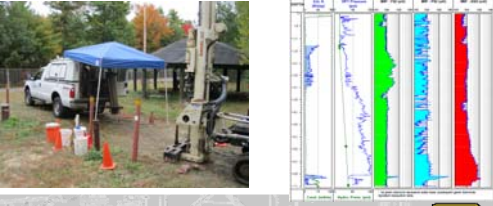


USE OF HIGH RESOLUTION CHARACTERIZATION DATA TO OPTIMIZE SOURCE AREA REMEDIATION AT AOC 50 AT FORMER BASE FORT DEVENS



FRTR Meeting November 2, 2016
Daniel Groher, USACE

US Army Corps of Engineers
U.S. Army

Presentation Outline

- Background for AOC 50 and Membrane Interface / Hydraulic Profiling Tool (MiHPT) Investigation
- Summary of Field Efforts and Procedures
- Results of MiHPT Investigation
- Interpretation of MiHPT Results
- Source Area Remediation Optimization

Page 2

US Army Corps of Engineers
U.S. Army


AOC 50 Background

- Sources of groundwater impacts are two World War II fueling systems, a former drywell associated with the parachute shakeout tower and a tetrachloroethylene (PCE) drum storage area
- The impacted groundwater extends from the Source Area approximately 3,000 feet downgradient
- ROD and full scale remedy in 2004
 - All the sources were removed and primary GW primary remedy is enhanced reductive dechlorination (ERD)
 - ERD system consists of periodic injections of a organic carbon substrate into permanent wells to stimulate microbial activity
 - Injections into the Source Area (Area 1) and then 4 additional transects across the plume

Page 3

US Army Corps of Engineers
U.S. Army


BACKGROUND - AOC 50



Page 4

US Army Corps of Engineers
U.S. Army

Detail of AOC 50 Source Area 1



Page 5

US Army Corps of Engineers
U.S. Army

2013 Groundwater Profiling Work

- Completed vertical profiling using direct push at each injection area
- Groundwater samples collected at 10' depth intervals for Volatile Organic Carbon (VOC) analysis.
- 15 locations advanced in Area 1 (Source Area)
- Once lab data reviewed:
 - Higher than expected PCE results in the Source Area at several locations compared to permanent well samples
 - Concluded that field-based high resolution site characterization warranted

Page 6

US Army Corps of Engineers
U.S. Army

2014 High Resolution Site Characterization

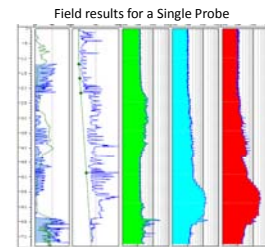
- Utilize MiHPT to determine where PCE hot spots exist and the relative permeability of these locations;
 - Investigate beneath Parachute Tower to determine if the floor drains in the building are an additional source
- 17 MiHPT locations in source area late September and early October 2014 (5 more than originally planned)
- Small number of confirmatory soil and groundwater samples (used to confirm and calibrate)
- Each boring was grouted upon completion



Page 7

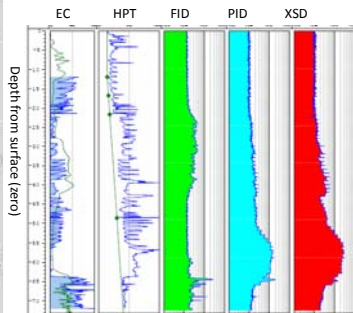
Background – How MiHPT Works

- MIP is a membrane located on the drill stem, connected to a carrier gas trunk line to the surface.
- Carrier gas pumped past the membrane collects VOCs from the subsurface at each discrete depth for field analysis (by FID, PID, and XSD).
- An electrical conductivity (EC) probe is also attached to the drill stem.
- Hydraulic profiling (HPT) via an hydrostatic pressure probe.
- HPT operates by pumping clean water into the formation and recording the injection pressure.
- More information: <http://geoprobe.com/mihpt>



Page 8

Interpreting MiHPT Output Graphs

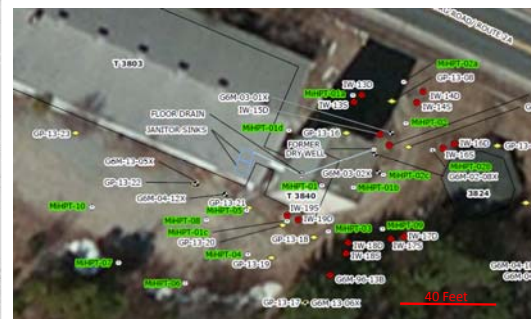


- EC – Electrical Conductivity – translates to hydraulic conductivity
- HPT – Higher pressure signifies denser material
- FID – Flame ionization detector – measures gases such as methane, a byproduct of ERD
- PID – Photo ionization detector – measures VOC concentrations.
- XSD – Detector calibrated specifically to PCE.



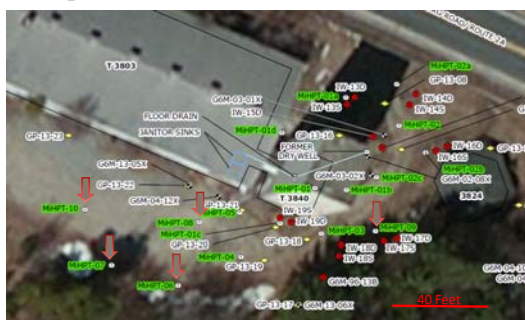
Page 9

Completed Locations



Page 10

Completed Locations



↓ Extra/unplanned location



Page 11

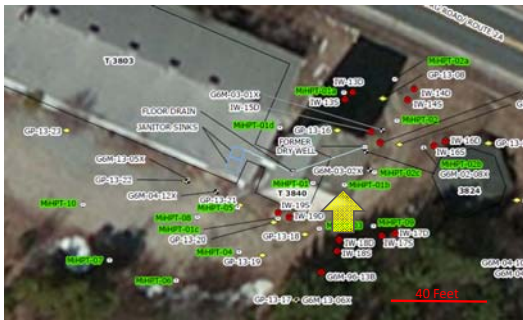
Evaluation of Data

- MiHPT logs were developed for each location.
- Side-by-side logs for each detector.
- Allowed analysis of PCE concentrations related to subsurface features (stratigraphic changes/boundaries)
- Allowed evaluation of microbial activity through methane detection by FID.
- Grab groundwater samples collected for calibration/evaluation at select locations
- Soil geotechnical data collected to confirm hydraulic profiling tool (HPT) data



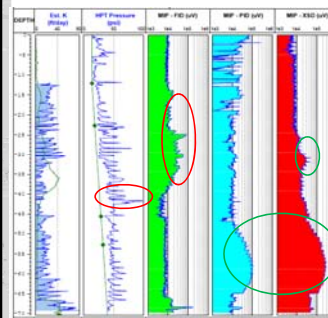
Page 12

Highlight - MiHPT 1b



Page 13

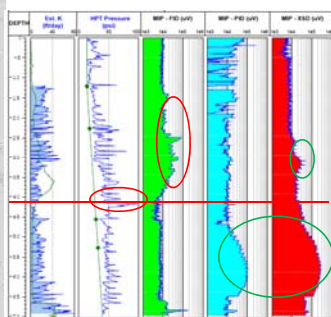
MiHPT Interpretation - MiHPT 1b



- HPT indicates dense zone at 40-42' bgs.
- FID increases in shallow zone likely methane response from past ERD injections - concentrated shallower than 40' bgs.
- Bulk of PCE mass is below 45' bgs, with a smaller mass in the 25' to 35' zone, correlating with FID increased results.
- Nature and extent are consistent with CSM/dry well source.

Page 14

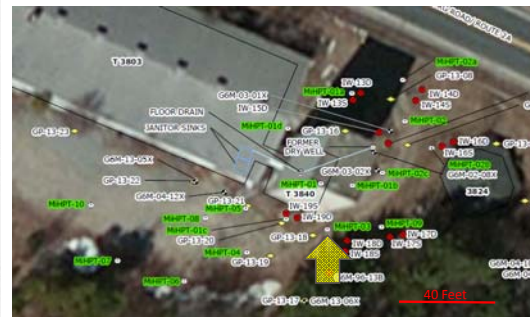
MiHPT Interpretation - MiHPT 1b (cont'd)



- Dense zone at 40-42 feet may represent a low permeability layer limiting ERD effect. This is supported by increased FID results at shallower depths coupled with residual mass at shallower depths.
- One conclusion is that remediation injections are concentrating in the aquifer above 40' and have more limited contact with bulk of mass deeper.

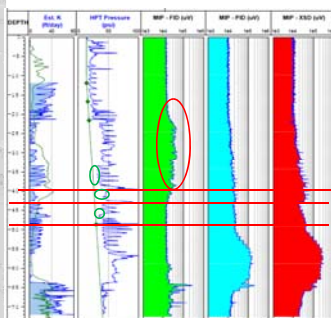
Page 15

Highlight - MiHPT-03



Page 16

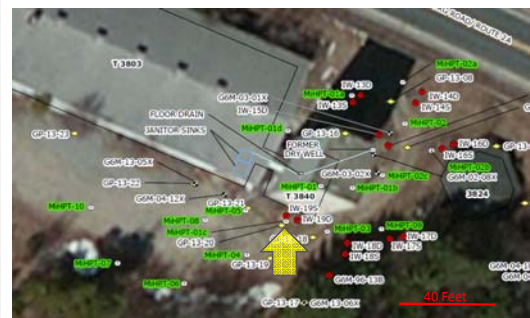
MiHPT Interpretation - MiHPT 03



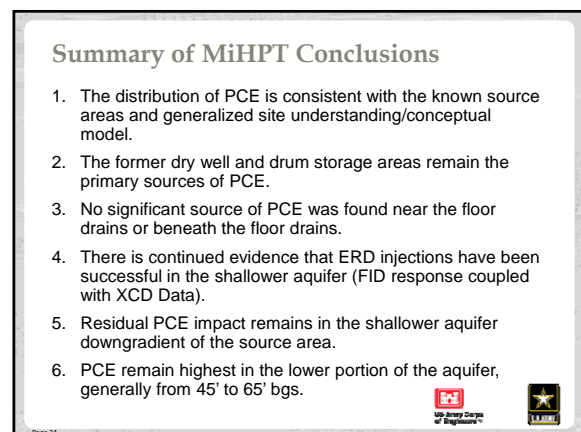
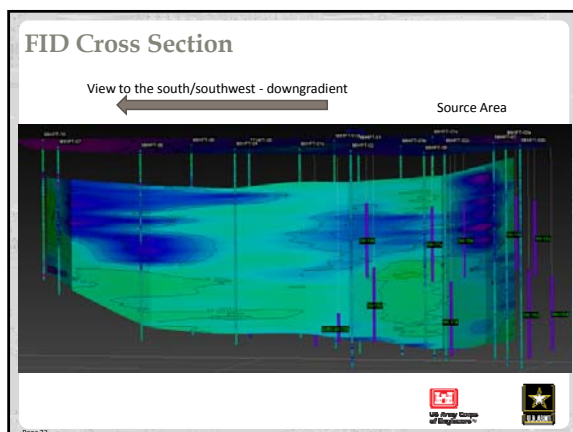
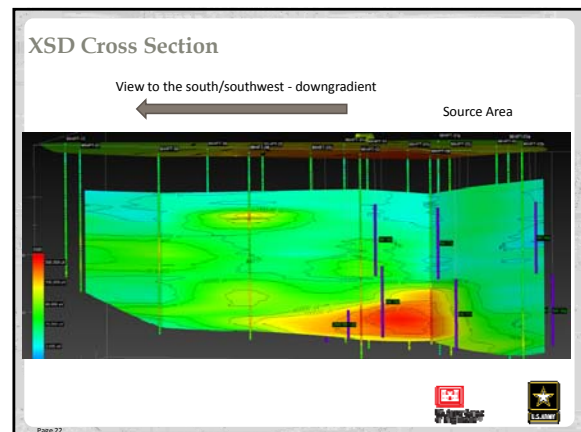
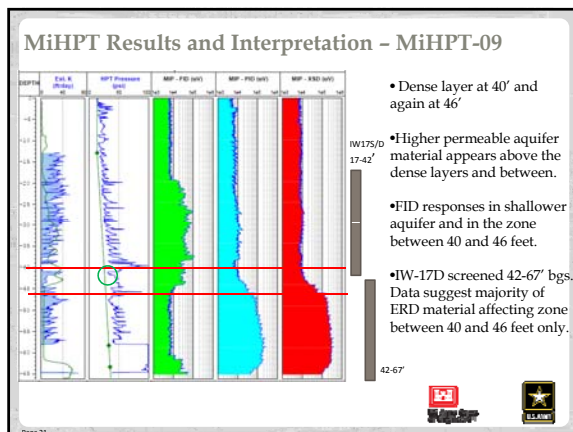
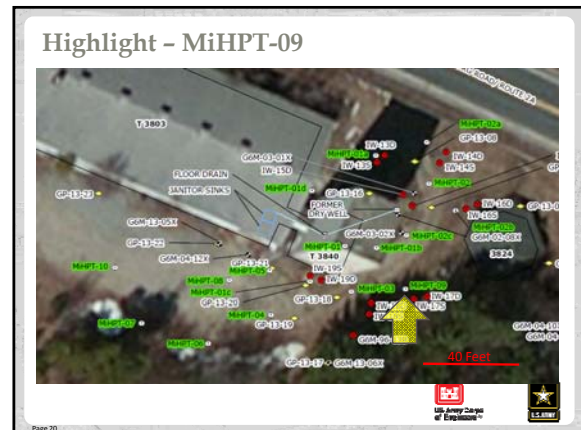
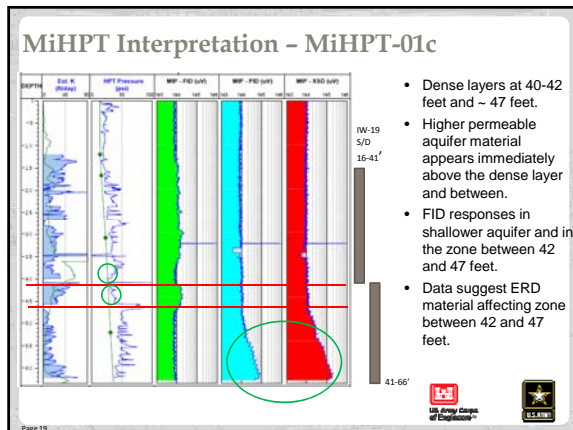
- Dense zone at 40-50 feet may represent an ERD contact barrier. Note less dense zones (green circles).
- Blue rectangles represent well screens for IW-18S/D.
- Suggests gravity ERD injections in IW-18S resulting in methane generation, injections in IW-18D may be biased in permeable areas shallower than zone of most impact.

Page 17

Highlight - MiHPT-01c



Page 18



Summary of MiHPT Conclusions (Cont'd)

7. Maximum relative concentrations by XSD were between 1 and 5 ppm. Confirmatory groundwater grab sample at MiHPT-09 was approximately 1 ppm.
8. HPT indicates a silty/clay layer approximately 40-45 feet depth with less dense material above.
9. Deep injection wells extend from 38 to 67' and intersect both the silty/clay layers at 40-45' as well as the less dense material.
10. ERD material may be only partially penetrating the deeper areas as material injected may be exiting at the very top of the screens above the silty clay layer.

Page 25



Optimization of AOC 50 Remedial Program

Injection began in October 2004 and occurred twice a year – originally molasses and then switched to ABC-product (soluble lactates).

- The lactates which also contain lactate esters and alcohols function as a short-term component, its quickly consumed.

Changed source area *well* injections in July 2015 using substrate that contains lactates, C18 fatty acid and zero valent iron.

- The C18 fatty acid, also known as Oleic Acid – less soluble and longer lasting

Page 25



Optimization, continued

- Used direct-push technology (Geoprobe™) to supplement permanent wells
 - Lactates, Oleic Acid, and zero valent iron (ZVI)
 - ZVI assists with ERD aiding in the production of hydrogen which in turn feeds the anaerobic degradation process
- No obvious improvement in monitoring well data after first “optimized” injections
- Additional ERD injections planned: both wells and additional direct push injections

Page 27

