Case Study: Remediation of TCE in Fractured Rock

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Abstract

Trap & Treat® BOS 100® was injected in fractured shale bedrock at a corporate site in New Jersey in 2018. The Classification Exception Area /Well Restriction Area (CEA/WRA) was removed 25 months post-injection after achieving New Jersey Ground Water Quality Standards (GWQS).

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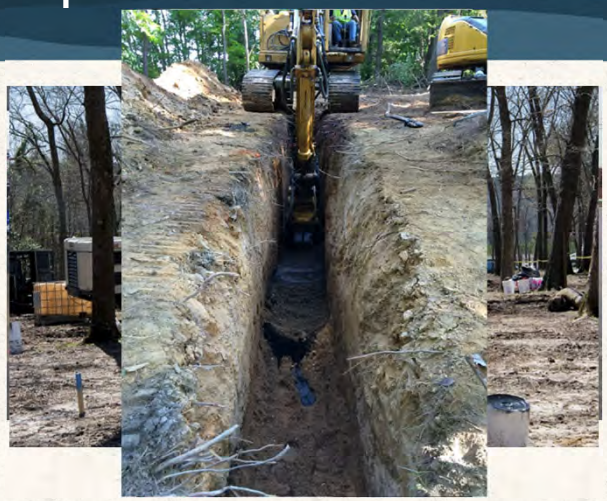
Slurry Application Techniques

- Direct Push (top-down)
  - Clay/silt/sand/gravel
- GeoTAP™ Method (top-down)
  - Sonic or auger → DPT
- Bedrock (bottom-up)
  - Straddle packer isolates fractures
- Soil mixing (trench or areal)



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GeoTAP™ Technique

- Sites where DPT (alone) cannot be used due to refusal
  - e.g. gravel/cobble zones, glacial till, weathered bedrock, historic fill, etc.
- Pre-drill each location
  - Augers (HSA, SSA) or Sonic to the target/total depth
- Backfill borehole with engineered bentonite; hydrate; build in lifts
- Probe through bentonite using DPT
- High energy injection cuts though bentonite
- 50+ sites in various geologies/regions completed to date

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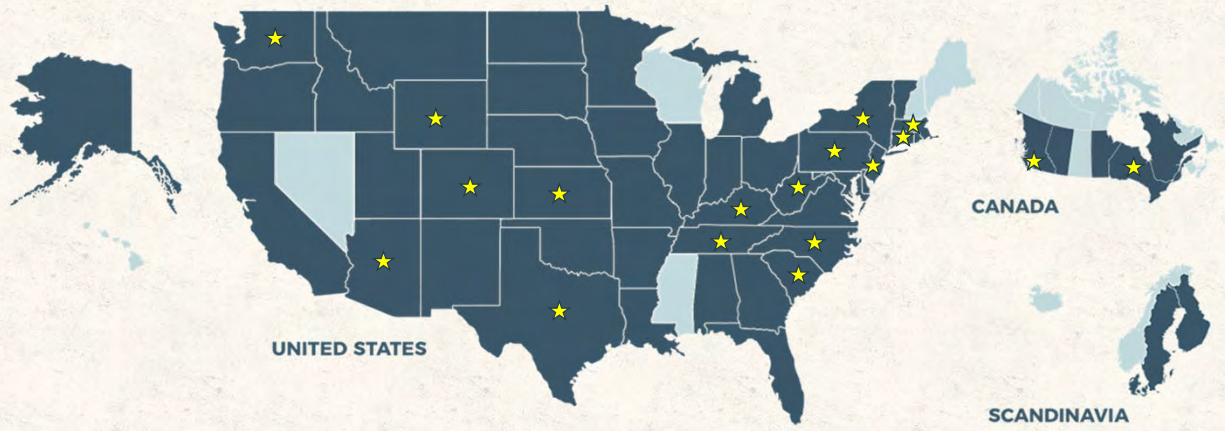
GeoTAP™ Applications



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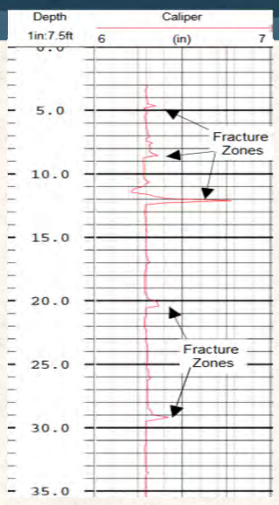
Bedrock Injection via Packers

- Straddle packers used after downhole geophysics to isolate and inject into fractures
- Straddle packers can also be used to isolate and sample fractures
- High energy injection systems necessary when working with slurries



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Injection at Various Flow Rates

Various Flow Rates

75 lpm, 230 lpm
455 lpm, 945 lpm

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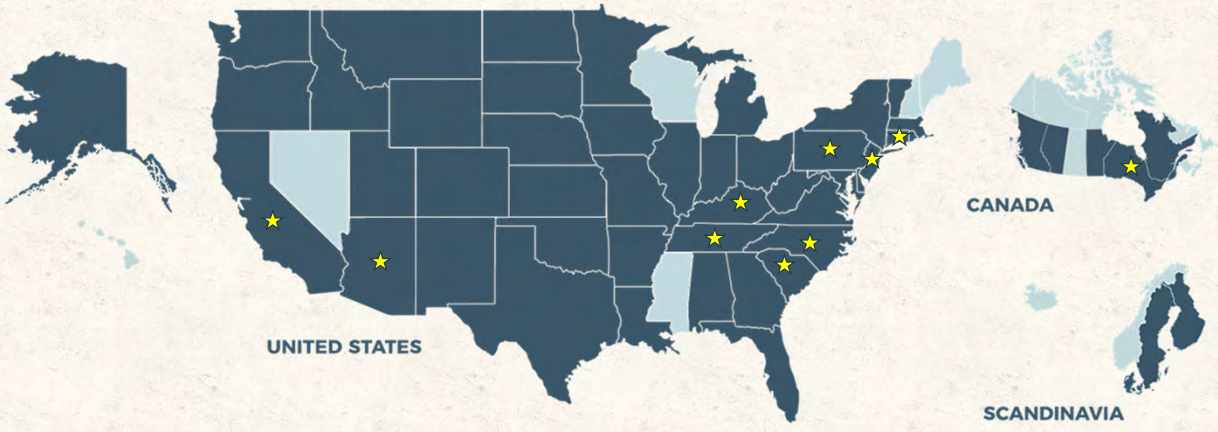
Fractured Bedrock Applications



Dark Blue: Places we've worked
Other locations not shown- UK, France, Italy, South Africa, Australia, and Puerto Rico

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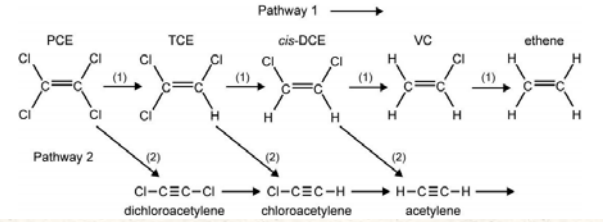
Technology Selected – BOS 100®

- GAC platform (93.5% w/w)
- Impregnated with metallic iron (6.5% w/w)
- Not a mixture of ZVI/Carbon
- Chemical reduction via β-elimination
  - Limits daughter product generation



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Key Project Dates

- 1992 – Unknown TCE discharge discovered in groundwater testing
- 2011 – Former catch basin and soils removed
- 2016 – Remedial Investigation Report (RIR)
- 2018 – BOS 100 injections
- 2020 – No Further Action Granted

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Site Information

- Lithology: Reddish-brown argillaceous shale, localized sandstone/siltstone interbedding
- Depth to Water: 3 m below ground surface (m-bgs)
- Contaminants: TCE and 1,1-DCE
- Chlorinated solvent impacts were not above limits for overburden soils, effort focused on treating groundwater in PWR and bedrock.

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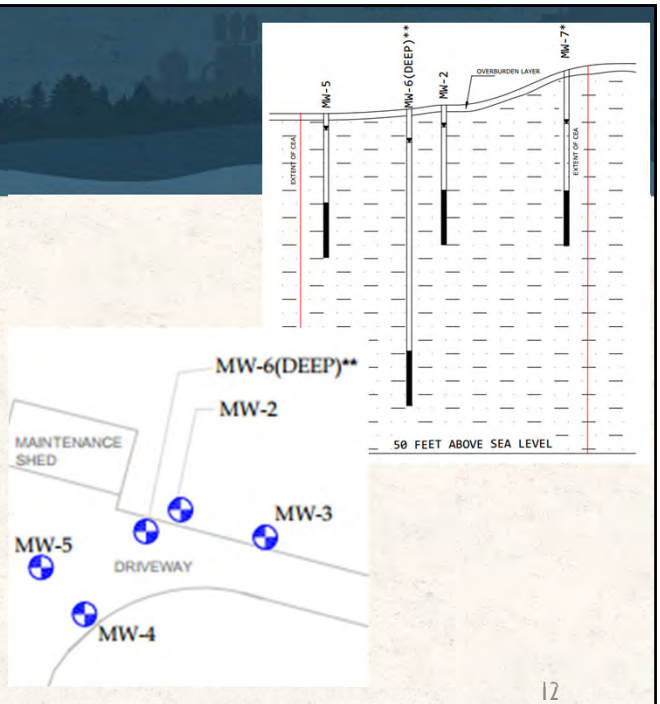
Conceptual Site Model

- TCE > NJ GWQS (1 µg/L)
- Overburden impacts non-existent
  - Soil/bedrock interface ~1 m bgs
  - No perched groundwater
- PWR Transition Zone undefined
- 86.9 µg/L to 98.9 µg/L TCE in the groundwater



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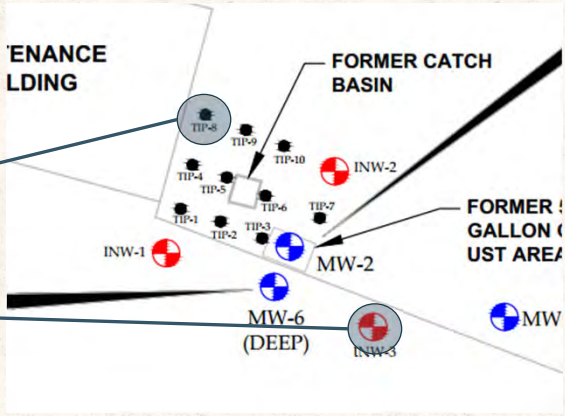
Treatment Area Information

- Treatment Area = 325 m2
- Treatment Interval: 4.5 to 18 m bgs
- Transition Zone Implementation Method: GeoTAP
- Bedrock Zone Implementation Method: Straddle Packer



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Bedrock RDC, Findings, and Remedial Approach

- 3 open borehole wells ~26 m bgs
- 10 GeoTAP points installed to 7.6 m bgs
- Downhole Geophysics
- Aquifer Characterization: straddle packer pump test and discrete interval sampling, transducer data logging
- CVOC impacts in borehole fractures
- Sorbed mass in PWR persistent source for dissolved impacts

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Remedial Approach

- BOS 100 slurry was applied within the fracture network and pre-drilled points within the transition zone.
- Fracture Network Injections were conducted using the AST bedrock truck unit which provides high flow rates through a narrow (0.5 m) straddle packer system.
- Transition Zone Injections were also conducted using the AST bedrock truck unit, injections were completed using high flow rates through 2.25” direct-push rods with a custom port injection tip.
- Injection flow rates of 265 to 380 liters per minute were used over the course of the project.

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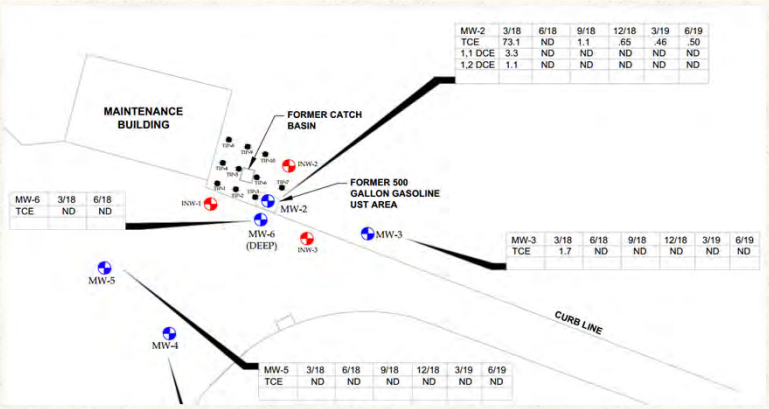
Results

- The maximum baseline concentrations for the target contaminants in MW-2 was 73.1 ug/l for TCE and 3.3 ug/L for 1,1-DCE, prior to transition and bedrock zone injections
- All four (4) monitoring wells within the treatment footprint achieved the project objective of 1 ug/l for TCE and 1,1-DCE in less than 6 months of the injection event.



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Thank You

Q&A

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