

# *Welcome*



## **Environmental Advisory Board (EAB) Meeting**

**Robins Air Force Base**

**November 3, 2022**



# **Welcome and Program Introduction**

**Dr. Linda Smyth  
EAB Community Co-chair**



# Acronyms and Abbreviations

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- **AEHS - Association of Environmental Health and Sciences**
- **AO - Alternate Objective**
- **API - American Petroleum Institute**
- **ASC - Advanced Site Characterization**
- **ASTM - American Society for Testing and Materials**
- **BTEX - Benzene, Toluene, Ethylbenzene, Xylene**
- **CLU-IN - Contaminated Site Clean-Up Information**
- **CSM - Conceptual Site Model**
- **cVOC - Chlorinated Volatile Organic Compound**
- **DNAPL - Dense Non-Aqueous Phase Liquid**
- **FID - Flame Ionization Detector**
- **ft/day - feet per day**



# Acronyms and Abbreviations

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- **GW - Groundwater**
- **HPT - Hydraulic Profiling Tool**
- **HRSC - High Resolution Site Characterization**
- **ITRC - Interstate Technology Regulatory Council**
- **LNAPL - Light Non-Aqueous Phase Liquid**
- **mg/cu. ft - milligram per cubic feet**
- **mg/kg - milligram per kilogram**
- **mg/L - milligram per liter**
- **MGP - Manufactured Gas Plant**
- **MiHpt - Membrane Interface Probe with Hydraulic Profiling Tool**
- **MIP - Membrane Interface Probe**
- **mL/min - milliliter per minute**
- **mV - millivolts**



# Acronyms and Abbreviations

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- **NAPL - Non-Aqueous Phase Liquid**
- **NGWA - National Ground Water Association**
- **OIP - Optical Interface Probe**
- **PID - Photoionization Detector**
- **ppm - parts per million**
- **psi - pounds per square inch**
- **SURF - Sustainable Remediation Forum**
- **TPH - Total Petroleum Hydrocarbon**
- **USEPA - United States Environmental Protection Agency**
- **UV - Ultraviolet**
- **VOC - Volatile Organic Compounds**
- **XSD - Halogen Specific Detector**



# Environmental Advisory Board

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## Complex Sites: The Role of High Resolution Site Characterization (Briefing and Demonstration)

John Sohl, CEO  
Columbia Technologies

November 3, 2022



# Overview

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- **Alternative Objective (AO) Sites**
- **Columbia Briefing**
- **Equipment Demonstration**



# AO Sites

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- Sites with *“complex attributes that have, to date, inhibited progress toward the achievement of RC [Response Complete].”*
- AO sites generally have an incomplete conceptual site model (CSM) and are expected to require longer than 30 years to achieve Response Complete under current remedial approach





# AO Sites

## ■ Path Forward for AO Sites

- **Advanced Site Characterization (ASC)/High Resolution Site Characterization (HRSC)**
  - SSI
  - Revised CSM
  - Updated groundwater monitoring program
- **Remedy Evaluation and Recommendation**
  - Pilot Studies/Treatability Tests, as applicable
- **Decision Document amendment, as applicable**
- **Remedial system operation**
- **Annual groundwater sampling**

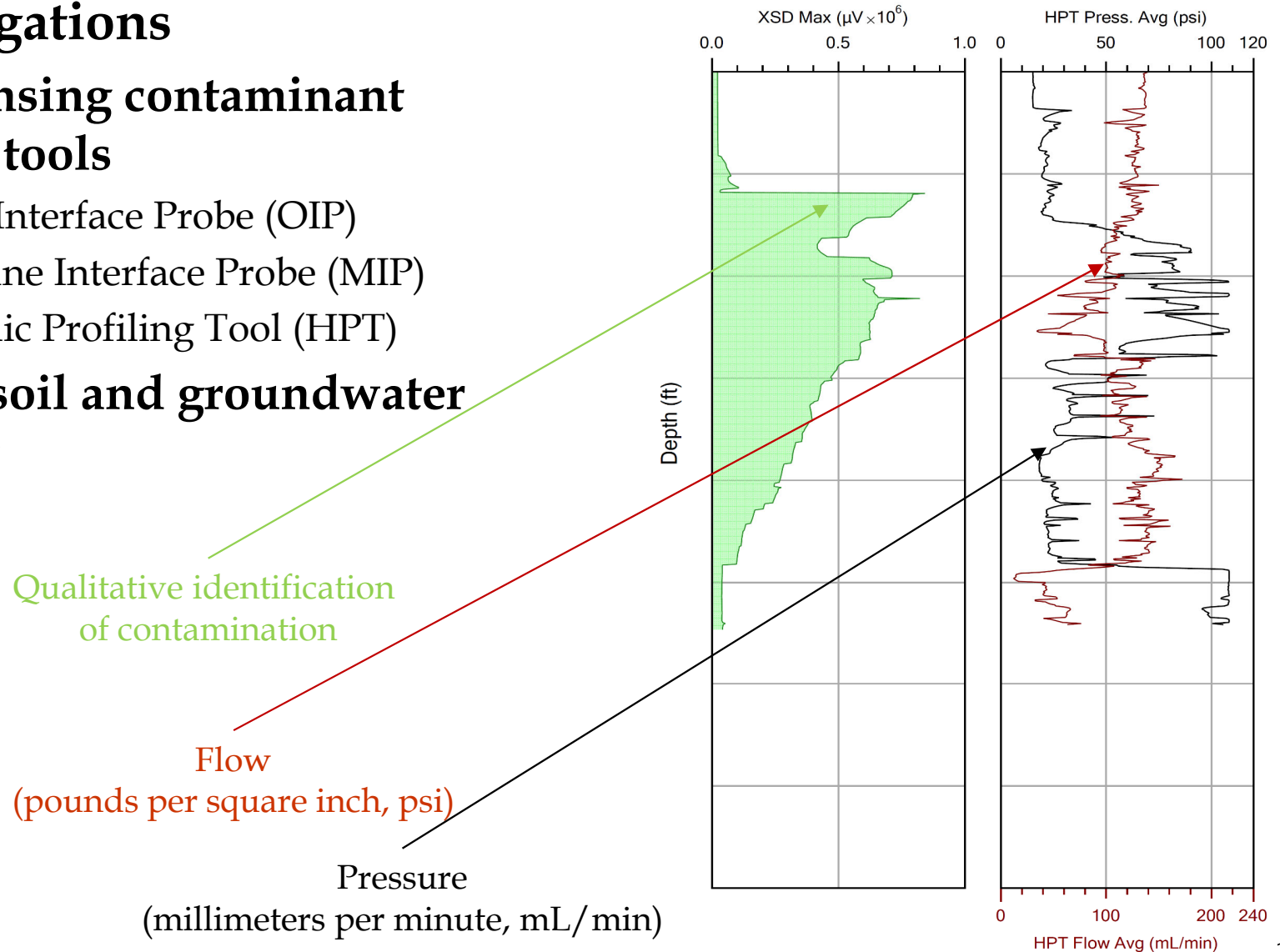
} Implementation of these tasks will be based on outcome of the site investigations



# AO Sites

## ■ Site Investigations

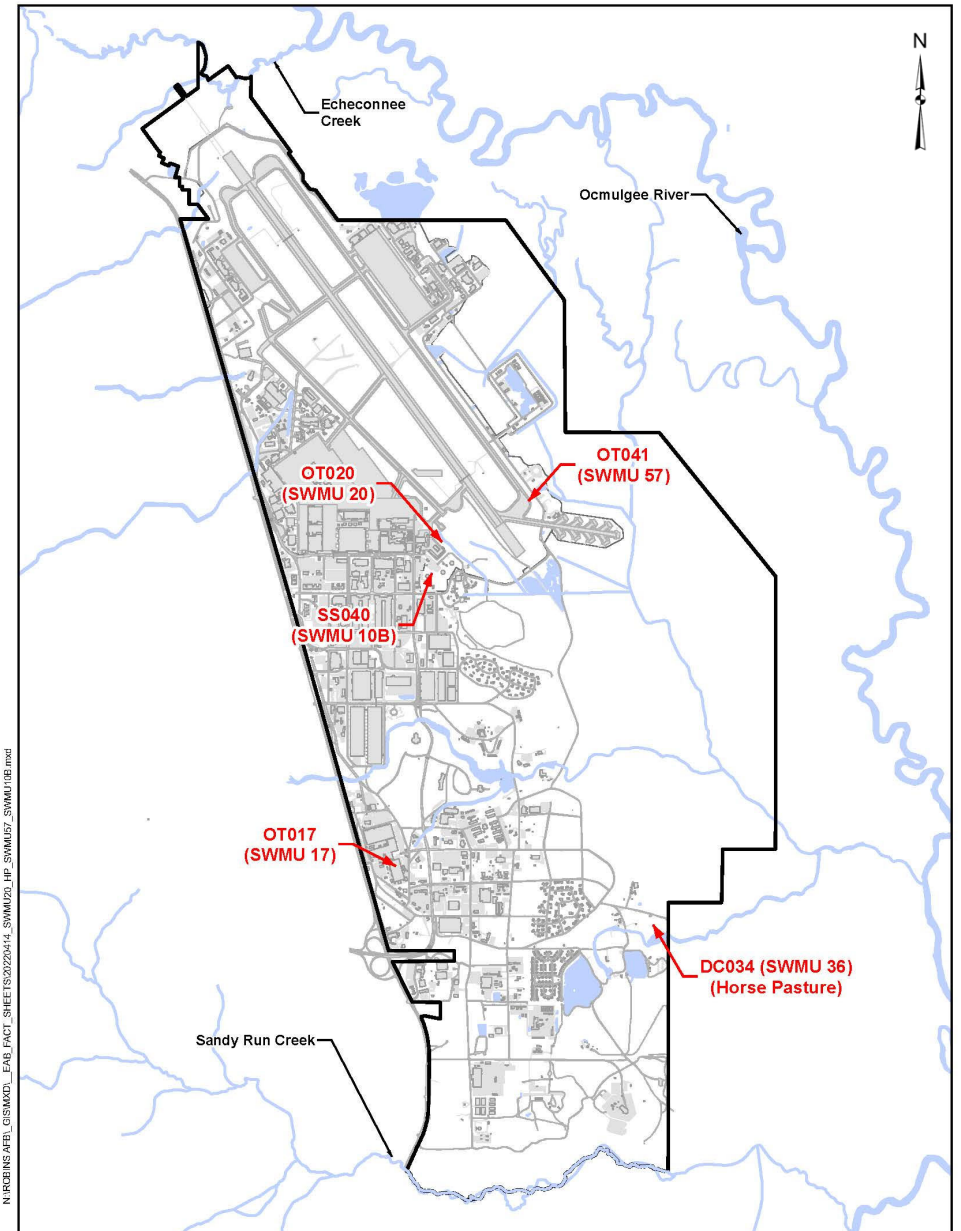
- **Direct sensing contaminant profiling tools**
  - Optical Interface Probe (OIP)
  - Membrane Interface Probe (MIP)
  - Hydraulic Profiling Tool (HPT)
- **Discrete soil and groundwater sampling**





# AO Sites

- **DC034 (Solid Waste Management Unit [SWMU] 36) (Horse Pasture)**
- **OT017 (SWMU 17)**
- **OT020 (SWMU 20)**
- **OT041 (SWMU 57)**
- **SS040 (SWMU 10B)**



N:\RCE\INS\AFBL\GIS\MOD\_1\_PAB\_FACT\_SHEETS\2020\4\_SWMU20\_HP\_SWMU57\_SWMU17.mxd



BETTER DATA. DEEPER UNDERSTANDING.  
MORE SUSTAINABLE OUTCOMES.

LEARN MORE

## *Complex Sites: The Role of High Resolution Site Characterization*

**John Sohl CEO**

Certified Sustainability Practitioner



# ***Our Sustainable Purpose***



Environment  
Economic  
Social



Chemical  
Hydrological  
Geochemical  
Microbiological

# U.S. Industry Resources



**American Petroleum  
Institute (API)**



**American Society for  
Testing and Materials (ASTM)**



**Association for Environmental  
Health and Sciences (AEHS)**



**Contaminated Site Clean-Up  
Information (CLU-IN)**



**Interstate Technology  
Regulatory Council (ITRC)**



**National Ground Water  
Association (NGWA)**

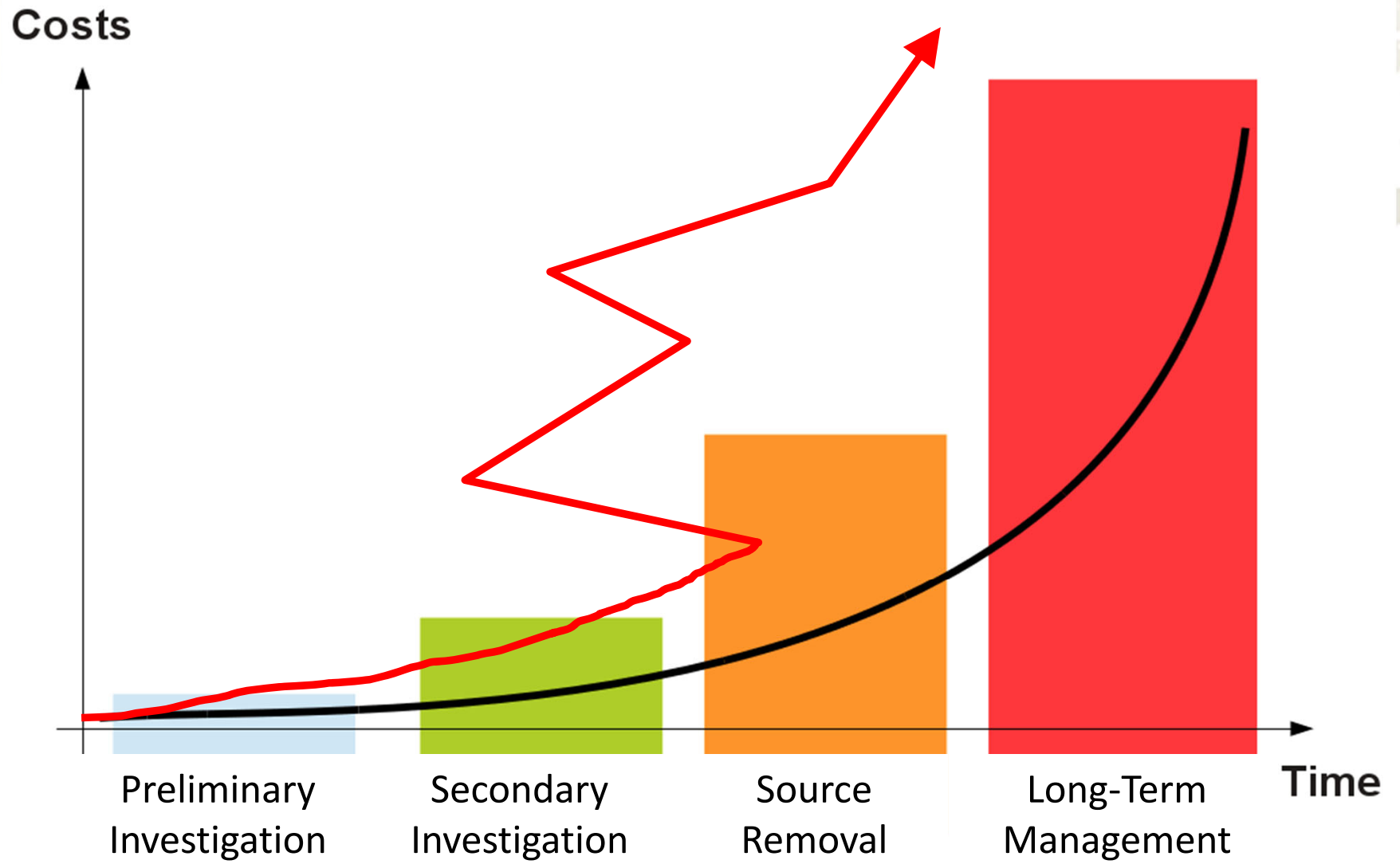
**Sustainable Remediation  
Forum (SURF)**



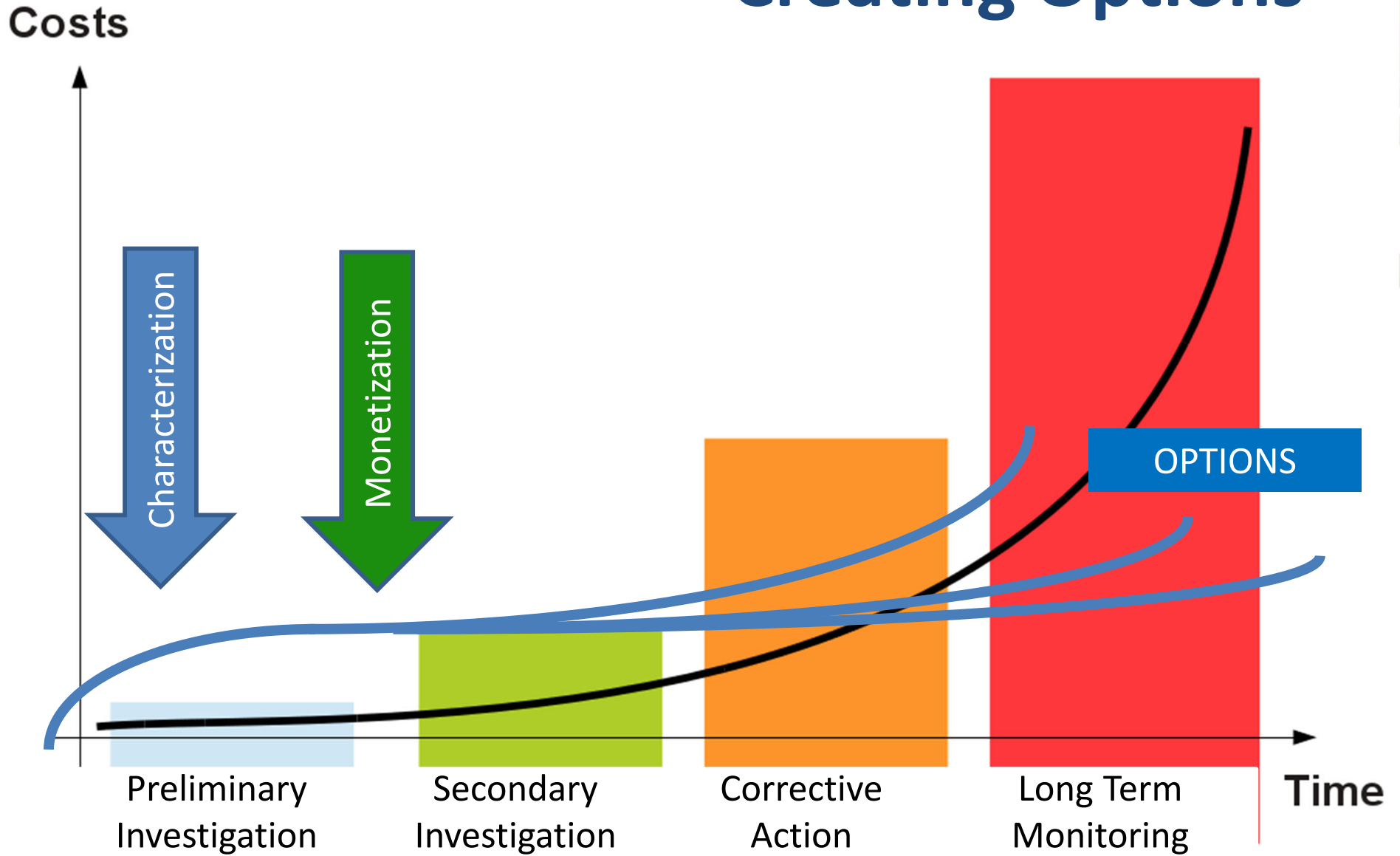
**United States Environmental  
Protection Agency (USEPA)**



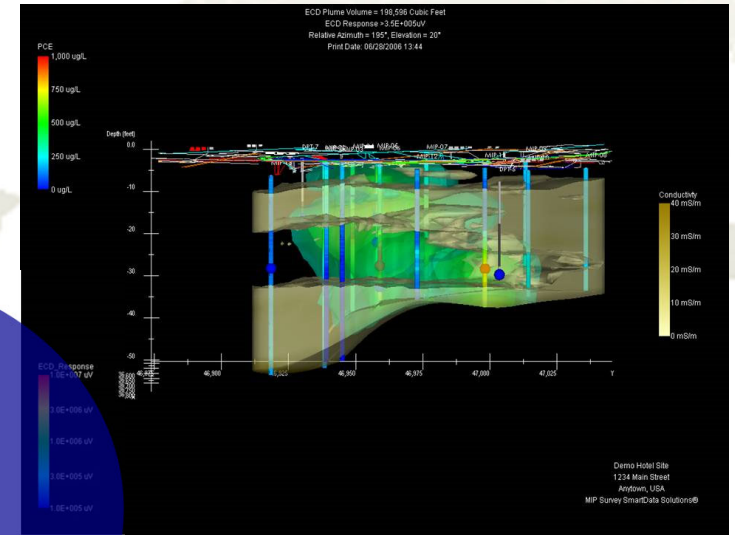
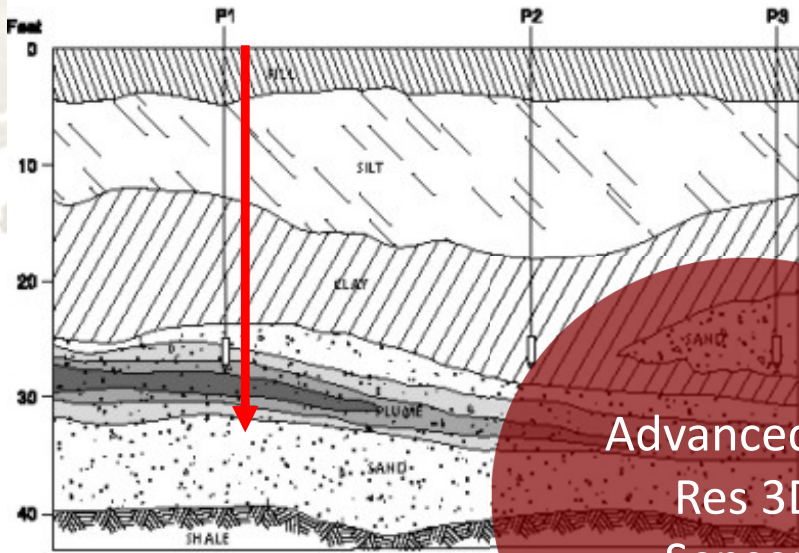
# Cost Curve is Unsustainable



# Creating Options



# High-Resolution SmartData Approach



Advanced Hi-Res 3D Sensors

Real-Time Analytics

Professional Services





# ***WHY HIGH RESOLUTION?***

# Where we were 10 years ago...

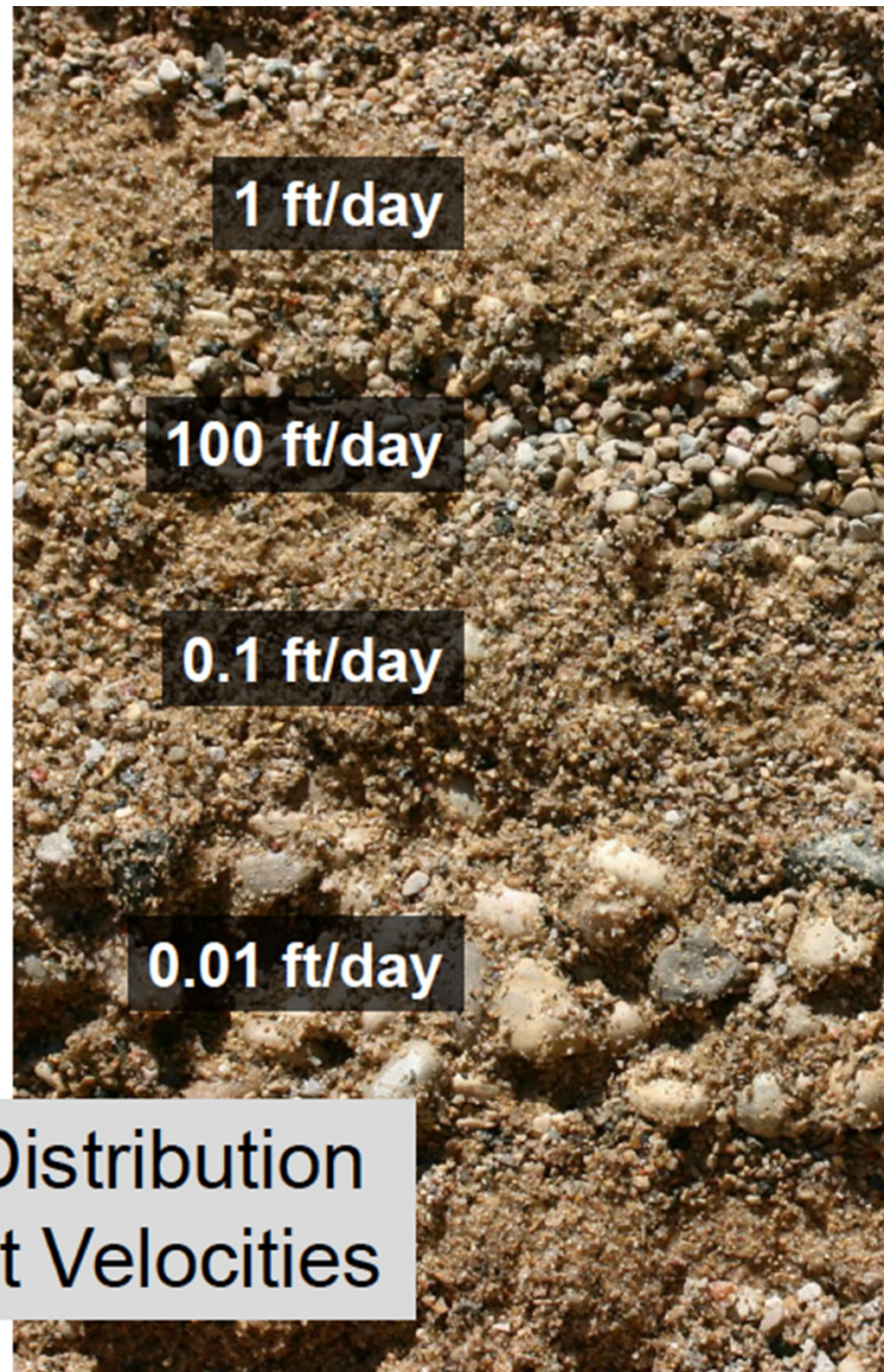


What's really there...



# Impact on Conceptual Site Models

**1 ft/day**



**Example: Distribution  
of Transport Velocities**

**Colorado State University**  
**Civil and Environmental Engineering**  
**Center for Contaminant Hydrology**  
**CCH**



Lee Ann Doner, [laruther@engr.colostate.edu](mailto:laruther@engr.colostate.edu)  
Tom Sale, [tsale@engr.colostate.edu](mailto:tsale@engr.colostate.edu)

Courtesy Tom Sale, PhD, Colorado State University (Go RAMS)

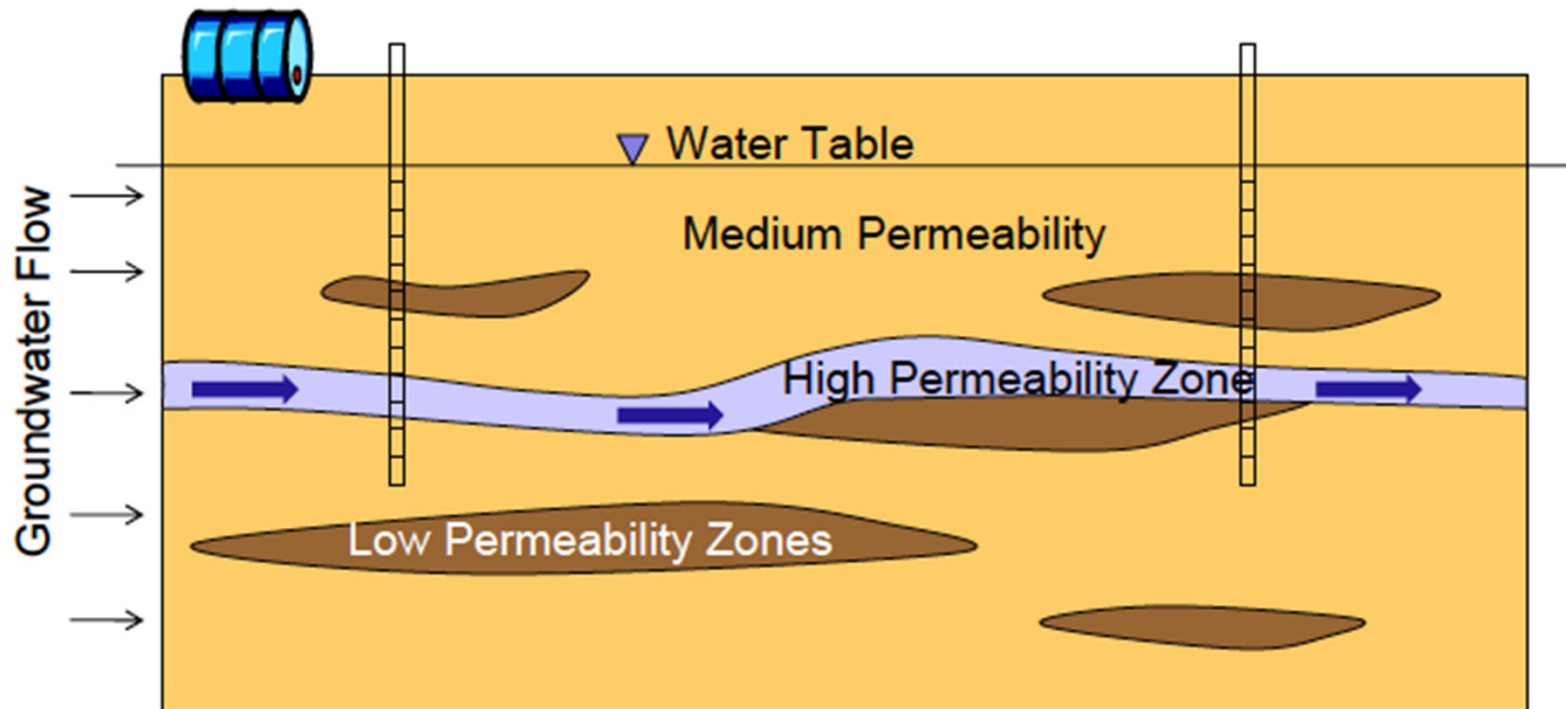


**Colorado**  
**State**  
University

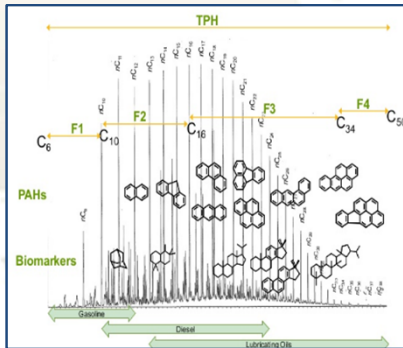


# Geologic X-Section: Setting the Stage for a DNAPL Release

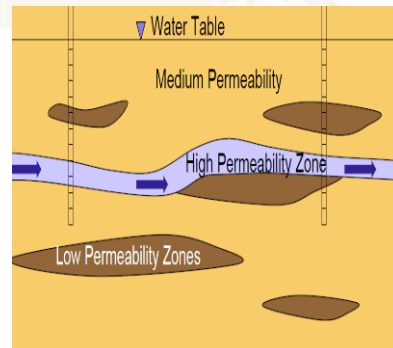
Key Point: Groundwater flux is dominant in high-permeability zones  
Groundwater velocity in high-permeability zones >>> average value



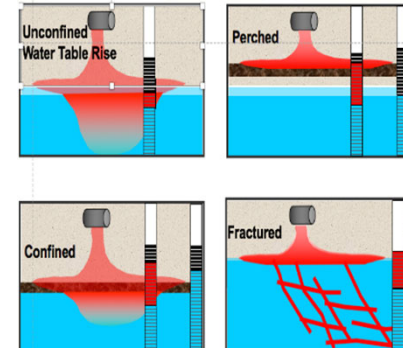
Highly simplified illustration of heterogeneous geology



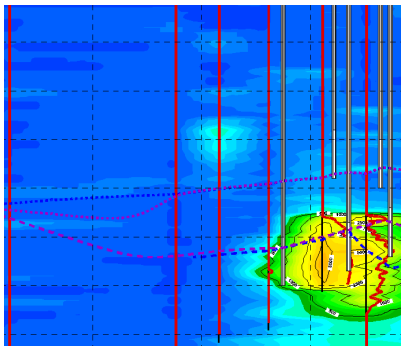
## LNAPL CHEMISTRY



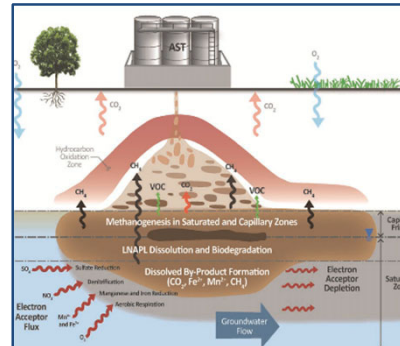
## SOIL PERMEABILITY



## GROUND WATER



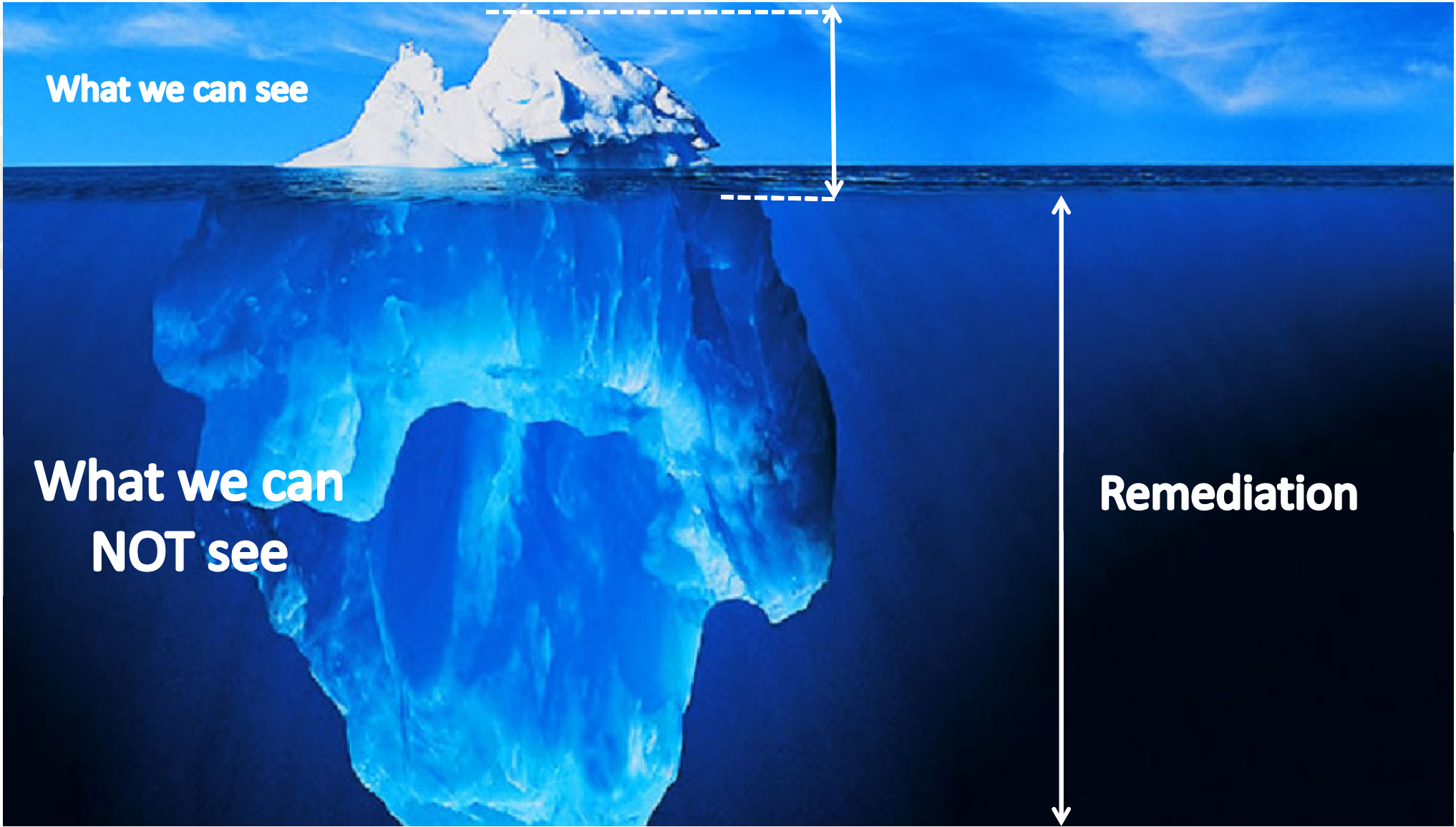
## DISSOLVED PHASE



## VAPOR PHASE



## SPATIAL ALIGNMENT



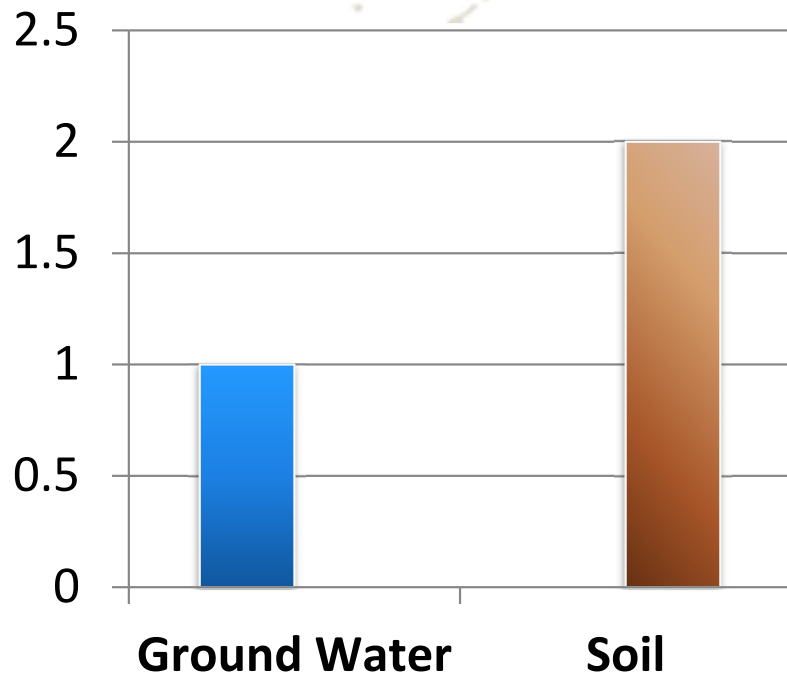
**What we can see**

**What we can NOT see**

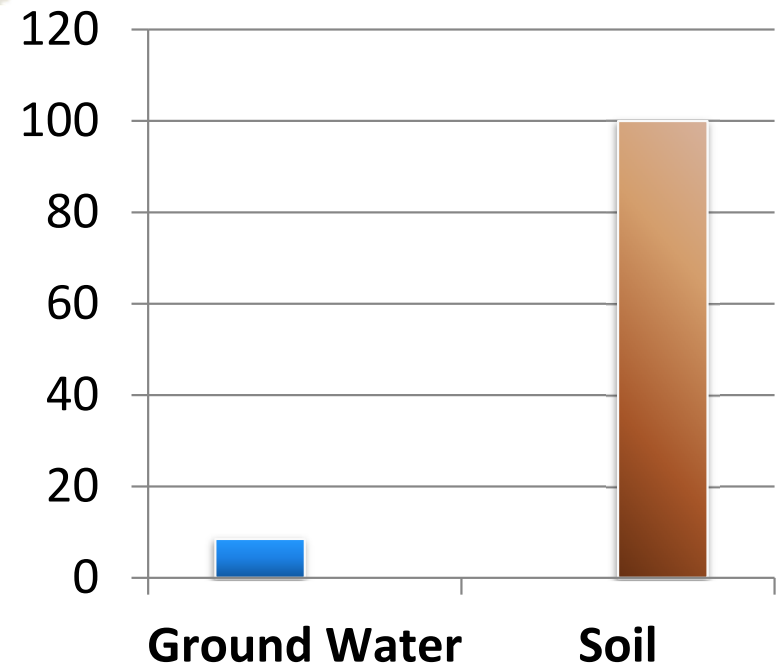
**Remediation**

# Remediation Targets the Soil Mass

## Soil and Ground Water Contamination (ppm)



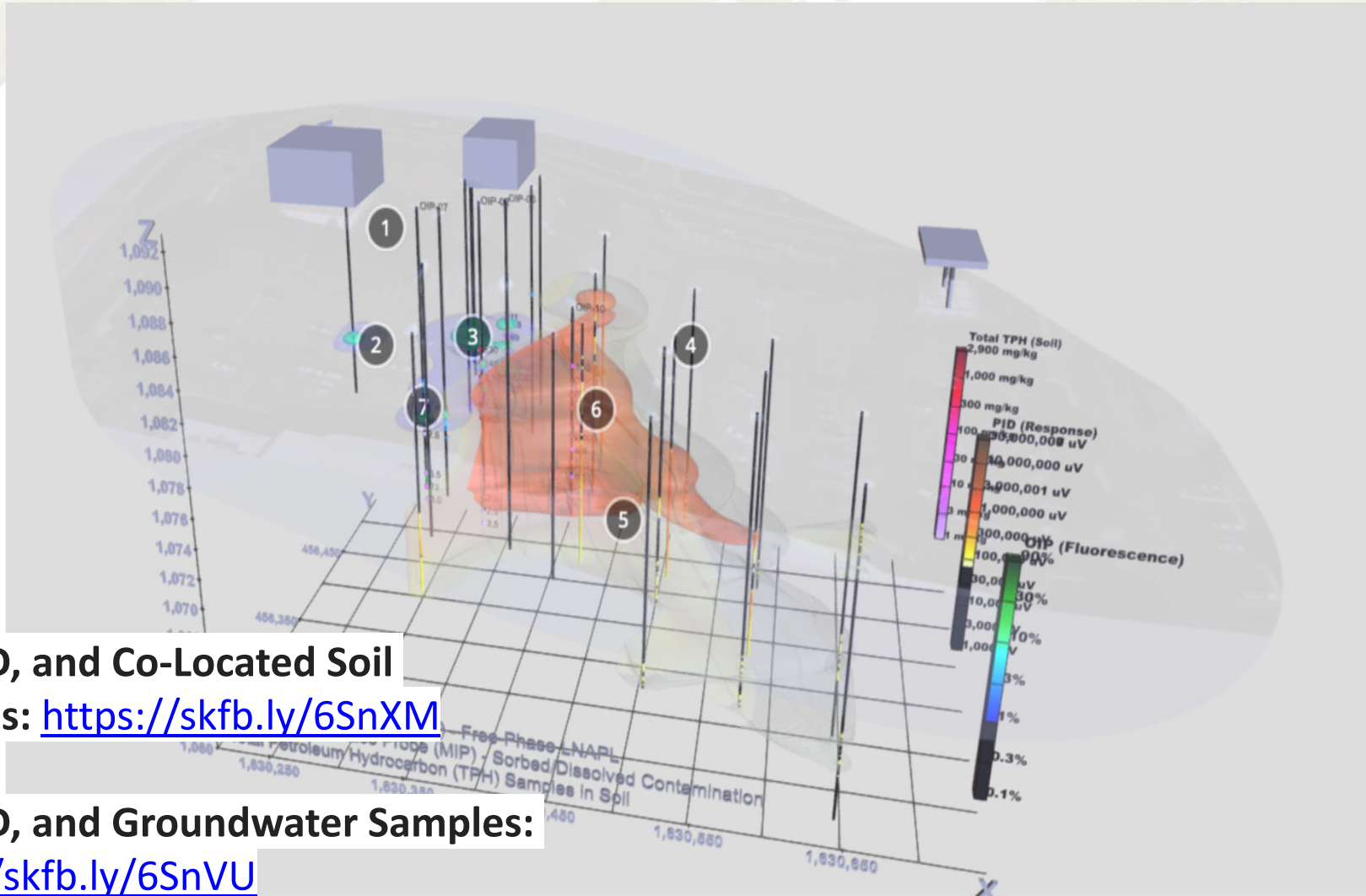
## Contaminant Load mg / 100 cu. ft.



# Multiple Lines of Evidence



# Focus on Clarity in 3D



OIP, PID, and Co-Located Soil  
Samples: <https://skfb.ly/6SnXM>

OIP, PID, and Groundwater Samples:  
<https://skfb.ly/6SnVU>



# ***HIGH-RESOLUTION DIRECT SENSING TECHNOLOGIES***

# Direct Push Technologies

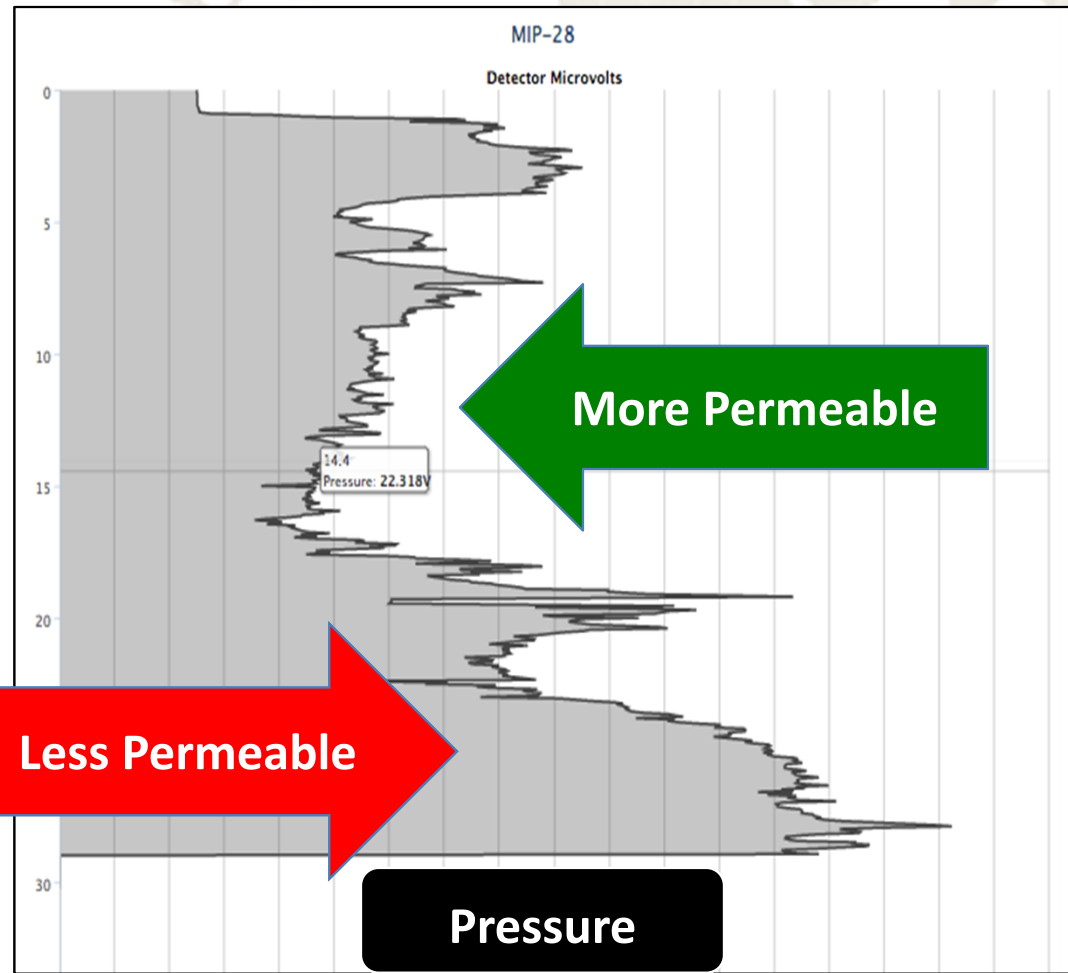






# ***SOIL PERMEABILITY***

# Hydraulic Profiling Tool (HPT) to Measure Soil Pore Pressure





# ***CHEMICAL DETECTION***

# Textbook Contamination Release

Release Source



Vapor Phase

Vadose Zone

100 mg/kg

LNAPL

Dissolved Phase

1 mg/liter

Modified from Huntley and Beckett, 2002

Courtesy of:



# What is NAPL?

## NAPL

**NonAqueous Phase Liquid** – a separate or “free” phase liquid; not in solution

## LNAPL

A liquid ***that is less dense than water***

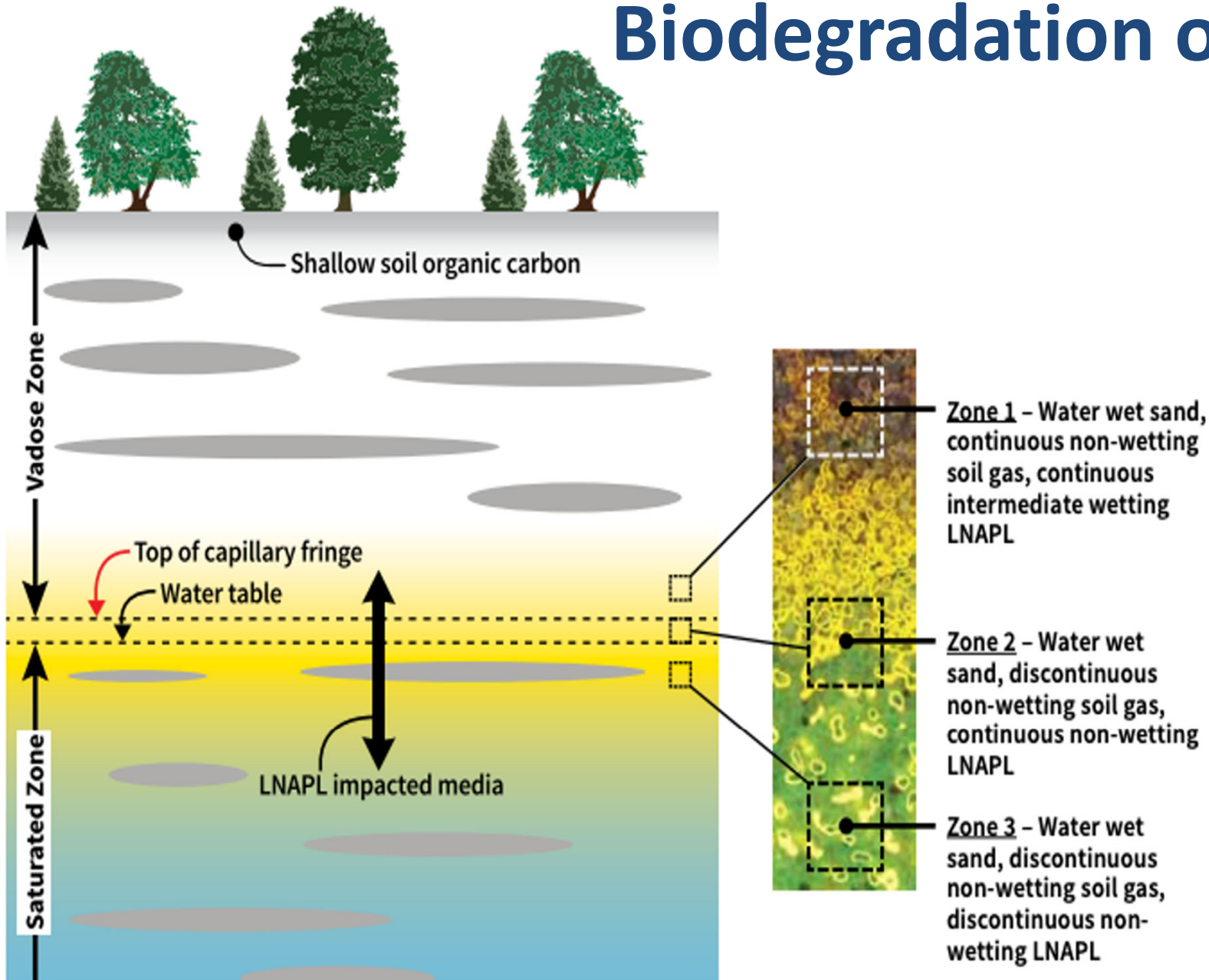
Common examples of LNAPL include gasoline, diesel fuel, jet fuel, and crude oil

Can also include multi-component mixtures

Can be ***unconfined or confined by groundwater***



# Biodegradation of NAPL

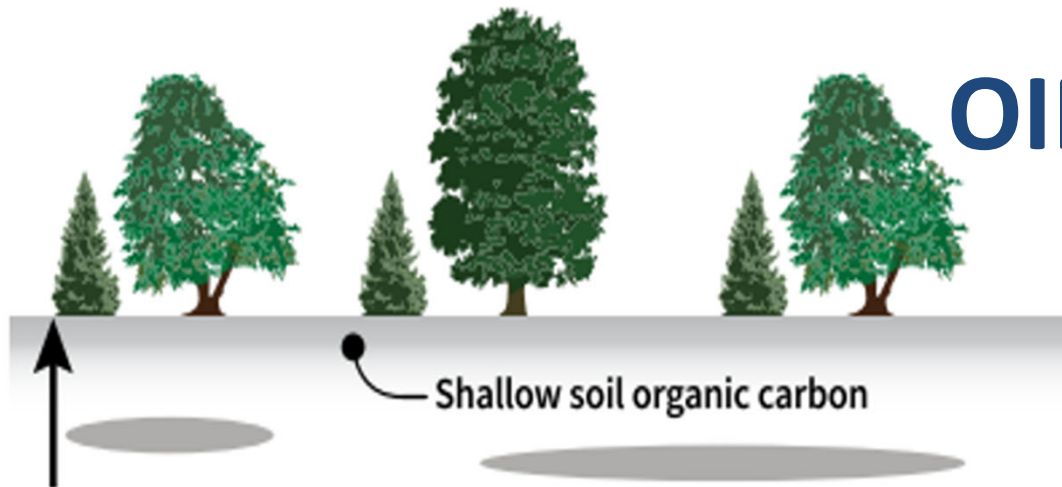


# OIP Description

- **OIP Probe:** Robust with simple connection to the trunkline.
- **Driveable:** Using 7822 series machines and drive cushions.
- **Compatible:** With Geoprobe 1.5 inch and 1.75 inch rod systems.

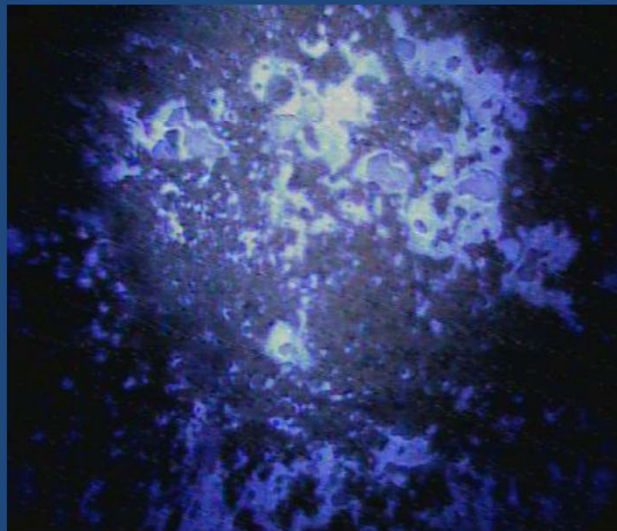


# OIP Image of NAPL

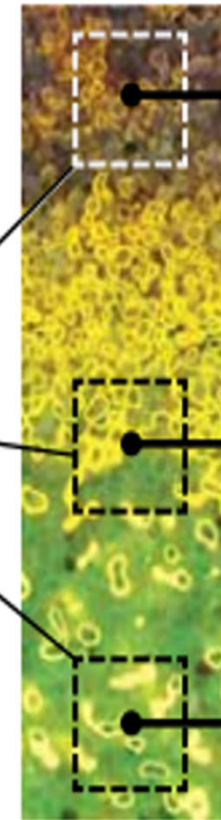


## OIP UV Image

9.5 mm



7 mm



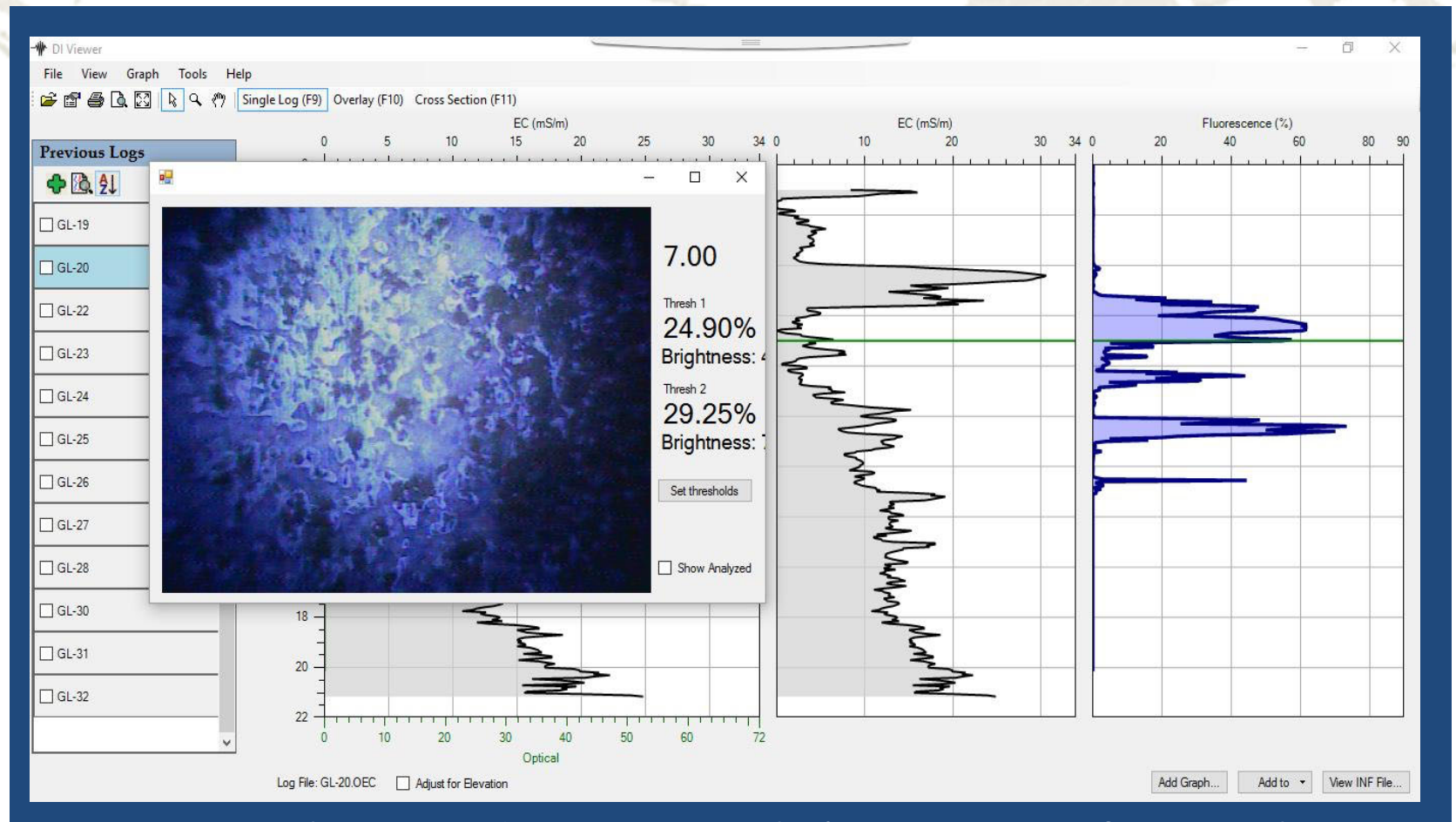
**Zone 1** - Water wet sand, continuous non-wetting soil gas, continuous intermediate wetting LNAPL

**Zone 2** - Water wet sand, discontinuous non-wetting soil gas, continuous non-wetting LNAPL

**Zone 3** - Water wet sand, discontinuous non-wetting soil gas, discontinuous non-wetting LNAPL



# Optical Interface Probe Fluorescence Mapping of Petroleum



# Membrane Interface Probe

MIP (Membrane Interface Probe)



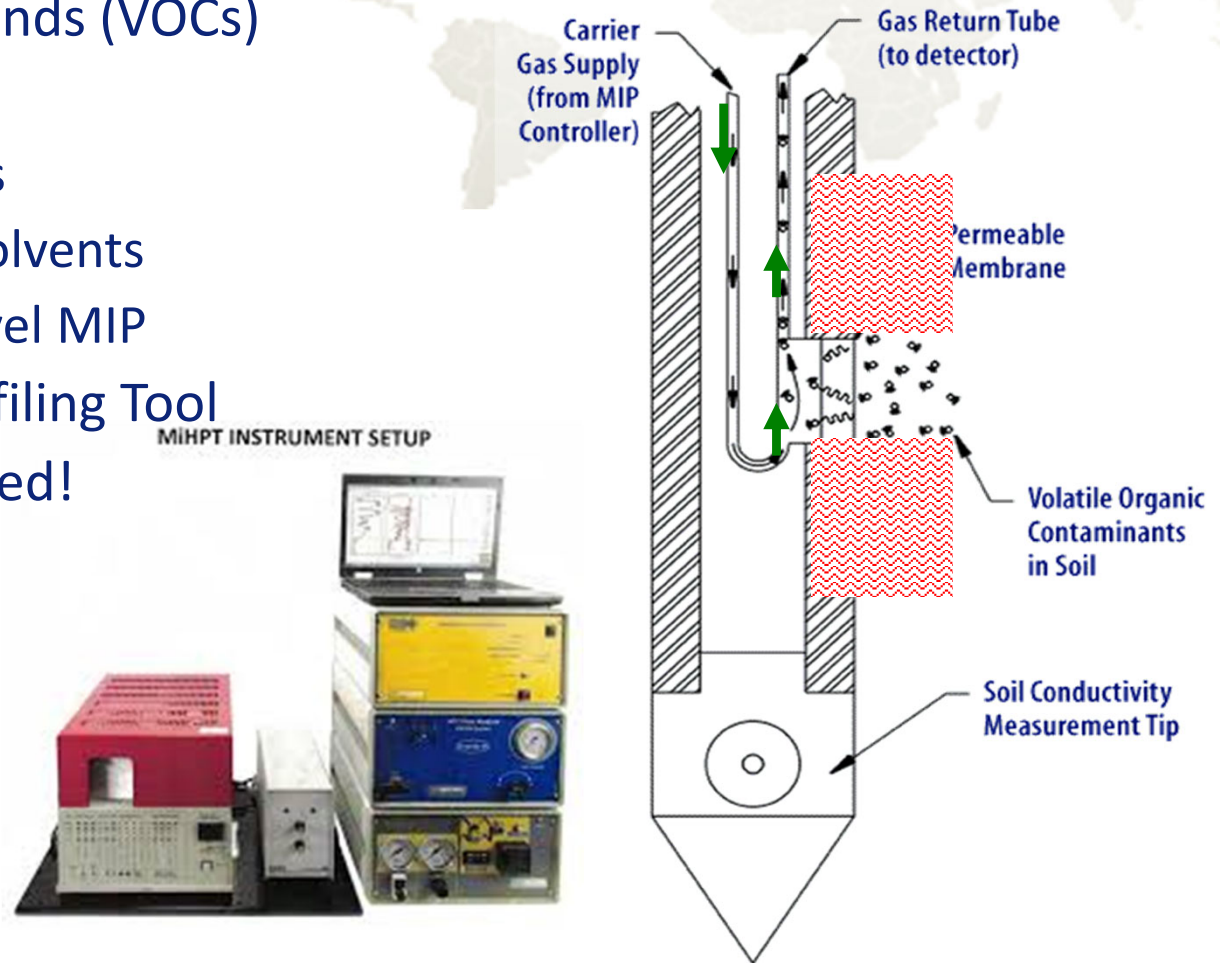
# Membrane Interface Probe



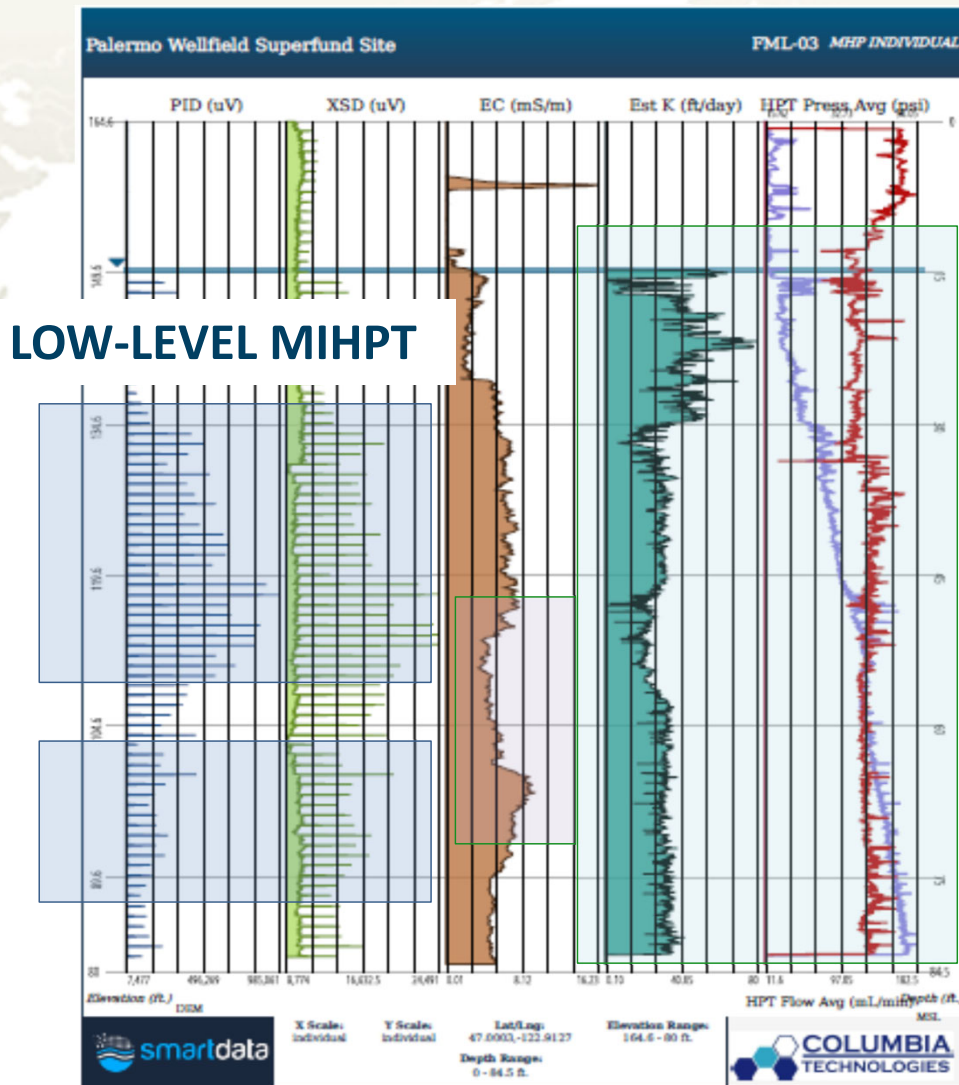
# Principles of Operations (MIP)

- **Quick Notes:**

- Volatile Organic Compounds (VOCs)
- Typical Detection Limits:
  - 1 ppm petroleum fuels
  - 200 ppb chlorinated solvents
  - 10X Lower for Low-Level MIP
- Integrated Hydraulic Profiling Tool
- Performance Test Required!



# Benefits of High-Resolution Information



Example direct sensing boring log

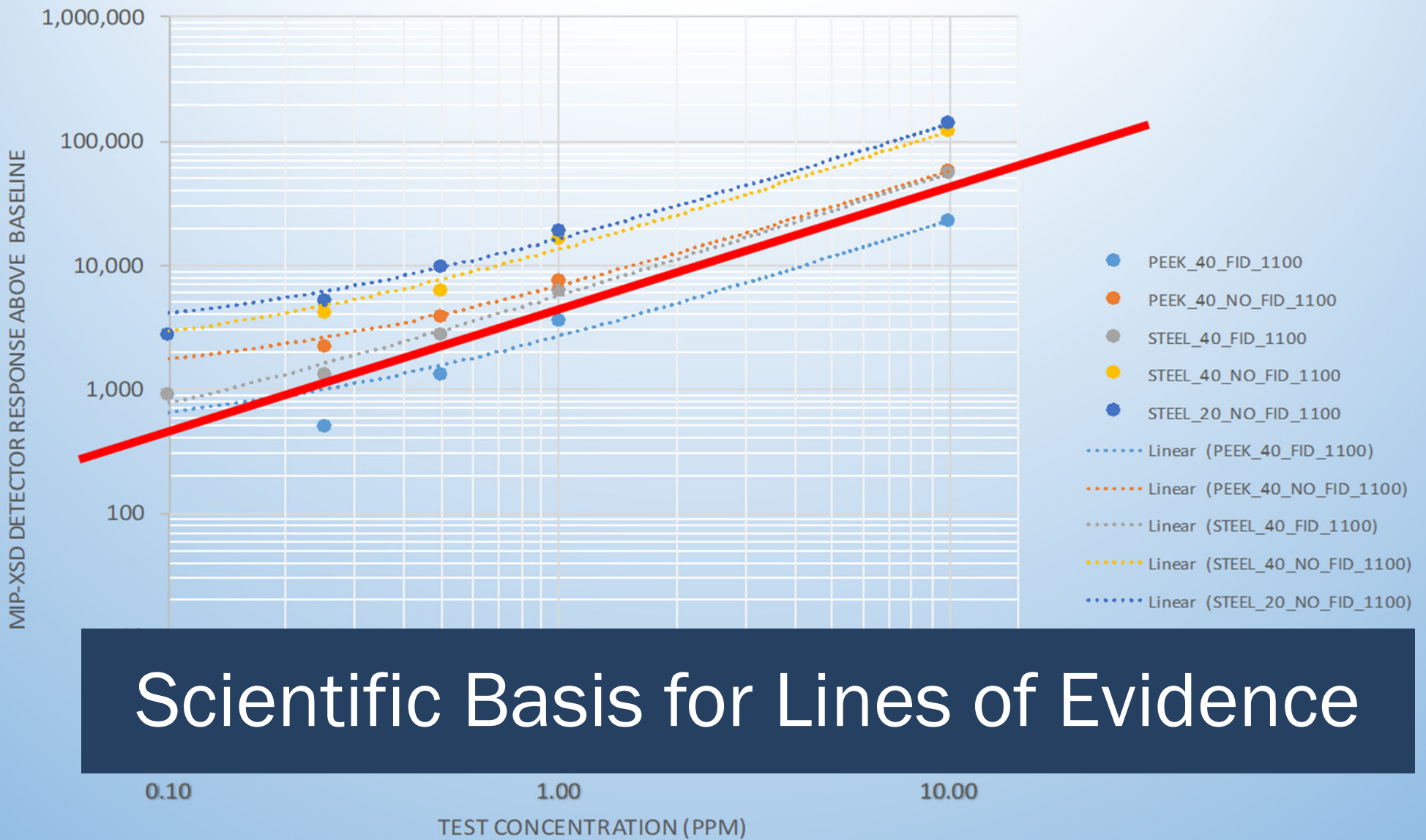
- Identified solvent contamination at discrete subsurface elevations

- Hydraulic pressure and flow vs. depth
- Estimated hydraulic conductivity

- Soil particle size

# MIP-XSD Response to Aqueous Phase Test Solution

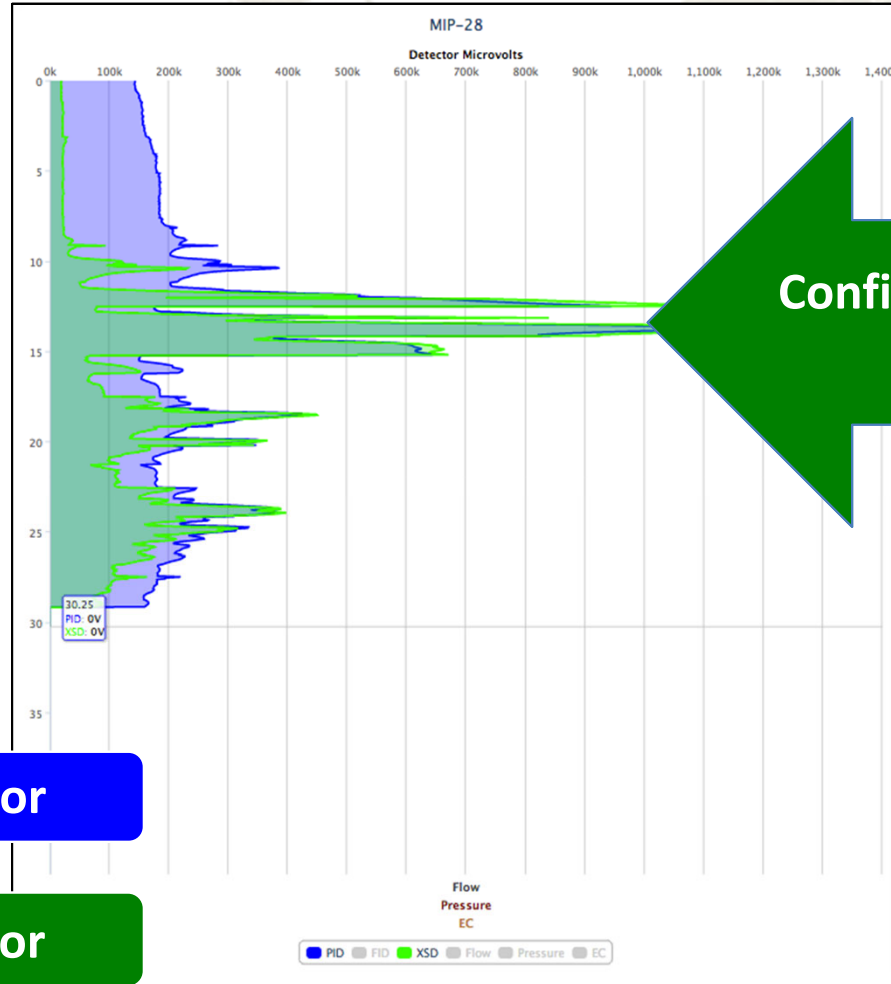
(April 2016)



## Scientific Basis for Lines of Evidence

# Membrane Interface Probe (MIP)

Chlorinated  
Volatile Organic  
Compounds



Confirms chlorinated  
compound

Photo Ionization Detector

Halogen Specific Detector

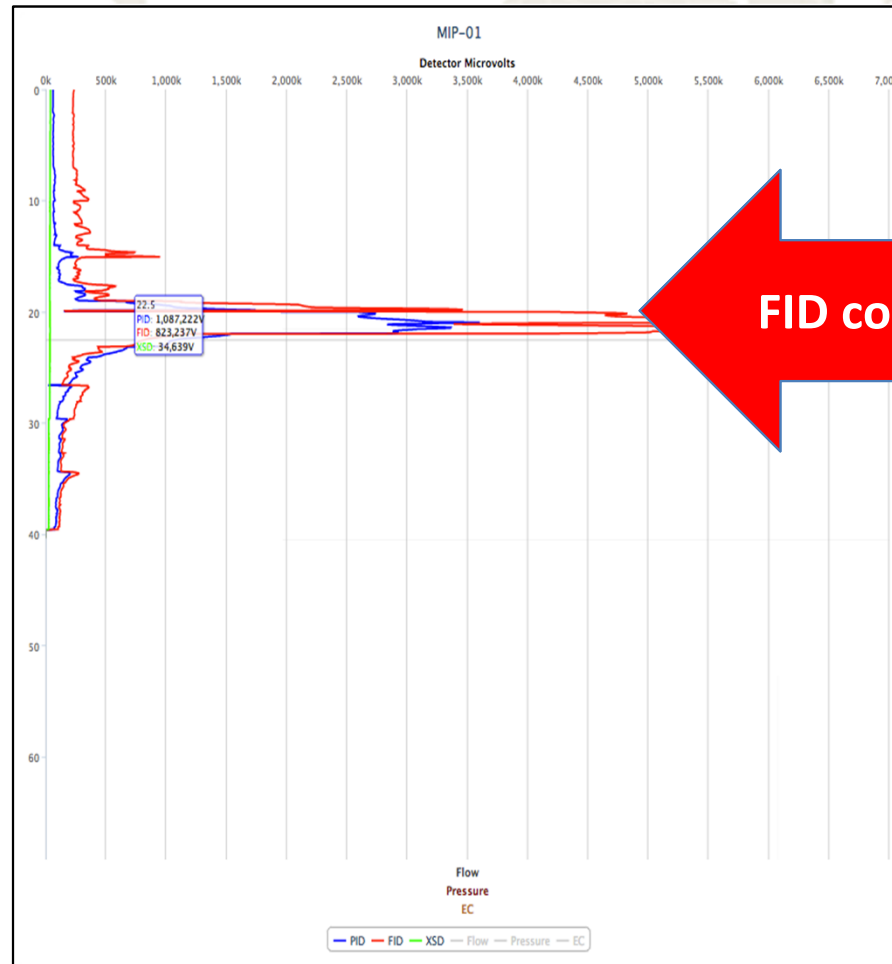
# Membrane Interface Probe (MIP)

**Petroleum  
Volatile Organic  
Compounds**

**Flame Ionization Detector**

**Photo Ionization Detector**

**Halogen Specific Detector**

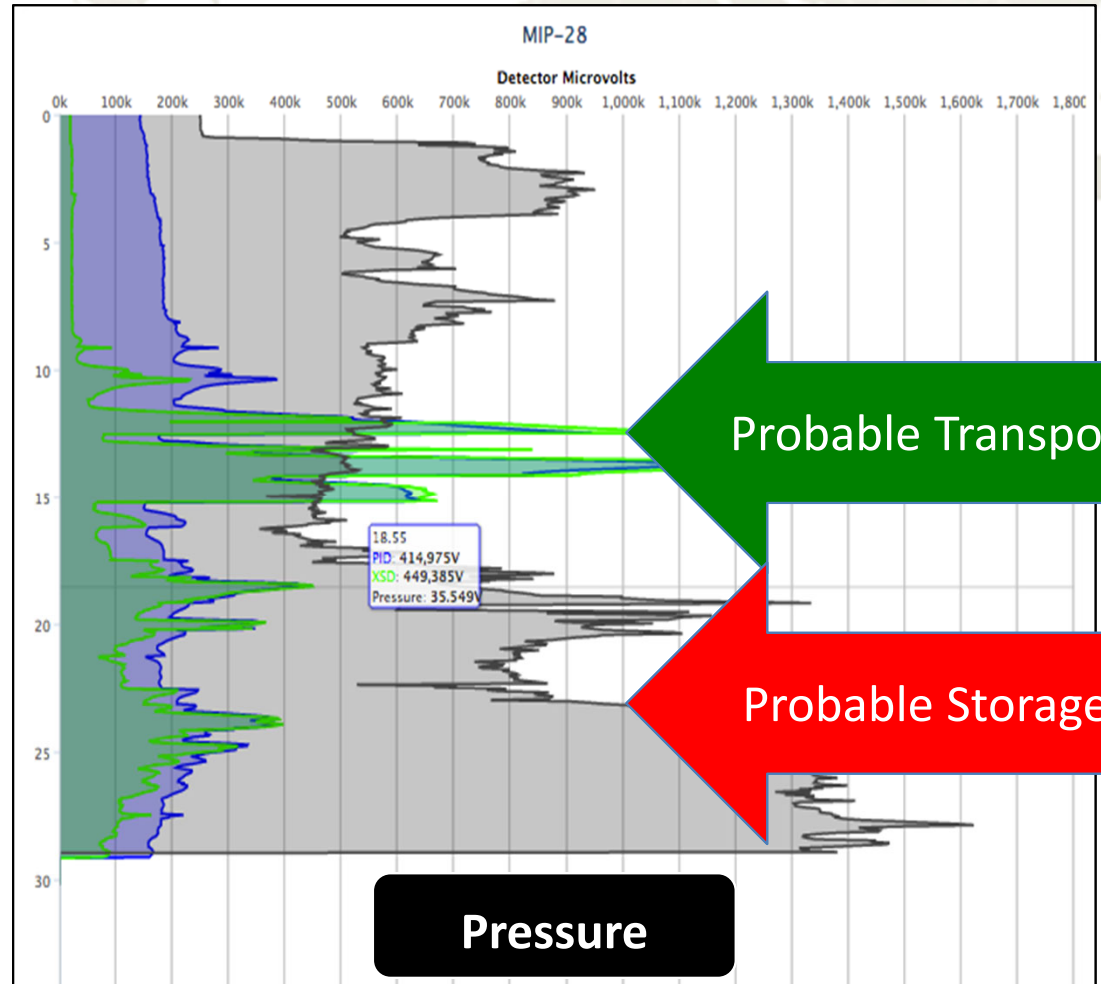
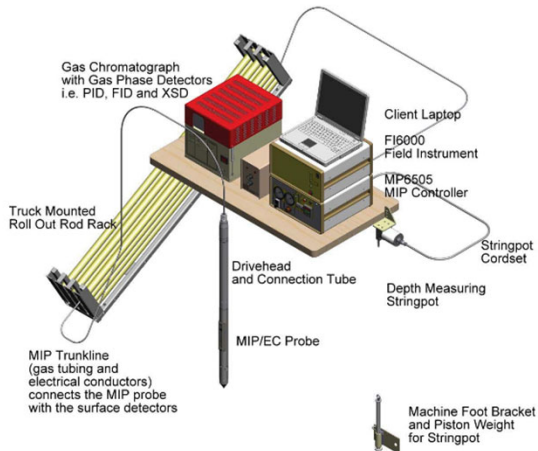




# Combined Membrane Interface Probe and Hydraulic Profiling Tool (MiHpt)

Photo Ionization Detector

Halogen Specific Detector





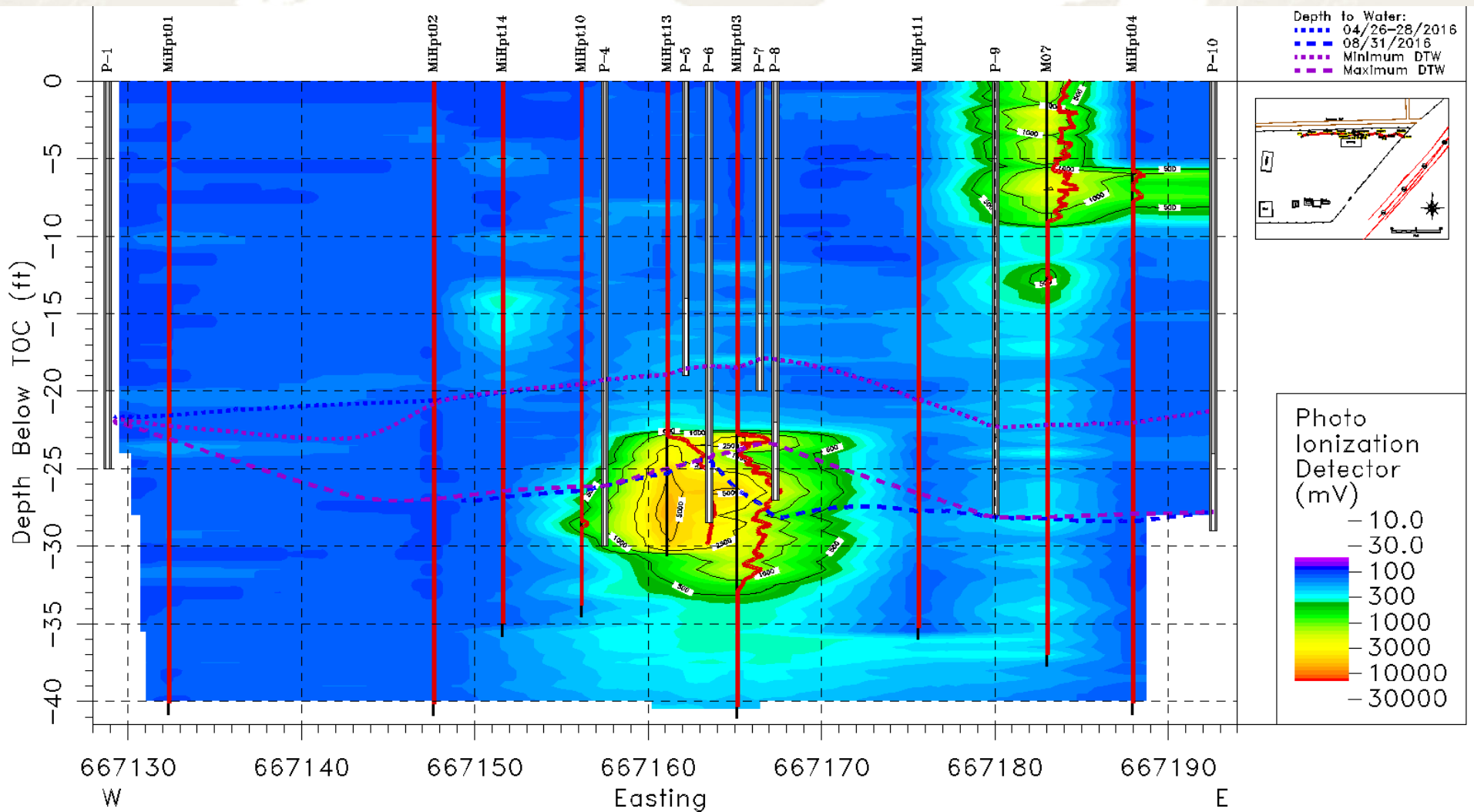
# Performance Testing Required!

**ASTM Standard  
D7352 Standard Practice for the Membrane Interface  
Probe (MIP) for Volatile Contaminant  
Logging using Direct Push Methods**

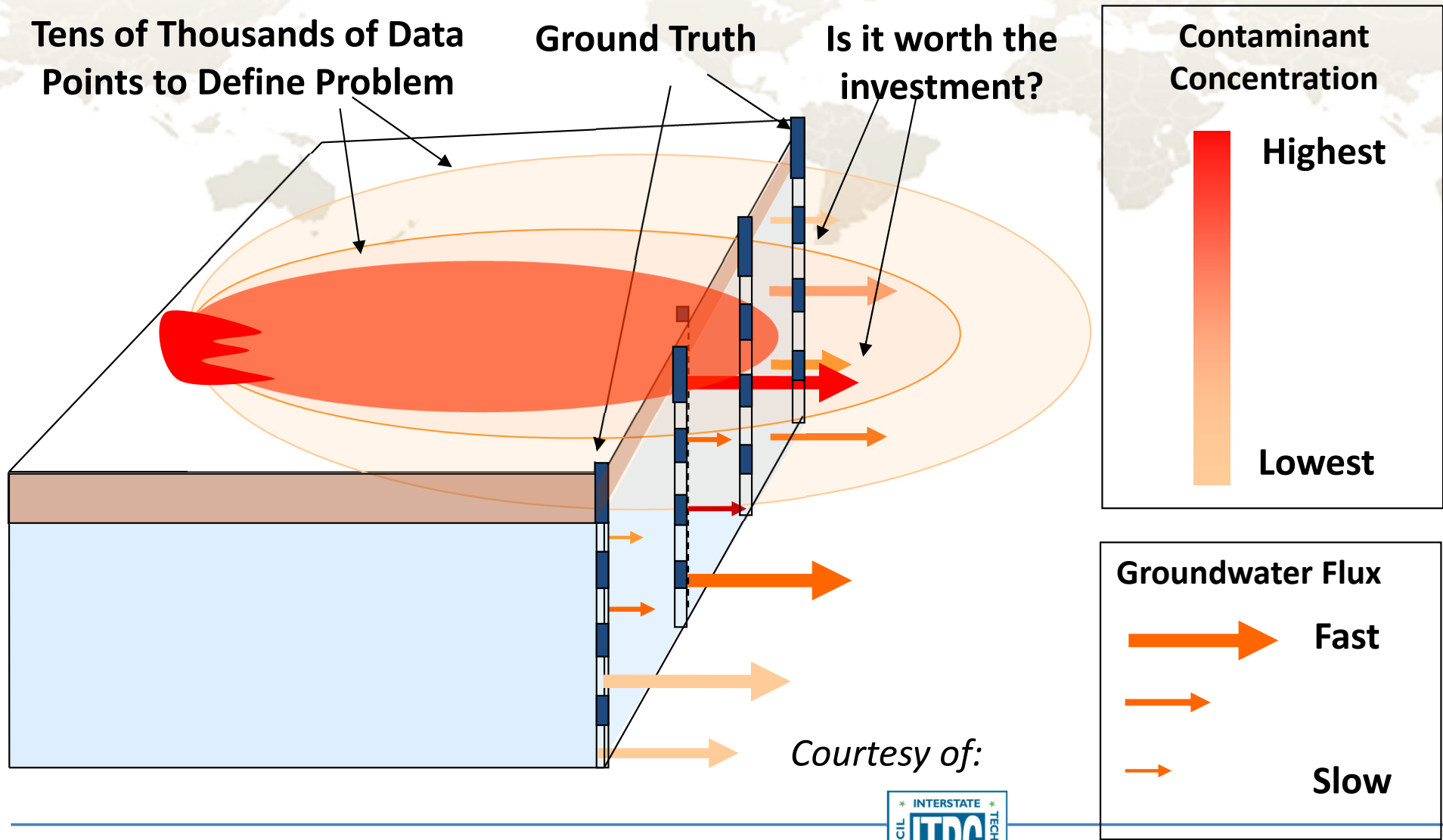


# ***GROUNDWATER DISSOLVED PHASE CONTAMINATION***

# Mass FLUX Diagram

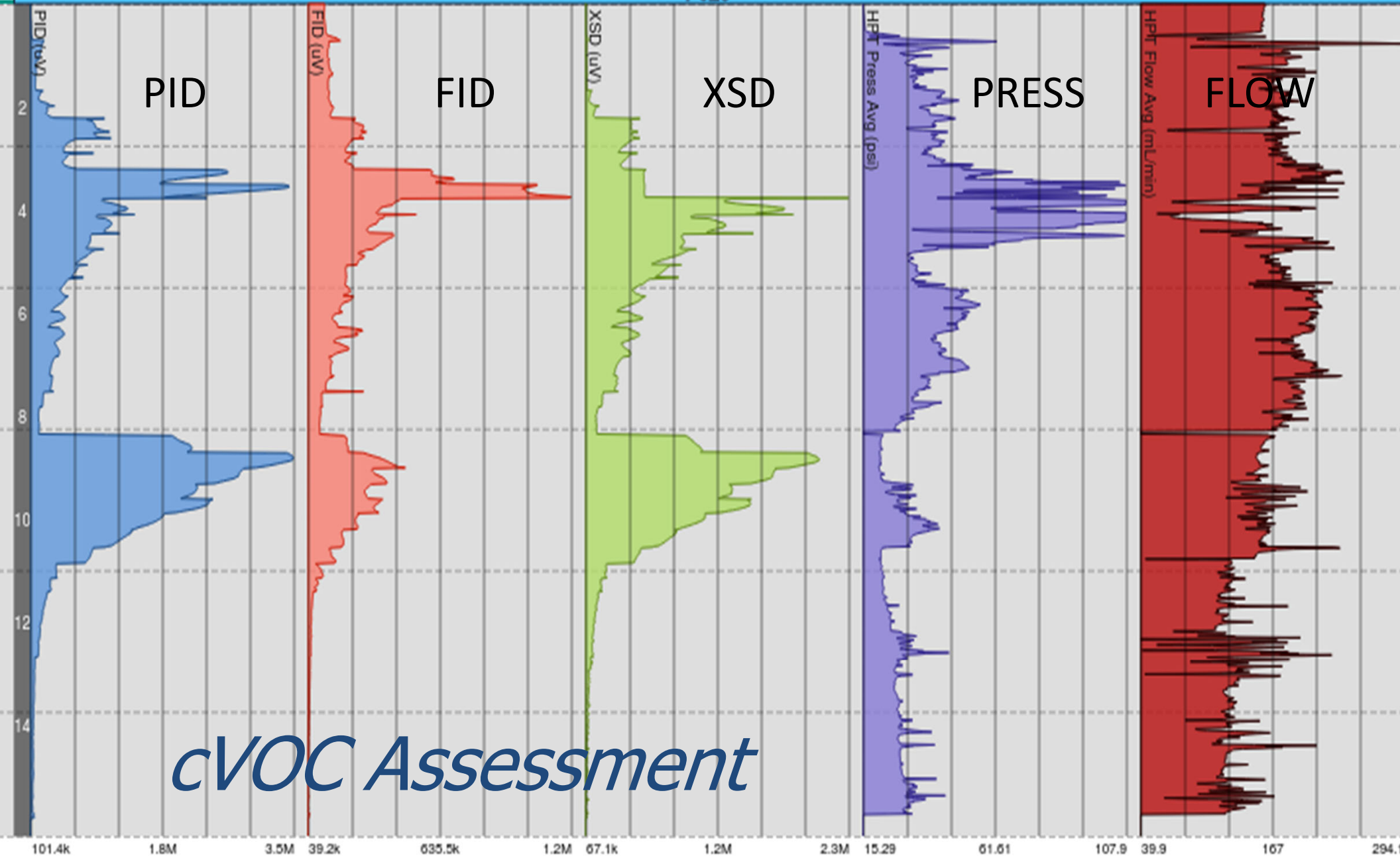


# Mass vs Flow

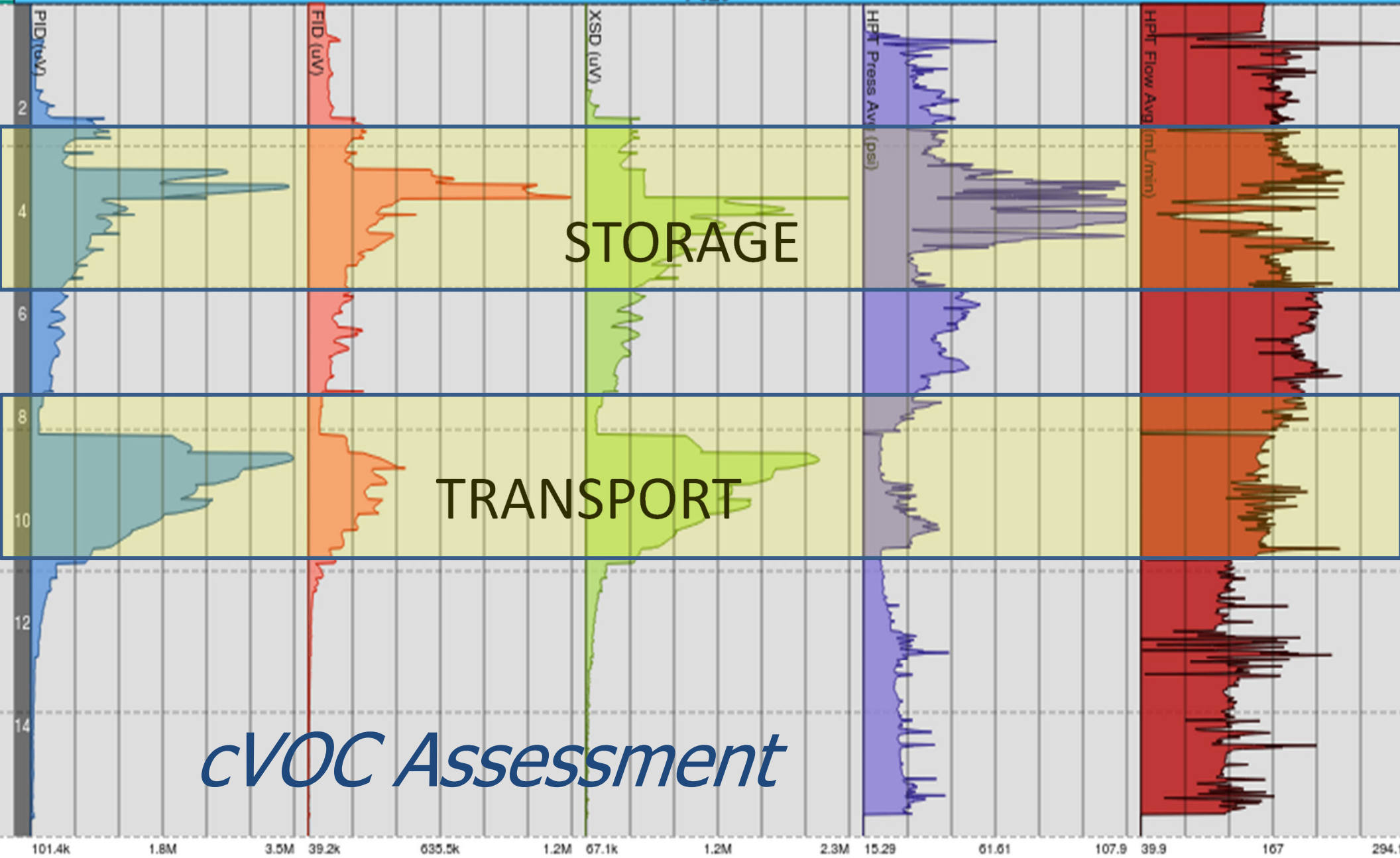




# DATA INTERPRETATION



# *cVOC Assessment*

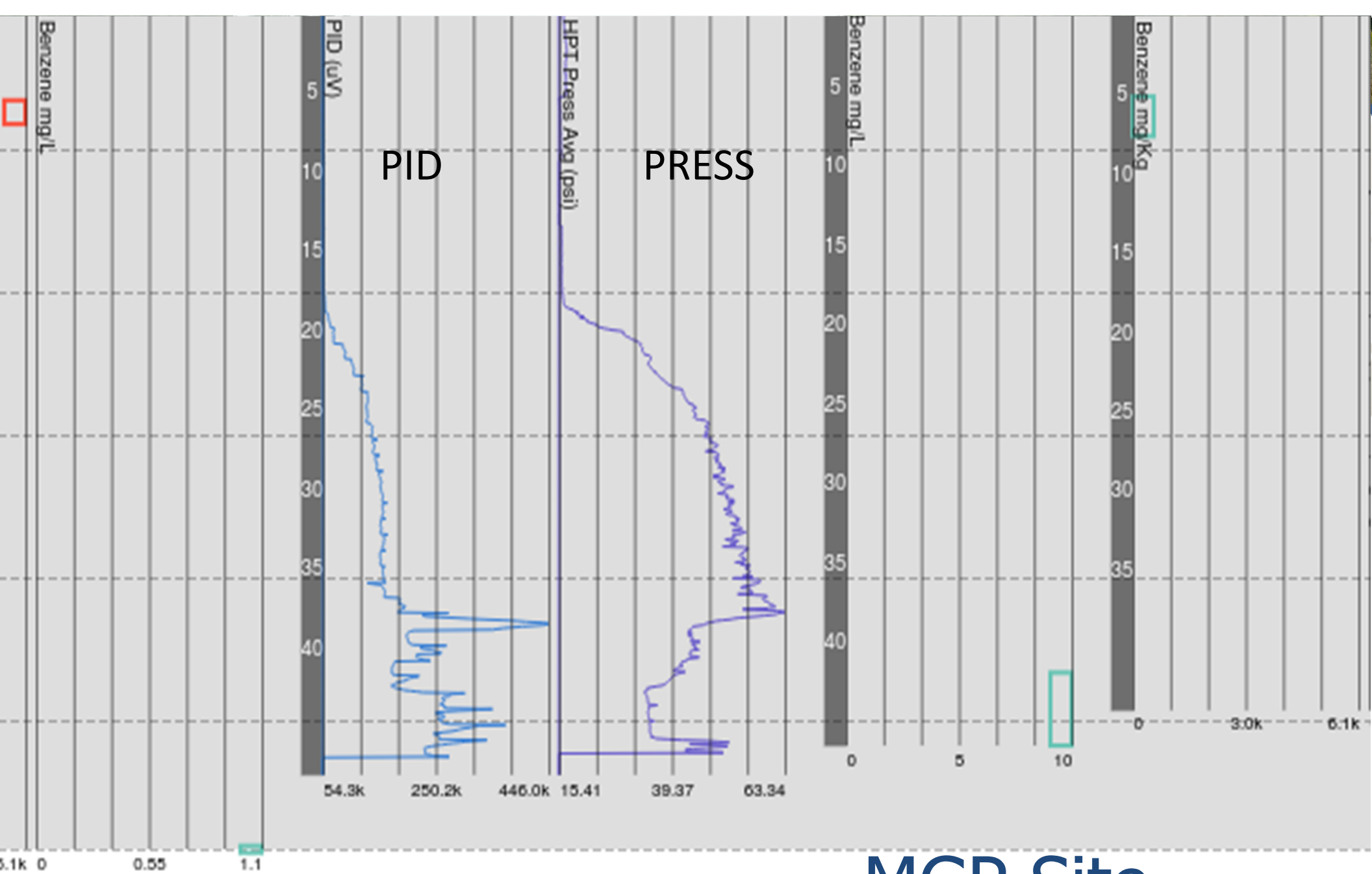


STORAGE

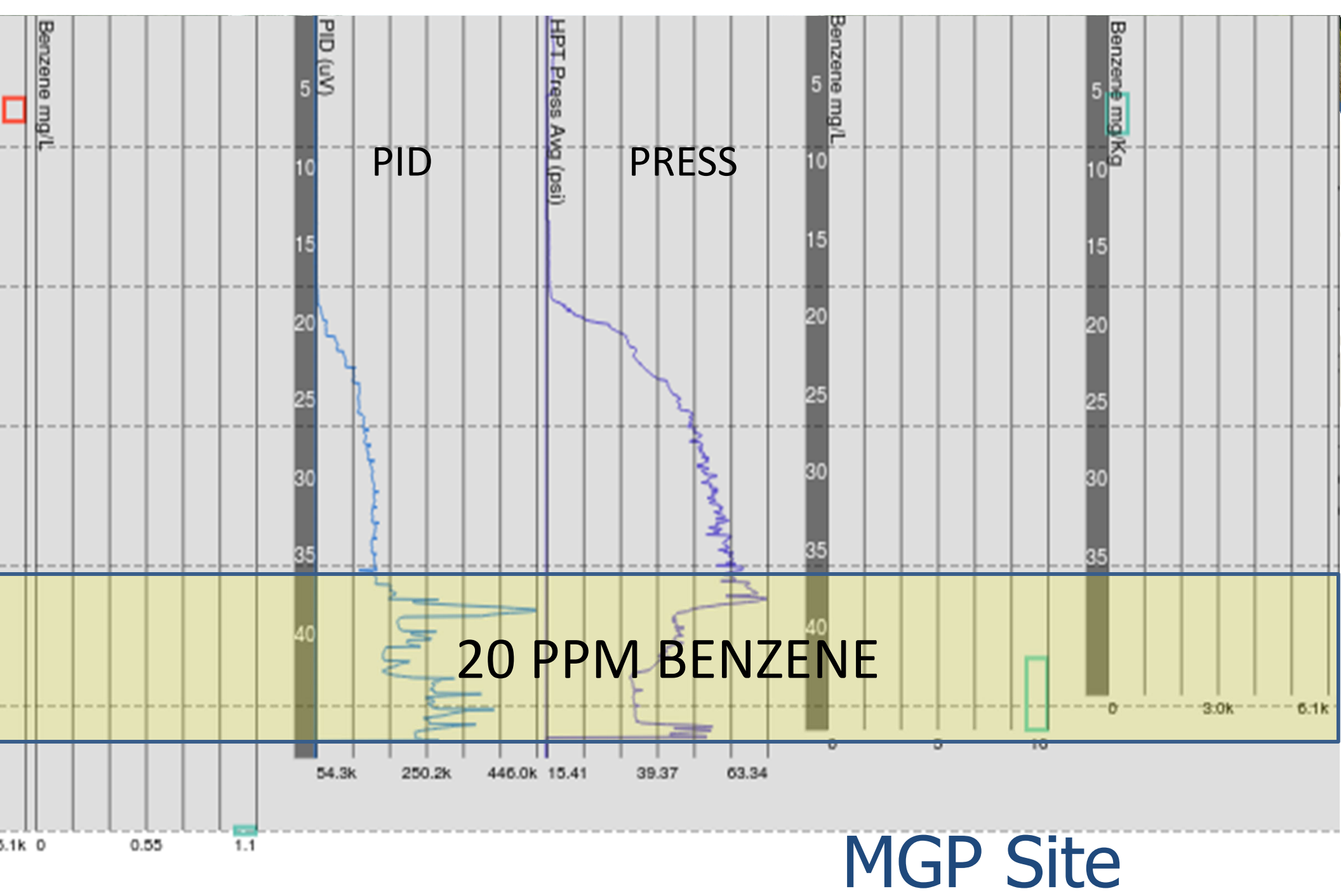
TRANSPORT

# *cVOC Assessment*

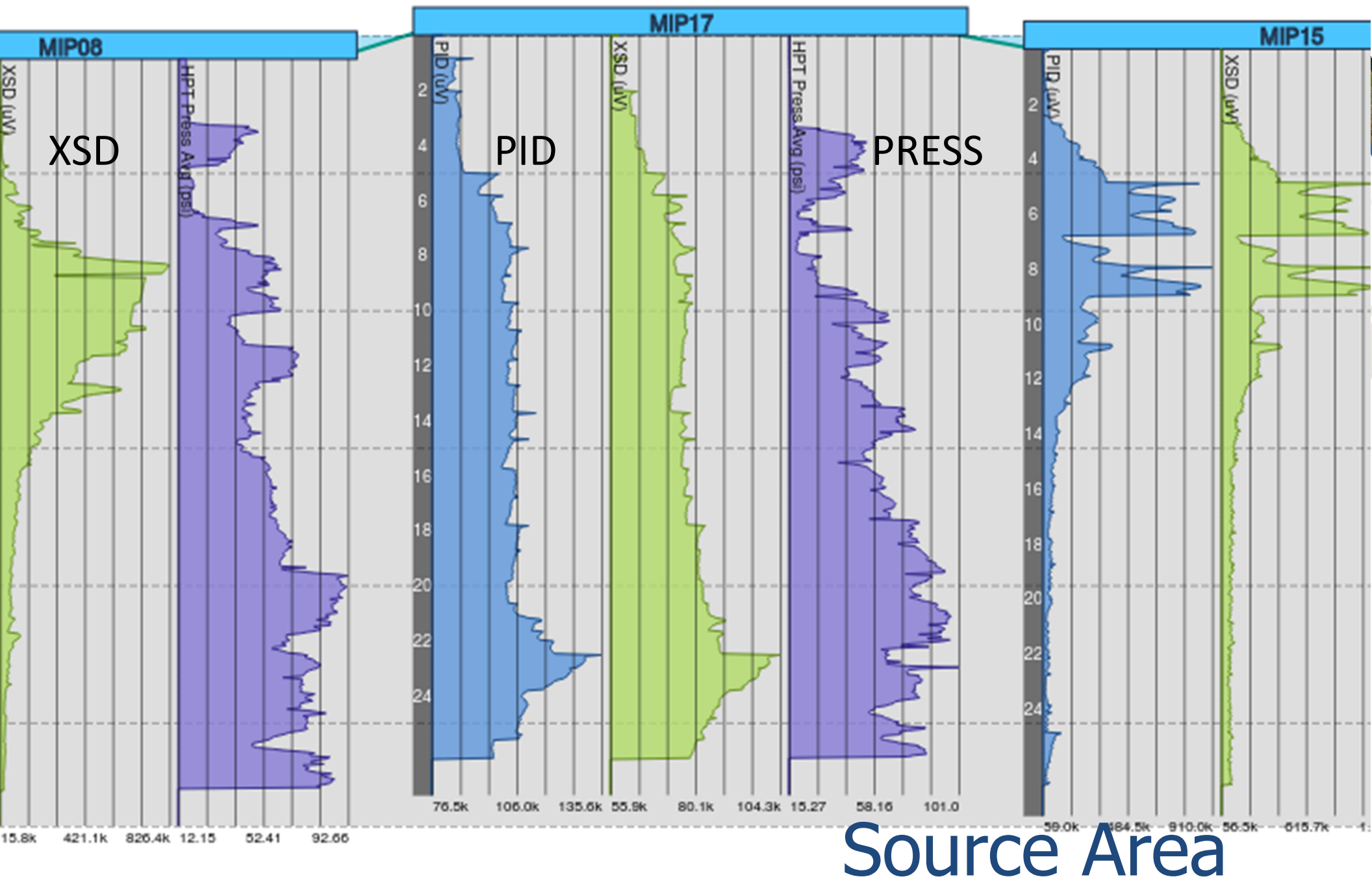


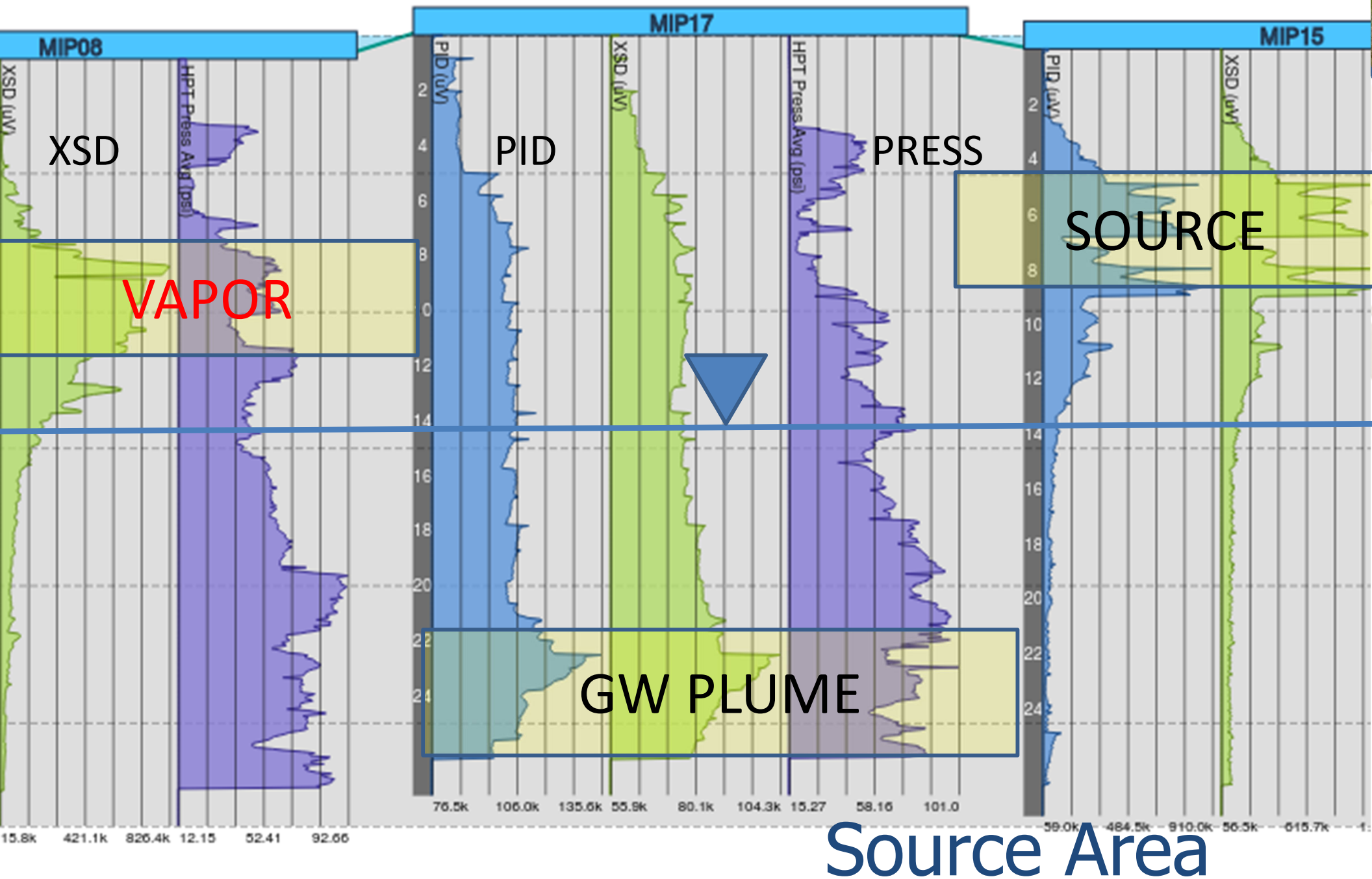


# MGP Site



# MGP Site





# Real-Time SmartData Solutions®

Robins AFB - ORC OT041 (SWMU-57) Geosyntec

My Site Assessments My Account

Dashboard Site Model 3D Model Report Project Setup General Info Team Edit Stations Project Data

DISABLE ALL COLLAPSE ALL Save ScreenShot Options Bing Satellite

2020-GROUNDWATER-LABS Total: 19  
Icons Labels  
Compounds Layers Stations/Max Vals  
Benzene  
Chlorobenzene

2021-GROUNDWATER-LABS Total: 19  
Icons Labels  
Compounds Layers Stations/Max Vals  
Benzene  
Chlorobenzene

MIP Total: 21  
Icons Labels  
Detectors Layers Stations/Max Vals  
PID FID XSD

HPT Total: 21  
Icons Labels  
Detectors Layers Stations/Max Vals

321 ft.  
11 ft.  
200 m  
500 ft.

SSALES2\_C452....pdf Screenshot SSALES2\_C452....pdf MESSER\_Invoice....pdf invoice\_11077.pdf Show All

# Key Takeaway Points

- **High-resolution** – Scale appropriate information is critical to minimizing uncertainty in Site Conceptual Model
- **Remediation parameters** are not the same as risk parameters (e.g., BTEX in water does not represent TPH mass in soil)
- **Multiple lines of evidence** are required – One technology or approach will not provide all the answers needed for remedial design selection

*Think.*  
*Restore,*  
*Sustainably*



John Sohl, President/CEO  
[jsohl@columbiatechnologies.com](mailto:jsohl@columbiatechnologies.com)  
+1-301-455-7644



# Equipment Demonstration

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# Questions?

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# **New Business and Program Closing**

**Dr. Linda Smyth  
EAB Community Co-chair**



# Next EAB Meeting

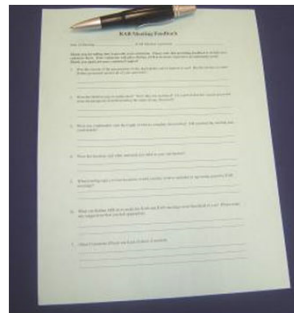
Thursday, February 2, 2023





**Please...**

**Complete the meeting evaluation and  
feedback form and return to sign-in table or leave at seat**



**Leave your name tag at the sign-in table or seat for the  
next meeting**



**Thank you!**