Filling in the Data Gaps at Complex Sites before Focused Remediation: Three Case Studies

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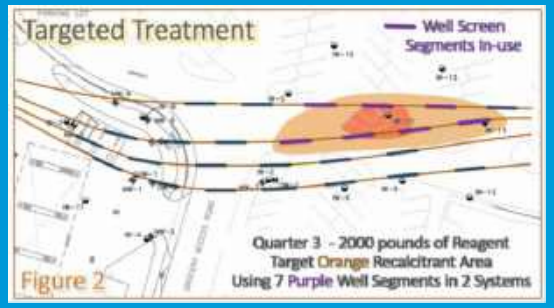
Groundwater Resources Association of California

Western Groundwater Congress 2022



Filling in the Data Gaps at Complex Sites before Focused Remediation: Three Case Studies

1) Railroad Tie Treating Facility Located Adjacent to a Lake with Impacted Sediments

2) Gasoline Fuel and Solvent Release Sites, Plumes Underlying Roads and Buildings

3) Chlorinated Solvent Site Located in the Bay Area in California.

1) Railroad Tie Treating Facility Located Adjacent to a Lake with Impacted Sediments

- Filling in investigation data gaps with surface geophysics.
- Before passive long-term control of NAPL migration.

1 -- Railroad Tie Treating Facility Located Adjacent to a Lake with Impacted Sediments

THANKS TO: Todd Halihan, Ph.D., P.Gp. (CA)
Professor, OSU School of Geology
Chief Technical Officer, Aestus, LLC

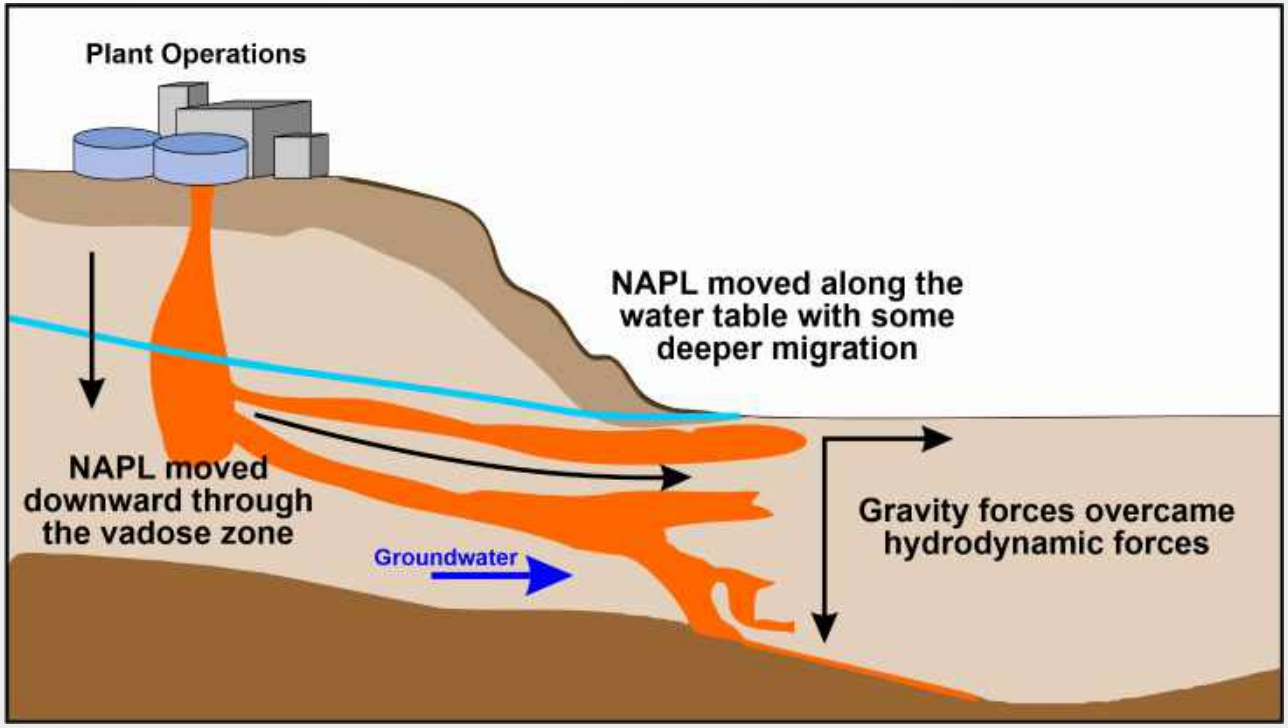
Jeff Gentry, P.E. (OR and NY)
Senior Expert, Jacobs

Aestus, LLC

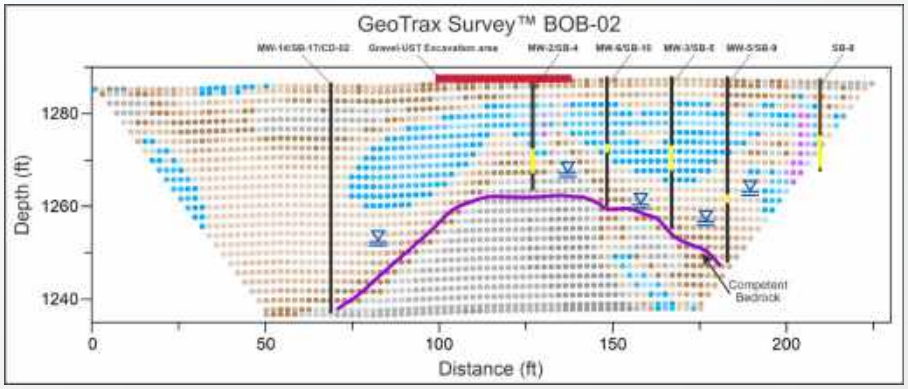
Site Background

- Treating plant on Lake Michigan
- Shoreline creosote seep observed in 2005
- Interim measures taken to reduce surface impacts
- Final remedy to focus on passive-only long-term control of NAPL migration and groundwater to surface water interface concentration reduction
  - Objective: Naphthalene <11 µg/L at GSI interface

Conceptual Site Model
NAPL impacts

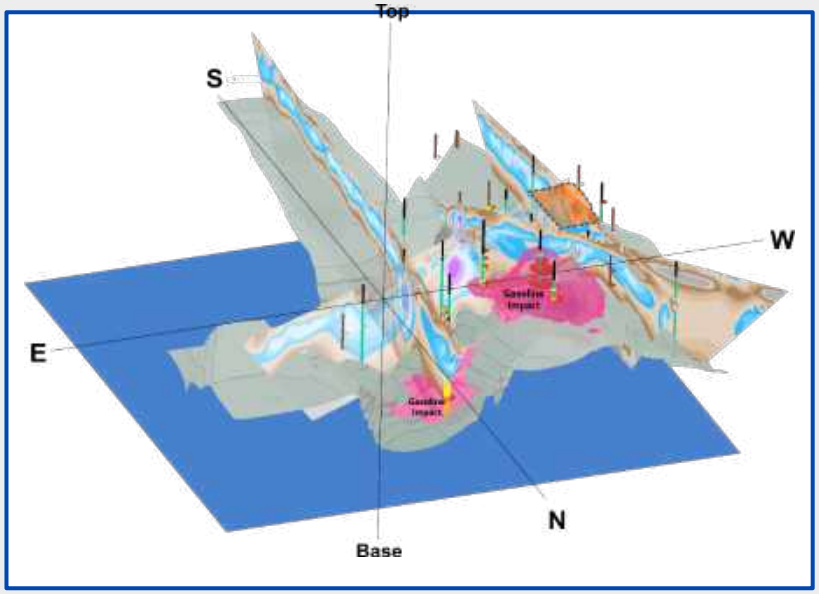


What is Ultra-HRSC or Electrical Hydrogeology?



Scan, then confirm

- 2,750 electrical data points
- 6 borings
- BTEX data
- PID data

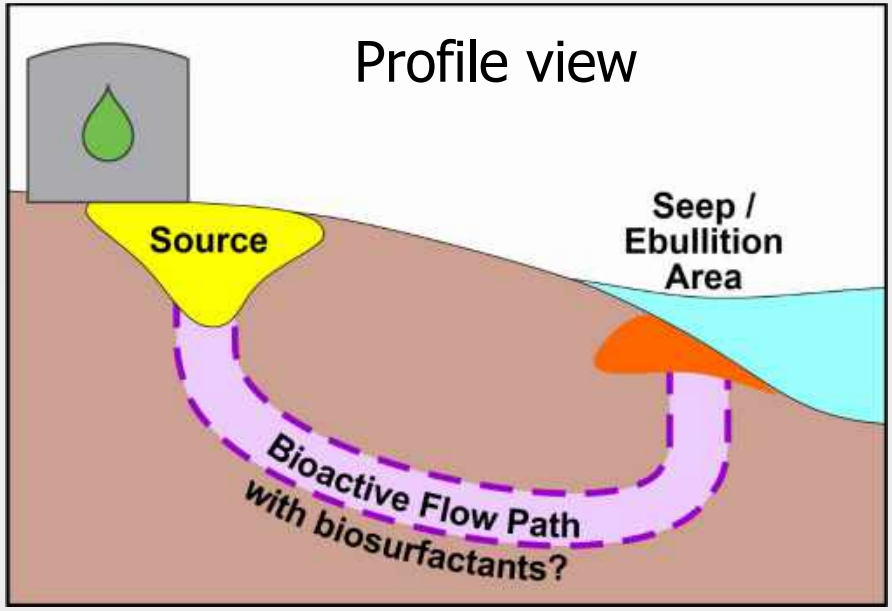


3D Conceptual Site Model

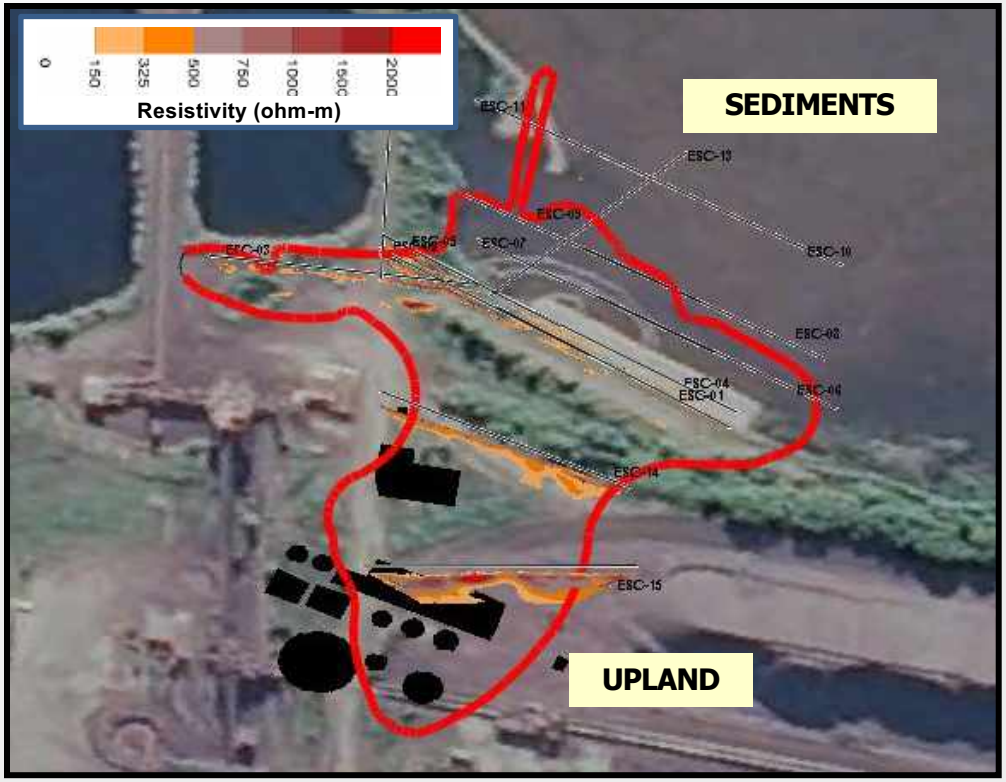
- 22,000 electrical data points
- Pathways delineated

Typical CSM+ via Electrical Scanning Seeps into Sediment Sites

- Bioactive pathway follows vertical flowpaths from source to water body
- Hypothesis is that bioactivity and biosurfactants control the mobilization of old NAPL material
- Thus far, every Aestus NAPL seep case is an electrically conductive path going to the waterway

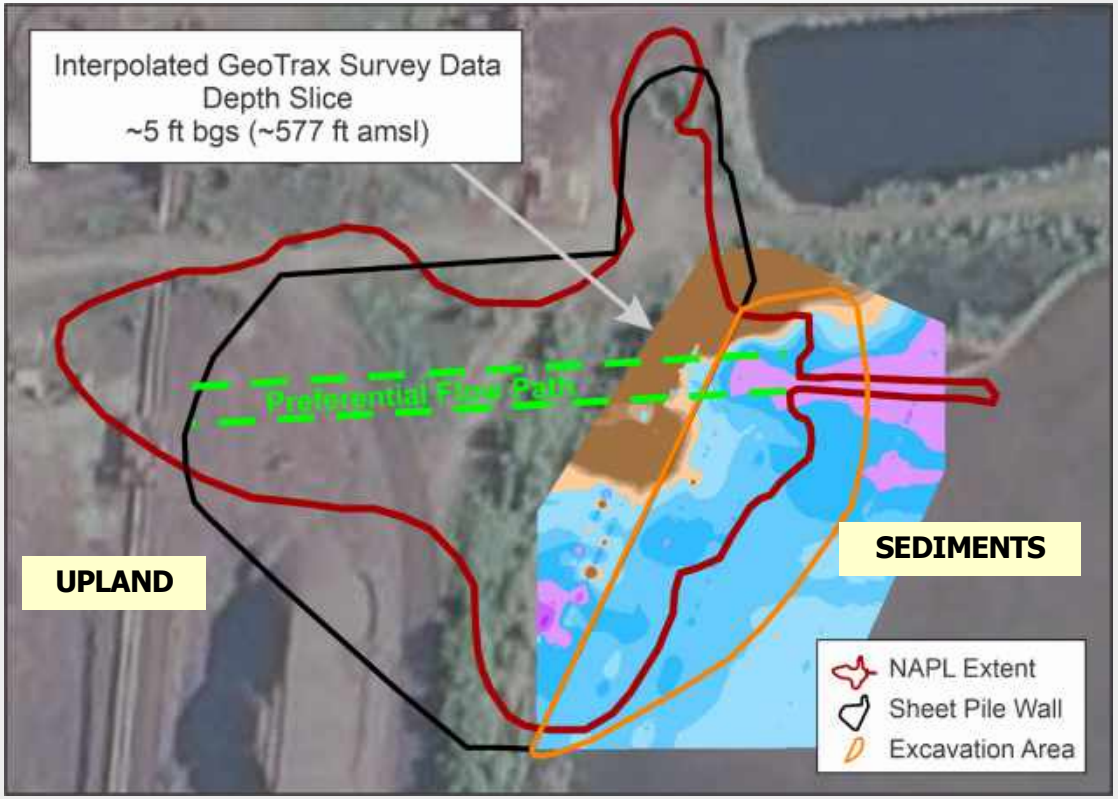


Upland Site
Electrically Resistive Zones



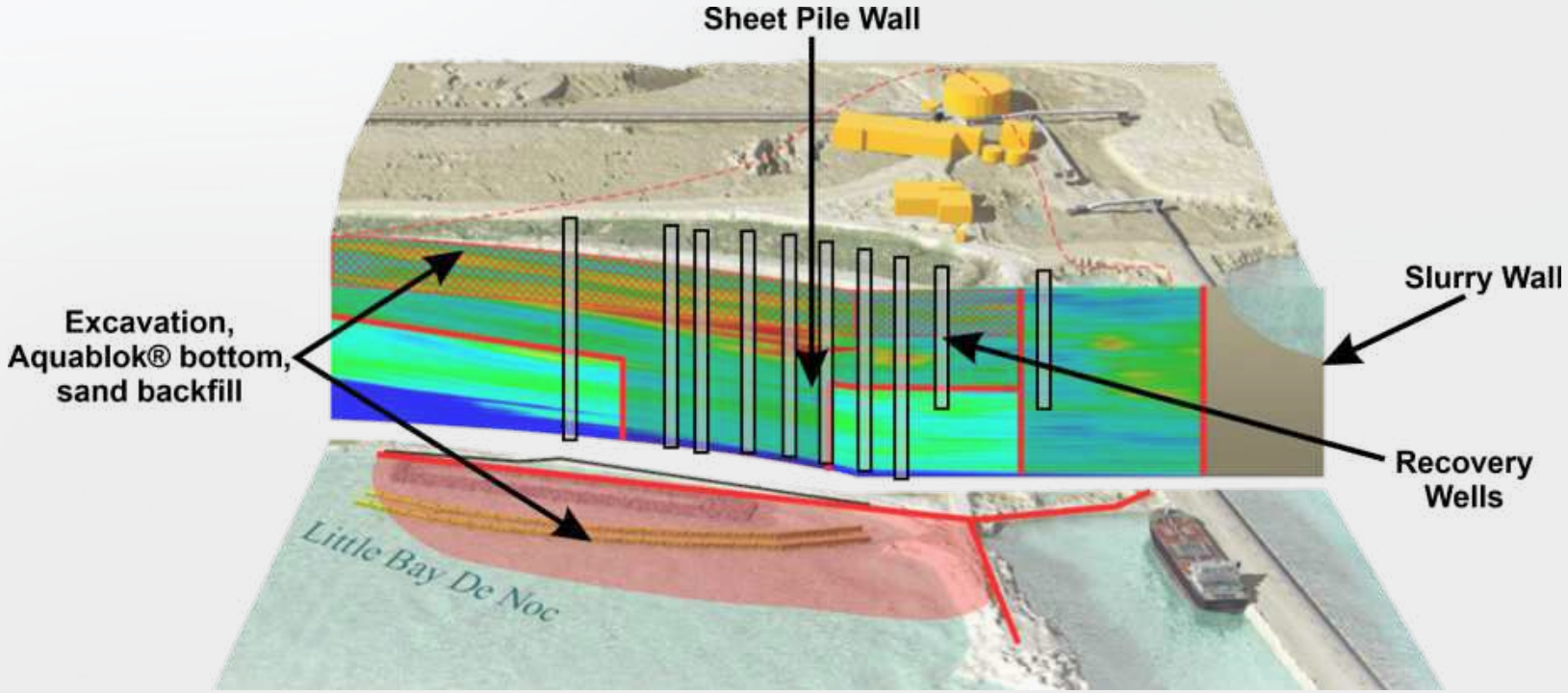
- Upland areas had **electrically resistive targets** corresponding to source areas and interpreted historic buried log chute remnants
- **Red** line is delineated NAPL extent

Near Surface Electrical Data Site Elevation Slice (~5 ft bgs)



- Shallow resistive zones illustrate impacts (**brown**)
- Conductive preferential pathway indicating bioactive pathway (**purple**)
- **Red** line is delineated NAPL extent

Shoreline Remedy Profile View



Naphthalene > GW/SW interface

- 400 feet preconstruction
- <100 feet 6 months after
- Continuing to monitor remedy

Remediation Success (Before and After)

- Sustainable Remedy: No groundwater pumping or discharge, no energy consumption
- Cost Effective: Higher capital investment yielded lower cost O&M
- Provides Treatment: Biodegradation that naturally occurs treats naphthalene discharge

Discovery

Interim Action

Completed Project

Results: ~$4M Savings

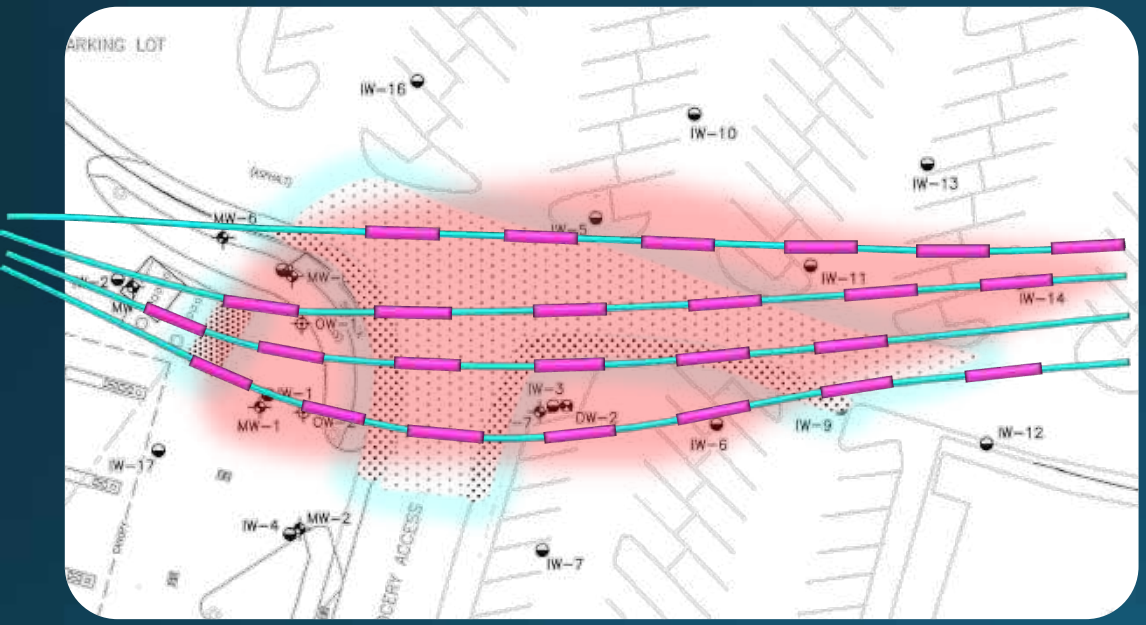
- Collaborative effort with lead consultant (Jacobs)
- Demonstrated preferential flow path
- Lines of evidence for impact distribution & bioactivity
- Field data to support GW model results
- Eliminating GW pumping resulted in 90% O&M budget reduction from ~$300K/year to ~$30K/year
- Total savings to RP industrial client ~$4 Million

2) Gasoline Fuel and Solvent Release Sites, Plumes Underlying Roads and Buildings

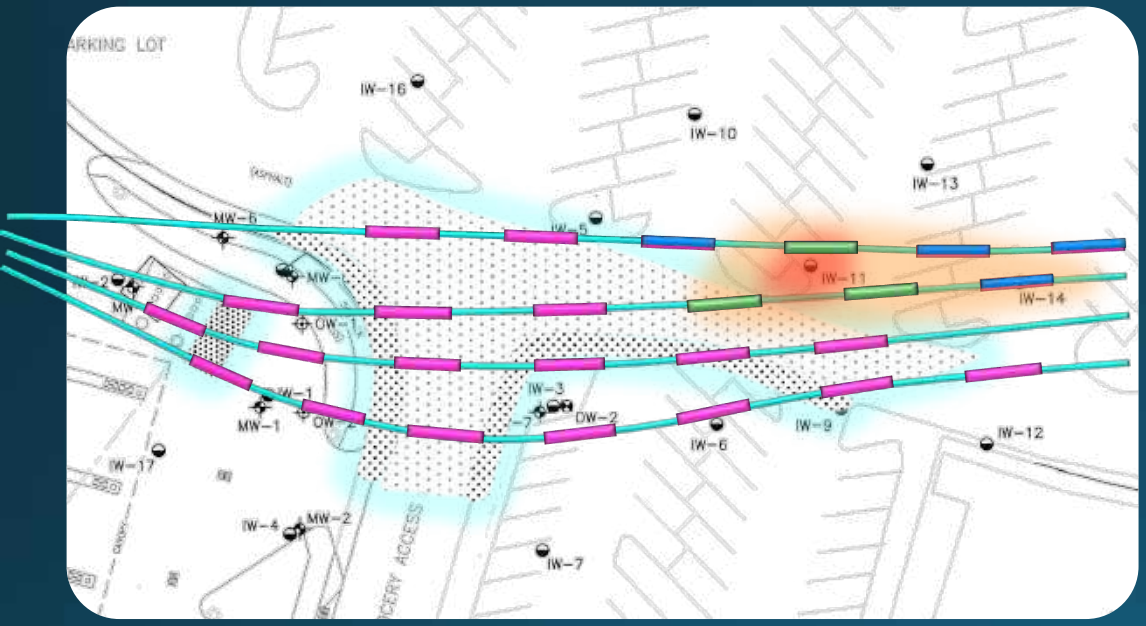
- Filling in investigation data gaps with horizontal nested wells.

- Before remediation using In-Situ Chemical Oxidation.

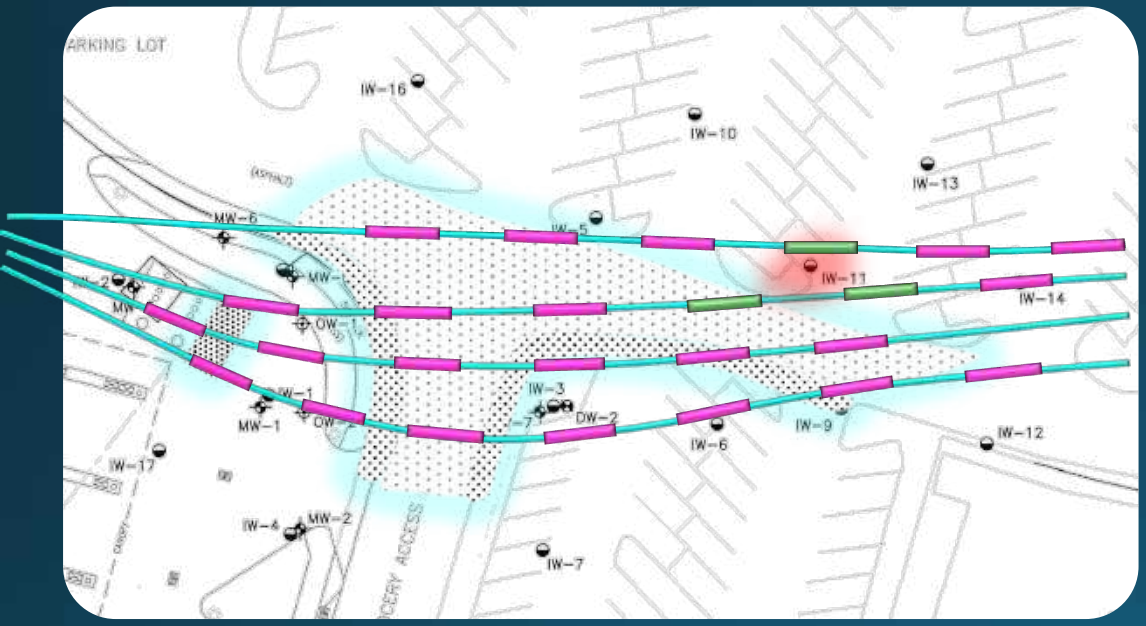
#2a--Gasoline Fuel Release Sites, Plumes Underlying Roads



- Impacts under tanks, adjacent roadway and parking lot
- Resistant adjacent property owners
- 25 Vertebrae Wells installed for treatment
- Shading indicates relative intensity of dosage



- Subsequent assessment indicated a recalcitrant area toward the rear of the plume, requiring further treatment.
- Adjustments were made with simple reproportioning of the treatment scheme to match the plume dynamics…with a cell phone



- Engineer can surgically control the treatment in real time.

Adaptive application made and closure achieved.

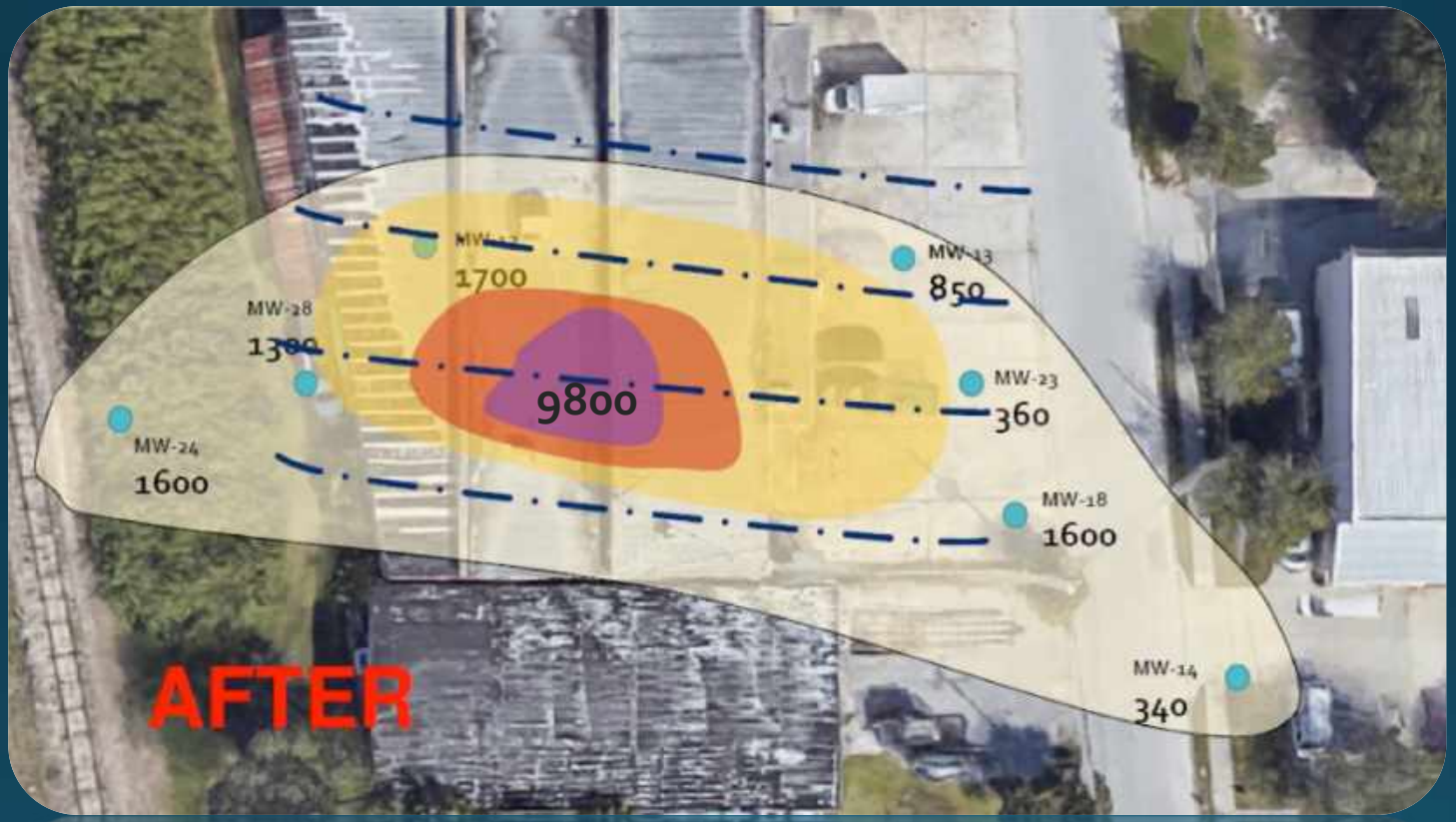
Segmented Horizontal Well System Installation

#2b--Solvent Case Study – Minimal Data

Results - 1,2 DCE in ppb

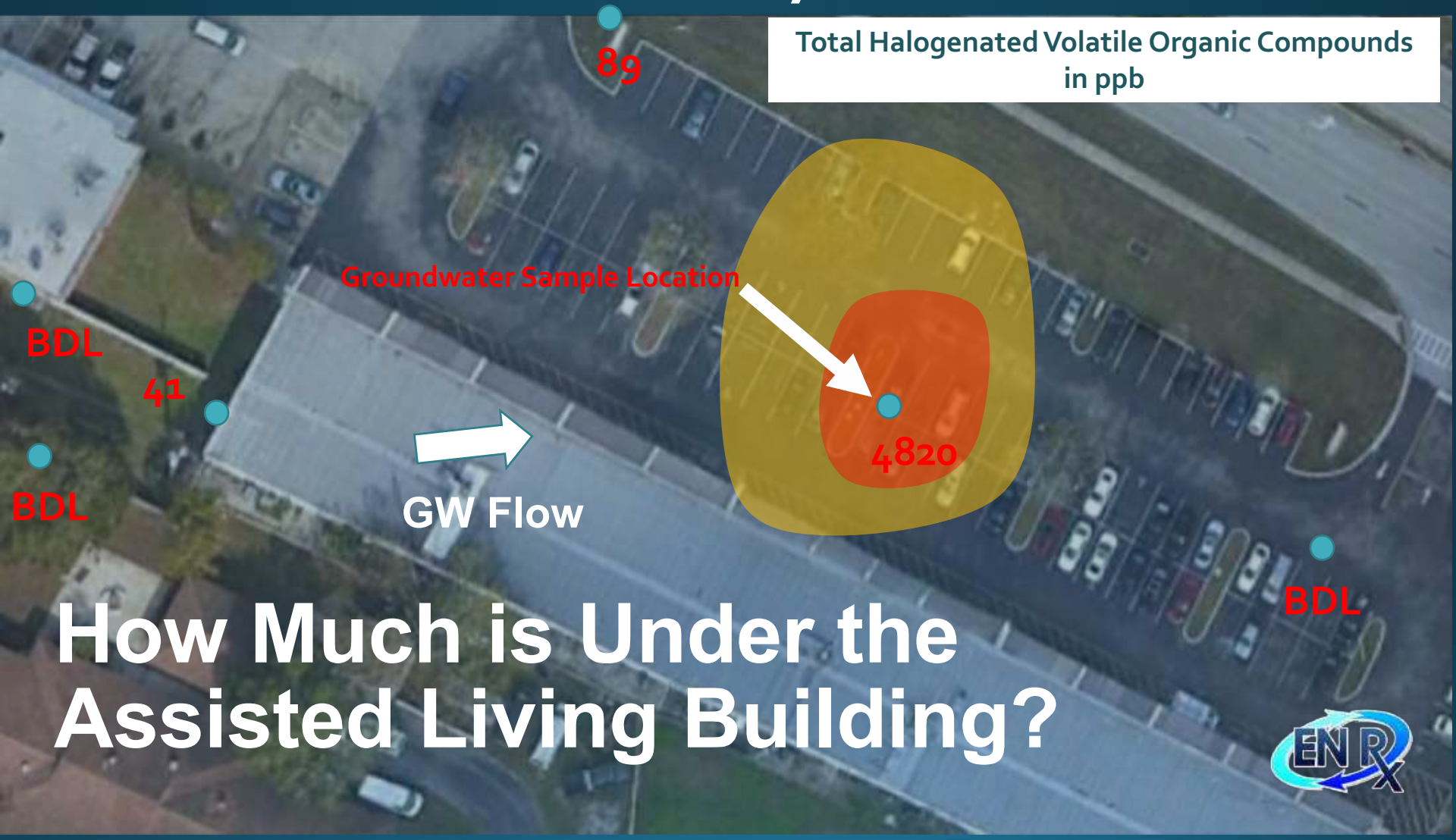
Limited access to buildings-skinny hallways

#2b--Solvent Case Study - Data Gaps Filled

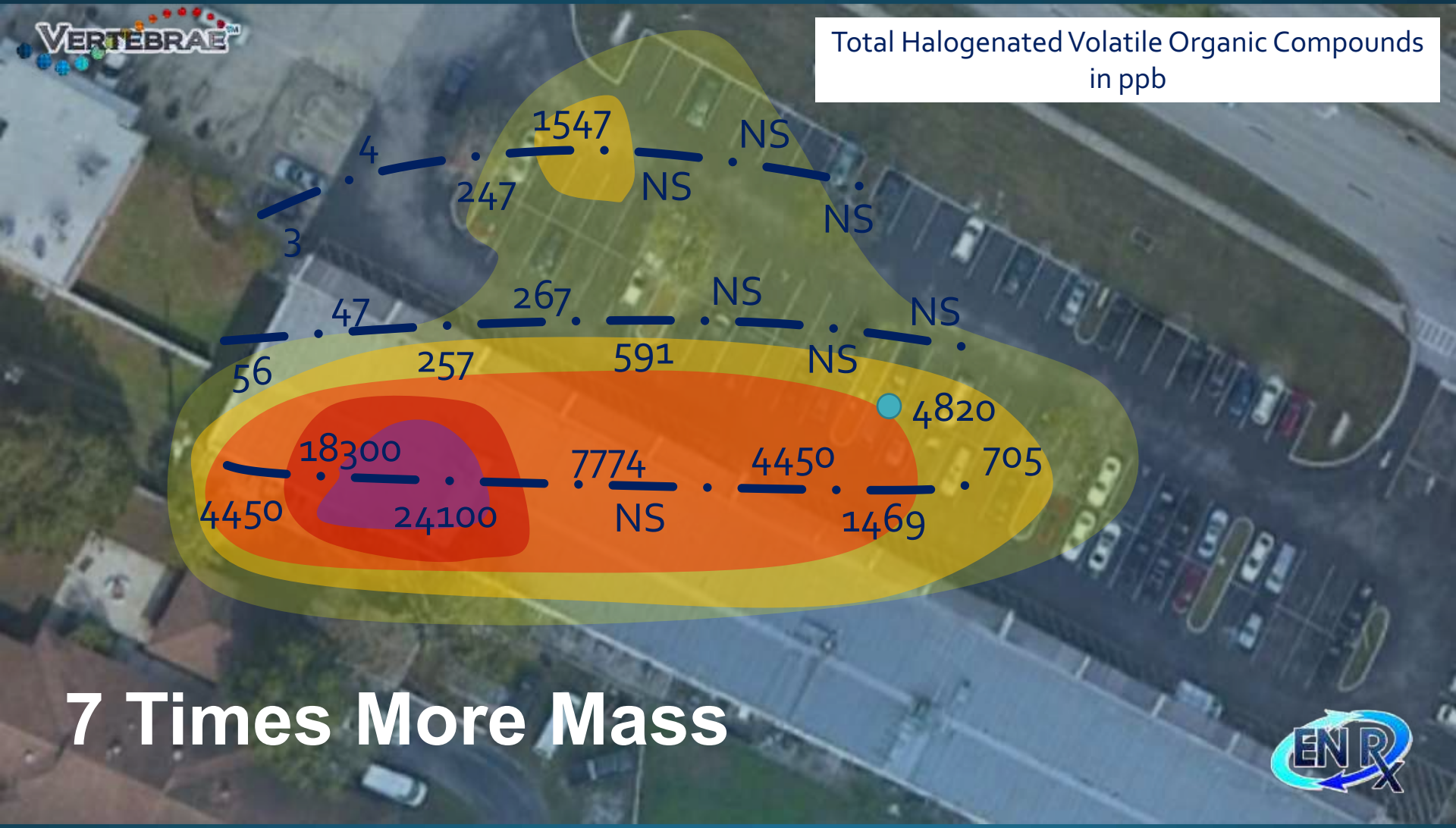


- Sampling nested wells identified 4 times More Mass.
- Opposing wells for recirculation--ISCO

#2c--Solvent Case Study – Minimal Data



#2c--Solvent Case Study - Data Gaps Filled

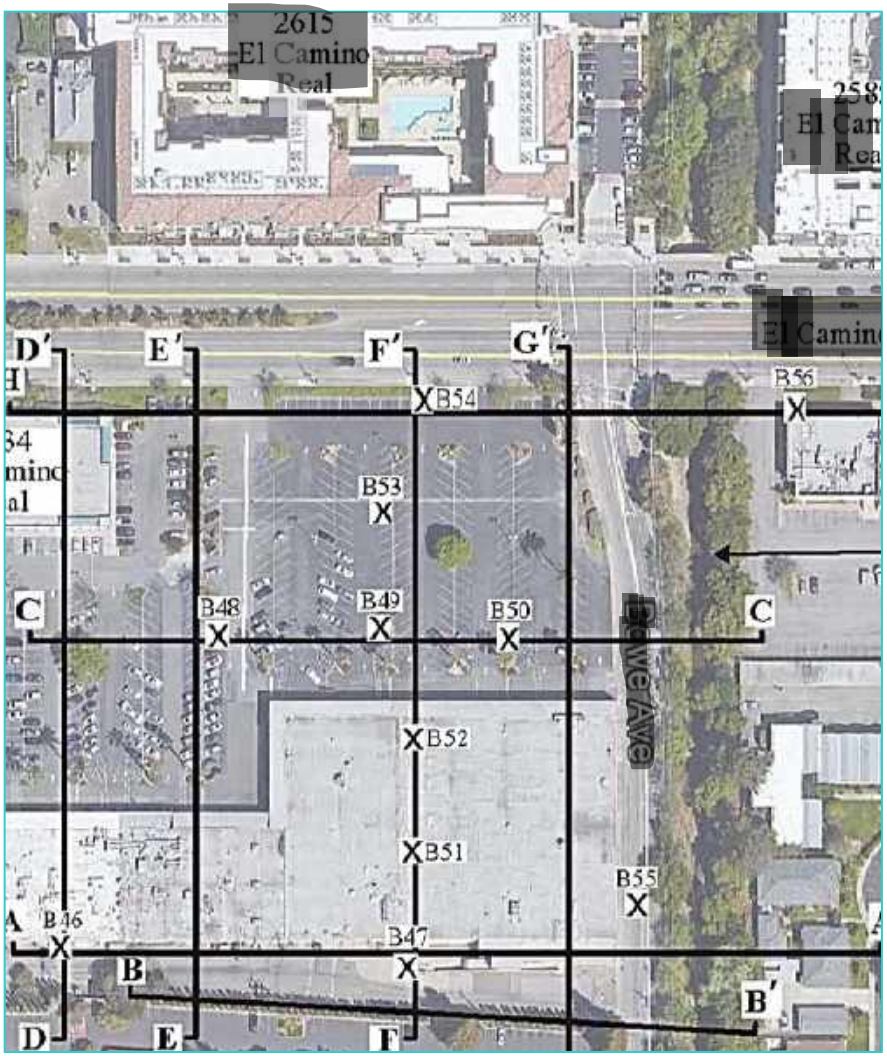


Remediation using ISCO

3) Chlorinated Solvent Site Located in the Bay Area in California.

- Filling in investigation data gaps with existing wells.
- Before remediation using biostimulation/augmentation and In-situ Chemical Reduction.

#3--Chlorinated Solvent Site Located in the Bay Area in California



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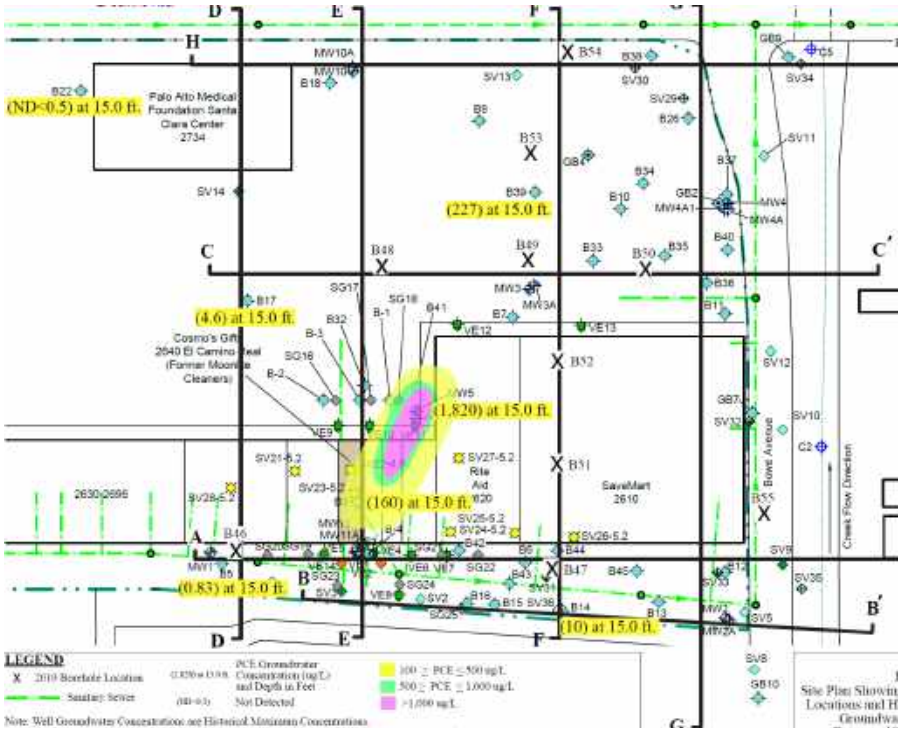
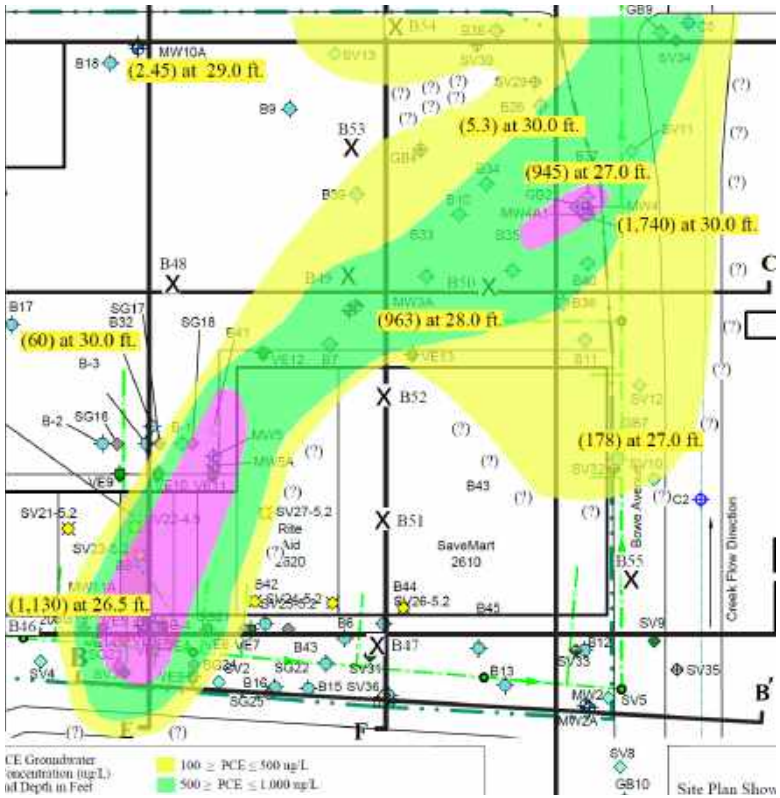
Remediation and Characterization Products and Support

Plume Maps at Different Depth Slices

10 to 15 ft



15 to 20 ft



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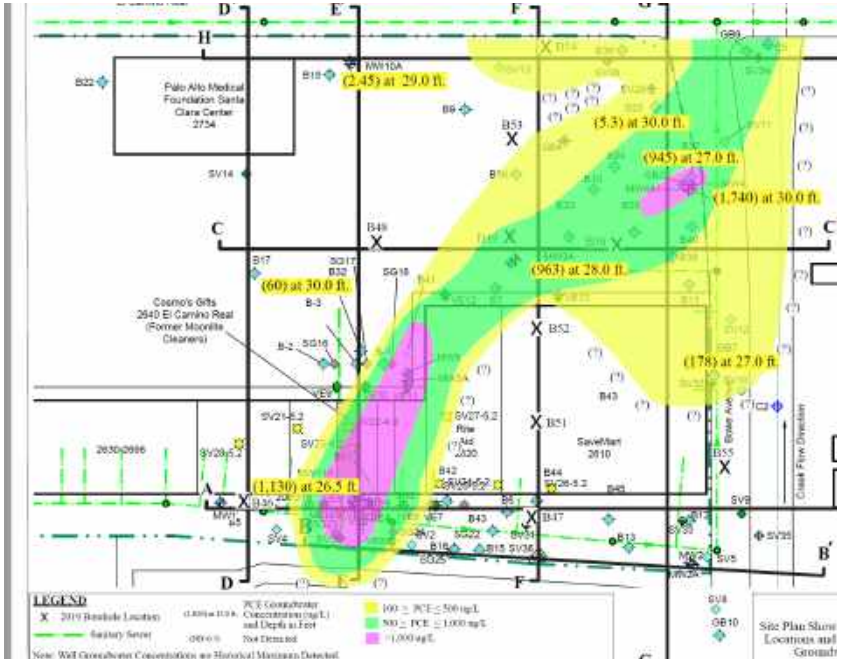
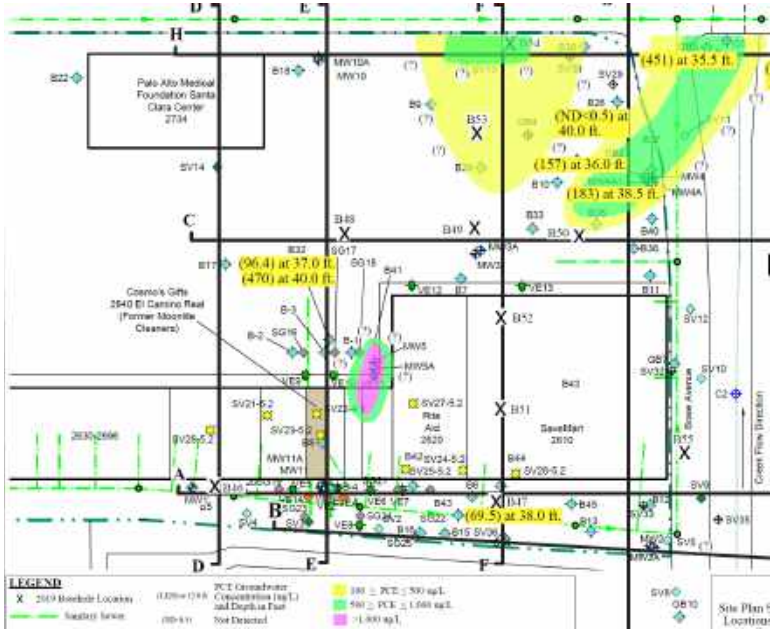
Remediation and Characterization Products and Support

Plume Maps at Different Depth Slices

25 to 30 ft



35 to 40 ft



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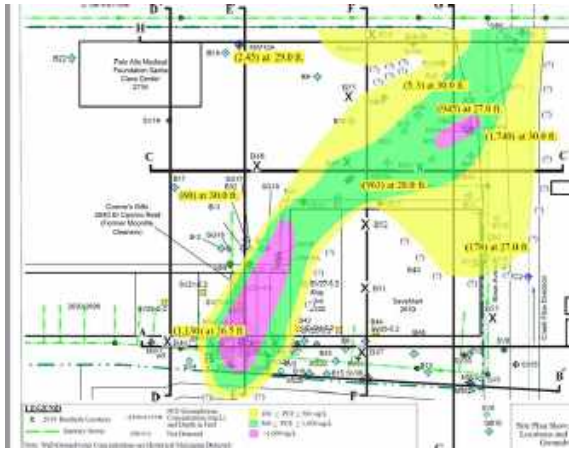
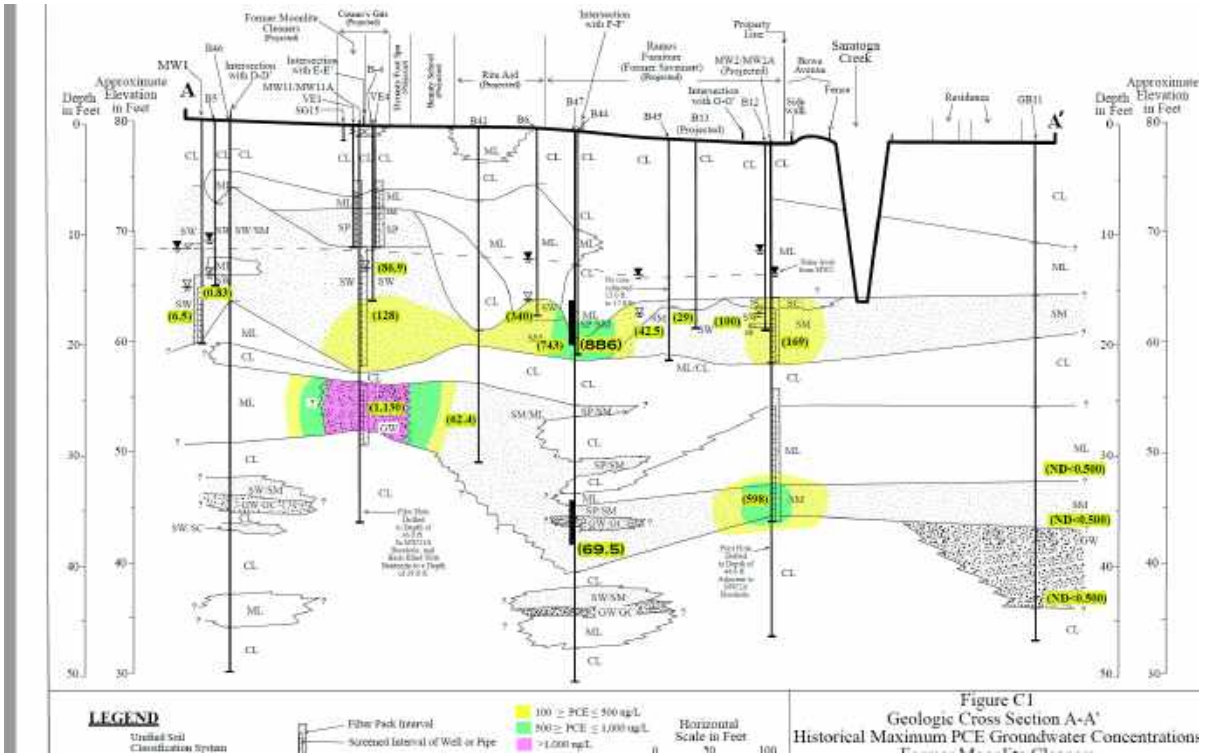
Remediation and Characterization Products and Support

Cross Section

25 to 30 ft depth



A-A’ (bottom)



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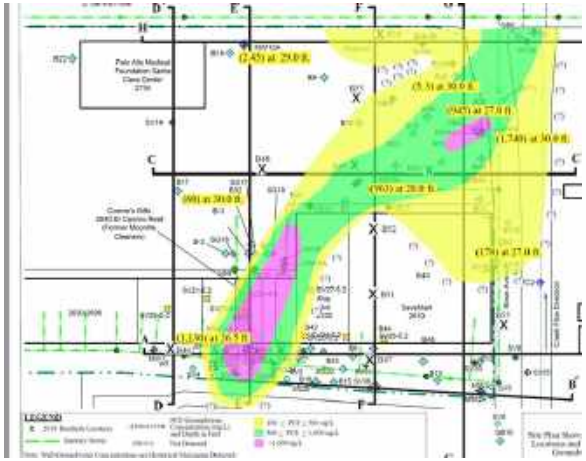
Cross Section

G-G’ (right side)

25 to 30 ft depth



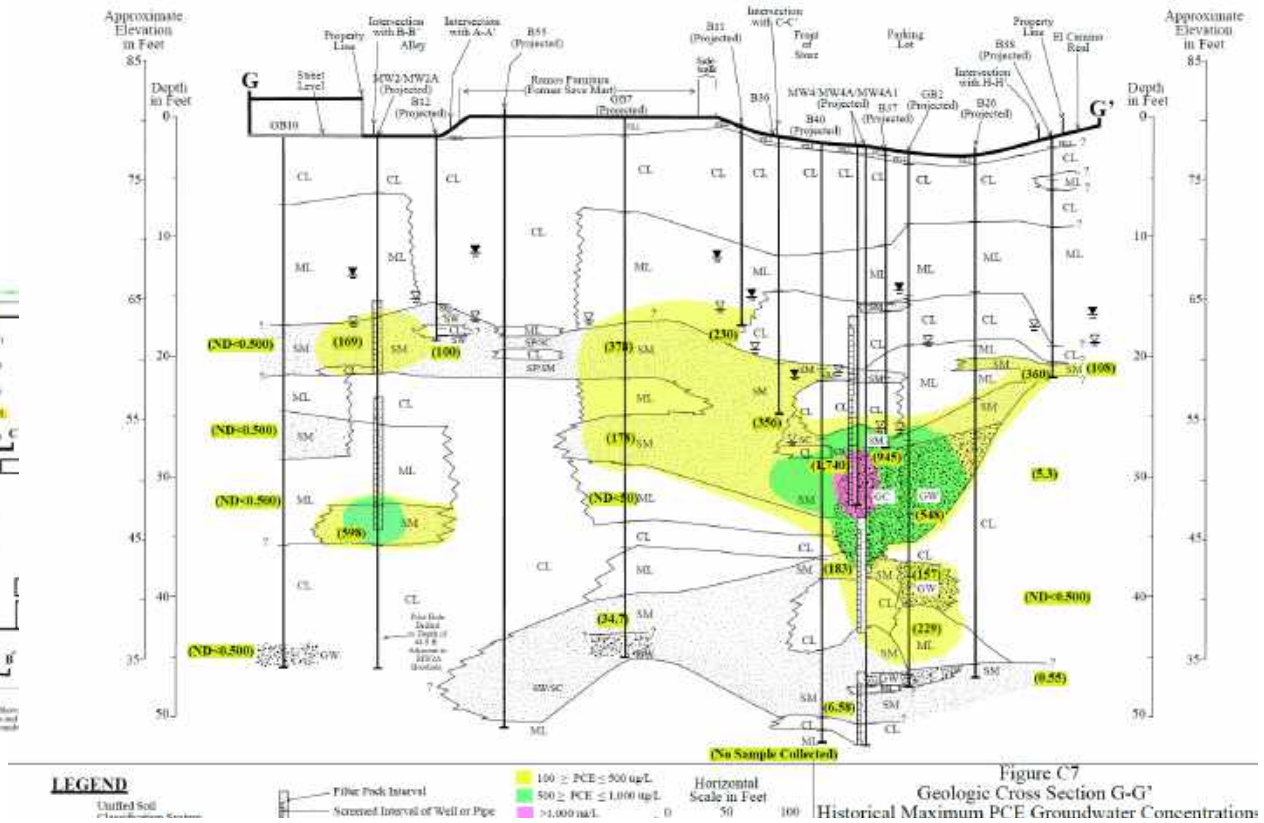


Figure C7
Geologic Cross Section G-G’
Historical Maximum PCE Groundwater Concentrations

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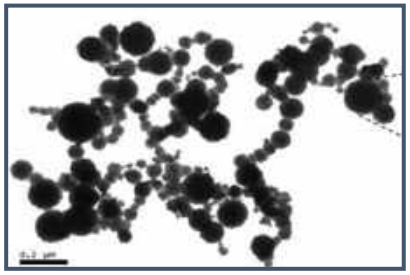
Remediation and Characterization Products and Support

In-Situ Chemical and Biological Reduction
Iron-Based Products

Soluble
Fe^{+2}, Bicarb

Nano
nZVI

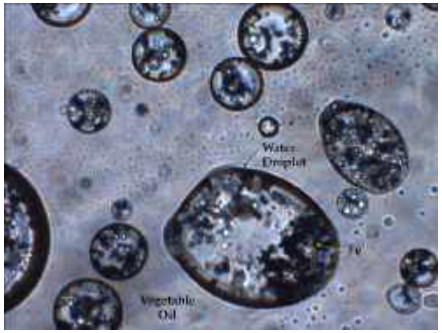


Microscale
mZVI liquids

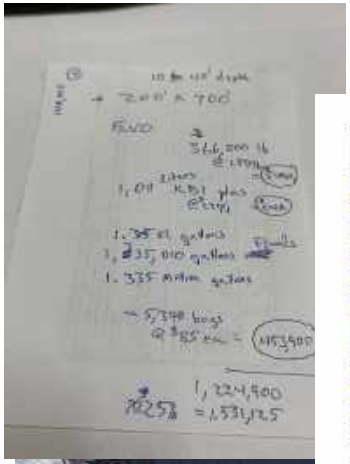
Microscale
ZVI Slurries

Granular ZVI

0 µm **0.2 µm** **< 5 µm** **50** **2 mm**



Targeted Injections



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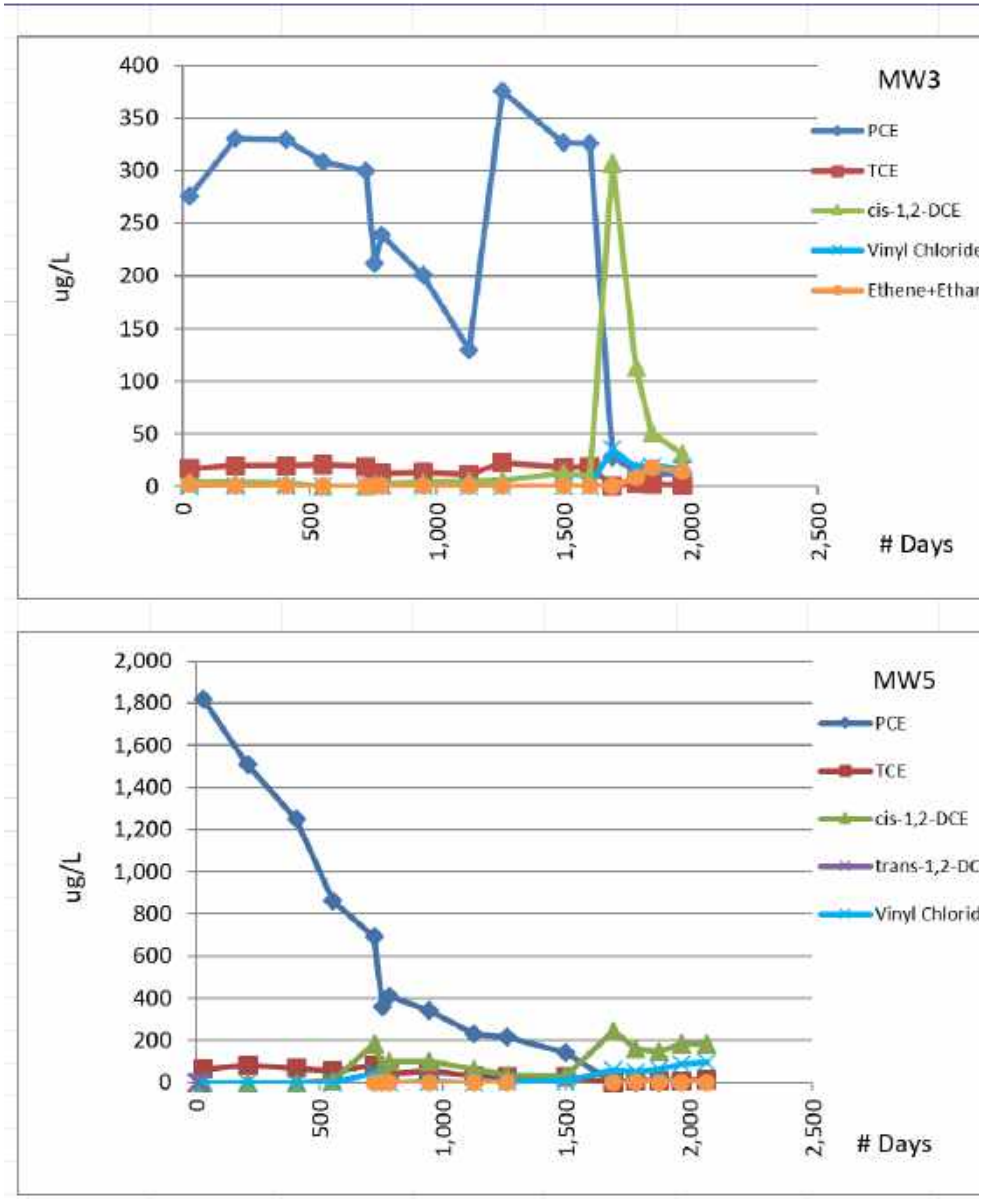
Performance Monitoring



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Performance Monitoring

Volatile Organic Compounds						Field Parameters		Other Param					
PCE (µg/L)	TCE (µg/L)	cis-1,2-DCE (µg/L)	trans-1,2-DCE (µg/L)	Vinyl Chloride (µg/L)	Total VOCs (µg/L)	D.O. (mg/L)	O.R.P. (mV)	Nitrate (as N) (mg/L)	Sulfate (mg/L)	Methane (µg/L)	Ethane (µg/L)	Ethene (µg/L)	Carbon Dioxide (µg/L)

Total Iron (µg/L)	Dissolved Iron (µg/L)	Ferrous Iron (mg/L)	Dissolved Manganese (µg/L)	TOC (mg/L)

Volatile Fatty Acids						Gene-Trac® Analysis			
							Functional Gene Assay		
Lactate (mg/L)	Acetate (mg/L)	Propionate (mg/L)	Formate (mg/L)	Butyrate (mg/L)	Pyruvate (mg/L)	Dhc (%)	vcrA (%)	bvcA (%)	tceA (%)

NEXT?

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Remediation and Characterization Products and Support

Questions?

"When charged with the task of cleaning up soil or groundwater, it is suggested that first you **scan** and **sample** for below-ground contamination. Once done, we can help you **eat it** (biologically), **heat it** (resistive or conductive) or **treat it** (surfactant or ISCR or ISCO)."

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