Geosyntec consultants

835 Georgia Avenue, Suite 500
Chattanooga, TN 37402-2218
PH 423.385.2310
FAX 678.202.9501
www.Geosyntec.com

25 July 2024

Kate Betsill
Environmental Engineer
Safe Dams Program
Georgia Department of Natural Resources
2 Martin Luther King, Jr. Drive
Atlanta, Georgia 30334

Subject: LLO Repair Comment Response
Pickens County
Permit #112-009-00462

Dear Ms. Betsill:

Big Canoe Property Owners Association (POA) and its consultant Geosyntec Consultants, Inc. (Geosyntec) received the Safe Dams Program (SDP) comments on the plan set for restoration of the low-level outlet (LLO) operability for Lake Petit Dam (Dam) in your letter dated 25 June 2024. For continuity and clarity, we have listed each of your comments from this letter below, along with our responses.

1. The note, "For review purposes only, Permit drawing – not for construction," must be removed from each sheet of the plans before the plans can be approved.

   Geosyntec – This phrase has been removed.

2. A 24-hour contact must be added to the first sheet of the plans.

   Geosyntec – Contact information has been added to cover sheet.

3. Please discuss the condition of the gate including, but not limited to, whether it will be capable of properly sealing the aperture.

   Geosyntec – The gate was inspected by a diver from the reservoir side in September 2020 and April 2023, and on the downstream side of the gate in December 2022. Inspections noted the gate was in satisfactory condition. There were no adverse conditions related to the sealing of the gate noted when the back of the gate was directly observed by dive inspection in December 2022 and the gate is expected to be able to seal upon completion of the LLO repair based on conversations with the gate manufacturer.

4. Are there environmental concerns or regulations related to possible re-routing or relocating of the asbestos cement vent pipe in Note 7, Sheet 4?

   Geosyntec – The plan notes have been revised to remove the option of relocating the vent pipe.

5. Please verify that the thrust blocks, thrust block connecting elements, frame link and end plates, bolts and other hardware associated with these plates, and gate stem are adequate given the forces acting on them. Additionally, please verify that the frames and connectors will adequately resist buckling, especially given over 100 feet of water head acting on the lower frame sections. Please have a structural engineer prepare and stamp computations showing the adequacy of the structure and verify that items on the plan sheets are structurally adequate.

   Geosyntec – Verified. A calculation package, stamped by the structural engineer who performed the design, is included with this comment response letter.

6. Please clarify the apparent discrepancy of the HSS 14X0.25 showing a thickness of 3/16-inch in Detail 12, Sheet 5. Please better define the connections between the HSS 2X2X3/16 and HSS 5X3X3/16 members of the frames.

   Geosyntec – There is no discrepancy in the plan set. The frame is comprised of three different Hollow Steel Shapes (HSS). The longitudinal side members are circular tubes with a 14-inch outer diameter and 1/4-inch wall thickness. The cross-frame members are rectangular tube sections measuring 5-inches by 3-inches with a 3/16-inch wall thickness. The center longitudinal member between the cross-frame members is a 2-inch by 2-inch square HSS with a 3/16-inch thickness. The connections between the HSS framing members is a 3/16-inch fillet weld all the way around the perimeter of the square/rectangular HSS members.

7. Will there be reinforcement in the anchor blocks? If so, verify it will not conflict with the 1/2-inch diameter threaded rods embedded a minimum of 6 inches in the anchor block. If not, please explain why it is not needed.

   Geosyntec – See Detail 6 on Sheet 4 for reinforcement detailing. There is no structural impact should reinforcement be intercepted by the frame anchors as this reinforcement is not the primary structural reinforcement and is provided to control temperature and shrinkage cracks.

8. What type of operator will be used?

   Geosyntec – A Hydrogate Bevel Gear Model CPS20 with a gear ratio of 18:1 (or approved equivalent) is proposed as the operator type.

9. What material strengths should be specified? Should any specifications related to connecting or sinking the frames be included?

   Geosyntec – See frame material notes on Sheet 5. No specifications related to constructing this frame or placing the frame should be included, as these are means and methods that are the responsibility of the contractor. The contractor will submit a work plan to be approved by the engineer prior to construction that describes their approach to connecting and sinking of the frame.

A revised version of the LLO Repair plan set has been developed based on your comments and our responses above and is included with this comment response letter.

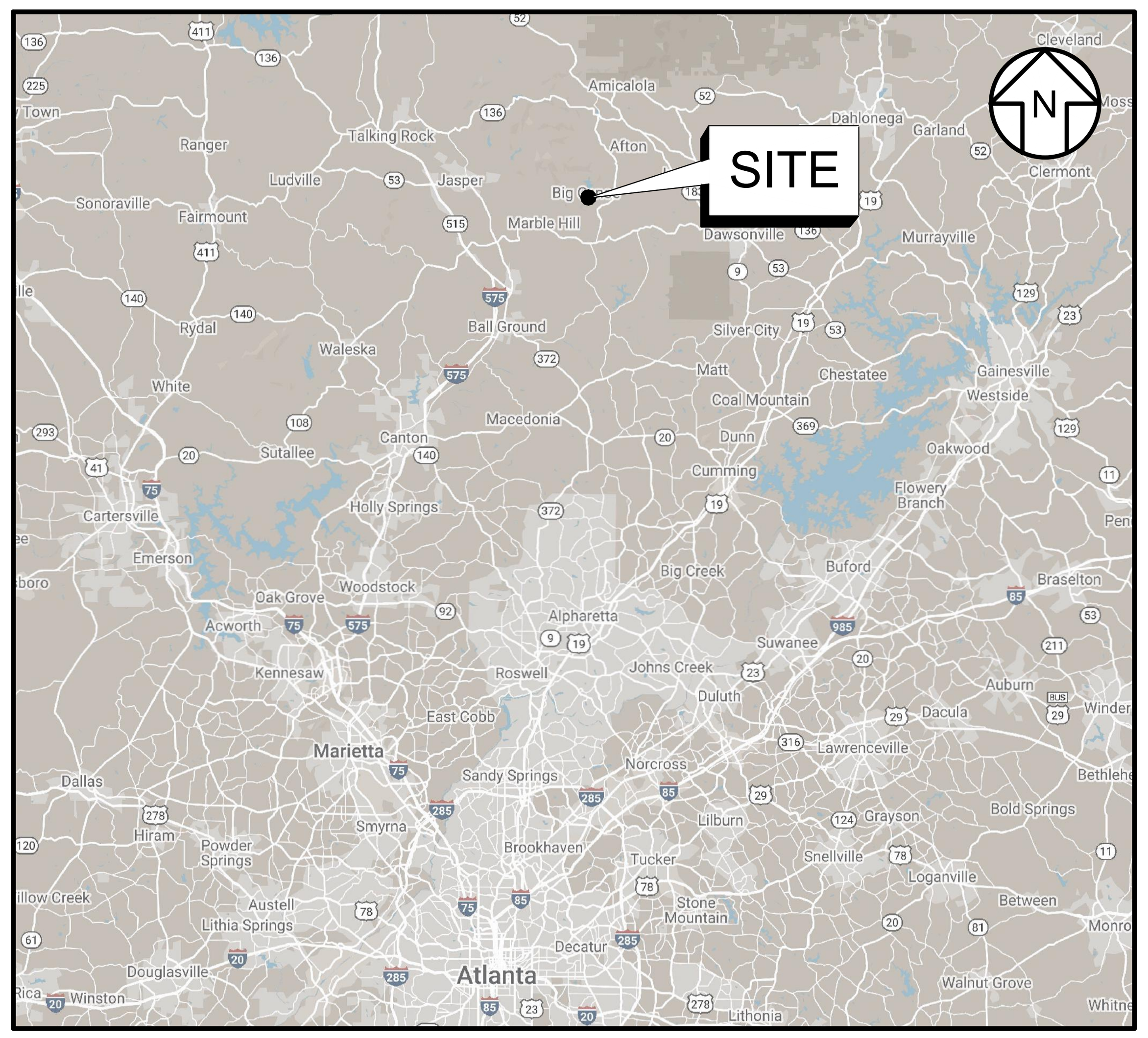
On behalf of Big Canoe POA, Geosyntec thanks you for your review and comments in finalizing this portion of the LLO Repair design. Please contact the undersigned, at 423.385.2316, if you have any questions.

Sincerely,

Vernon James Dotson, Jr., P.E. (GA, AL, NC, TN)
Senior Principal Engineer and Engineer of Record
Geosyntec Consultants, Inc.

cc: Scott Auer, Big Canoe Property Owners Association
Wesley MacDonald, P.E., Geosyntec Consultants, Inc.

LLO REPAIR
LAKE PETIT DAM
JASPER, GEORGIA
JULY 2024

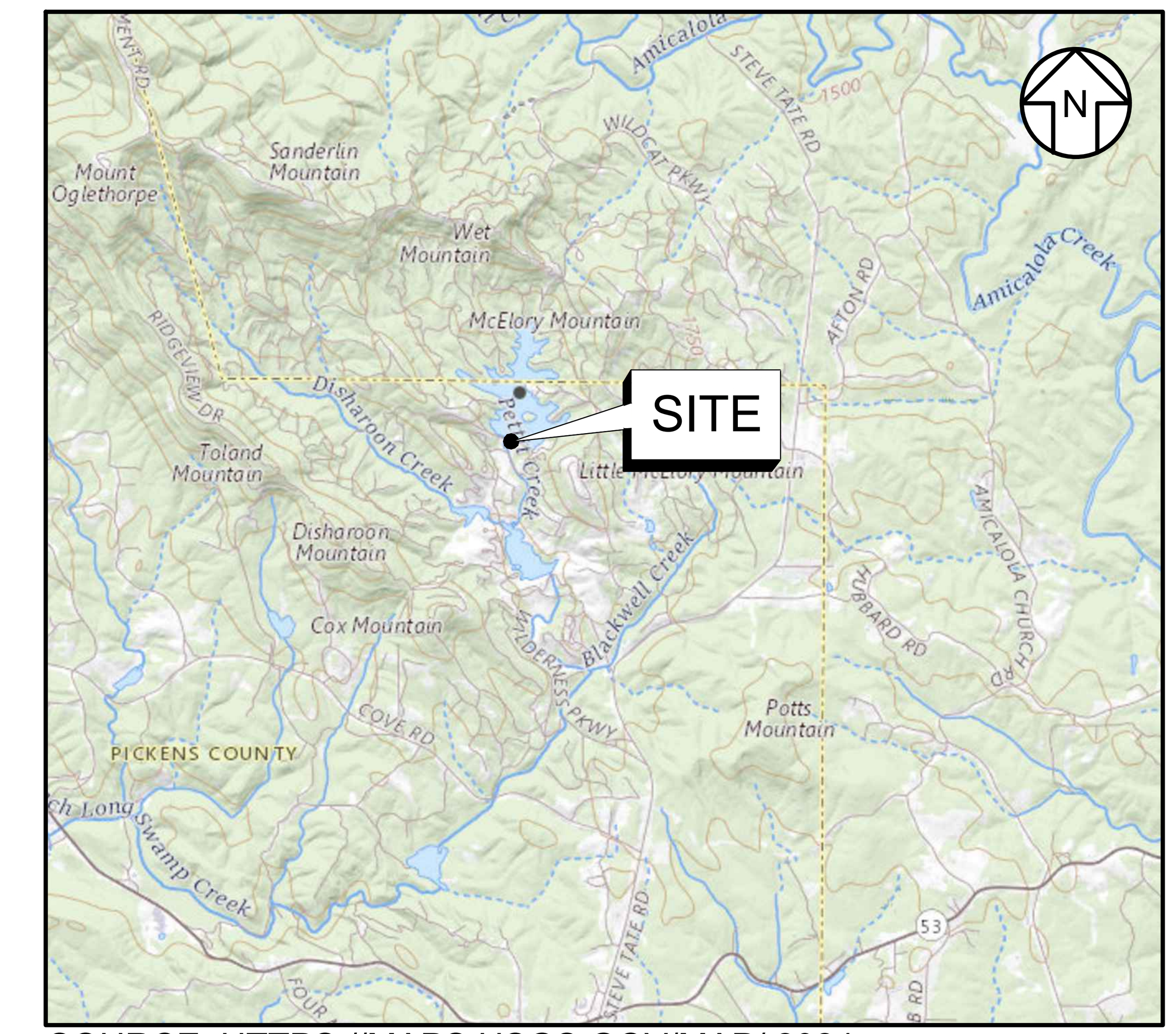


SOURCE: GOOGLE MAPS 2023

LOCATION MAP

0 10 MILES 20 MILES
SCALE IN FEET

SHEET LIST TABLE	
SHEET NUMBER	SHEET TITLE
1	COVER SHEET
2	AERIAL PHOTOGRAPH
3	EXISTING CONDITIONS & PROPOSED DEMOLITION
4	PROPOSED STEM FRAME
5	PROPOSED STEM FRAME DETAILS



SOURCE: HTTPS://MAPS.USGS.GOV/MAP/ 2024

VICINITY MAP

0 10,000' 20,000'
SCALE IN FEET

LAKE PETIT DAM INFORMATION	
STATE ID	NO, 112-009-00462
NID	GA00685
GPS LOCATION	34.4625 (NORTH), -84.2903 (WEST)
NORMAL POOL LEVEL ELEVATION	EL. 1635.5
TOP OF DAM ELEVATION	EL. 1647.0
UPSTREAM TOE DAM ELEVATION (APPROXIMATELY)	EL. 1540
DOWNSTREAM TOE ELEVATION (APPROXIMATELY)	EL. 1530
RESERVOIR SURFACE AREA (NORMAL POOL)	107 ACRES
NORMAL POOL VOLUME	4235 ACRE-FT
RESERVOIR SURFACE AREA (MAX. WATER STORAGE ELEV.)	137 ACRES
MAX. WATER STORAGE VOLUME	5,635 ACRES
NOTES: EL. - ELEVATION (FT NAVD88)	

811 Know what's below. Call before you dig.

GEORGIA 811
CALL BEFORE YOU DIG
DIAL 811 OR CALL
1-800-282-7411
UTILITIES PROTECTION CENTER
SERVICE AND SAFE WORK SITE

NOTE: CONSTRUCTION MUST COORDINATE WITH UTILITY PROVIDERS TO MAINTAIN UTILITY SERVICE AND A SAFE WORK SITE

Big Canoe POA

PREPARED FOR:
BIG CANOE PROPERTY OWNERS ASSOCIATION
10586 BIG CANOE
JASPER, GA 30143

24 HOUR - LLO REPAIR CONTACT:
LYDELL MACK
BIG CANOE PROPERTY OWNERS ASSOCIATION
PHONE: 678.578.9763

Geosyntec consultants

PREPARED BY:
GEOSYNTEC CONSULTANTS, INC.
835 GEORGIA AVENUE, SUITE 500
CHATTANOOGA, TN 37402
TELEPHONE: 423.385.2310

REV	DATE	DESCRIPTION	DRN	APP
1	07/25/2024	ADDRESSED SDP COMMENTS	MAF	VJD
0	05/31/2024	PERMIT DRAWINGS	MAF	VJD

GEORGIA REGISTERED No. PE044249 PROFESSIONAL ENGINEER VERNON JAMES DOTSON, JR. 07/25/2024

DESIGN BY:	NPH
DRAWN BY:	MAF
CHECKED BY:	NPH
REVIEWED BY:	WMT
APPROVED BY:	VJD

TITLE: COVER SHEET
PROJECT: LLO REPAIR
SITE: LAKE PETIT DAM - BIG CANOE

Big Canoe POA
Geosyntec consultants
835 GEORGIA AVENUE, SUITE 500
CHATTANOOGA, TN 37402

DATE:	MAY 2024
PROJECT NO.:	GST8061
FILE:	GST8061C01
SHEET NO.:	1 OF 5

1	2	3	4	5	6	7	8

N

0 500' 1000'

SCALE IN FEET

NOTE:

1. AERIAL IMAGERY SHOWN IS PROVIDED BY BING MAPS (THROUGH AUTOCAD CIVIL 3D).

REV	DATE	DESCRIPTION	DRN	APP
1	07/25/2024	ADDRESSED SDP COMMENTS	MAF	VJD
0	05/31/2024	PERMIT DRAWINGS	MAF	VJD

GEORGIA REGISTERED PROFESSIONAL ENGINEER No. PE044249 VERNON JAMES DOTSON, JR. 07/25/2024

DESIGN BY:	NPH
DRAWN BY:	MAF
CHECKED BY:	NPH
REVIEWED BY:	WMT
APPROVED BY:	VJD

TITLE: AERIAL PHOTOGRAPH

PROJECT: LLO REPAIR

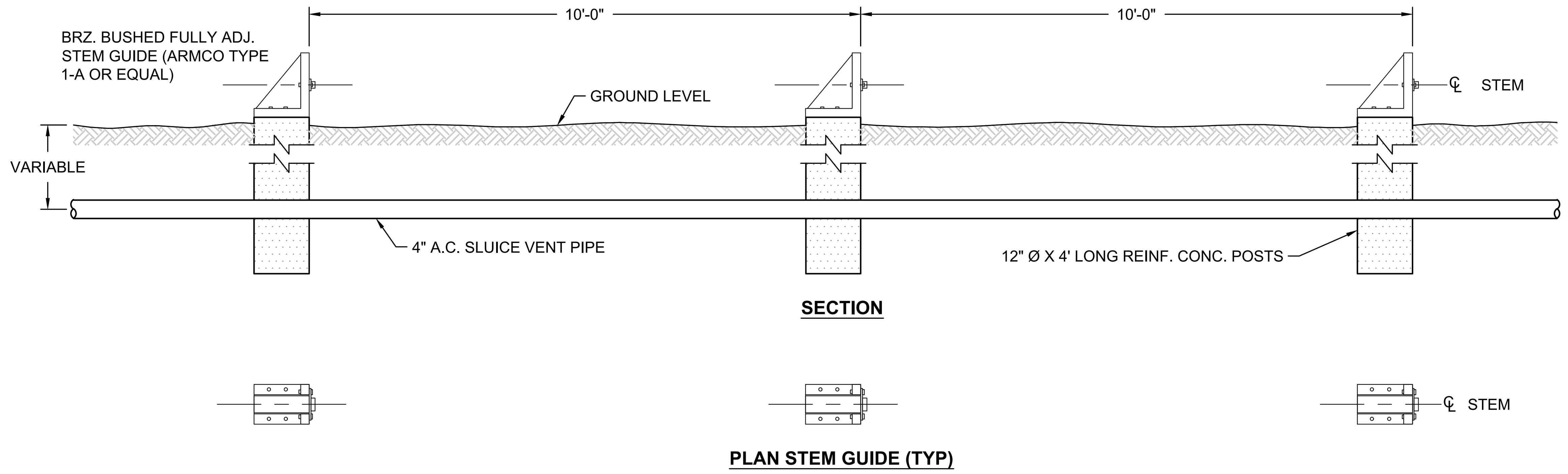
SITE: LAKE PETIT DAM - BIG CANOE

Big Canoe POA

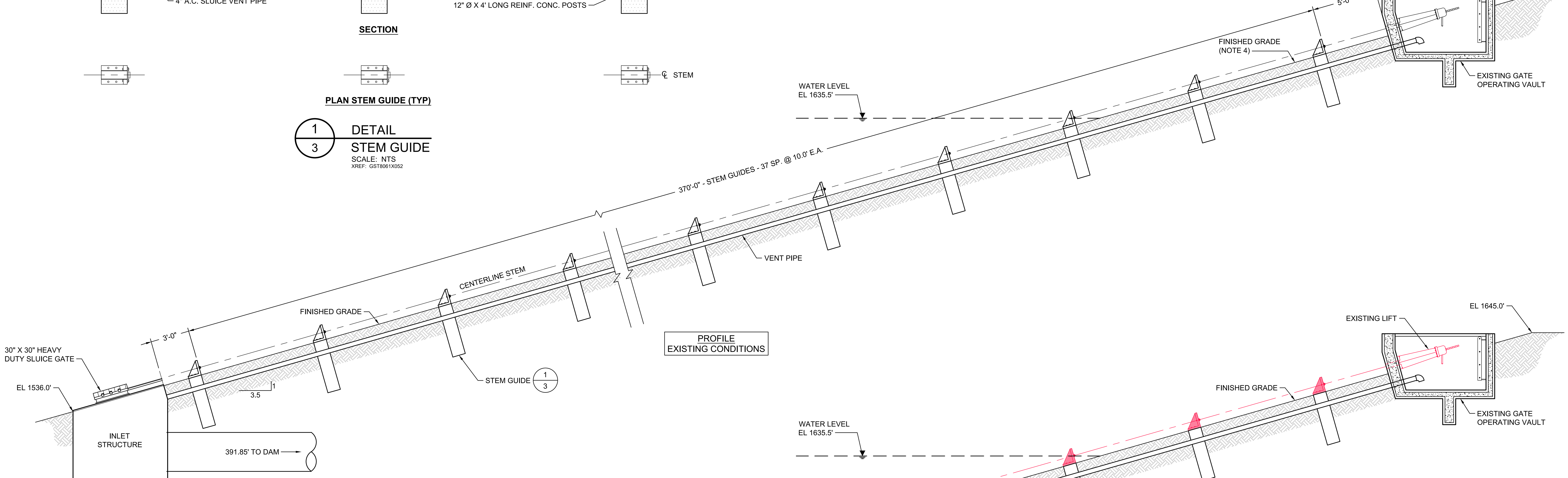
Geosyntec consultants

835 GEORGIA AVENUE, SUITE 500
CHATTANOOGA, TN 37402

DATE:	MAY 2024
PROJECT NO.:	GST8061
FILE:	GST8061C02
SHEET NO.:	2 OF 5



DETAIL 1/3
STEM GUIDE
SCALE: NTS
XREF: GST8061X052



PROFILE
EXISTING CONDITIONS

PROFILE
PROPOSED DEMOLITION

NOTES:

1. EXISTING DETAILS HAVE BEEN DIGITIZED BASED ON DRAWINGS TITLED "LOW LEVEL OUTLET DETAILS", SHEET NO 9 OF 9, DATED NOVEMBER 1971, REVISED 14 DECEMBER 1971.
2. ELEVATIONS CORRESPOND TO NORTH AMERICAN VERTICAL DATM OF 1988 (NAVD88) IN US SURVEY FEET, CONTRACTOR SHALL NOTIFY ENGINEER IN THE EVENT OF A DISCREPANCY.
3. CUT EXISTING STEM GUIDES FLUSH WITH FINISHED GRADE.
4. CURRENT FINISHED GRADE AT THE SHORELINE (I.E., FROM APPROXIMATE ELEVATION 1632.5 FEET TO 1639.5 FEET) INCLUDES SLOPE RIPRAP BEDDING (FROM TOP TO BOTTOM): APPROXIMATELY 27 INCHES OF GA DOT TYPE 1 RIP RAP; 6 INCHES OF GA DOT #4 COARSE BEDDING STONE; AND A NON-WOVEN GEOTEXTILE. THESE ARE NOT SHOWN FOR CLARITY. (GEOSYNTEC, 2023). REFER TO DETAIL 3 ON SHEET 4.
5. CONTRACTOR TO PROTECT EXISTING VENT PIPE.

REV	DATE	DESCRIPTION	DRN	APP
1	07/25/2024	ADDRESSED SDP COMMENTS	MAF	VJD
0	05/31/2024	PERMIT DRAWINGS	MAF	VJD

GEORGIA REGISTERED PROFESSIONAL ENGINEER No. PE044249 VERNON JAMES DOTSON, JR. 07/25/2024

DESIGN BY:	NPH
DRAWN BY:	MAF
CHECKED BY:	NPH
REVIEWED BY:	WMT
APPROVED BY:	VJD

TITLE: EXISTING CONDITIONS & PROPOSED DEMOLITION

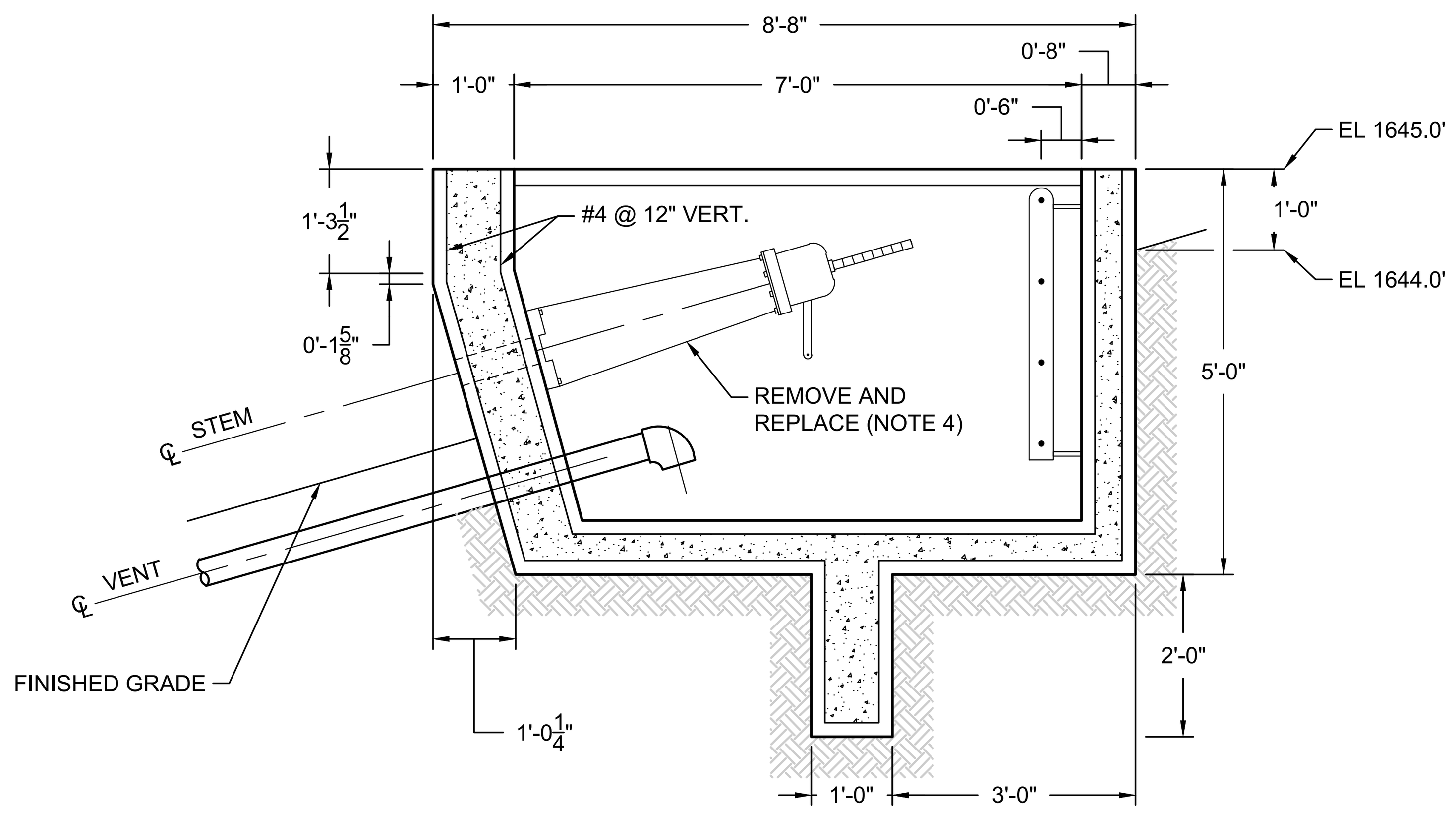
PROJECT: LLO REPAIR

SITE: LAKE PETIT DAM - BIG CANOE

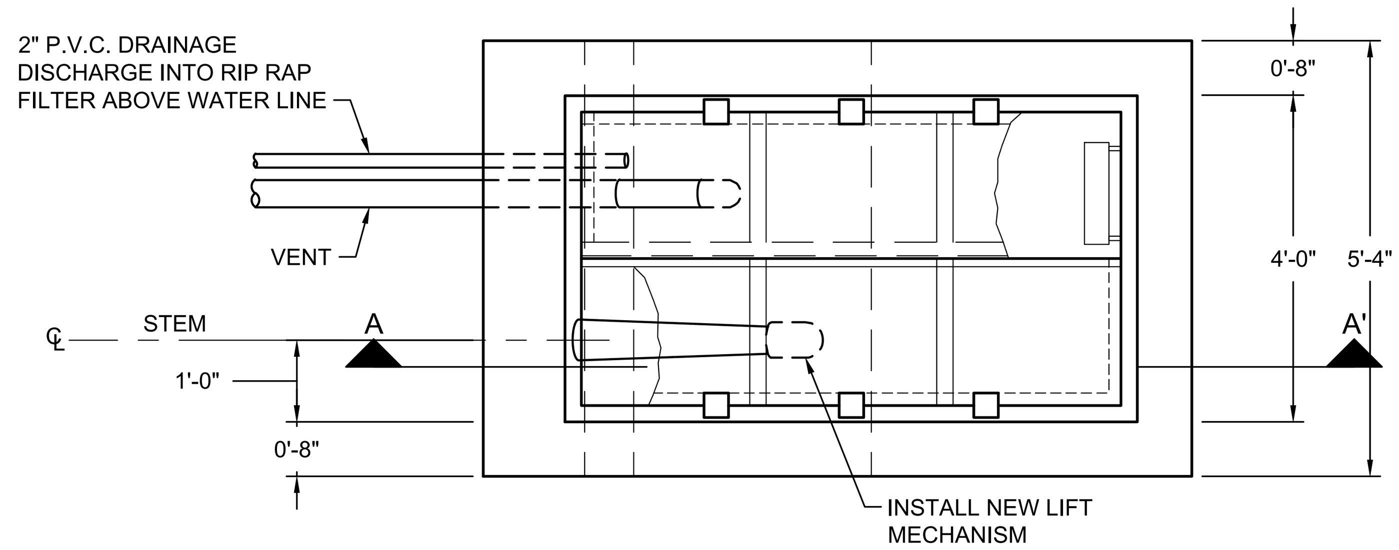
Big Canoe POA

Geosyntec consultants
835 GEORGIA AVENUE, SUITE 500
CHATTANOOGA, TN 37402

DATE:	MAY 2024
PROJECT NO.:	GST8061
FILE:	GST8061C03
SHEET NO.:	3 OF 5

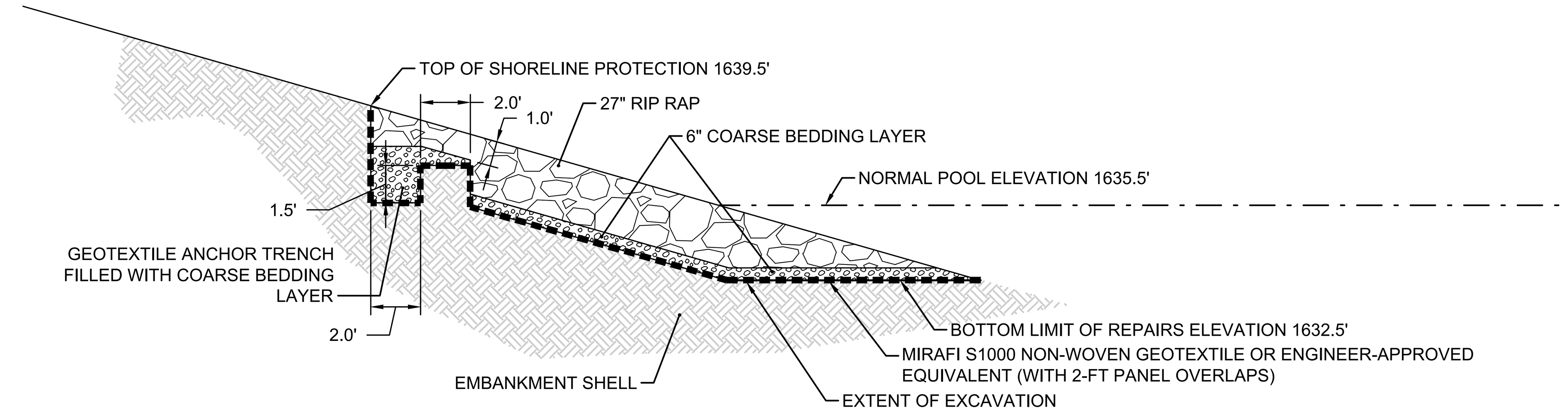


SECTION A-A'

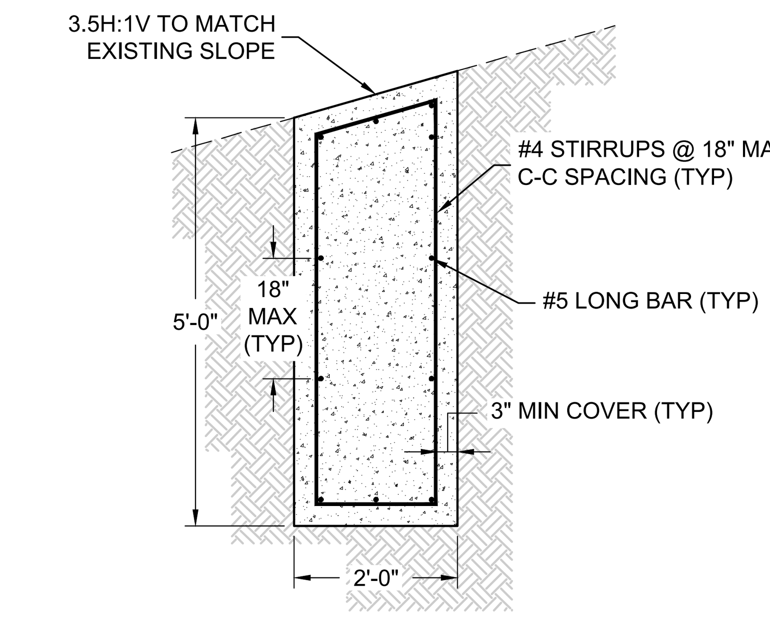


TOP VIEW

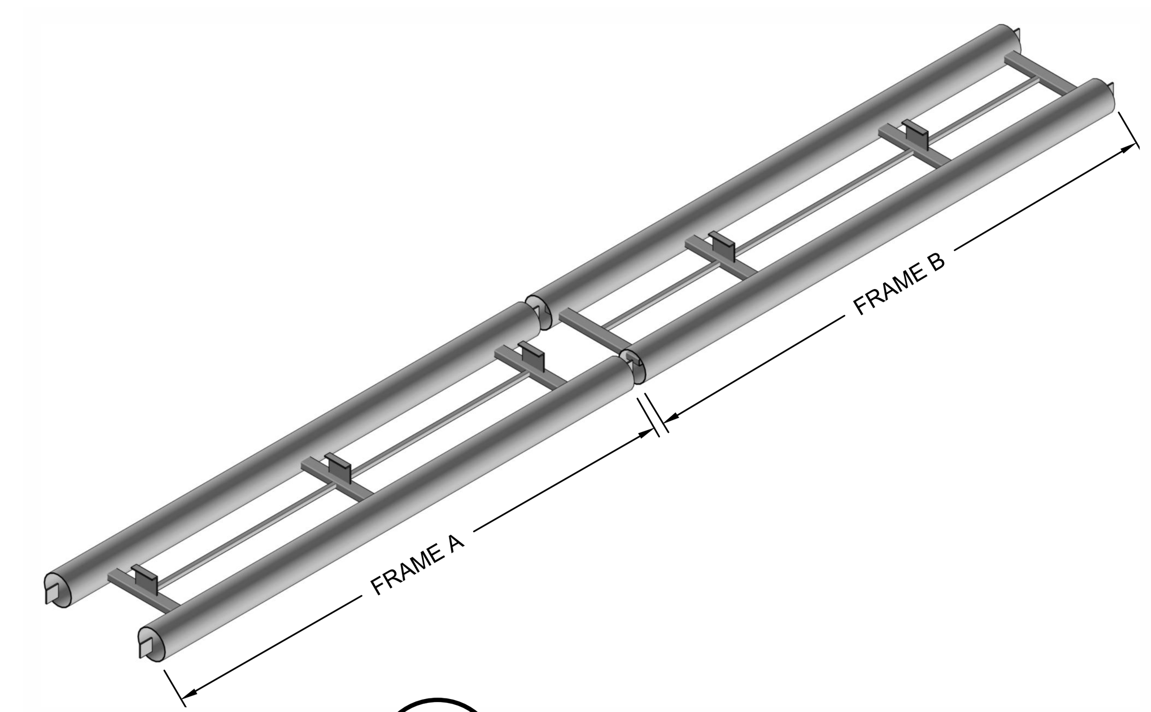
2/4 DETAIL
GATE OPERATOR VAULT MODIFICATIONS
VAULT DIMENSIONS BASED ON EXISTING PLANS (NOTES 1 AND 7)
SCALE: N.T.S.



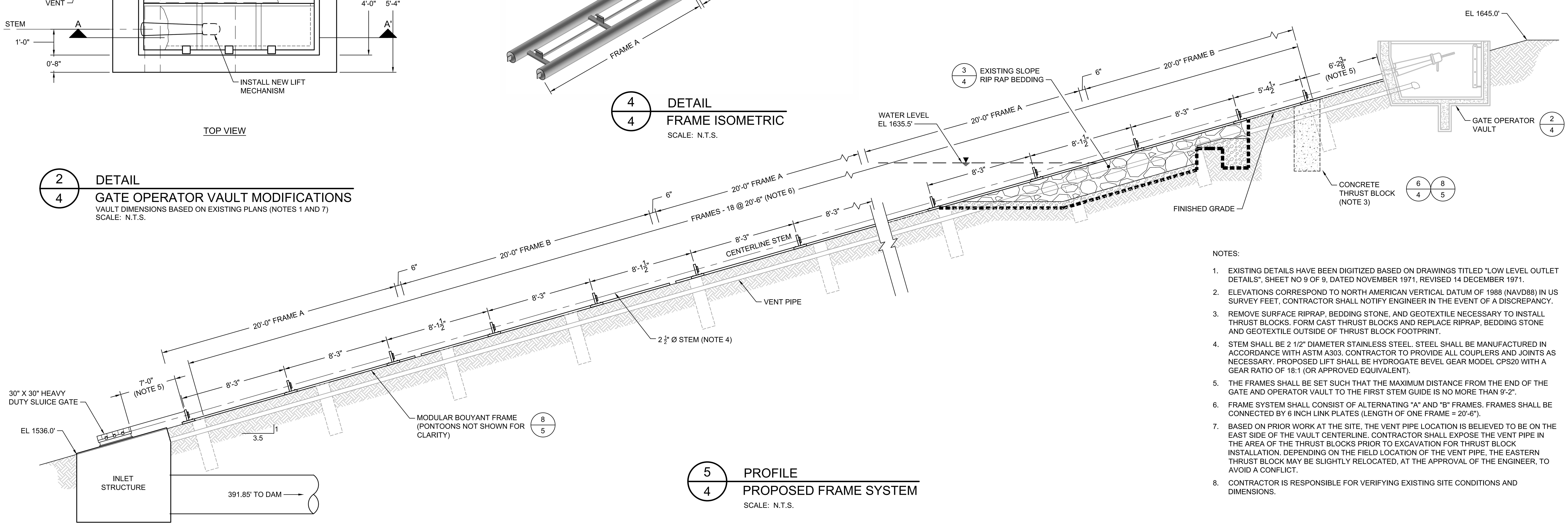
3/4 DETAIL
EXISTING SLOPE RIP RAP BEDDING
SCALE: N.T.S.



6/4 DETAIL
THRUST BLOCK
SCALE: N.T.S.



4/4 DETAIL
FRAME ISOMETRIC
SCALE: N.T.S.



5/4 PROFILE
PROPOSED FRAME SYSTEM
SCALE: N.T.S.

NOTES:

1. EXISTING DETAILS HAVE BEEN DIGITIZED BASED ON DRAWINGS TITLED "LOW LEVEL OUTLET DETAILS", SHEET NO 9 OF 9, DATED NOVEMBER 1971, REVISED 14 DECEMBER 1971.
2. ELEVATIONS CORRESPOND TO NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88) IN US SURVEY FEET, CONTRACTOR SHALL NOTIFY ENGINEER IN THE EVENT OF A DISCREPANCY.
3. REMOVE SURFACE RIPRAP, BEDDING STONE, AND GEOTEXTILE NECESSARY TO INSTALL THRUST BLOCKS. FORM CAST THRUST BLOCKS AND REPLACE RIPRAP, BEDDING STONE AND GEOTEXTILE OUTSIDE OF THRUST BLOCK FOOTPRINT.
4. STEM SHALL BE 2 1/2" DIAMETER STAINLESS STEEL. STEEL SHALL BE MANUFACTURED IN ACCORDANCE WITH ASTM A303. CONTRACTOR TO PROVIDE ALL COUPLERS AND JOINTS AS NECESSARY. PROPOSED LIFT SHALL BE HYDROGATE BEVEL GEAR MODEL CPS20 WITH A GEAR RATIO OF 18:1 (OR APPROVED EQUIVALENT).
5. THE FRAMES SHALL BE SET SUCH THAT THE MAXIMUM DISTANCE FROM THE END OF THE GATE AND OPERATOR VAULT TO THE FIRST STEM GUIDE IS NO MORE THAN 9'-2".
6. FRAME SYSTEM SHALL CONSIST OF ALTERNATING "A" AND "B" FRAMES. FRAMES SHALL BE CONNECTED BY 6 INCH LINK PLATES (LENGTH OF ONE FRAME = 20'-6").
7. BASED ON PRIOR WORK AT THE SITE, THE VENT PIPE LOCATION IS BELIEVED TO BE ON THE EAST SIDE OF THE VAULT CENTERLINE. CONTRACTOR SHALL EXPOSE THE VENT PIPE IN THE AREA OF THE THRUST BLOCKS PRIOR TO EXCAVATION FOR THRUST BLOCK INSTALLATION. DEPENDING ON THE FIELD LOCATION OF THE VENT PIPE, THE EASTERN THRUST BLOCK MAY BE SLIGHTLY RELOCATED, AT THE APPROVAL OF THE ENGINEER, TO AVOID A CONFLICT.
8. CONTRACTOR IS RESPONSIBLE FOR VERIFYING EXISTING SITE CONDITIONS AND DIMENSIONS.

REV	DATE	DESCRIPTION	DRN	APP
1	07/25/2024	ADDRESSED SDP COMMENTS	MAF	VJD
0	05/31/2024	PERMIT DRAWINGS	MAF	VJD

GEORGIA REGISTERED PROFESSIONAL ENGINEER No. PE044249 VERNON JAMES DOTSON, JR. 07/25/2024

DESIGN BY:	NPH
DRAWN BY:	MAF
CHECKED BY:	NPH
REVIEWED BY:	WMT
APPROVED BY:	VJD

TITLE: PROPOSED STEM FRAME

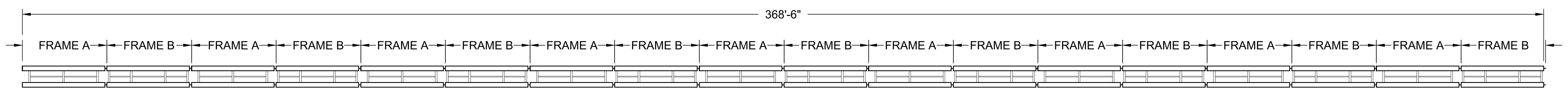
PROJECT: LLO REPAIR

SITE: LAKE PETIT DAM - BIG CANOE

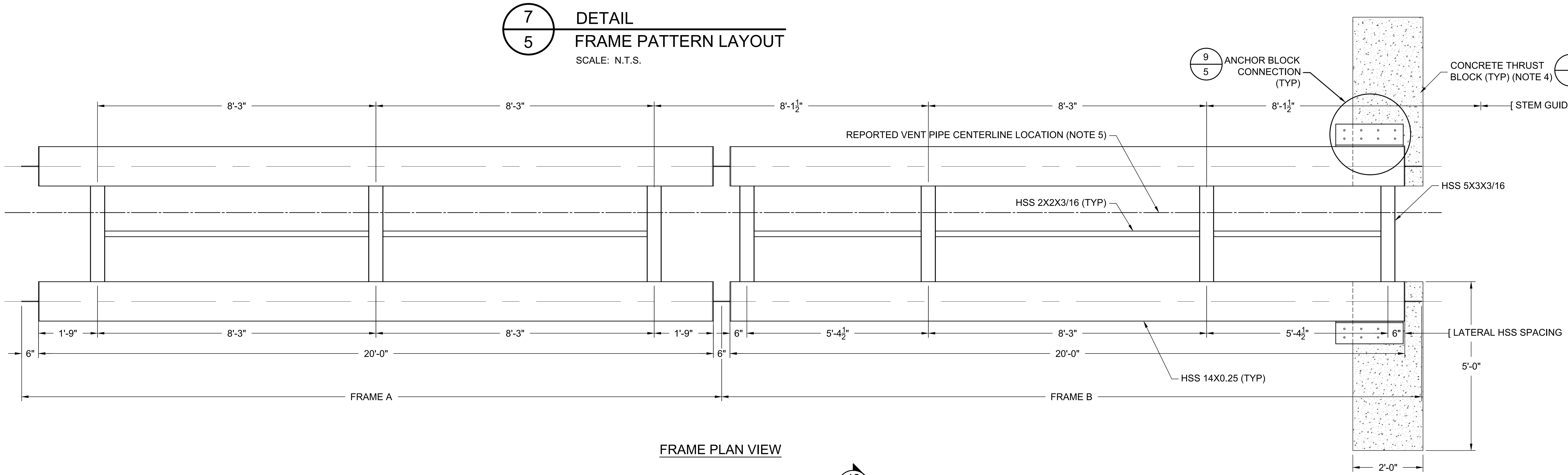
Big Canoe POA

Geosyntec consultants
835 GEORGIA AVENUE, SUITE 500
CHATTANOOGA, TN 37402

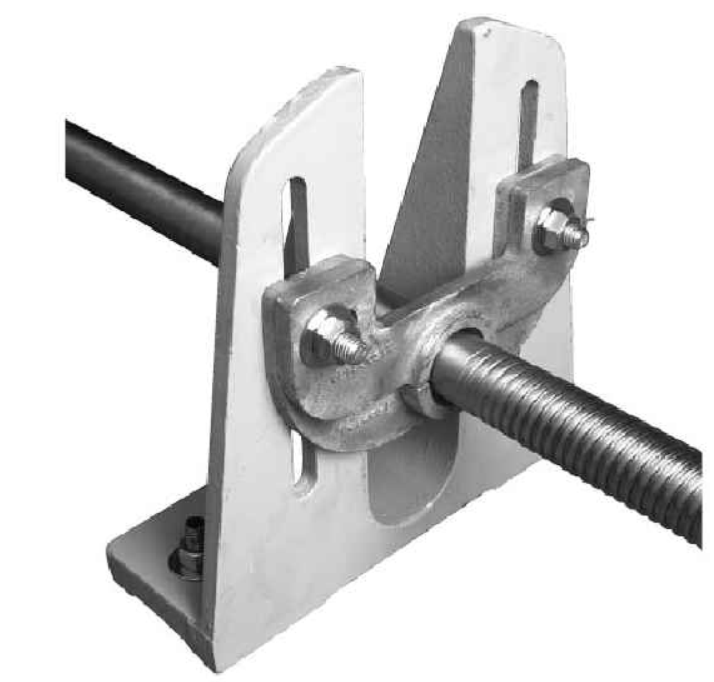
DATE:	MAY 2024
PROJECT NO.:	GST8061
FILE:	GST8061C04
SHEET NO.:	4 OF 5



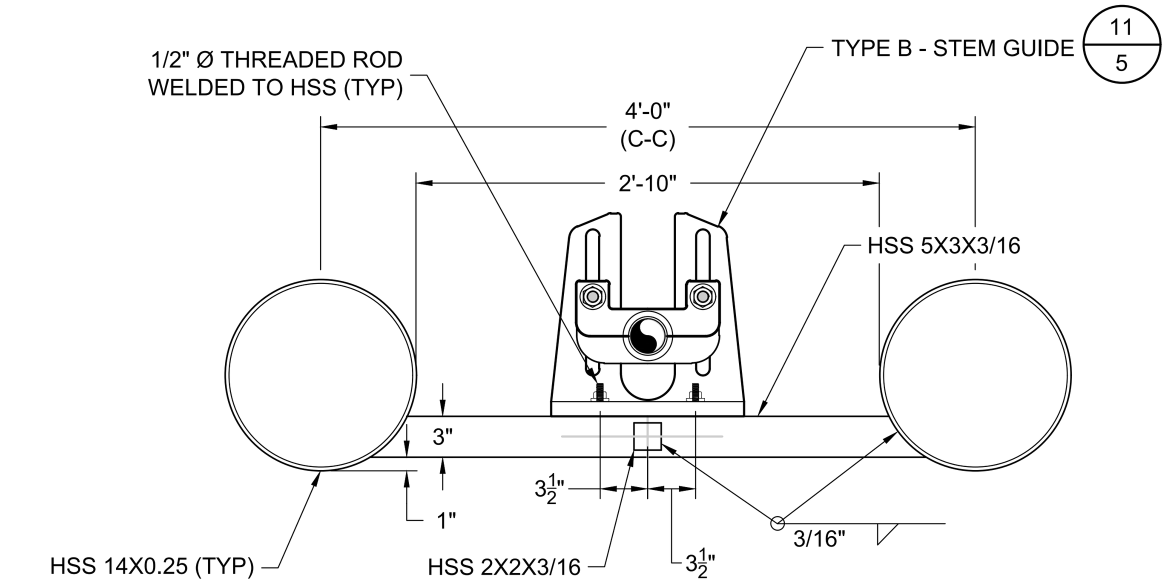
7/5 DETAIL
FRAME PATTERN LAYOUT
SCALE: N.T.S.



FRAME PLAN VIEW

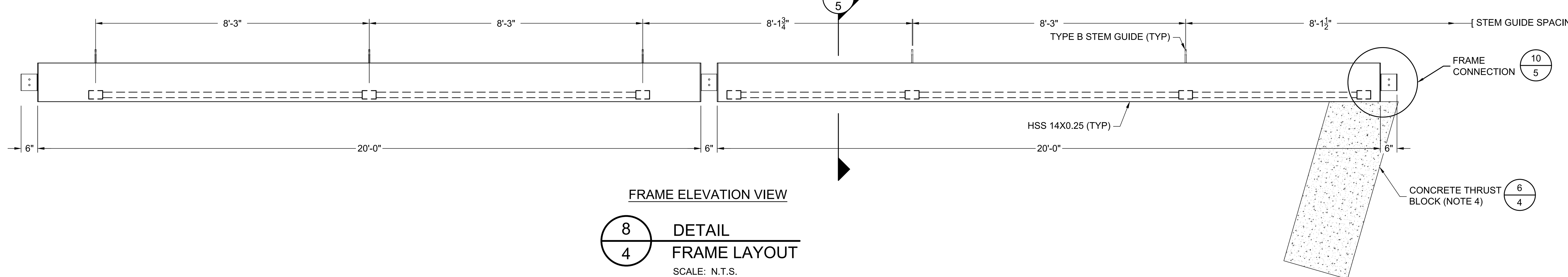


11/5 DETAIL
TYPE B - STEM GUIDE
(NOTE 2)
SCALE: N.T.S.



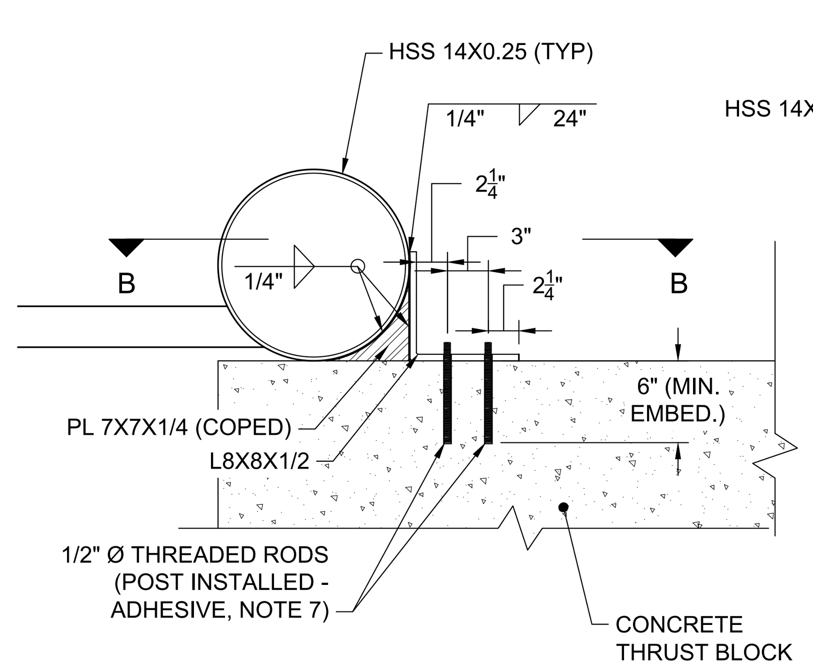
TYPICAL SECTION

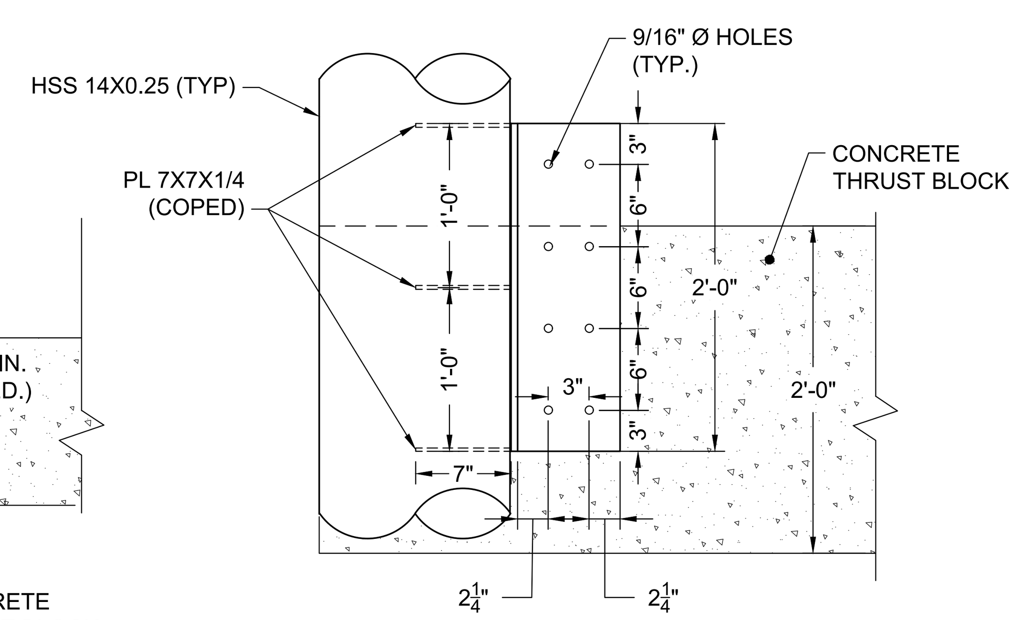
12/5 DETAIL
FRAME SECTION
SCALE: N.T.S.



FRAME ELEVATION VIEW

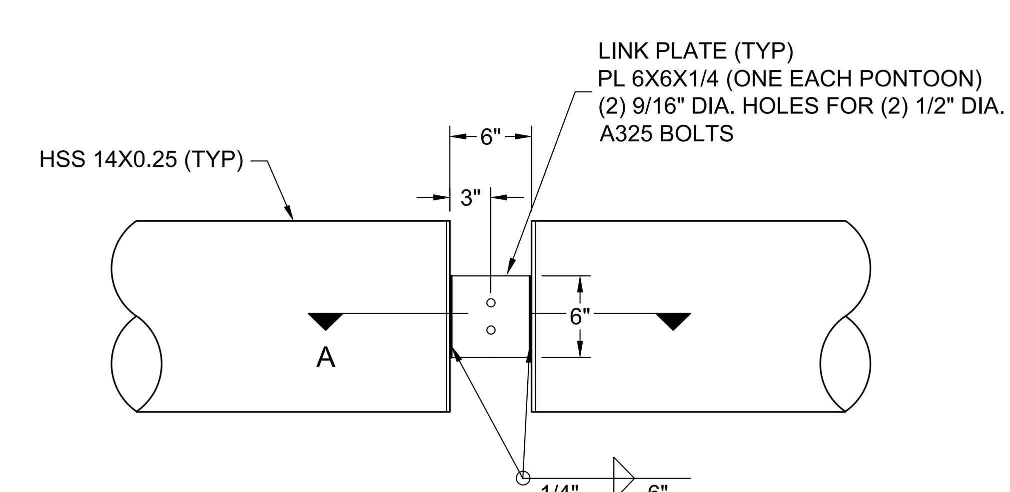
8/4 DETAIL
FRAME LAYOUT
SCALE: N.T.S.



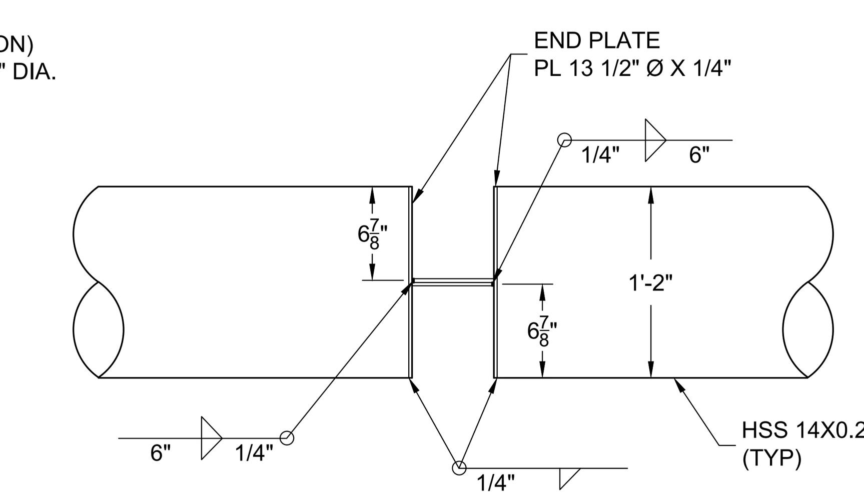


SECTION B-B

9/5 DETAIL
THRUST BLOCK CONNECTION
SCALE: N.T.S.



10/5 DETAIL
FRAME CONNECTION
SCALE: N.T.S.



SECTION A-A

NOTES:

1. PROPOSED STEM LIFT SHALL BE HYDROGATE BEVEL GEAR MODEL CPS36 (OR APPROVED EQUIVALENT).
2. EXAMPLE DETAIL OF PROPOSED STEM GUIDE (HYDROGATE® LIFTS AND LIFT ACCESSORIES BROCHURE).
3. THE TOP THREE FRAME SECTIONS (ADJACENT TO THE OPERATOR VAULT) SHALL BE GALVANIZED.
4. THRUST BLOCKS TO BE INSTALLED AT THE UPPER END OF THE TOP FRAME SECTION BETWEEN THE WATERLINE AND THE EXISTING OPERATOR VAULT.
5. BASED ON PRIOR WORK AT THE SITE, THE VENT PIPE LOCATION IS REPORTED TO BE ON THE EAST SIDE OF THE VAULT CENTERLINE. CONTRACTOR SHALL EXPOSE THE VENT PIPE IN THE AREA OF THE THRUST BLOCKS PRIOR TO EXCAVATION FOR THRUST BLOCK INSTALLATION. DEPENDING ON THE FIELD LOCATION OF THE VENT PIPE, THE PIPE MAY EITHER BE RE-ROUTED AROUND THE EASTERN THRUST BLOCK OR THE EASTERN THRUST BLOCK MAY BE ADJUSTED, AT THE APPROVAL OF THE ENGINEER, TO AVOID A CONFLICT.
6. IT IS THE CONTRACTORS RESPONSIBILITY TO MAINTAIN HORIZONTAL ALIGNMENT DURING ERECTION OF THE FRAME.
7. FOUR (4) ANCHORS ARE REQUIRED PER THRUST BLOCK CONNECTION. ADDITIONAL BOLT HOLES AND PLATE LENGTH ARE PROVIDED FOR INCREASED TOLERANCE FOR FRAME INSTALLATION. MINIMUM EDGE DISTANCE FROM ANCHOR TO CONCRETE IS 4". CONTRACTOR SHALL USE HILTI HIT-HY 200 V3 ADHESIVE OR APPROVED EQUAL.

FRAME MATERIALS SHALL CONSIST OF THE FOLLOWING:
- HSS SECTIONS: ASTM A500 GR. B
- OTHER STEEL SHAPES: ASTM A36
- BOLTS: ASTM A325
- NUTS: ASTM A563
- WASHERS: ASTM F436
- THREADED ROD: ASTM F1554 GR. 36
(RODS SHALL MEET THE REQUIREMENTS OF ASTM A36 FOR WELDING)
- WELD STRENGTH: F_{EXX} = 70 KSI

REV	DATE	DESCRIPTION	DRN	APP
1	07/25/2024	ADDRESSED SDP COMMENTS	MAF	VJD
0	05/31/2024	PERMIT DRAWINGS	MAF	VJD

GEORGIA REGISTERED PROFESSIONAL ENGINEER No. PE044249 VERNON JAMES DOTSON, JR. 07/25/2024

DESIGN BY:	NPH
DRAWN BY:	MAF
CHECKED BY:	NPH
REVIEWED BY:	WMT
APPROVED BY:	VJD

TITLE: PROPOSED STEM FRAME DETAILS
PROJECT: LLO REPAIR
SITE: LAKE PETIT DAM - BIG CANOE

Big Canoe POA

Geosyntec consultants
835 GEORGIA AVENUE, SUITE 500
CHATTANOOGA, TN 37402

DATE: MAY 2024
PROJECT NO.: GST8061
FILE: GST8061C05
SHEET NO.: 5 OF 5

Geosyntec consultants
engineers | scientists | innovators

Big Canoe® POA

LAKE PETIT DAM

Pickens County, Georgia
State ID No. 112-009-00462
NID No. GA00685

Low-Level Outlet Repair
Revision 0

Prepared for:

Big Canoe® Property Owners Association, Inc.
10586 Big Canoe
Jasper, GA 30143

Prepared by:

Geosyntec Consultants, Inc.
835 Georgia Avenue, Suite 500
Chattanooga, TN 37402

Project No: GST8061

Document No: GA240256

July 2024

NATHAN PETER HOLMER

GEORGIA REGISTERED No. PE 049663 PROFESSIONAL ENGINEER NATHAN P. HOLMER

STATE OF GEORGIA PROFESSIONAL ENGINEER LICENSE NO PE049663 EXP. 12/31/24

July 25, 2024

Geosyntec
consultants

CALCULATION PACKAGE COVER SHEET

Client: Big Canoe Property Owners Association **Project:** LLO Outlet Repair

Project No.: GST8061 **Task #:** 04/03

TITLE OF COMPUTATION Low-Level Outlet Repair

COMPUTATIONS BY:
Signature ______ 05/20/2024
DATE
Printed Name Nathan Holmer, P.E. (GA), S.E. (GA)
and Title Senior Engineer

ASSUMPTIONS AND PROCEDURES CHECKED BY:
(Peer Reviewer)
Signature ______ 05/24/2024
DATE
Printed Name Rick Poeppelman
and Title Senior Principal Engineer

COMPUTATIONS CHECKED BY:
Signature ______ 05/24/2024
DATE
Printed Name Rick Poeppelman
and Title Senior Principal Engineer

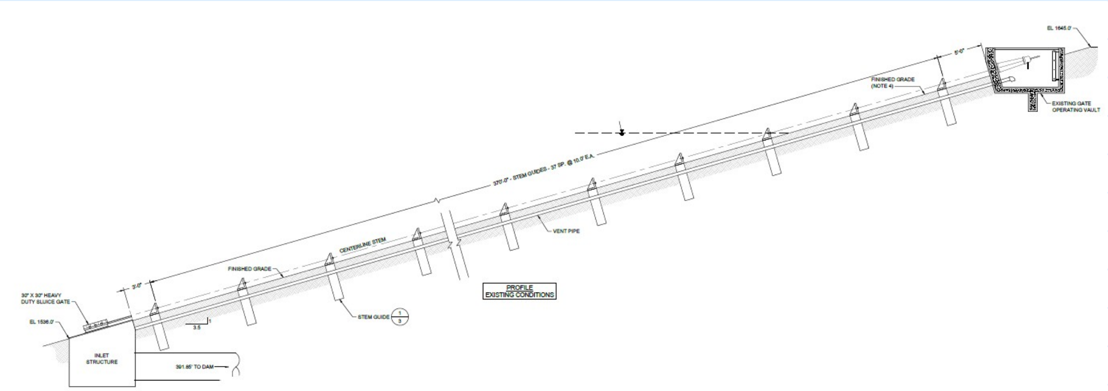
COMPUTATIONS BACKCHECKED BY:
(Originator)
Signature ______ 05/22/2024
DATE
Printed Name Nathan Holmer, P.E. (GA), S.E. (GA)
and Title Senior Engineer

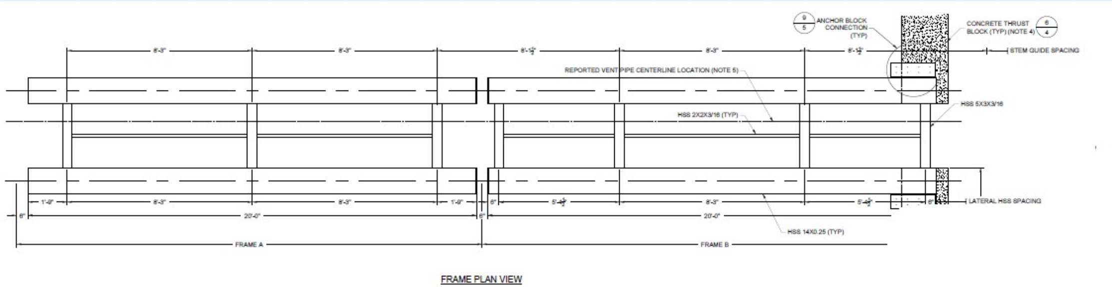
APPROVED BY:
(PM or Designate)
Signature ______ 07/25/2024
DATE
Printed Name Vernon James Dotson, Jr., P.E. (GA)
and Title Senior Principal Engineer

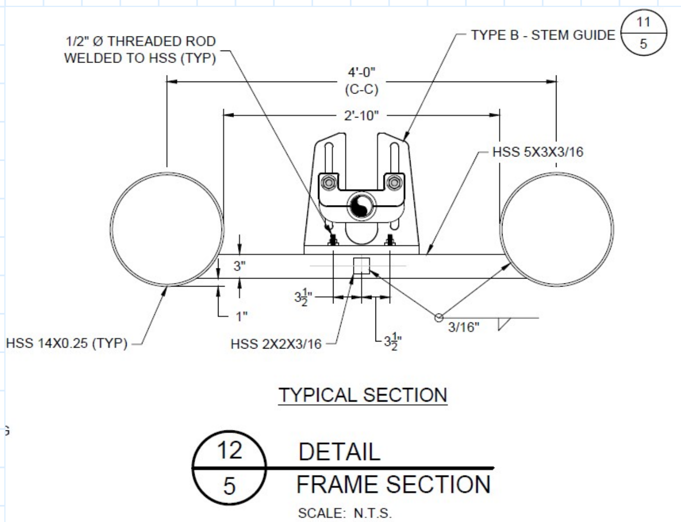
Gate Force Analysis and Guide Frame Member Sizing

REFERENCES:
- *AISC Steel Construction Manual 15 Ed.*
- *HILTI North American Product Technical Guide Vol 2*

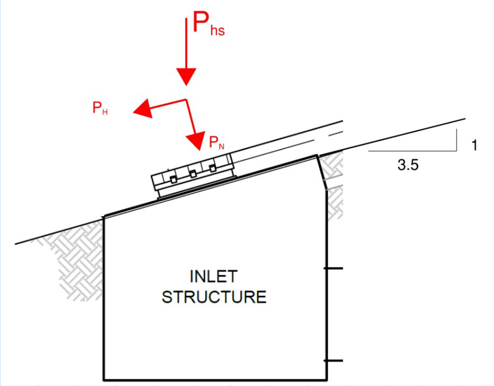
The Low Level Outlet (LLO) gate operating system will be replaced with a new stem, stem guides, and steel frame to support the stem guides. The steel frame will be composed of modular sections that are linked together and anchored near the top of the slope. This calculation package evaluates the force requried to operate the gate and the force effects on the proposed guide frame assembly.







Hydrostatic Force



$h_s := 100\ ft$ — Depth of water over gate

$\gamma_w := 62.4\ pcf$ — Density of water

$Q_{hs} := h_s \cdot \gamma_w = 6.24\ ksf$ — Hydrostatic Pressure

$b_{gate} := 2.833\ ft$ — Width of Gate

$l_{gate} := 2.5\ ft$ — Length of Gate

$A_{gate} := b_{gate} \cdot l_{gate} = 7.083\ ft^2$ — Area of Gate

$P_{hs} := A_{gate} \cdot Q_{hs} = 44.195\ kip$ — Total Hydrostatic Load on Gate

$\theta_{gate} := \text{atan}\left(\frac{1}{3.5}\right) = 15.945\ °$ — (Slope 3.5:1 H:V)

$P_N := \cos\left(\theta_{gate}\right) \cdot P_{hs} = 42.494\ kip$ — Force Normal to Plane of Gate Support

$P_H := \sin\left(\theta_{gate}\right) \cdot P_{hs} = 12.141\ kip$ — Force Parallel to plane of Gate Support

Reduction Factors

$\phi_c := 0.9$ $\phi_{ty} := 0.9$ $\phi_{tr} := 0.75$ — Reduction Factors for Steel under Compression, tension yielding, and tension rupture

Opening Force

$\mu_s := 0.4$ — Conservative (per Hydrogate representative, existing/historical gates and new gates have a coefficient of static friction of approximately 0.35)

$F_{n\_open} := P_H + \mu_s \cdot P_N = 29.139\ kip$

Closing Force

$$F_{n\_close} := \mu_s \cdot P_N - P_H = 4.856\ kip$$

Stem Guide Design

$F_y := 36\ ksi$ $F_u := 58\ ksi$ $E := 29000\ ksi$

Compression Design (Closing Operation)

$K := 1.0$ Assume Pinned at Stem Guides

$L_b := 8.25\ ft$ unbraced length of stem = spacing between stem guides

$D_{stem} := 2.5\ in$ Diameter of the stem

$t_{corr} := 0\ in$ Stem will be stainless steel, therefore corrosion is set to 0.

$$d_{stem} := D_{stem} - 2 \cdot t_{corr}$$

$$A_{stem} := \frac{\pi \cdot d_{stem}^{\ 2}}{4} = 4.909\ in^2$$ Area of the stem

$L_{stem} := 378\ ft$ Length of Stem

$$V_{stem} := A_{stem} \cdot L_{stem} = 12.885\ ft^3$$

$$I_{stem} := \frac{\pi \cdot d_{stem}^{\ 4}}{64} = 1.917\ in^4$$

$$W_{stem} := 1.05 \cdot V_{stem} \cdot 490\ pcf = 6.63\ kip$$

$$Z_{stem} := \frac{\pi \cdot d_{stem}^{\ 3}}{32} = 1.534\ in^3$$

$$w_{bar} := \frac{W_{stem}}{L_{stem}} = 17.539\ plf$$

$$r_{stem} := \frac{d_{stem}}{4} = 0.625\ in$$

$$\frac{L_b}{r_{stem}} = 158.4$$ Slenderness Ratio (<200)

$$F_e := \frac{\pi^2 \cdot E}{\left(\frac{K \cdot L_b}{r_{stem}}\right)^2} = 11.407\ ksi$$ (AISC E3-4)

$$F_{cr} := \text{if } \frac{K \cdot L_b}{r_{stem}} \le 4.71 \cdot \sqrt{\frac{E}{F_y}} \;\; \begin{cases} 0.658^{\left(\frac{F_y}{F_e}\right)} \cdot F_y \\ \text{else} \\ 0.877 \cdot F_e \end{cases} = 10.004 \; ksi$$

(AISC E3-2, E3-3)

$$\phi_c \cdot F_{cr} \cdot A_{stem} = 44.198 \; kip$$

(AISC E3-1)

$$FOS_{hs\_bar\_comp} := 3$$

Factor of Safety for Bar in Compression

$$Str\_Check\_Comp := \text{if } \frac{\phi_c \cdot F_{cr} \cdot A_{stem}}{F_{n\_close}} > FOS_{hs\_bar\_comp} \;\; \begin{cases} \text{"OK"} \\ \text{else} \\ \text{"Increase Bar Diameter"} \end{cases} = \text{"OK"}$$

$$\frac{\phi_c \cdot F_{cr} \cdot A_{stem}}{F_{n\_close}} = 9.101$$

Tension Design (Opening Operation)

$$T_c := min\left(\phi_{ty} \cdot F_y, \phi_{tr} \cdot F_u\right) \cdot A_{stem} = 159.043 \; kip$$

(AISC D2-1, D2-2)

$$FOS_{hs\_bar\_ten} := 5.0$$

$$Str\_Check\_Ten := \text{if } \frac{T_c}{F_{n\_open}} > FOS_{hs\_bar\_ten} \;\; \begin{cases} \text{"OK"} \\ \text{else} \\ \text{"Increase Bar Size"} \end{cases} = \text{"OK"}$$

$$\frac{T_c}{F_{n\_open}} = 5.458$$

Stem Guide Load

$$\mu_{guide} := 0.4$$

Friction between stem and guide bushing (Conservative value - Recommended value by Hydrogate was less than 0.2 for lubricated steel on bronze bushing)

$$No_{guide} := \text{ceil}\left(\frac{L_{stem}}{L_b}\right) = 46$$

$$F_{guide\_close} := \left(\frac{W_{stem}}{No_{guide}}\right) \cdot \mu_{guide} = 0.058 \; kip$$

$$F_{guide\_open} := \left(\frac{W_{stem}}{No_{guide}}\right) \cdot \mu_{guide} = 0.058\ kip$$

Guide assemblies are oversized to allow for free movement of the stem, therefore there is no transfer of the opening/closing force through friction to the guide assemblies.

Frame Load

$\mu_{frame\_soil} := 0.2$ Steel on Silty Soil

$L_{frame} := 20\ ft$ Length of Frame

$b_{frame} := 4\ ft$ Width of Frame (C-C Pontoon)

Approximate Frame Weight/ft

$w_{pontoon} := 36.75\ plf$ Weight of HSS 14x0.25 (round)

$w_{bot\_hss} := 4.32\ plf$ Weight of HSS 2x2x3/16 (tube)

$w_{bot\_hss\_lat} := 9.42\ plf$ Weight of HSS 5x3x3/16 (tube)

$w_{bar} = 17.539\ plf$ Weight of 2.5" Dia. stem

$$W_{frame} := 1.1 \cdot \left(2 \cdot w_{pontoon} + w_{bot\_hss} + w_{bar} + \left(w_{bot\_hss\_lat} \cdot \frac{b_{frame}}{L_b}\right)\right) = 109.918\ plf$$

Average weight of frame per foot

$Slide_{frame} := W_{frame} \cdot \sin\left(\theta_{gate}\right) = 30.197\ plf$ Frame Force acting downslope

$Normal_{frame} := W_{frame} \cdot \cos\left(\theta_{gate}\right) = 105.689\ plf$ Frame Normal Force

$Friction_{frame} := Normal_{frame} \cdot \mu_{frame\_soil} = 21.138\ plf$ Frame Friction Resistance Force

$$Static\_Stability_{Frame} := \text{if } \frac{Normal_{frame} \cdot \mu_{frame\_soil}}{Slide_{frame}} > 1.5 \;\; \| \text{“Okay”} \;\; \text{else} \;\; \| \text{“Support Frames at Anchor”} = \text{“Support Frames at Anchor”}$$

Due to the slope and poor friction between the steel frame and silty soils, the frames are not self stable, therefore they must be anchored. Full load will transfered through modular frame connections.

Frame Stability Load at Frame Bolt Connection

$$F_{H\_bolt\_frame} := L_{frame} \cdot \left(Slide_{frame} - Friction_{frame}\right) = 181.181\ lbf$$

Total Frame Stability Load Required at Anchors

$$F_{H\_anchor\_frame} := 1.5 \cdot \left(Slide_{frame} - Friction_{frame}\right) \cdot L_{stem} = 5.136\ kip$$

Maximum Frame Loads (reactions opposite of stem, ie; frame is in tension when the stem is in compression)

$No_{frame} := 18$

$$F_{total\_ten\_frame} := F_{H\_bolt\_frame} \cdot No_{frame} + F_{guide\_close} \cdot No_{guide} = 5.913\ kip$$

$$F_{total\_comp\_frame} := F_{guide\_open} \cdot No_{guide} - F_{H\_bolt\_frame} \cdot No_{frame} = -0.609\ kip$$

(No Compression load - Frame remains in tension during Opening Operations)

$F_{total\_ten\_frame}$ represents the maximum force at the last modular frame connection

<u>Evaluate frame members and connections under Design Tension Load</u>

By inspection, frame is sufficient under tension loading while the gate is being closed;
$F_{total\_ten\_frame} = 5.913\ kip$, $\frac{Pn}{\Omega} = 220\ kips$ for HSS 14x0.25 (AISC Table 5-6)

Each frame is connected by four (4) 1/2" Dia. A325 Bolts.

$F_{nv} := 68\ ksi$ Nominal Shear Strength of A325 Bolt (AISC T J3.2)

$d_b := 0.5\ in$ $d_{hole} := \frac{9}{16}\ in$

$A_b := \pi \cdot \frac{d_b^{\ 2}}{4}$

$R_{n\_bolt} := F_{nv} \cdot A_b = 13.352\ kip$ $\Omega := 2$ (AISC J3-1)

$l_c := 3\ in - \frac{d_{hole}}{2}$ Edge distance of bolt

$t_{plate} := 0.25\ in$ Connection plate thickness

$F_u := 58\ ksi$ Tensile Strength of A36

$R_{n\_plate} := min\left(1.2 \cdot l_c \cdot t_{plate} \cdot F_u, 2.4 \cdot d_b \cdot t_{plate} \cdot F_u\right) = 17.4\ kip$ (AISC J3-6a)

$$R_a := \frac{min\left(R_{n\_bolt}, R_{n\_plate}\right)}{\Omega} = 6.676\ kip$$

Capacity of one bolt is greater than the demand. By inspection the 4 bolt connection with 1/4 inch plates is sufficient.

Check welded connections

$D := 3$ Number of 16ths of an inch for weld size

$$R_{a\_weld\_inch} := 0.928 \cdot D \cdot 1\ in \cdot \left(\frac{kip}{in}\right) = 2.784\ kip$$ (AISC 8-2b)

3/16 inch welded connections are okay by inspection. Maximum Force per guide assembly is less than 100 pounds.

Thrust Block Connection

$No\_anchors := 8$ $R_u := 1.2 \cdot \frac{F_{total\_ten\_frame}}{No\_anchors} = 0.887\ kip$

Threaded Rod Strength Design (per HILTI) Assuming cracked concrete (CONSERVATIVE)

Table 41 — Steel design strength for Hilti HAS threaded rods for use with ACI 318 Chapter 17

Nominal anchor diameter in.	HAS-V-36 / HAS-V-36 HDG ASTM F1554 Gr. 36[4,6]			HAS-E-55 / HAS-E-55 HDG ASTM F1554 Gr. 55[4,6]			HAS-B-105 and HAS-B-105 HDG ASTM A193 B7 and ASTM F 1554 Gr.105[4,6]			HAS-R stainless steel ASTM F593 (3/8-in to 1-in)[5] ASTM A193 (1-1/8-in to 2-in)[4]		
	Tensile[1] ΦN_{sa} lb (kN)	Shear[2] ΦV_{sa} lb (kN)	Seismic Shear[3] $\Phi V_{sa,eq}$ lb (kN)	Tensile[1] ΦN_{sa} lb (kN)	Shear[2] ΦV_{sa} lb (kN)	Seismic Shear[3] $\Phi V_{sa,eq}$ lb (kN)	Tensile[1] ΦN_{sa} lb (kN)	Shear[2] ΦV_{sa} lb (kN)	Seismic Shear[3] $\Phi V_{sa,eq}$ lb (kN)	Tensile[1] ΦN_{sa} lb (kN)	Shear[2] ΦV_{sa} lb (kN)	Seismic Shear[3] $\Phi V_{sa,eq}$ lb (kN)
3/8	3,370 (15.0)	1,750 (7.8)	1,050 (4.7)	4,360 (19.4)	2,270 (10.1)	1,590 (7.1)	7,270 (32.3)	3,780 (16.8)	2,645 (11.8)	5,040 (22.4)	2,790 (12.4)	1,955 (8.7)
1/2	6,175 (27.5)	3,210 (14.3)	1,925 (8.6)	7,985 (35.5)	4,150 (18.5)	2,905 (12.9)	13,305 (59.2)	6,920 (30.8)	4,845 (21.6)	9,225 (41.0)	5,110 (22.7)	3,575 (15.9)

Table 40 — Hilti HIT-HY 200 V3 adhesive design strength with concrete / bond failure for threaded rod in cracked concrete [1,2,3,4,5,6,7,8,9]

Nominal anchor diameter in.	Effective embedment in. (mm)	Tension — ΦN_n				Shear — ΦV_n			
		f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)	f'_c = 2,500 psi (17.2 MPa) lb (kN)	f'_c = 3,000 psi (20.7 MPa) lb (kN)	f'_c = 4,000 psi (27.6 MPa) lb (kN)	f'_c = 6,000 psi (41.4 MPa) lb (kN)
3/8	2-3/8 (60)	1,900 (8.5)	1,935 (8.6)	1,990 (8.9)	2,075 (9.2)	2,045 (9.1)	2,085 (9.3)	2,145 (9.5)	2,235 (9.9)
	3-3/8 (86)	2,700 (12.0)	2,750 (12.2)	2,830 (12.6)	2,950 (13.1)	5,815 (25.9)	5,925 (26.4)	6,095 (27.1)	6,350 (28.2)
	4-1/2 (114)	3,600 (16.0)	3,665 (16.3)	3,775 (16.8)	3,930 (17.5)	7,755 (34.5)	7,900 (35.1)	8,130 (36.2)	8,465 (37.7)
	7-1/2 (191)	6,000 (26.7)	6,110 (27.2)	6,290 (28.0)	6,550 (29.1)	12,925 (57.5)	13,165 (58.6)	13,550 (60.3)	14,110 (62.8)
1/2	2-3/4 (70)	2,520 (11.2)	2,760 (12.3)	3,185 (14.2)	3,480 (15.5)	5,425 (24.1)	5,945 (26.4)	6,865 (30.5)	7,490 (33.3)
	4-1/2 (114)	5,215 (23.2)	5,310 (23.6)	5,465 (24.3)	5,690 (25.3)	11,230 (50.0)	11,440 (50.9)	11,770 (52.4)	12,260 (54.5)
	6 (152)	6,955 (30.9)	7,080 (31.5)	7,290 (32.4)	7,590 (33.8)	14,975 (66.6)	15,250 (67.8)	15,695 (69.8)	16,345 (72.7)
	10 (254)	11,590 (51.6)	11,800 (52.5)	12,145 (54.0)	12,650 (56.3)	24,960 (111.0)	25,420 (113.1)	26,160 (116.4)	27,245 (121.2)

Table 45 — Load adjustment factors for 1/2-in. diameter threaded rods in cracked concrete[1,2,3]

1/2-in. threaded rods cracked concrete		Spacing factor in tension f_{AN}				Edge distance factor in tension f_{RN}				Spacing factor in shear[4] f_{AV}				Edge distance in shear: ⊥ Toward edge f_{RV}				Edge distance in shear: ‖ To and away from edge f_{RV}				Concrete thickness factor in shear[5] f_{HV}			
Embedment h_{ef}	in. (mm)	2-3/4 (70)	4-1/2 (114)	6 (152)	10 (254)	2-3/4 (70)	4-1/2 (114)	6 (152)	10 (254)	2-3/4 (70)	4-1/2 (114)	6 (152)	10 (254)	2-3/4 (70)	4-1/2 (114)	6 (152)	10 (254)	2-3/4 (70)	4-1/2 (114)	6 (152)	10 (254)	2-3/4 (70)	4-1/2 (114)	6 (152)	10 (254)
Concrete thickness (h), - in. (mm): 1-3/4	(44)	n/a	n/a	n/a	n/a	0.48	0.48	0.45	0.41	n/a	n/a	n/a	n/a	0.10	0.05	0.04	0.02	0.21	0.11	0.08	0.05	n/a	n/a	n/a	n/a
2-1/2	(64)	0.58	0.58	0.57	0.54	0.54	0.54	0.50	0.44	0.55	0.53	0.53	0.52	0.18	0.09	0.07	0.04	0.35	0.19	0.14	0.08	n/a	n/a	n/a	n/a
3	(76)	0.60	0.60	0.58	0.55	0.58	0.58	0.53	0.46	0.56	0.54	0.53	0.52	0.23	0.12	0.09	0.06	0.47	0.25	0.18	0.11	n/a	n/a	n/a	n/a
4	(102)	0.63	0.63	0.61	0.57	0.66	0.66	0.60	0.49	0.58	0.55	0.55	0.53	0.36	0.19	0.14	0.09	0.66	0.38	0.28	0.17	0.58	n/a	n/a	n/a
5	(127)	0.67	0.67	0.64	0.58	0.76	0.76	0.67	0.53	0.61	0.57	0.56	0.54	0.50	0.26	0.20	0.12	0.76	0.53	0.40	0.24	0.65	n/a	n/a	n/a
5-3/4	(146)	0.69	0.69	0.66	0.60	0.83	0.83	0.73	0.56	0.62	0.58	0.57	0.55	0.62	0.33	0.24	0.15	0.83	0.65	0.49	0.29	0.70	0.56	n/a	n/a
6	(152)	0.70	0.70	0.67	0.60	0.85	0.85	0.75	0.57	0.63	0.58	0.57	0.55	0.66	0.35	0.26	0.16	0.85	0.70	0.52	0.31	0.71	0.57	n/a	n/a
7	(178)	0.74	0.74	0.69	0.62	0.96	0.96	0.83	0.62	0.65	0.60	0.58	0.56	0.83	0.44	0.33	0.20	0.96	0.88	0.66	0.39	0.77	0.62	n/a	n/a
7-1/4	(184)	0.74	0.74	0.70	0.62	0.98	0.98	0.85	0.63	0.65	0.60	0.58	0.56	0.88	0.46	0.35	0.21	0.98	0.92	0.69	0.42	0.78	0.63	0.57	n/a
8	(203)	0.77	0.77	0.72	0.63	1.00	1.00	0.91	0.66	0.67	0.61	0.59	0.56	1.00	0.54	0.40	0.24	1.00	1.00	0.80	0.48	0.82	0.66	0.60	n/a
9	(229)	0.80	0.80	0.75	0.65			1.00	0.70	0.69	0.62	0.60	0.57		0.64	0.48	0.29			0.96	0.58	0.87	0.70	0.64	n/a
10	(254)	0.84	0.84	0.78	0.67				0.75	0.71	0.64	0.61	0.58		0.75	0.56	0.34			1.00	0.67	0.92	0.74	0.67	n/a

$\phi V_{sa} := 3.2\ kip$ $\phi V_n := 15.695\ kip$ $f_{AV} := 0.53$ $f_{RV} := 0.14$

$$R_{a\_anchor} := min\left(\phi V_{sa}, \phi V_n \cdot f_{AV} \cdot f_{RV}\right) = 1.165\ kip$$

$$Design\_Check := \text{if } R_{a\_anchor} > R_u \;\; \text{"OK"} \;\; \text{else} \;\; \text{"Revise Design"} = \text{"OK"}$$