Why Did the Tunnel Cross the Road?

72” Water Line Tunneling Considerations

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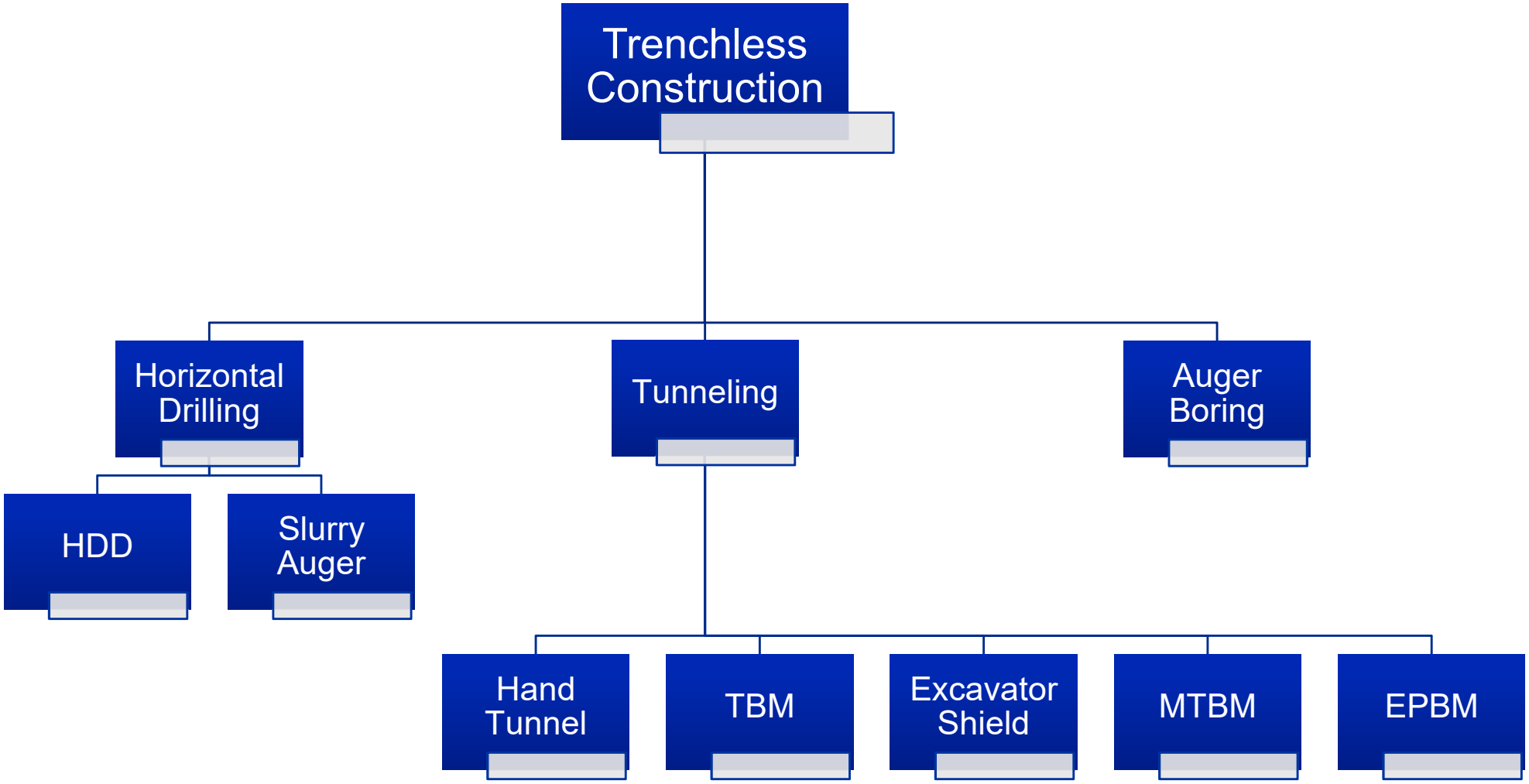
A LEO A DALY COMPANY

Introduction

- ALWAYS ask three questions for ANY tunnel

1. What size pipe?
2. How long is the drive?
3. What are the ground conditions?
   - Without Geotech only preliminary method can be determined

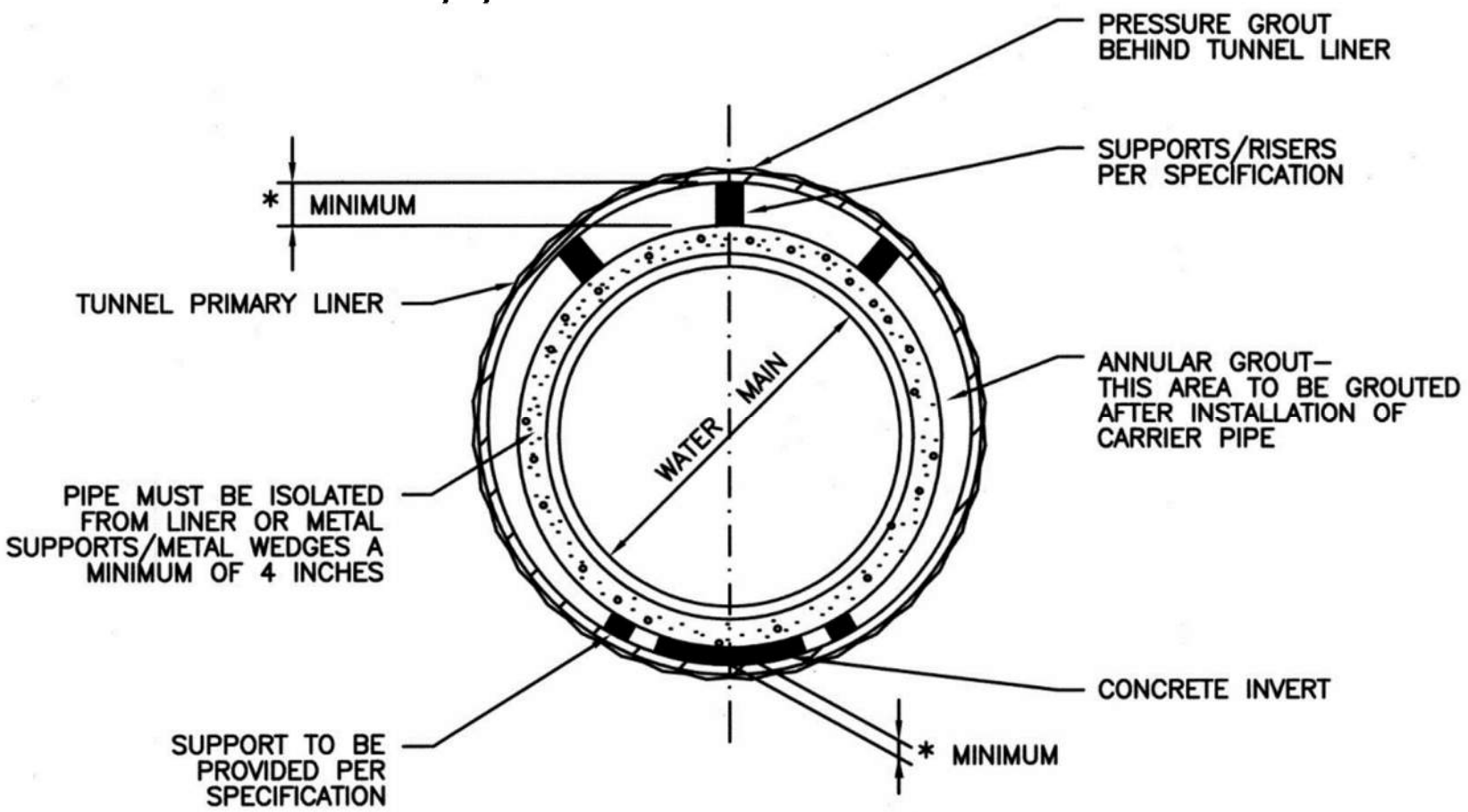
- These three questions will narrow your list of choices/options


Trenchless Construction
Horizontal Drilling
Tunneling
Auger Boring
HDD
Slurry Auger
Hand Tunnel
TBM
Excavator Shield
MTBM
EPBM

Tunneling Methodology

Two Pass Tunnels

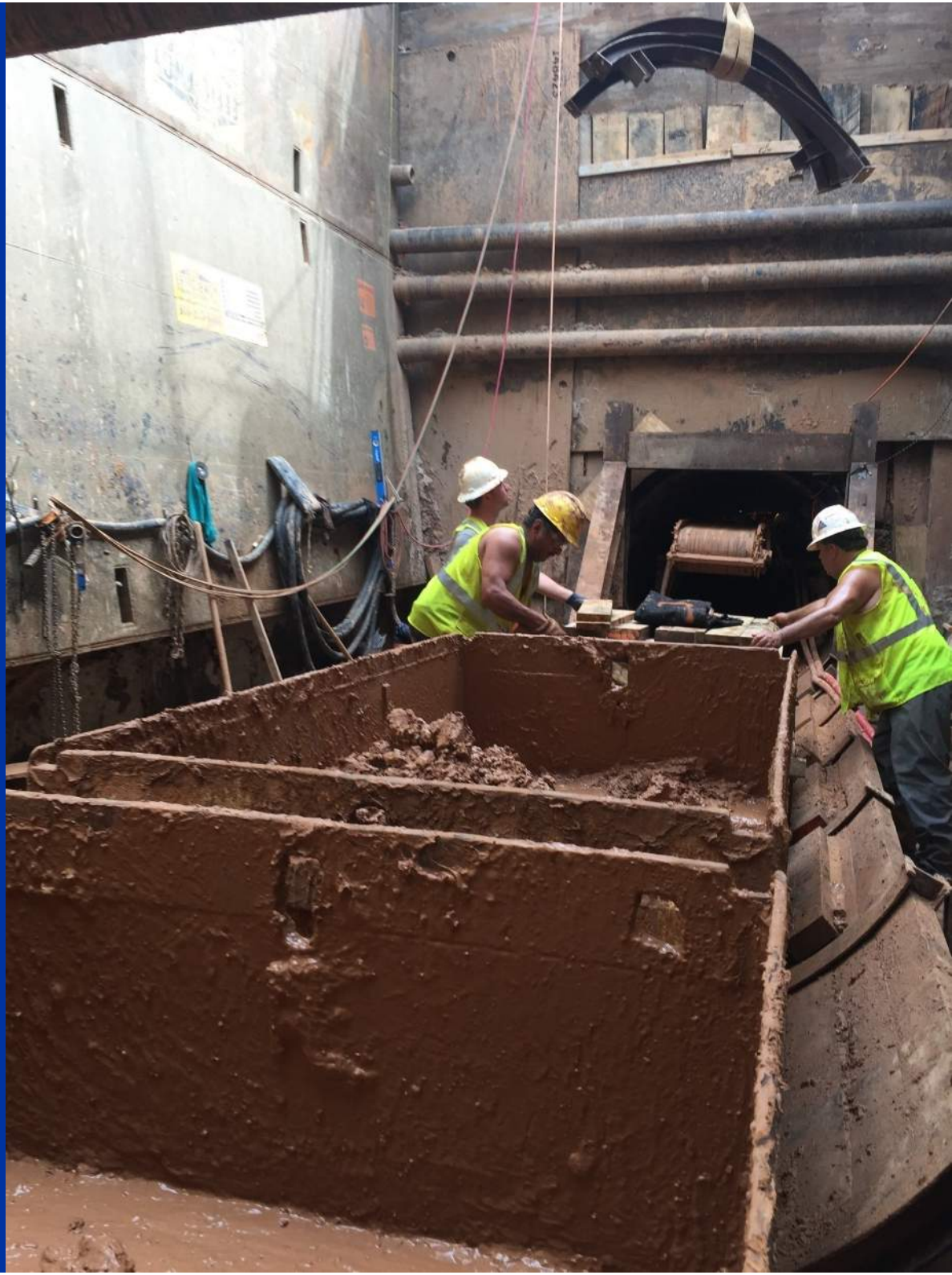
- Typically for water lines; require support
- Pass 1. Install steel liner
- Pass 2. Install carrier pipe



Two Pass Tunnels

- **Pass 1. Install steel liner**
  - Build tunnel (liner plate, ring beam and lag, etc.)
    - Hand tunnel
    - Excavator shield
    - TBM
  - Direct jack steel casing
    - Auger boring
    - TBM
    - MTBM
    - EPBM
- **Pass 2. Install carrier pipe**
  - Grout floor bottom for pipe carrier to travel on
  - FRP, RCP, Steel, etc.
    - Pipe carriers
    - Jacking frame

72-Inch Diameter Tunnel Options



Hand Tunnel

- Relatively short drive lengths with exceptions
- Install size 42”+
- Small pit size
  - Only need room for haul unit with muck bucket
  - When pipe jacking, need room for hydraulic cylinders
- Crew size ~6 workers

Hand Tunnel

- Noise considerations: Low
- Traffic effects: One lane closure (typically)
- Install rate: 10ft on a good day (size dependent)

Excavator Shield

- Capability of 1000+ ft runs
- Install size 100”+
- Large pit size
  - Need room to launch machine
  - Dependent on pipe length
- Crew size ~6 workers

Excavator Shield

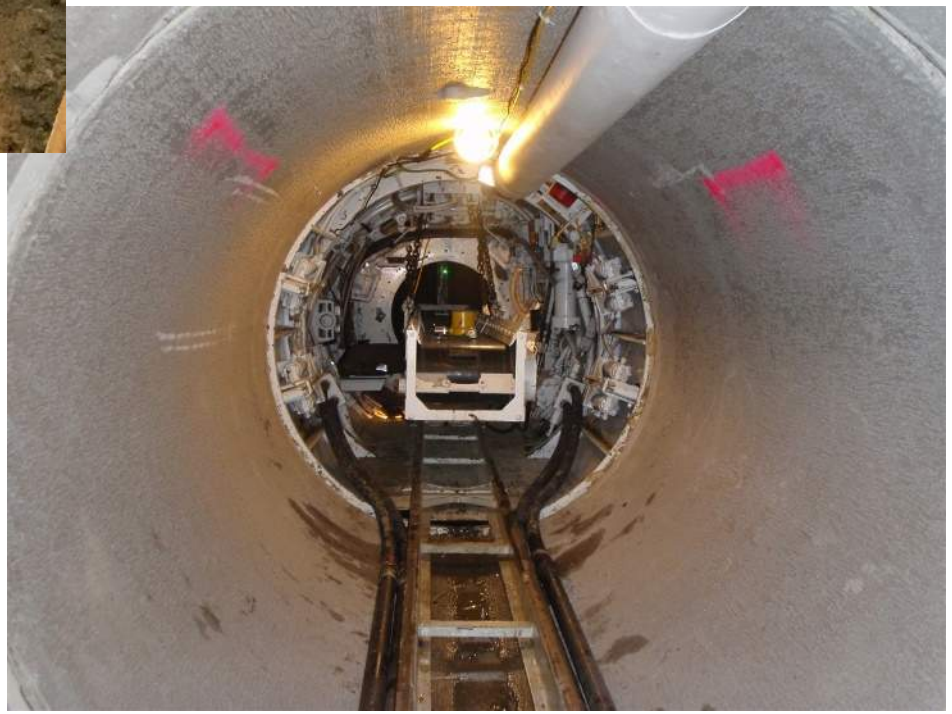
- Noise considerations: Medium to high
- Traffic effects: Depending on machine size
- Install rate: 20-40 ft on a good day (pipe jacking)

Tunnel Boring Machine

- Capability of 1000+ ft runs
- Install size 48”+
- Large pit size
  - Need room to launch machine (sometimes longer than pipe)
  - Dependent on pipe length
- Crew size ~6 workers

Tunnel Boring Machine

- Noise considerations: Medium to high
- Traffic effects: Depending on machine size but can be down to one lane closure
- Install rate: 40 ft on a good day (pipe jacking)



Tunnel Boring Machine

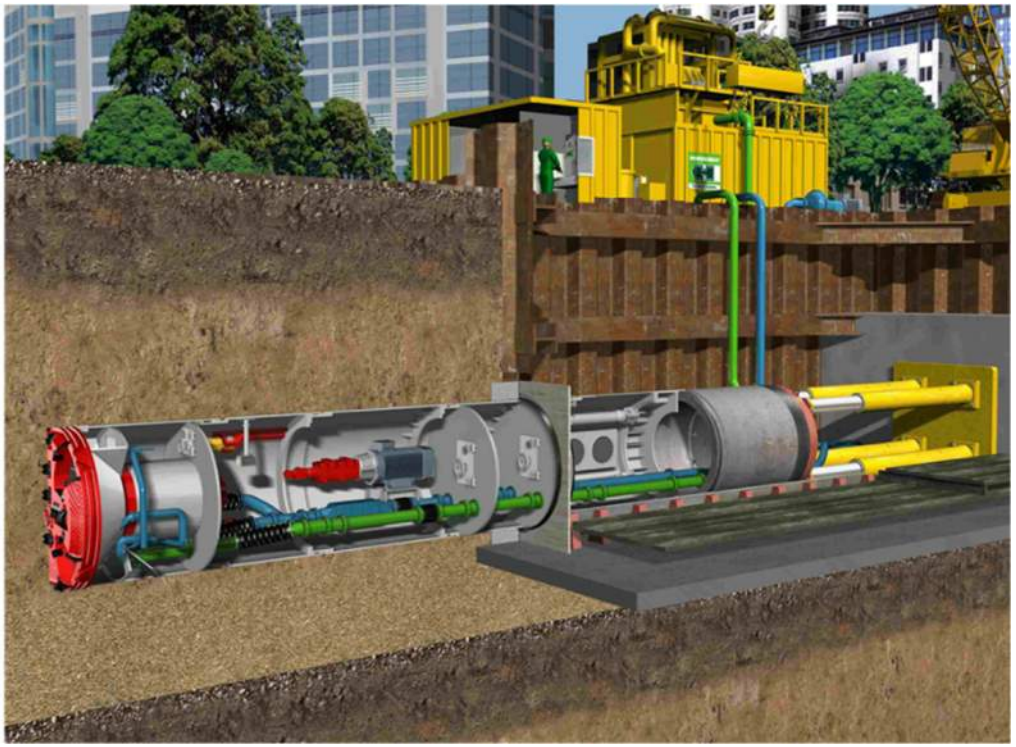
- **Closed Face is not pressurized head!**
- Confirm head specifications with manufacturer

Microtunnel Boring Machine

- Pipe Jacking Operation
- Controlled from Surface
- Steerable to Line and Grade
- Above or Below Water Table

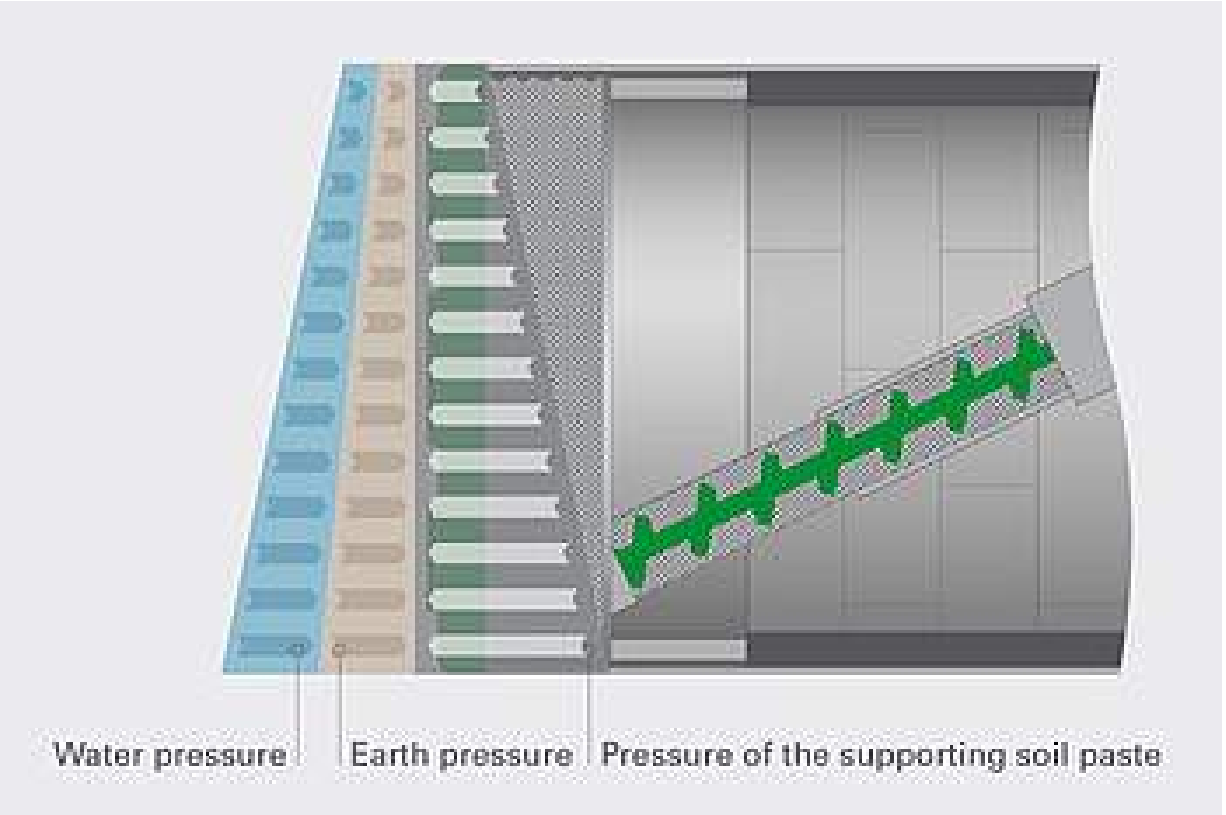
Microtunnel Boring Machine

- Capability of 1000+ ft runs
- Install size 30”+
- Small machines typically stay in the 500 ft range
  - Don’t have enough power
- Large pit size
  - 30” machine requires about 12’ round shaft
  - Dependent on pipe length
- Crew size ~ 6-10 workers

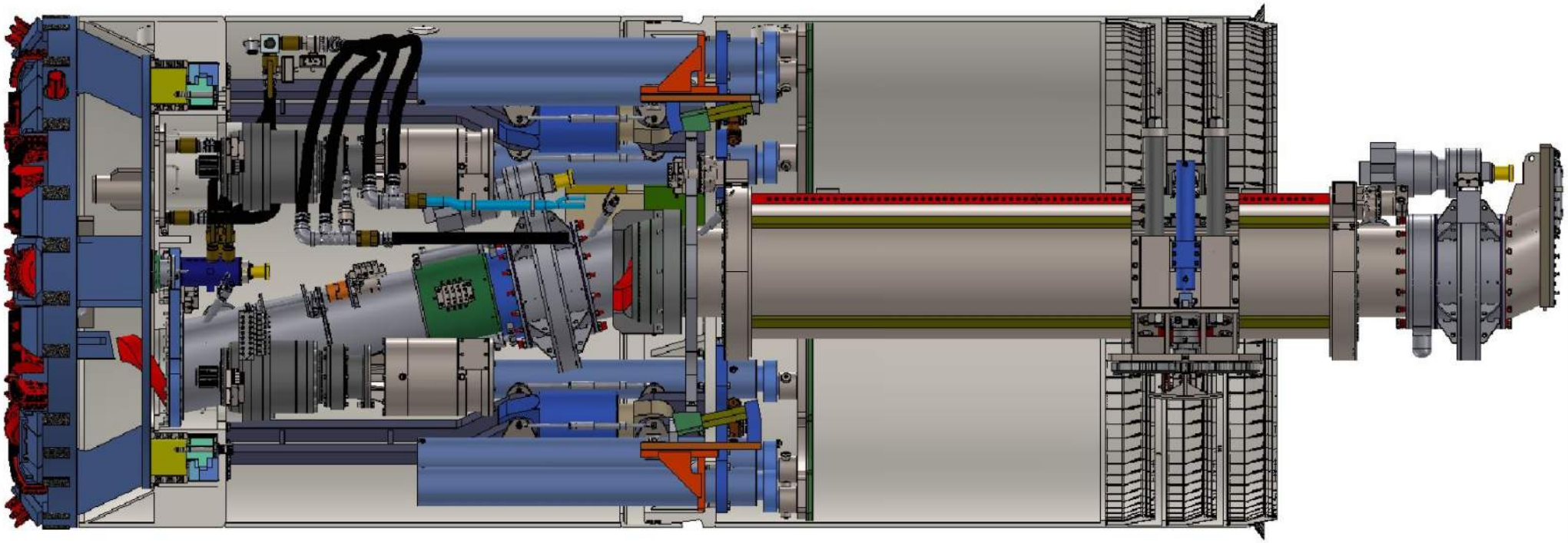


Earth Pressure Balance Machine

- EPBMs monitor and maintain earth pressures by balancing the machine advancements and excavation rates
- Equipment layout is project specific
- Capability of 1000+ ft runs
- Install size 100”+
- Large pit size
- Crew size ~10 workers



Earth Pressure Balance Machine



Earth Pressure Balance Machine

Considerations For Tunneling a 72-Inch Pipe

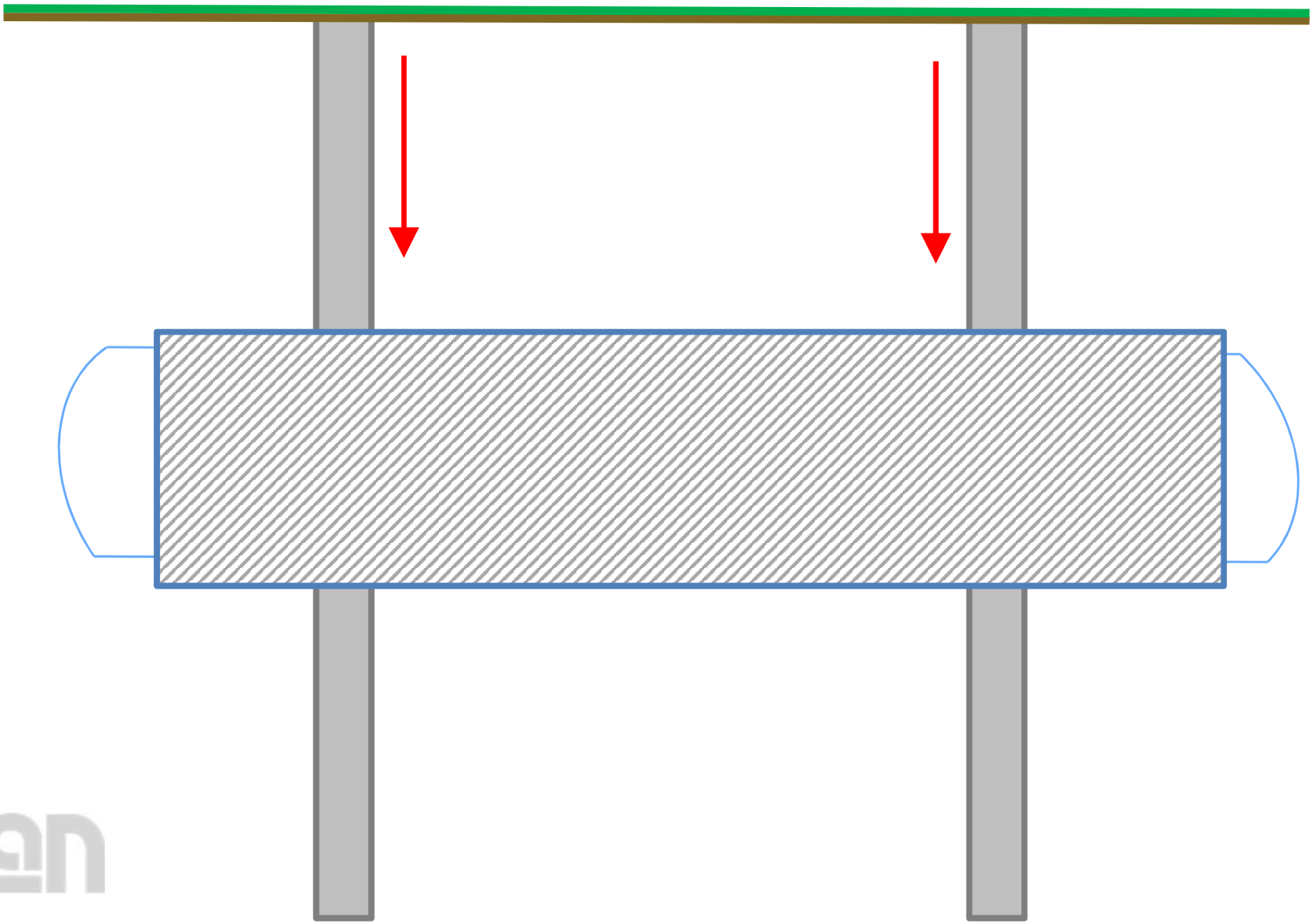
Above Ground Impacts

- **Pit Limits**
  - Choose methodology based on excavation limitations
- **Deep Excavation in Unstable Soils**
  - Design pit and alignment to accommodate soils
- **Settlement Monitoring**
  - How and when

Underground Obstacles

- **Groundwater**
  - Work uphill or downhill
- **Floating Boulders**
  - How to handle over-excavation of tunnels
- **Drilled Shafts**
  - Above ground and below grade accommodations for vertical piers

Underground Obstacles



Permitting

- **Limited methods and flexibility**
  - Design with the permit in mind
- **Variances**
  - Engineering justification

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Closing Remarks

- Trenchless Technology Methods each have their place
- Many things to consider when going trenchless
- No two tunnels are the same
- What is an appropriate method based on pipe requirements?
- Constraints to that method?
- After these two questions, may be back at square one

Questions

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