

# Innovative Evaluation of Chlorinated Solvent Source Area Mass for the Baghurst Drive Superfund Site Thermal Remedial Design

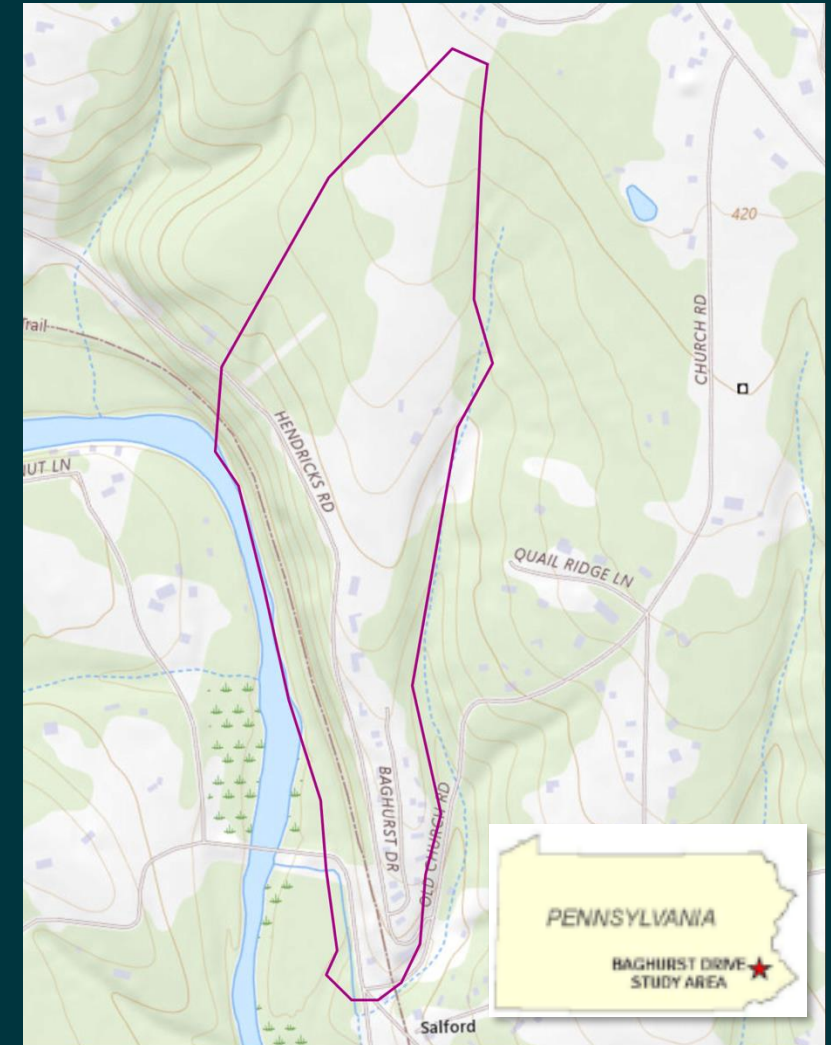
# Presentation Overview

1. What is the Baghurst Drive Superfund Site?
2. What is AECOM's role with the Site?
3. What were the opportunities for innovative characterization methods?
4. What are CORE<sup>DFN</sup> and MAE?
5. Where and how were CORE<sup>DFN</sup> and MAE used and evaluated on this project?
6. What value do these methods hold for other investigations?

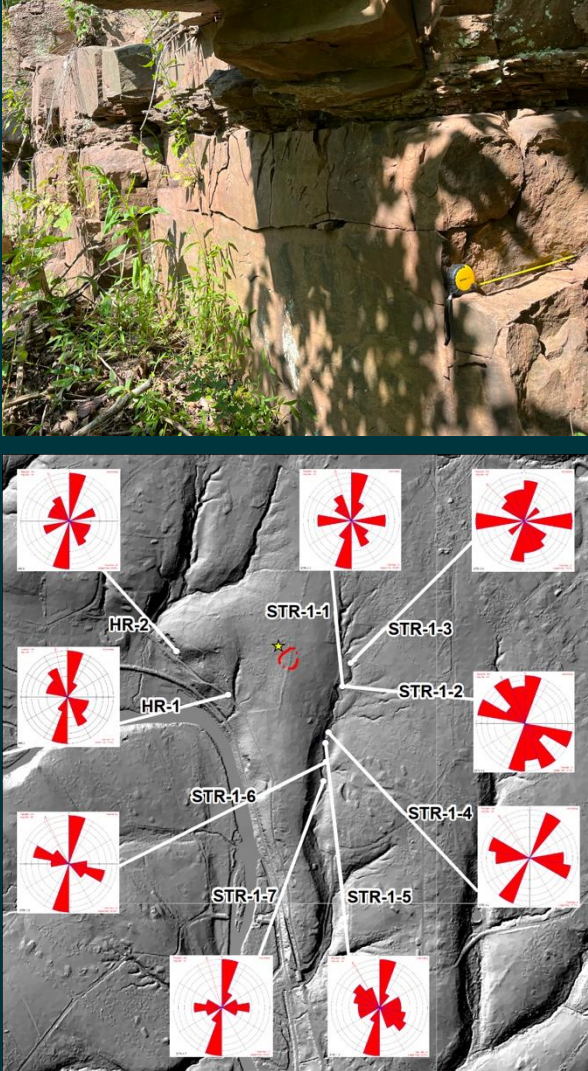
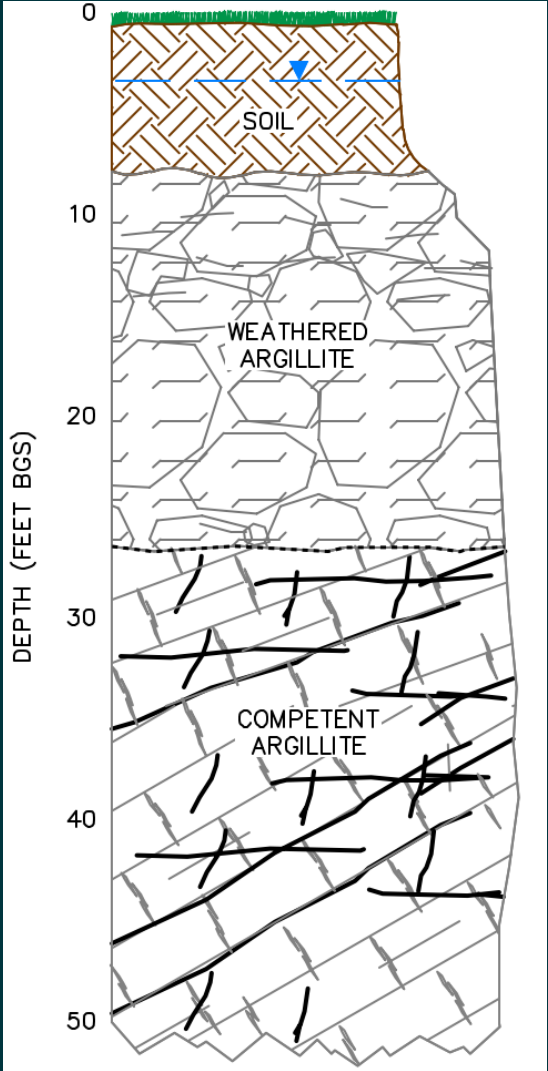
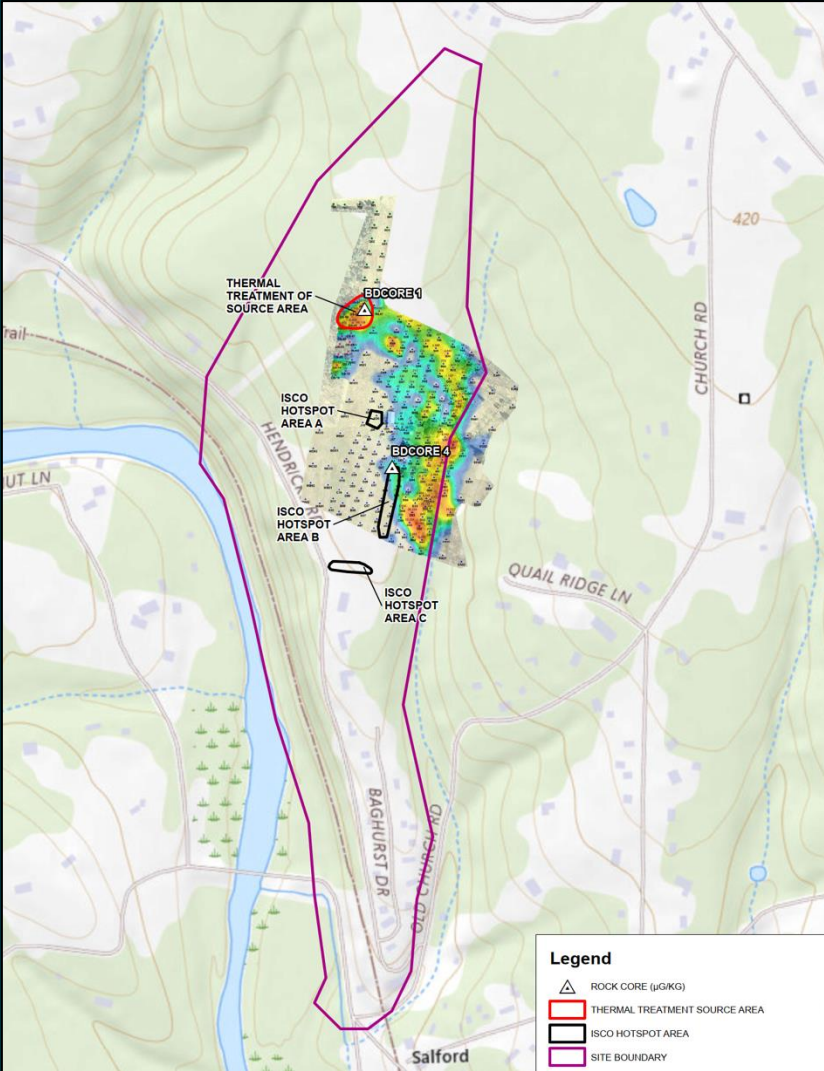


# Baghurst Overview & AECOM Role

- Rural setting north of Philadelphia in Montgomery County, Pennsylvania, along the Perkiomen Creek.
- Unpermitted, suspected septic waste disposal containing degreasers, principally 1,1,1-trichloroethane (1,1,1-TCA).
- Impacted groundwater in the Brunswick Formation of the Triassic Newark Basin, a fractured, leaky-confined groundwater system and sole source aquifer in the region.
- 17 home wells and 1 community supply well contaminated as a result
- Record of Decision (May 2022) Selected thermal remediation of the source area and in-situ chemical oxidation (ISCO) treatment of the down gradient plume
- AECOM is the Engineer of Record and Remedial Designer for EPA.

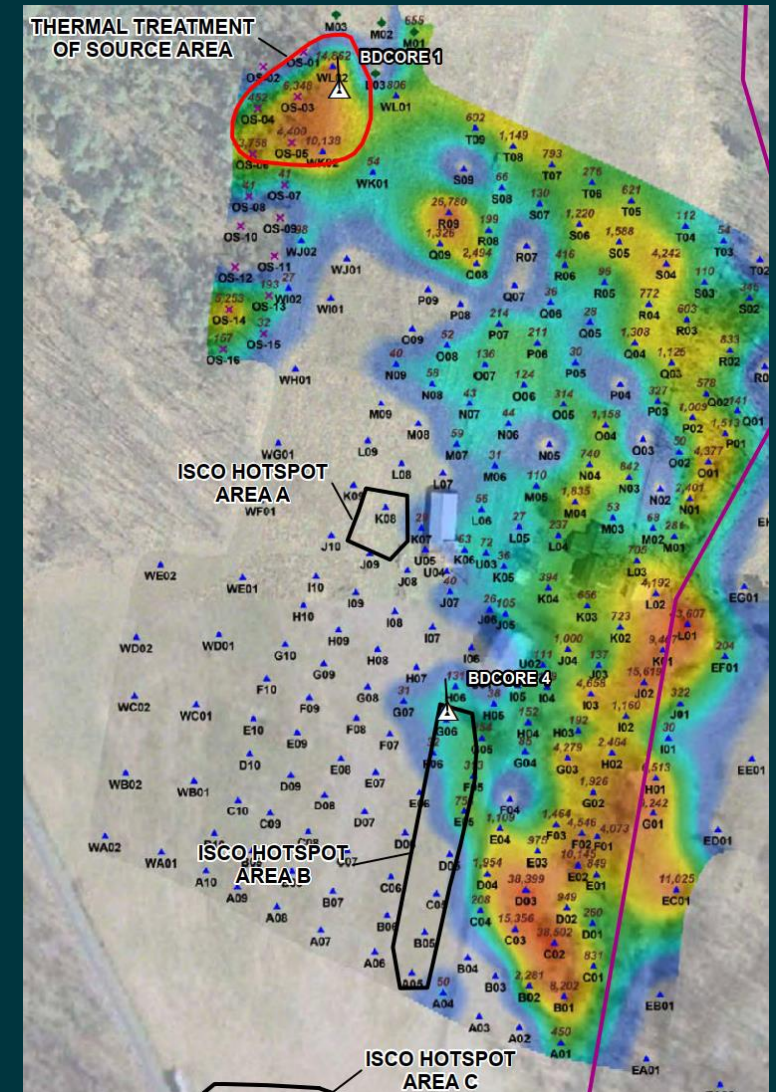


# Baghurst Overview & AECOM Role

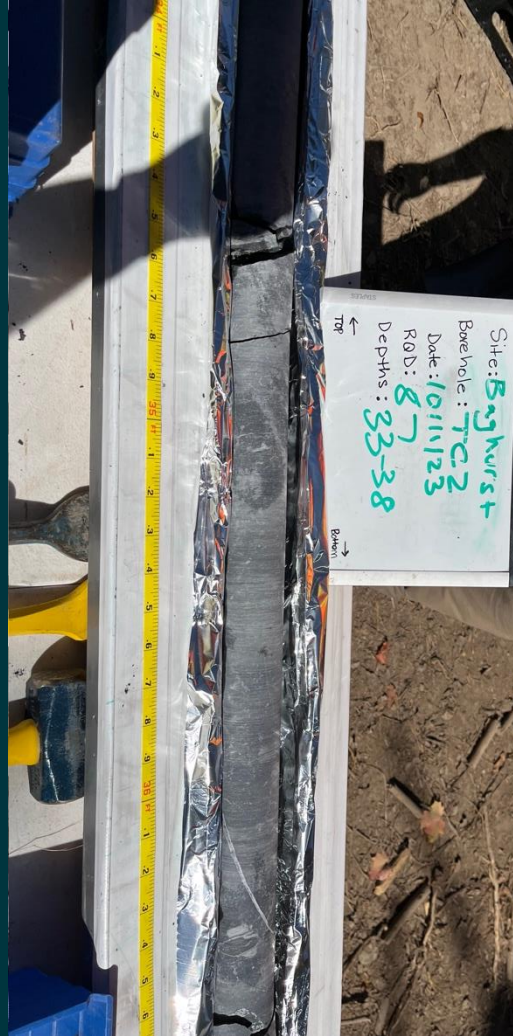


# Innovative Investigation Opportunities

- ROD recognized need for more delineation of the source area initially defined during the RI with a passive soil gas survey and one CORE<sup>DFN</sup> MAR rock core
- ROD recognized need for pilot testing ISCO in the dissolved plume
- AECOM opportunities to use and compare the utility of the CORE<sup>DFN</sup> and/or MAE analytical process at Baghurst:
  - Thermal resistivity bench scale test
  - Source area delineation
  - ISCO reagent pilot test



# Review of Methods



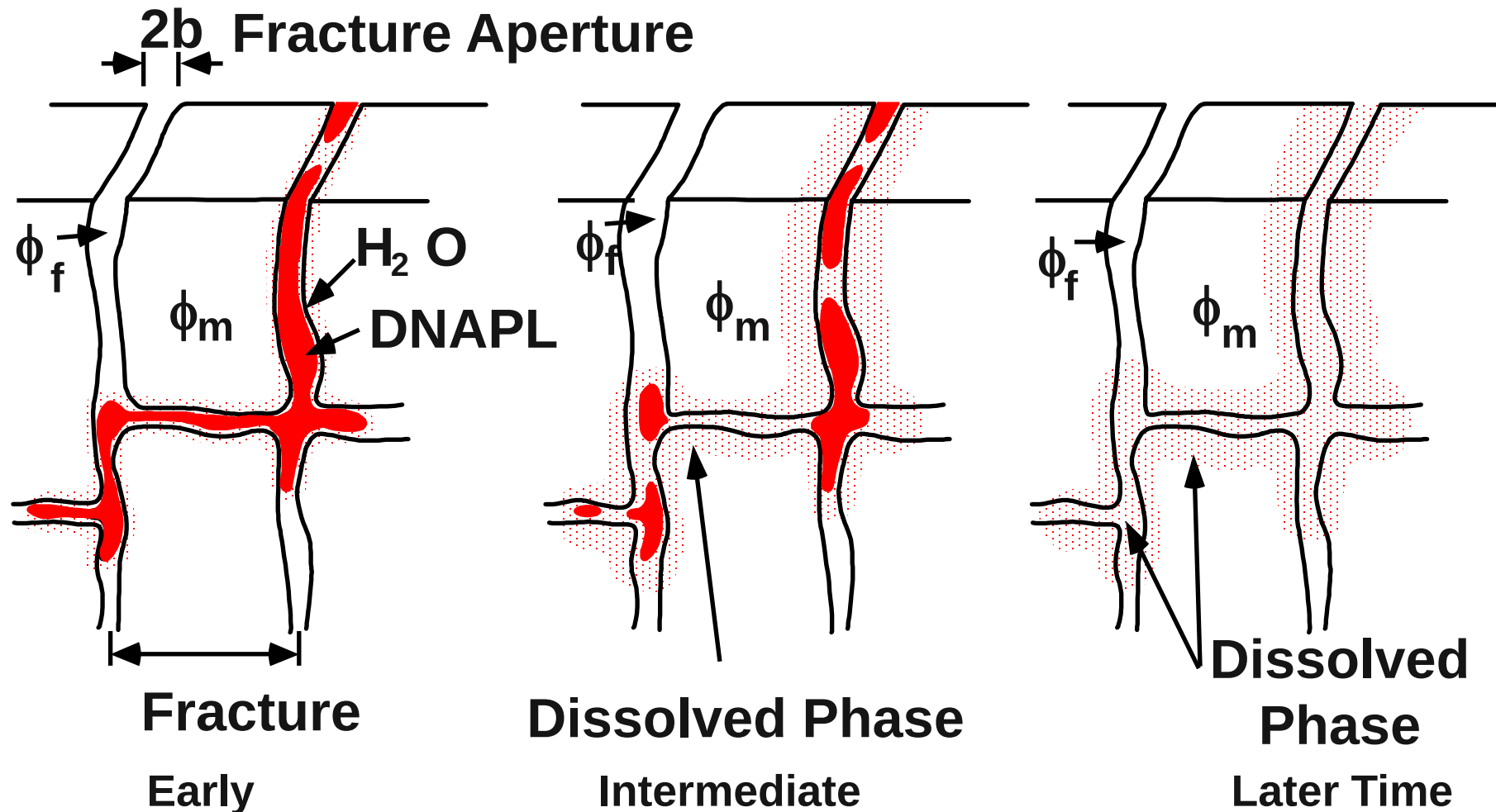
- Rational for CORE<sup>DFN</sup>
- CORE<sup>DFN</sup> Principles
- CORE<sup>DFN</sup> Procedures – Sampling and Analytical

SANBORN  HEAD



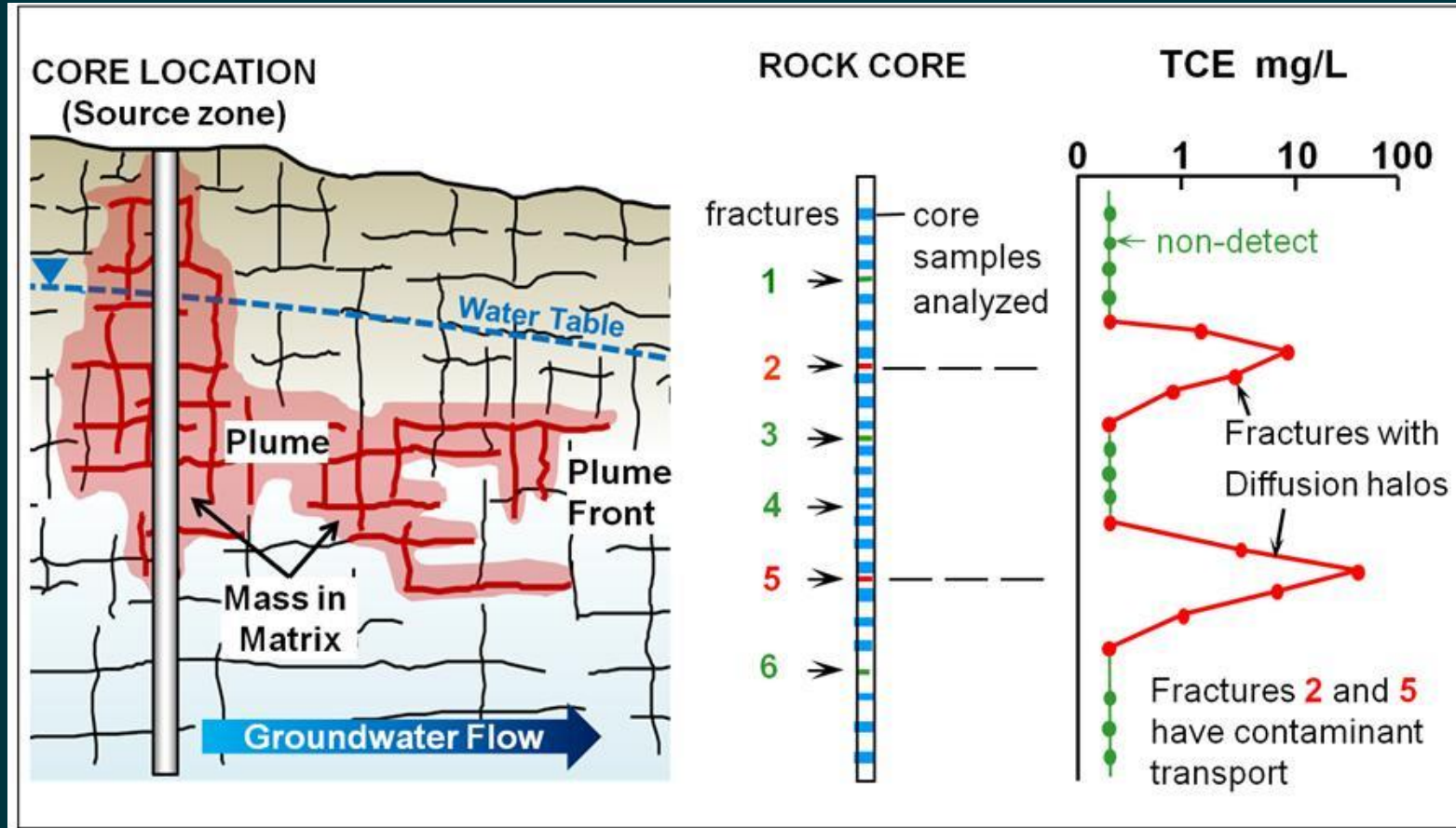
# Review of Methods

DNAPL Disappearance from Fractures by Diffusion  
Parker *et al.*, *Ground Water* (1994)



# Rock Core Sampling Approach

## Transport Pathways and Mass Distribution



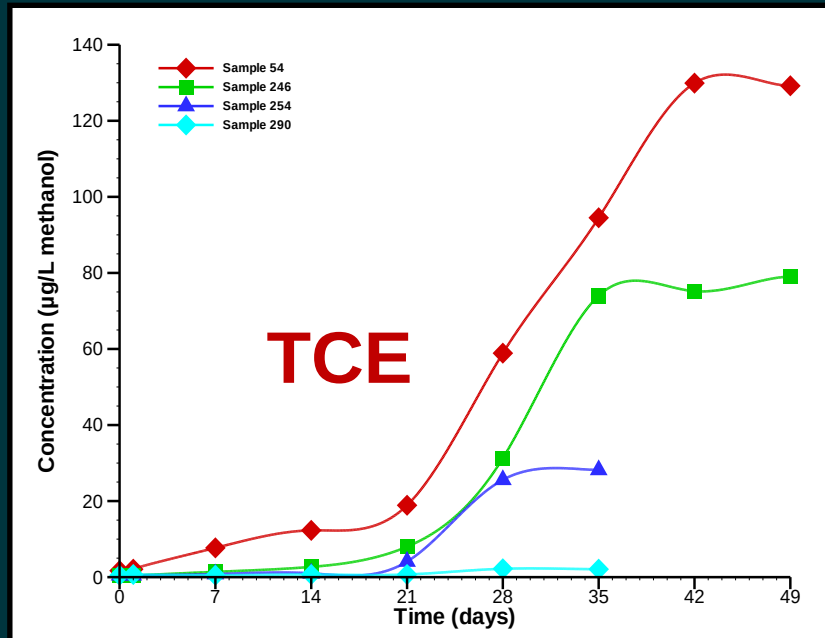
Continuous core collection with rigorous logging, sample collection, crushing, extraction and analysis protocols.

# CORED FN Sampling and Preservation



# MAE versus Shake-flask method

- Simultaneous extractions
- Short extraction times
- High throughput
- Extracts analyzed by GC/MS via EPA Method 8260 with full QA/QC
- MAE has an equivalent or higher efficiency in analyte recovery than the shake-flask extraction.



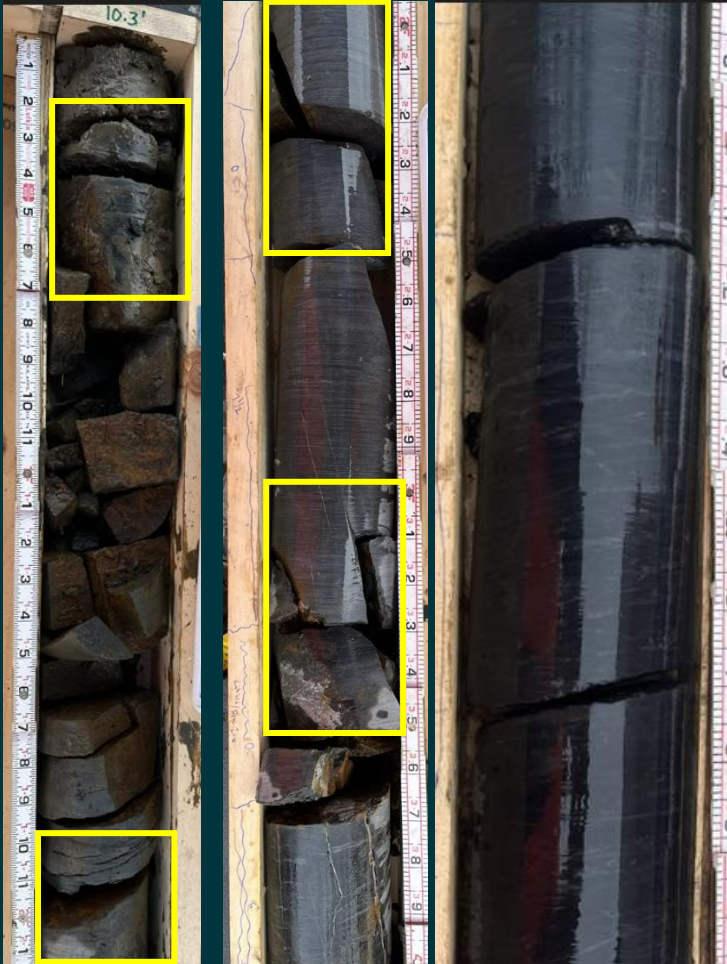
# Thermal Resistivity Bench Test (Opportunity 1)

- Contaminated argillite in the Source Area had to be evaluated for applicability of Electrical Resistivity Heating (ERH)....Was the rock conductive enough?
- AECOM elected to recover rock core in March 2023 adjacent (< 10 ft) to BDCore1.
  - BDCORE 1 subjected to CORE<sup>DFN</sup> and MAE analysis during the RI (May 2017) and represented SA impacts.
- One PQ core, BDCoreSW, was advanced to 50-ft bgs for laboratory scale resistivity testing (McMillan & McGee)
- AECOM selected rock from 7 intervals from top of rock to 50 fbg for laboratory analysis for the nine ROD constituents of concern (COCs) to attempt to document the vertical distribution of source mass using conventional extraction method for 8260D
- Results were compared to the BDCore1 8260 analyses, using the MAE method.

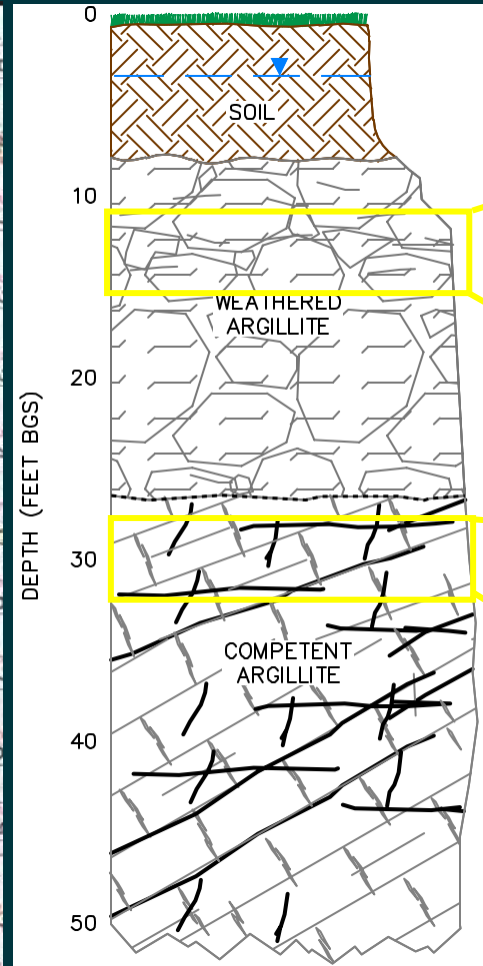


# Thermal Resistivity Bench Test (Opportunity 1)

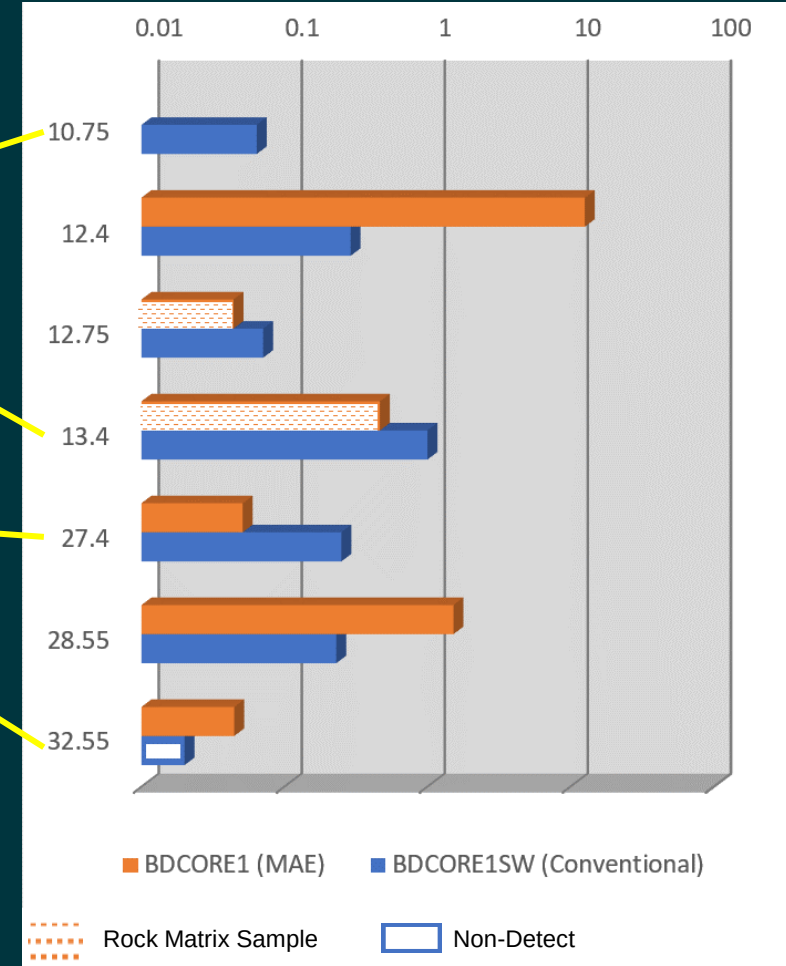
BDCORE1SW (2023)



Typical Lithologic Profile



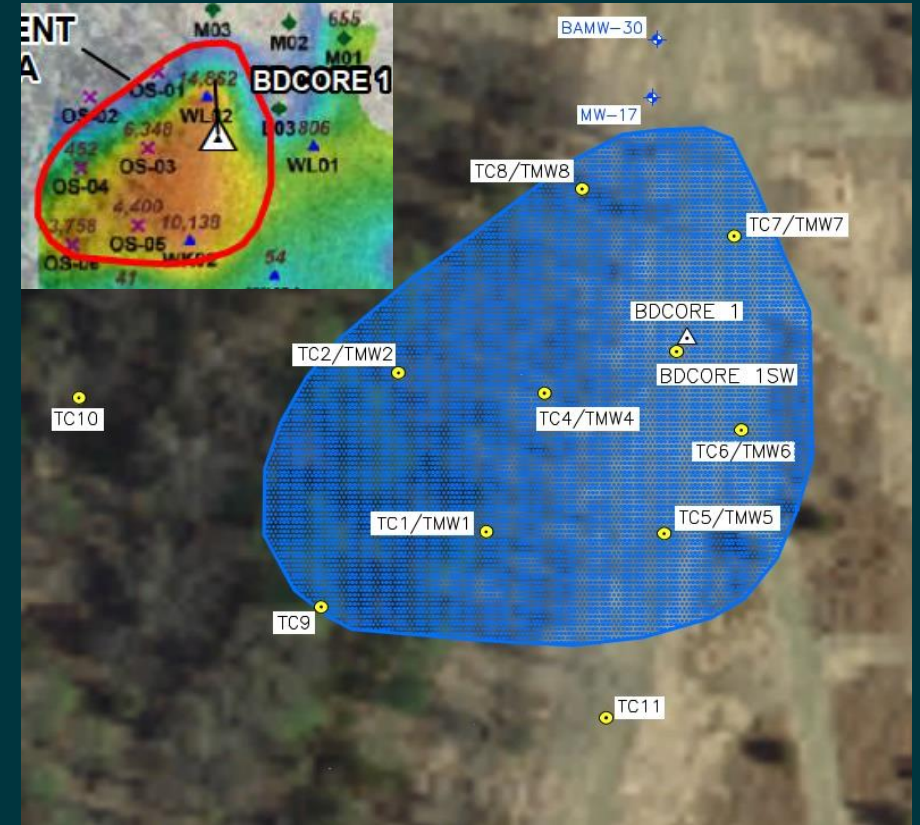
1,1,1-TCA mg/kg Concentration, log scale



- Results of the conventional vs. heated extraction methods differed significantly
- Poor correlation ( $r^2=8.5E-05$ )

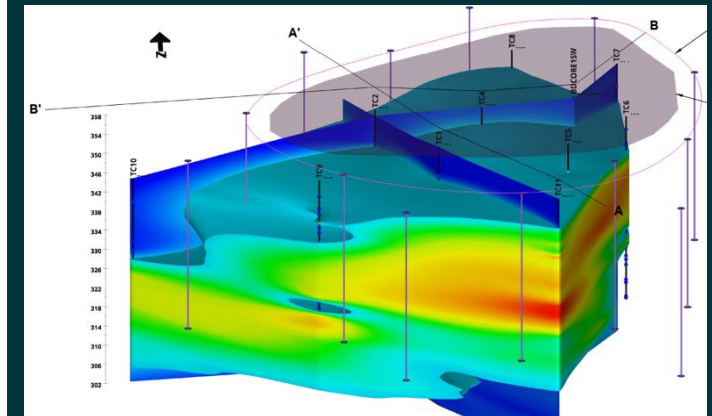
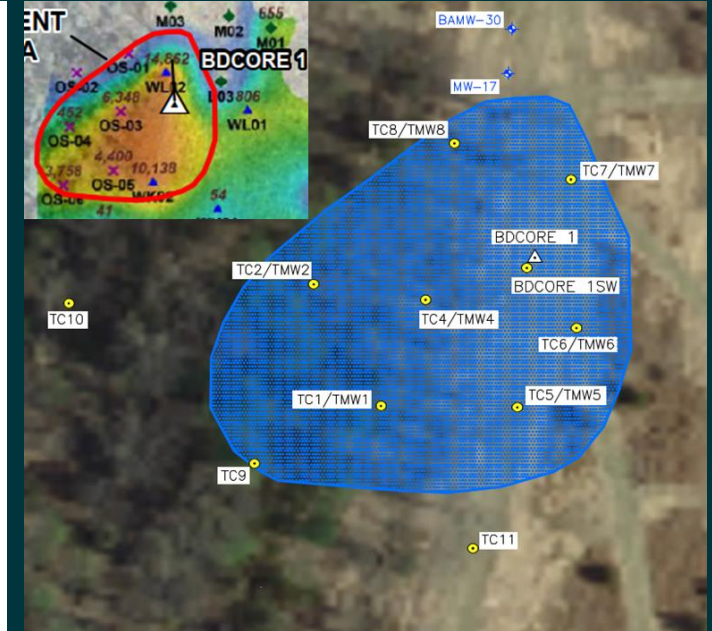
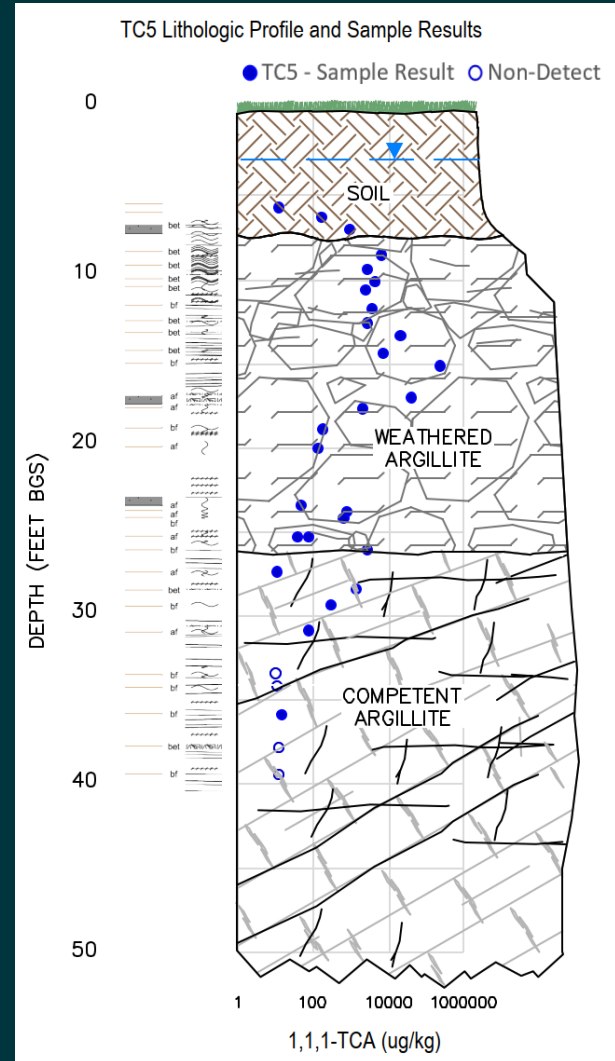
# Source Area Investigation (Opportunity 2)

- Verify the magnitude and extent of the ROD defined source area for the thermal RD.
- RI core BDCore1 vs recent thermal bench test conventional results strongly indicated COREDFN and MAE optimum source mass delineation method.
- 11 cores advanced 35 to 50 fbg
- Collect, process, preserve, and analyze samples every 1-2 ft
- 8 monitoring wells installed for groundwater sample collection & analysis.
- Rock mass and calculated pore water vs, actual groundwater results for comparison.



## Source Area Investigation (Opportunity 2)

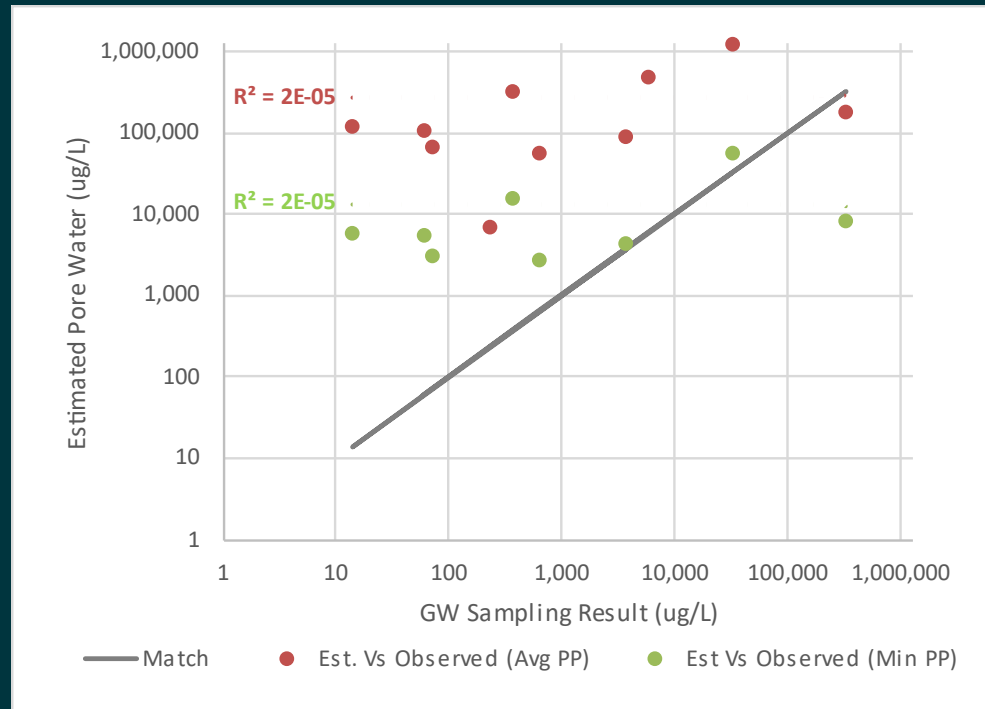
- TC5 presented as example of typical distribution and worst impacts (1,1,1-TCA)
- As in RI, minimal impacts in soil
- Impacts predominantly in weathered/highly fractured portion of rock
  - $RQD_{\text{Weathered}} = 0 - 50\%$  (Avg. = 23%)
  - $RQD_{\text{Competent}} = 47 - 100\%$  (Avg. = 80%)
- Extent confirmed to coincide with PSG
- MAE/DFN rapid TAT allowed for quick field decisions with respect to vertical and horizontal observations



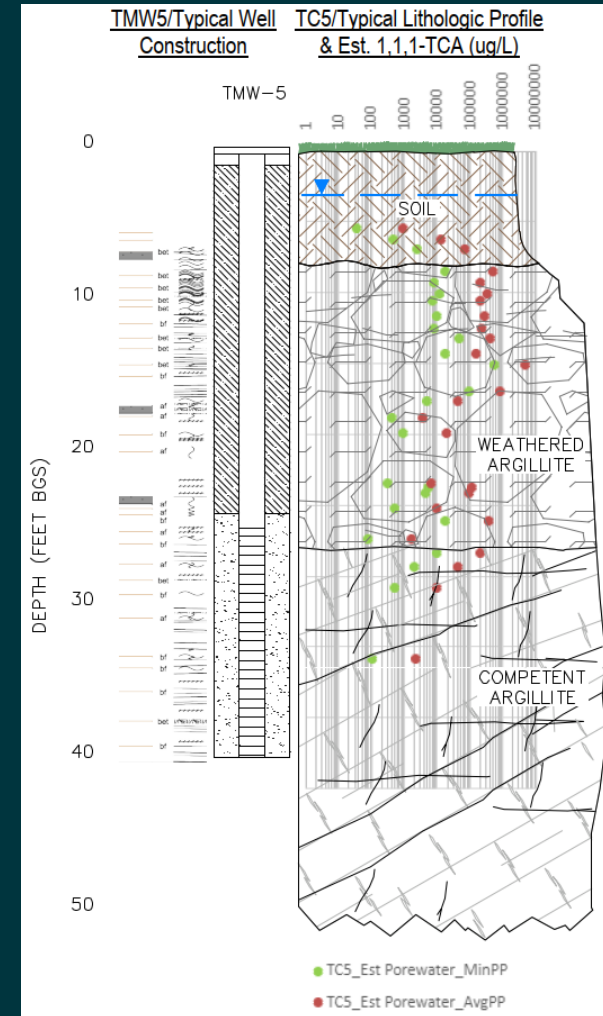
# Source Area Investigation (Opportunity 2)

## Groundwater Sampling Results (8 locations) vs Estimated Porewater Concentrations (from screen interval)

- Average GW Result  $[1,1,1\text{-TCA}]_{\text{TTZ}} = 45,854 \text{ ug/L}$
- Average  $[1,1,1\text{-TCA}]_{\text{TTZ}}$  Pred = 281,904 ug/L (average PP)
- Average  $[1,1,1\text{-TCA}]_{\text{TTZ}}$  Pred = 45,098 ug/L (minimum PP)
- Physical Properties (“PP”) values used in porewater estimation calculation
  - (13) bedrock samples

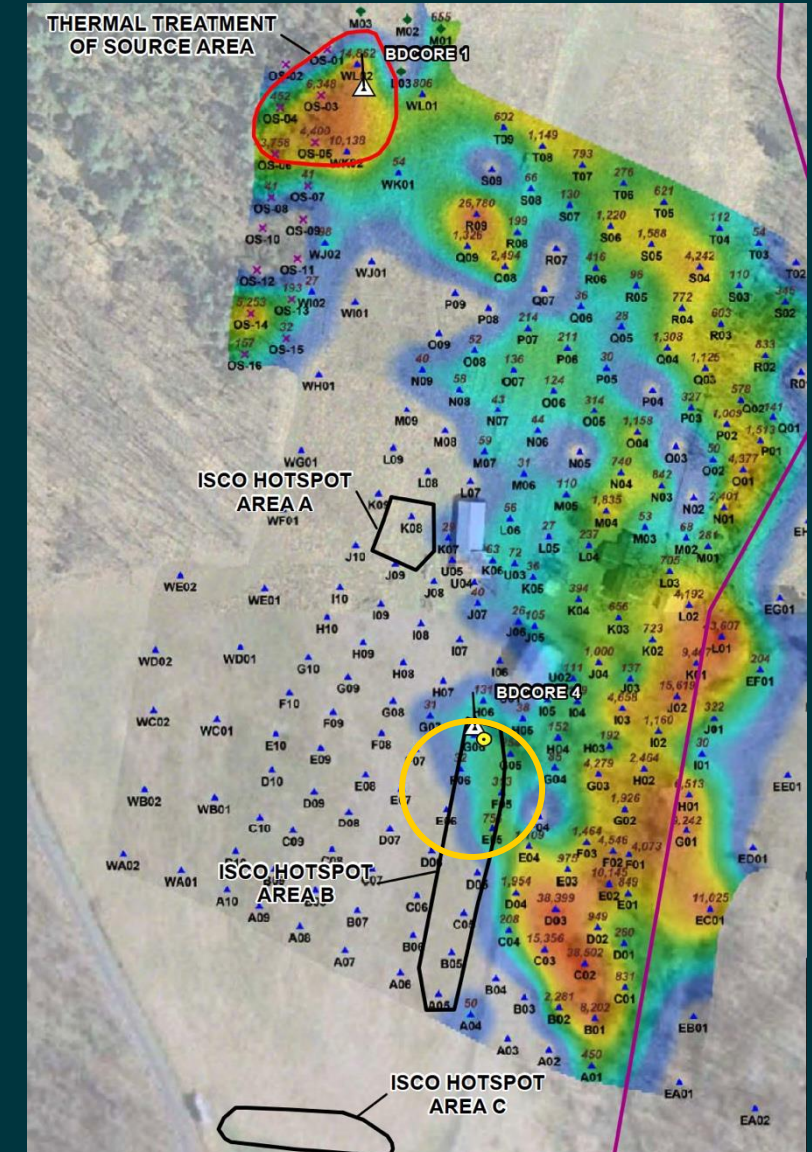


Comparison of average predicted porewater in screen interval vs observed groundwater concentrations

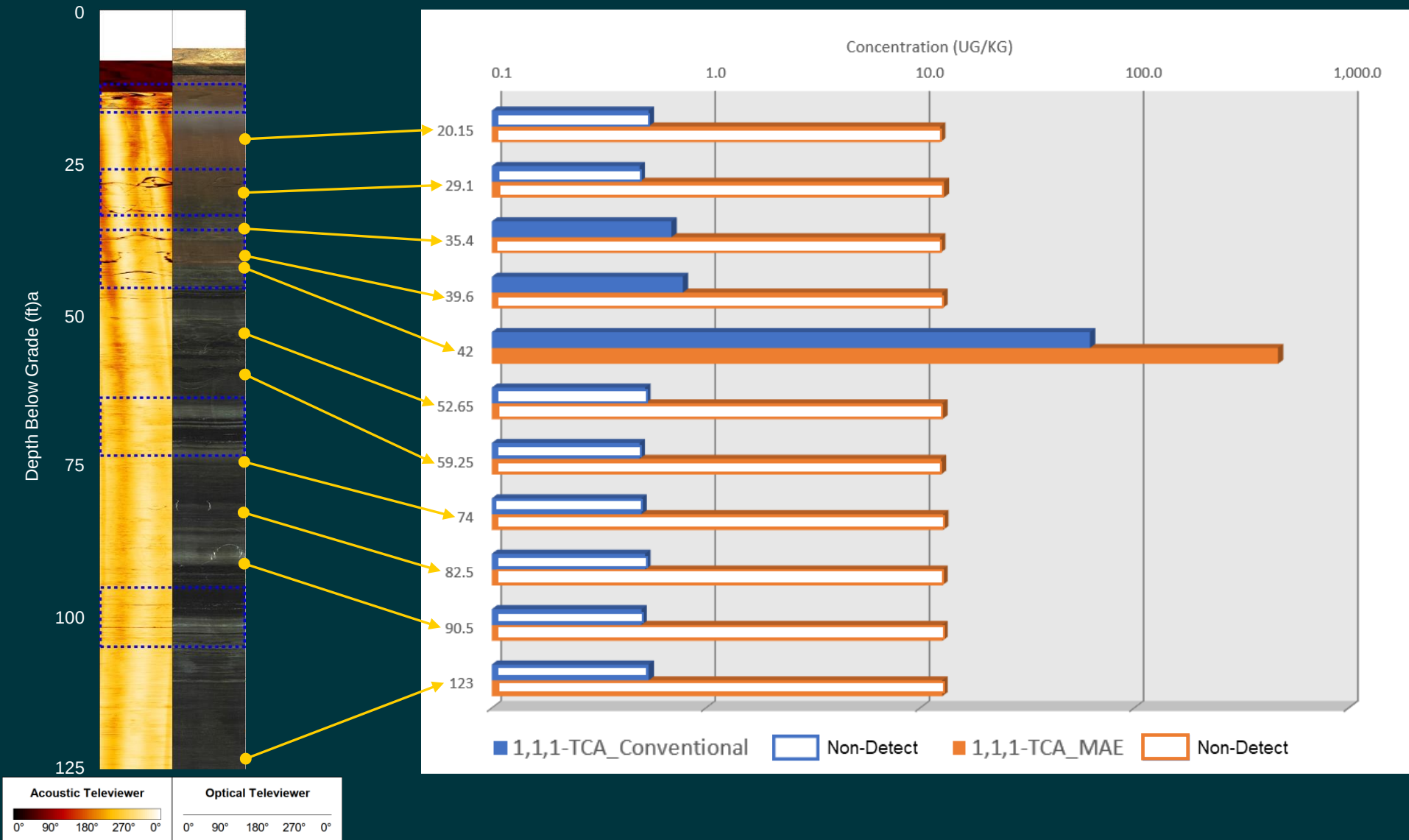


# ISCO Bench Test (Opportunity3)

- AECOM was tasked with completing a bench scale evaluation of reagent effectiveness.
- One PQ core was advanced to 125 fbg in the principal pathway of the dissolved plume to provide rock media for column testing with groundwater from historically most impacted wells
- 11 subsets of rock were obtained from approximate first groundwater (25 fbg) to 125 fbg for laboratory analytical testing to establish baseline concentrations of Site COCs
- Samples were split, from each interval, one for conventional extraction and analysis with 8260D and one set for the MAE method with 8260D.
- Direct comparison of results.

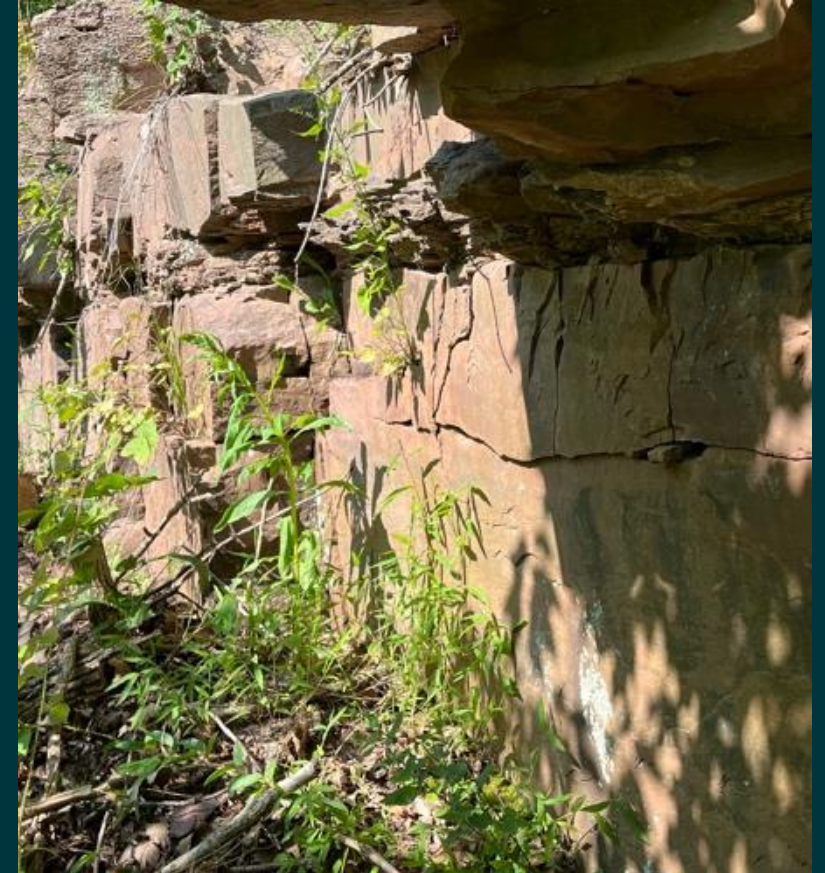


# ISCO Bench Test (Opportunity 3)



# Opportunities for All Fracture Rock Sites?

- Reliable outcomes for fractured rock characterization that appear to most reliably estimate source mass for effective remediation
- Rapid analytical reporting for making on the fly field decisions for vertical and horizontal limits as well as focal sampling distribution



THANK YOU!

Kevin Mudrick