VERTICAL SCALE, FEET
NO VERTICAL EXAGGERATION



E C-11 SECTION
RIGHT EMBANKMENT

HORIZONTAL SCALE, FEET
0 10 20
VERTICAL SCALE, FEET
NO VERTICAL EXAGGERATION

NO.	DATE	ISSUE/REVISION	APP
0	xx/xx/xxxx	CONCEPTUAL DESIGN SUBMITTAL	--

Attention:
0 1"
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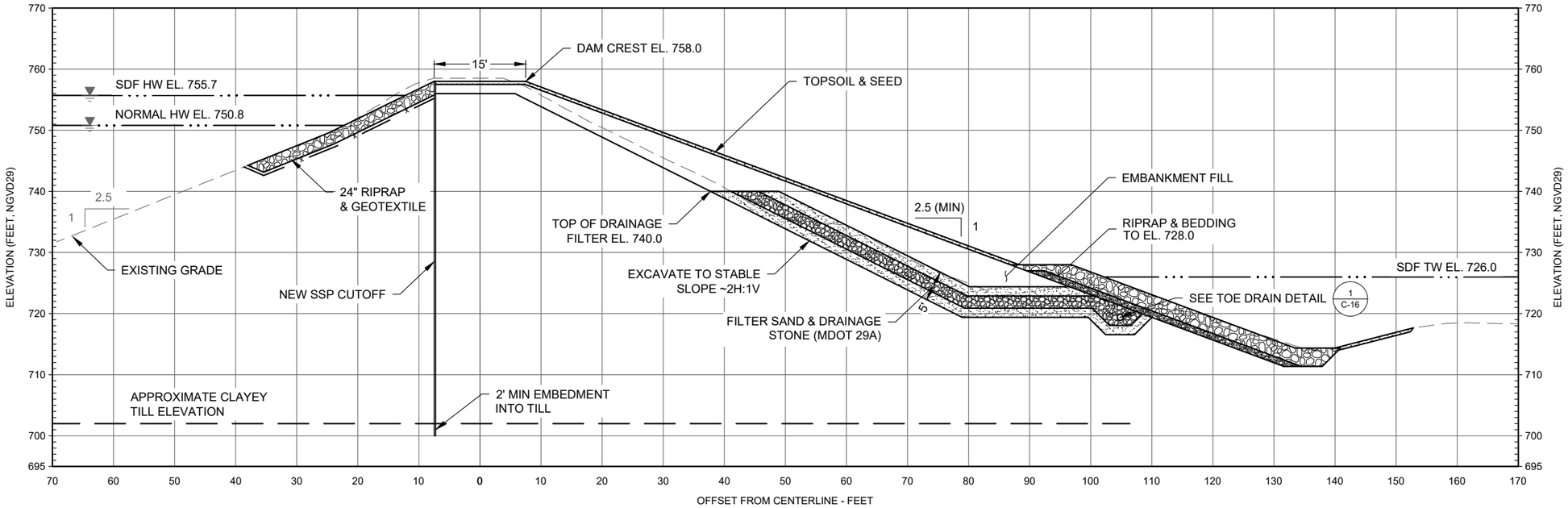
Gladwin County, Michigan

RIGHT EMBANKMENT - MODIFIED SECTIONS

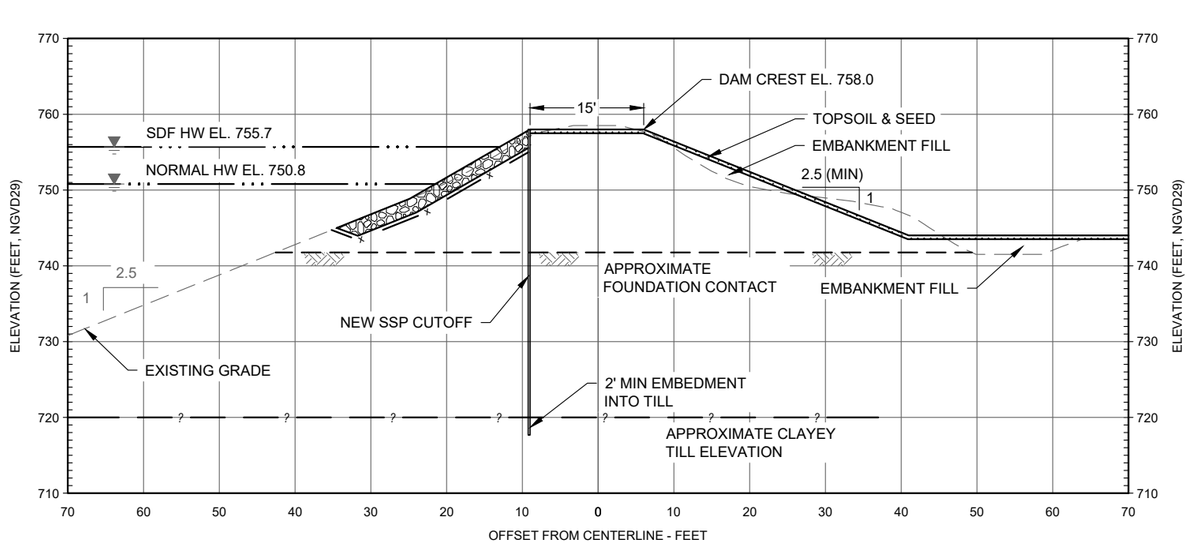
DWG. NO. C-14

SHEET NO. 16



F C-13 SECTION LEFT EMBANKMENT

HORIZONTAL SCALE, FEET
0 10 20
0 10 20
VERTICAL SCALE, FEET
NO VERTICAL EXAGGERATION



G C-13 SECTION LEFT EMBANKMENT

HORIZONTAL SCALE, FEET
0 10 20
0 10 20
VERTICAL SCALE, FEET
NO VERTICAL EXAGGERATION

NO.	DATE	ISSUE/REVISION	APP
0	xx/xx/xxxx	CONCEPTUAL DESIGN SUBMITTAL	--

Attention: 0 1" — If this scale bar does not measure 1" then drawing is not original scale.

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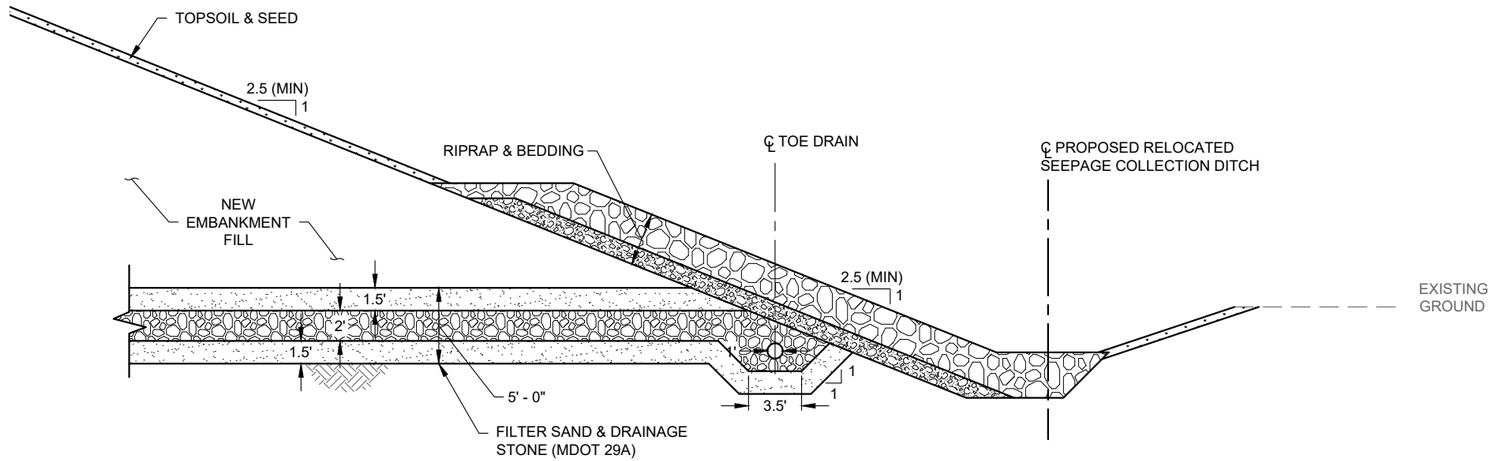
Gladwin County, Michigan

LEFT EMBANKMENT - MODIFIED SECTIONS

DWG. NO. C-15
SHEET NO. 17



1 / C-14 / C-15 **DETAIL**
TOE DRAIN

0 5 10
SCALE, FEET

Attention:
0 1"
If this scale bar does not measure 1" then drawing is not original scale.

NO.	DATE	ISSUE/REVISION	APP
0	xx/xx/xxxx	CONCEPTUAL DESIGN SUBMITTAL	--

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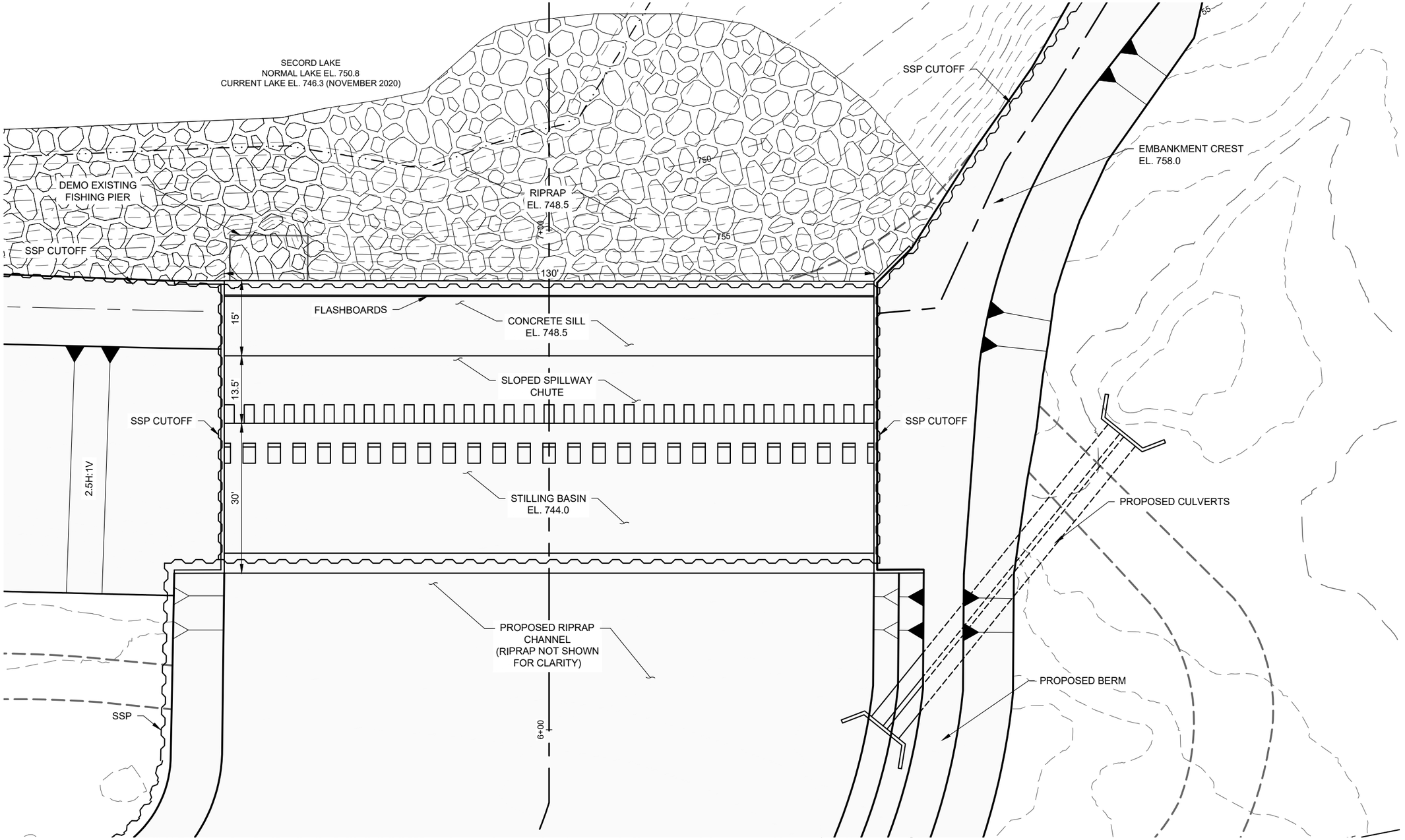
RIGHT AND LEFT EMBANKMENTS - MODIFICATION DETAILS

DWG. NO. C-16

SHEET NO. 18

\\MSN1L-AMICH C:\Temp Local C\FLTF\Secord\CAD\Design\Task4.3_ConceptDesign\C-03_Embankment Modifications.dwg - 1/18/2021



PLAN VIEW
PROPOSED AUXILIARY SPILLWAY

0 10 20
SCALE, FEET

NO.	DATE	ISSUE/REVISION	APP
0	xx/xx/xxxx	CONCEPTUAL DESIGN SUBMITTAL	--

Attention:
0 1"
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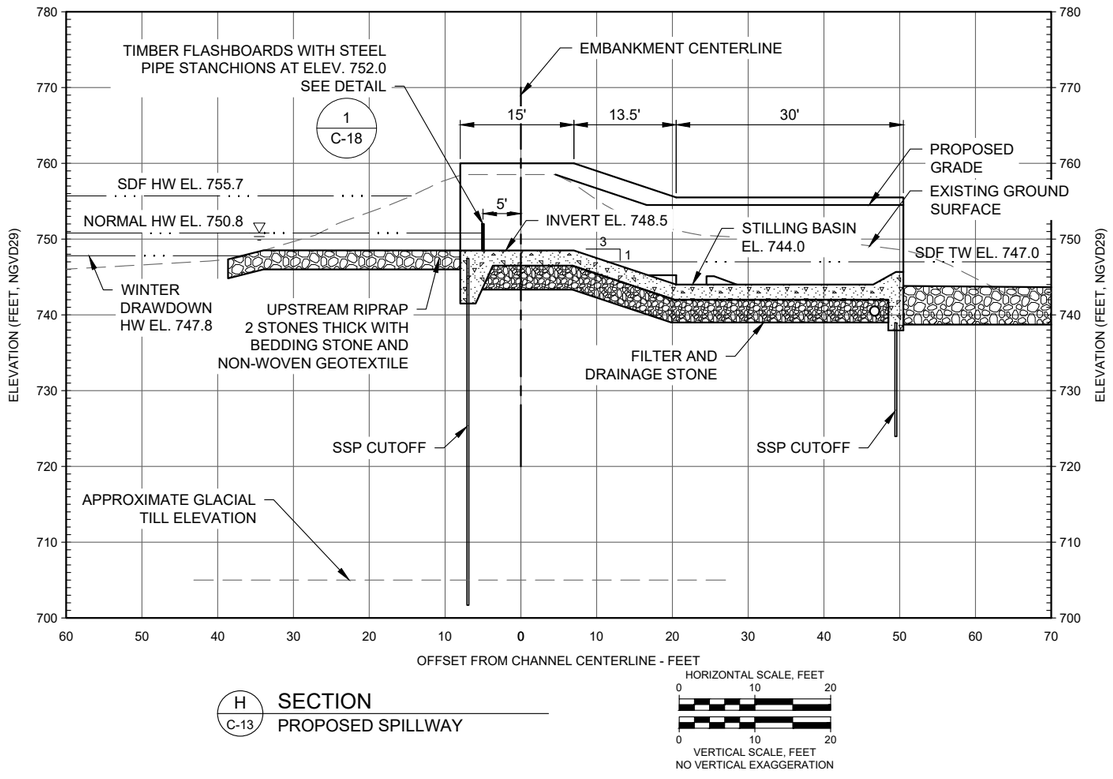
Gladwin County, Michigan

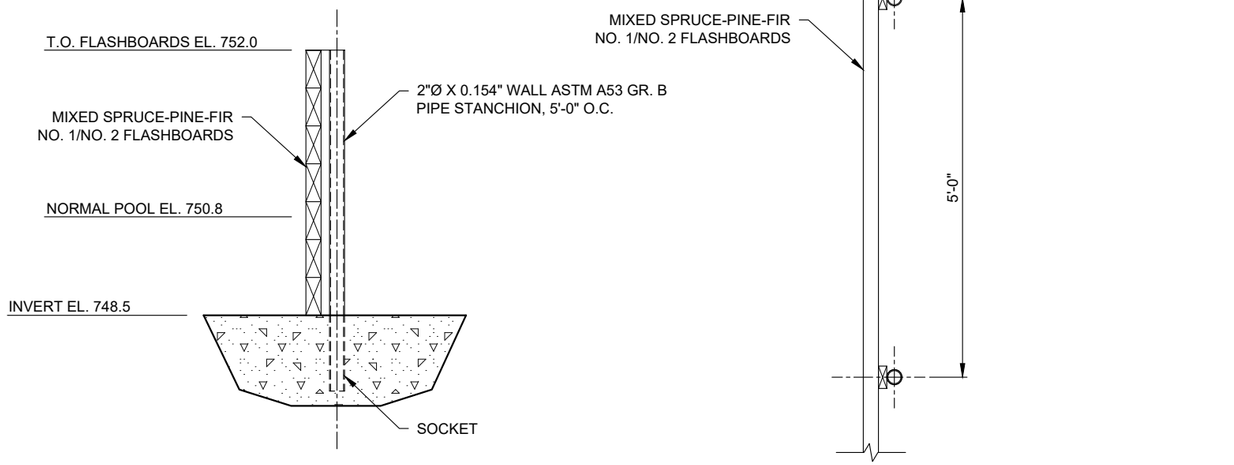
AUXILIARY SPILLWAY - PROPOSED PLAN VIEW

DWG. NO. C-17

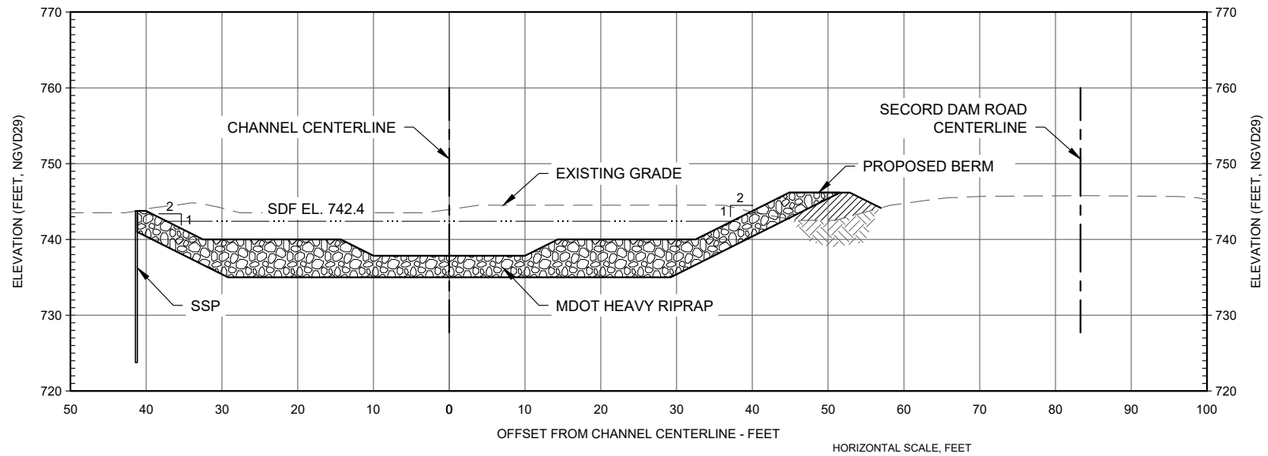
SHEET NO. 19



H C-13 SECTION
PROPOSED SPILLWAY



1 C-18 DETAIL
FLASHBOARD AND STANCHION



J C-13 SECTION
PROPOSED SPILLWAY CHANNEL

NO.	DATE	ISSUE/REVISION	APP
0	xx/xx/xxxx	CONCEPTUAL DESIGN SUBMITTAL	--

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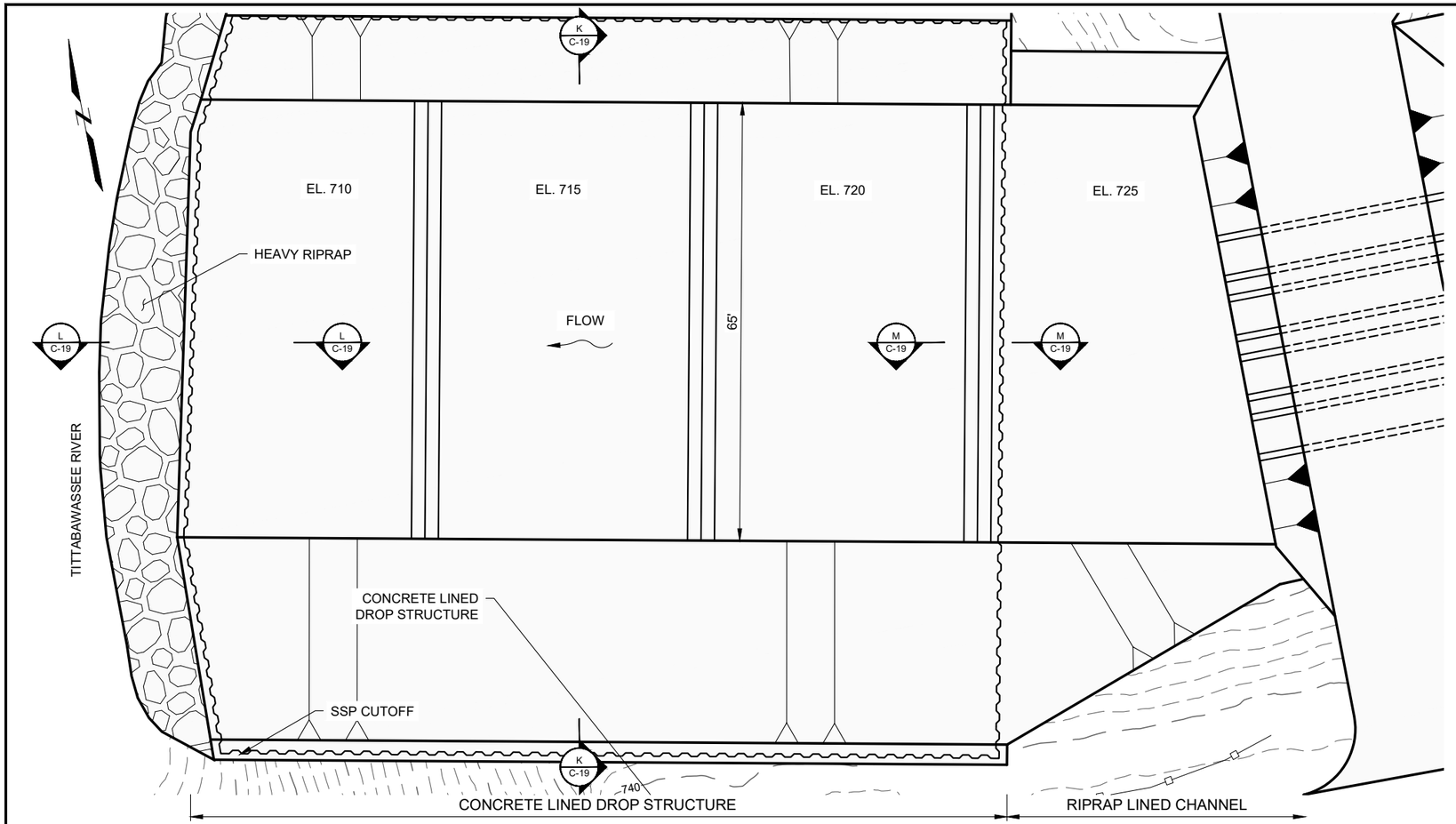
AUXILIARY SPILLWAY - PROPOSED SPILLWAY CROSS SECTION

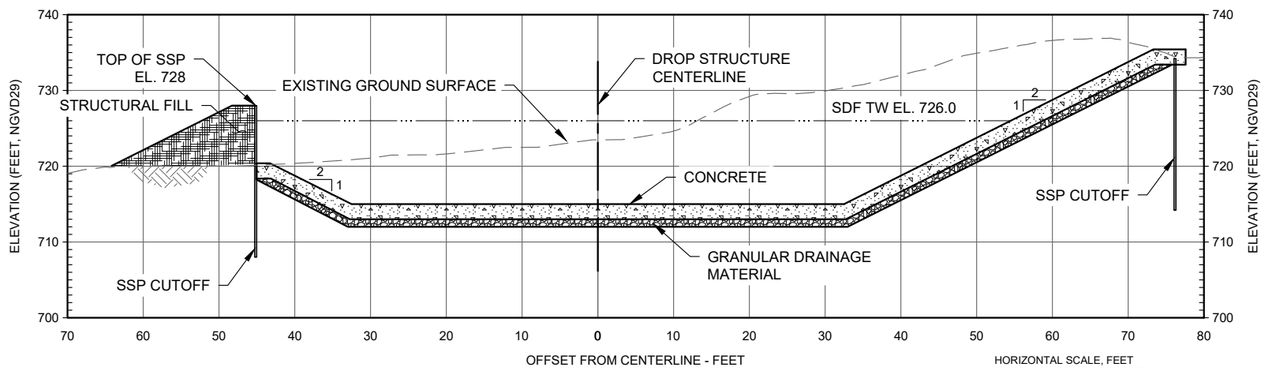
DWG. NO. C-18

SHEET NO. 20



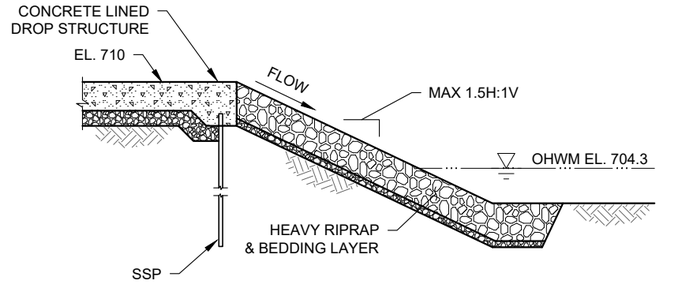
DROP STRUCTURE PLAN

0 10 20
SCALE, FEET



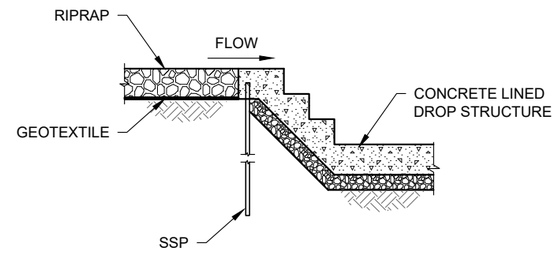
HORIZONTAL SCALE, FEET
0 10 20
0 10 20
VERTICAL SCALE, FEET
NO VERTICAL EXAGGERATION

K C-19 SECTION
CONCRETE LINED DROP STRUCTURE



L C-19 SECTION
AUX. SPILLWAY OUTLET

0 5 10
SCALE, FEET



M C-19 SECTION
CHANNEL/DROP STRUCTURE CONNECTION

0 5 10
SCALE, FEET

Attention: 0 1" If this scale bar does not measure 1" then drawing is not original scale.				
	0	xx/xx/xxxx	CONCEPTUAL DESIGN SUBMITTAL	--
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AUXILIARY SPILLWAY TERMINAL STRUCTURE - PROPOSED PLAN AND SECTION

DWG. NO. C-19
SHEET NO. 21