

TRI - REGIONAL JETS 2025



Challenges and Innovations:

Rehabilitation of the Indian Lake Dam

Greg Johnson, PE, PMP



Engineering
& Design





Presenter

Greg Johnson PE, PMP

Colliers Engineering & Design

Discipline Leader, Water



Engineering
& Design



- **Sports Teams:** Go Bills
- **Vacation Spots:** National Parks
- **Did You Know:** I grew up in Indiana, live in Rochester, New York and have worked on projects all over the eastern US.
- **Hobbies:** Doing anything in the national parks - mostly hiking with my wife.
- **Cooler Project(s):** Everything dealing with water retaining structures – it's my life!
- **Bonus Did You Know:** I am also a closet Dead Head.

Learning Objectives

- Understand the challenges frequently experienced with water retaining structures, especially older ones.
- Understand how water retaining structures differ from other civil engineering structures.
- See how challenges were overcome at the Indian Lake project.
- Benefit from lessons learned from the work accomplished at Indian Lake Dam.



Agenda

- Project/Site History
- Design Challenges & Solutions
- Construction Challenges & Solutions
- Q&A / Discussion

Project History



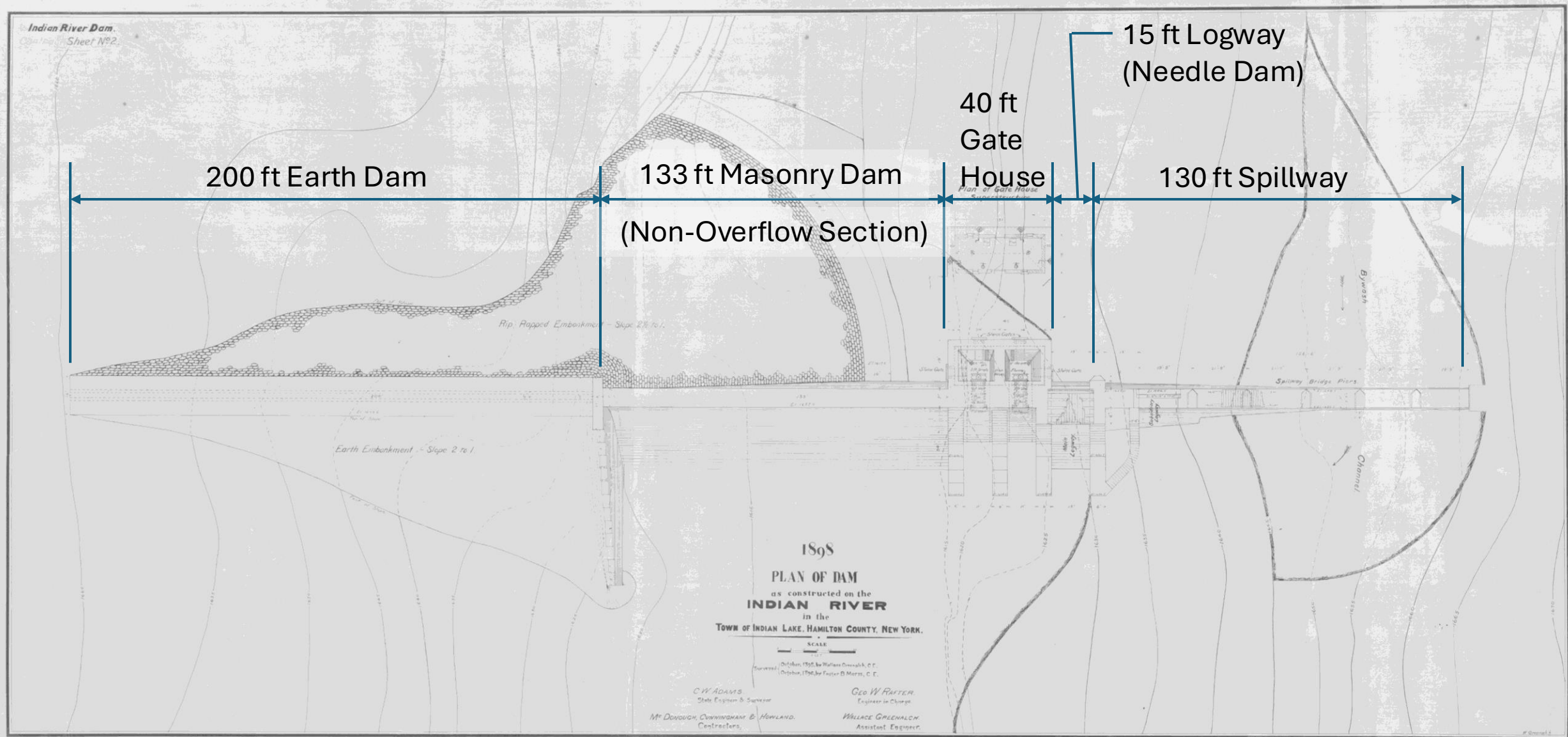


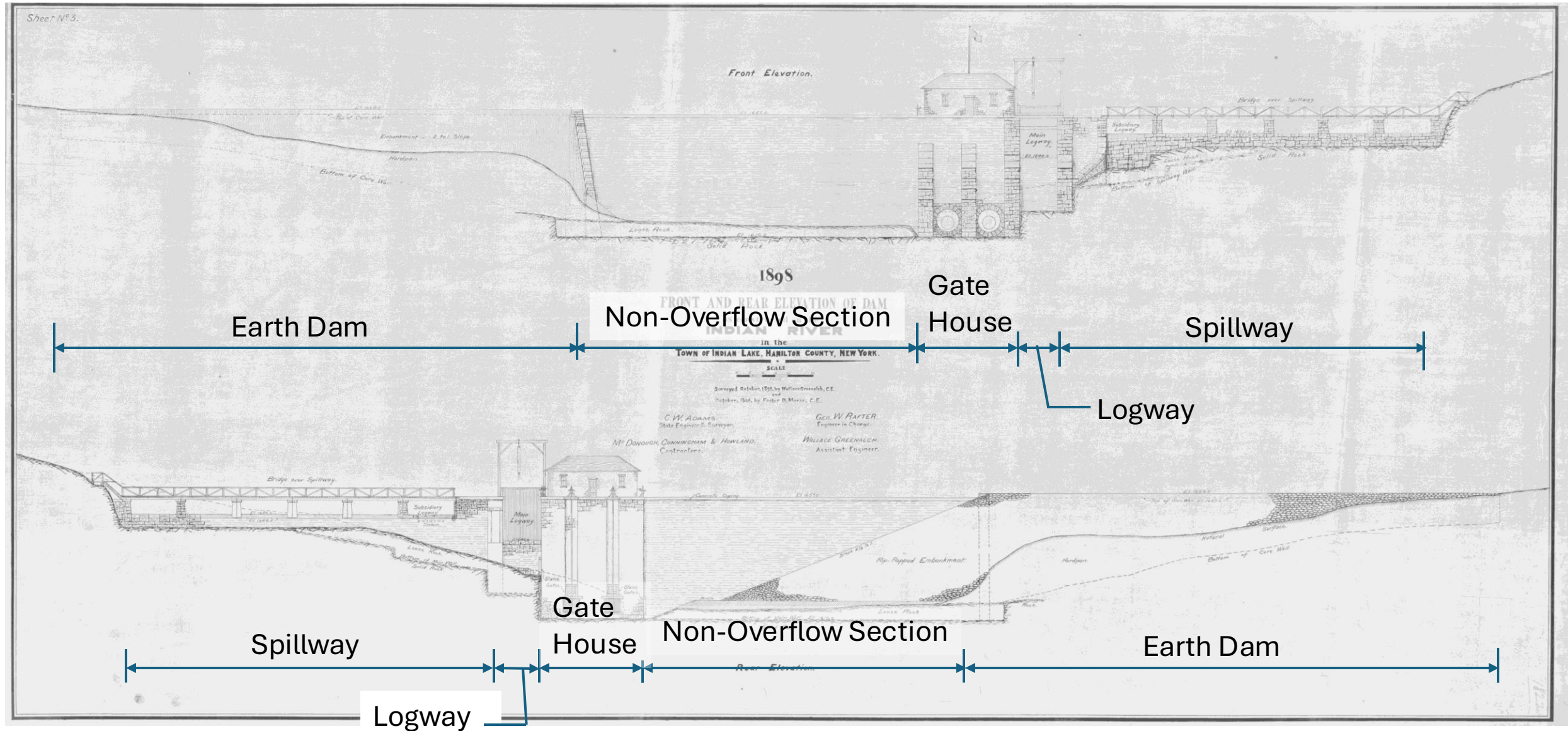
Indian Lake Dam

- Stone Masonry/Cyclopean Concrete circa 1898
- Various owners – Built by Indian River Co., International Paper Co., State of NY (HRBRRD)
- Vital Statistics
 - Located in the Adirondack Park of NYS
 - High Hazard
 - 40 ft tall
 - 500 ft long
 - Drainage area 132 sq. mi.
 - Normal Storage 95,000 acre-ft (30 billion gallons)
 - Max Storage 132,000 acre-ft
 - Bedrock Founded – Granitic Gneiss



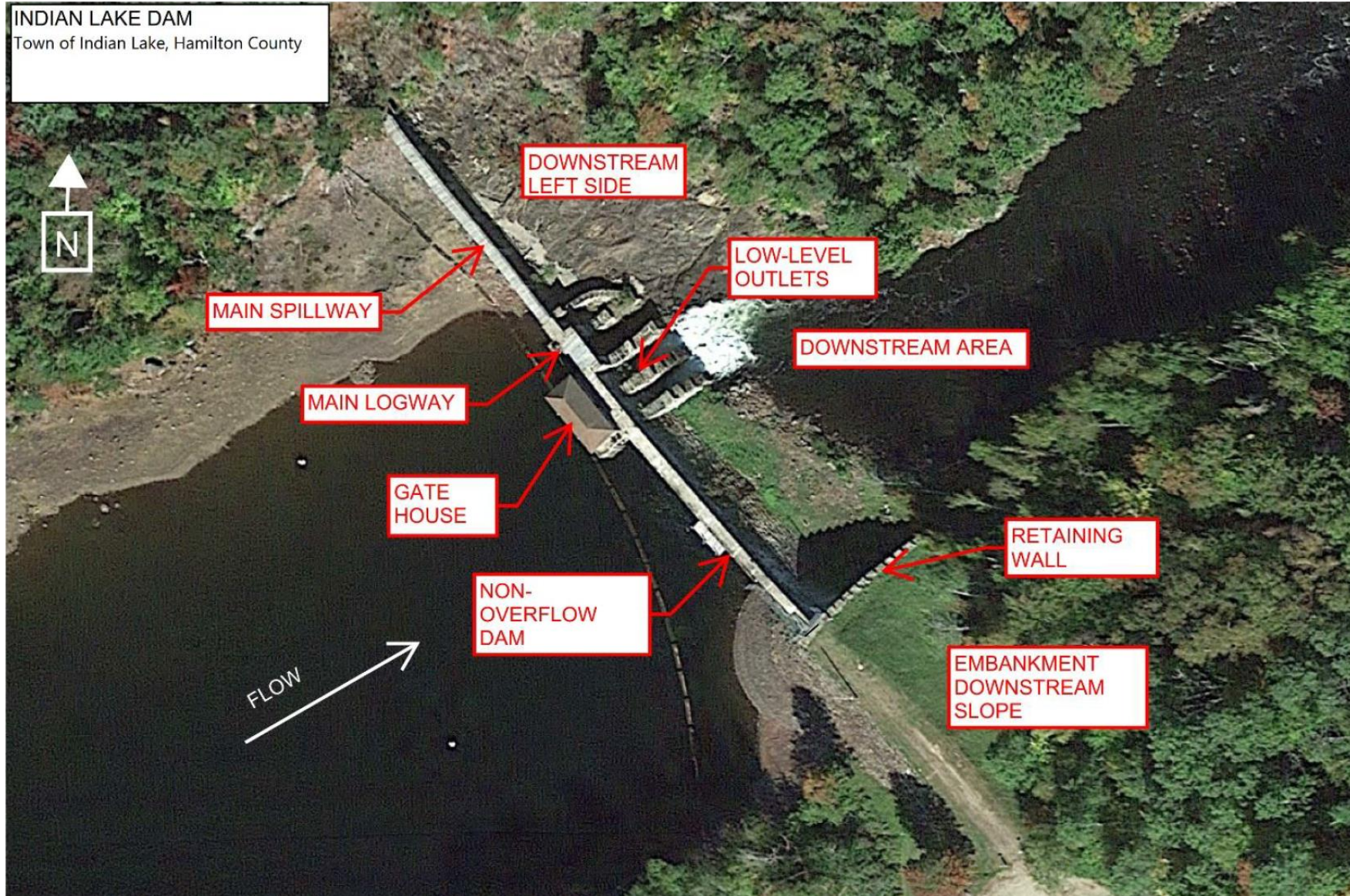


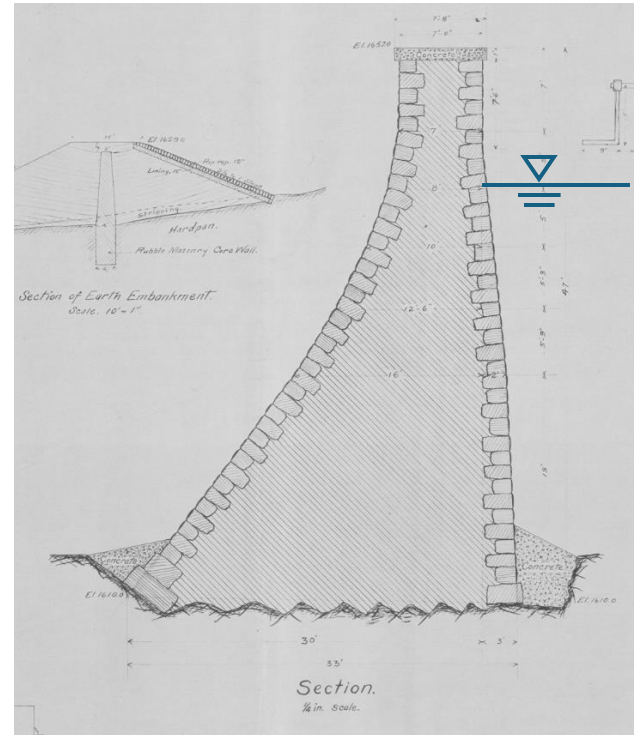




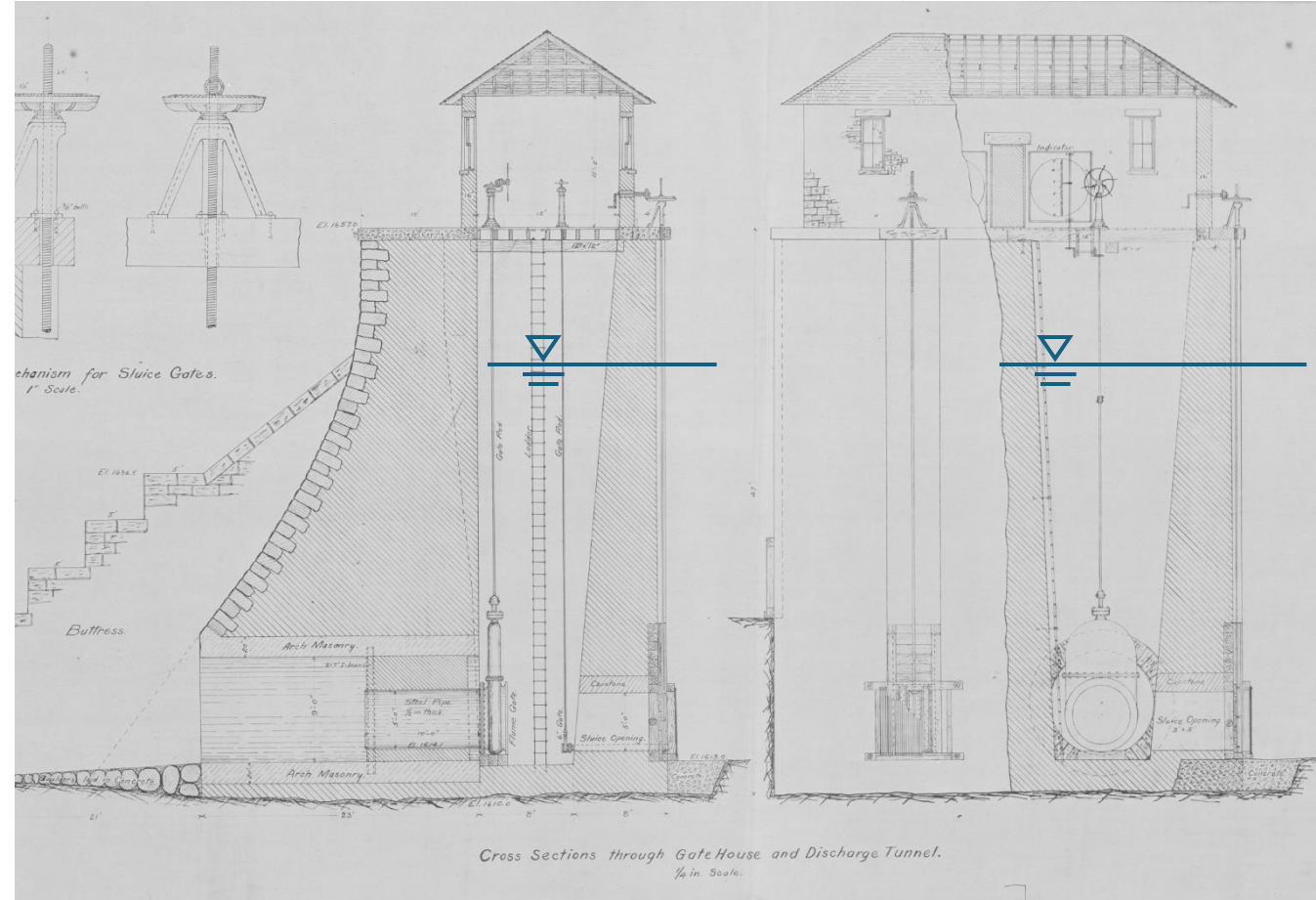
INDIAN LAKE DAM

Town of Indian Lake, Hamilton County

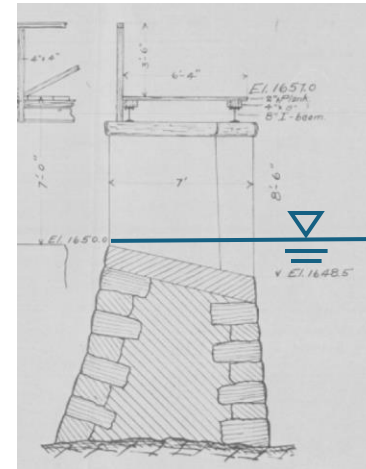




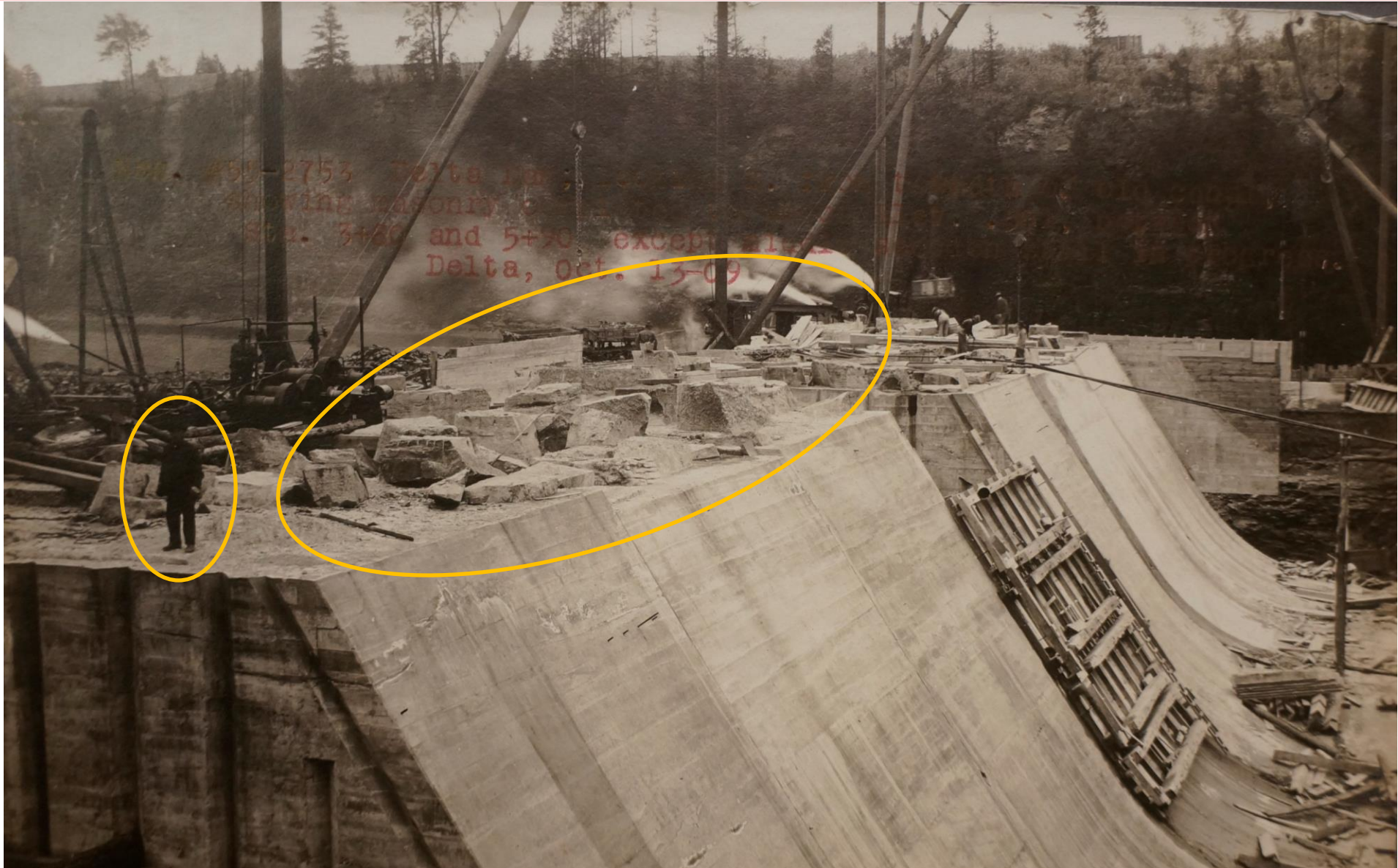
Masonry Dam
Cyclopean Concrete with
Stone Masonry Faces



Gate House

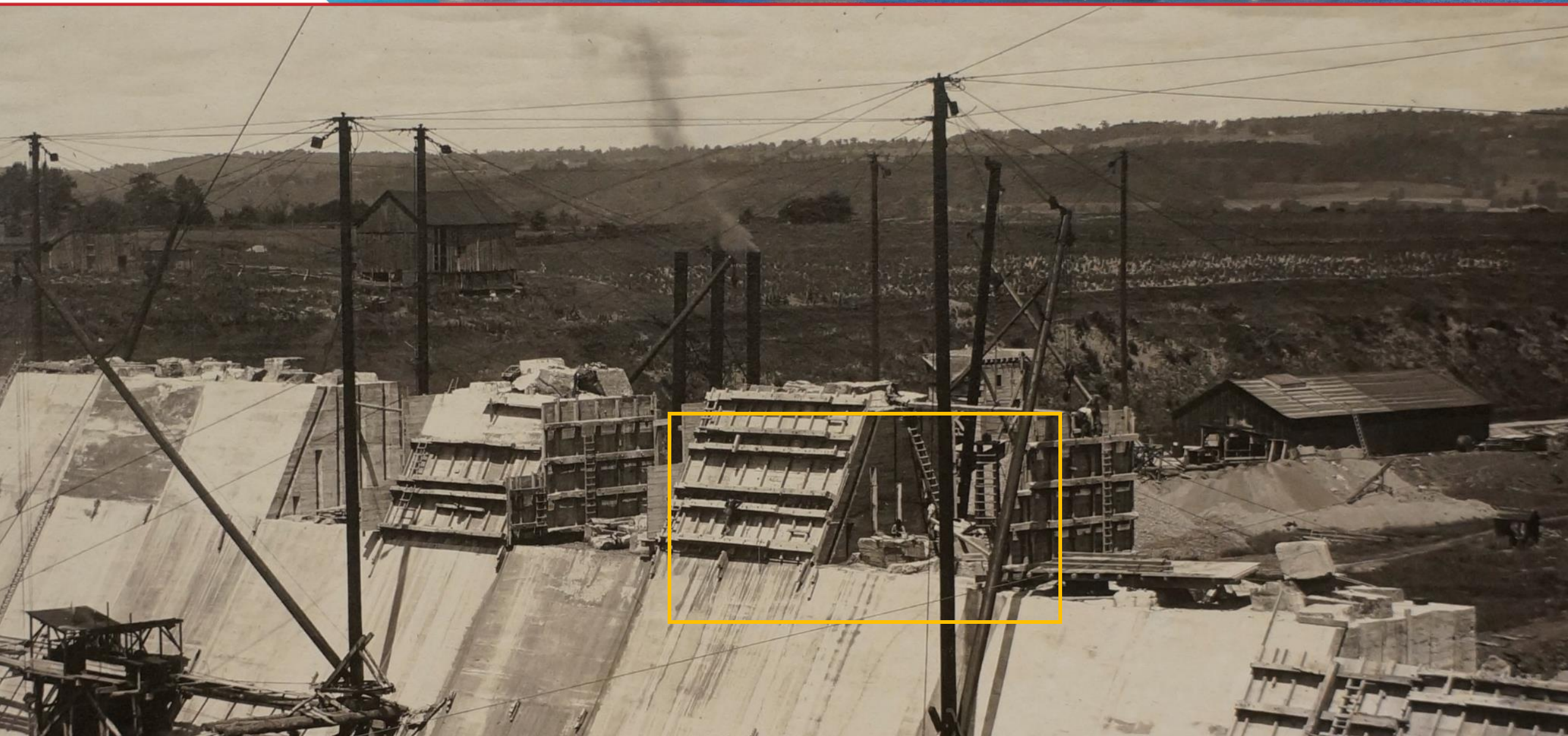


Spillway



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Design Challenges & Solutions



Design Deficiencies

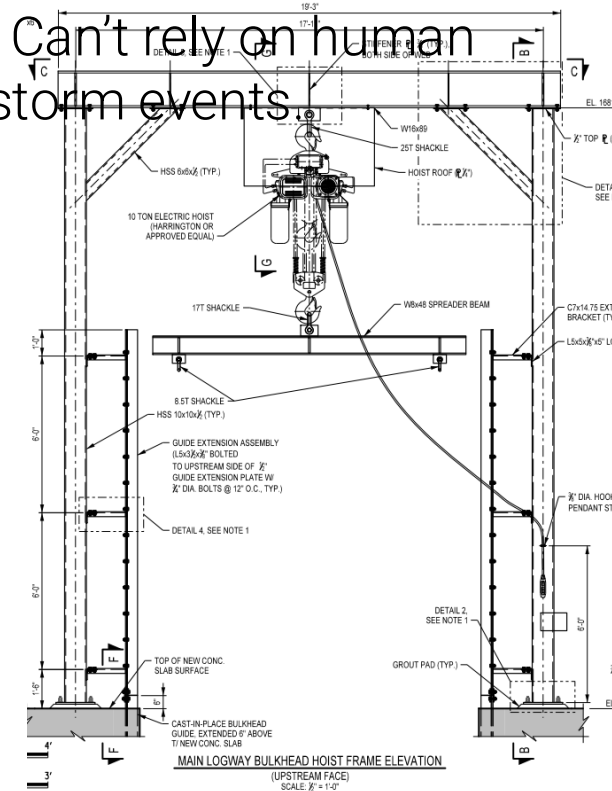
- Spillway Capacity (NYS requirement $\frac{1}{2}$ PMF)
 - Slight Overtopping (<1 ft, ~26hr duration)
- Structural Stability (Overturning & Sliding)
 - Resultant outside of base for flood case
- Slope Stability
 - FOS 1.3 vs. 1.5 req'd
- Operability/General Improvements
 - Timber Sluice Gates, Unsafe Platforms, Deteriorated Bridge over Spillway
- Leakage through the dam!



Spillway Capacity Improvement Options

- New gate at logway **Why Not?**
- Raise embankment
- Allow flow over non-overflow dam
- Improve existing spillway (ogee shape)
- New spillway

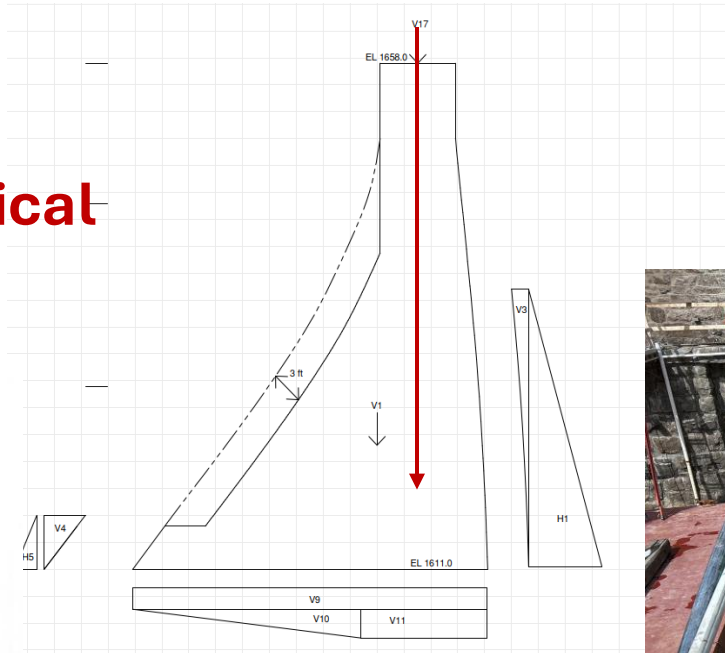
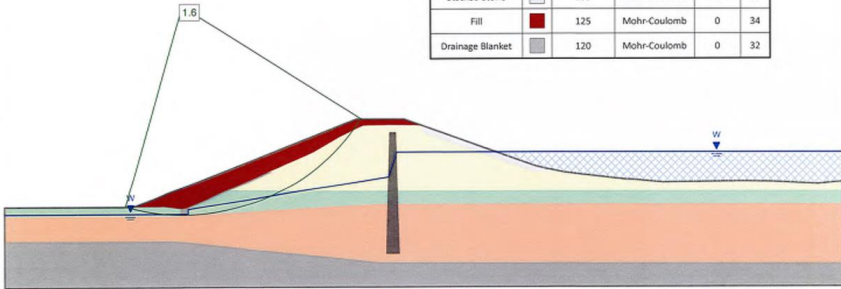
NYS Requirement – Can't rely on human intervention during storm events



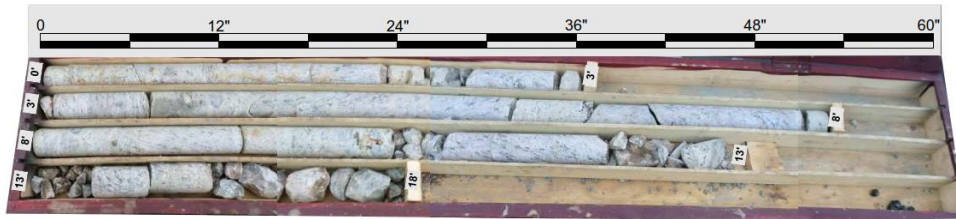
Stability Improvements (nothing really innovative...)

- Rock Anchors **Structural**
- Flatten Slopes **Geotechnical**

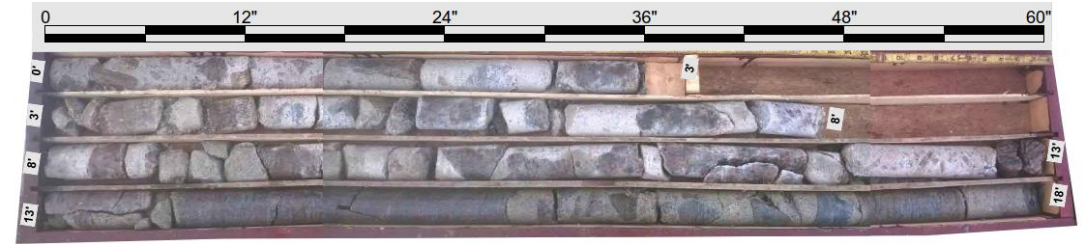
Material Name	Color	Unit Weight (lbs/ft ³)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment		120	Mohr-Coulomb	0	32
Sand w/ Organics		115	Mohr-Coulomb	0	28
Native Till		125	Mohr-Coulomb	0	36
Rock		150	Undrained	10000	
Core Wall		140	Mohr-Coulomb	0	45
Stacked Stone		135	Mohr-Coulomb	0	38
Fill		125	Mohr-Coulomb	0	34
Drainage Blanket		120	Mohr-Coulomb	0	32



Leakage Improvements



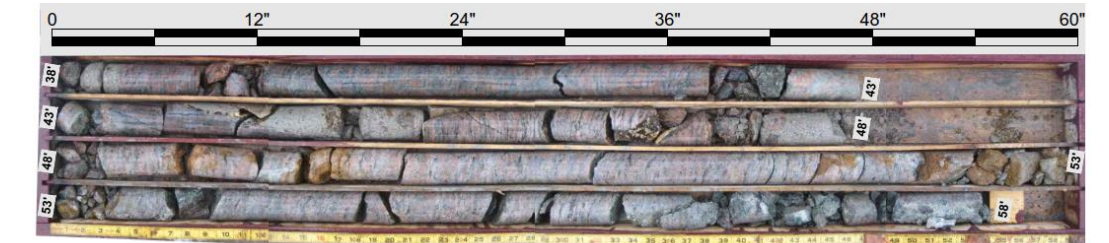
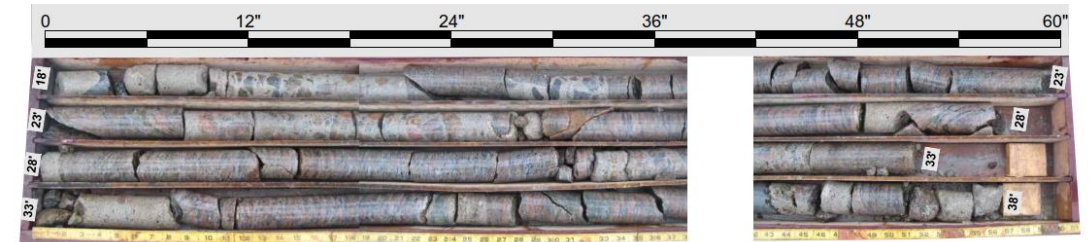
0-18 ft



18-38 ft

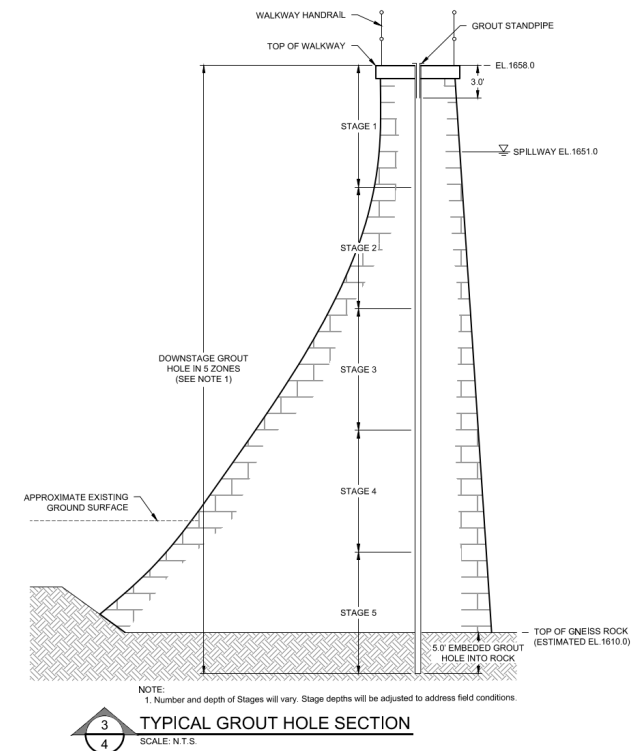
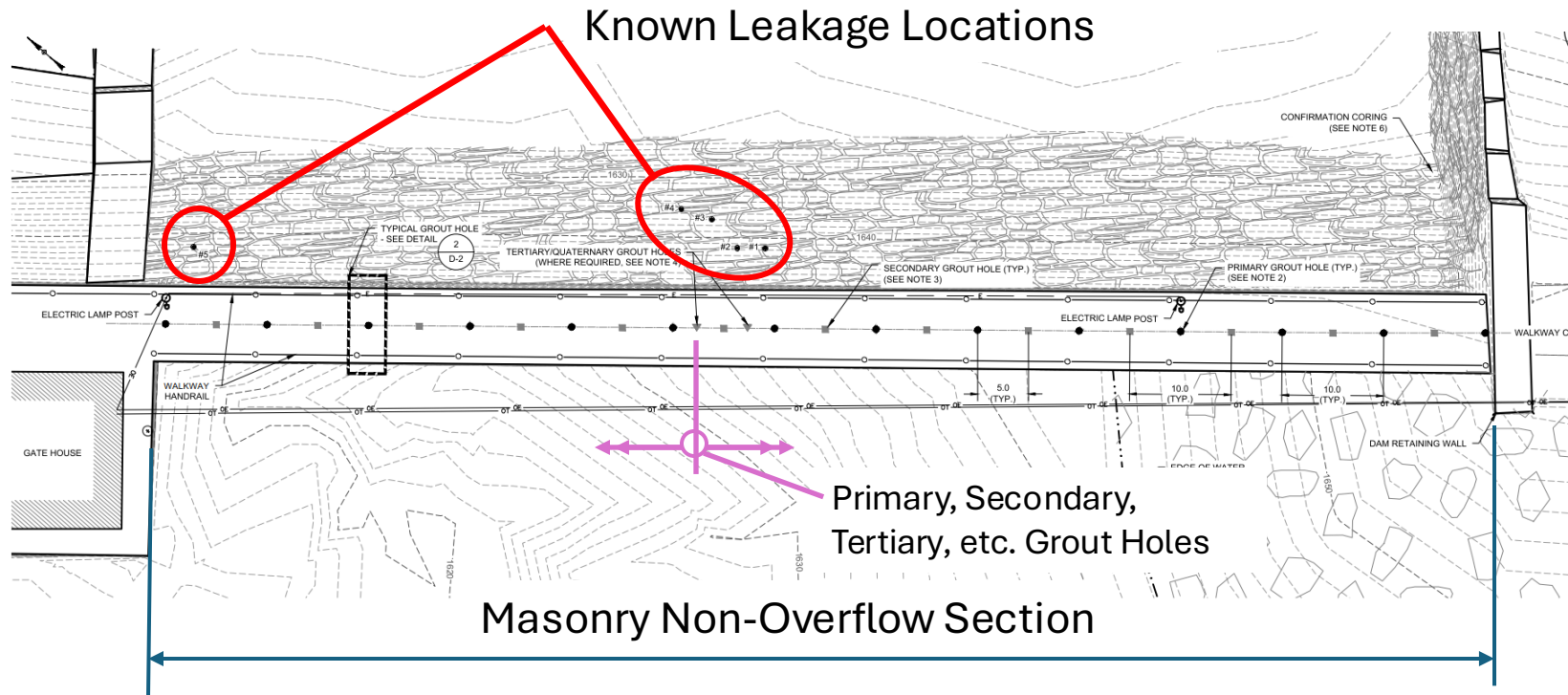


38-58 ft



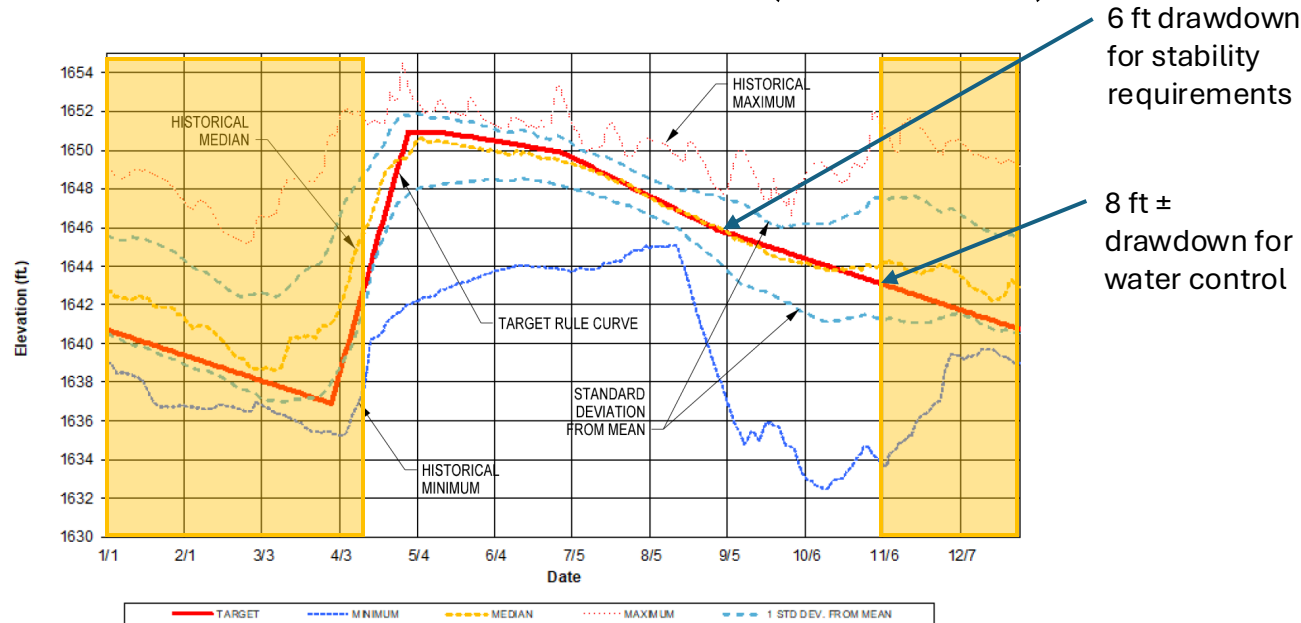
Leakage Improvements – Easy Peasy

- Masonry repointing and grouting of dam (Conventional)



Leakage Improvements – Not So Fast

- Masonry repointing and grouting of dam
- But how to deal with running water & increased uplift due to grouting?
 - Grout when WSEL is Lower (Fall/Winter)



HISTORICAL RESERVOIR WATER LEVELS (1985 - 2021)



Leakage Improvements – Contract Docs

CONSTRUCTION SEQUENCING NOTES:

1. DUE TO EXPECTED LAKE LEVEL FLUCTUATIONS, THE TIMING OF CERTAIN PORTIONS OF THE WORK IS CRITICAL. THE TABLE BELOW DETAILS THE PORTIONS OF THE WORK FOR WHICH LOWERED RESERVOIR ELEVATIONS ARE NECESSARY TO MAINTAIN THE DAM IN A SAFE CONDITION. IT MAY BE TO THE CONTRACTOR'S ADVANTAGE TO COMPLETE OTHER WORK WITH THE RESERVOIR LOWERED. ANY SUCH WORK FOR CONTRACTOR CONVENIENCE IS NOT INCLUDED IN THE TABLE BELOW. WORK SHALL BE PLANNED AND SEQUENCED BY THE CONTRACTOR AS NECESSARY TO ALLOW FOR THE REQUIRED WORK DURING THE PERIODS WHEN THE RESERVOIR IS AT LOWER ELEVATIONS AS INDICATED ON THE TARGET RULE CURVE.
2. IN ADDITION TO WATER LEVEL RESTRICTIONS AND REQUIRED SEQUENCING, ADDITIONAL FACTORS SUCH AS RESTRICTIONS ON WINTER FILL PLACEMENT WILL ALSO FACTOR INTO THE SCHEDULE AND SEQUENCING OF OPERATIONS. SUCH REQUIREMENTS ARE NOT INCLUDED IN THE TABLE.

WORK REQUIRED TO BE COMPLETED WITH RESERVOIR AT OR BELOW SPECIFIC RESERVOIR ELEVATION

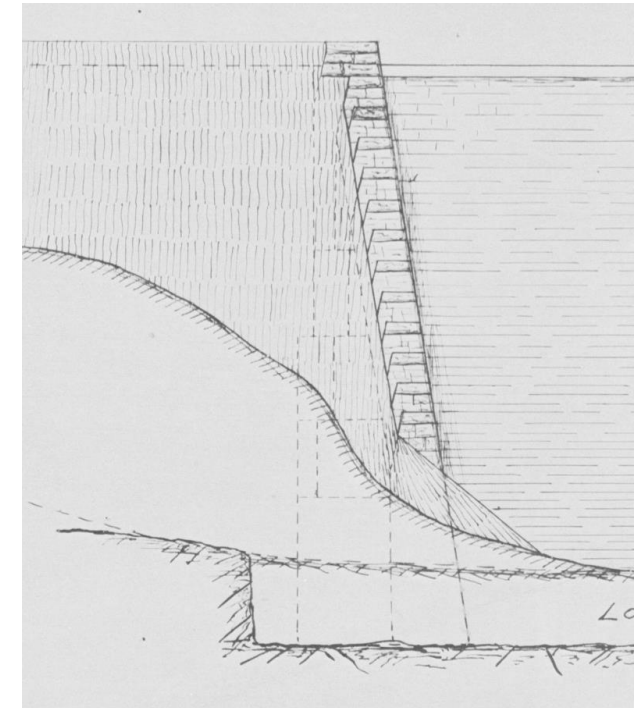
WORK ITEM	GENERAL REQUIRED ELEMENTS	MAXIMUM PERMISSIBLE RESERVOIR ELEVATION	DRAWINGS
STUMP REMOVAL, EXCAVATION, AND EMBANKMENT REPAIRS	REMOVAL OF STUMPS AND EXCAVATION REPAIRS AS DETAILED	1646.0	EW-1 THRU EW-4
EMBANKMENT DRAINAGE SYSTEM INSTALLATION	INSTALLATION OF DRAINAGE PIPING, GRANULAR FILTER MATERIAL AND A MINIMUM 2-FOOT COVERING OF DAM EMBANKMENT IN PLACE OVER THE FILTER MATERIALS. FINAL COLLECTION PIPING RUNS AND CONNECTION TO THE WEIR BOX IS NOT REQUIRED.	1646.0	EW-1 THRU EW-4
EMBANKMENT CORE WALL EXTENSION	EXCAVATION INTO CREST AND VERTICAL CONCRETE EXTENSION OF CORE WALL	1652.0	EW-7
RETAINING WALL FACING AND EXTENSION	INSTALLATION OF SECANT PILE AND SOLDIER PILE FOUNDATIONS, DRILLING AND GROUTING ROCK ANCHORS.	1646.0	EW-8 THRU EW-16
CONSOLIDATION GROUTING OF NON-OVERFLOW DAM AND SPILLWAY	GROUT INJECTION INTO DRILLED HOLES AT NON-OVERFLOW DAM AND SPILLWAY	1646.0	D-1 & D-2



Design Consequences = Design Innovations

- Embankment Raise + Masonry Wall with No Records = New Concrete Wall

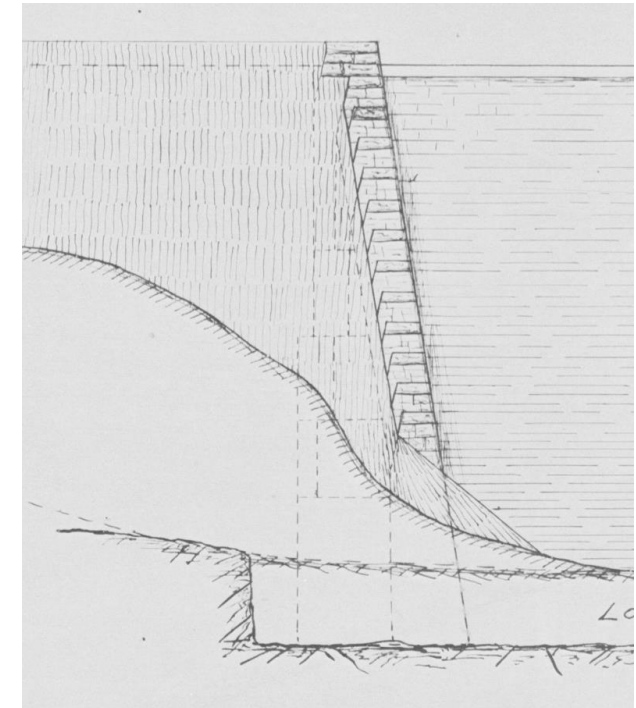
Challenge	Solution
Tall Wall	Cased Anchor Tiebacks



Design Consequences = Design Innovations

- Embankment Raise + Masonry Wall with No Records = New Concrete Wall

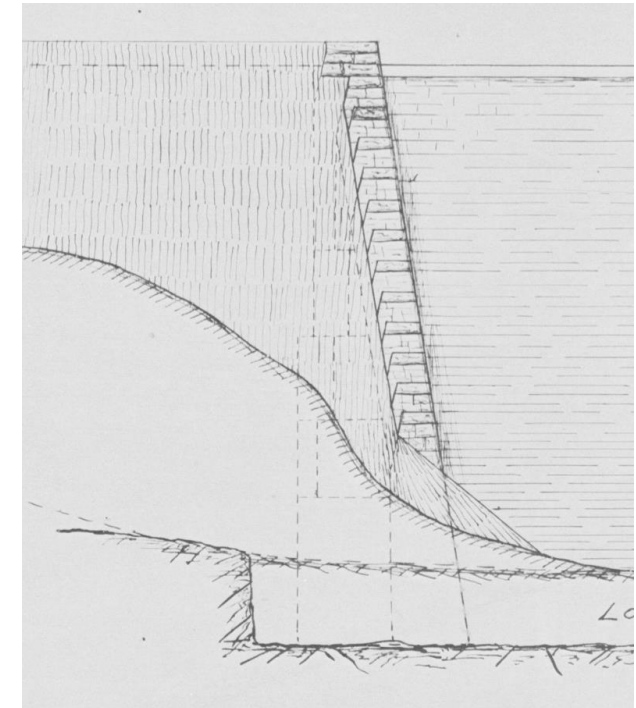
Challenge	Solution
Tall Wall	Cased Anchor Tiebacks
High Moments	Soldier Piles



Design Consequences = Design Innovations

- Embankment Raise + Masonry Wall with No Records = New Concrete Wall

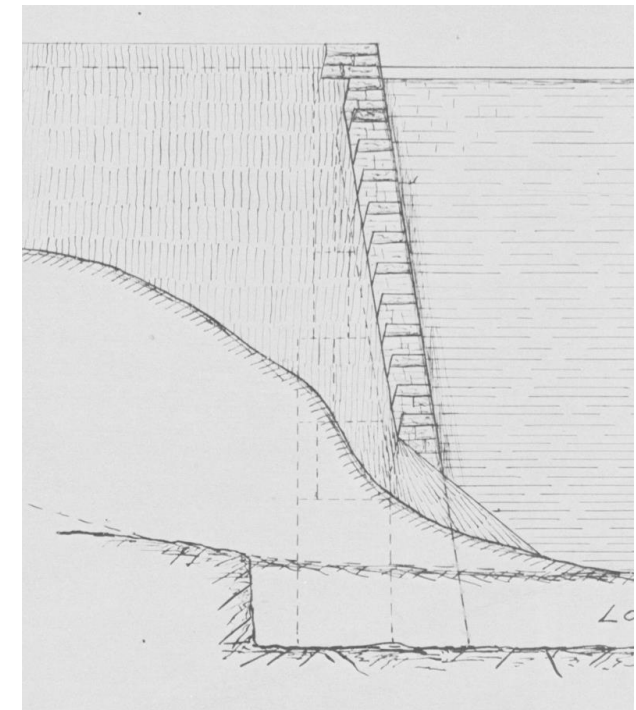
Challenge	Solution
Tall Wall	Cased Anchor Tiebacks
High Moments	Soldier Piles
Soil in front of wall	Secant Piles w/ Rock Sockets for Soldier Piles to Support Vertical Weight



Design Consequences = Design Innovations

- Embankment Raise + Masonry Wall with No Records = New Concrete Wall

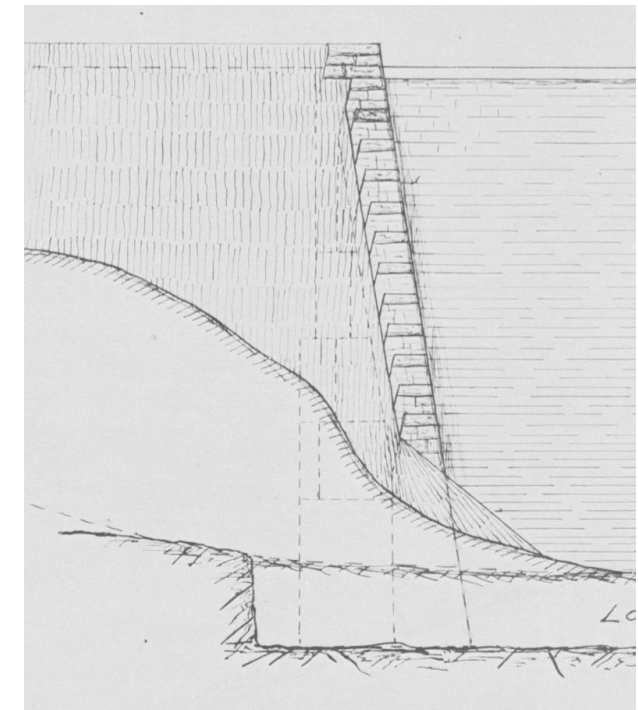
Challenge	Solution
Tall Wall	Cased Anchor Tiebacks
High Moments	Soldier Piles
Soil in front of wall	Secant Piles w/ Rock Sockets for Soldier Piles to Support Vertical Weight
Concern with long term uncontrolled seepage below concrete facing	Secant Piles



Design Consequences = Design Innovations

- Embankment Raise + Masonry Wall with No Records = New Concrete Wall

Challenge	Solution
Tall Wall	Cased Anchor Tiebacks
High Moments	Soldier Piles
Soil in front of wall	Secant Piles w/ Rock Sockets for Soldier Piles to Support Vertical Weight
Concern with long term uncontrolled seepage below concrete facing	Secant Piles
Retaining wall extension	Found on Secant Piles



PROPOSED FINISHED GRADE

VARIES

6"

1'-5"

SOLDER PILE & ANCHOR TIEBACK W.P.

EL. VARIES

FACE OF EXIST. STONE MASONRY RETAINING WALL

WALL ANCHOR TIEBACK

W.P.

1'-5" MIN. EMBEDMENT

APPROX. EXIST. GRADE

EXISTING STONE MASONRY EMBANKMENT RETAINING WALL

3'-4"

WALL ANCHOR TIEBACK

W.P.

10.5'

W14x132 SOLDER PILE

WALL ANCHOR TIEBACK

W.P.

APPROX. EXIST. TOP OF LOOSE ROCK (EL. 1611.0±)

SECANT PILE WALL

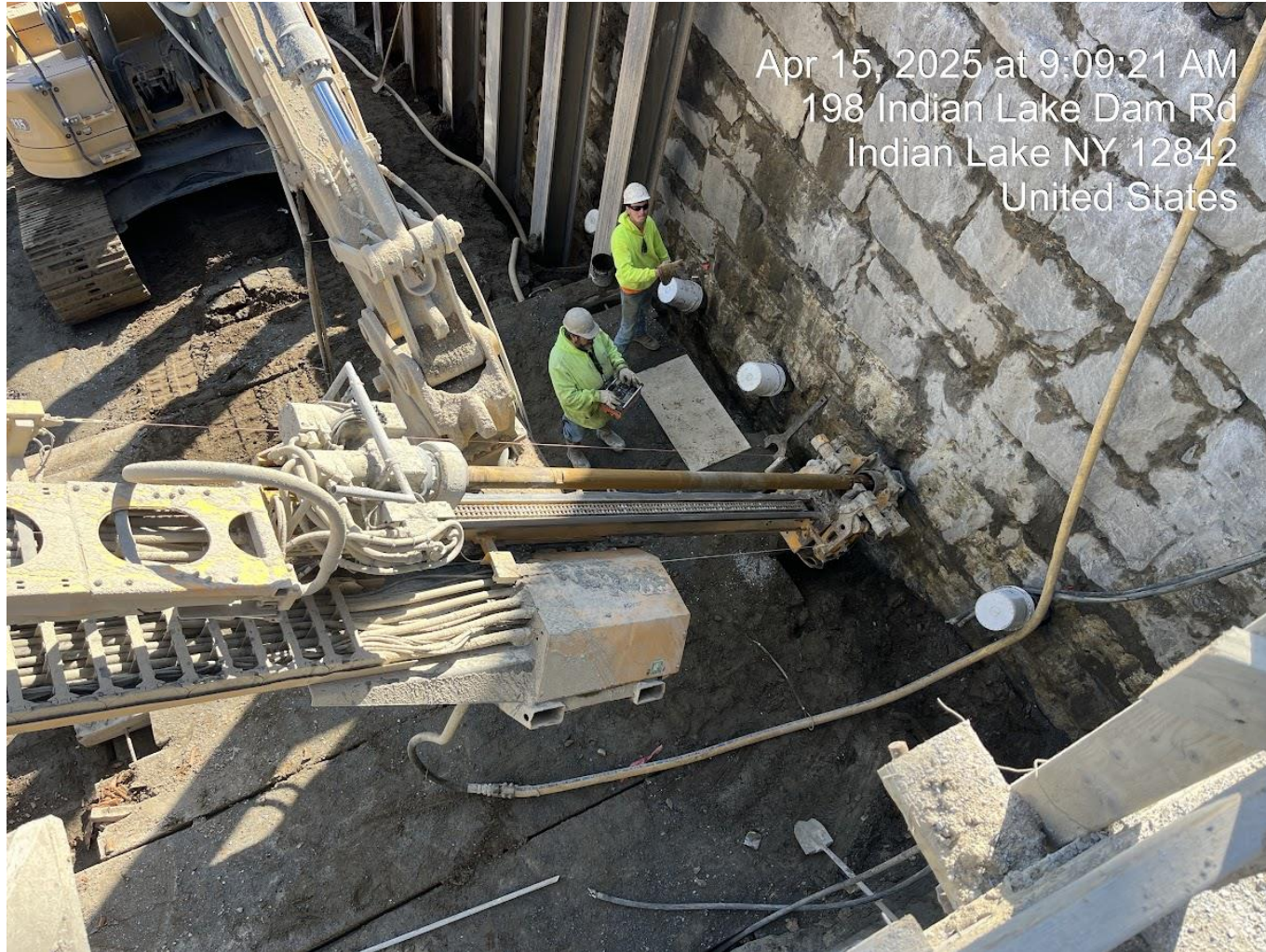
EL. 1611.0±

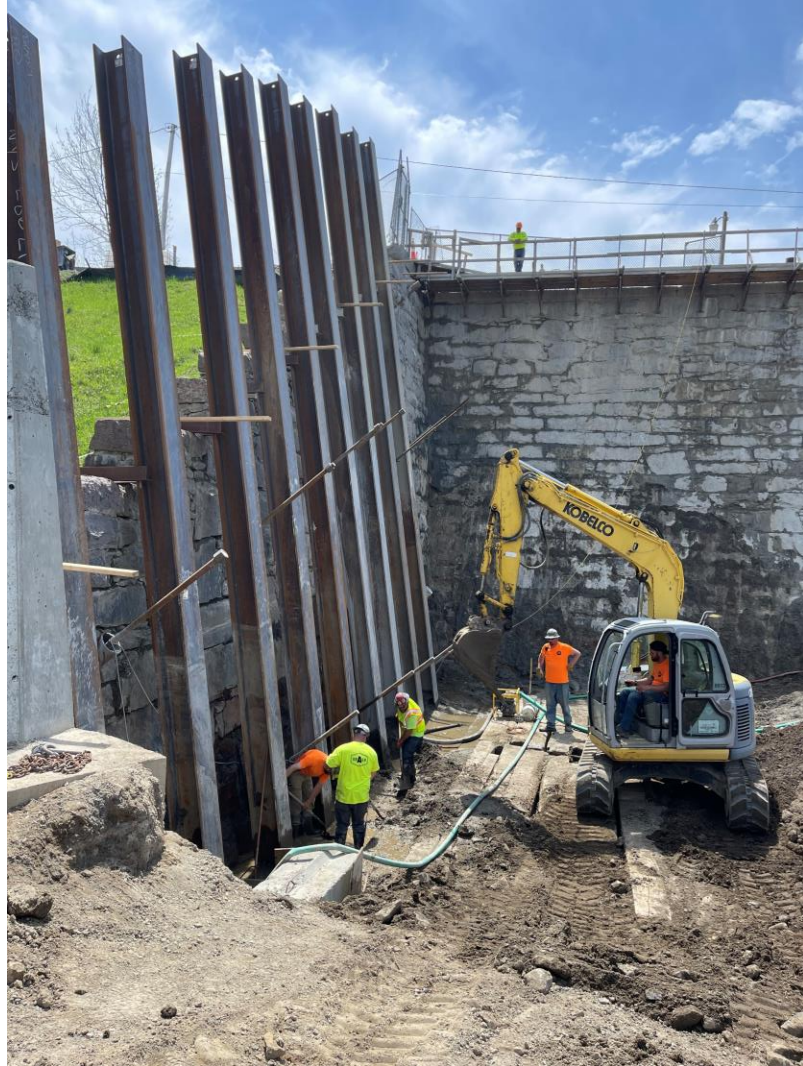
SOLDER PILE WORK POINT PER DWG. EW-11

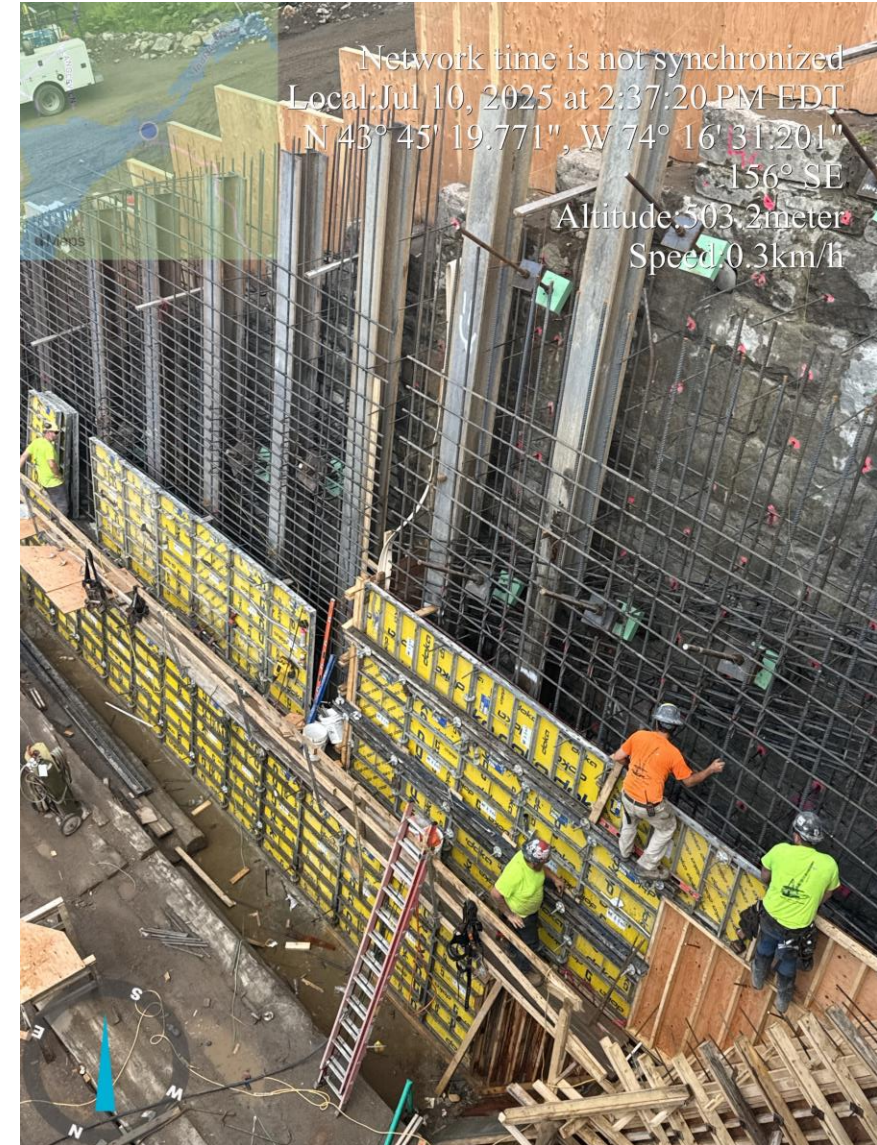
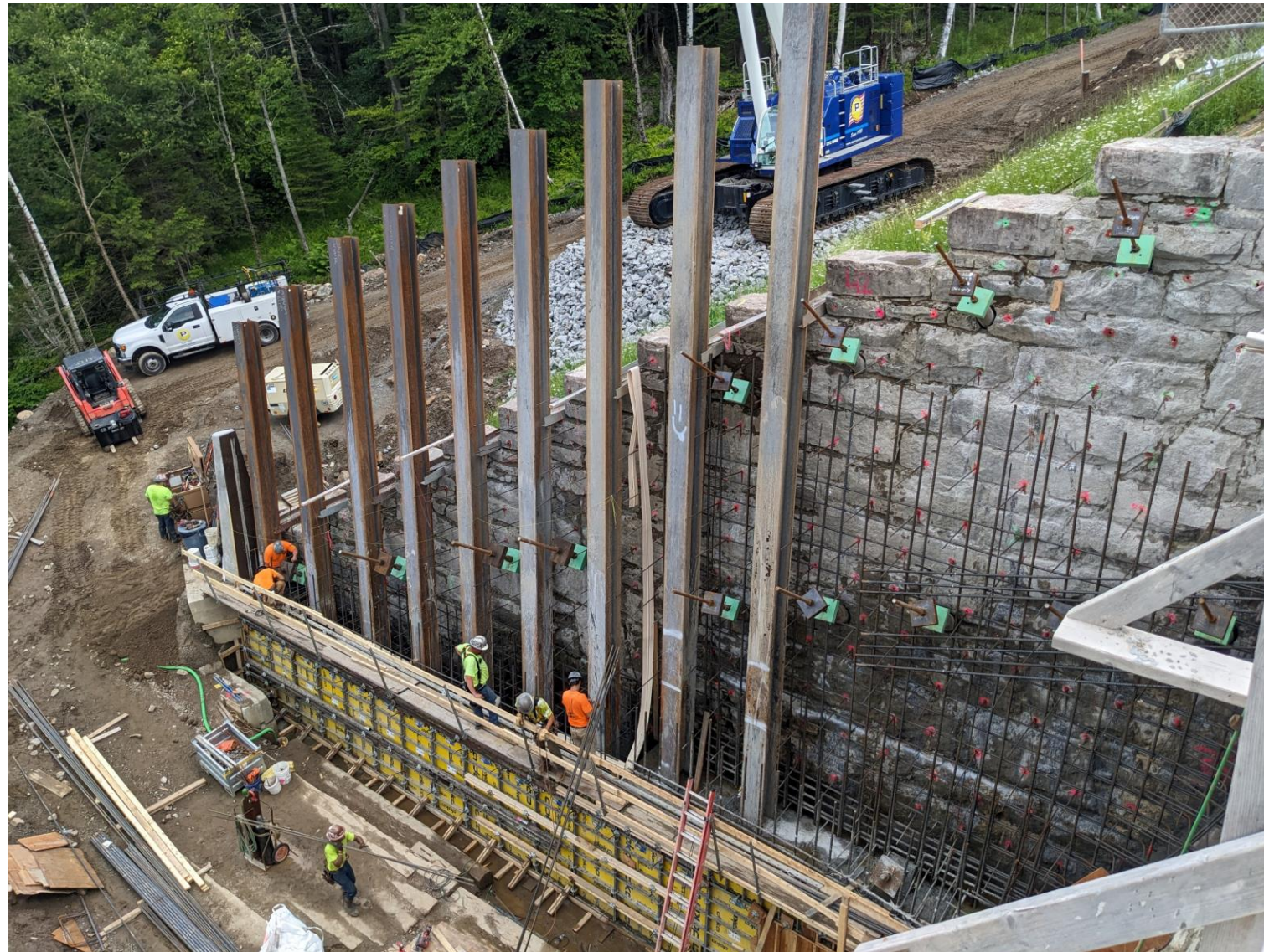
ROCK SOCKET

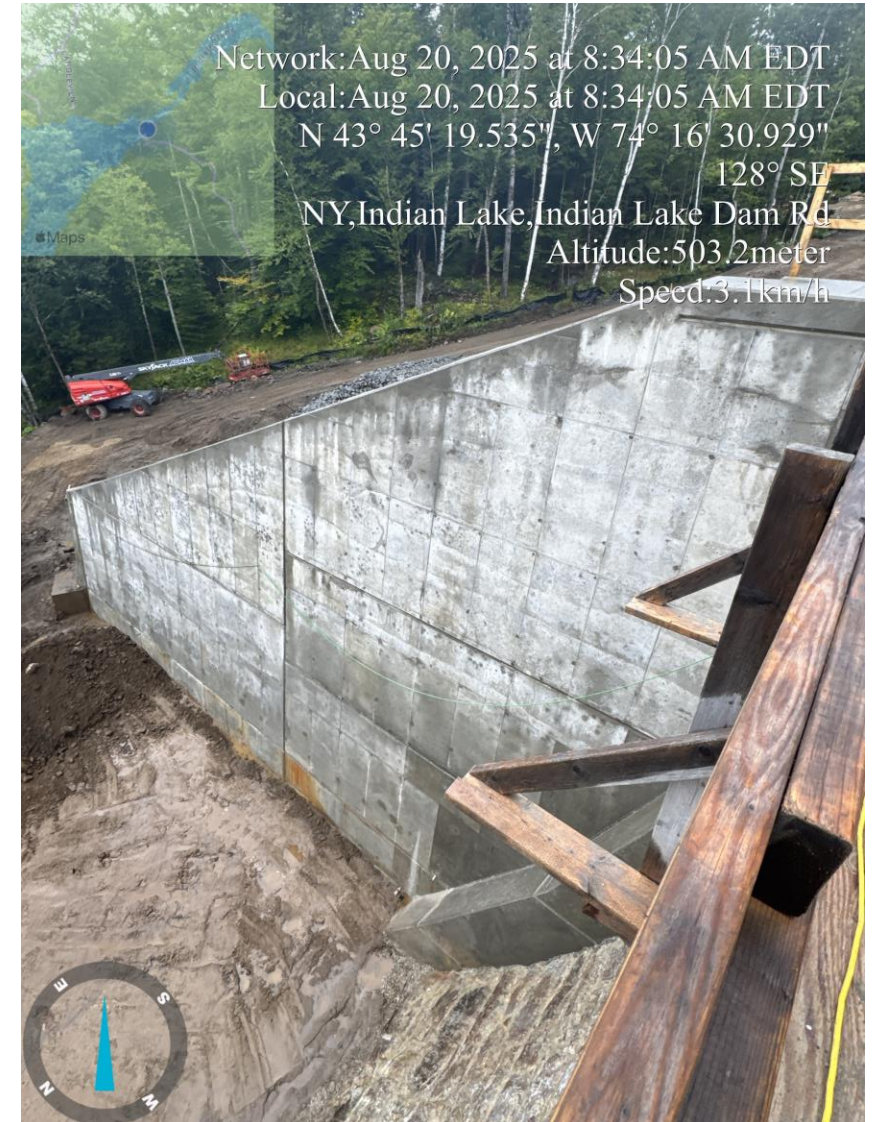
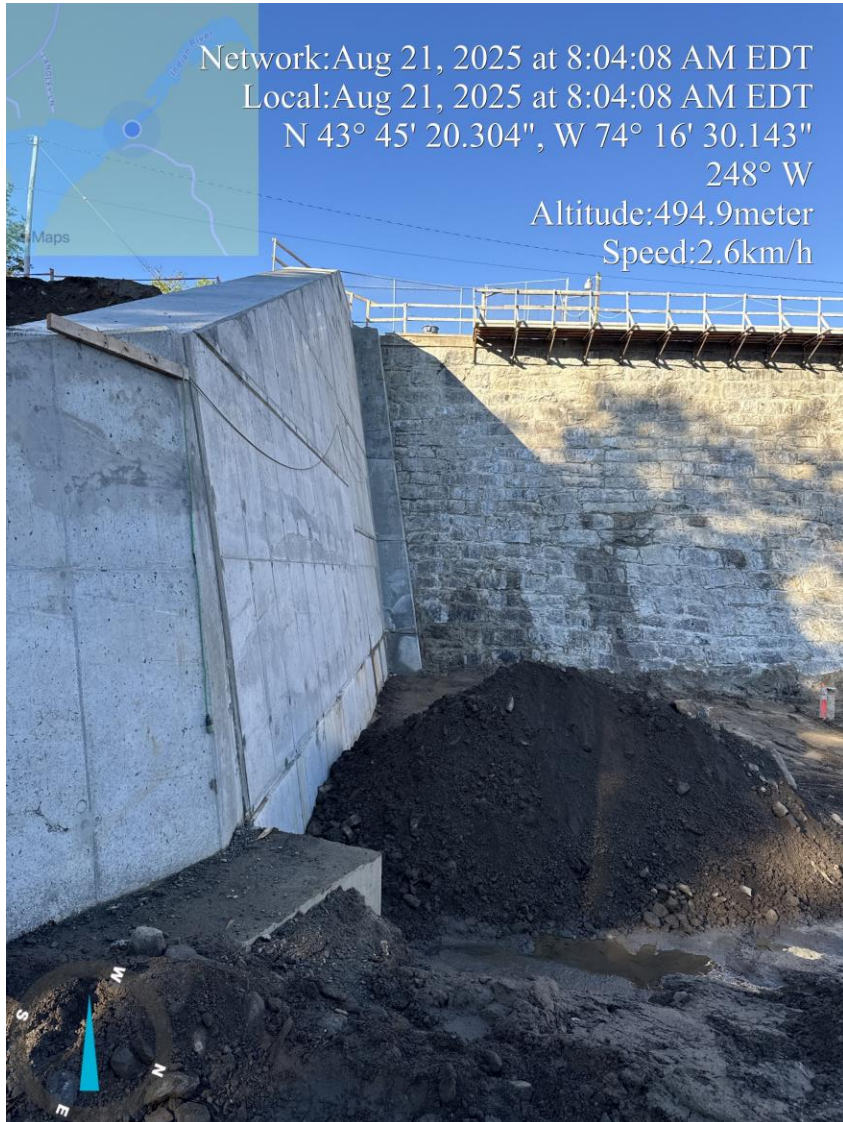
DRILL & GROUT #6 BARS @ 2'-0" MAX. E/W

APPROX. EXIST. SOLID ROCK







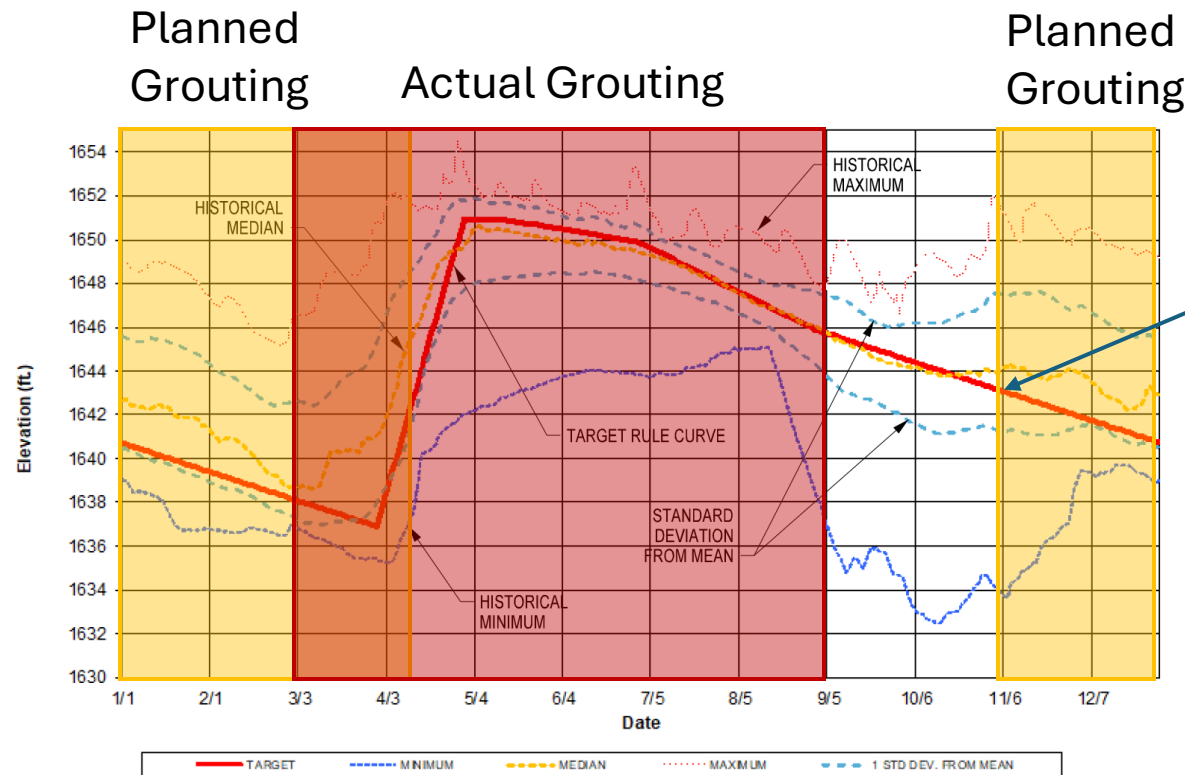


Construction Challenges & Solutions

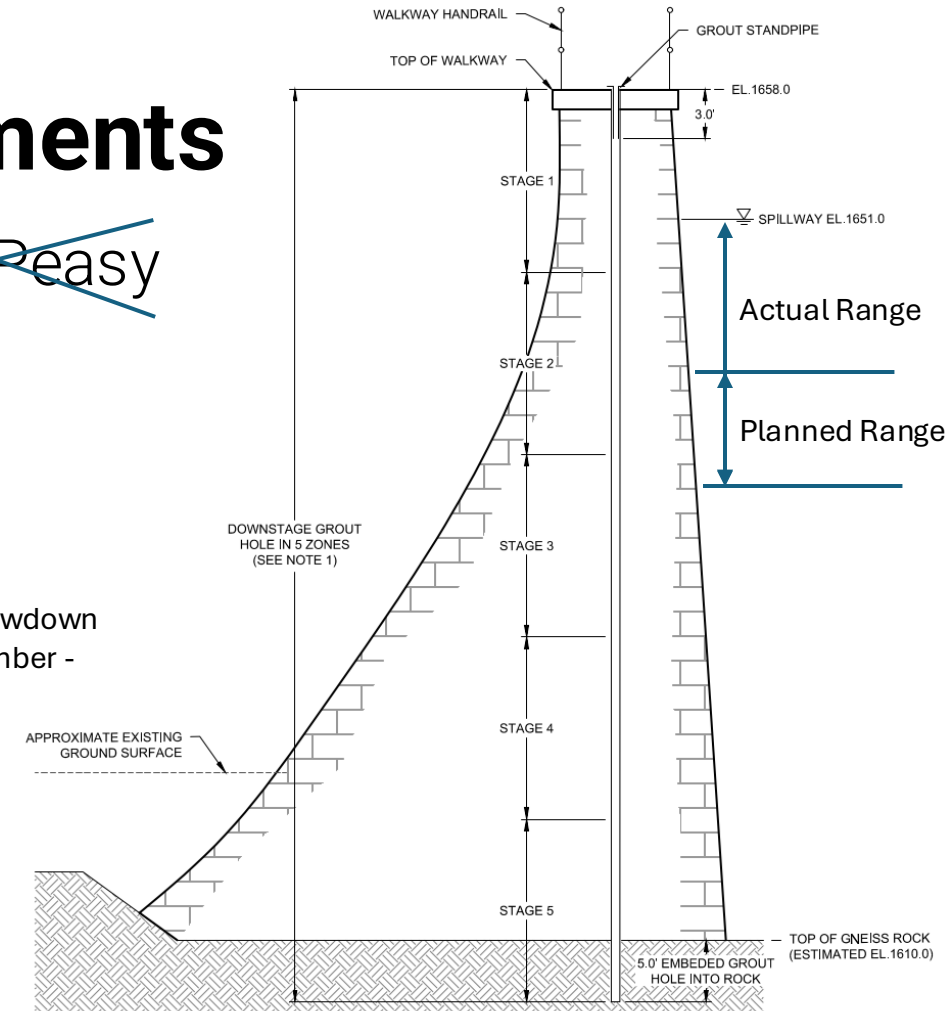


Challenge 1 - Leakage Improvements

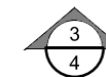
- Perform Grouting at Lower Pool Levels – ~~Easy Peasy~~



HISTORICAL RESERVOIR WATER LEVELS (1985 - 2021)



NOTE:
1. Number and depth of Stages will vary. Stage depths will be adjusted to address field conditions.



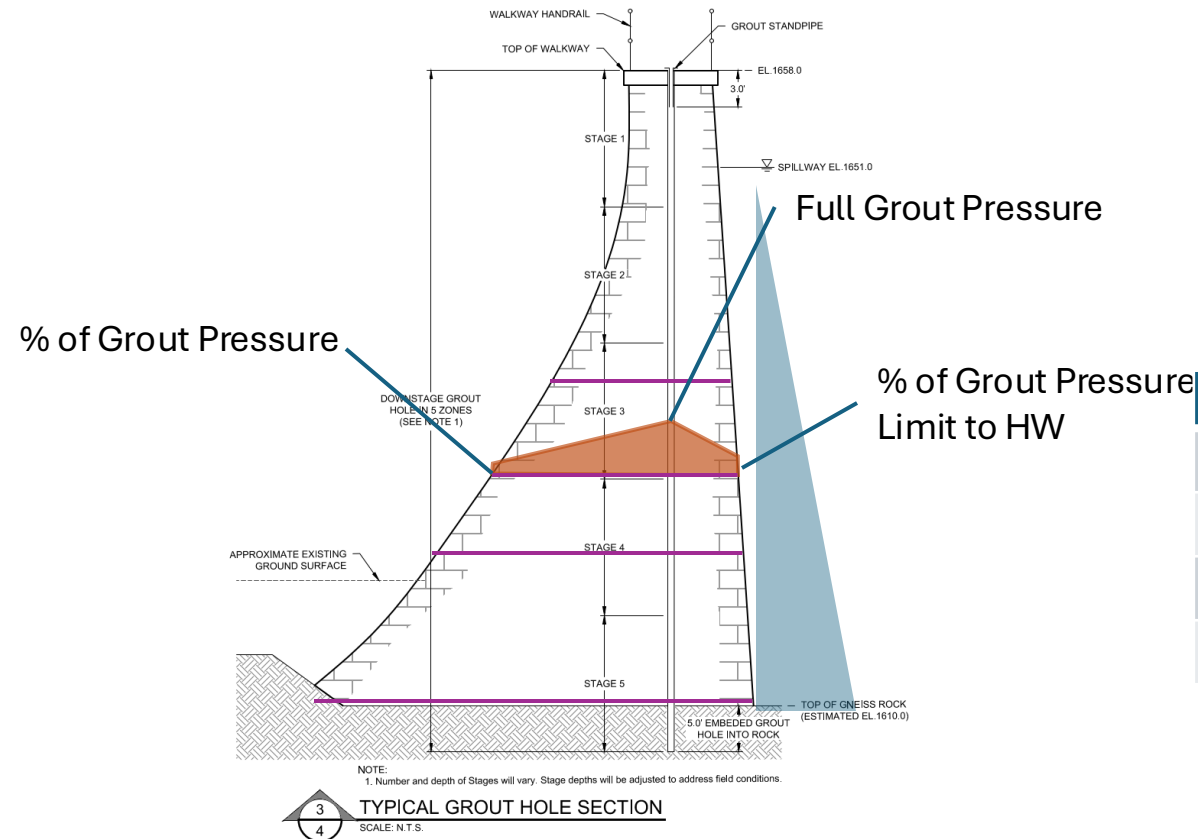
TYPICAL GROUT HOLE SECTION

SCALE: N.T.S.

Challenge 1 - Leakage Improvements

- Analysis performed for 4 different failure planes:

- at the main leak elevation
- 5 ft above
- 5 ft below
- at the base of the dam

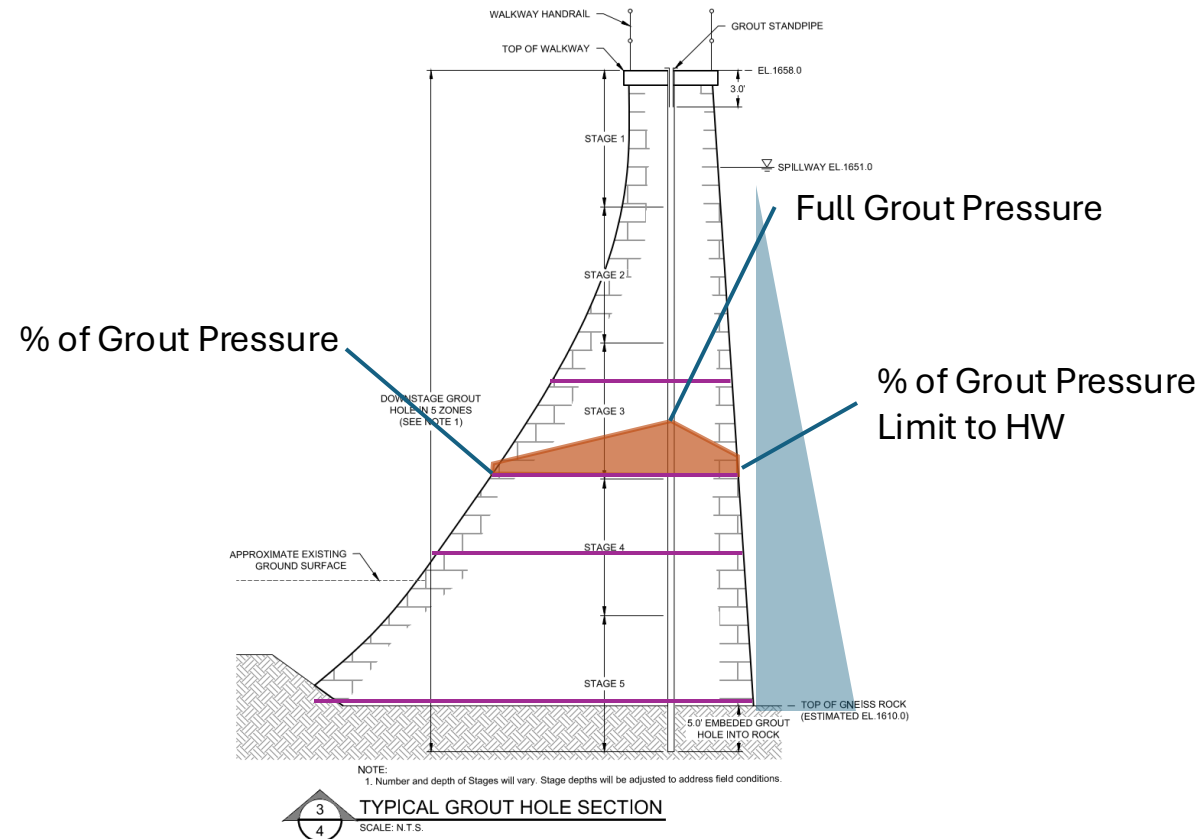


Location	DS Grout %	US Grout %
5' above leak	50	50
At leak	75	50
5' below leak	50	50
Base	20	20

- Maximum of grout pressure or triangular uplift used in calculations.

Challenge 1 - Leakage Improvements

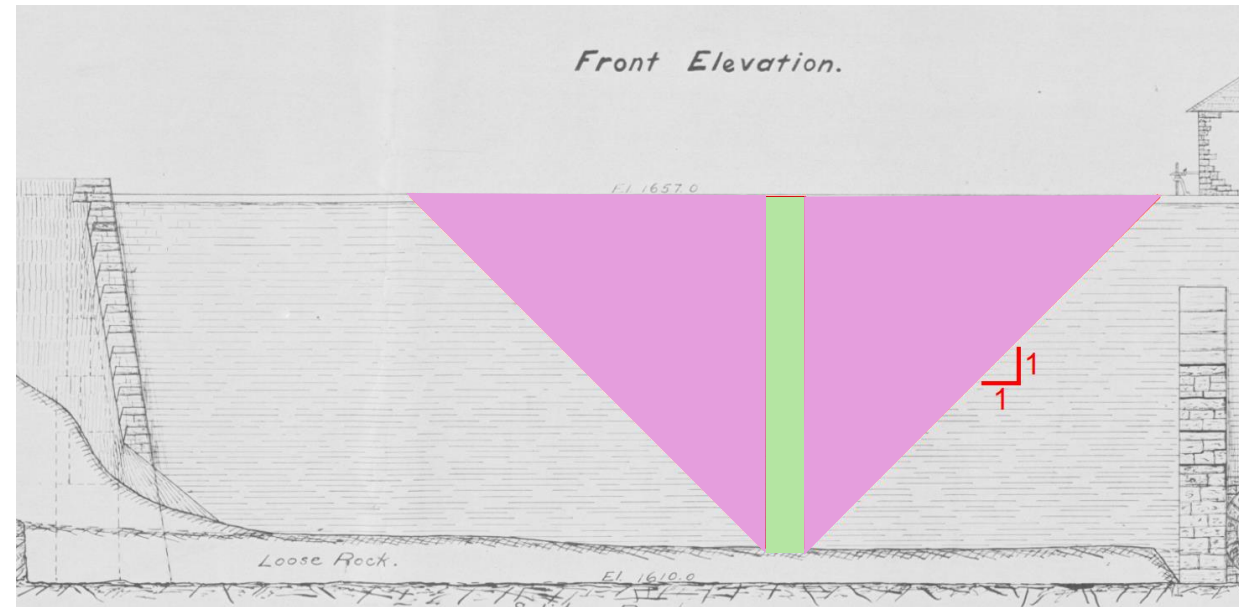
- Analysis looks at certain widths of sections and uses a corresponding assumed grout pressure



Effective width of grout travel (ft)	Effective overall % of maximum grout pressure across width	Equivalent Load Distribution
5	100	Rectangular
10	75	
15	60	
20	50	Triangular

Challenge 1 - Leakage Improvements

- Additional resistance from adjacent “extra” mass (purple)
- Stability of section run without grout pressure to determine “extra” mass available.
- This “extra” mass included in the analysis described prior (the stability on the green section)





Challenge 1 - Leakage Improvements

- Analysis showed that stability was acceptable
- LOTS of assumptions
- Added requirement for survey measurements of displacements during grouting operations

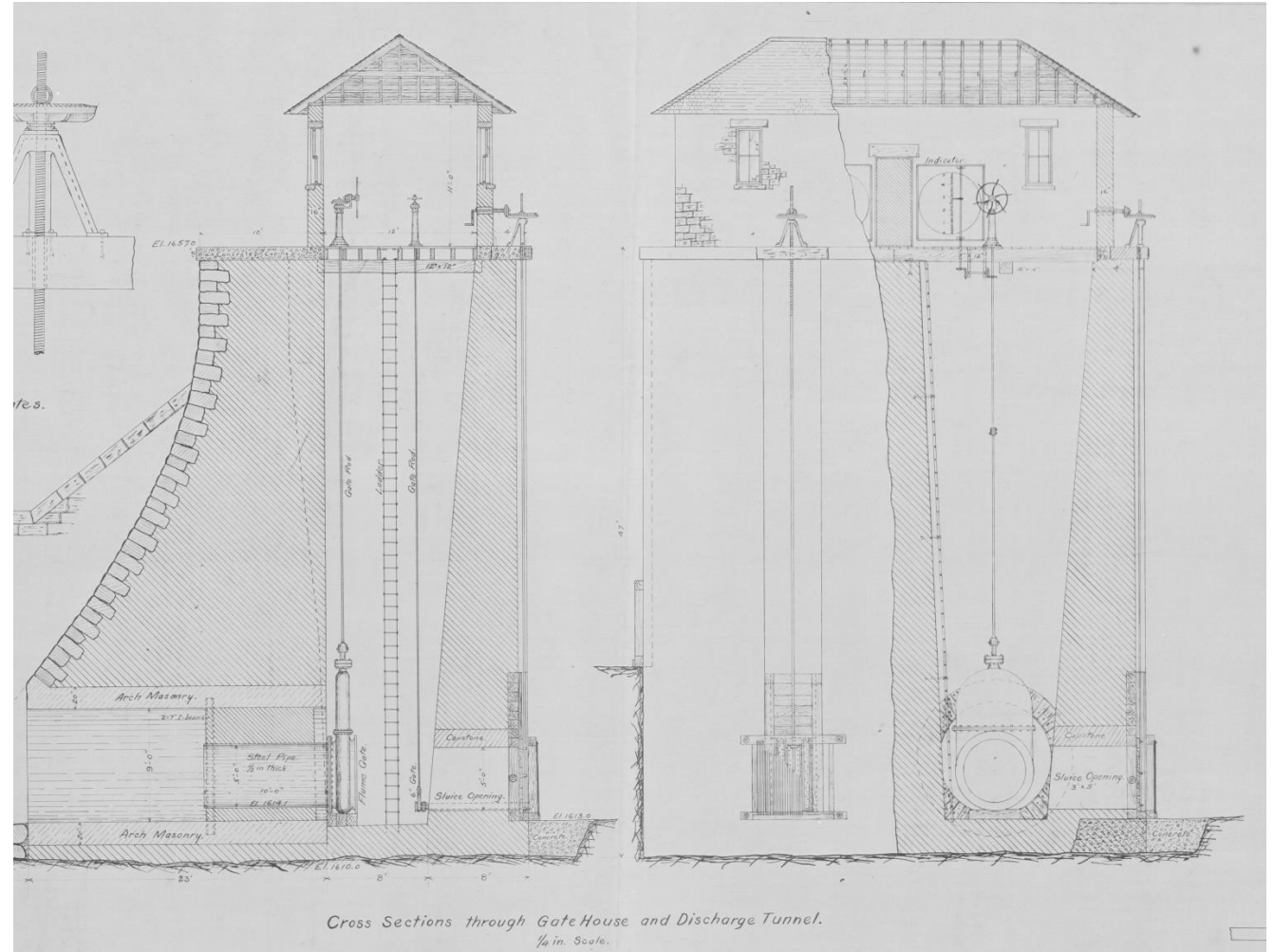




Challenge 2

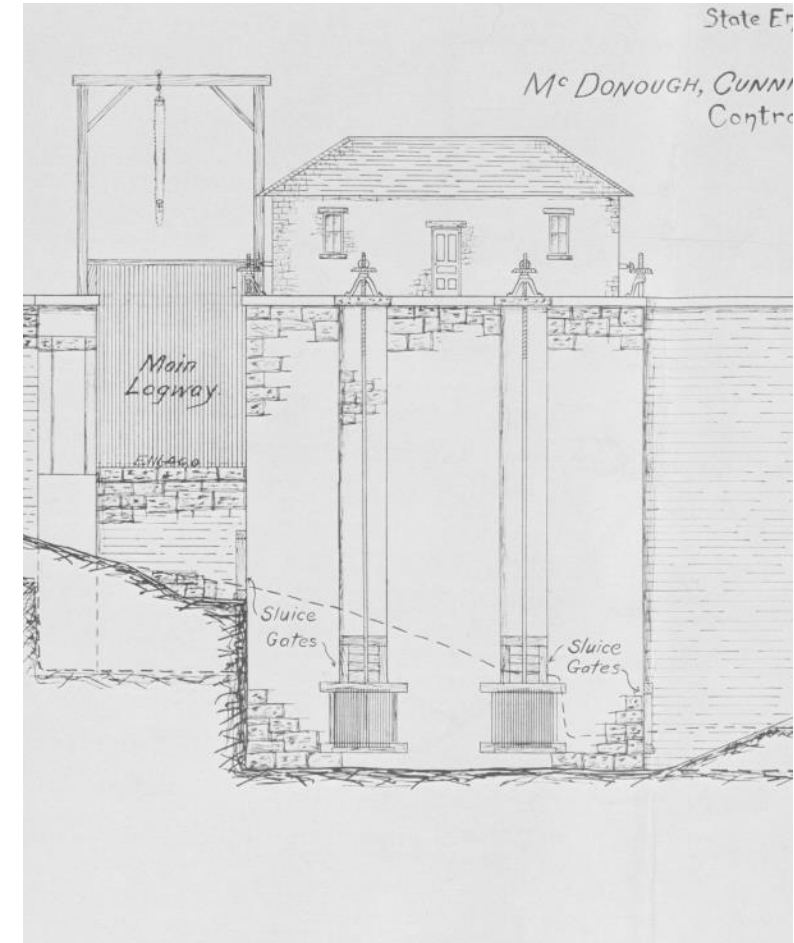
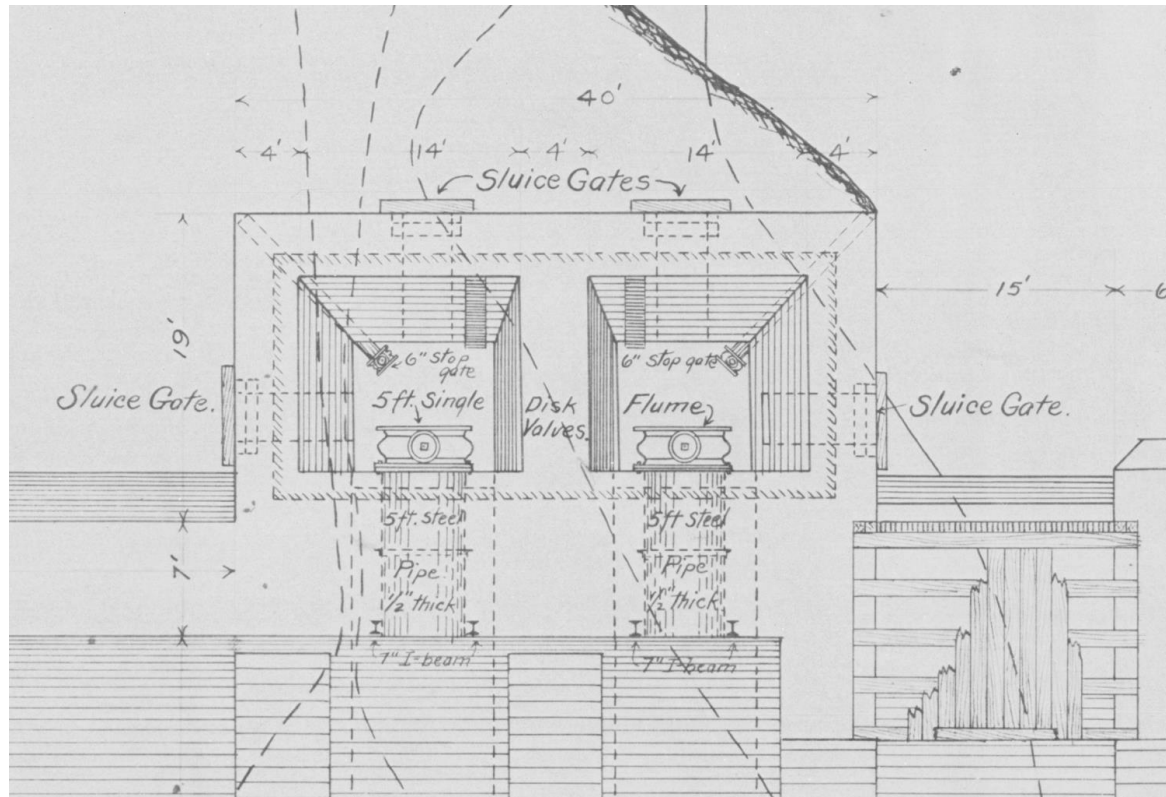
Gate House

- Scary Dive Video
- Extensive loss of mortar
- Area near gates “bites”
- Concrete floor nonexistent



Cross Sections through Gate House and Discharge Tunnel.
1/4 in. Scale.

Challenge 2 Gate House



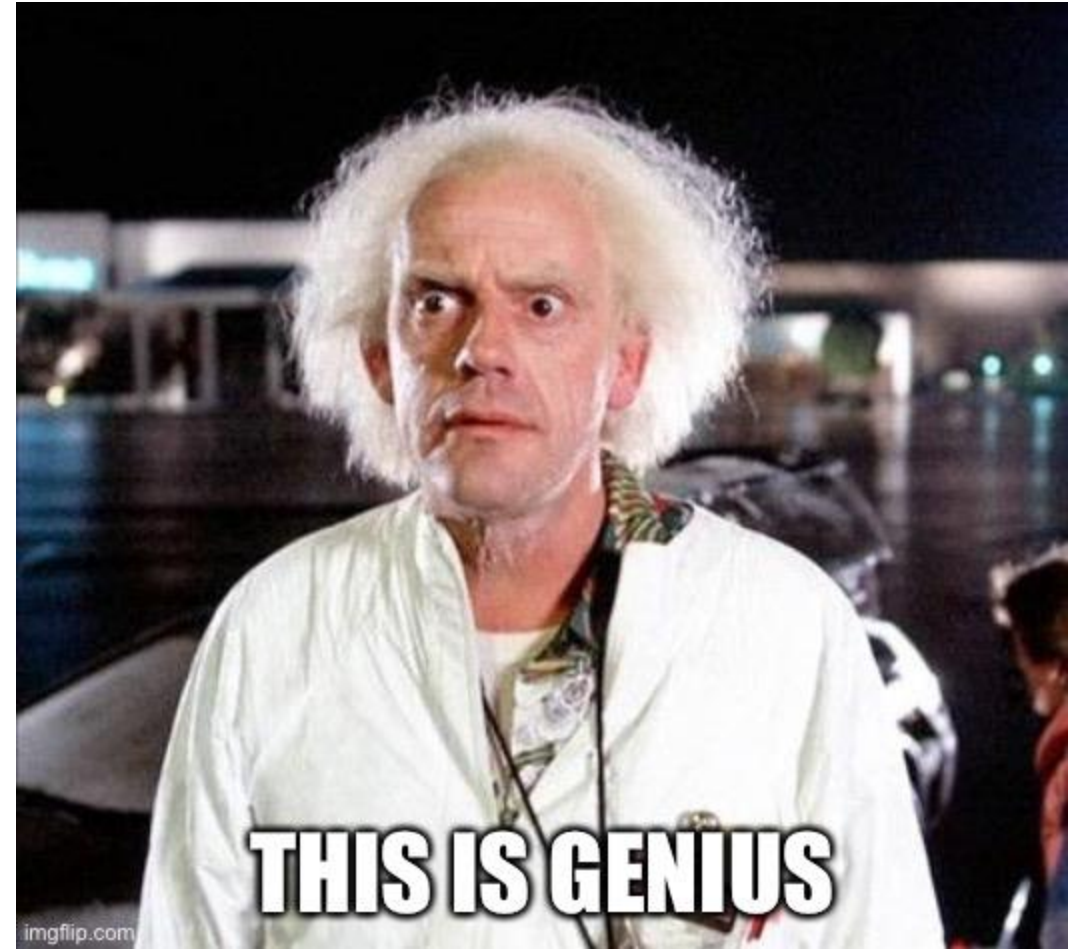
Challenge 2 Gate House

- We are 30' underwater
- Significant loads to design for
- Significant challenges for construction
- How to build?
 - Cofferdam? \$\$\$\$\$\$\$\$
 - Divers? \$\$\$\$\$\$

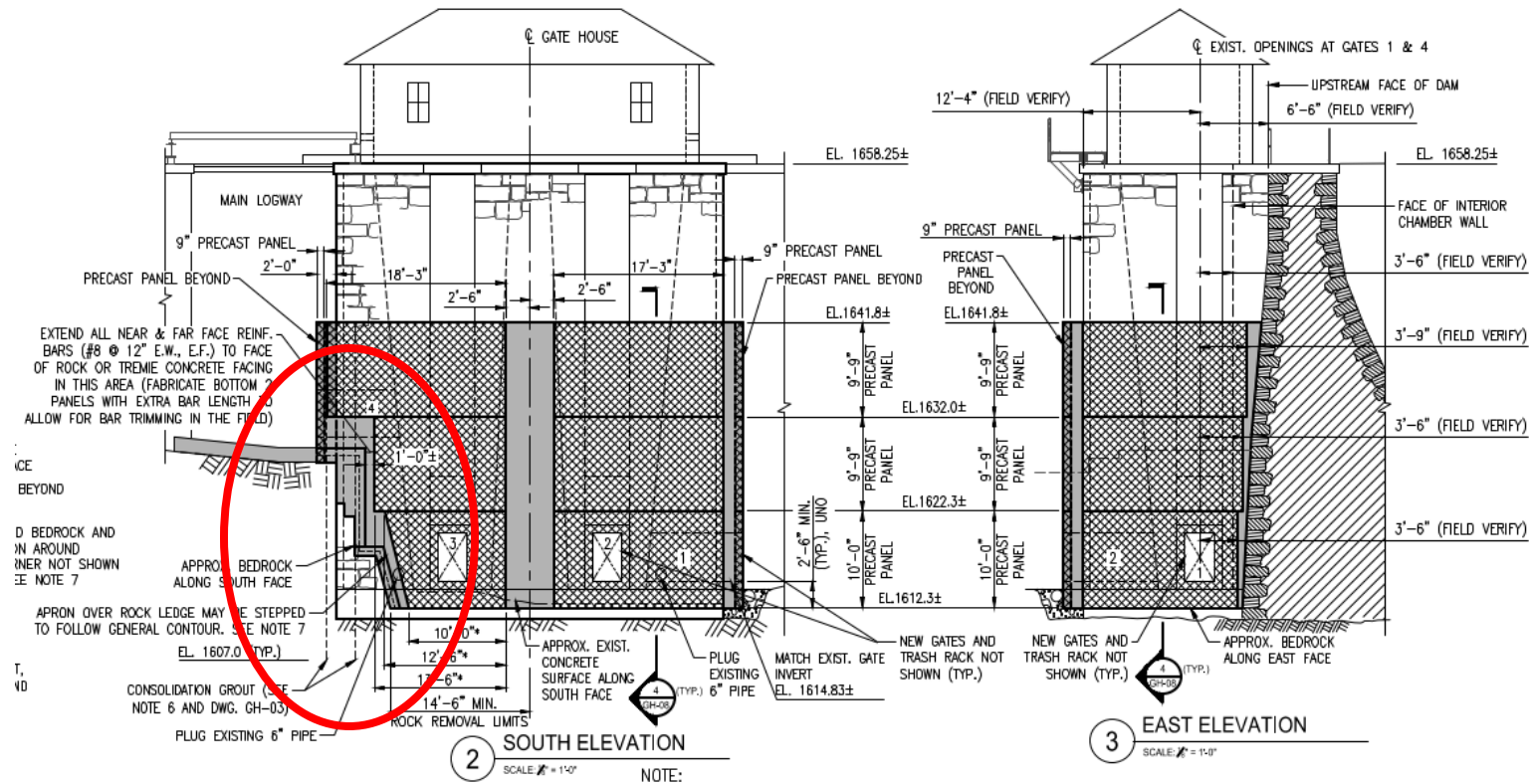


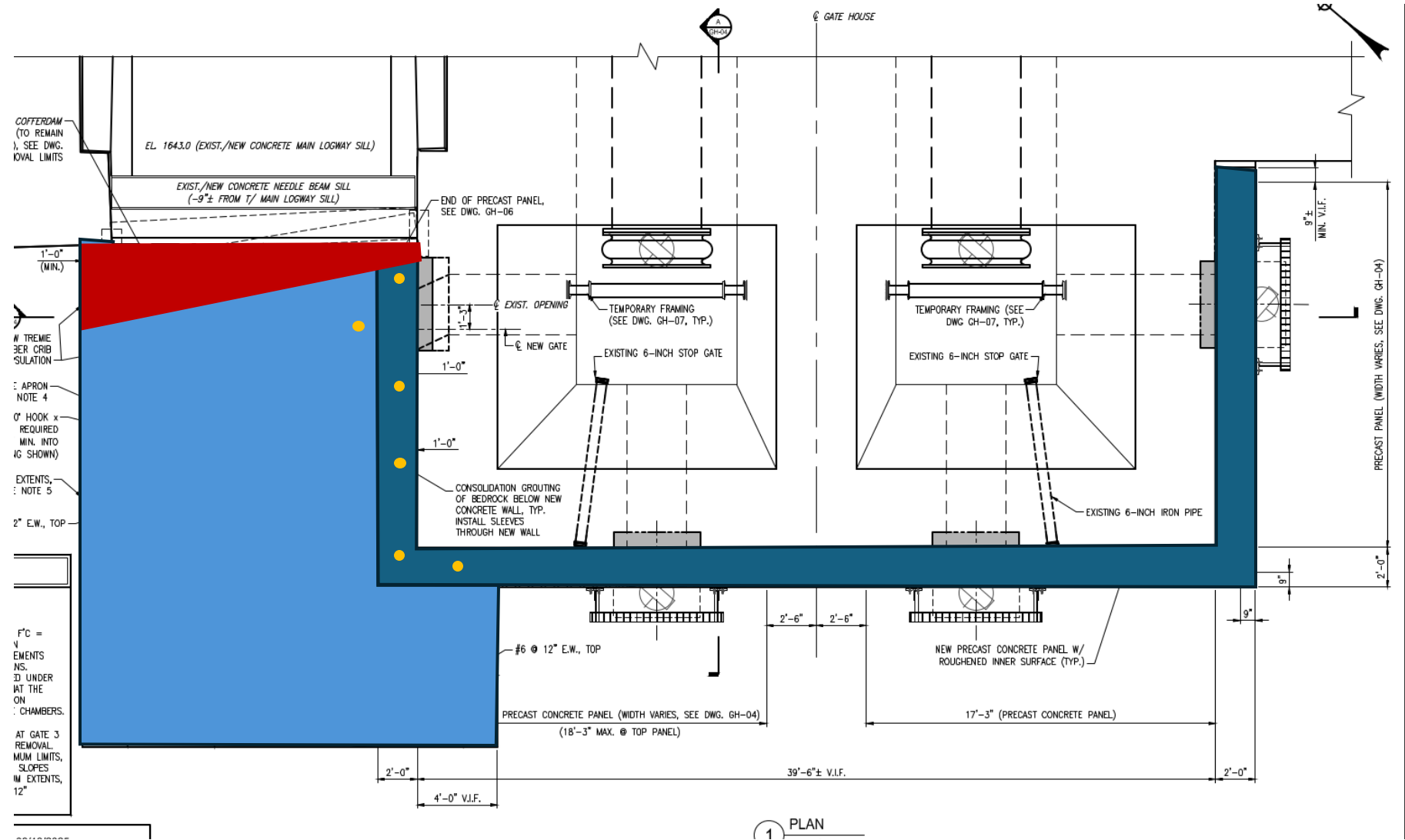
Challenge 2 Gate House

- Precast concrete forms
- Gate thimbles cast into precast
- Tie steel above water
- Set panels in place
- Tremie fill



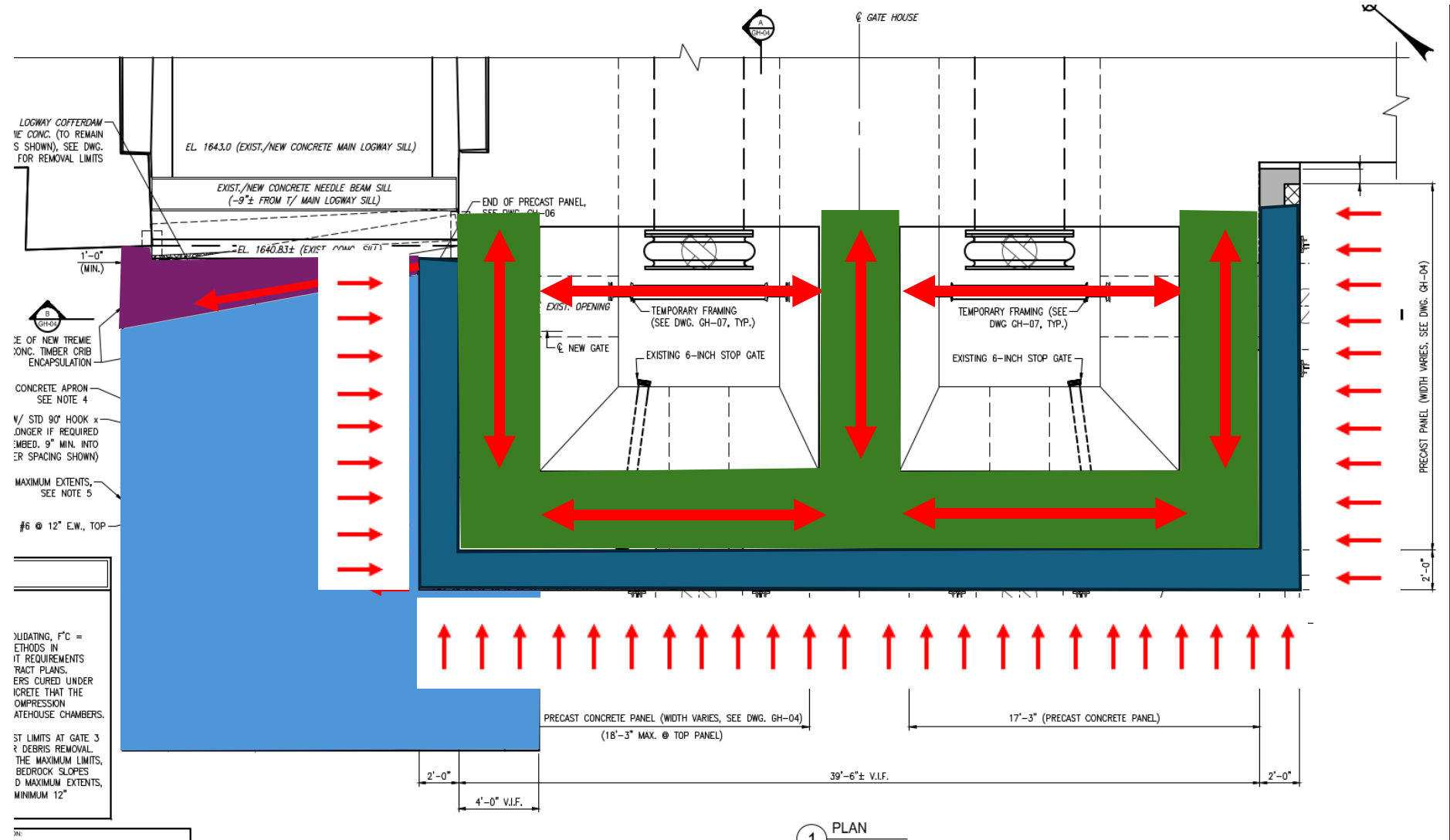
Challenge 2 Gate House



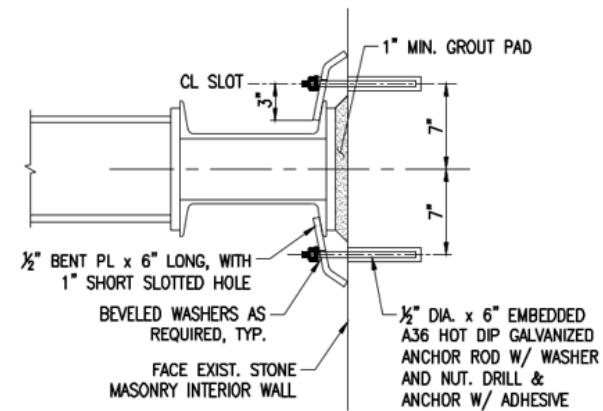
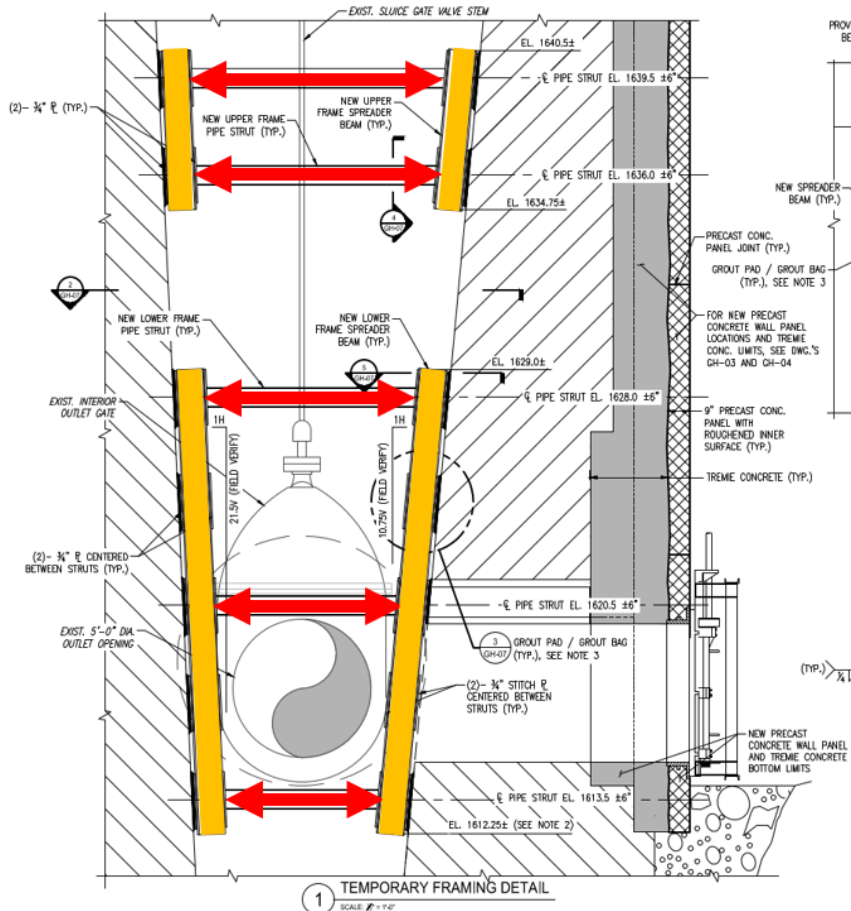


Load Distribution:

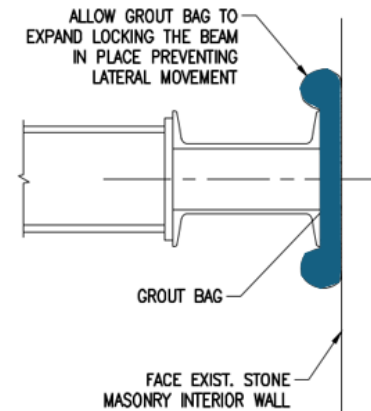
- Precast/Tremie Walls
- Existing Walls (Axial)
- Internal Struts
- Apron Slab
- Logway Wall



Internal Struts (Interim Temporary)



GROUT PAD OPTION

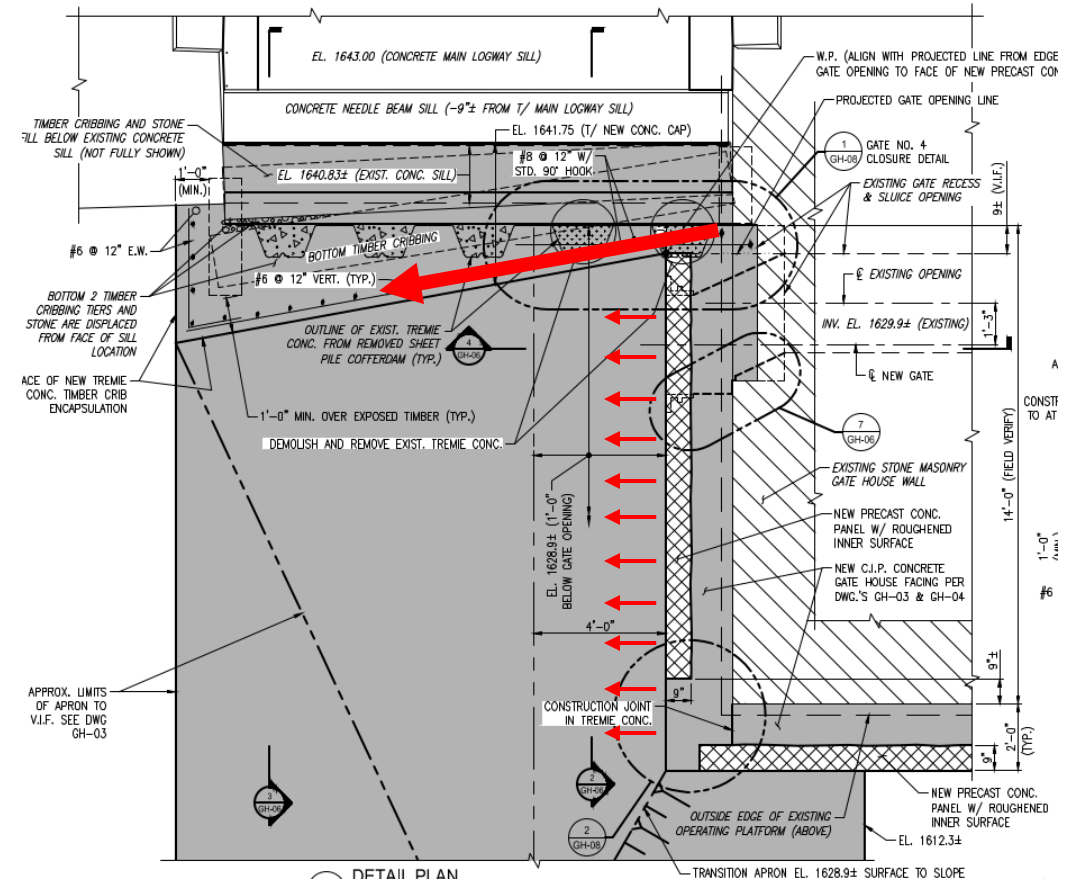
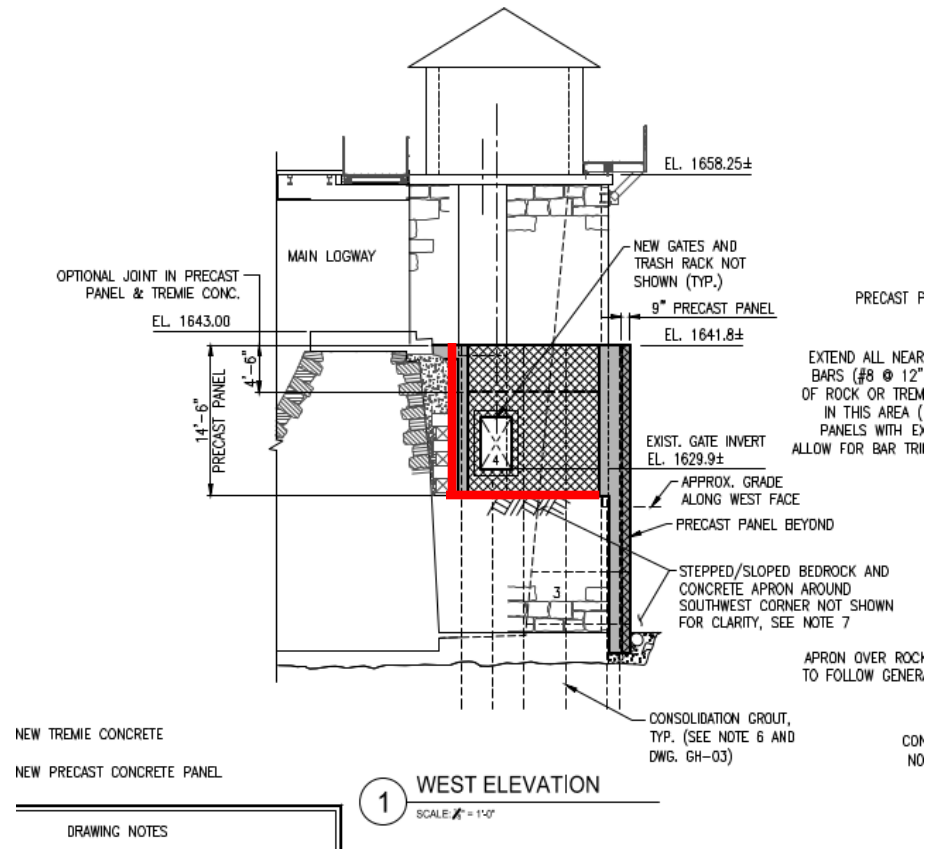


GROUT BAG OPTION

5 BEAM BEARING DETAIL (TYPICAL AT EACH STITCH PLATE LOCATION)

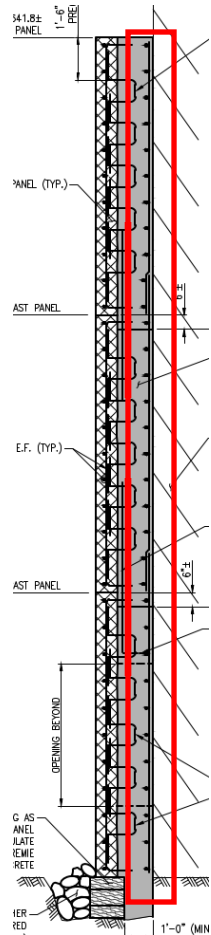
SCALE: 1/4" = 1'-0"

Logway Wall & Apron

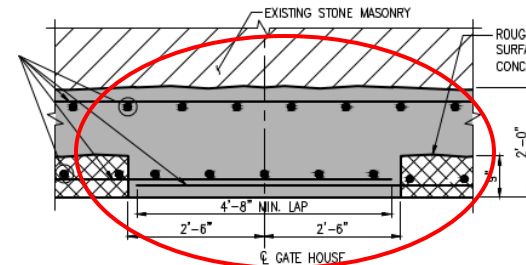
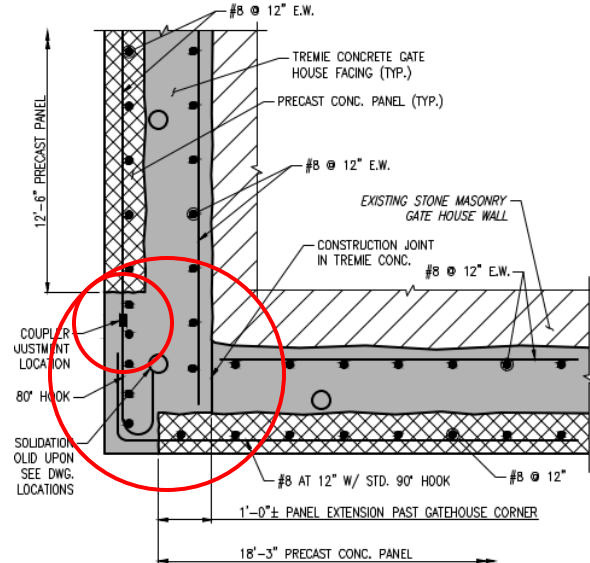


Constructability

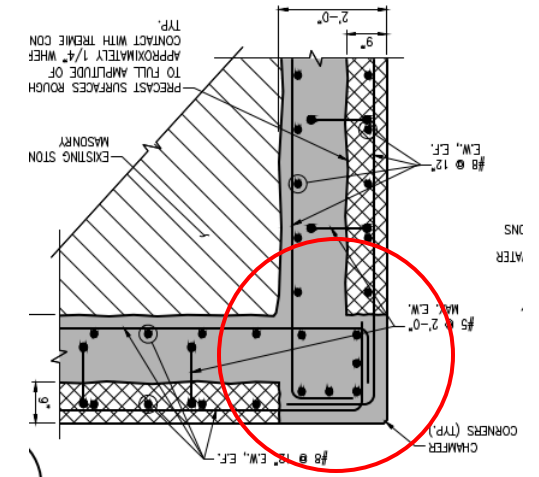
- Panels sized based on crane/barge capacity
- Panel Joints sized for lap splices & std. hooks
- Crimp-type couplers where panel location may vary somewhat
- Rear face steel continuous through joints
- Front face continuity bars at horizontal panel joints



Section



Plan









Contact Me



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Engineering
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Q&A / Discussion

