NICHOLSON

GERALD A. LEONARDS LECTURE

Application of Innovative Geotechnical Solutions

Rick Deschamps, PE, PhD, V.P. of Engineering

Jerry Leonards, my mentor, colleague and friend.

- An Innovative Engineer – a practitioner > 150 challenging consulting jobs.
- All his research began as topics that were inadequately understood in practice.
- A relentless investigator – with his Sherlock Holmes approach to failure investigations.
- Unquenchable thirst for understanding.
- Brusque and intimidating to some people.
- Long running debate-based correspondence with many of his peers.
- He taught that models are imperfect tools that guide us – not reality. Our judgement was critical.

Outline

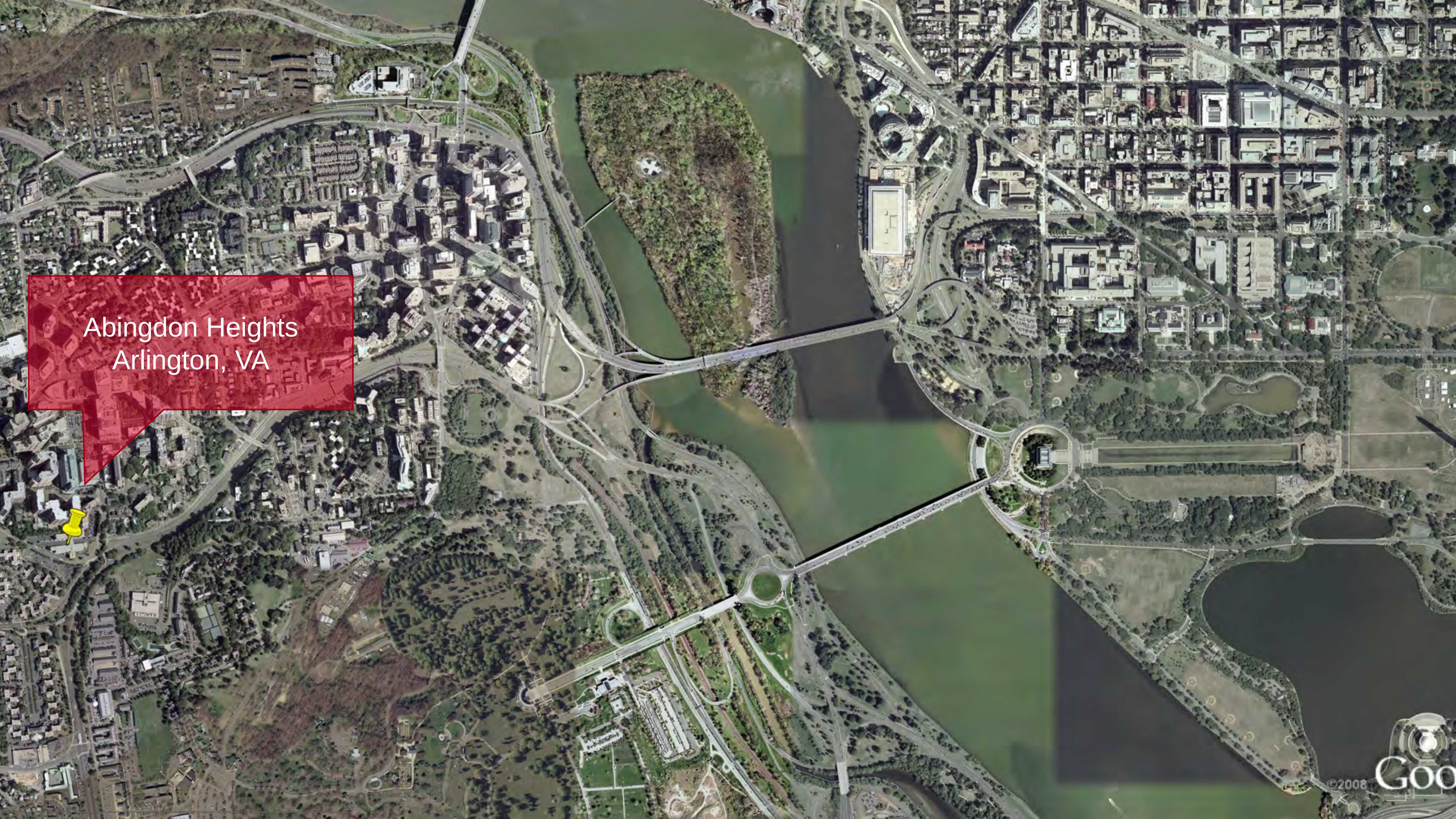
- Perquisites for Innovative Design
- Case Histories
    - Abingdon Heights Cantilever Wall
    - Crookston Slope Stabilization
    - Portland CSO Storage Structure
    - Prairie du Sac Dam Rehabilitation

Innovative Design Generally Requires:

- A motivated owner: significant reductions in cost, schedule or risk,
- An uncommon problem, where the best solutions have not yet evolved,
- Sufficient and reliable information,
- Enough time to really explore various options,
- Analytical tools, often numerical modeling, to provide credibility to the approach, and
- The eagerness and confidence to try something new.

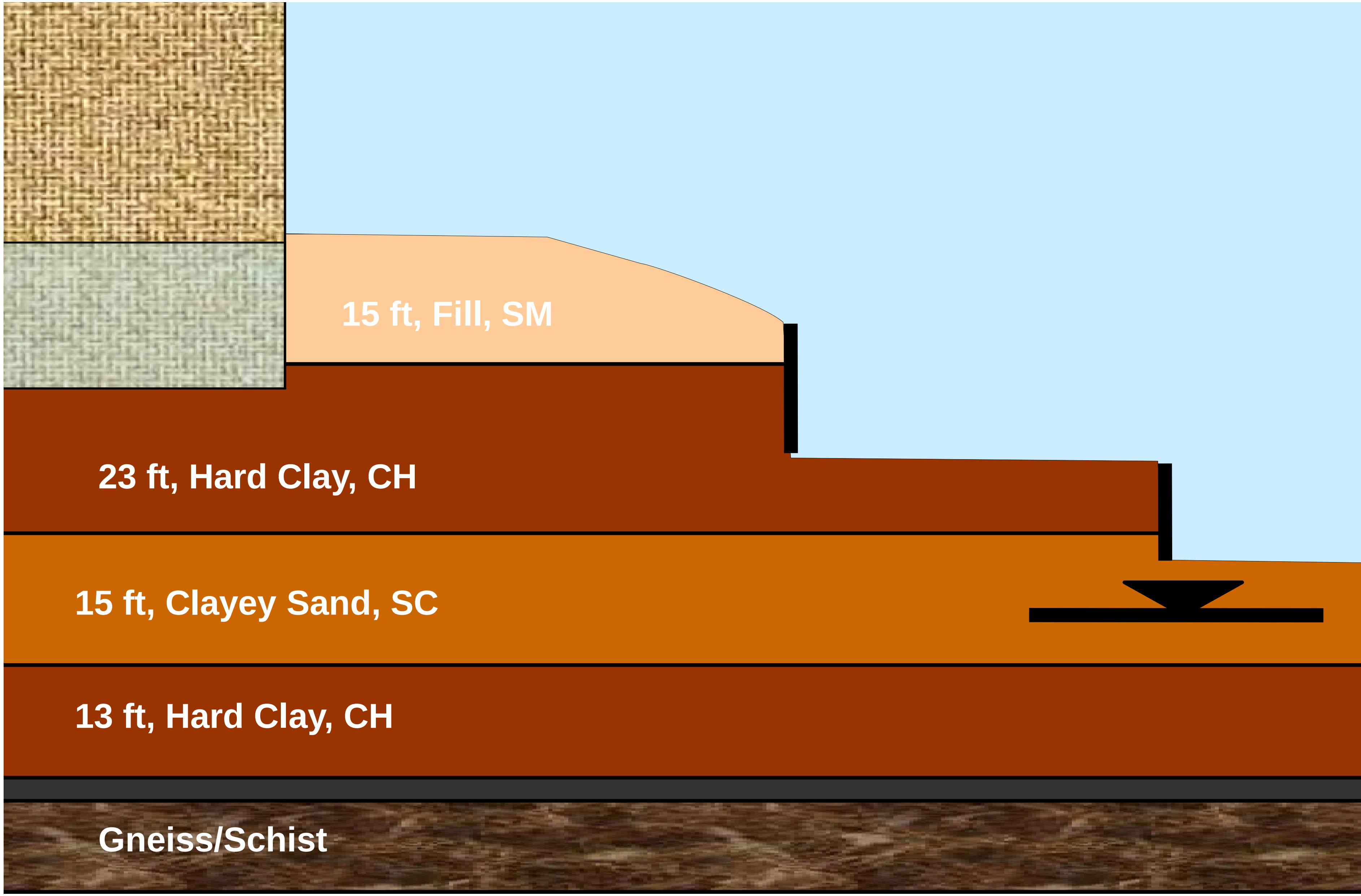
Pete Nicholson, RIP - Eagerness to try something new.

Abingdon Heights, Arlington VA - 48.5 ft Cantilever Wall


Abingdon Heights
Arlington, VA

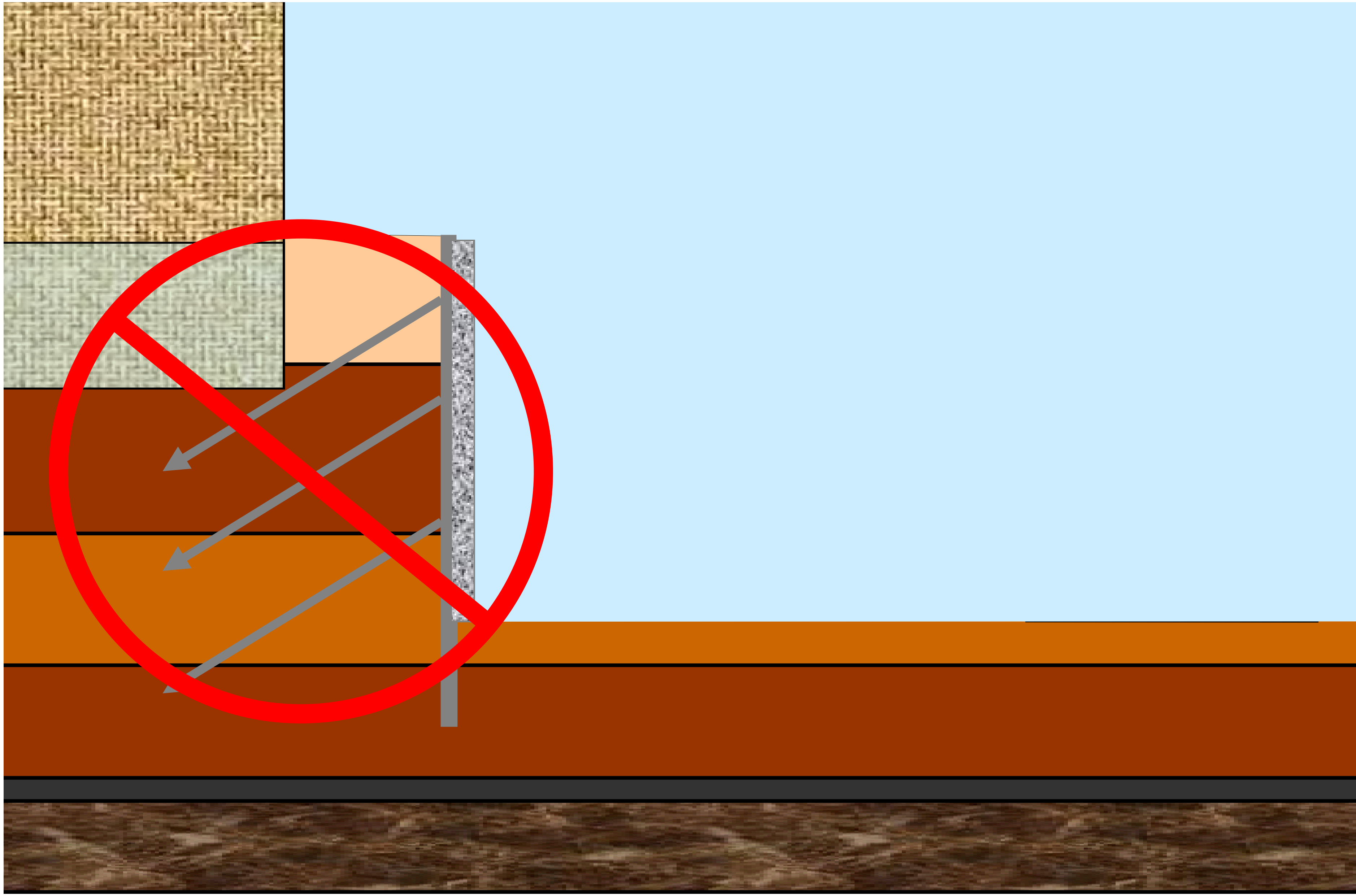
13th St N
230'
N Courthouse Rd
N Troy St
195'
175'
12th Ct N
Arlington Blvd
185'
Arlington Boulevard Trail
50
175'
~ 20' Excavatiion
Fairfax Dr
11th St N

Geotech Profile

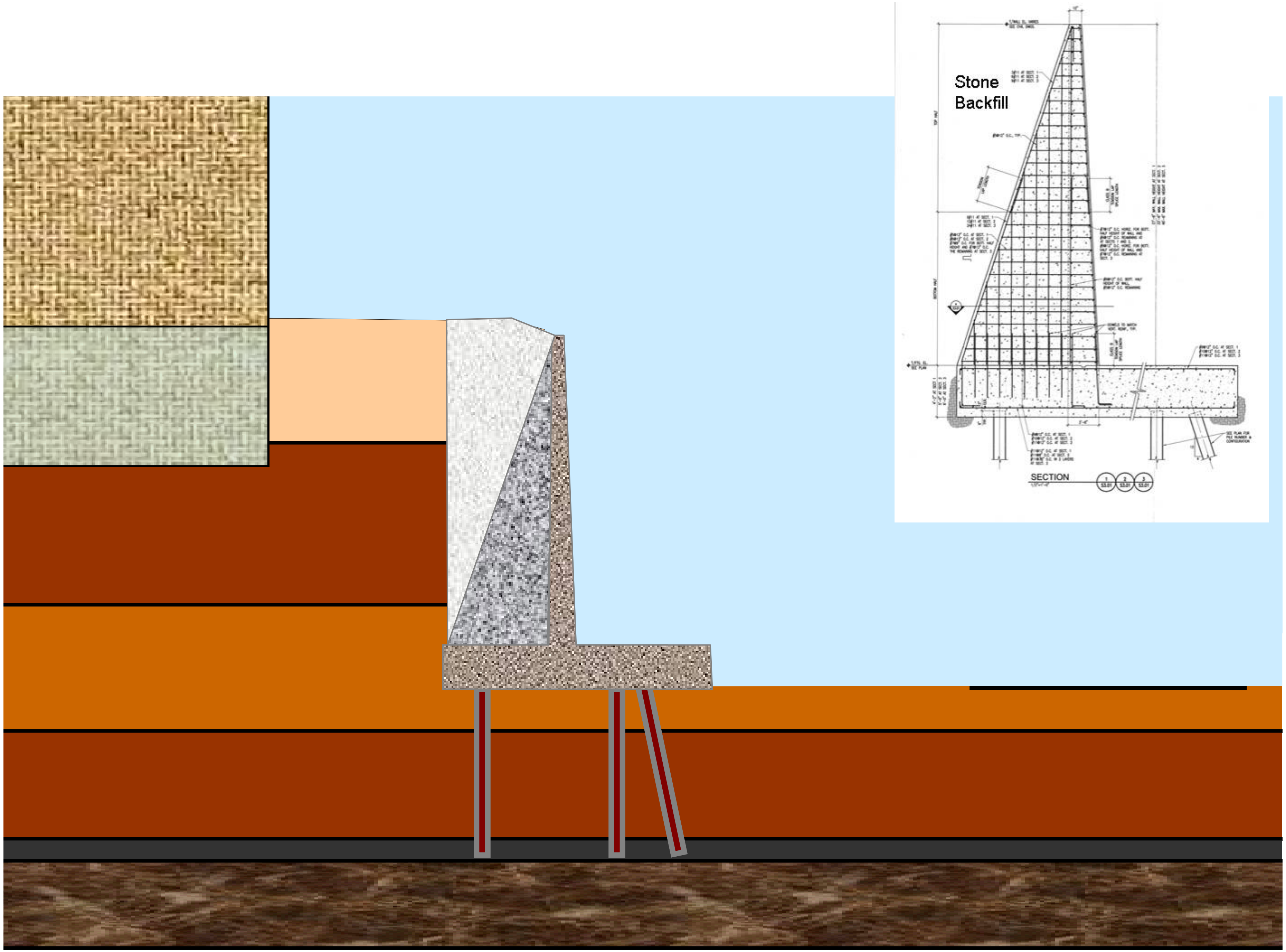


Design Concepts

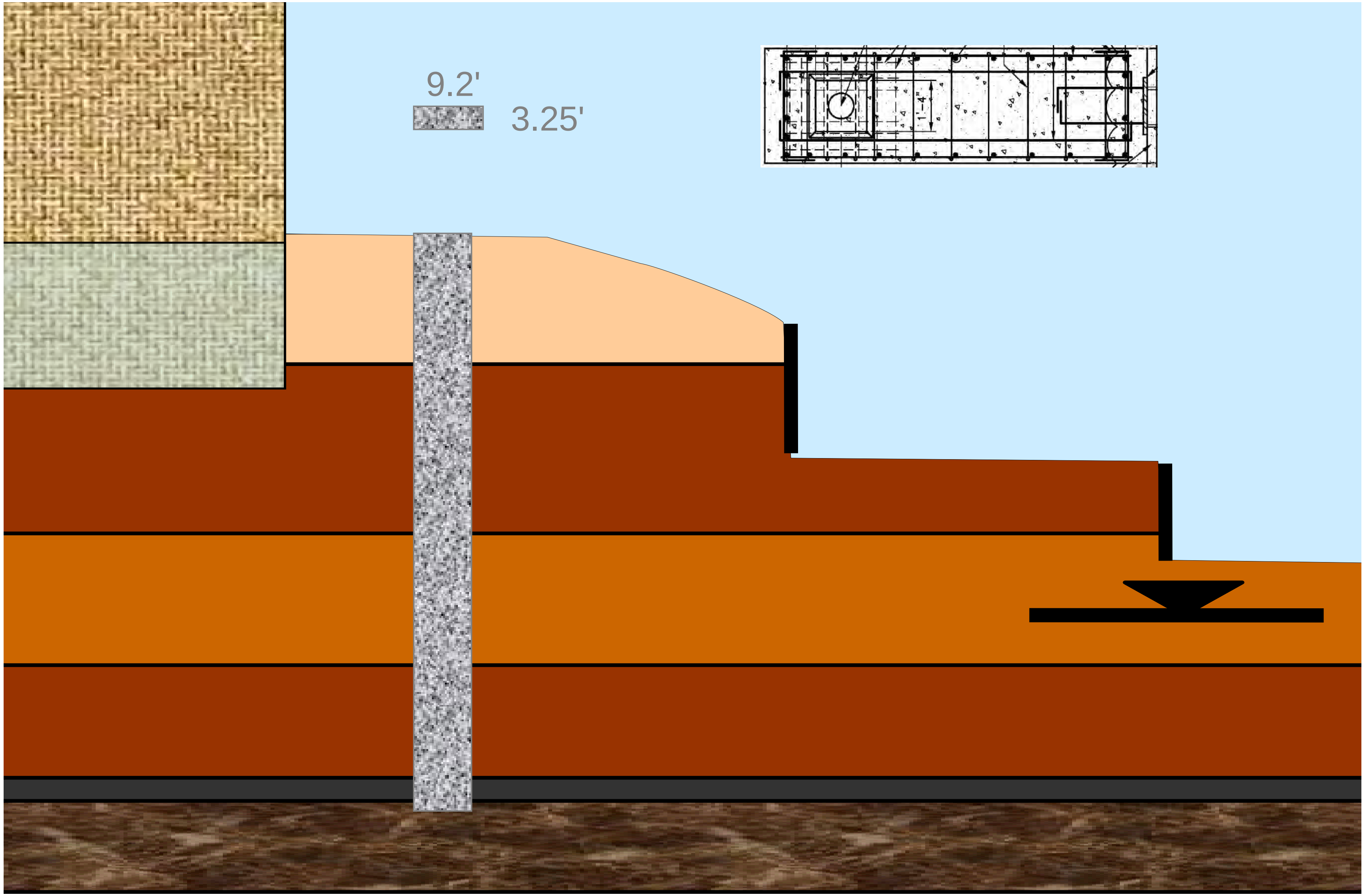
Most Economical Design



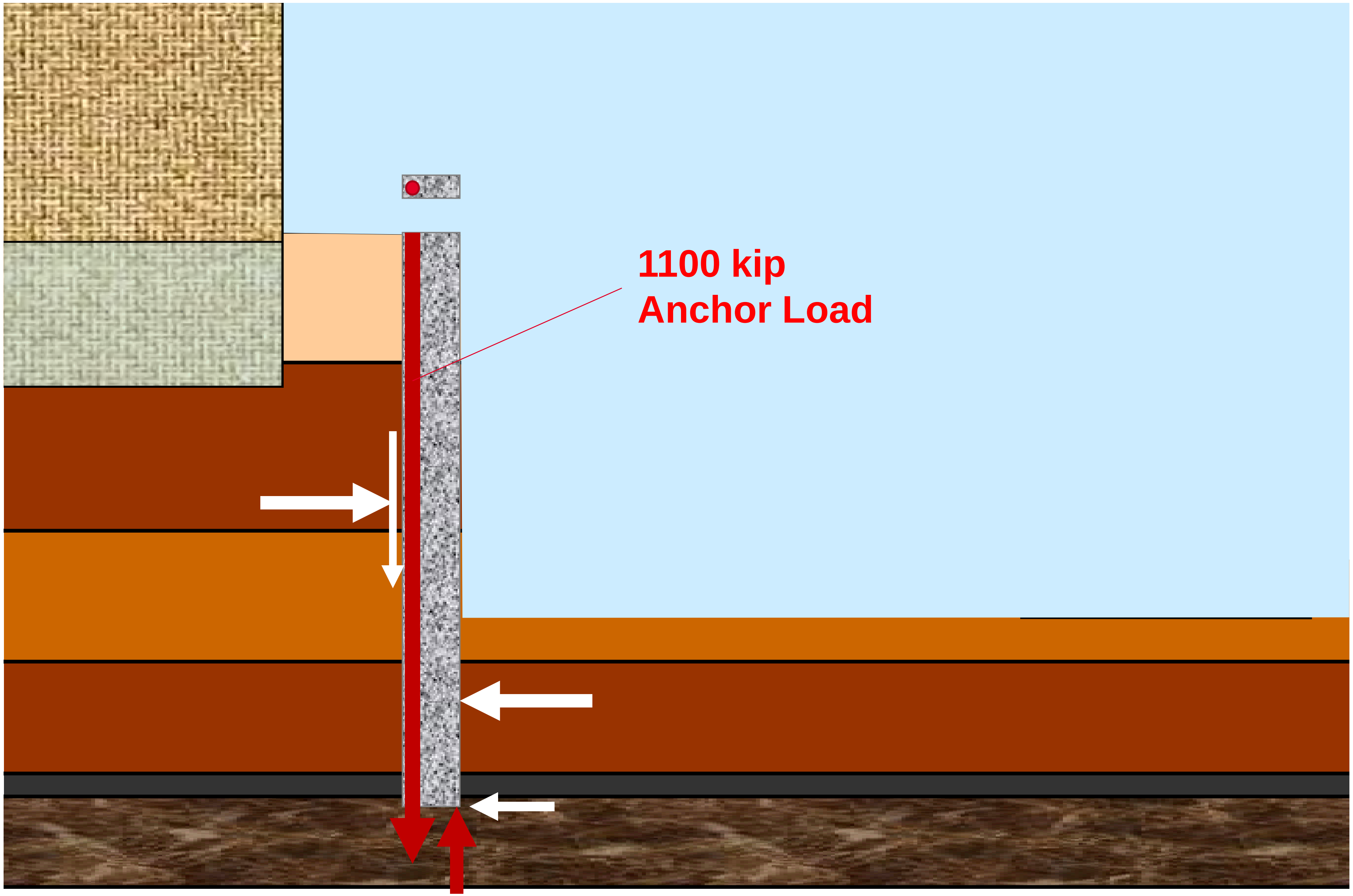
Original Design



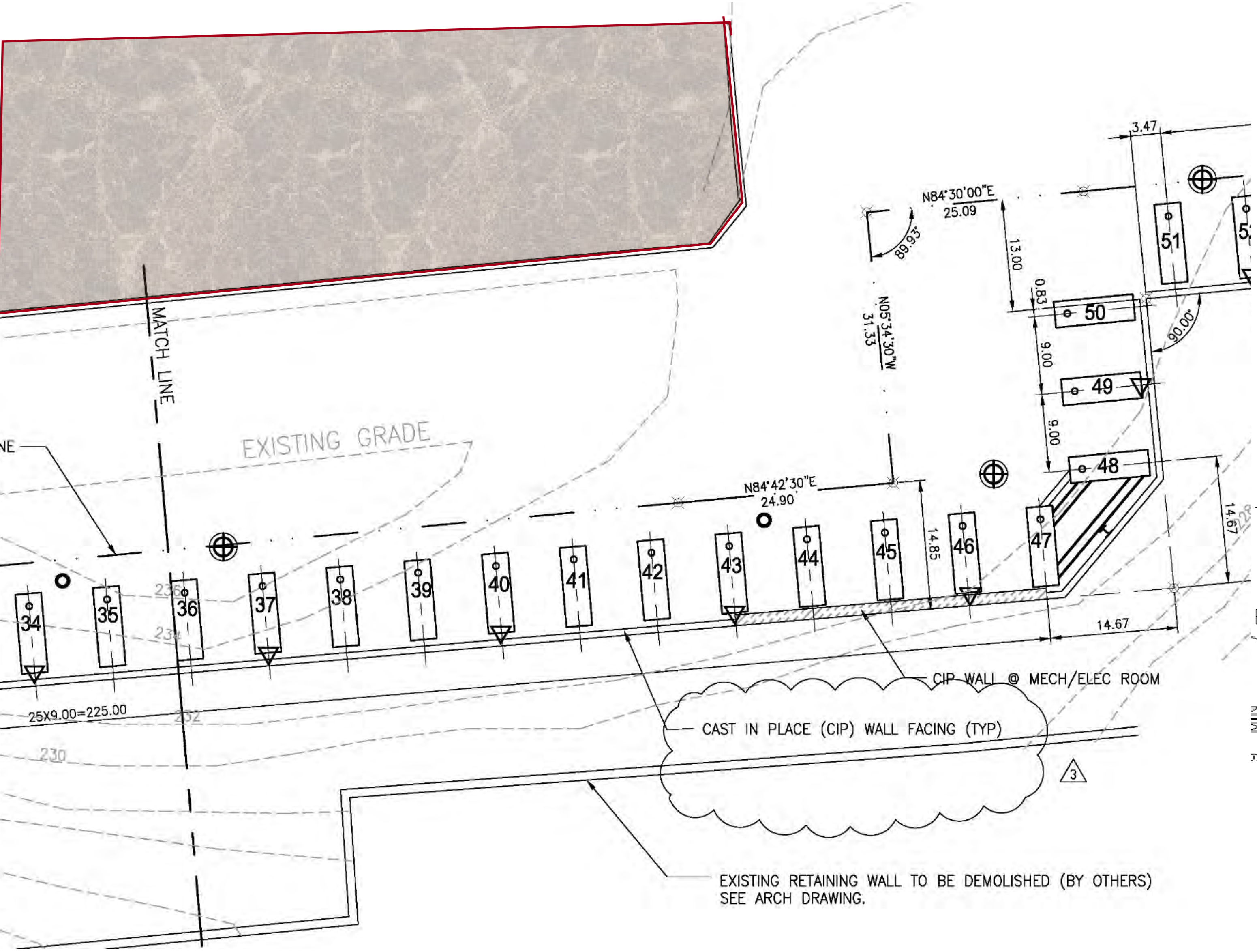
Alternative Design

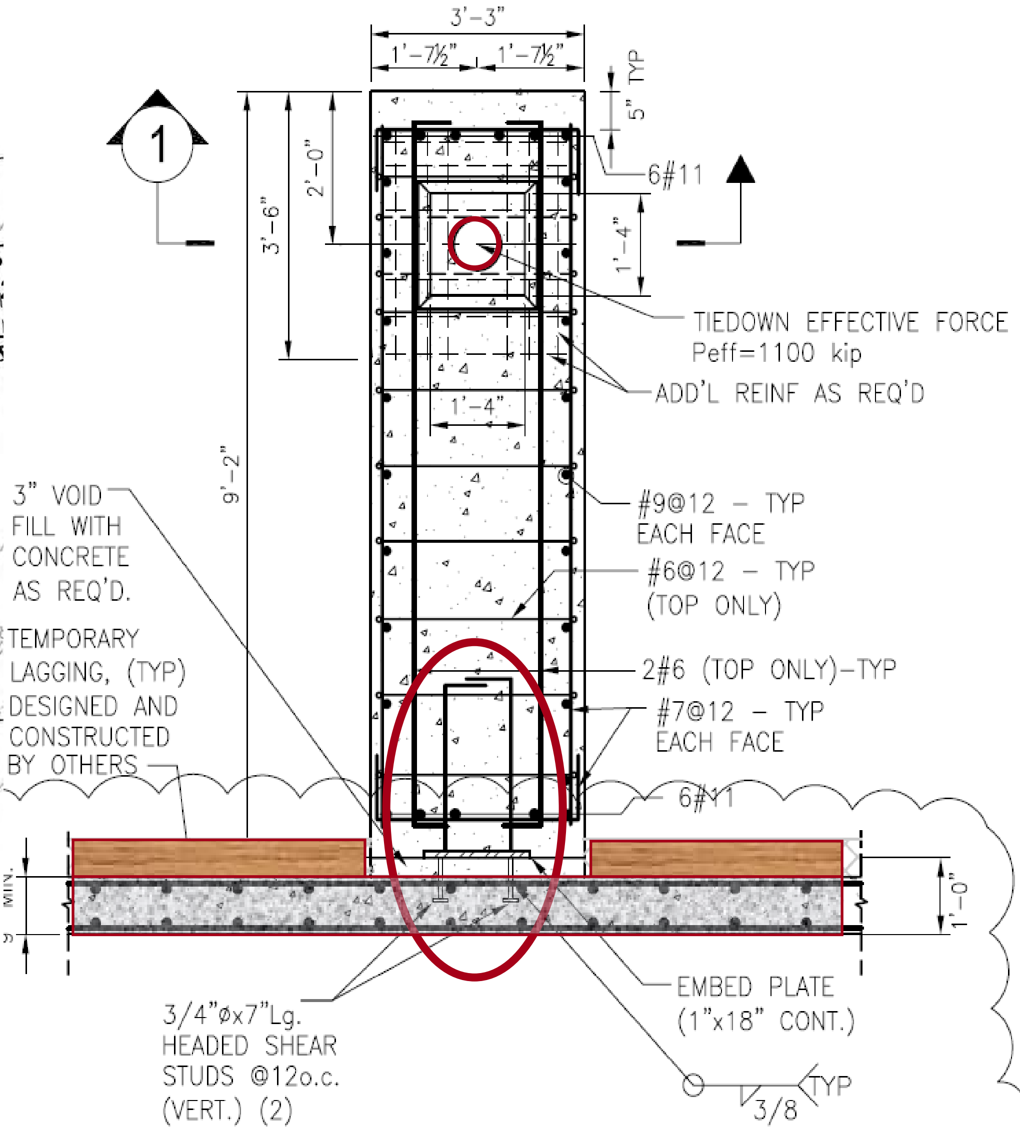


Alternative Design



Barrette Layout





Construction Phase

Stable Work Platform

Excavation

Excavation

Setting Cages

Setting Cages

Concreting

Concreting

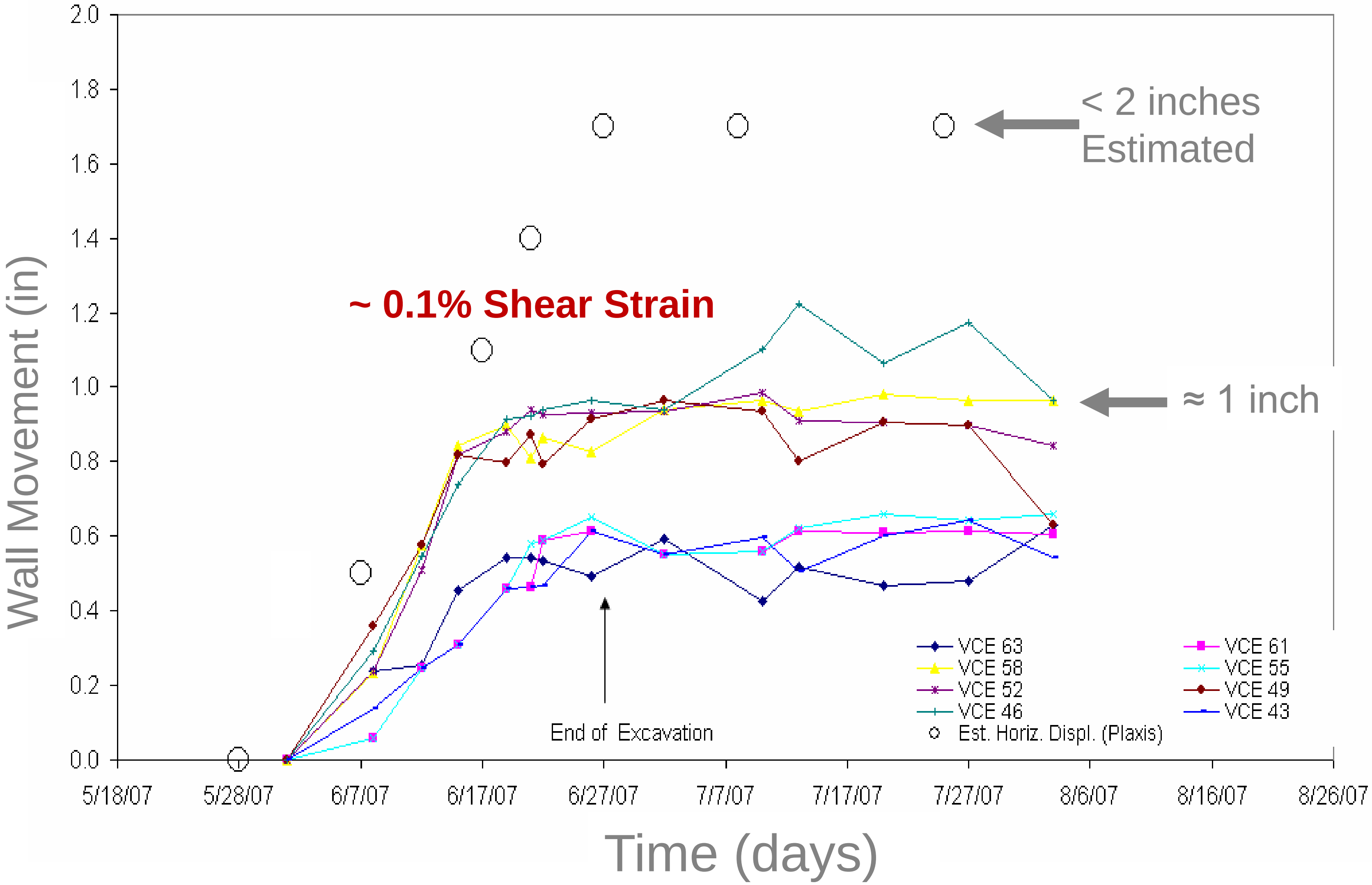
Tie- Down Anchors

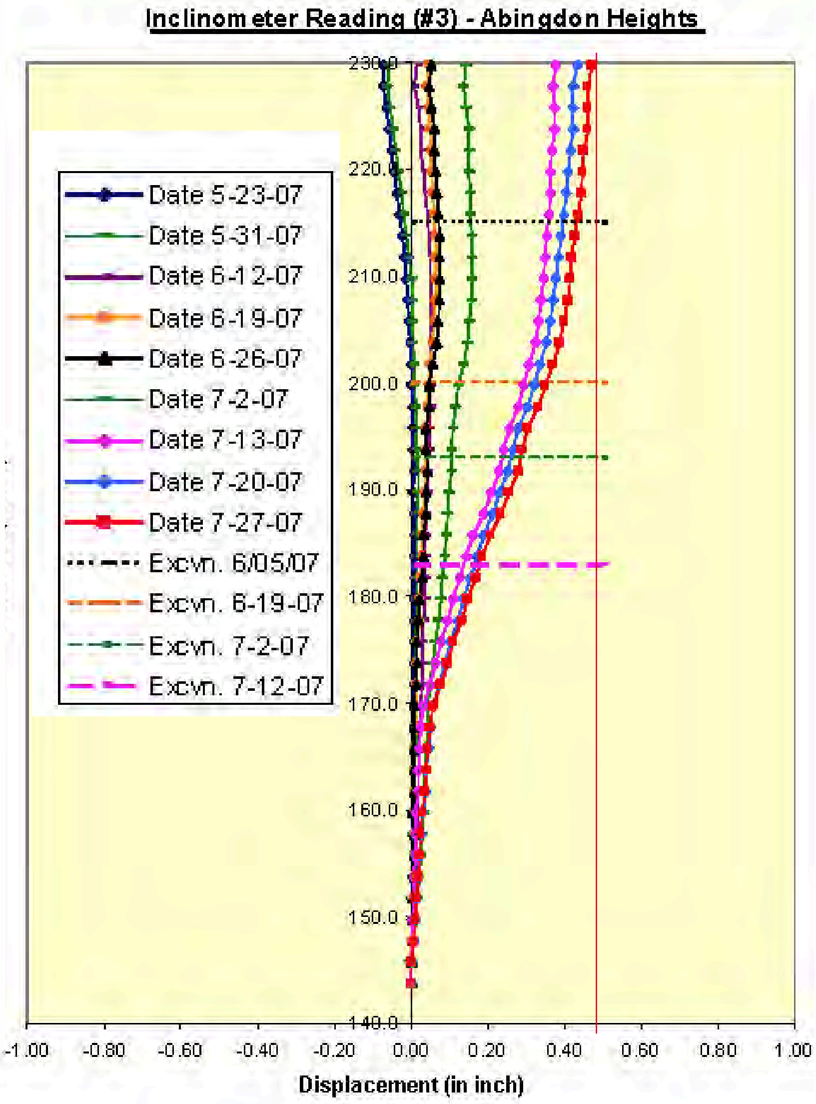
Anchor Stressing

Lagging and Drainage

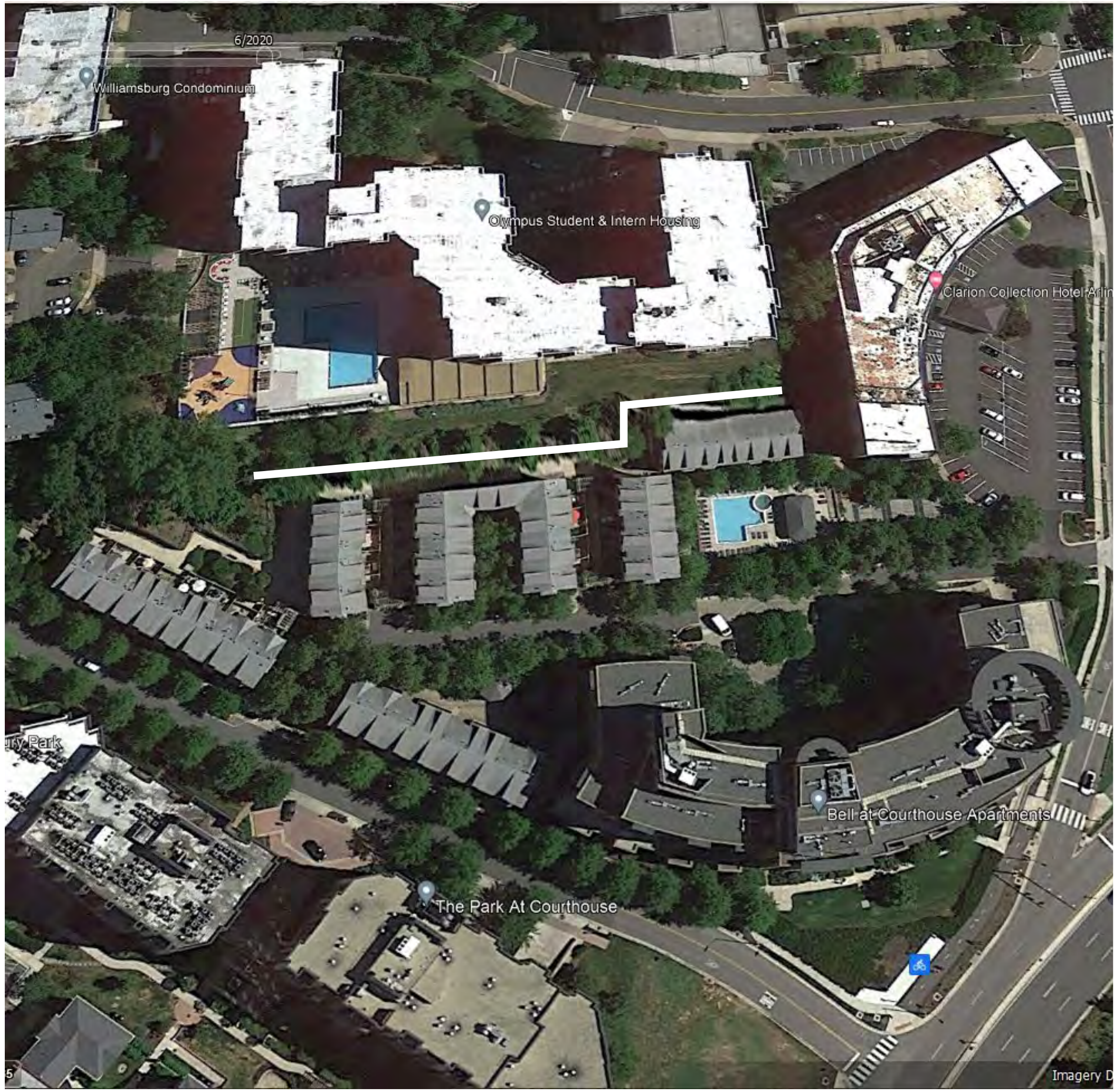
Cast-in-Place Concrete Facing

Monitoring Results





Final Conditions



Crookston, MN – Slope Stabilization

State Highway #2

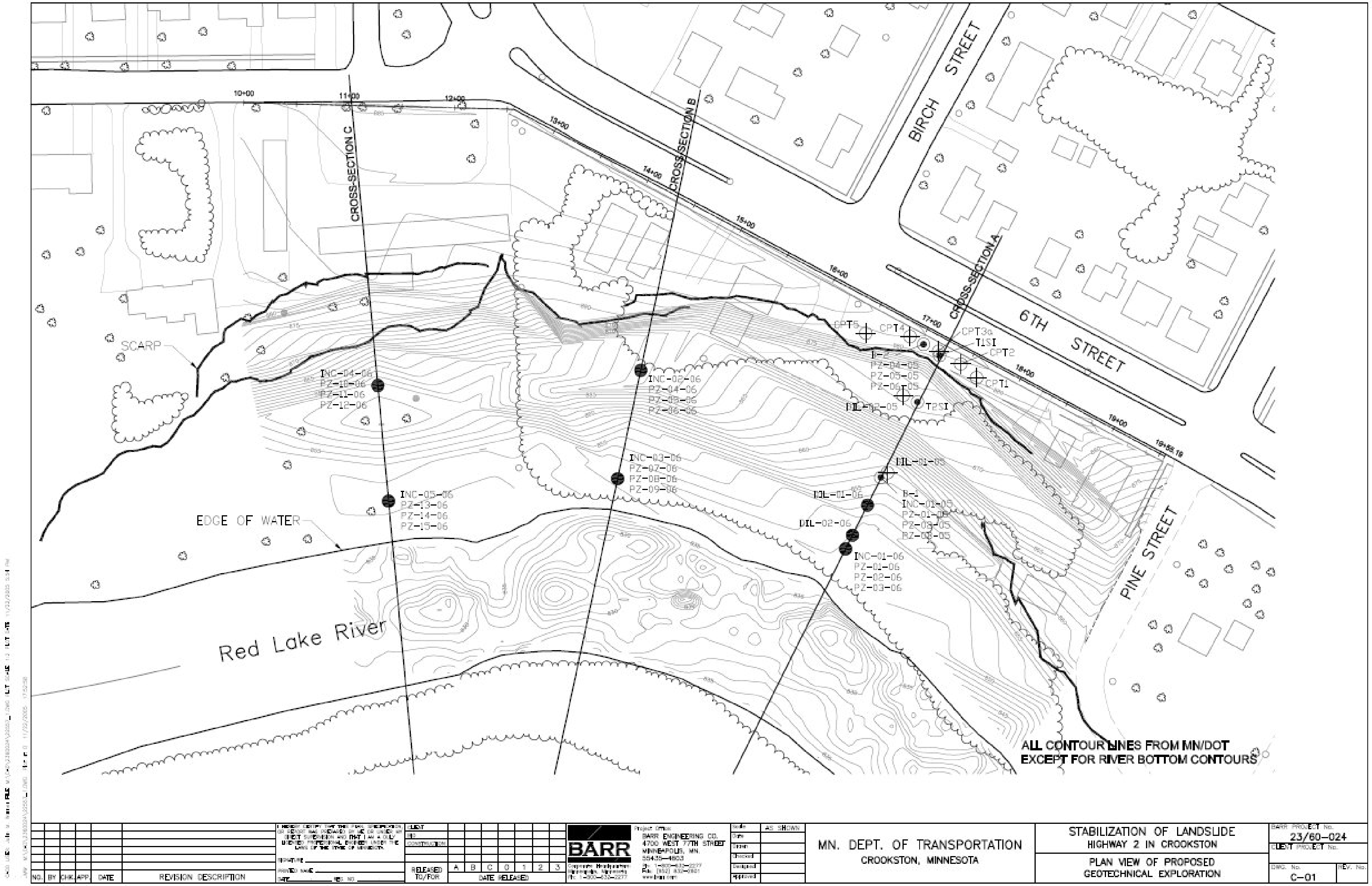
Moving Slide Threatening the Highway

1934 Slide

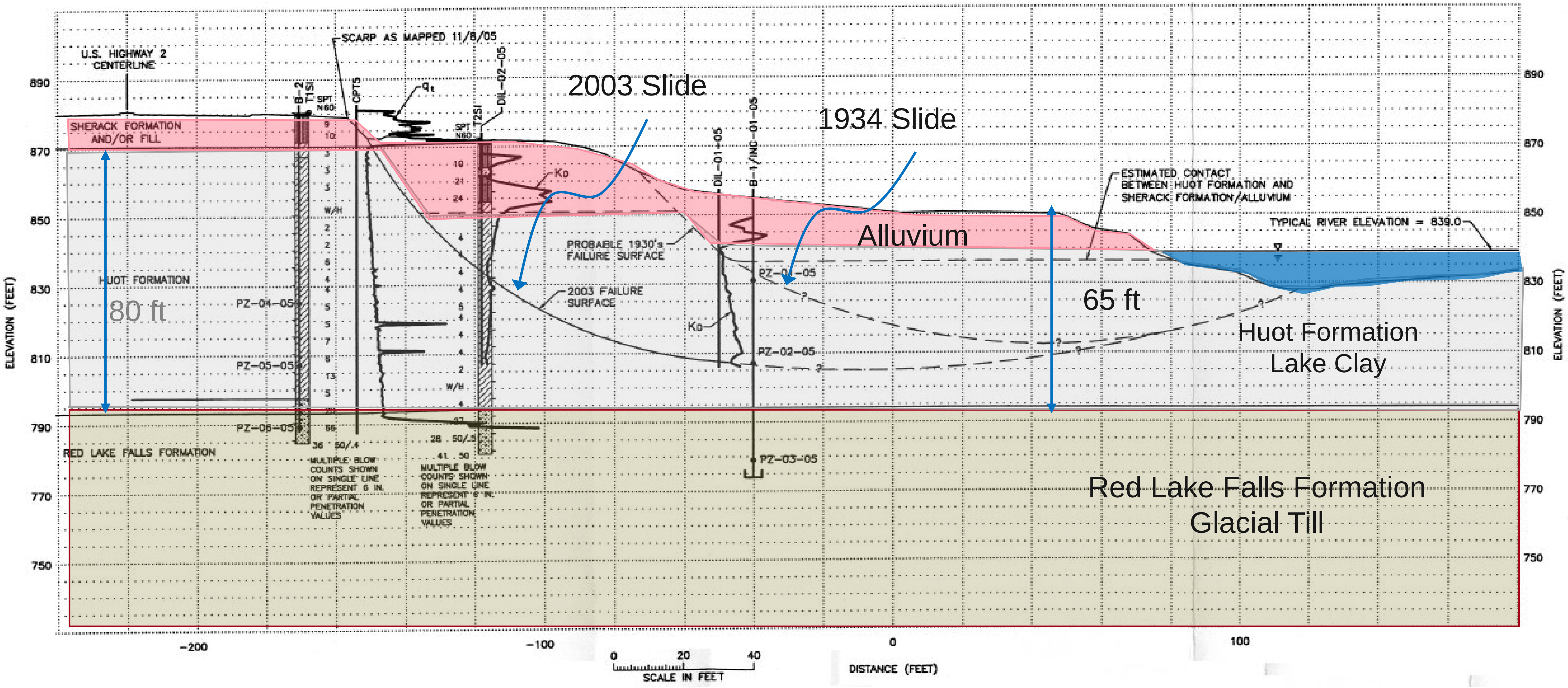
The 1934 DARKOW Landslide in Crookston, Minnesota — The Green Gables tourist center was established here by Paul and Dwight Darkow, later proprietors of the Country Club Motel, located in the same area. As picture indicates some of the Green Gables "took a drop."


2003 Slide

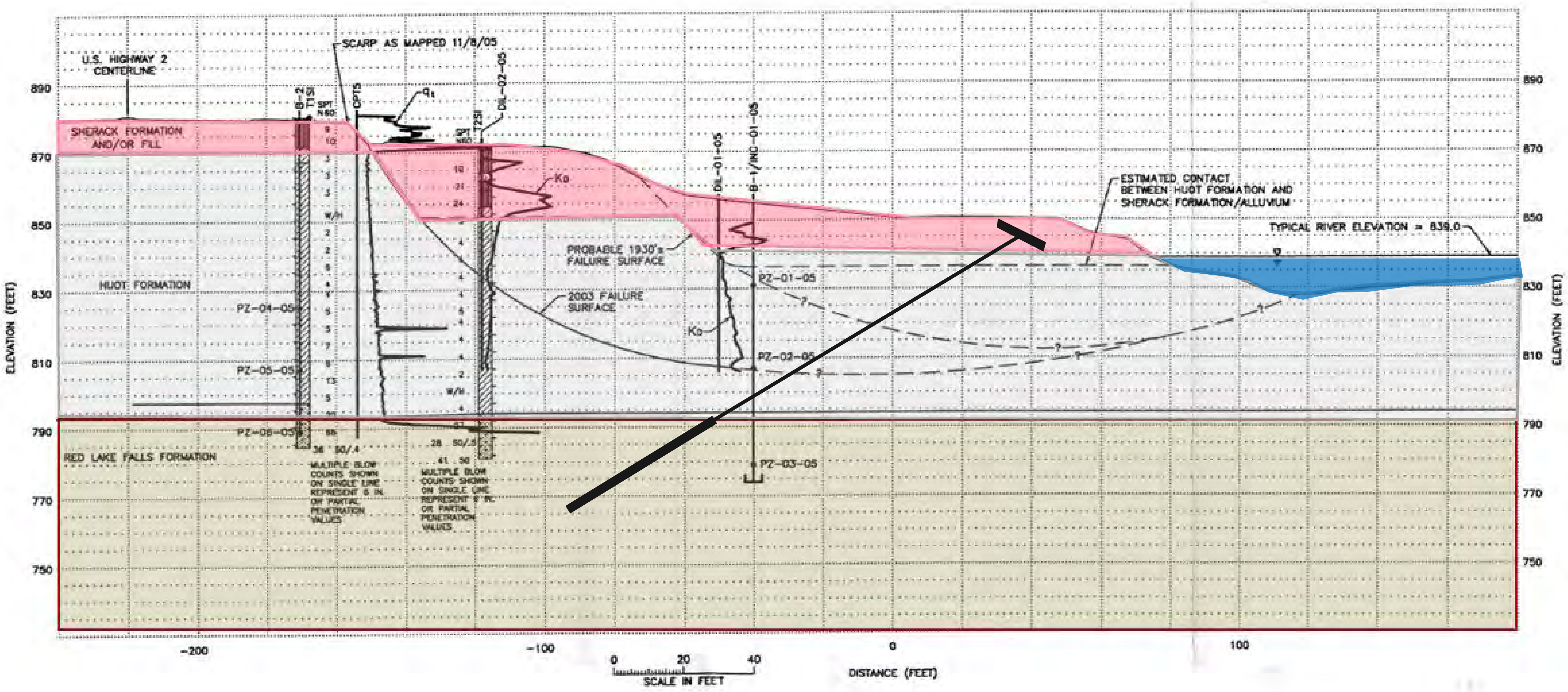
2004 Study by Barr Engineering



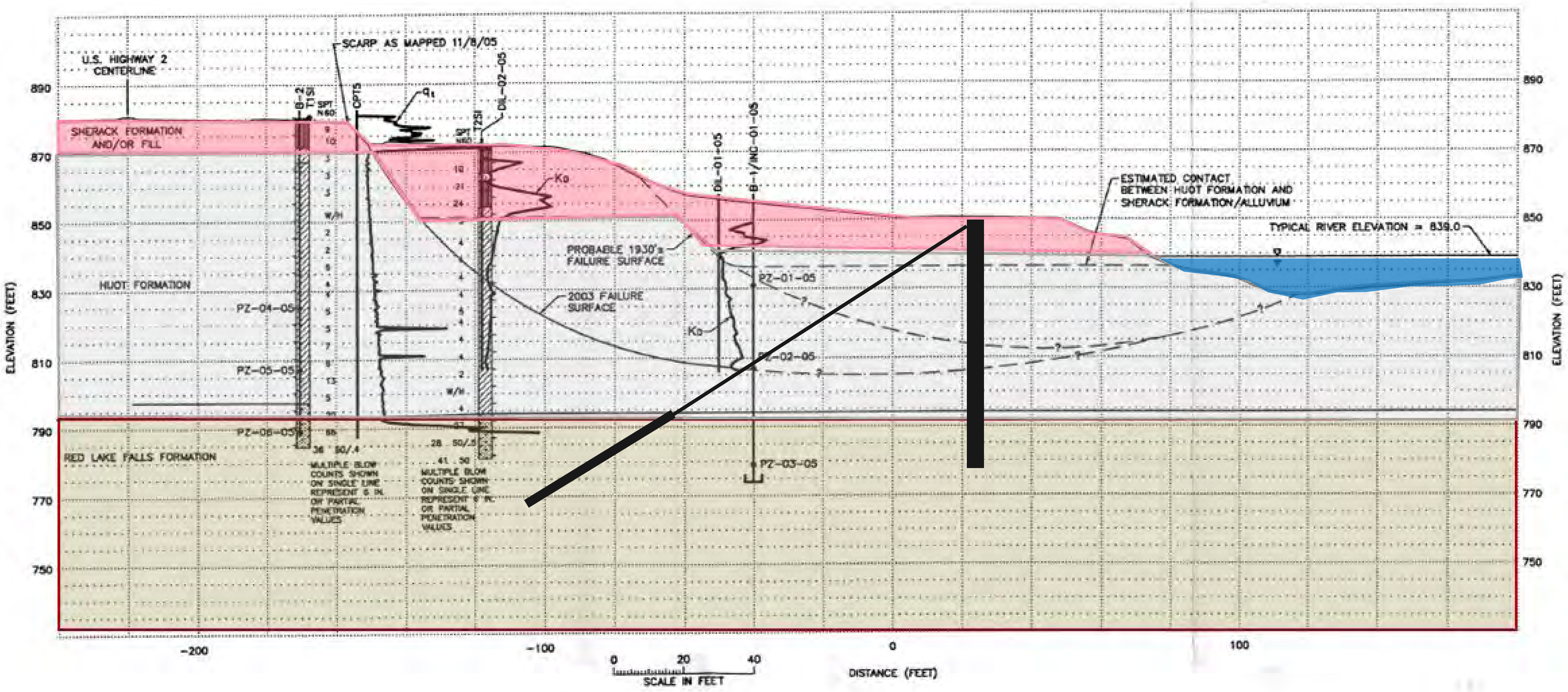
Cross Section “A”



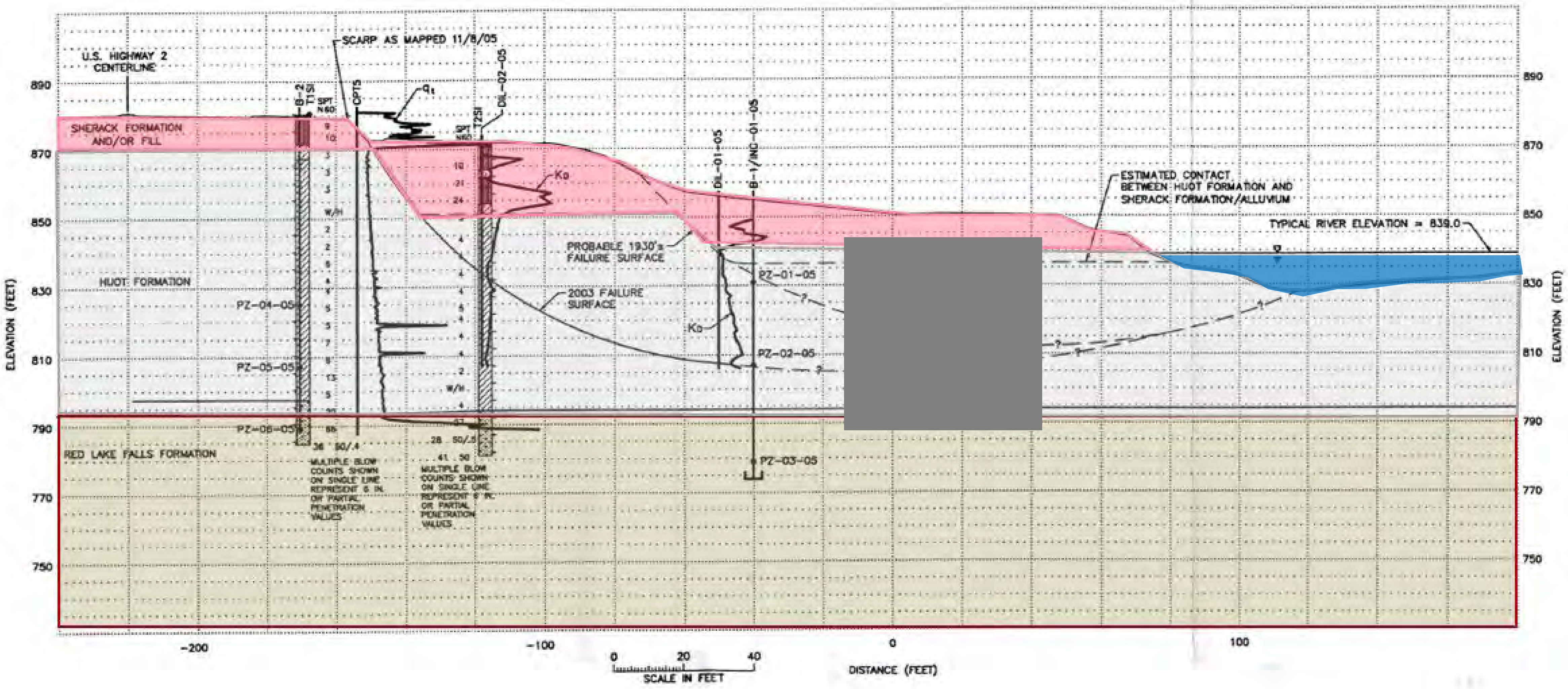
Stabilizing Methods Considered – Anchored Blocks



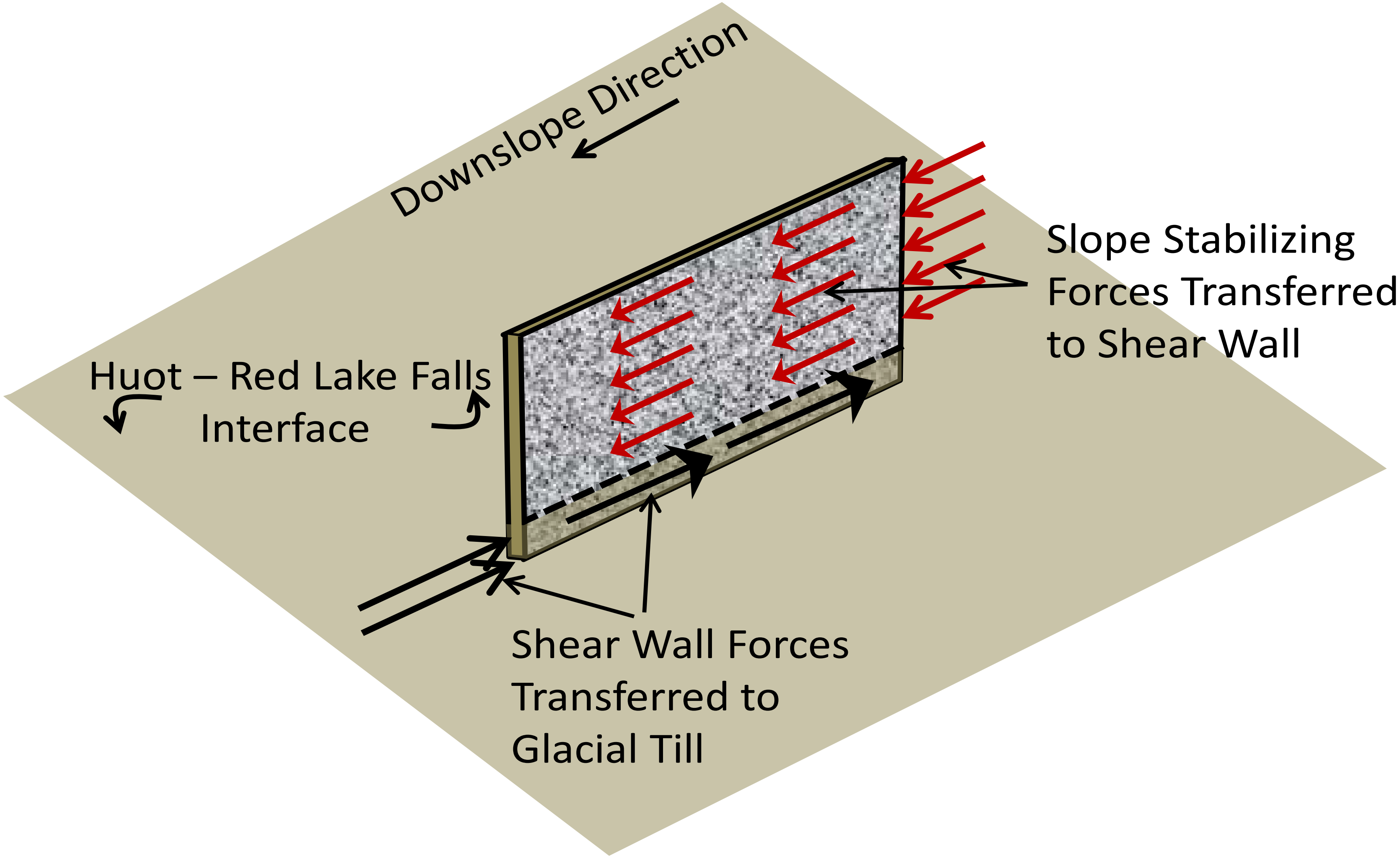
Stabilizing Methods Considered – Large Piles



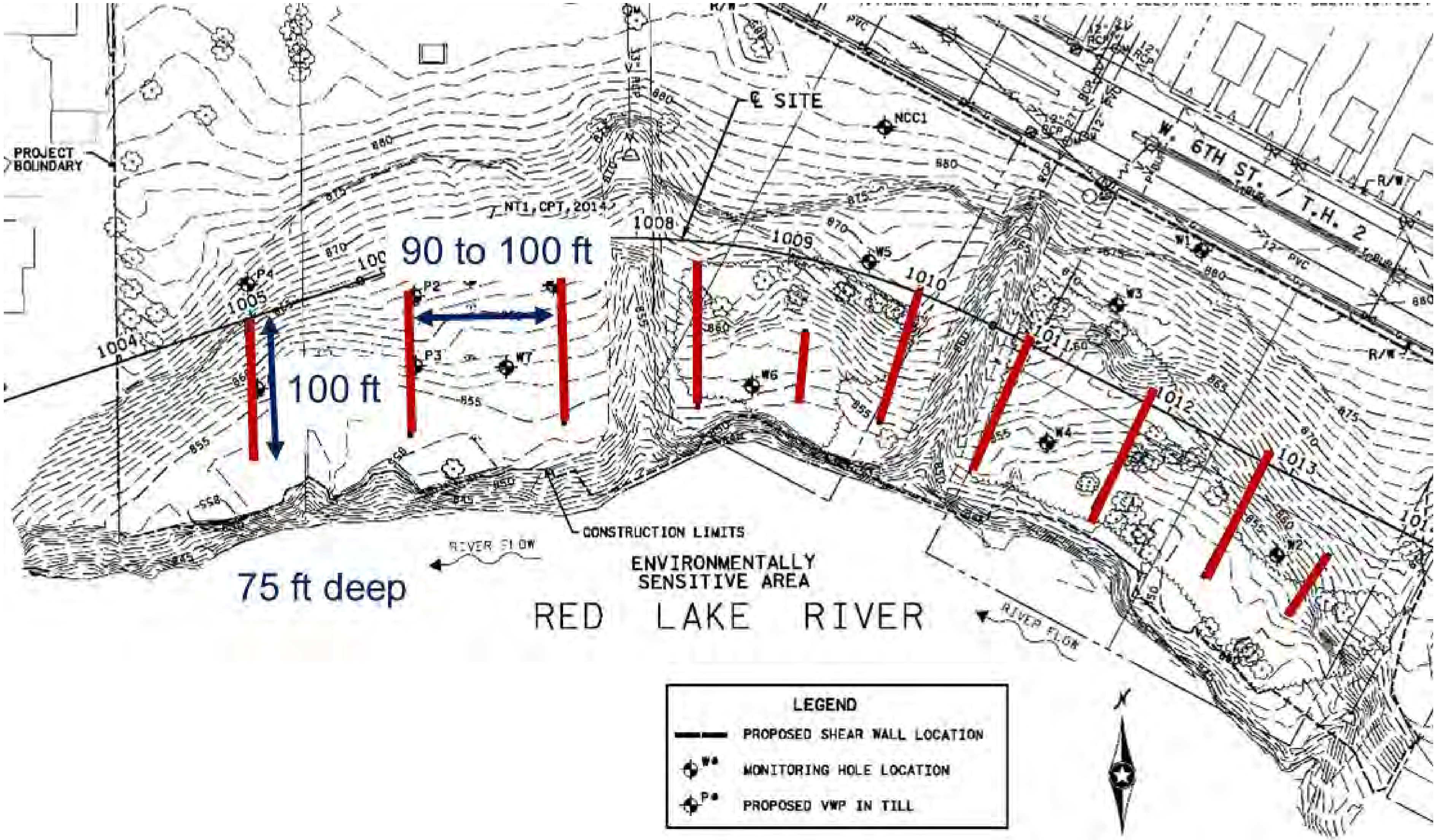
Stabilizing Methods Considered – Shear Walls



Load Transfer Mechanisms

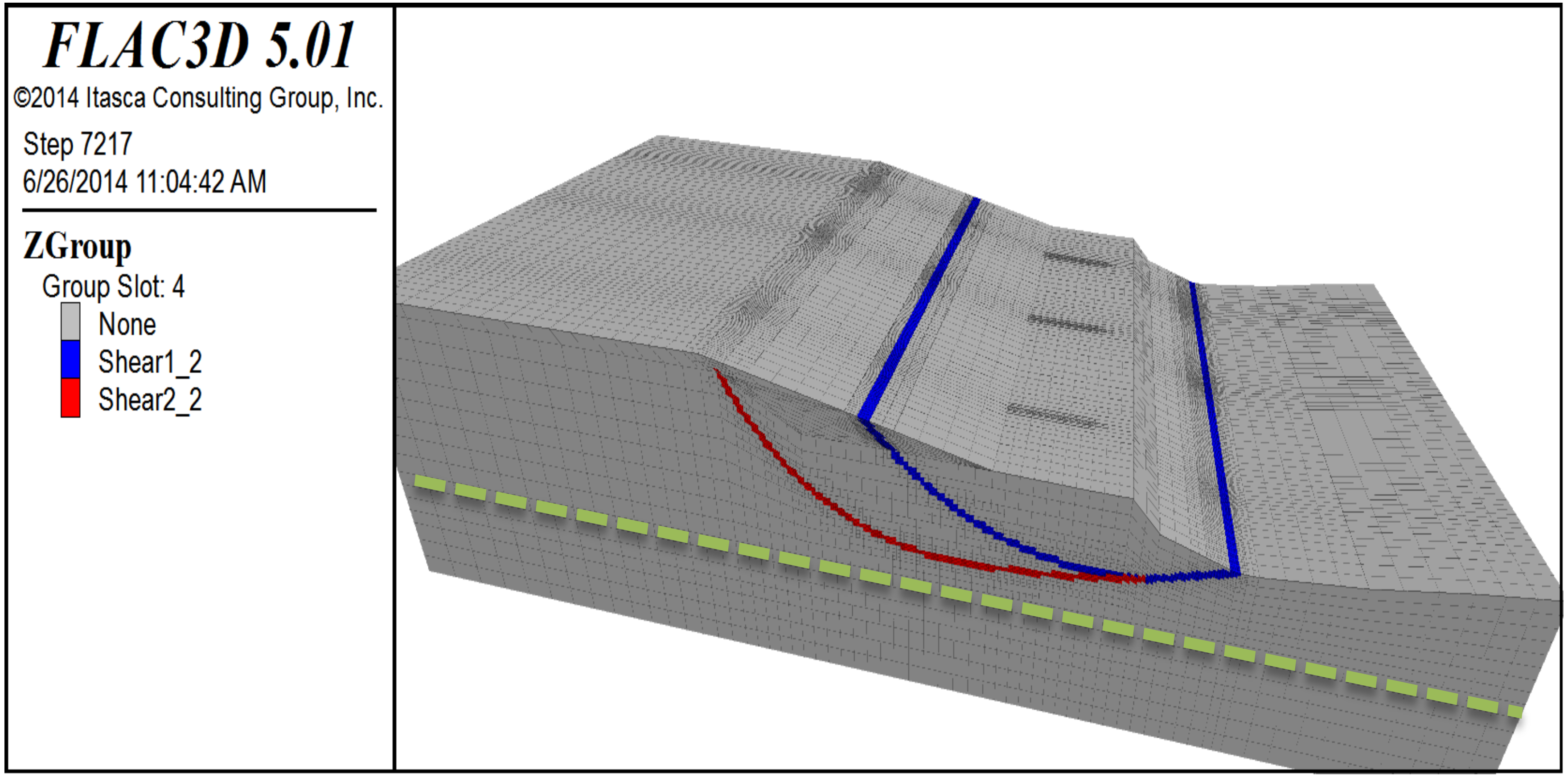


Shear Wall Layout



FLAC3D – Modeling of Shear Walls

- Assess residual strength based on strength reduction.
- Evaluate stability improvements with shear walls.
- Confirm failure between walls does not control.



Initial Site Conditions

Site Grading Prior to Construction

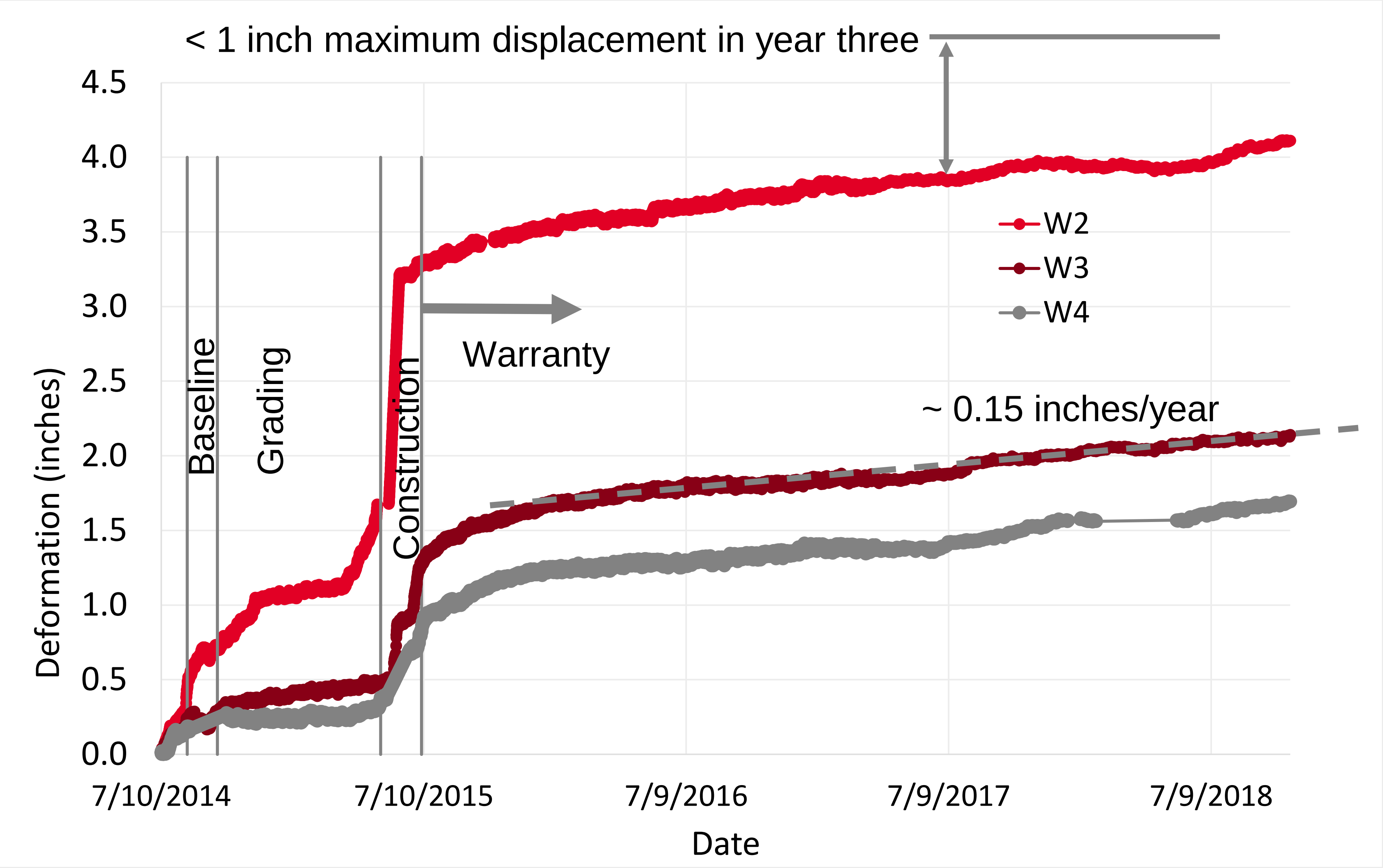
Monster Excavator – 100 ft Reach

Trench Excavation

Clay Spoil

Plant

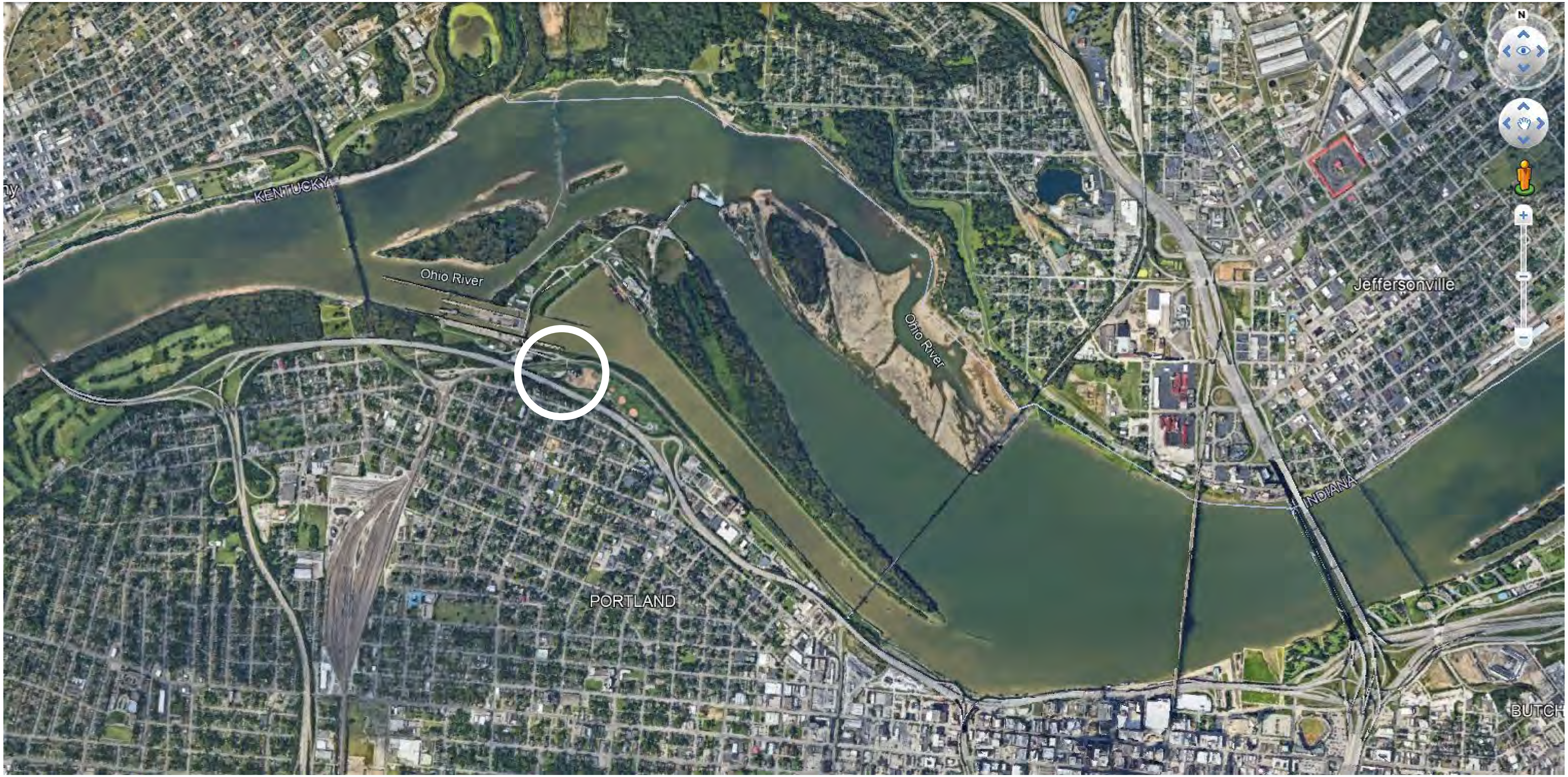
Deformation Chronology and Warranty



Crookston, MN – Slope Stabilization

Crookston Site from Street View Today

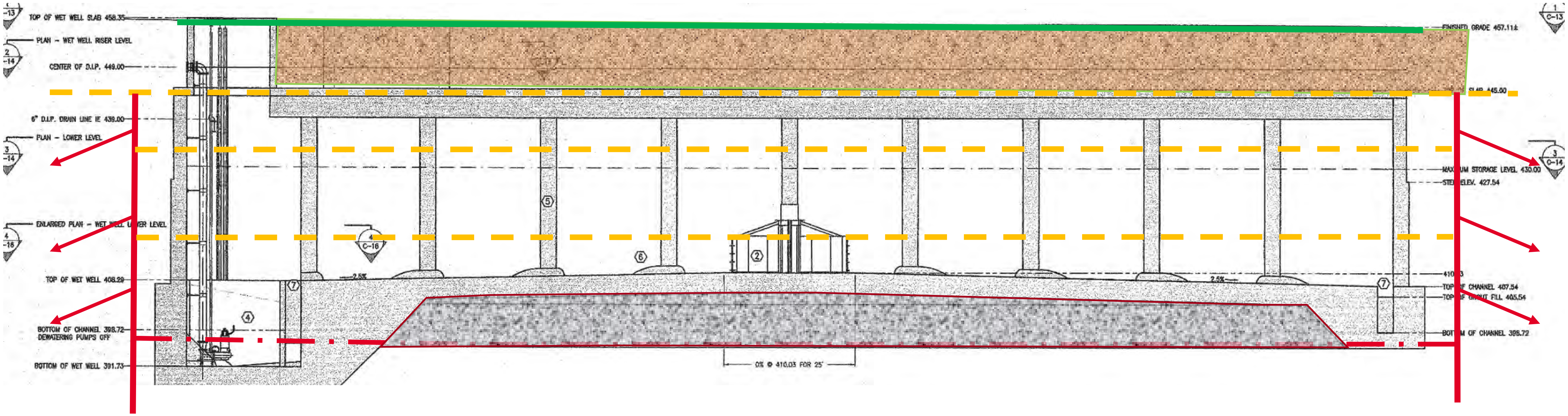
Louisville, KY - Portland CSO Shaft



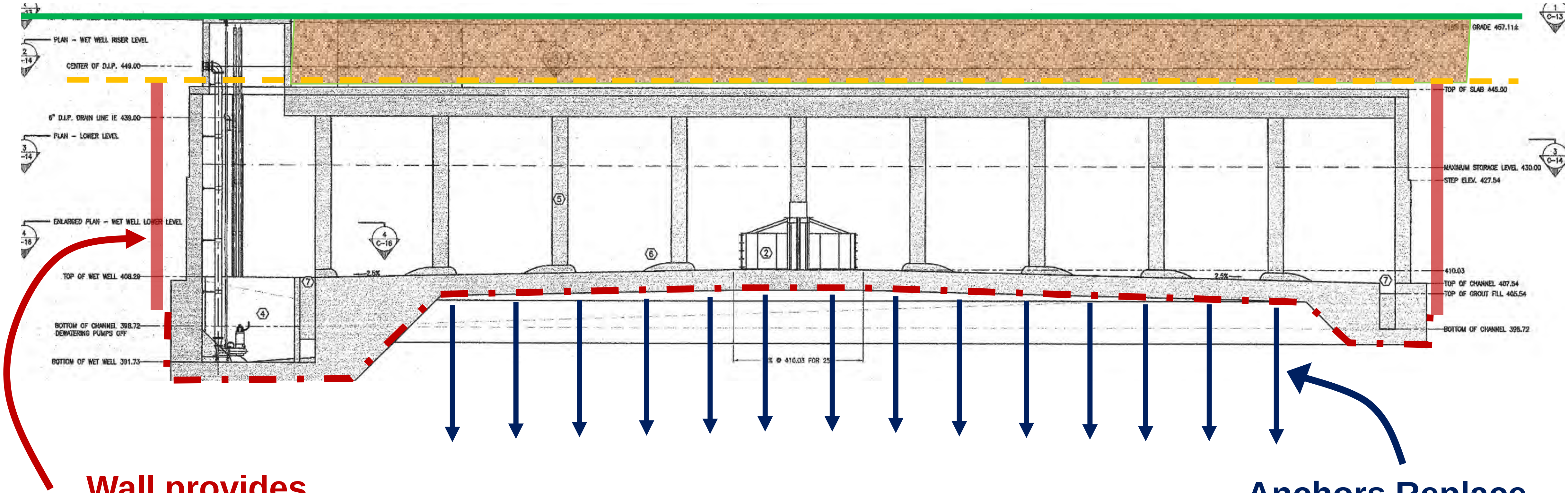

Ohio River
Existing Levee
Old
Landfill

Louisville, KY - Portland CSO Shaft

Anticipated Approach



Alternative Approach with Cost/Schedule Saving Measures

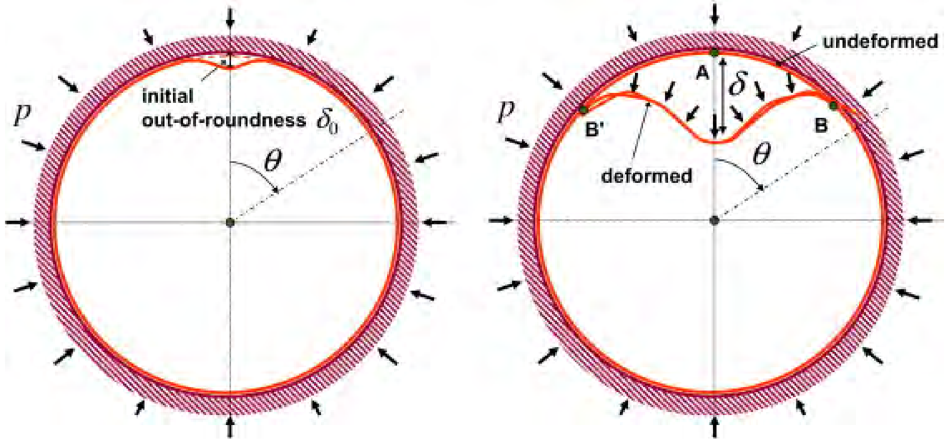


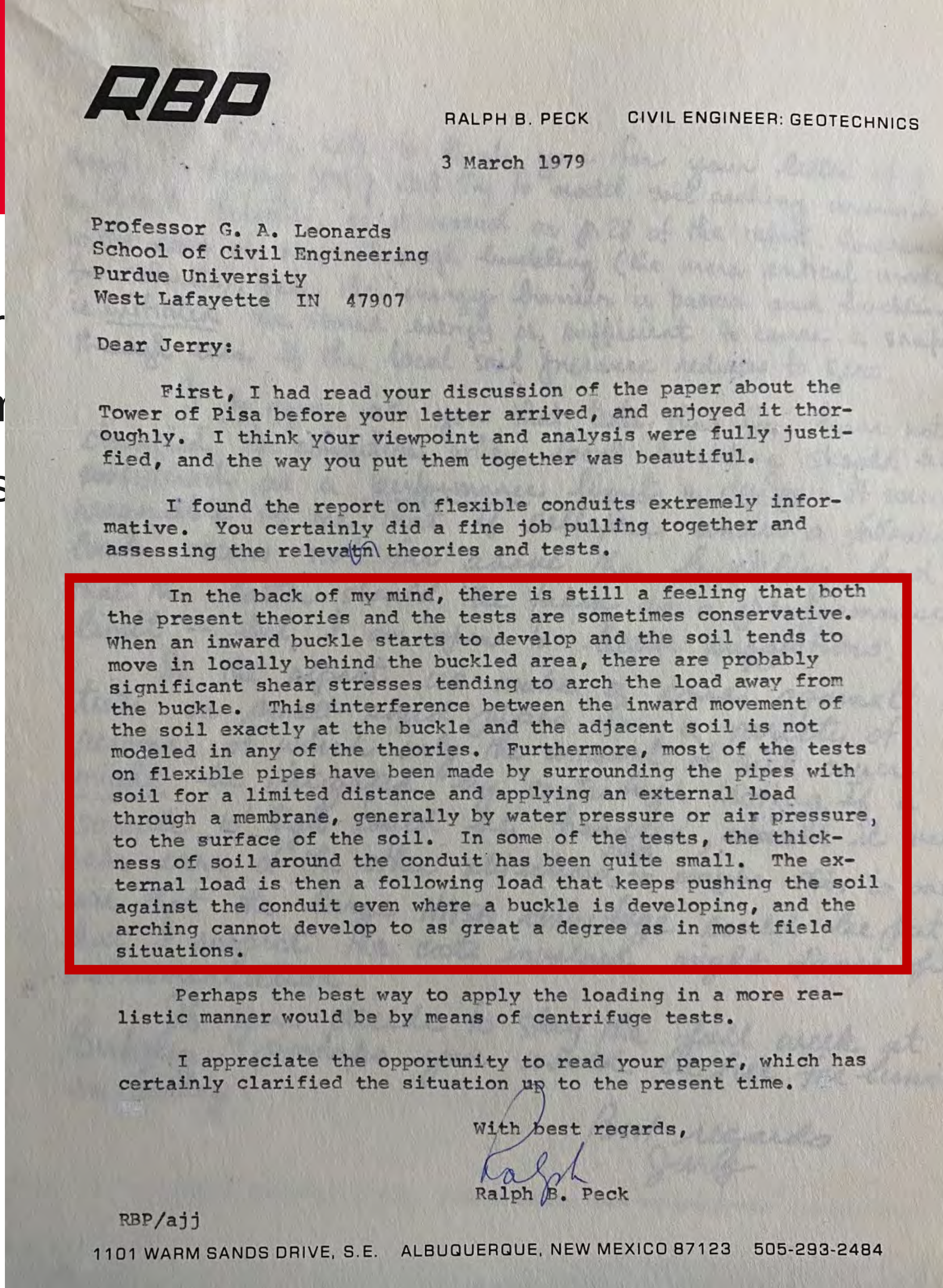
Wall provides permanent support

Anchors Replace Mass Concrete

So, Why Didn't the Structure Buckle?

- The structure is categorized as thin-walled; d/t > 20, her
- Most buckling models predicted buckling at half this diam
- A basic difference is the soil stress is not a constant pres arching. An appropriate model is needed to approach a





RBP

RALPH B. PECK CIVIL ENGINEER: GEOTECHNICS

3 March 1979

Professor G. A. Leonards
School of Civil Engineering
Purdue University
West Lafayette IN 47907

Dear Jerry:

First, I had read your discussion of the paper about the Tower of Pisa before your letter arrived, and enjoyed it thoroughly. I think your viewpoint and analysis were fully justified, and the way you put them together was beautiful.

I found the report on flexible conduits extremely informative. You certainly did a fine job pulling together and assessing the relevatn theories and tests.

In the back of my mind, there is still a feeling that both the present theories and the tests are sometimes conservative. When an inward buckle starts to develop and the soil tends to move in locally behind the buckled area, there are probably significant shear stresses tending to arch the load away from the buckle. This interference between the inward movement of the soil exactly at the buckle and the adjacent soil is not modeled in any of the theories. Furthermore, most of the tests on flexible pipes have been made by surrounding the pipes with soil for a limited distance and applying an external load through a membrane, generally by water pressure or air pressure, to the surface of the soil. In some of the tests, the thickness of soil around the conduit has been quite small. The external load is then a following load that keeps pushing the soil against the conduit even where a buckle is developing, and the arching cannot develop to as great a degree as in most field situations.

Perhaps the best way to apply the loading in a more realistic manner would be by means of centrifuge tests.

I appreciate the opportunity to read your paper, which has certainly clarified the situation up to the present time.

With best regards,

Ralph

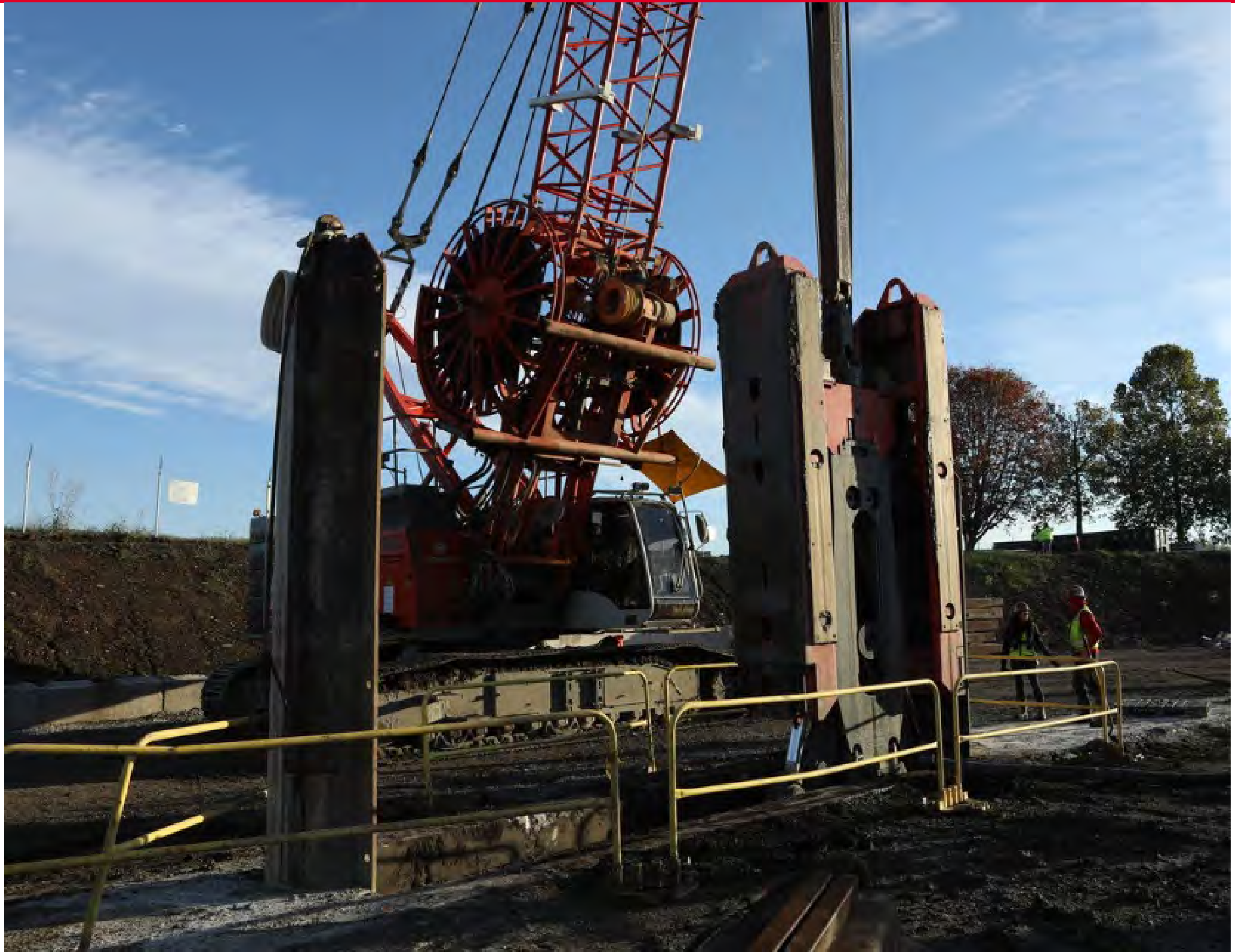
Ralph B. Peck

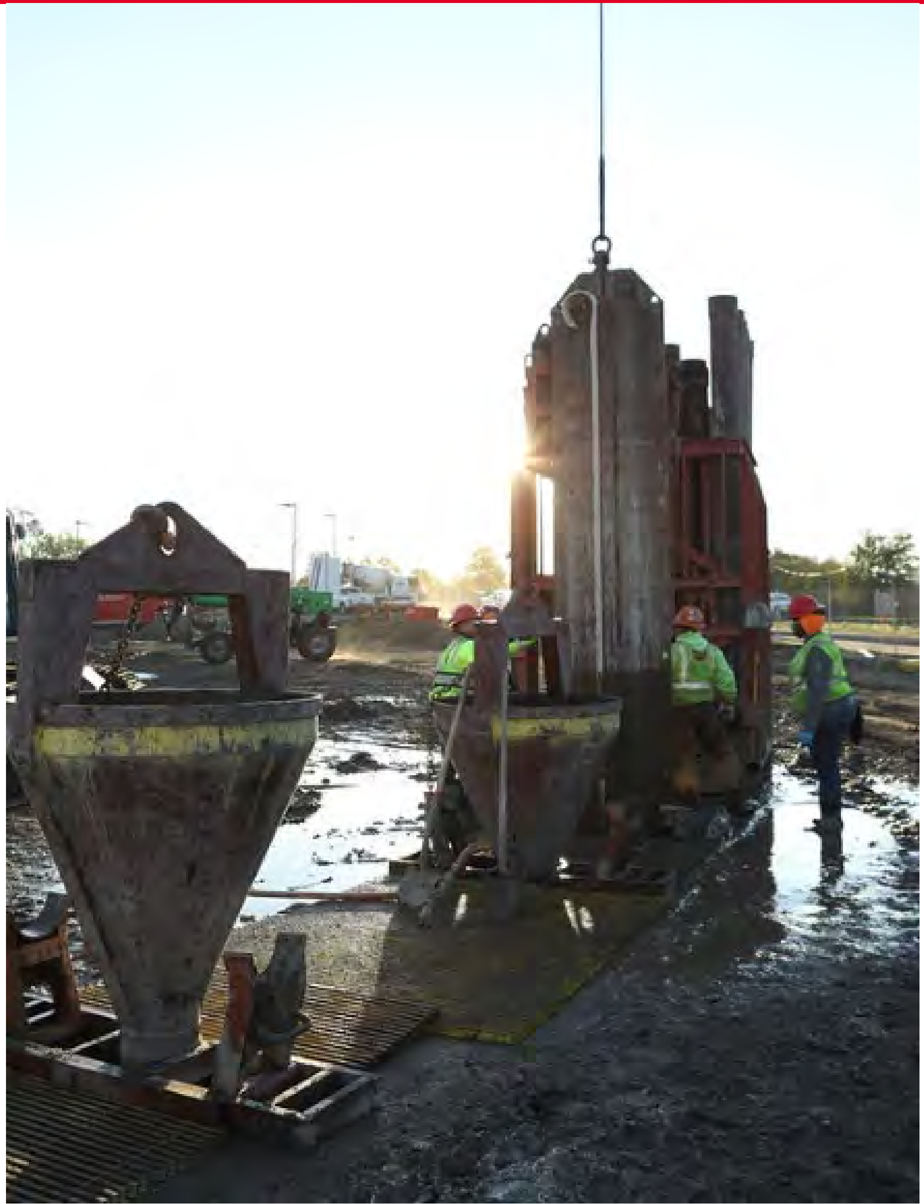
RBP/ajj

1101 WARM SANDS DRIVE, S.E. ALBUQUERQUE, NEW MEXICO 87123 505-293-2484

Guide Walls and Dwall Excavation

Panel Excavation





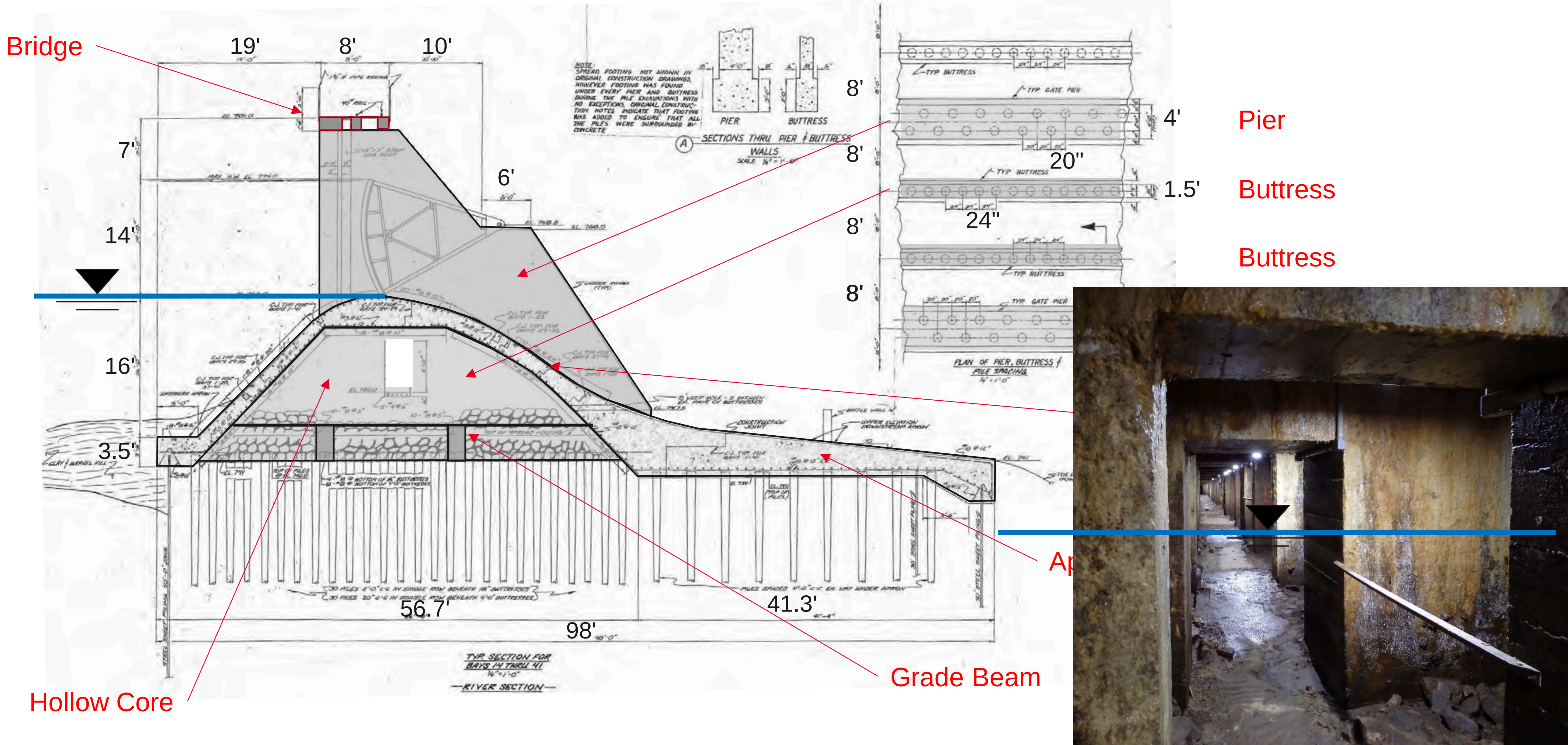
Placing Concrete

Tiedown Anchors Installation Overview

Tiedown Anchors Proof Testing

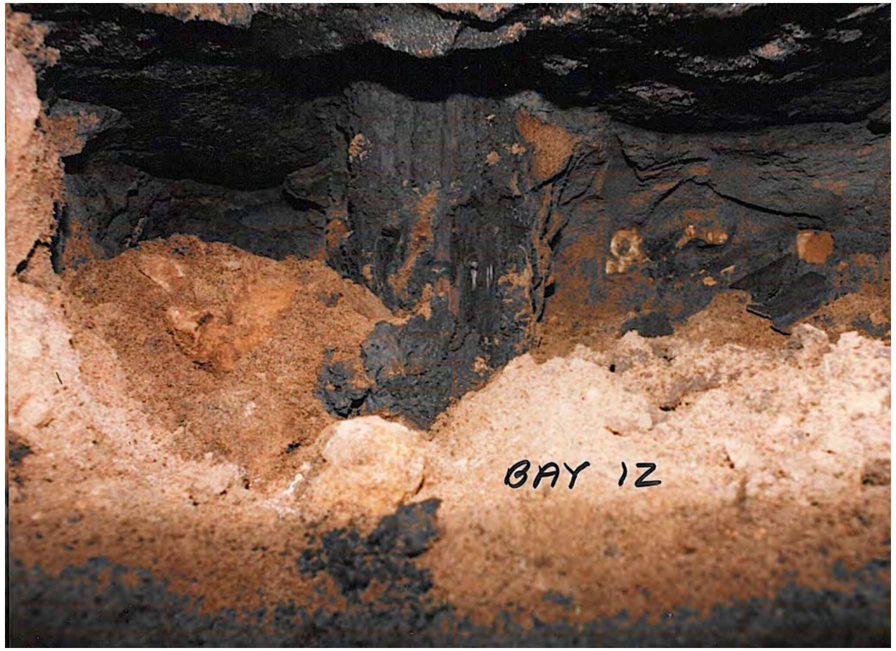
Prairie du Sac Dam, Wisconsin River, WI

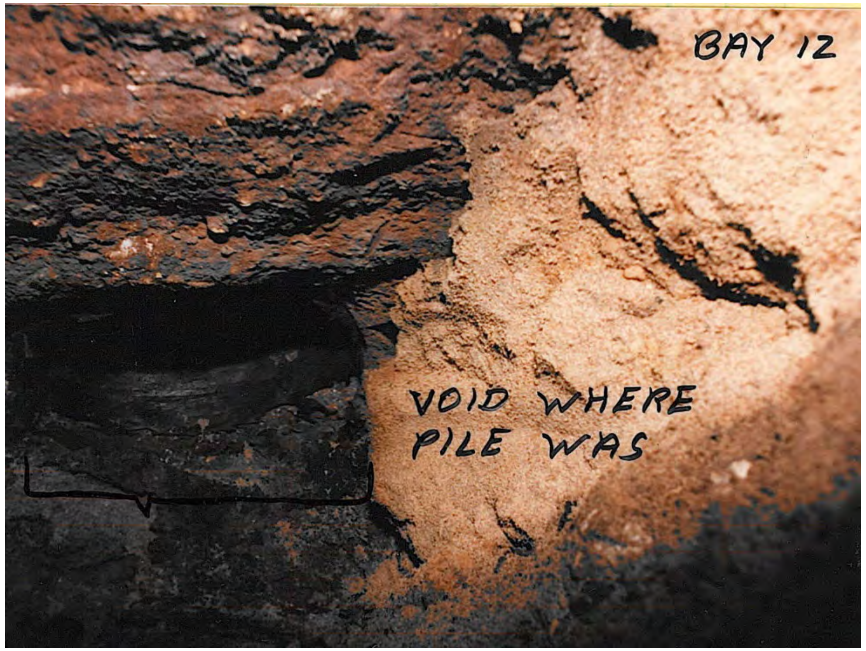
Dam Geometry



Observation of Deteriorating Piles

Tailwater recession after construction exposed timber piles

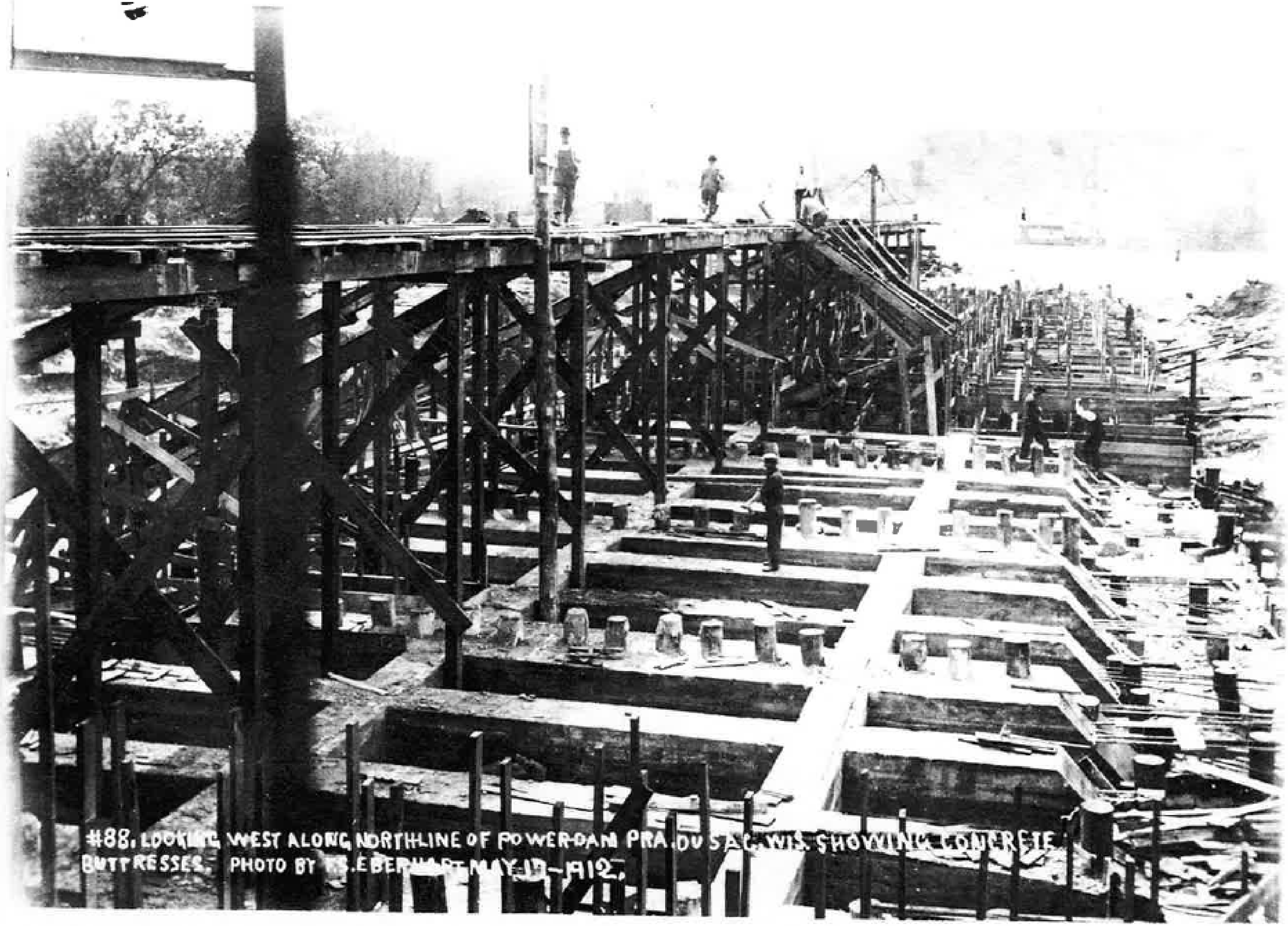




Pile deterioration could lead to differential settlement and cracking (no observable settlement to date)

Drawings Don’t Tell the Whole Story!!


CONCRETE FROM ELEVATED ROAD AT POWER-DAM, PRA.DUSAC, WIS, PHOTO BY F.S.EBERHART, MAY 17-12.



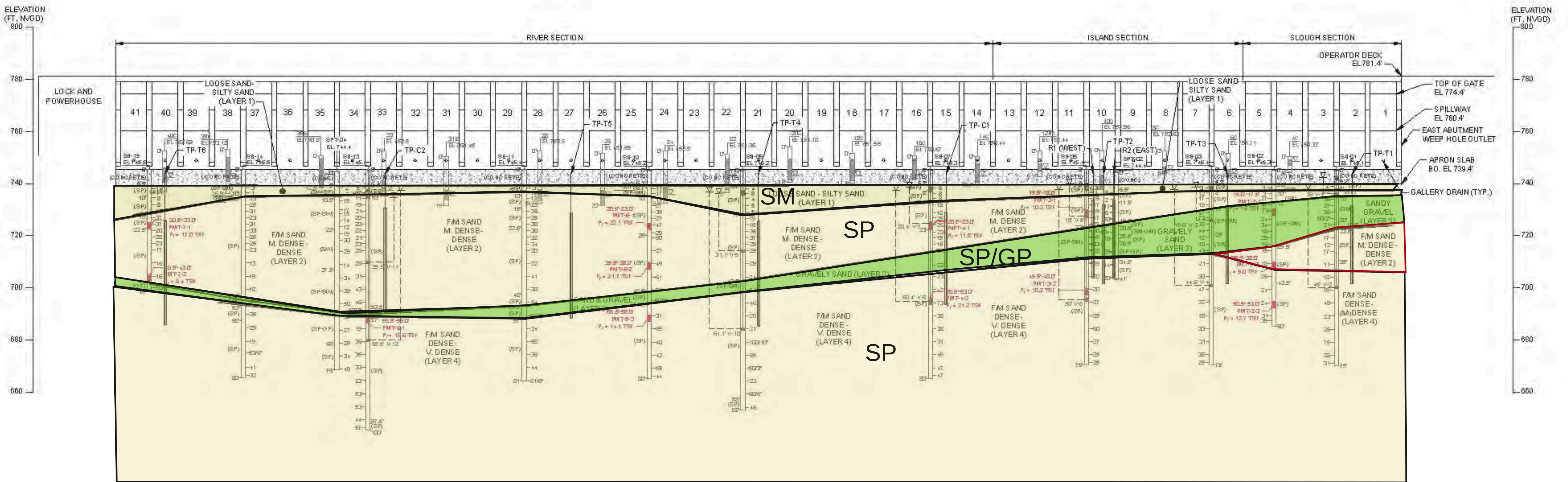
#88. LOOKING WEST ALONG NORTHLINE OF POWERDAM PRA. DU SAC. WIS. SHOWING CONCRETE BUTTRESSES. PHOTO BY H.S. EBERHART MAY 17-1912.

#97. VIEW OF EAST END OF POWER-DAM "DOWN STREAM SIDE" PRA. DU SAC, WIS. PHOTO BY F.S. EBERHART, JUNE 30-1912.

Remediation Goals

- Minimize disturbance ("do no harm")
- Take up dam loads with no significant settlement or displacement
- Ensure no increase in uplift pressures
- Satisfy criteria for exit gradients and piping potential
- Meet FERC performance requirements, and provide long-term, reliable service

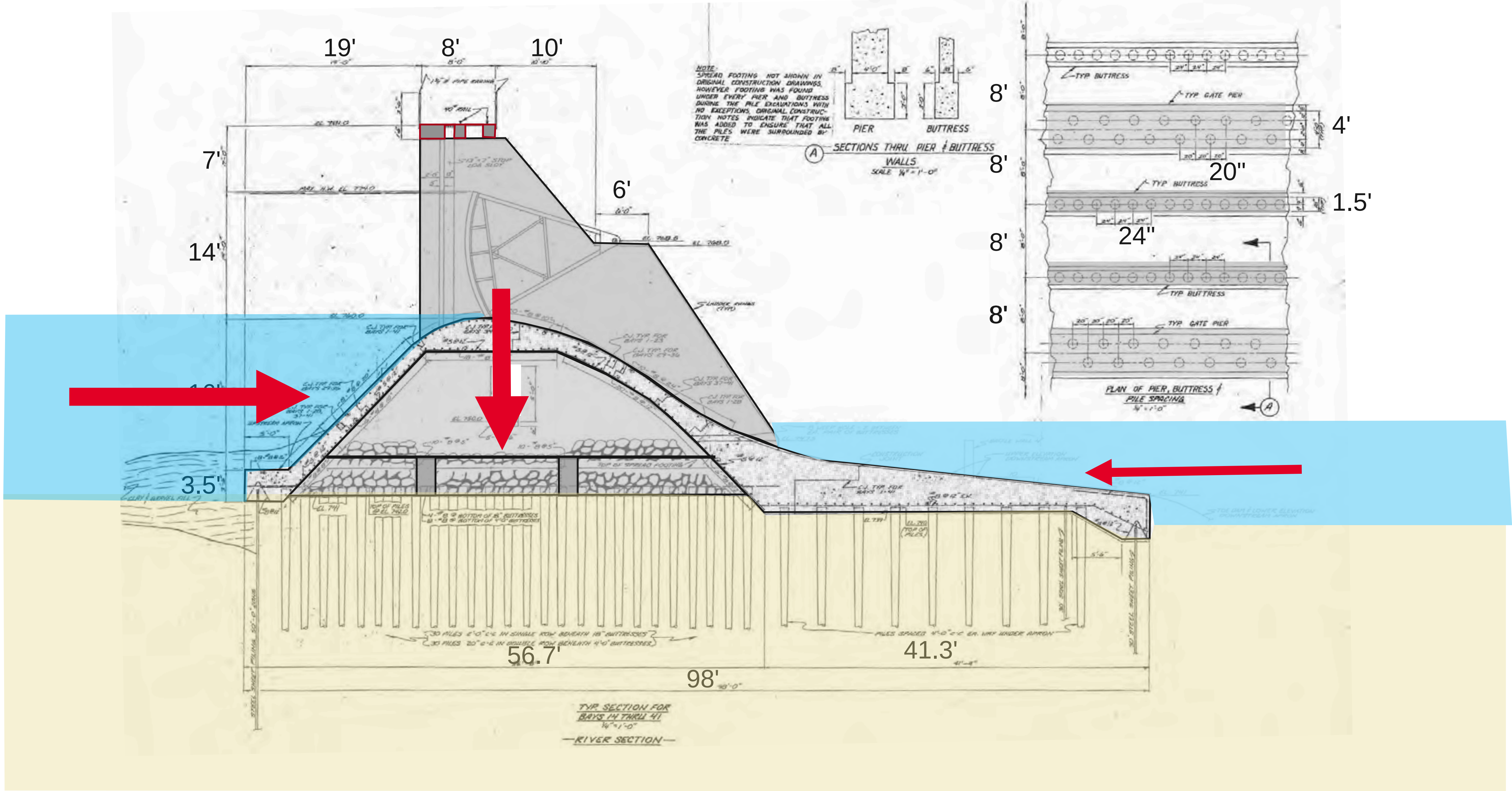
Subsurface Conditions



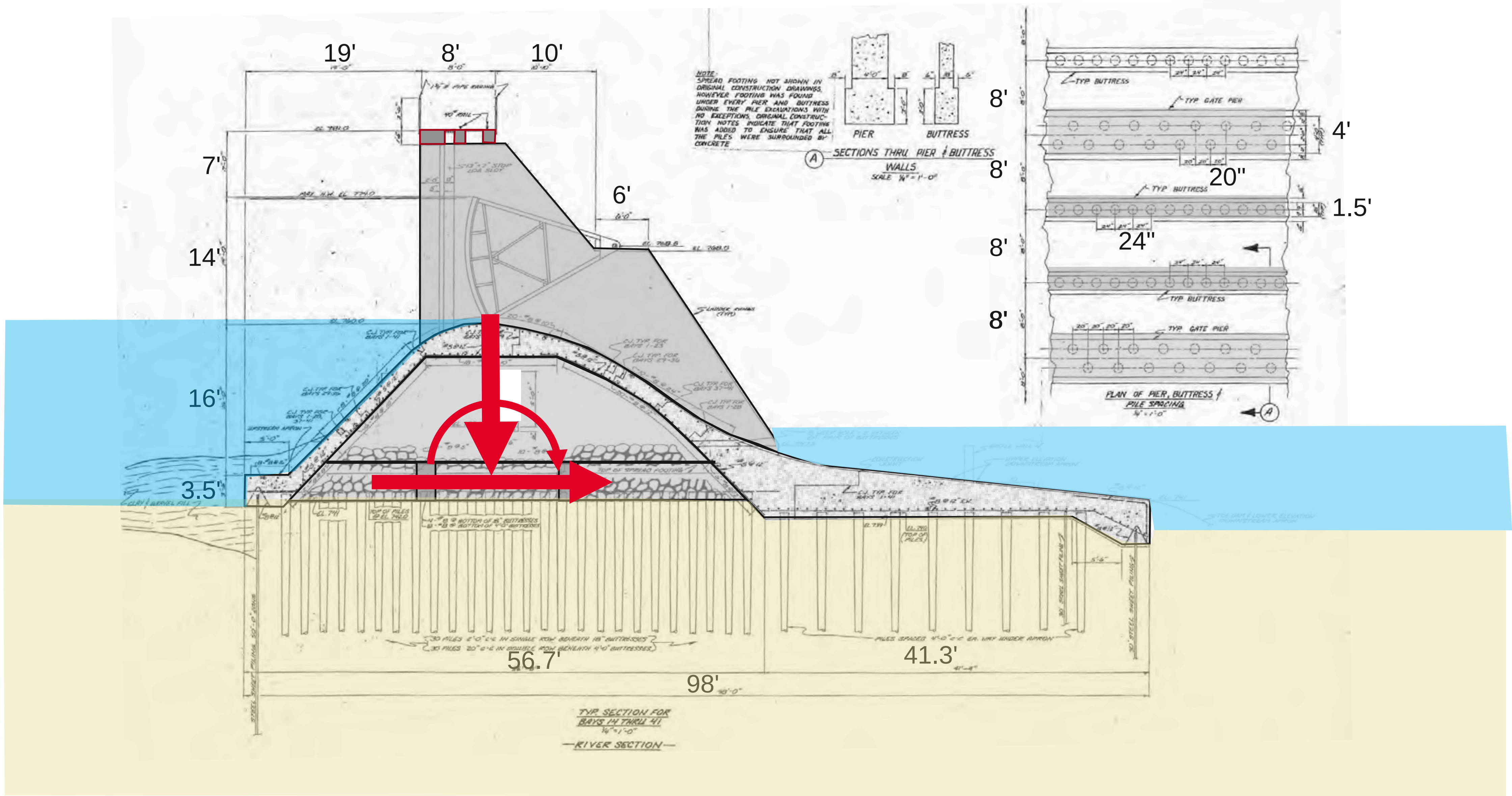
Other Challenges – Water

Other Challenges - Access

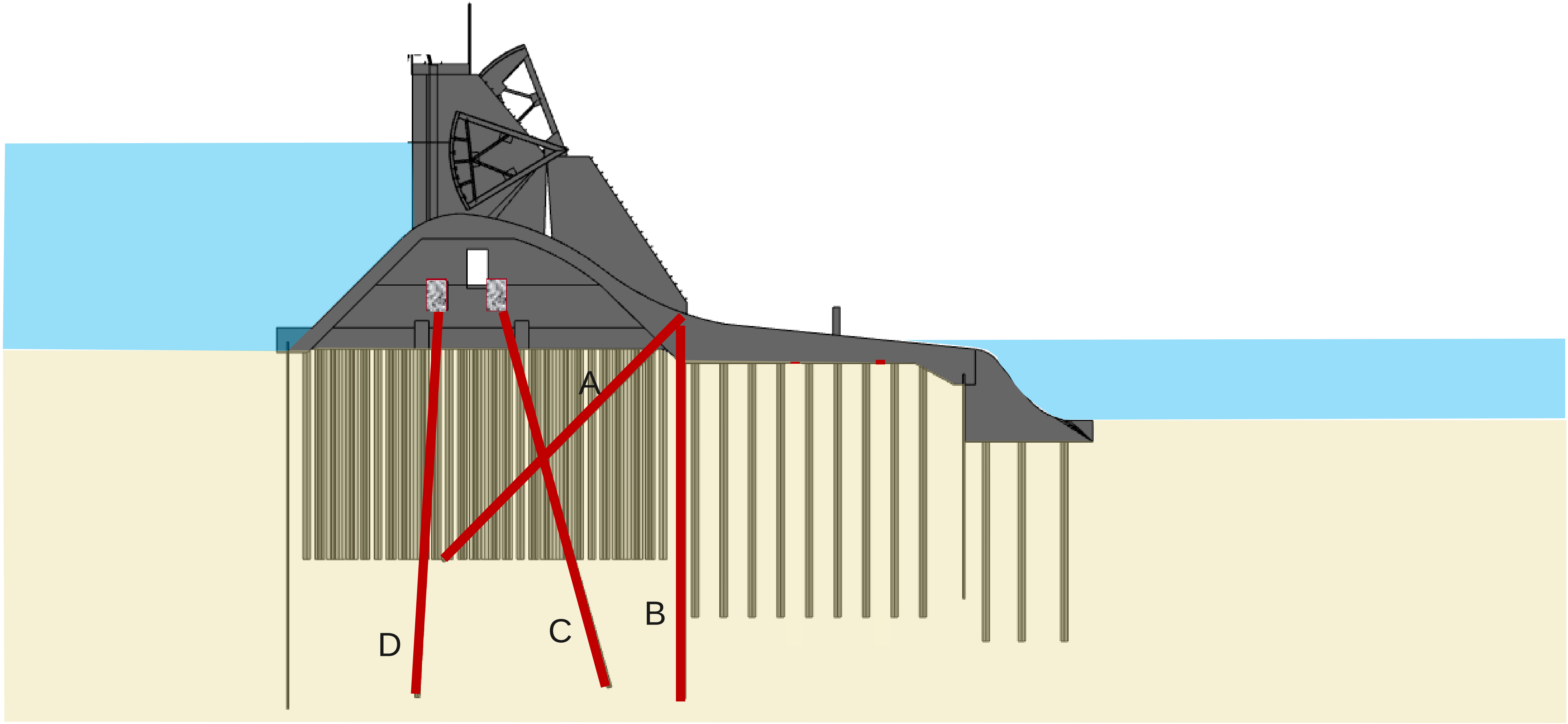
Design Approach – Gravity and Hydraulic Loads



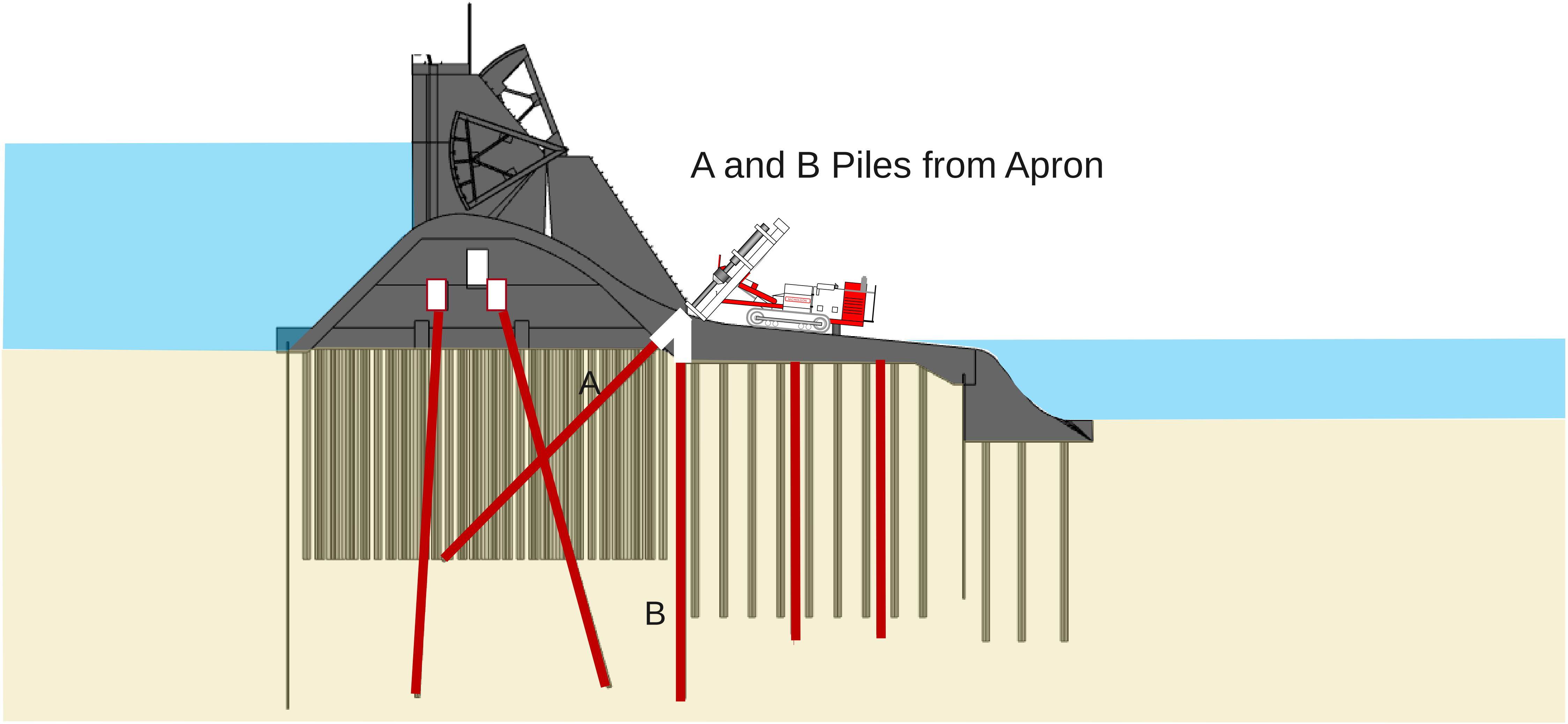
Design Approach – Determine Resultant Loads



Design Approach – Install Micropiles

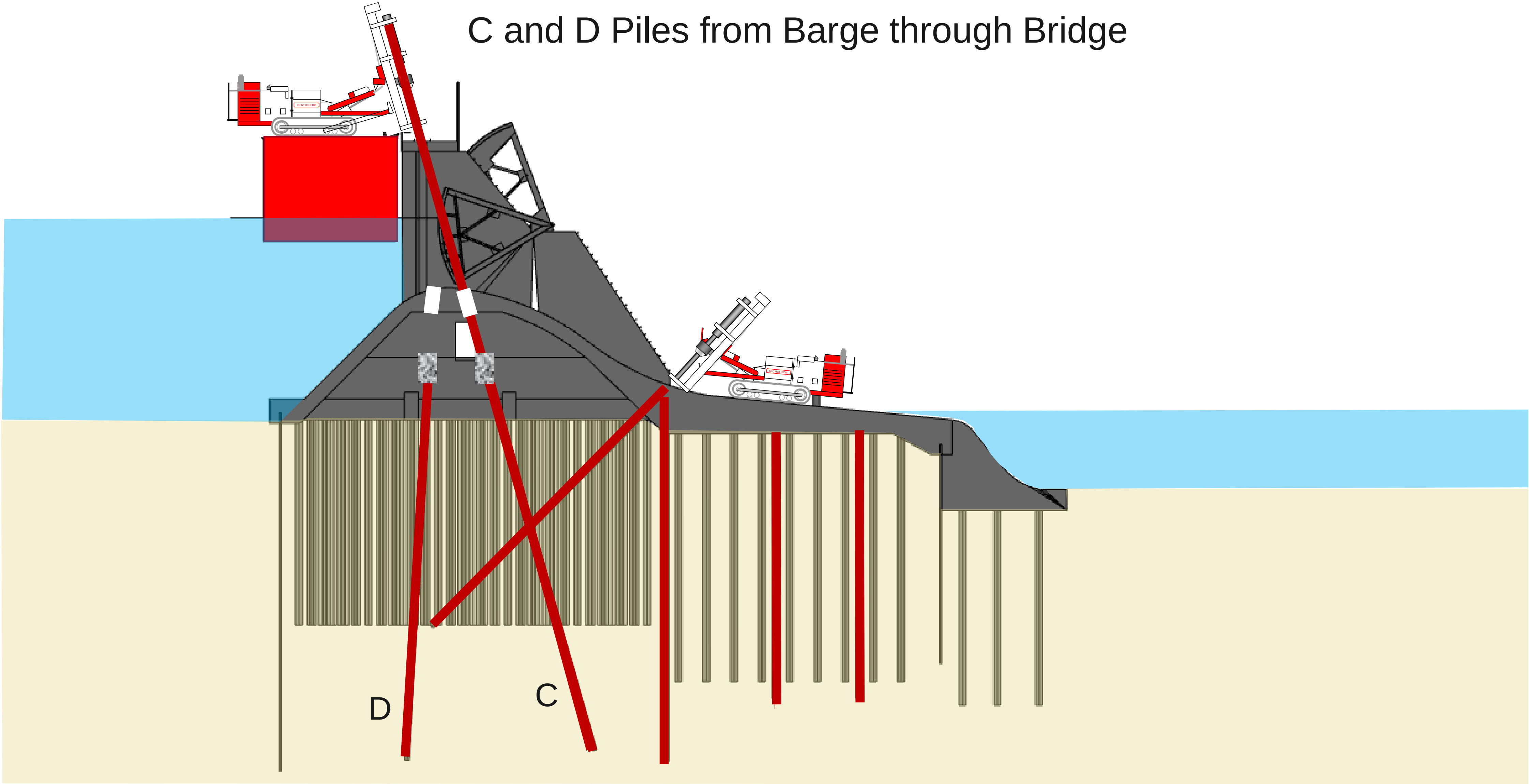


Construction Approach

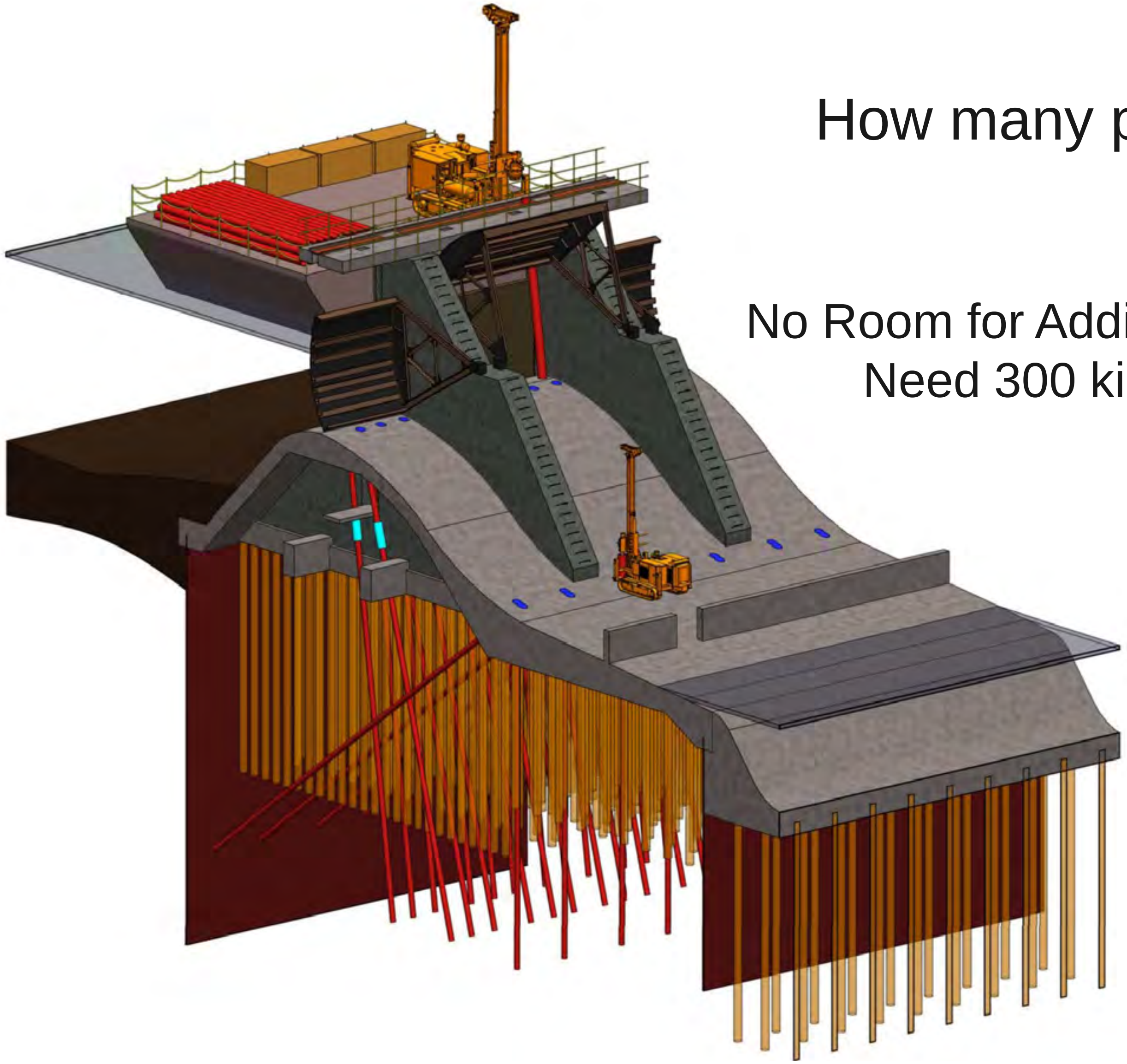


Construction Approach

C and D Piles from Barge through Bridge

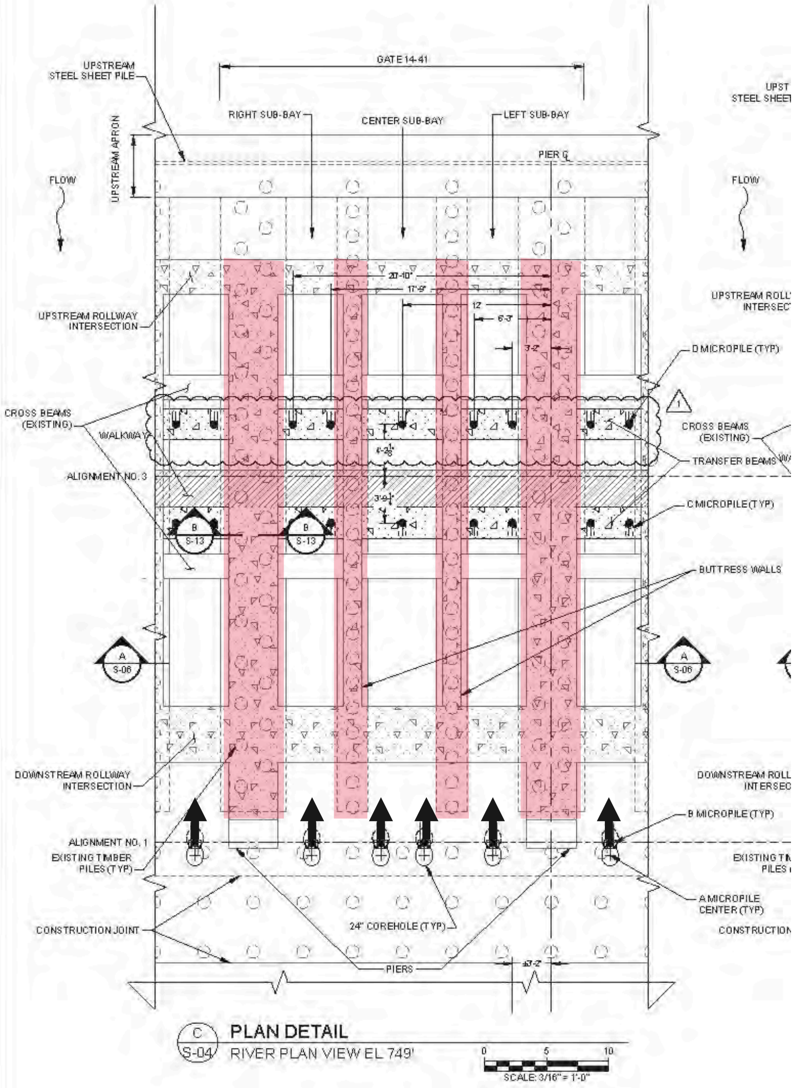


Construction Approach (cont.)



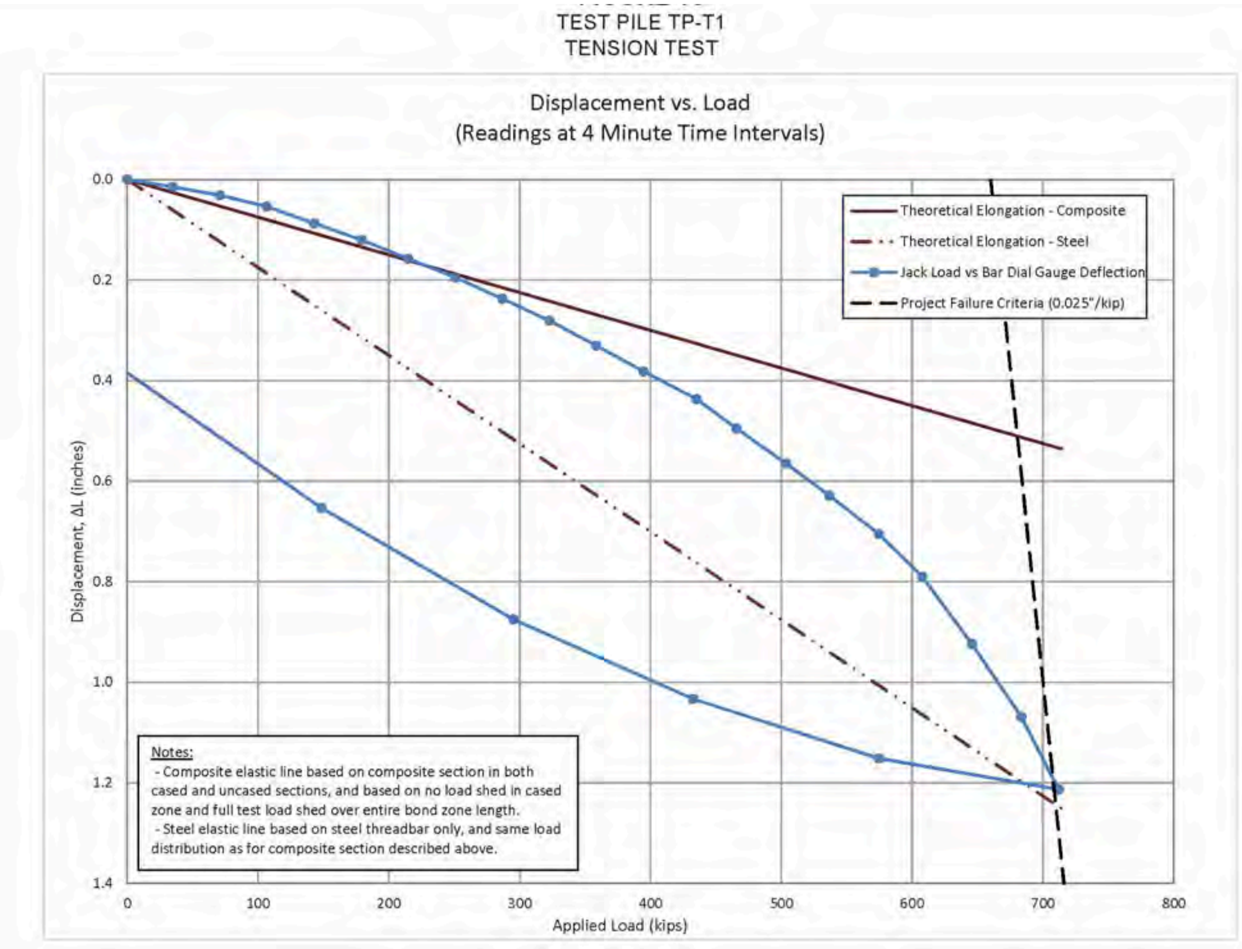
How many piles?

No Room for Additional Piles!
Need 300 kips/pile



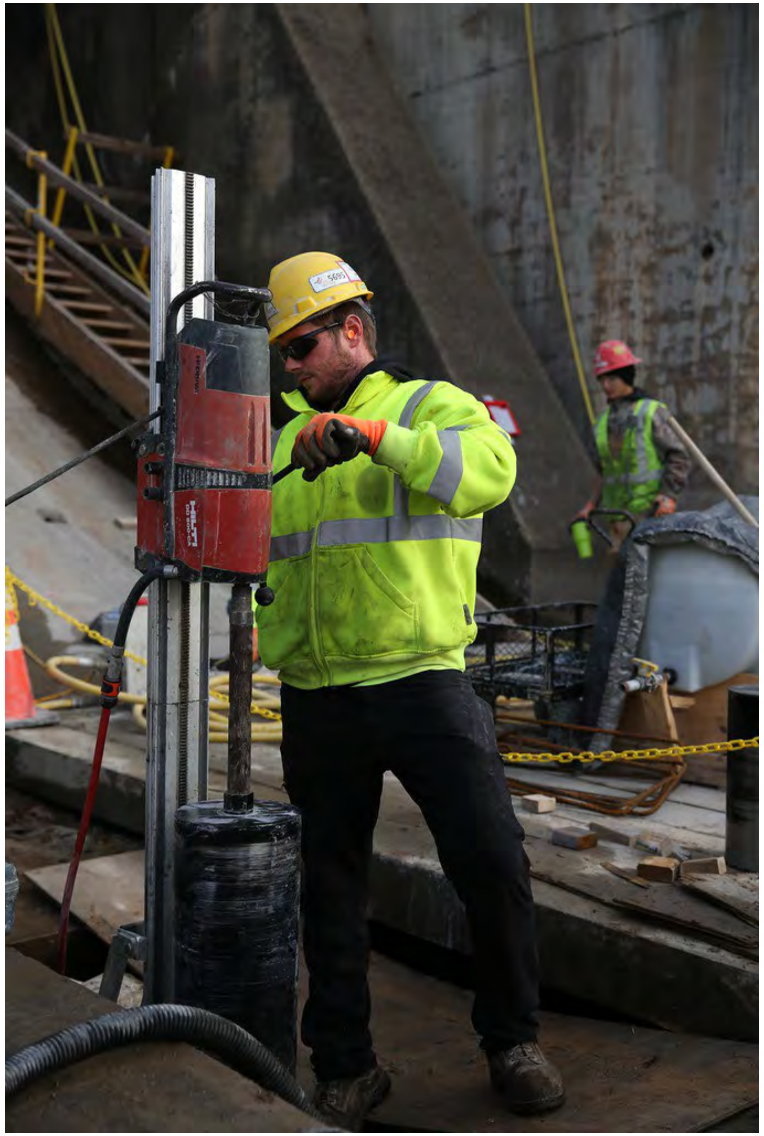
Extensive Test Program (2017)

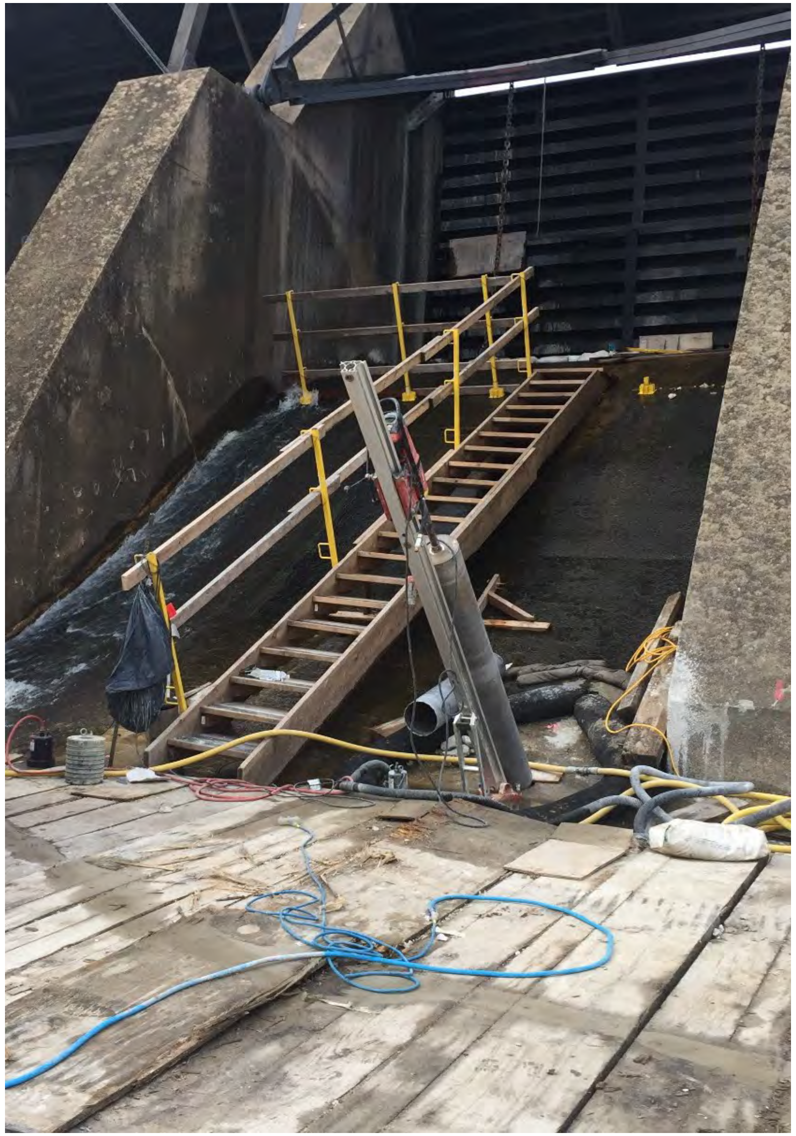
- Goal of 0.25 inches of movement at design load of 300 kips.
- Piles tested to 80 psi bond stress without failure with post-grouting.

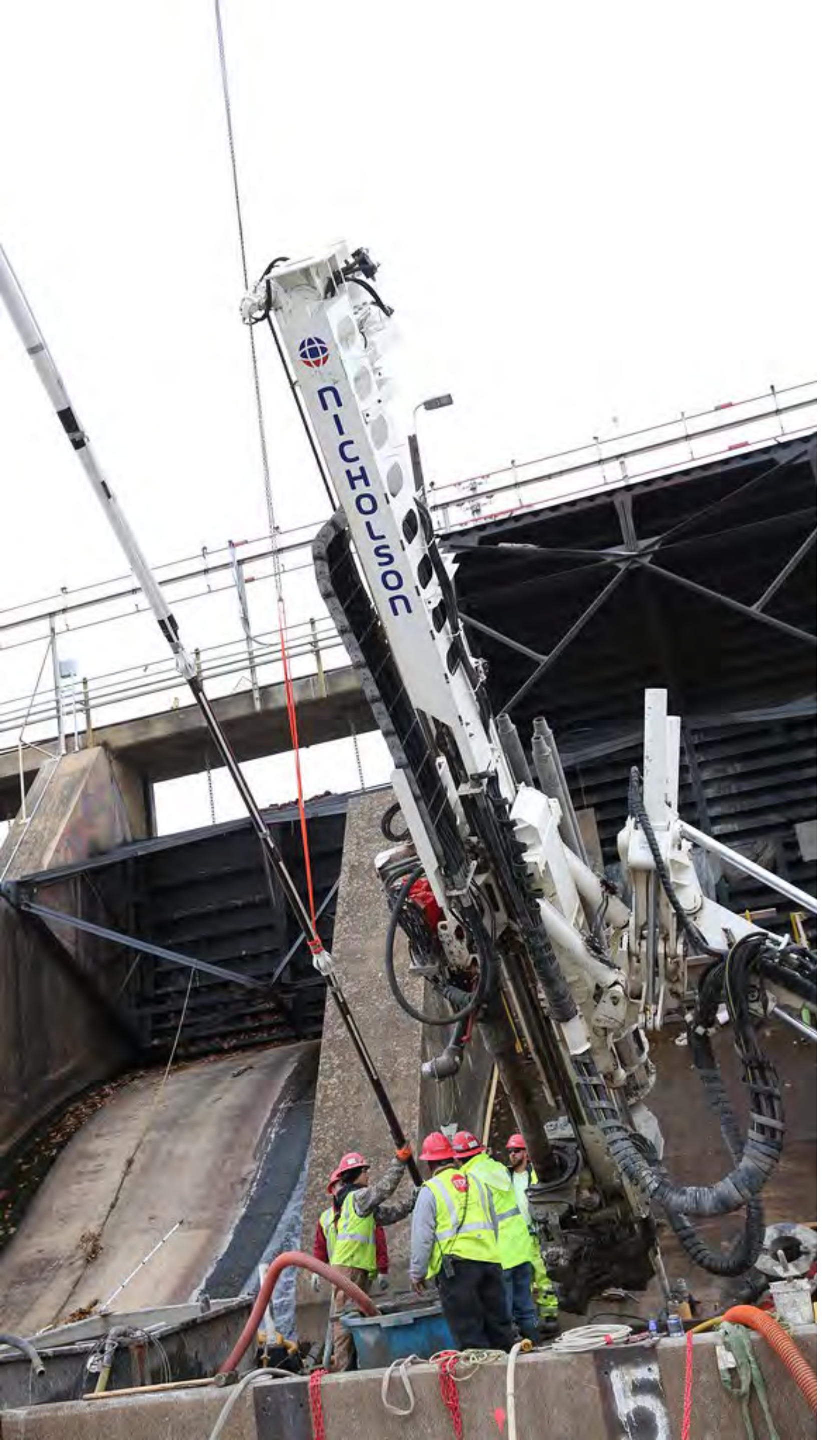


Construction

Coring Into/Thru Dam



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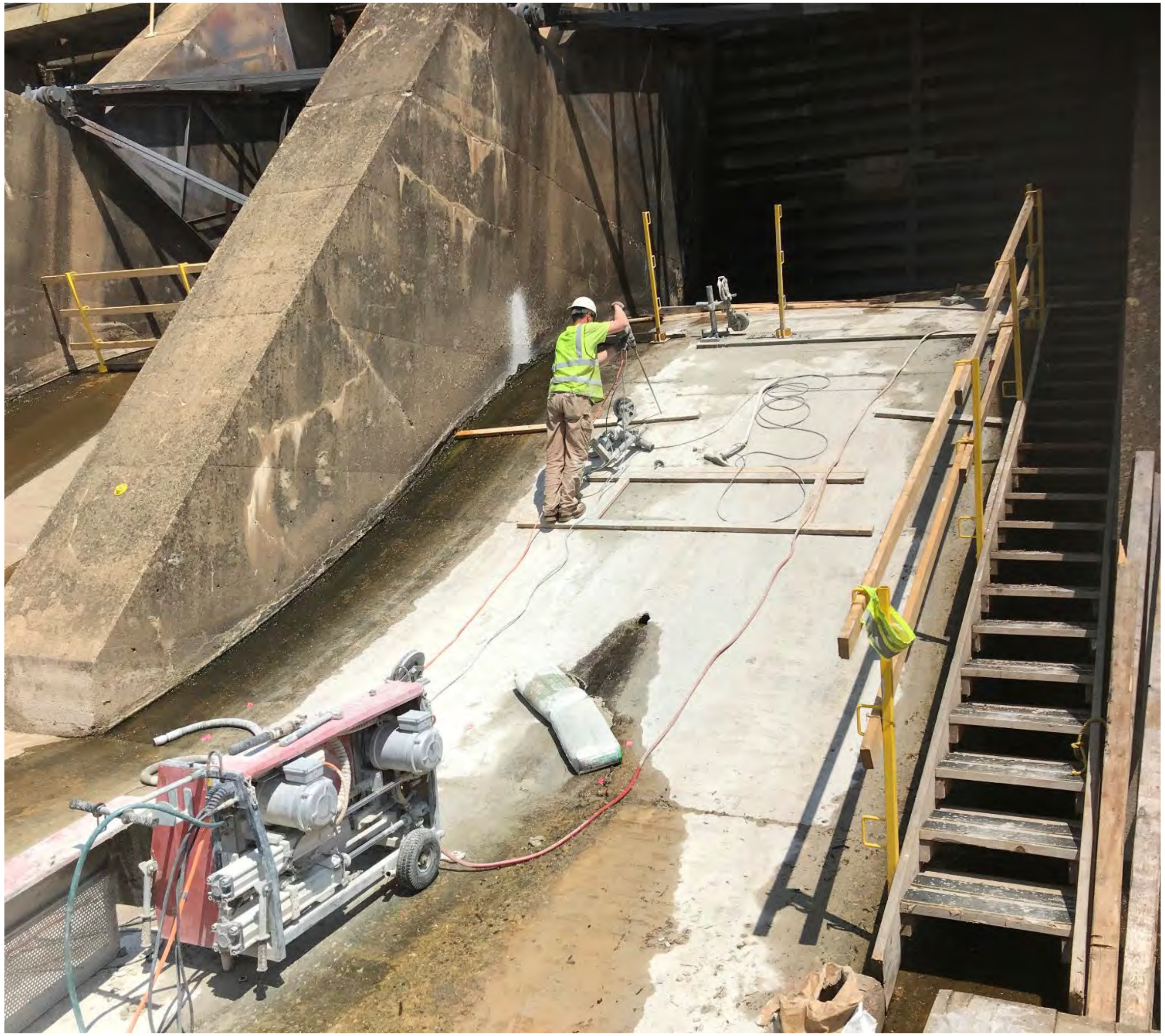
Gallery Access

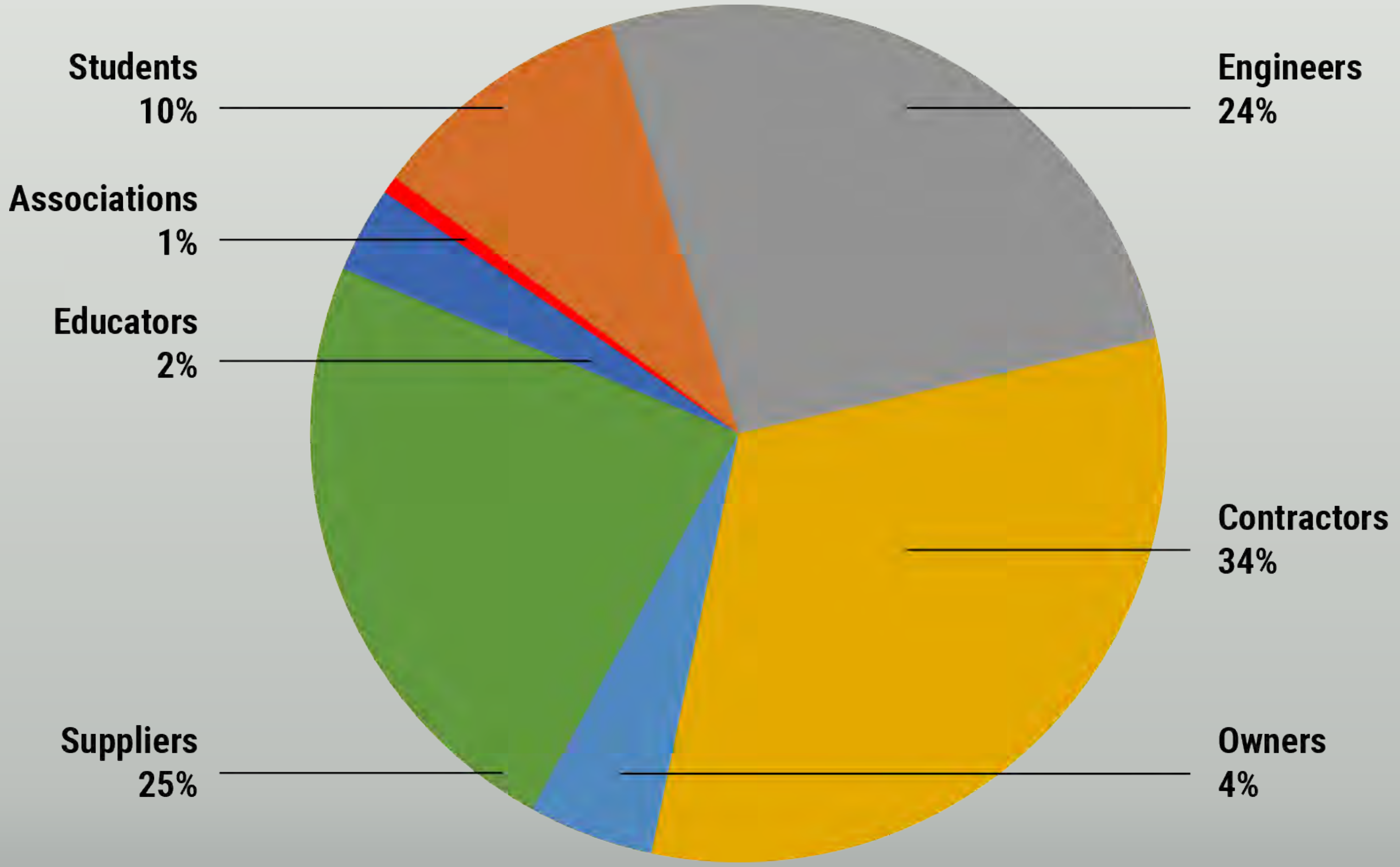


Gallery




THANK YOU!
ANY QUESTIONS?
NICHOLSON

An International Association of Multidisciplinary Members



FINDING COMMON GROUND

Student Resources

FINDING COMMON GROUND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Murphy
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Roan
Lola