



TEXAS TECH UNIVERSITY™



# High-Resolution Delineation of Chlorinated Solvent Concentrations, Biogeochemical Processes, and Microbial Communities in Saturated Subsurface Environments

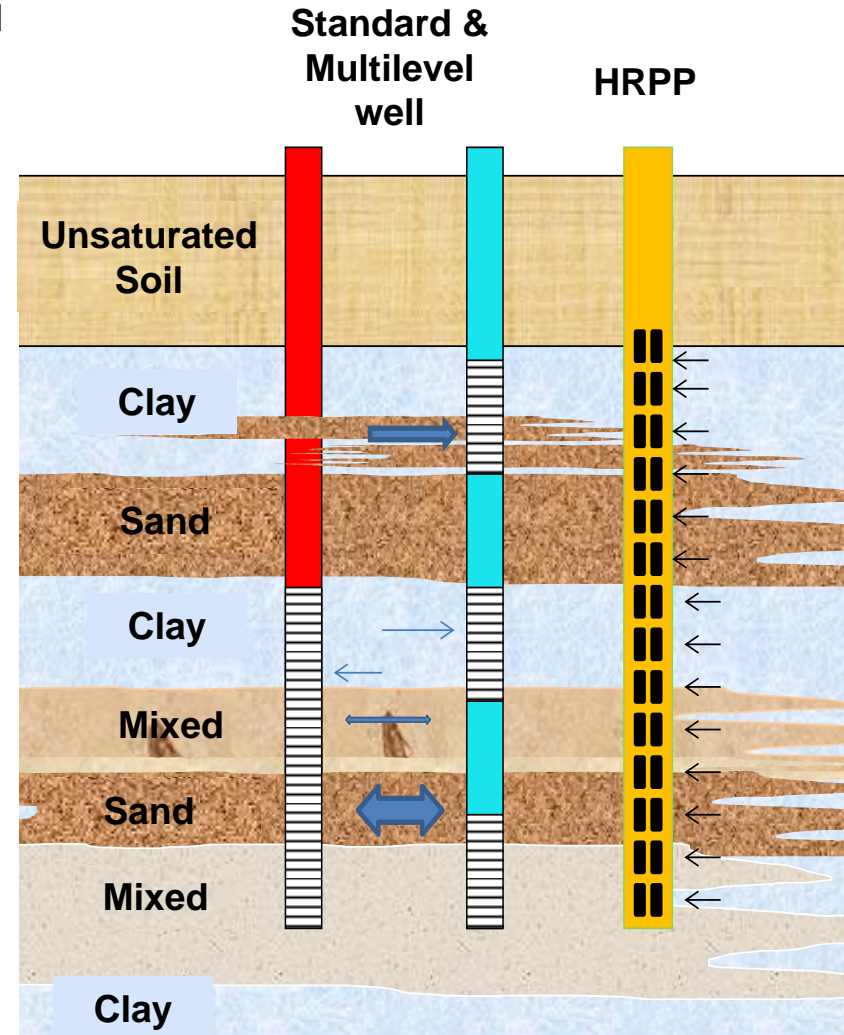
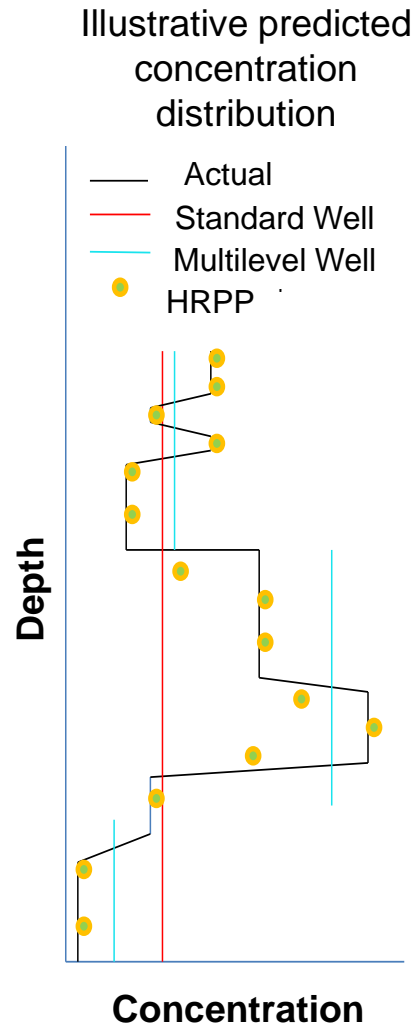
**Haley Schneider**  
**Texas Tech University**

**Battelle Bioremediation Symposium**  
**May 24, 2017**



# Problem Statement

- Contaminant fate and transport prediction limited by intrinsic heterogeneity
- Low permeability zones sustain groundwater plumes

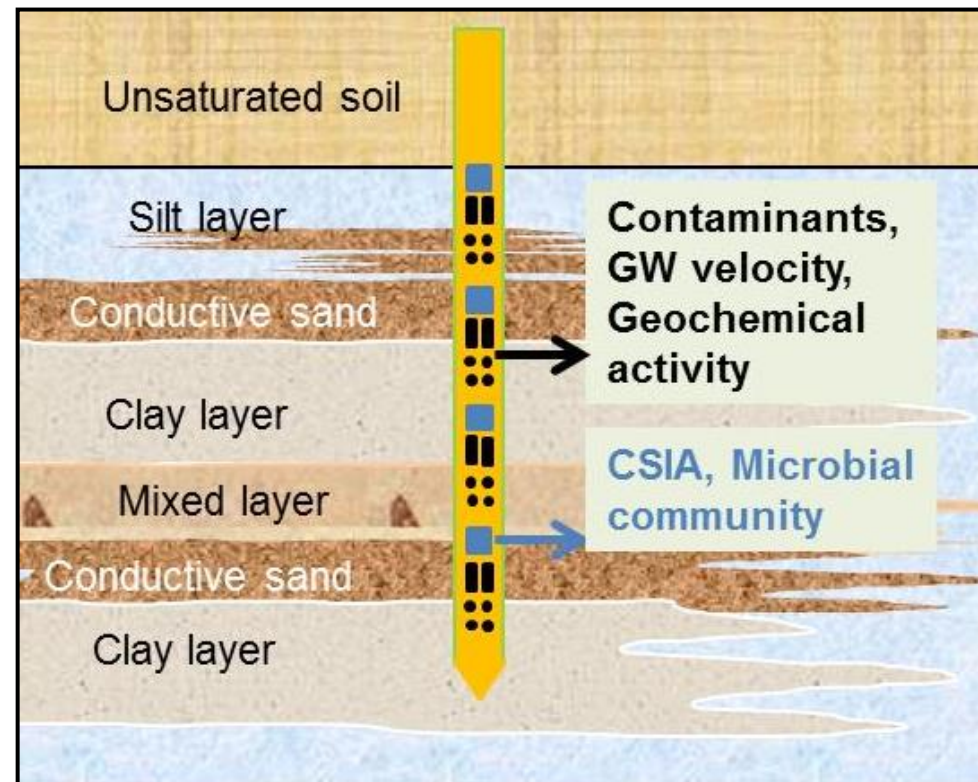


# Research Objectives



**Overall goal: develop and demonstrate a High Resolution Passive Profiler (HRPP) as a fine-scale delineation tool for the saturated subsurface**

1. Directly measure groundwater and contaminant flux at the cm-scale
2. Quantify biogeochemical conditions at the cm-scale
3. Assess microbial community structure and activity at the cm-scale

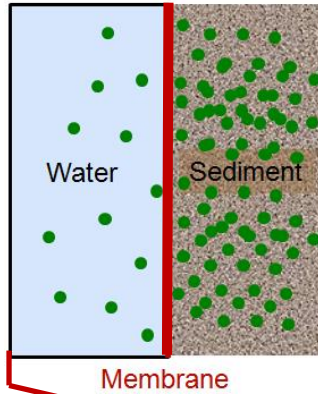


Tested with laboratory experiments and 2 field trials

# HRPP Functionality



$$C = C_0(1 - e^{-k_m \frac{A}{V} t})$$

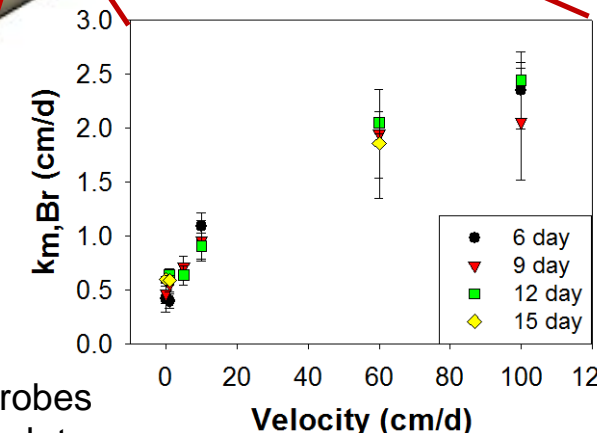
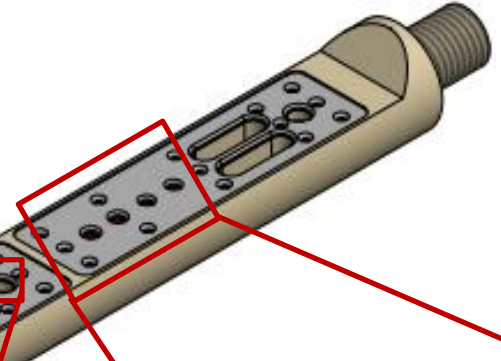


Steel Mesh

Viton

Nylon Mesh

Membrane



Bio-sep beads (pictured with standard biotrap)



Fill HRPP cell with bio-sep beads

Microbes attach to beads



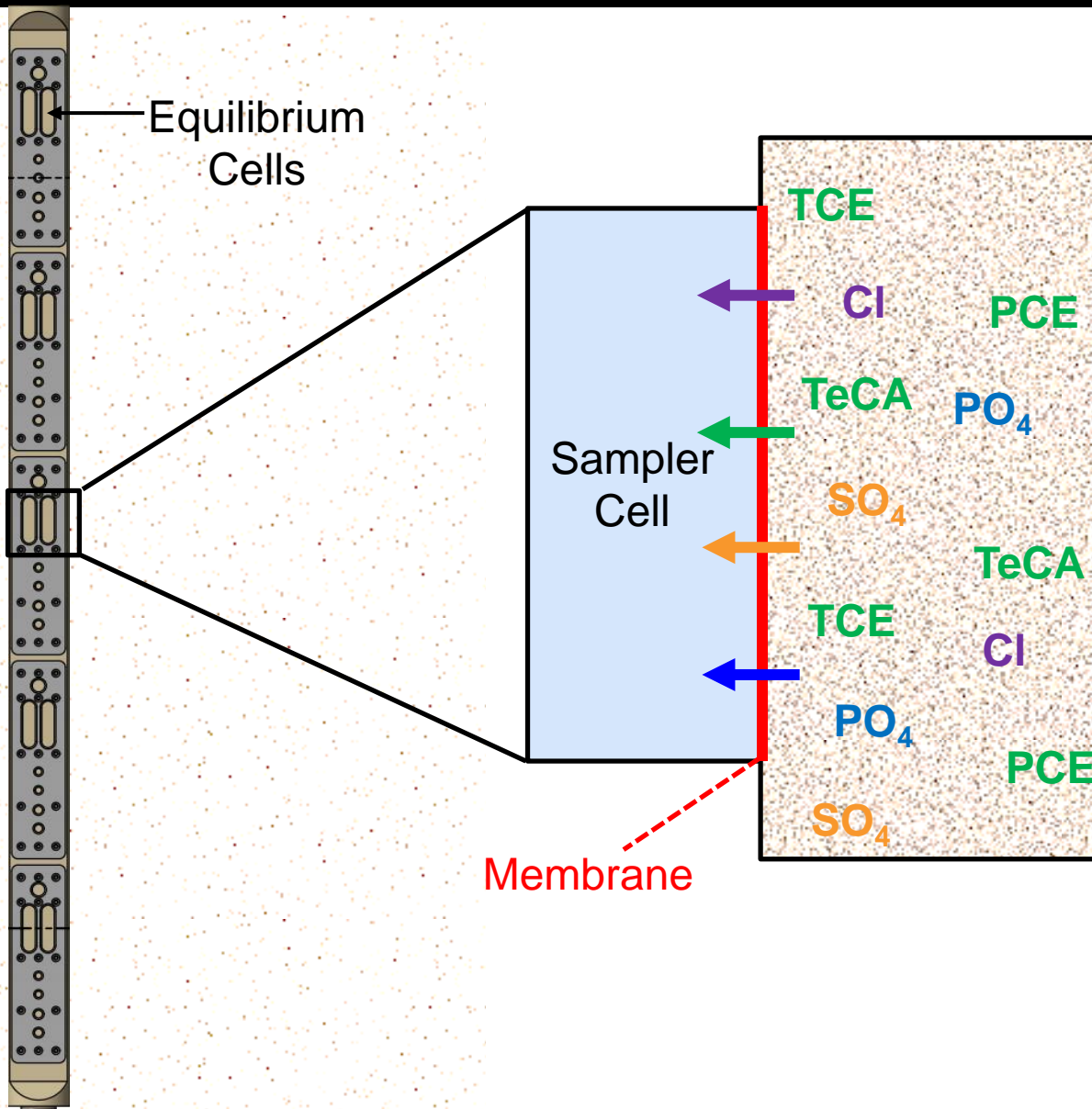
Quant Array Analysis

Contaminants adsorb to beads



Compound Specific Isotope Analysis

# Equilibrium Porewater Sampling

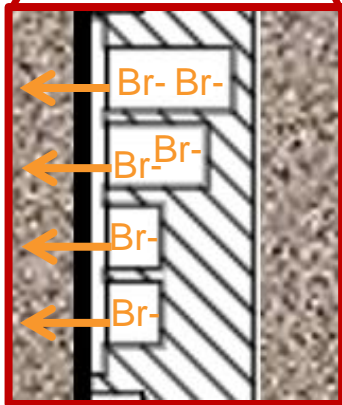
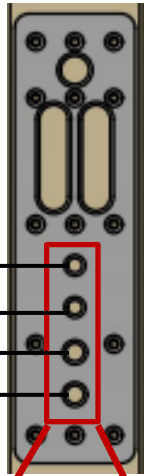


- ~3 weeks (tunable)
- Any soluble species

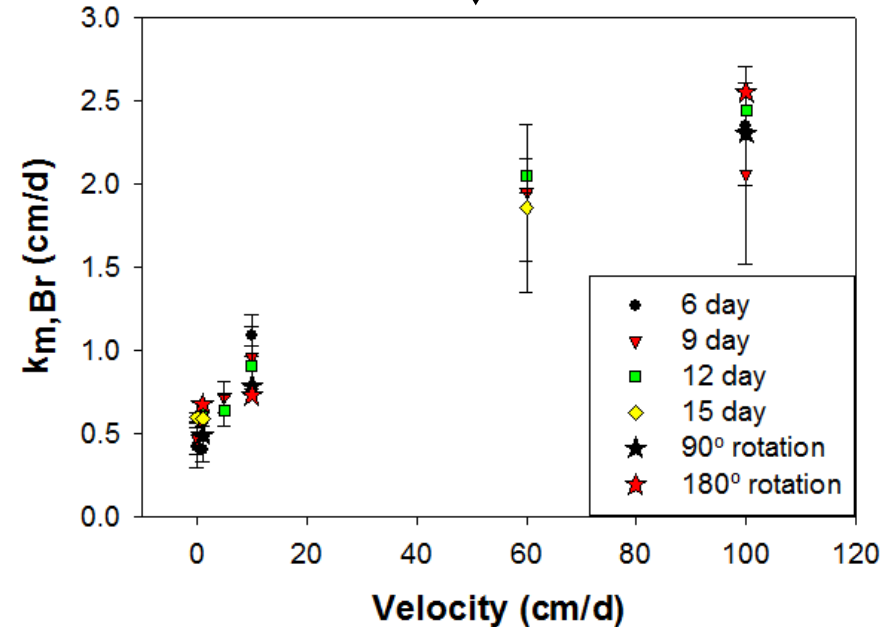
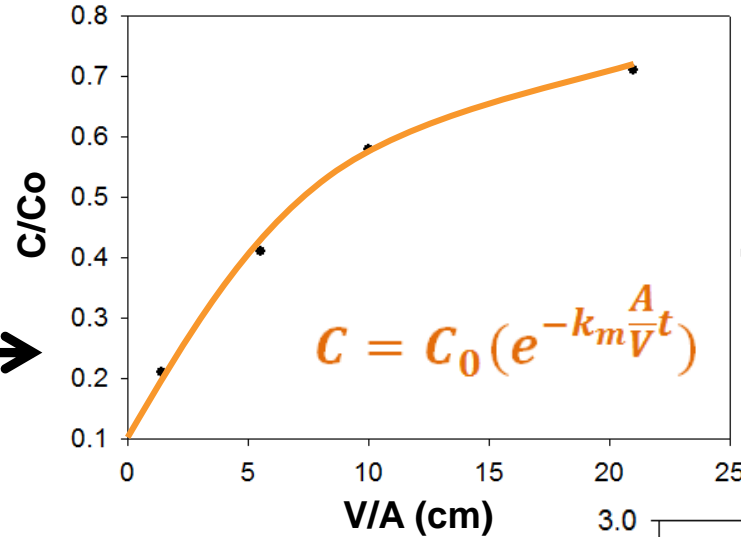
# Estimating Groundwater Velocity



Measure Br- concentration after HRPP is extracted



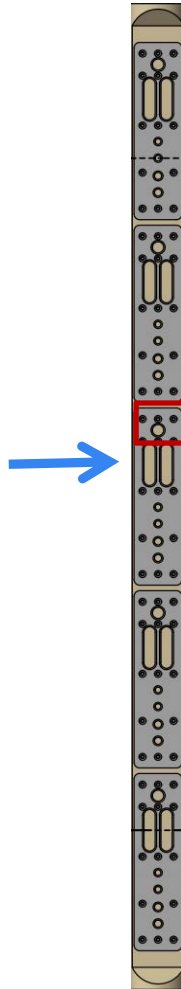
Plot  $C/C_0$  vs.  $V/A$  and fit equation for  $k_m$



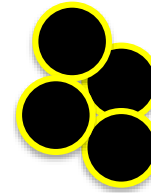
# Microbial Community and Compound Specific Isotope Analysis



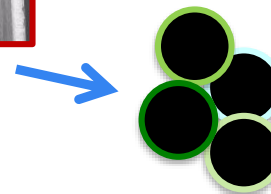
Bio-sep beads  
(pictured with  
standard biotrap)



Microbes attach  
to beads



Quant Array Analysis:  
Detection of microbial  
communities and  
degradative genes



Contaminants  
adsorb to beads

Compound Specific  
Isotope Analysis:  
Contaminant source,  
potential for  
degradation, extent of  
current degradation

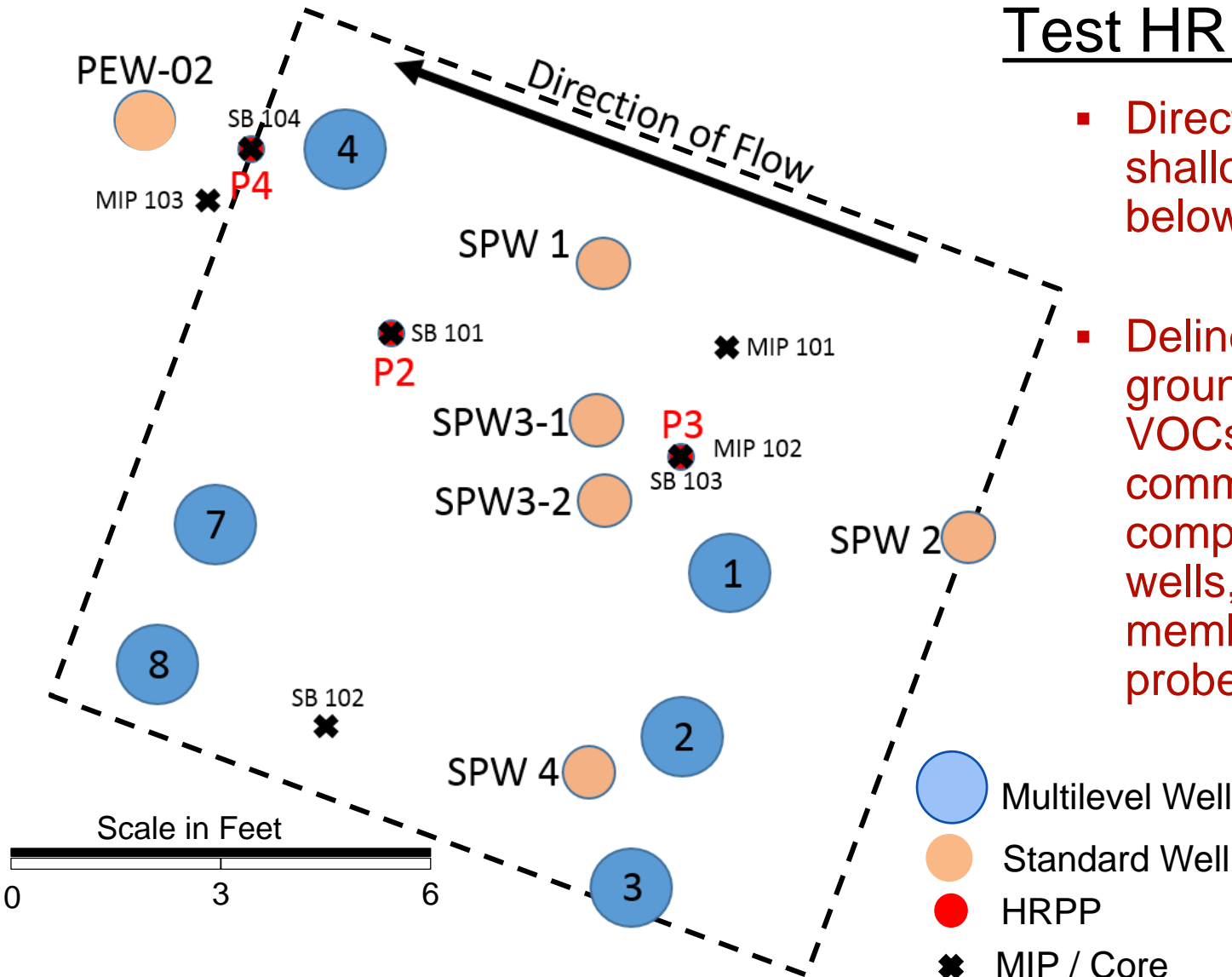
# Field Deployment of HRPP

## Naval Air Station – Alameda, CA



### Test HRPP for:

- Direct push insertion into shallow aquifer (~20 feet below ground surface)
- Delineation of groundwater velocity, VOCs, microbial communities, and CSIA compared to monitoring wells, soil cores, and membrane interface probe (MIP) data





# Field Deployment of HRPP



Preparation



Insertion

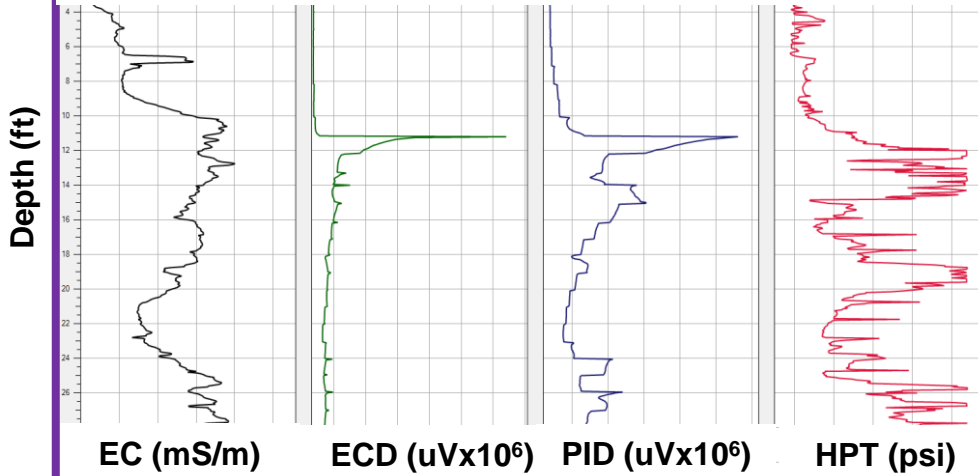


Sampling

# Comparative Data Sets



## Membrane Interface Probe



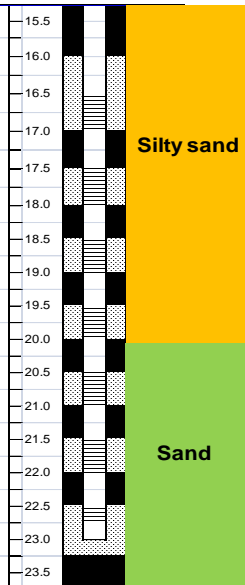
## Passive Flux Meter



## Soil Cores

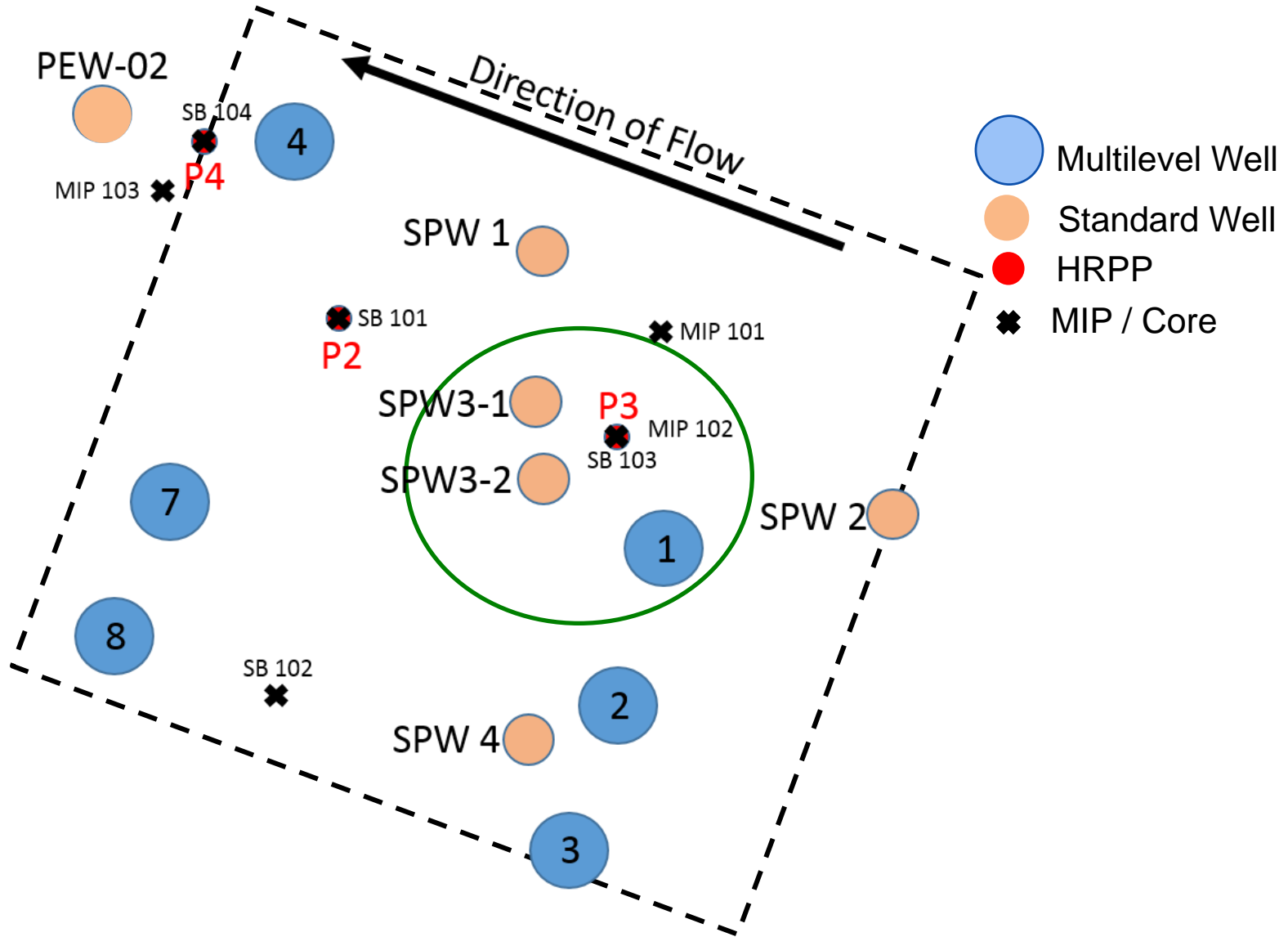


## Multilevel Wells



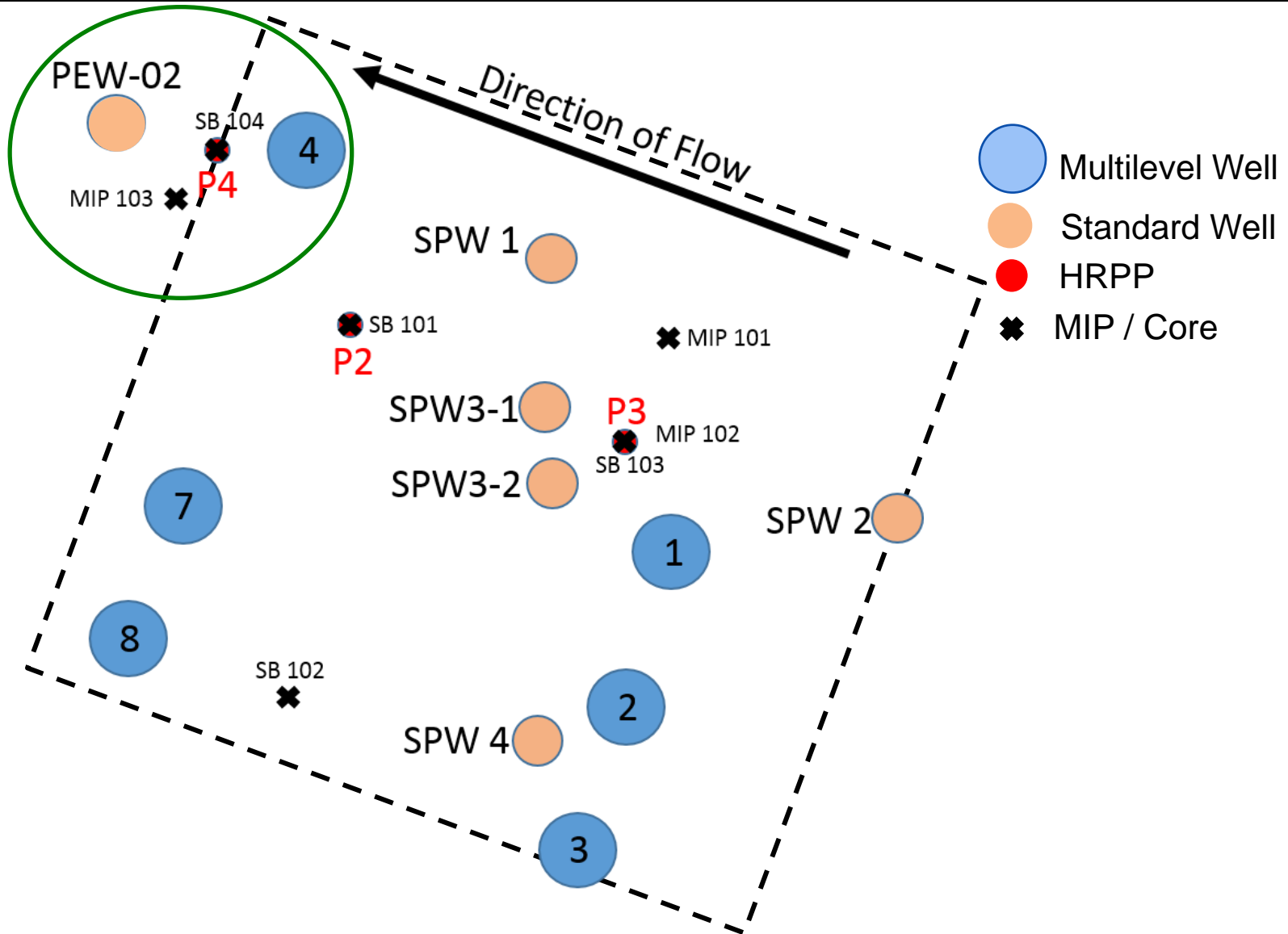
# P3 and Surrounding Area

## Naval Air Station – Alameda, CA

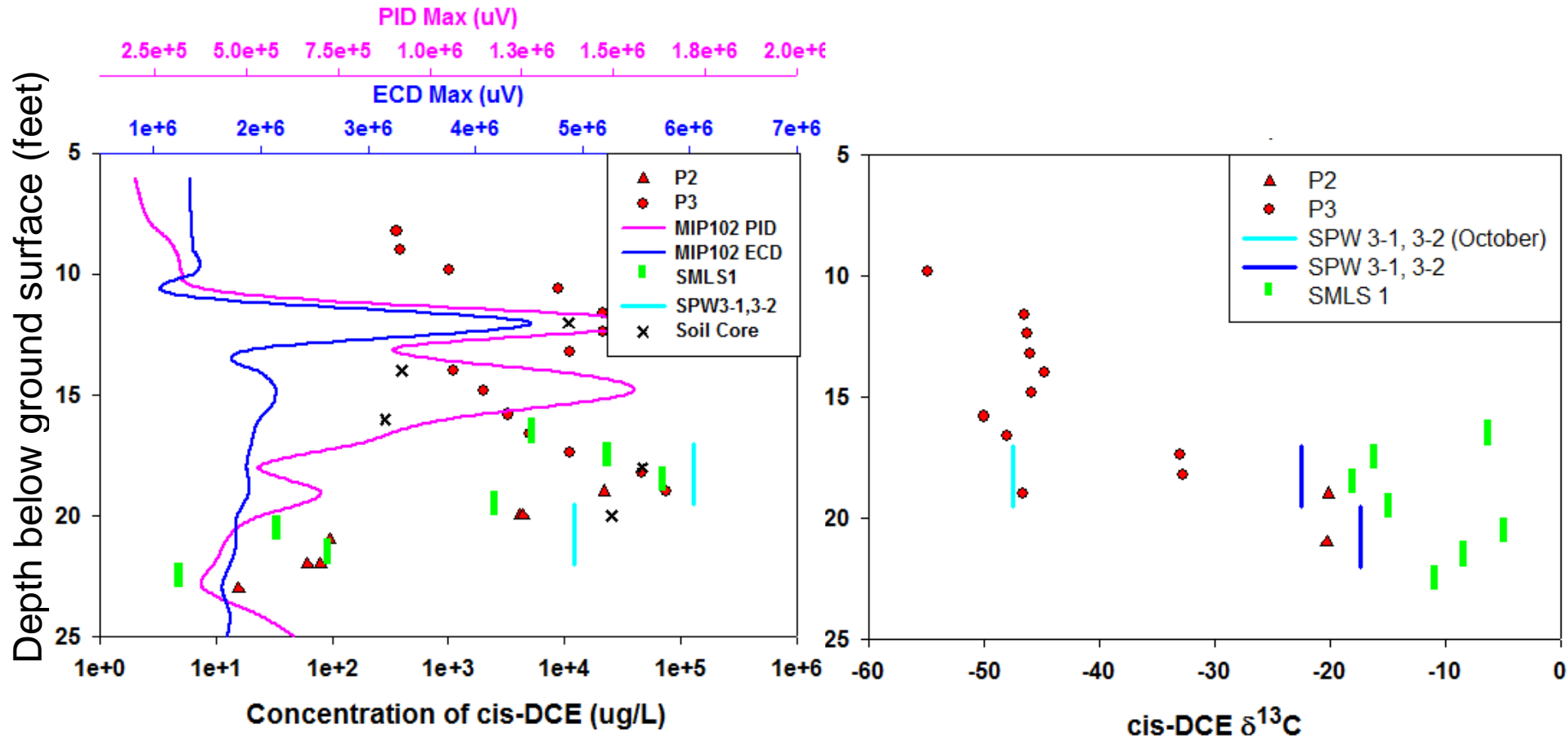


# P4 and Surrounding Area

## Naval Air Station – Alameda, CA

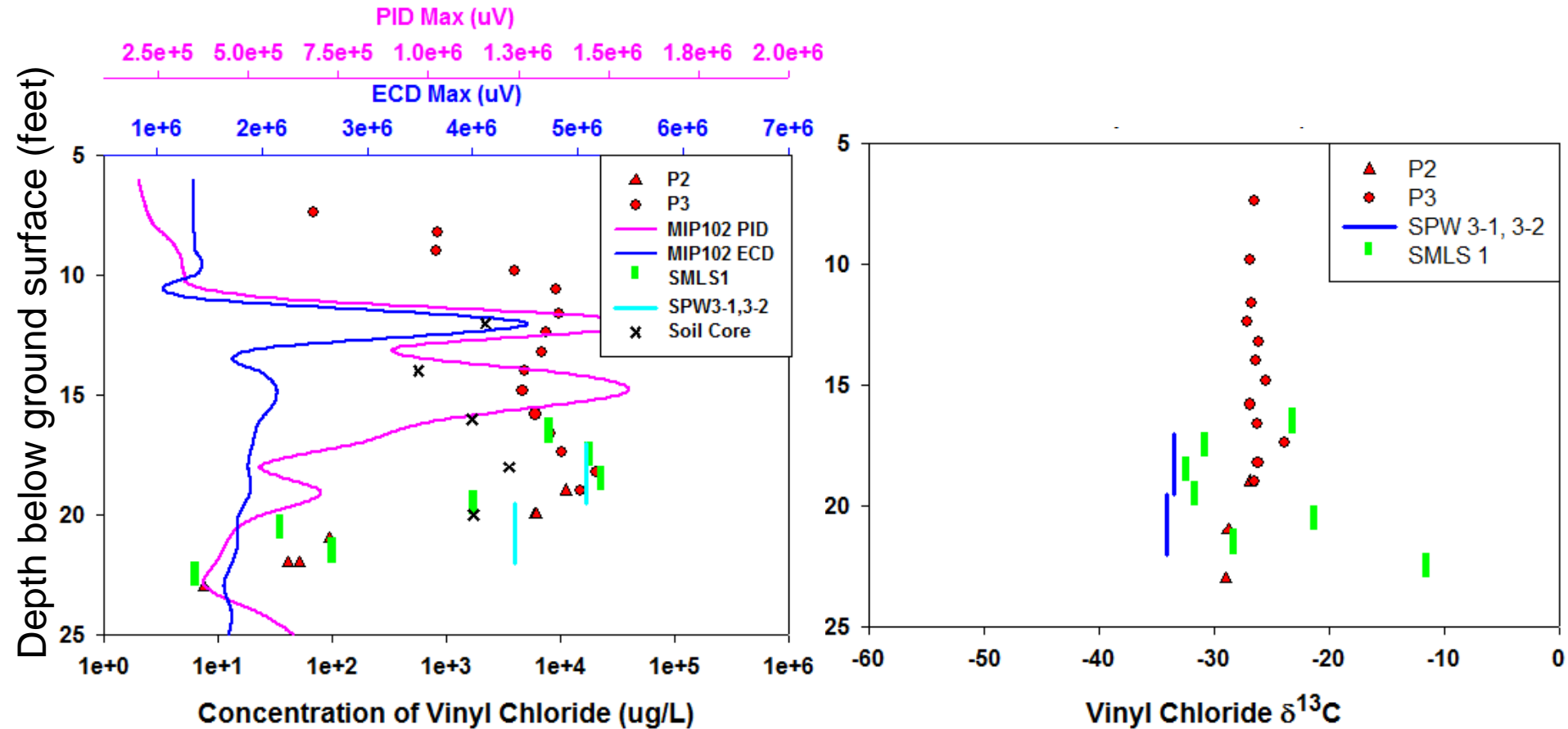


# cis-1,2-Dichloroethylene Concentrations & CSIA



PID – photoionization detector  
 ECD – electron capture detector

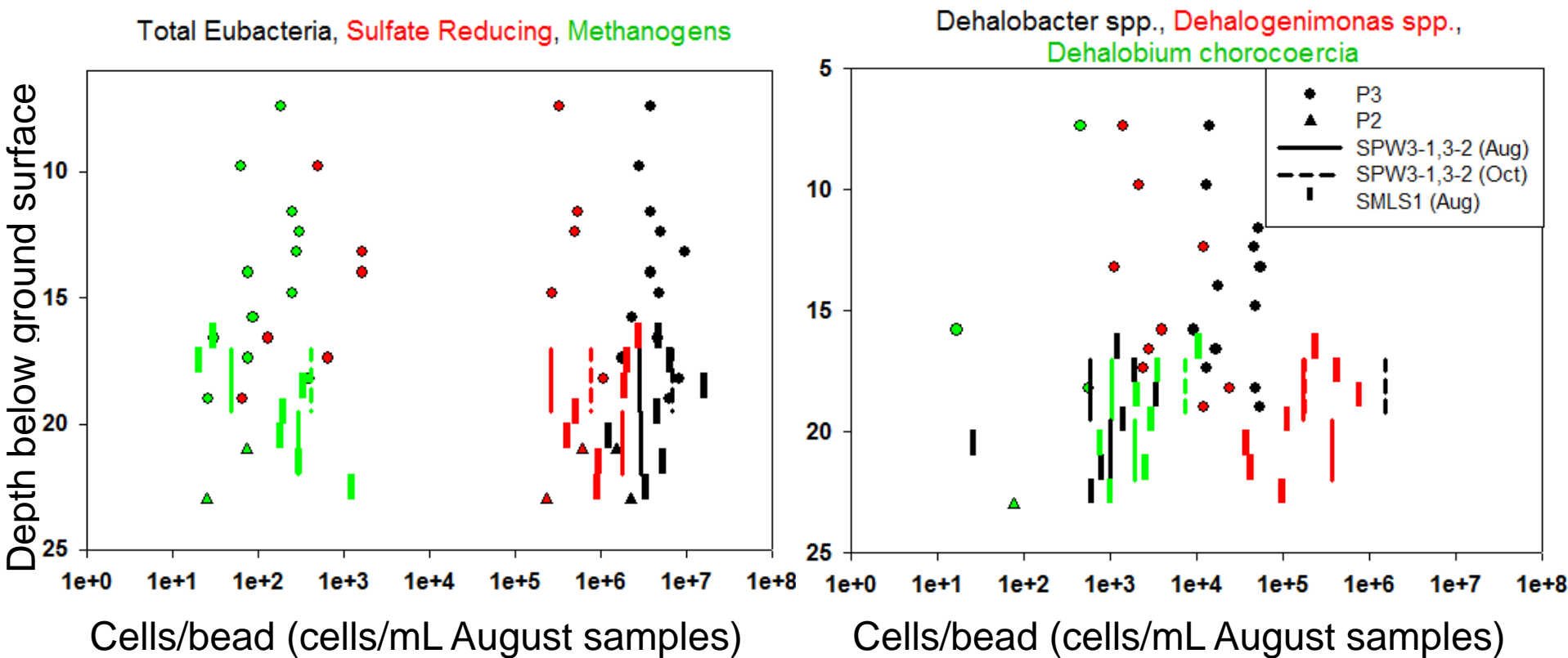
# Vinyl Chloride Concentrations & CSIA



PID – photoionization detector  
 ECD – electron capture detector



# Microbial Communities

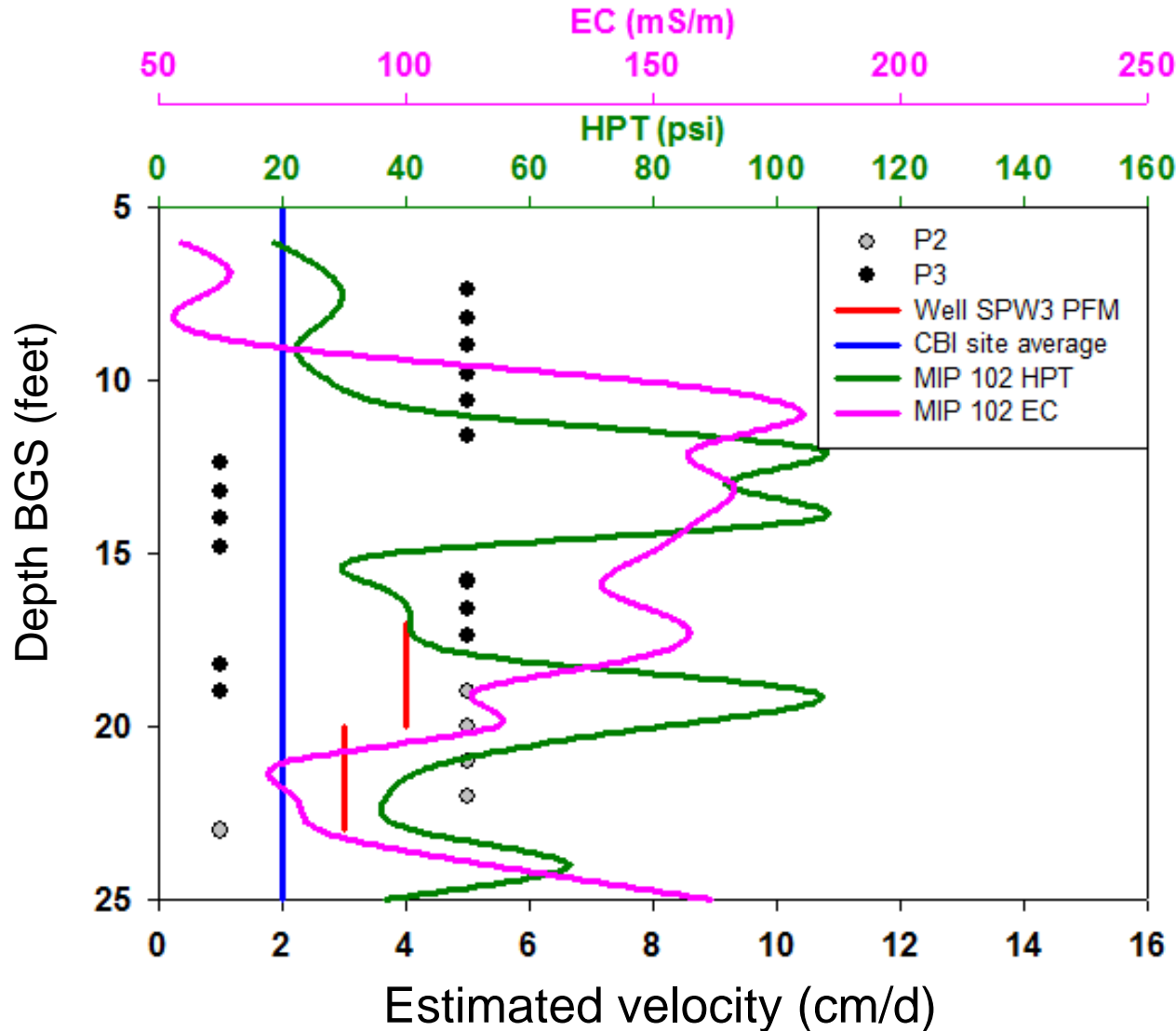


Other Possible Data:

DHC	DSM	RDEG	VCR	TOD	EtnE	DCM	PHE	DCMA
DSB	TCBO	TCE	SMMO	RMO	BVC	PMMO	EtnC	



# Groundwater Velocity Estimates



EC – electrical conductivity

HPT – hydraulic profiling tool

# Conclusions



Groundwater velocity can be estimated (~1-100 cm/d)

## HRPP yields

- Higher resolution contaminant profiles
- Independent of formation hydraulic conductivity

## HRPP capabilities

- Microbial community analysis
- Compound Specific Isotope Analysis

HRPP is structurally adequate for direct-push insertion

# Importance of Work



## High resolution data can independent from well production rates

- Enable better site modeling
- Remediation design
  - *Natural attenuation potential*
  - *Need for bioaugmentation*
- Impact of remedial activities
  - *Distribution of amendments*
  - *Bacterial community/capacity*
- Determine impact of low permeability zones
  - *Potential for rebound*
  - *Well placement*



# Acknowledgements



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SERDP ER-2419



TEXAS TECH  
UNIVERSITY.

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Henry Yew





# Questions ?

For additional information, please visit  
<https://www.serdp-estcp.org/Program-Areas/Environmental-Restoration/Contaminated-Groundwater/Persistent-Contamination/ER-2419>

## Speaker Contact Information

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