Grouting and Anchoring an 1880's Masonry Dam

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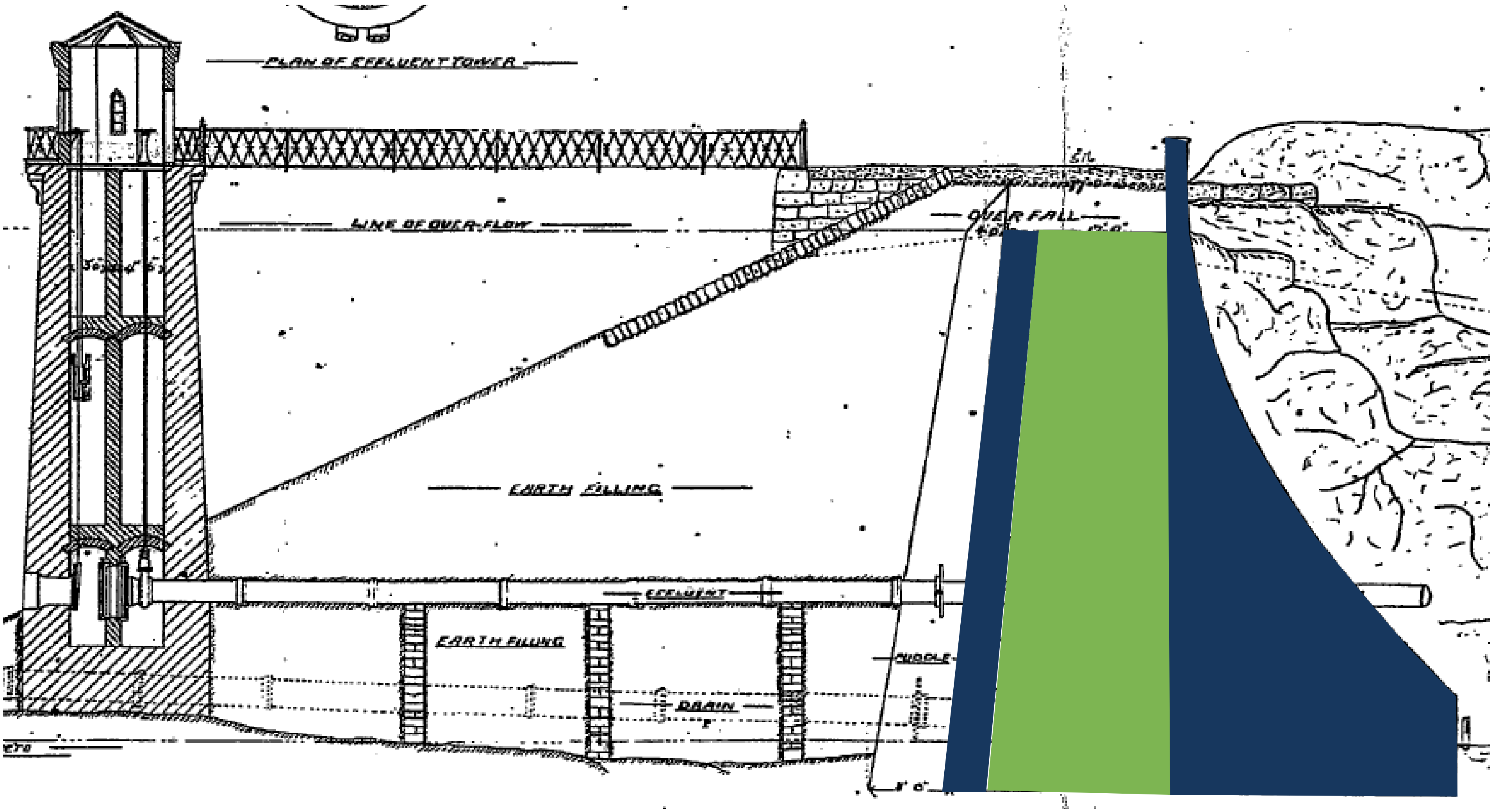
Presentation Overview

- History
- Design
- Construction
- Challenges and Takeaways



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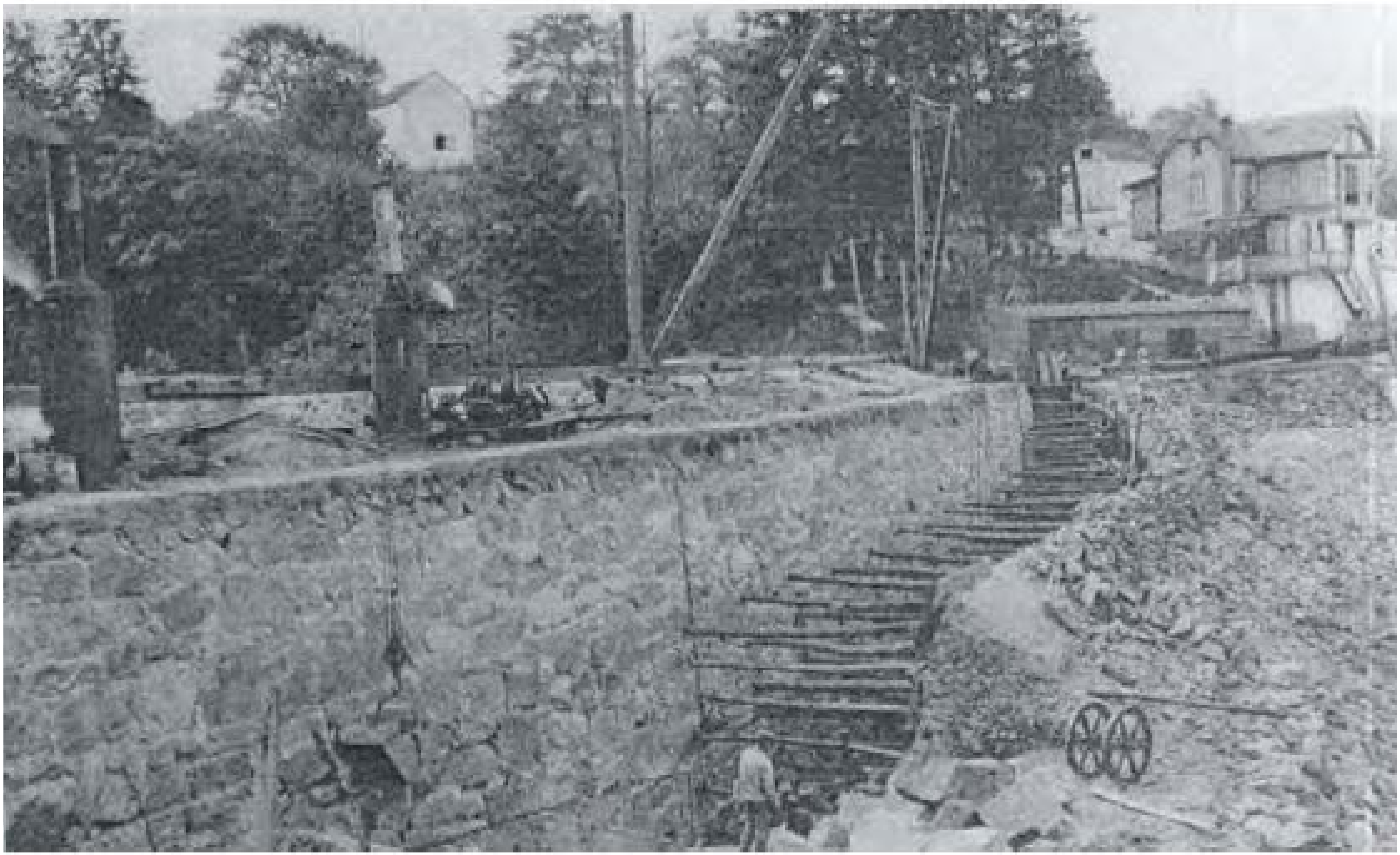
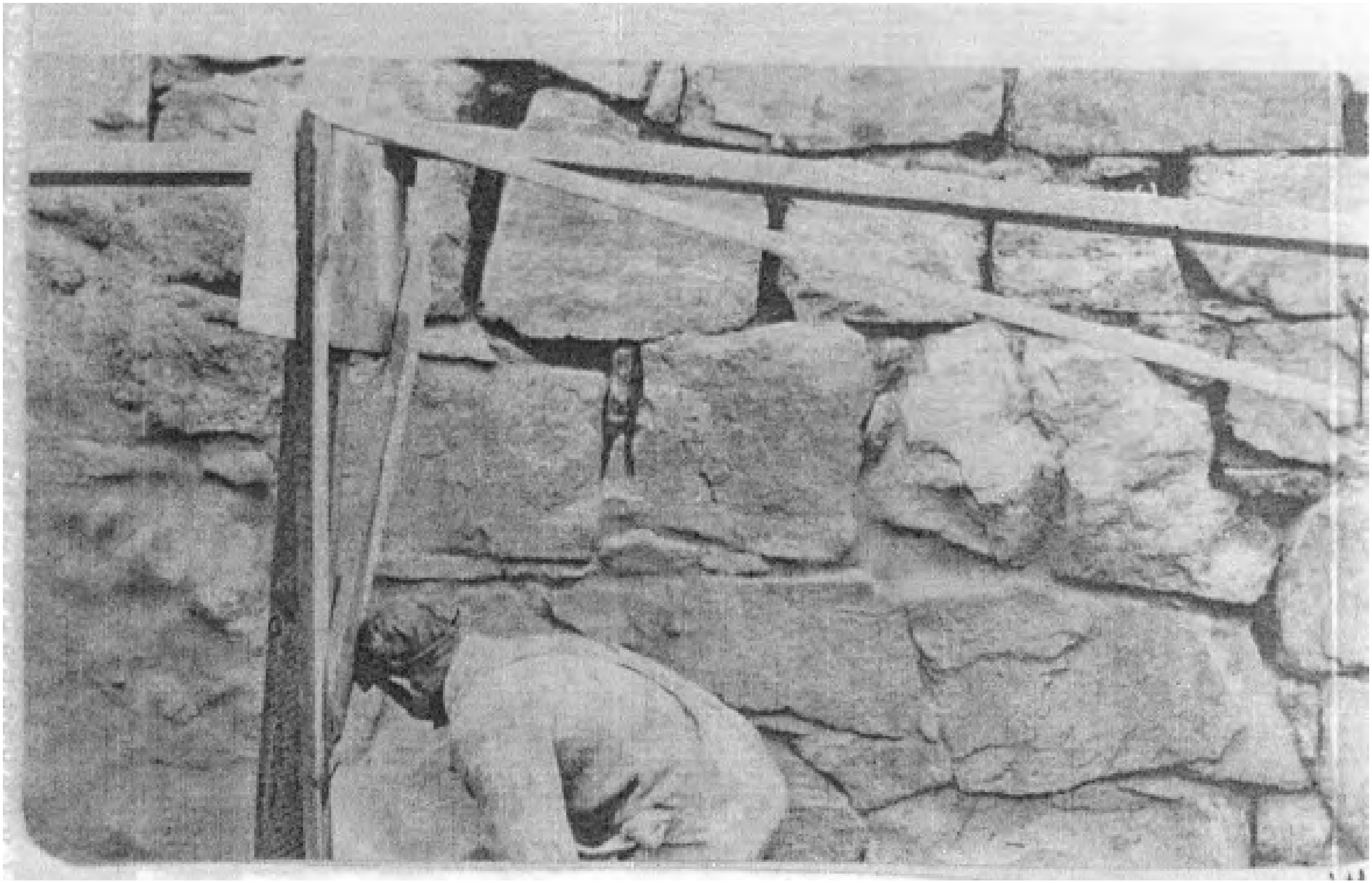


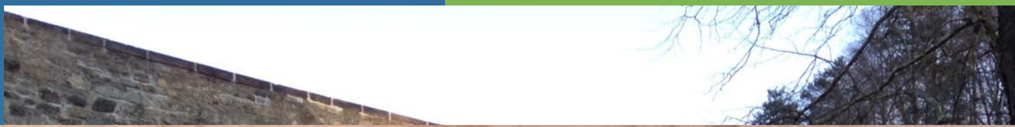


Background

- Deficiencies
  - Spillway Capacity
  - Stability
- Alternatives
  - Anchor
  - Buttress

Background

- Exploration
  - Traditional coring
  - Piezometers



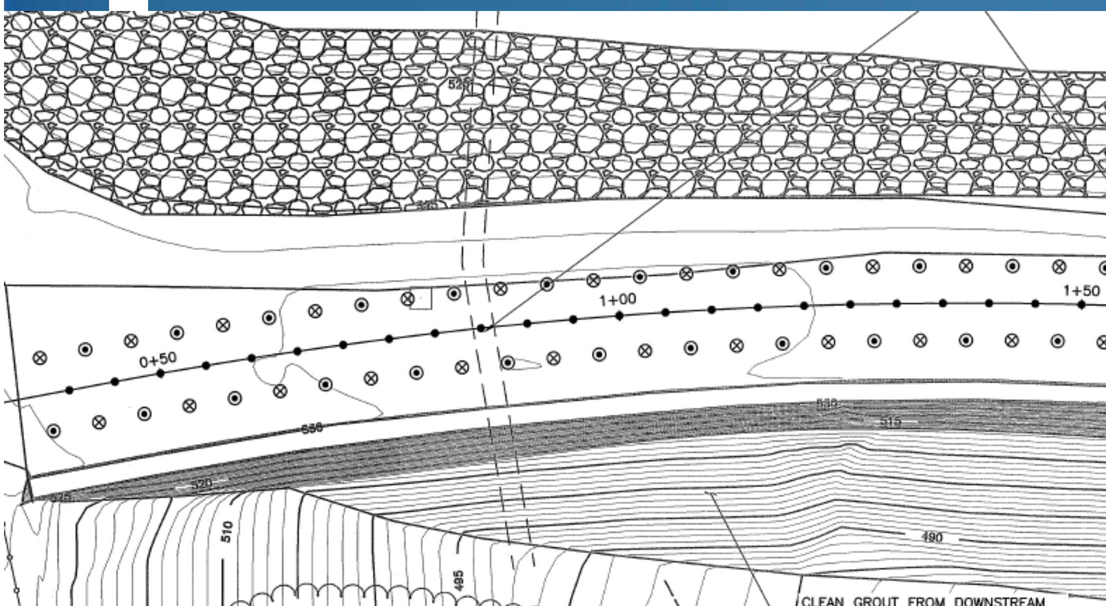
Design

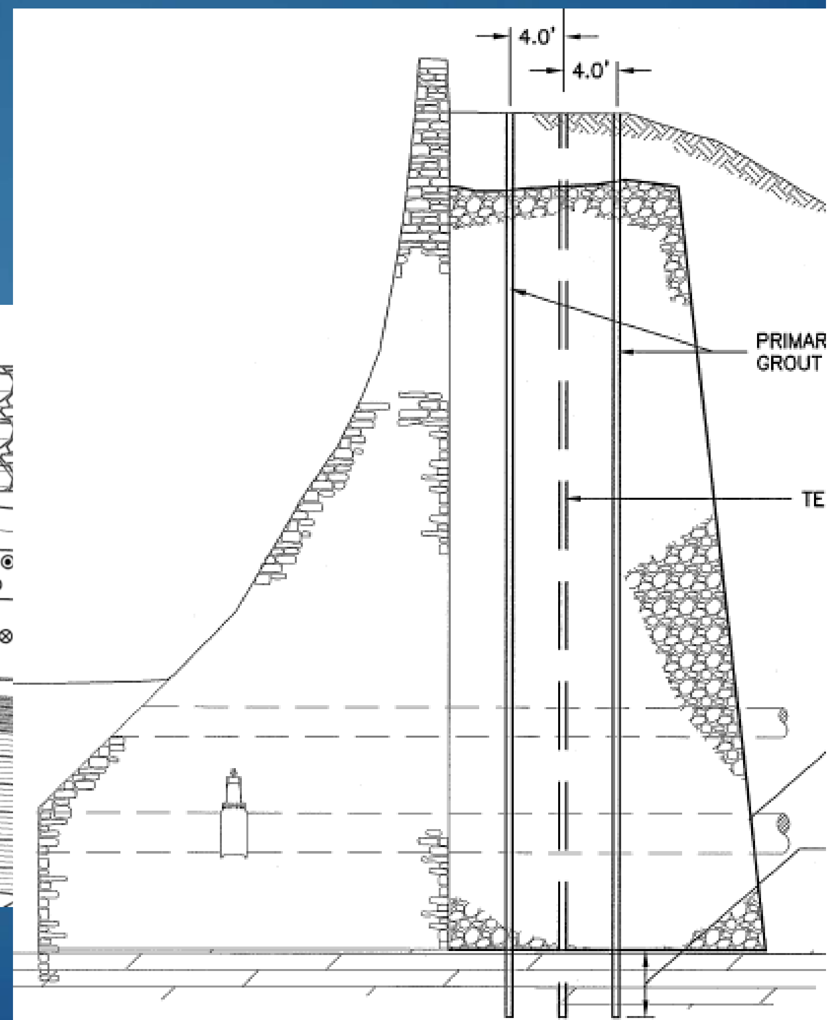
Stabilize for PMF Overtopping

- Grout rubble masonry
- Dowel masonry units together
- Anchor dam

Design

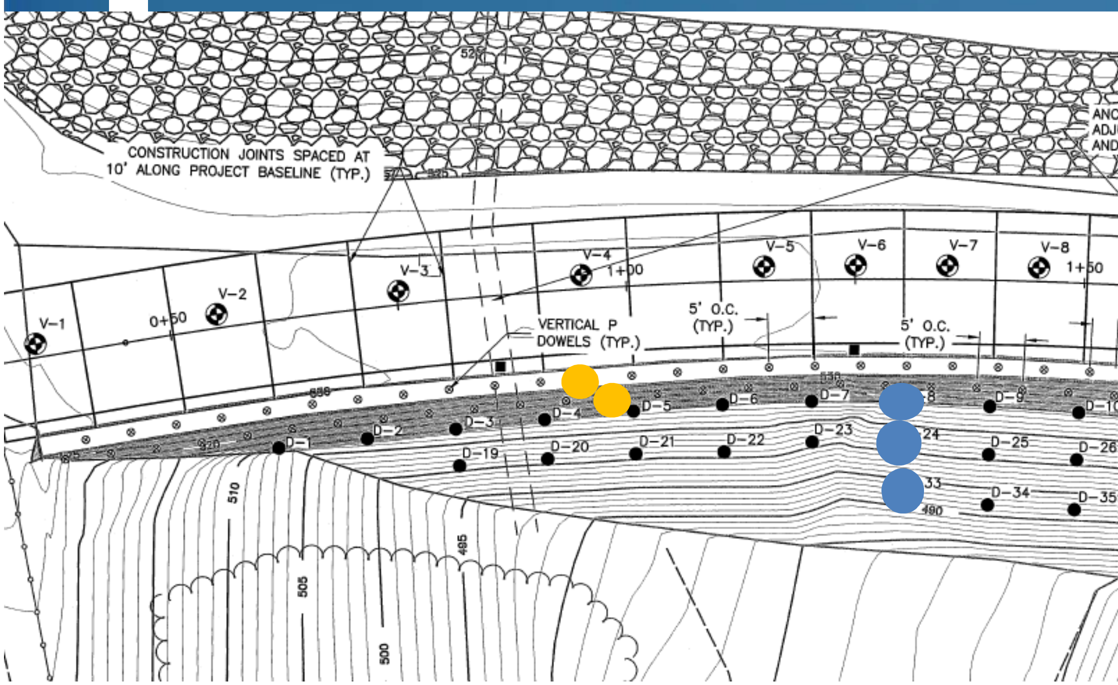
- Pressure grout rubble fill
  - MMG and HMG
    - Balanced / stable grouts
    - Real time monitoring
    - Primarily ascending stage

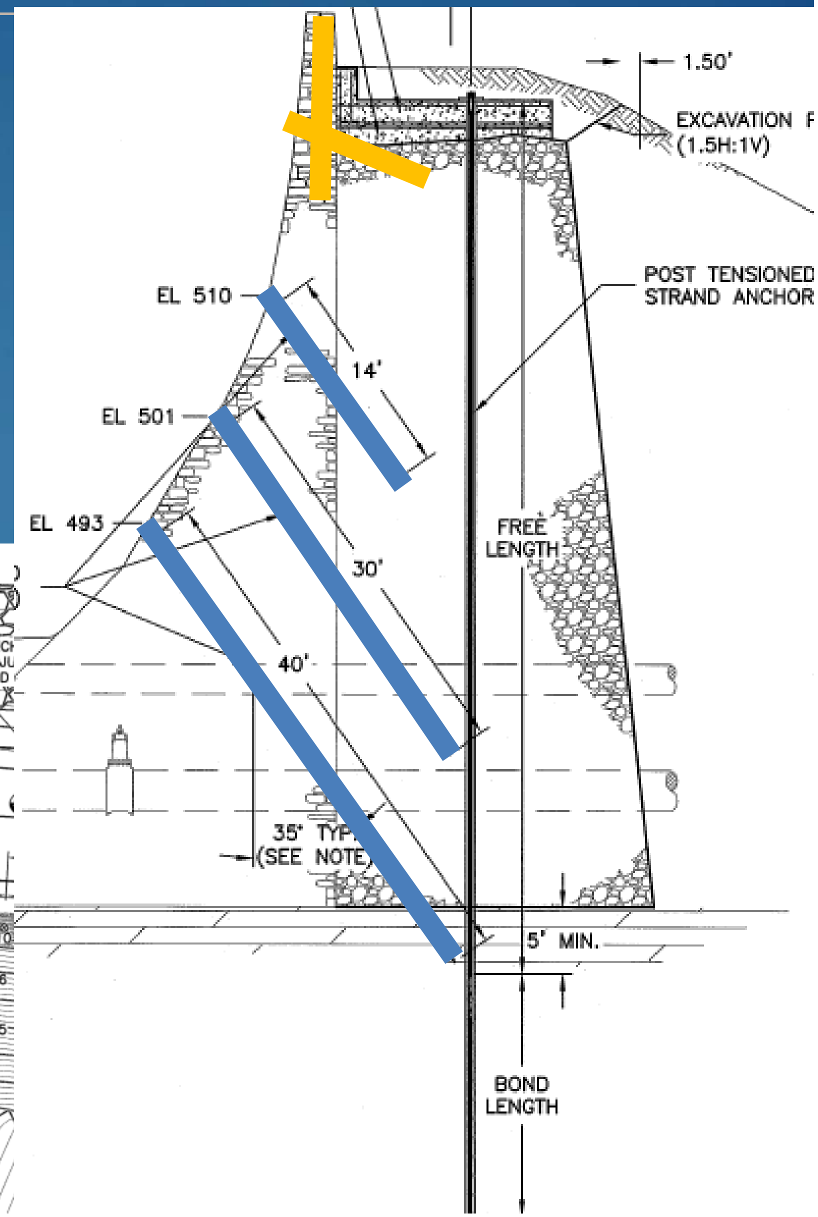




Design

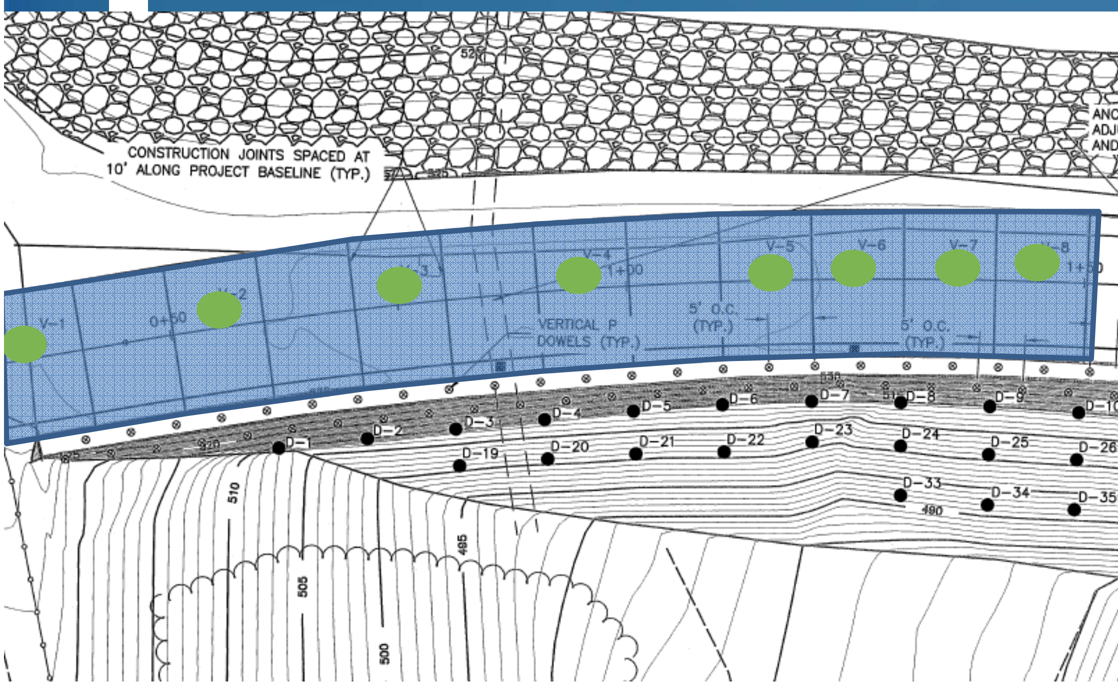
- Grout rubble fill
- Dowel masonry

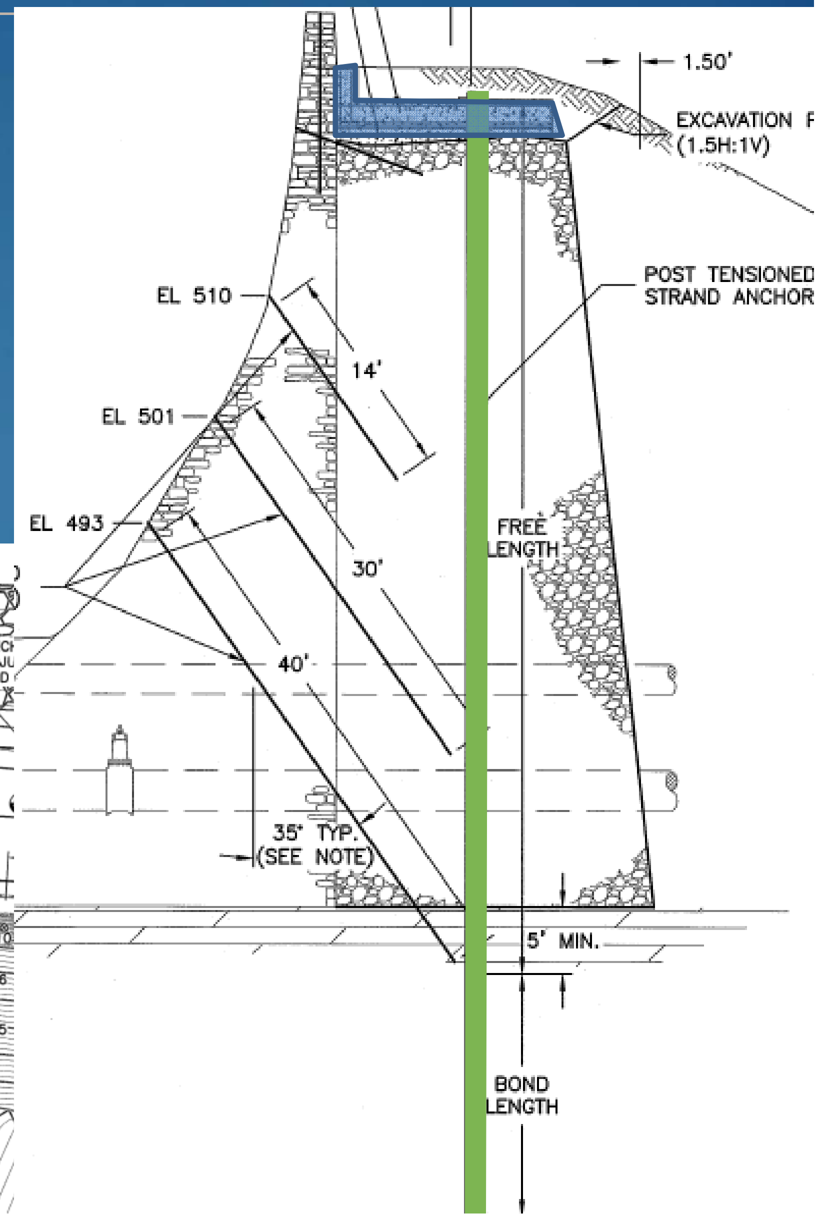




Design

- Grout rubble fill
- Dowel masonry
- PT anchor dam



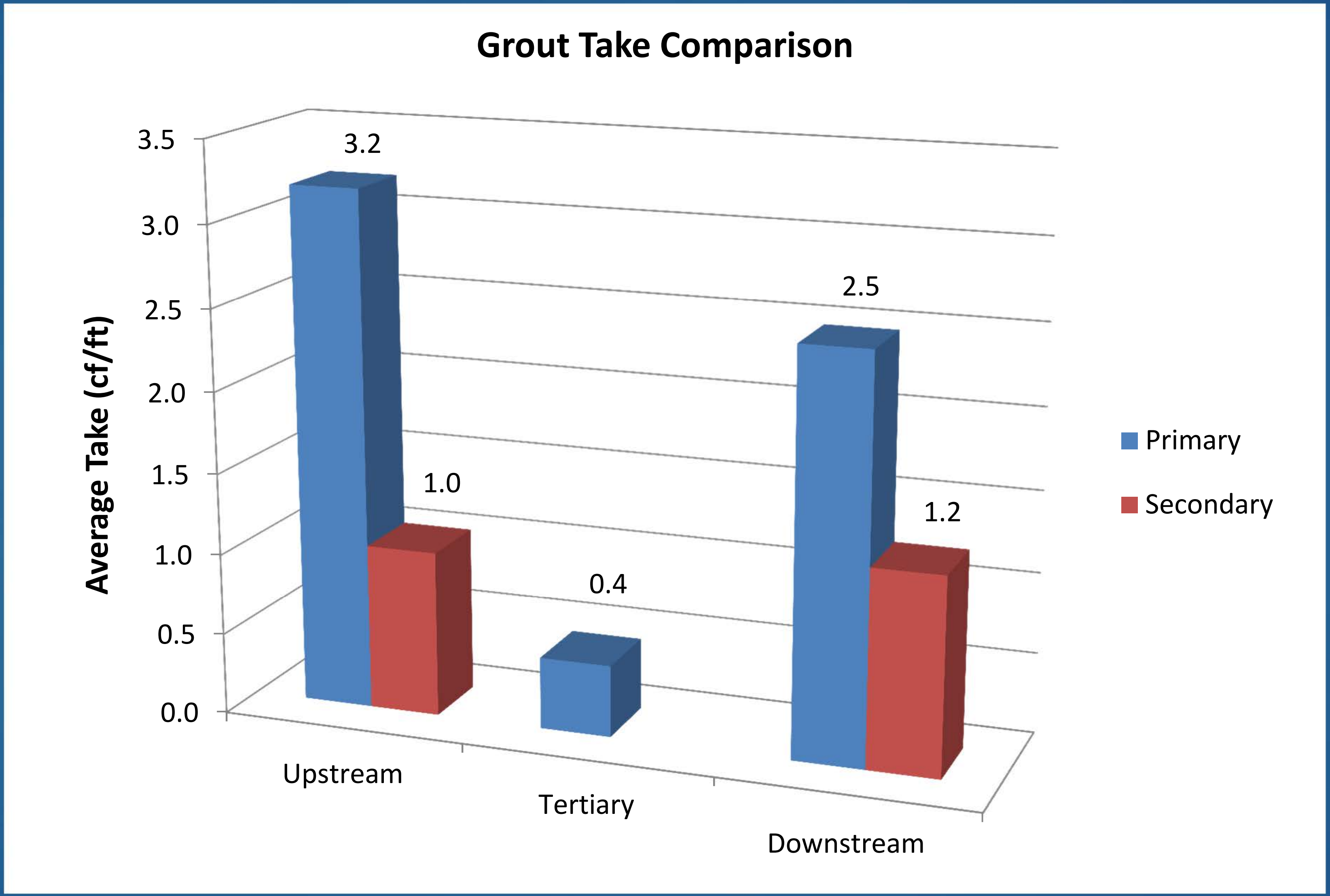


Parapet Dowels

Crest Excavation

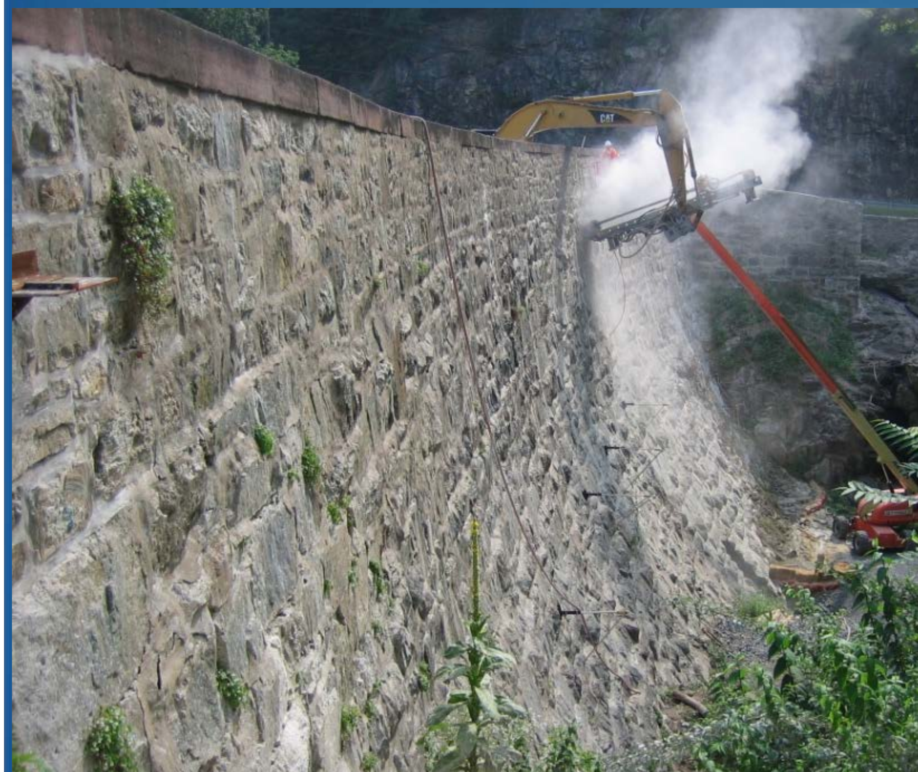
Grouting

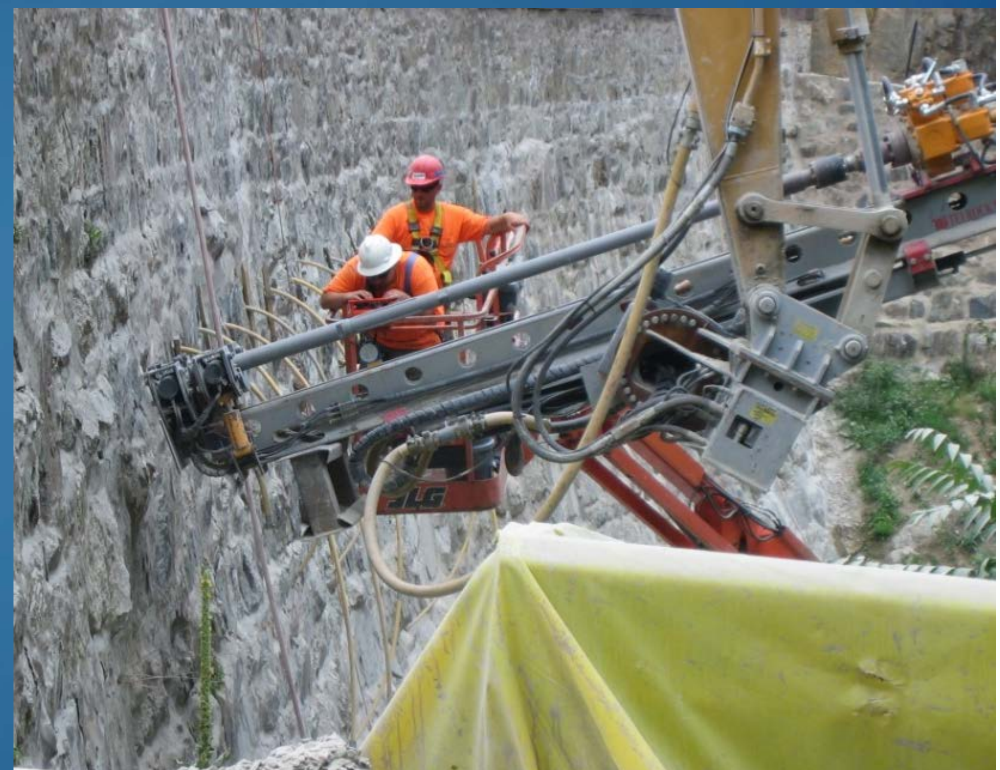
Grouting Evaluation



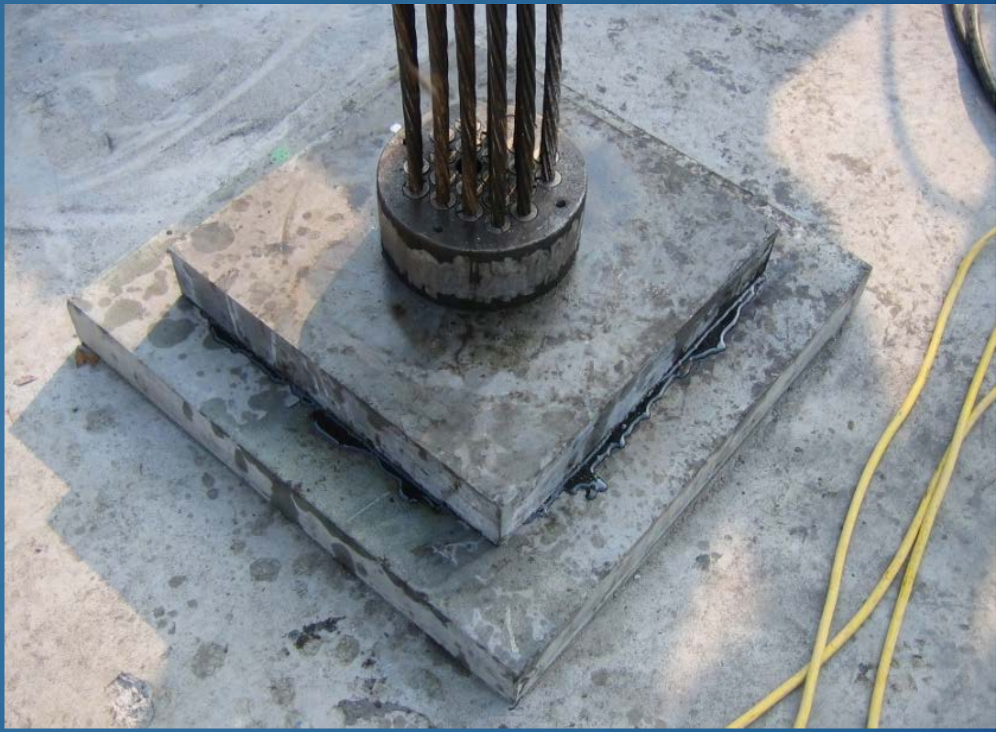
Grouting Evaluation

Masonry Dowels

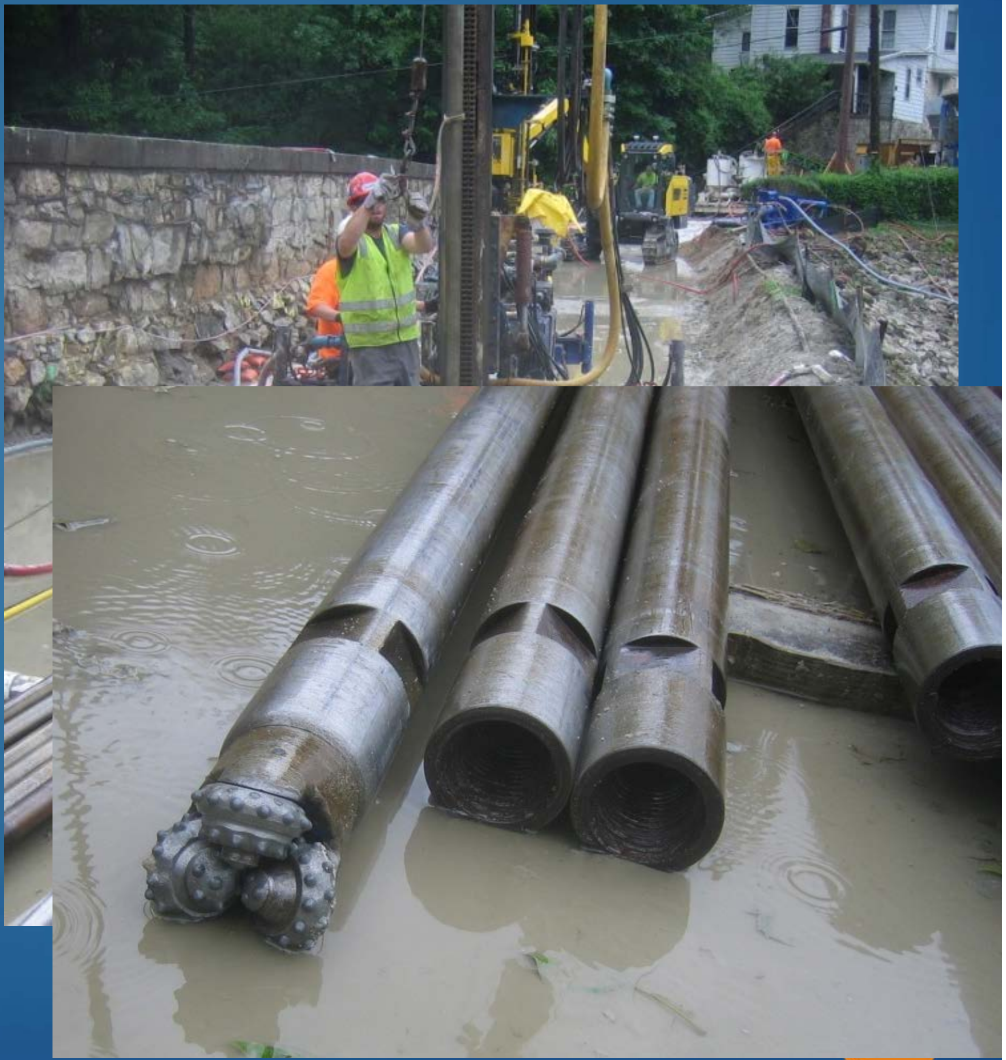




PT Anchors

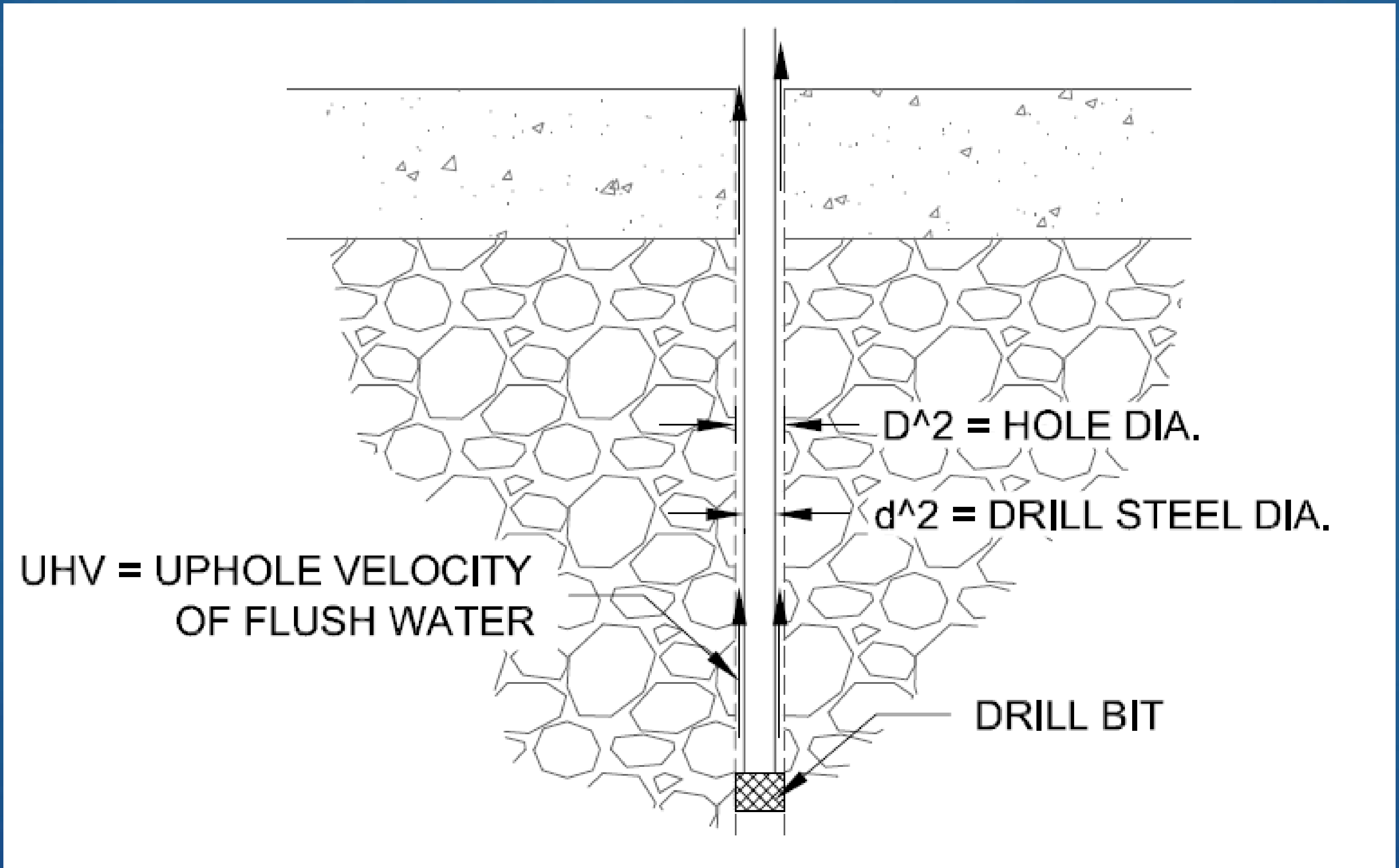


Drilling Challenges



Drilling Challenges

Uphole Velocity



Drilling Challenges

Cuttings Removal

Uphole Velocity

$$\text{UHV (m/min)} = \frac{\text{1274xFlush Rate (liters/min)}}{D^2 - d^2\ \text{(mm)}}$$

Ref 1

Slip Velocity

Stokes law w/ drag force, stagnant fluid

$\nu_{sl} = d_s^{\,2} g(\rho_s - \rho_f) / (18\mu)$

Ref 2

Turbulent slip velocity

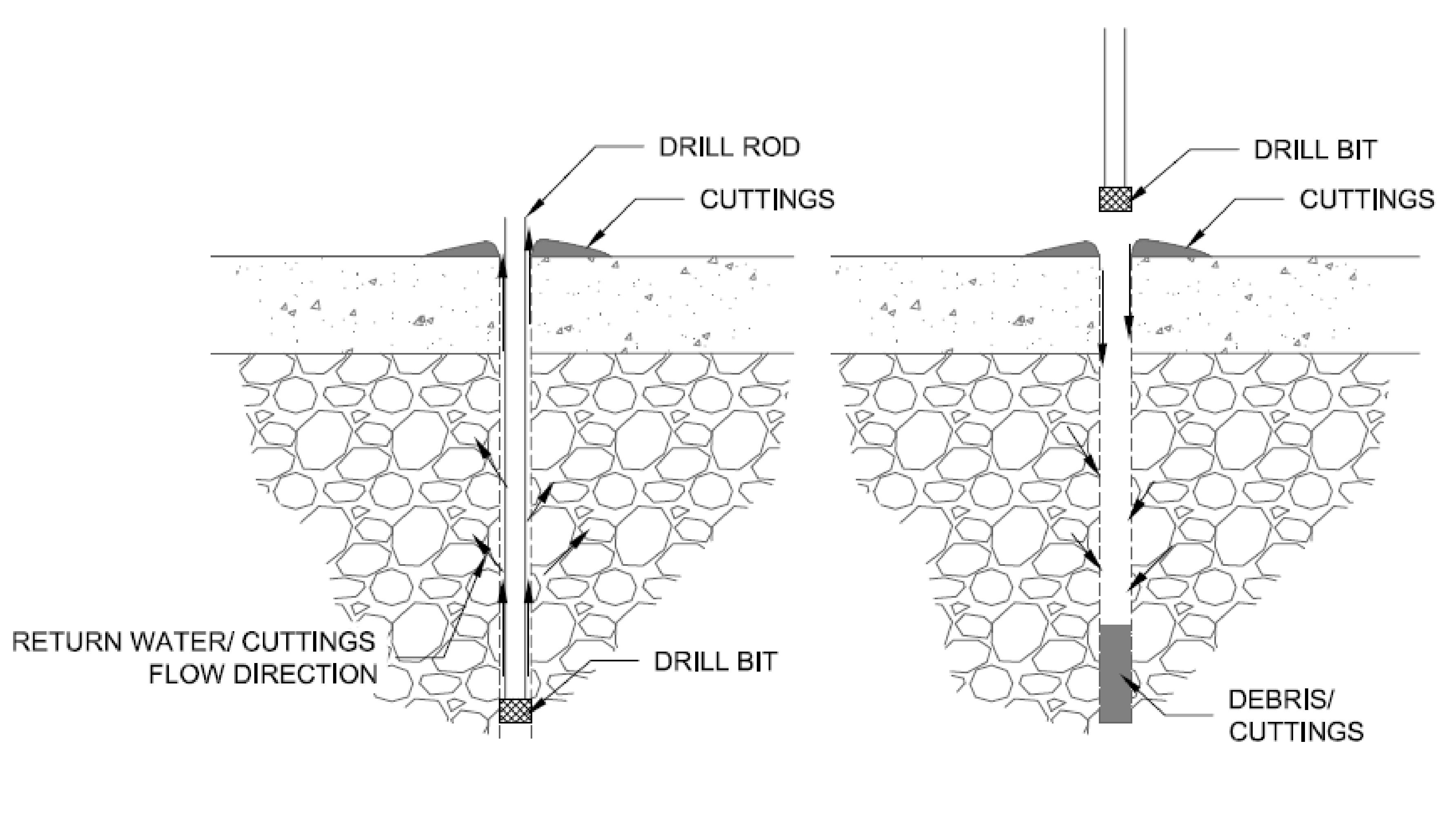
$$v_{sl} = \frac{2}{3}\sqrt{\frac{3gd_s(\rho_s - \rho_f)}{f\rho_f}}$$

Ref 2

1. Grouting Fundamentals and Current Practice, *Basics of Drilling*, presented by Dr. Donald Bruce, June 2012
2. http://petrowiki.org/Cuttings_transport

Drilling Challenges

Drilling Challenges



Drilling / Grouting Challenges

- Exploration
  - Coring ≠ Drilling
  - Test drilling methods
- Drilling
  - Water Loss
  - Caving
  - Cutting removal
  - Dam disturbance
- Grouting
  - MMG/HMG
  - Pressure

Thank You