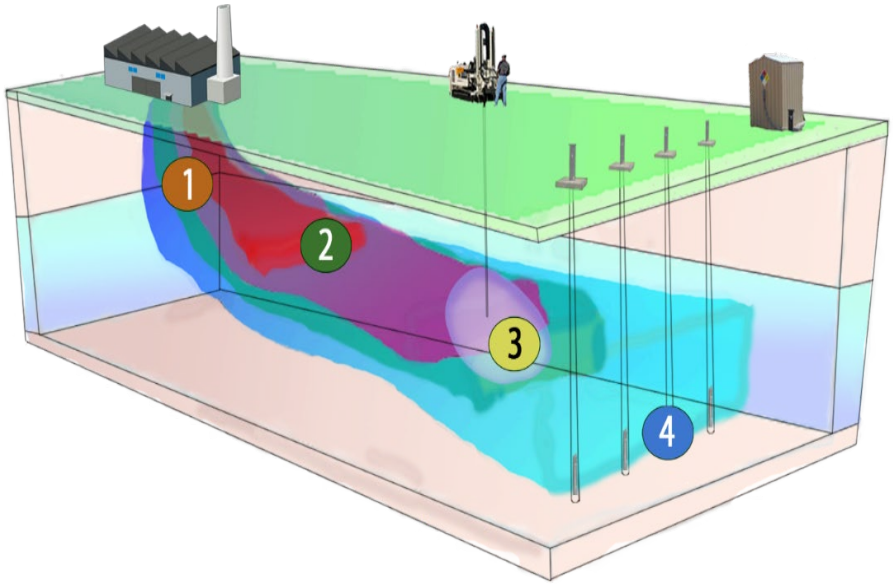
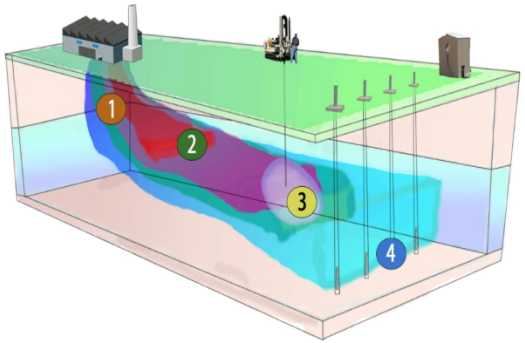
# Managing Complex Sites with High Resolution Site Characterization and Focused Remediation




**John Sankey, P.Eng., True Blue Technologies**

True Blue Technologies

Remediation and Characterization Products and Support




- **Dry Cleaner Site**
  - Ultra-high resolution scanning technology, three-dimensional data integration and visualization
  - Post injection
- **Fort Ord, Monterey Bay**
  - Multilevel wells
  - Another client
- **South Tacoma Channel Superfund site in Tacoma**
  - Rigorous conceptual site model
  - In situ thermal remediation for source
  - Enhanced anaerobic bioremediation for hot spots

# Boone Dry Cleaners, Jackson, TN

## Credit Aestus

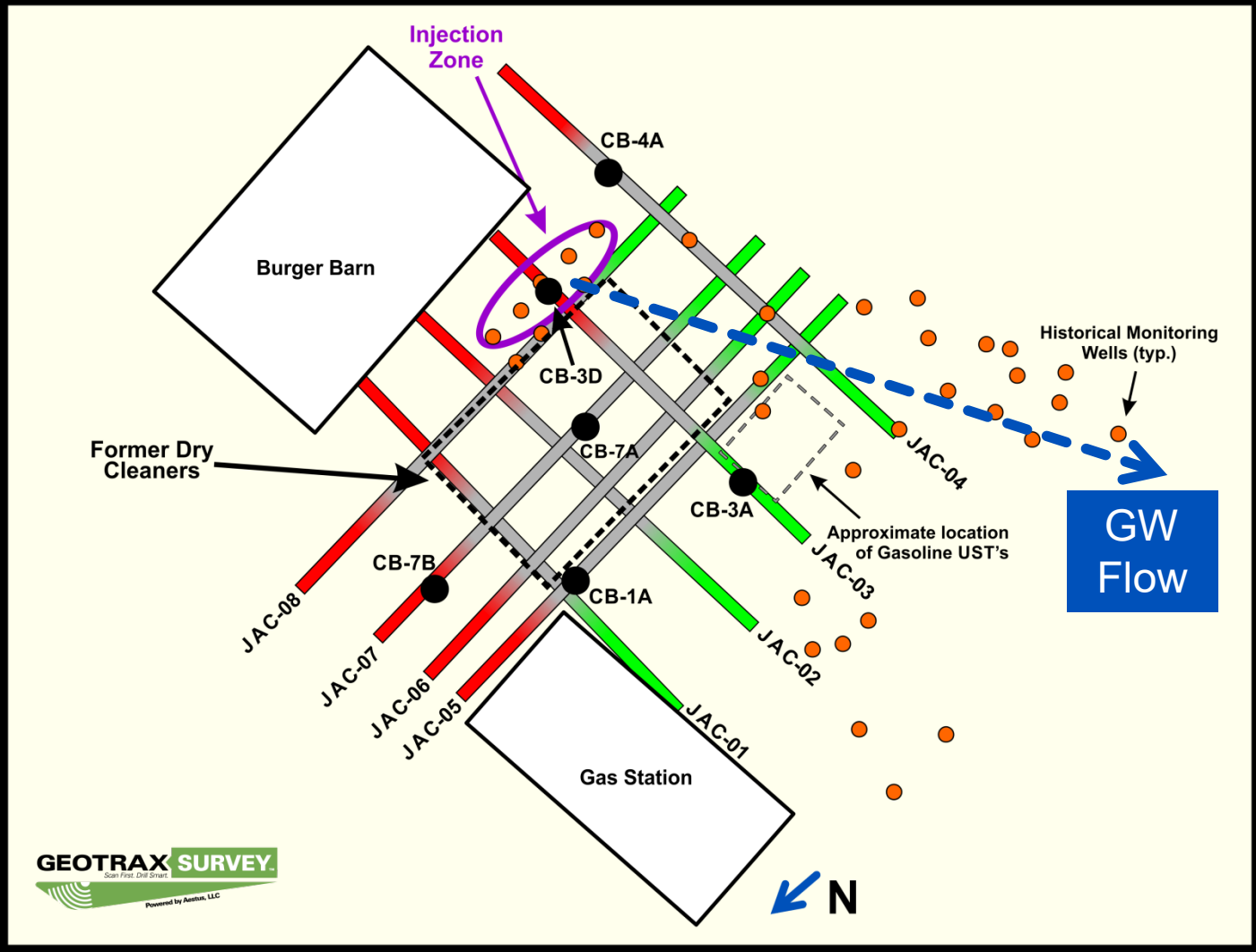
- Dry cleaners - 1945 to 1977
- Bioremediation injectates – 2002
- Soil excavation - 2004
- Injectate effectiveness unknown - 2008
- Ultra-High Resolution Scan– 2009

Aestus
Aestus, LLC

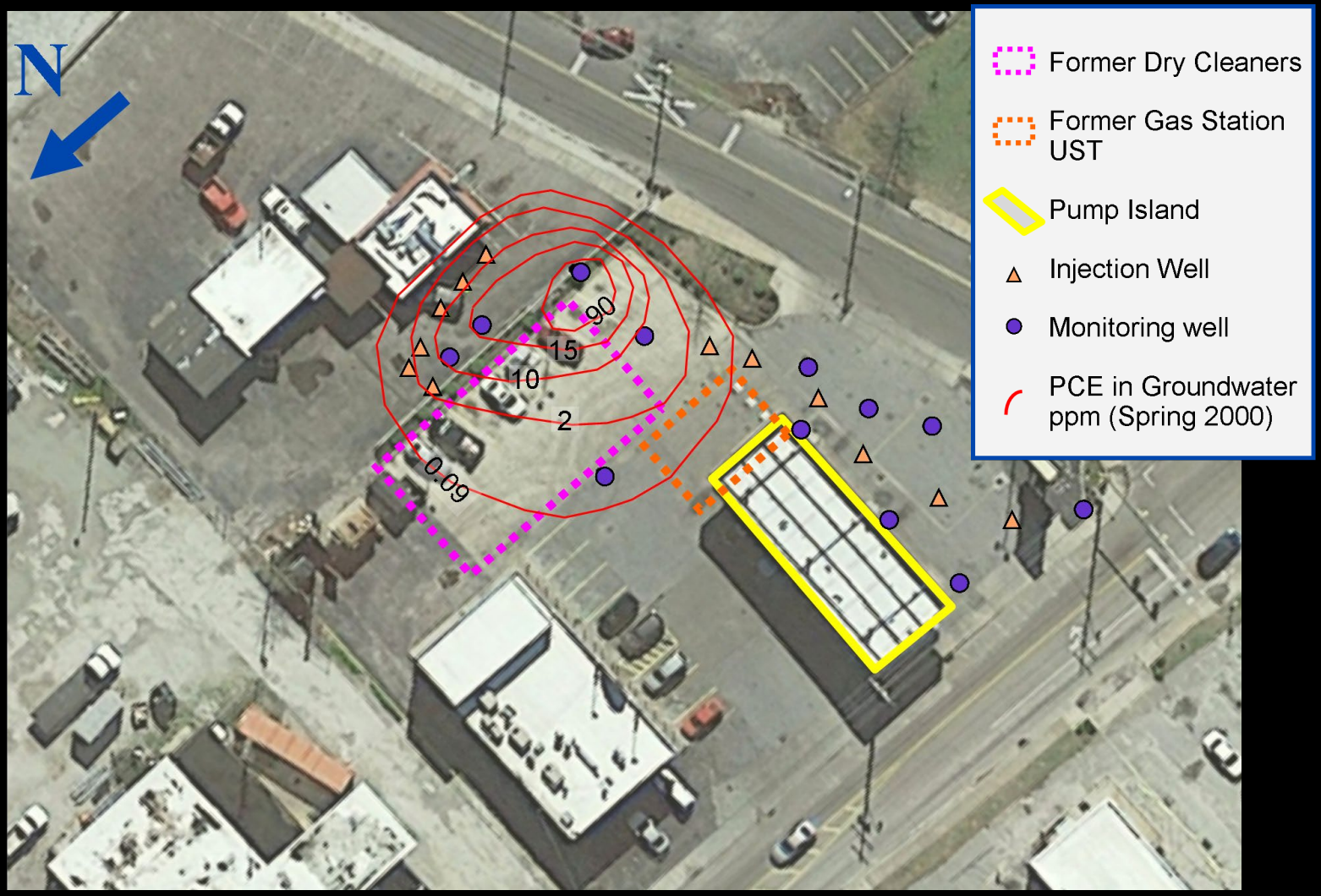
# ULTRA-HIGH RESOLUTION SCAN - DATA ACQUISITION

## *GEOTRAX SURVEY™*

# GeoTrax Survey™ Scan Locations

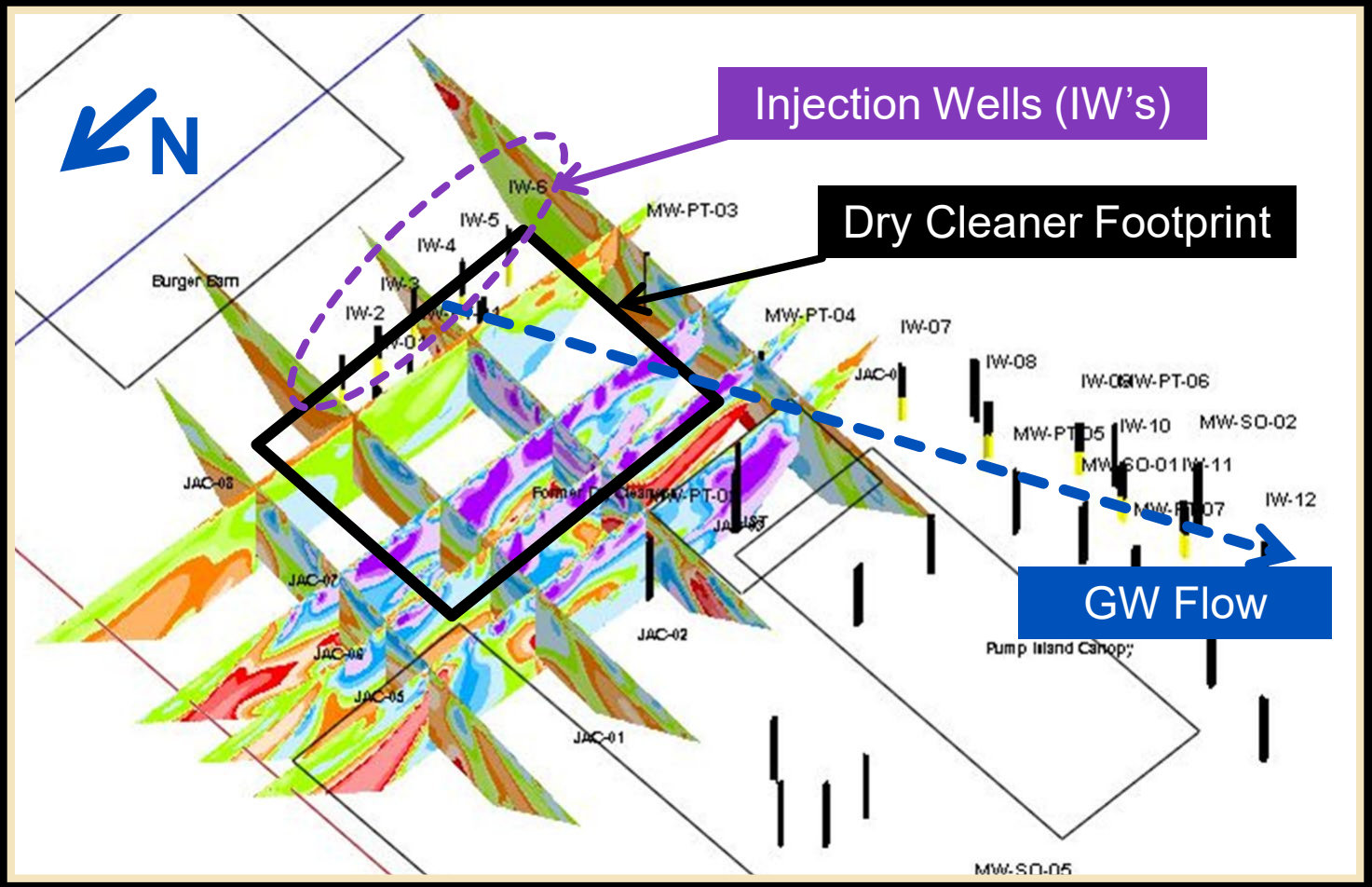


# Pre-Scan Site CSM



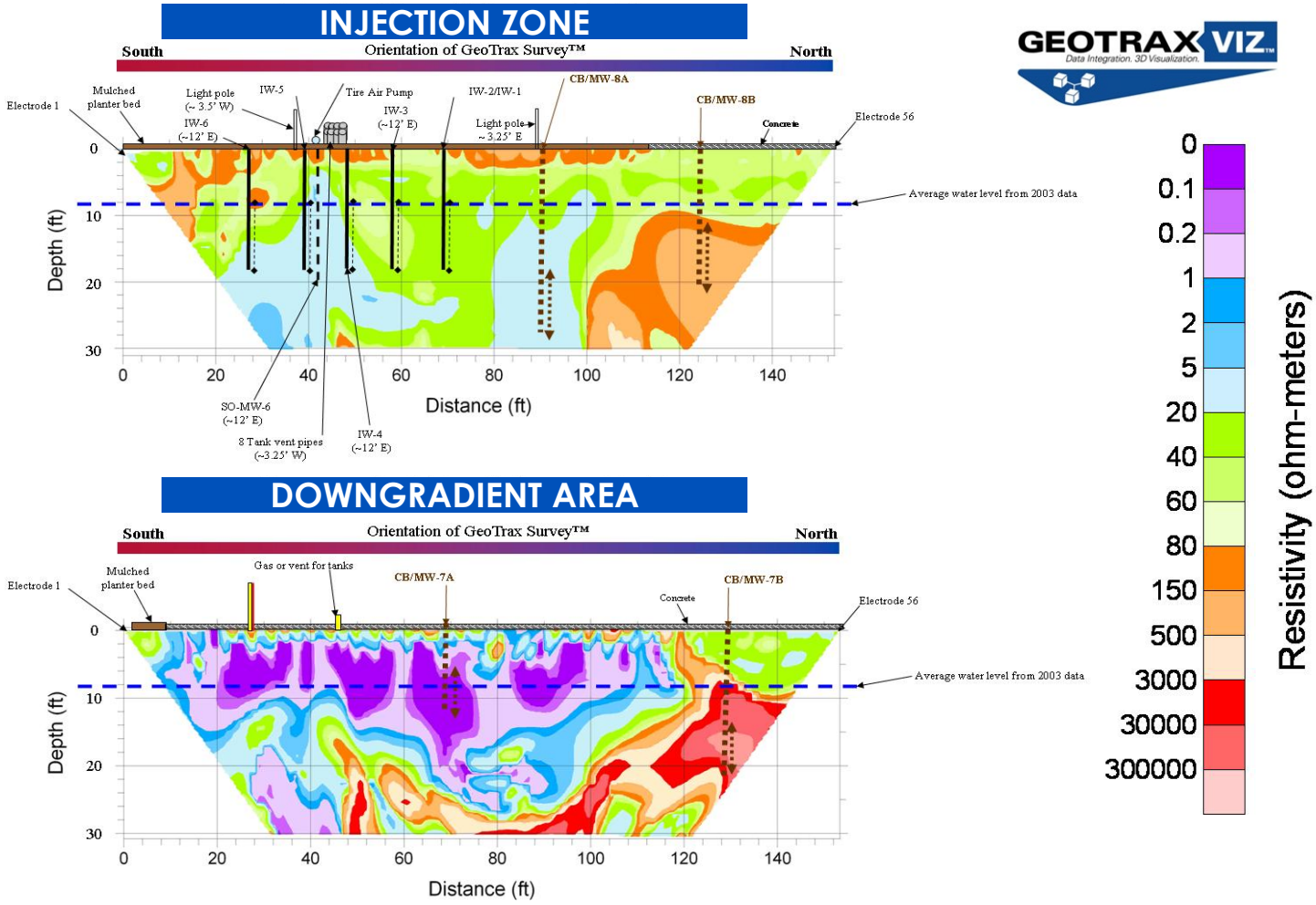
# 3D Data Integration

## GeoTrax Viz™



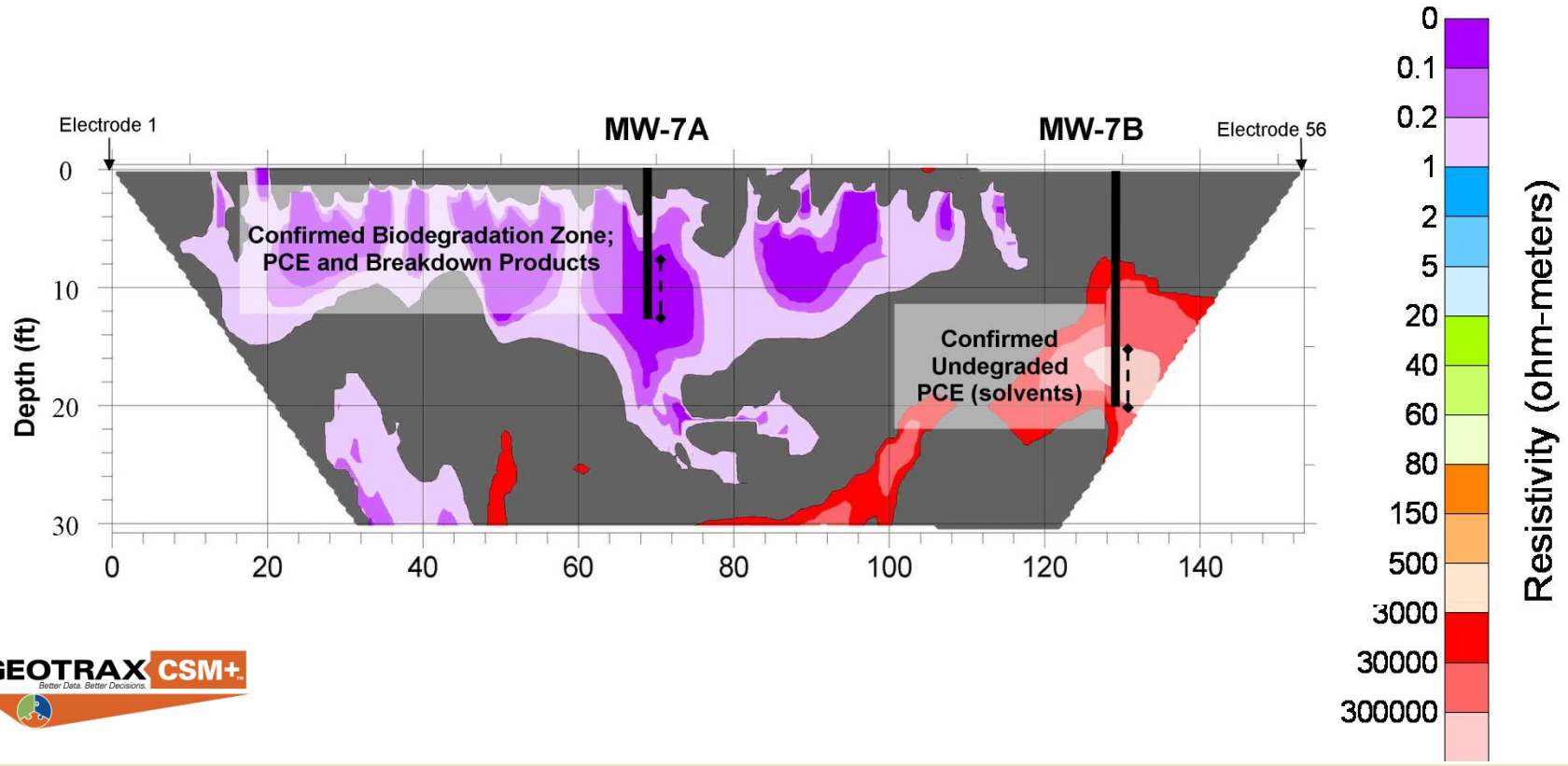
# 2D Data Integration

## GeoTrax Viz™



# Profile View - Ultra-High Resolution CSM

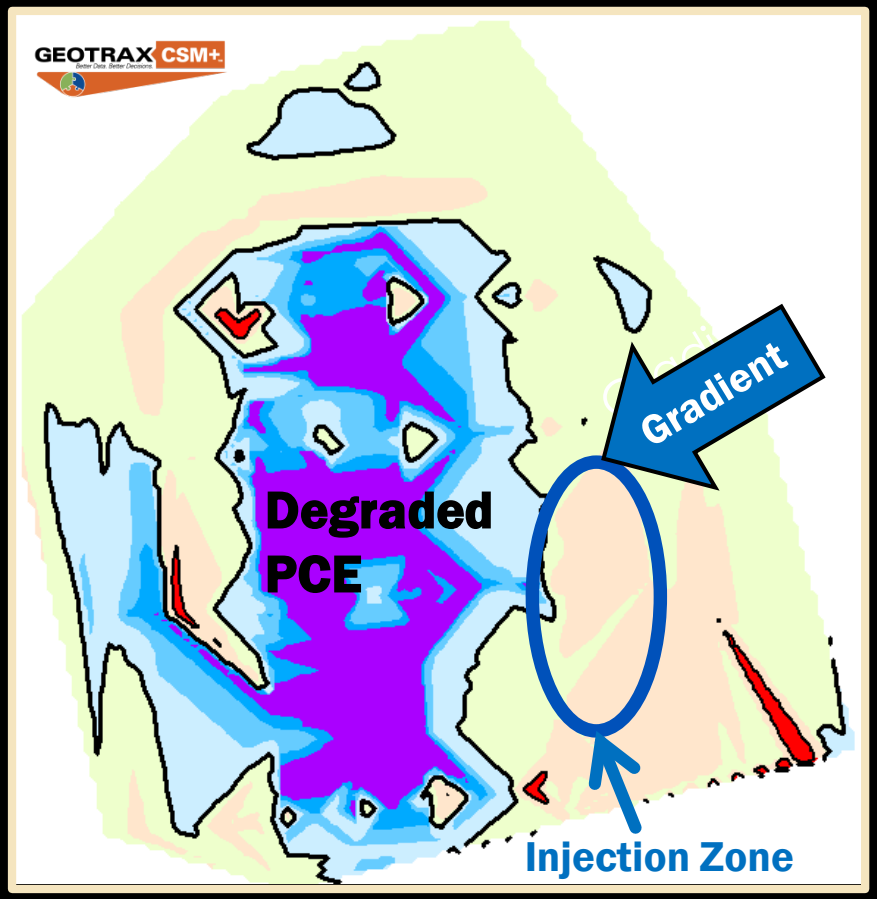
## w/ Confirmation Drilling Results



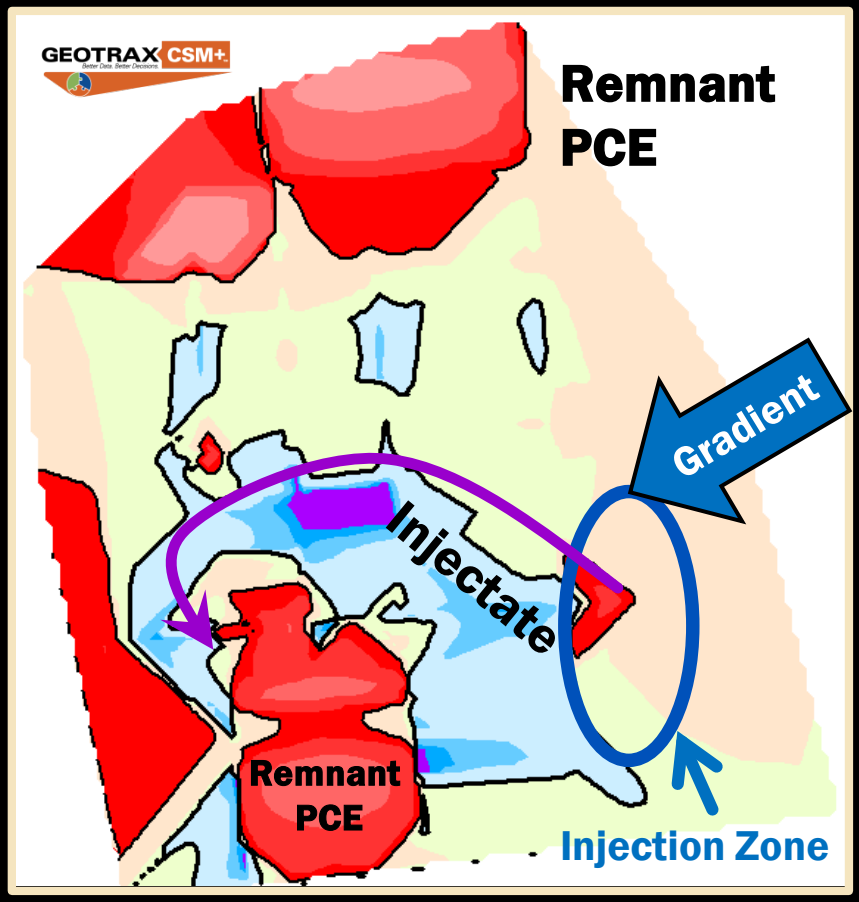

GEOTRAX CSM+ Better Data. Better Decisions.

# Plan View - Ultra-High Resolution CSM

## *Horizontal Elevation Slices (GeoTrax Survey™ Data)*

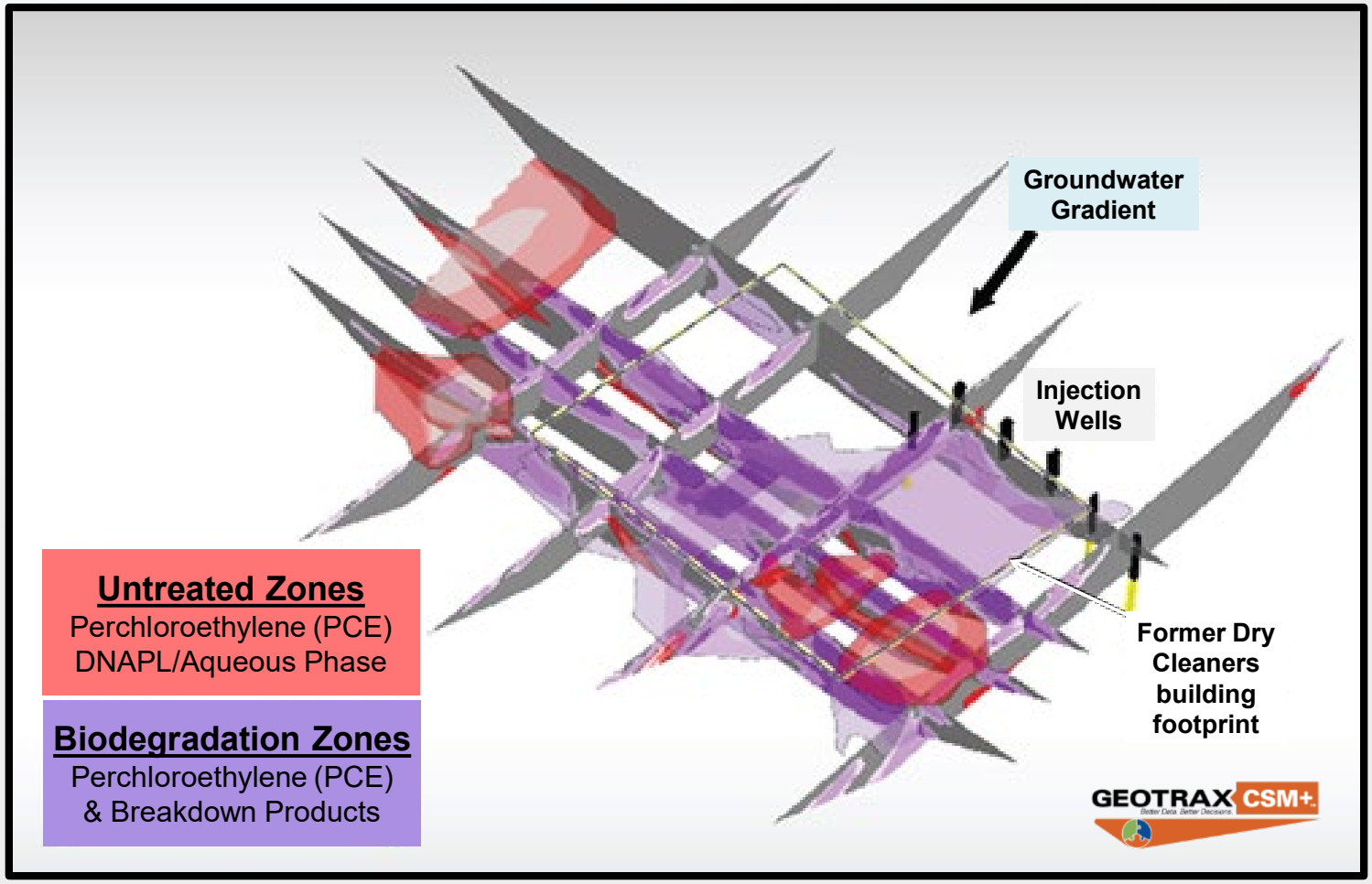



Vadose Zone




Phreatic Zone

# Example 3D CSM+




**Dry Cleaner CVOC Site**



Aestus, LLC

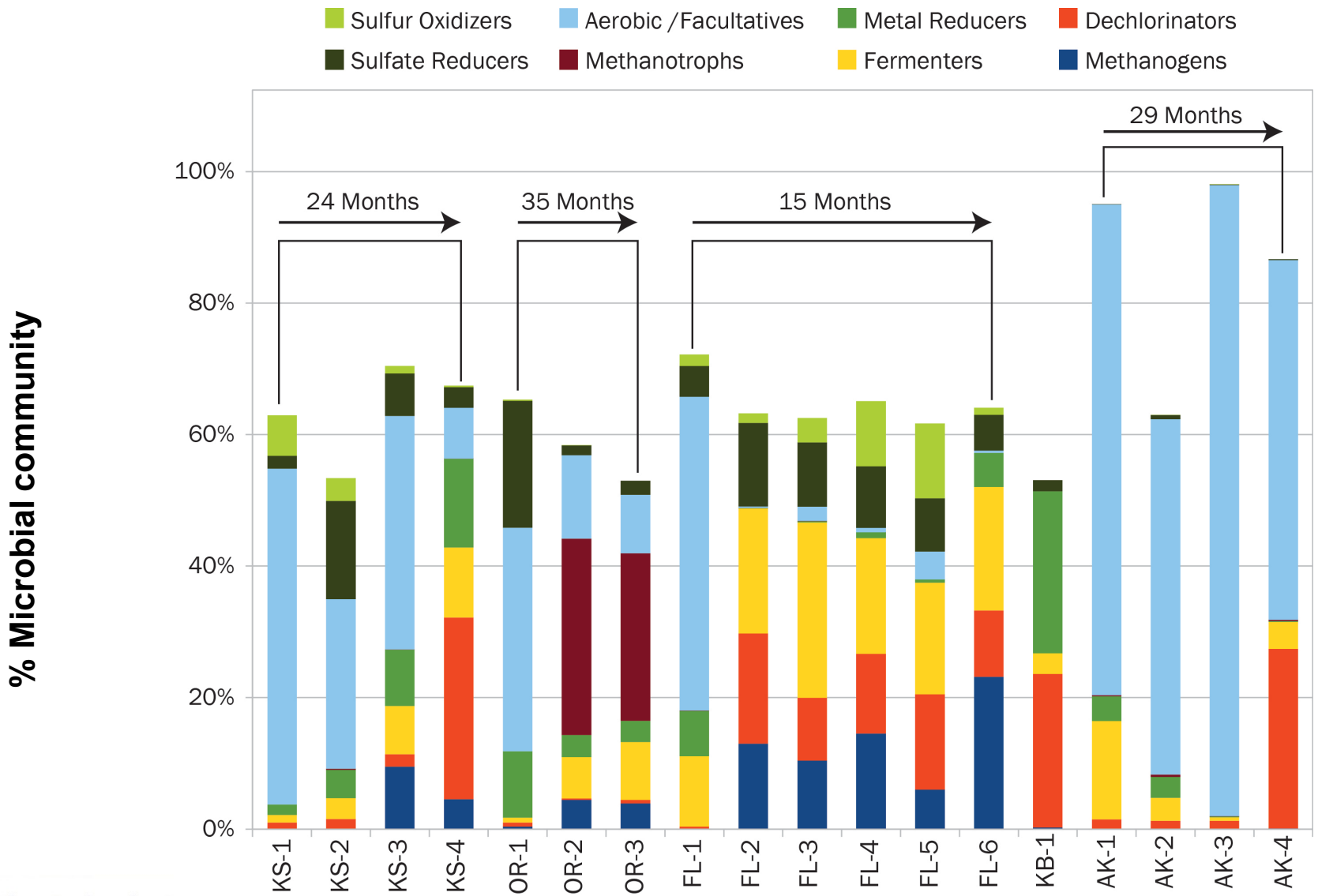
# Aestus GeoTrax CSM+™ Results

## *Boone Dry Cleaners Site*

- Visualization of enhanced bioactivity
- Newly delineated PCE/DNAPL extents
- Plume deeper than thought
- Existing monitoring wells unsatisfactory
- **Next steps easily understood by all involved**

Aestus, LLC

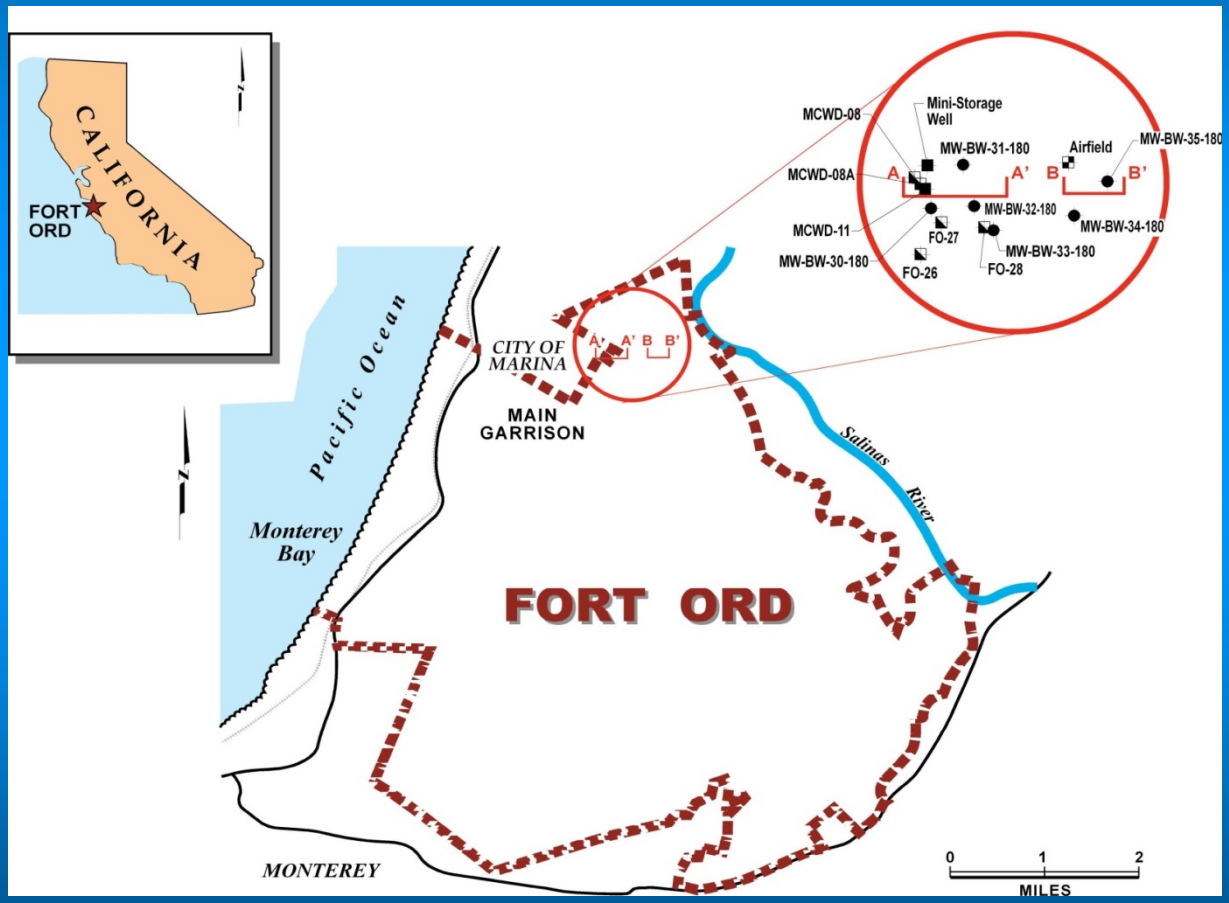
# Treatability /Molecular Testing
# -diverse communities
# -credit SiREM Lab




True Blue Technologies

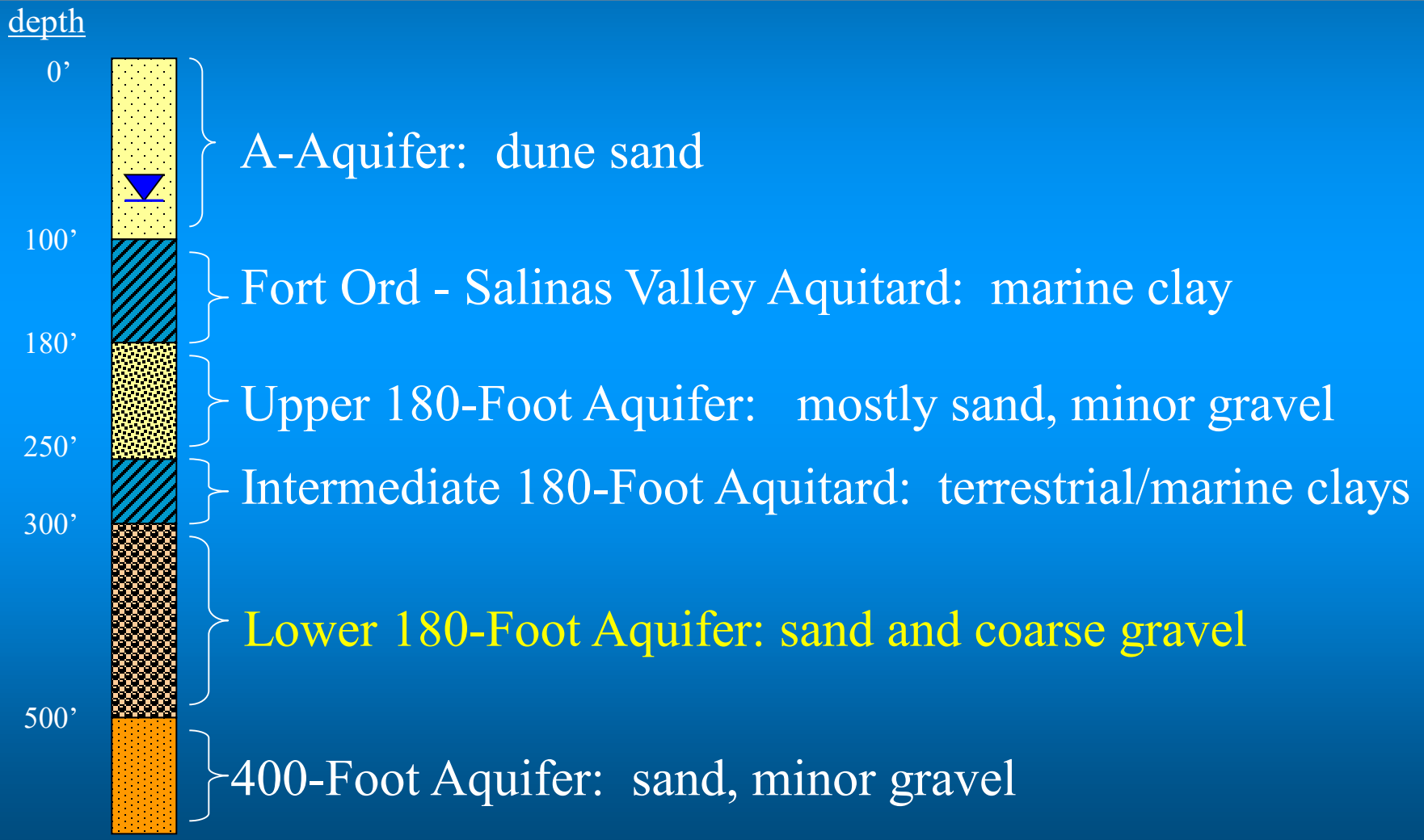
Remediation and Characterization Products and Support

# Former Fort Ord, California

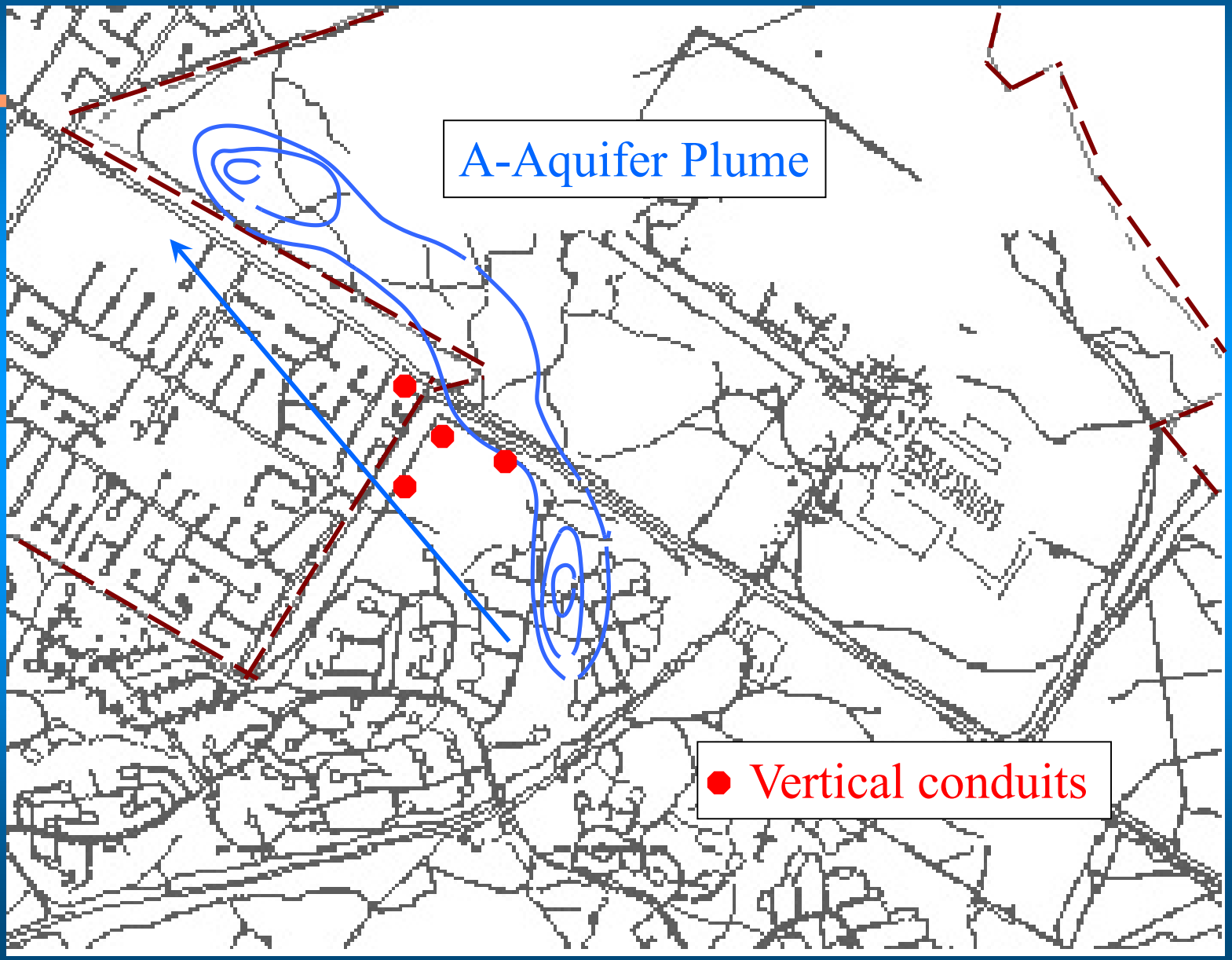



Credit USACE, Wood and Westbay

# Fort Ord Hydrostratigraphy



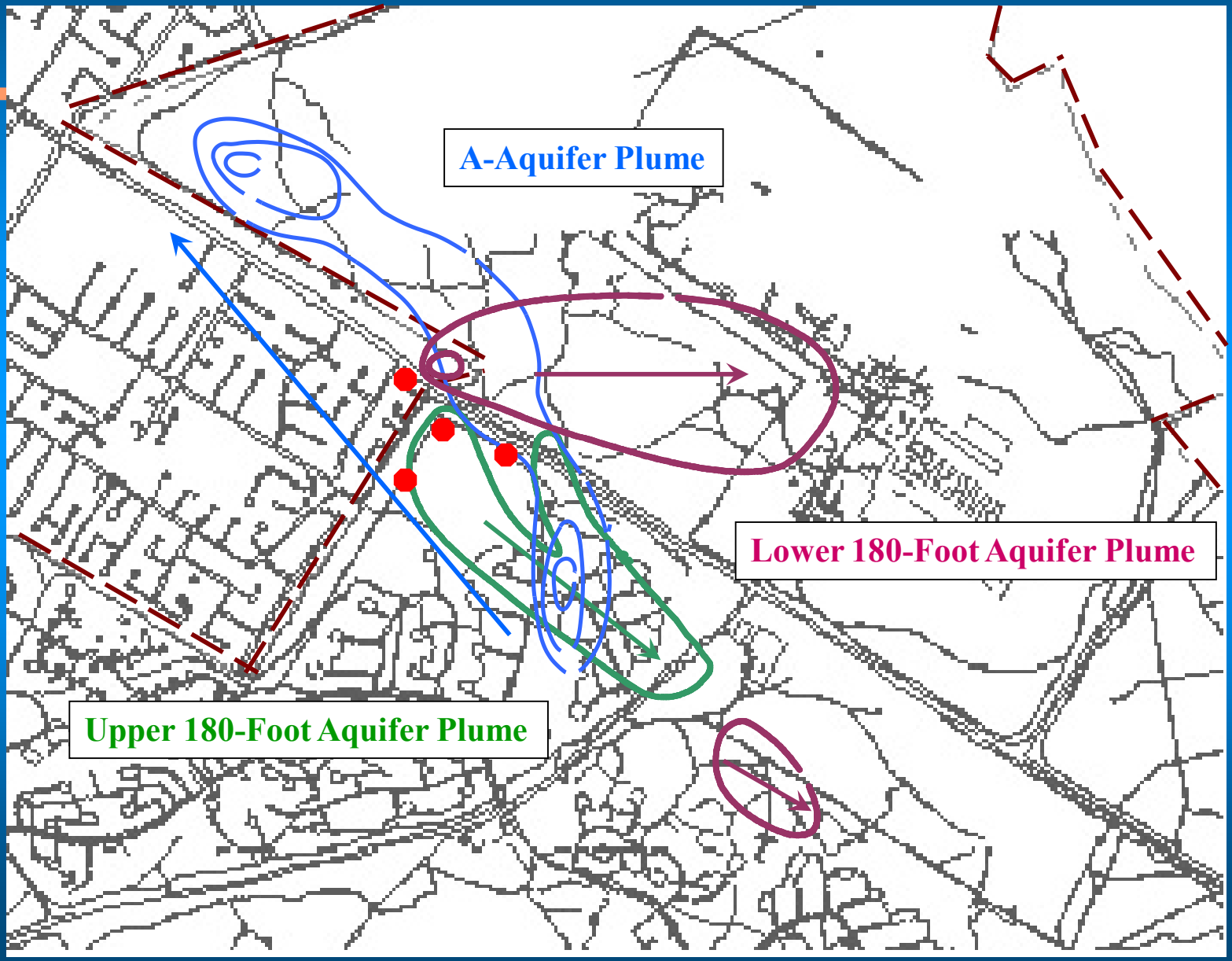
# Fort Ord Carbon Tetrachloride Plumes



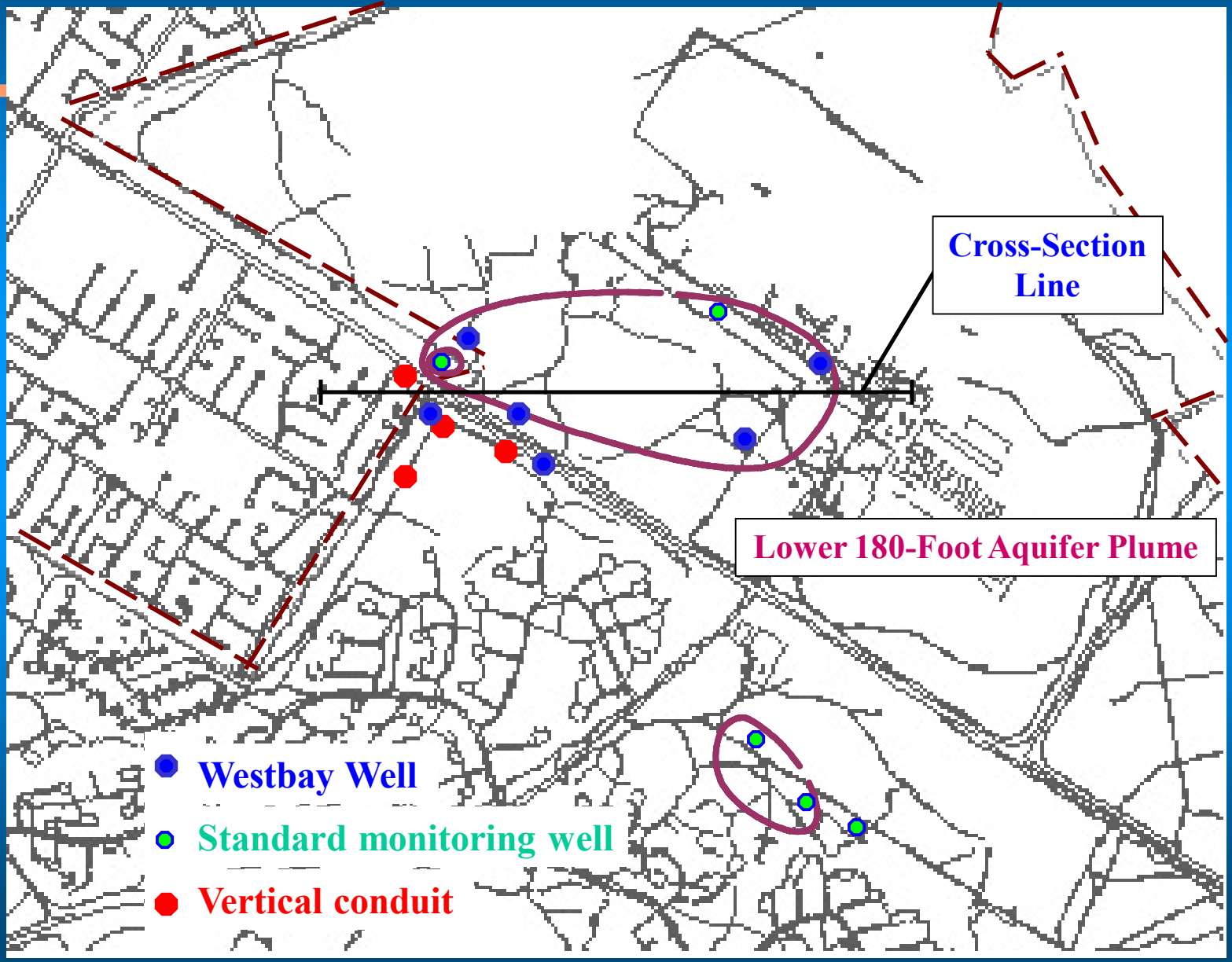
# Fort Ord Carbon Tetrachloride Plume Vertical Migration

- Several previously used drinking water wells had been installed with insufficient sanitary seals
- Historical data indicated the presence of CT
- All but one well are now destroyed
- Apparently one or more wells acted as a vertical conduit and led to deeper contamination

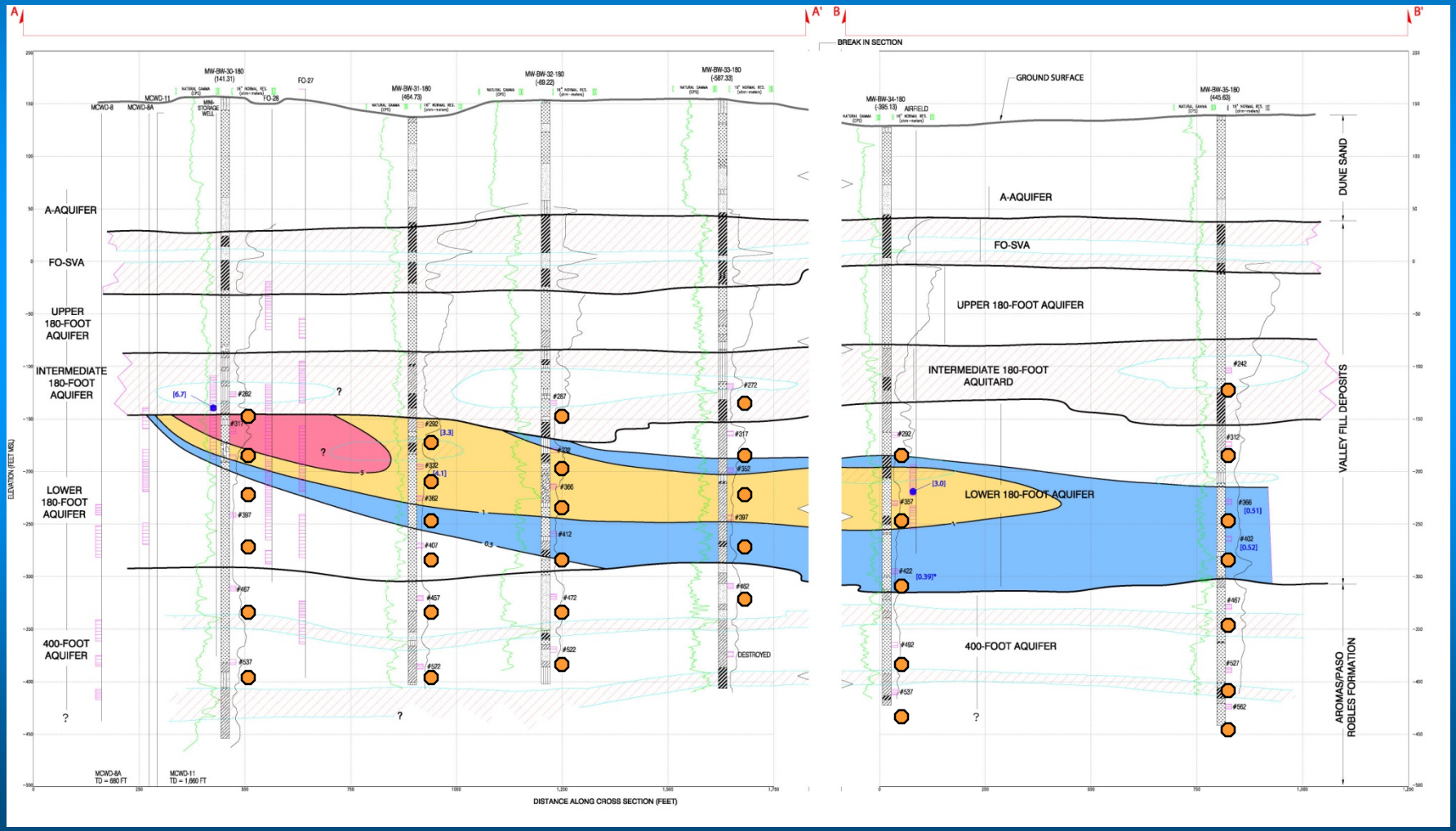
# Fort Ord Carbon Tetrachloride Plumes



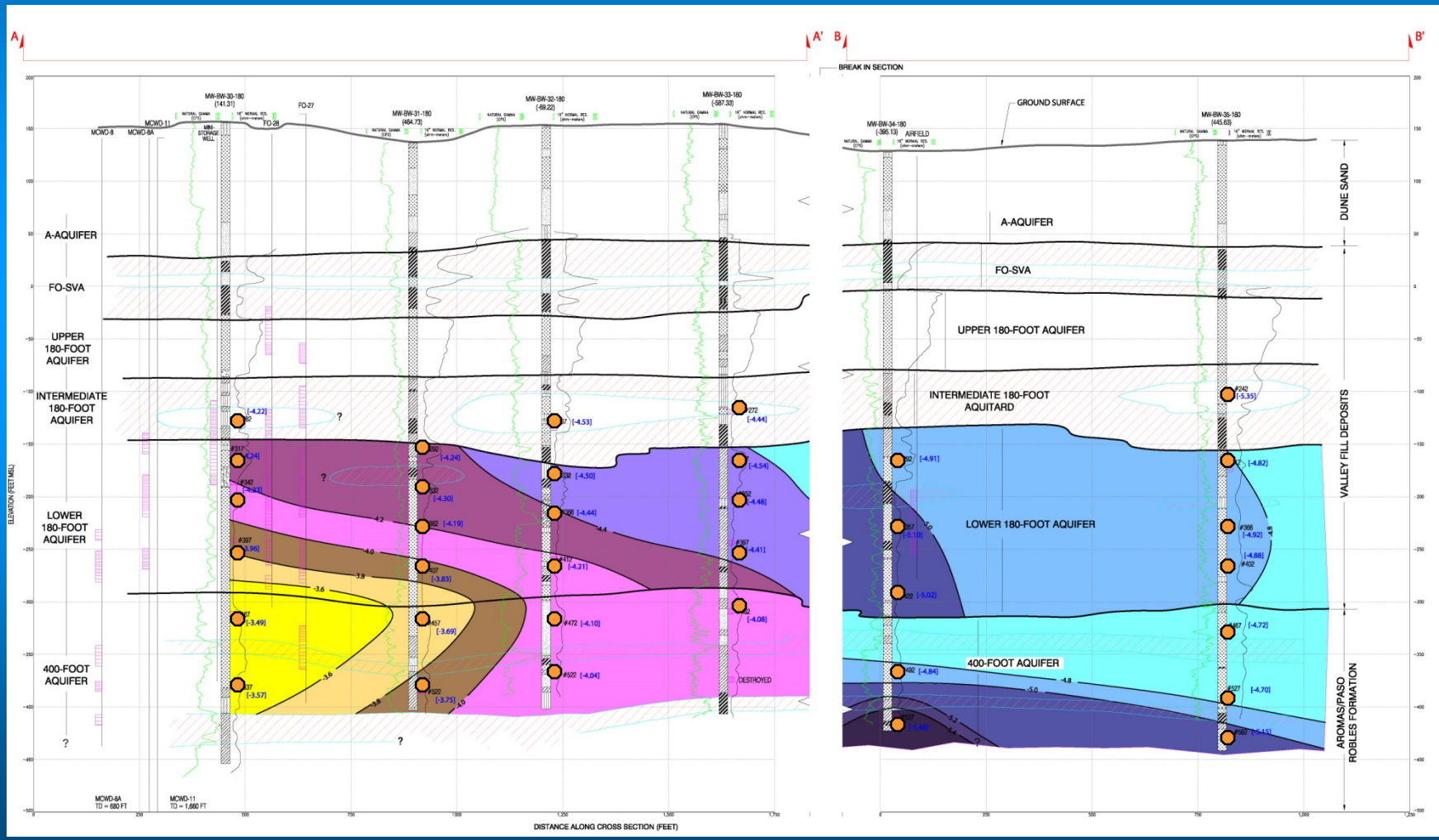
# Fort Ord Carbon Tetrachloride Plumes



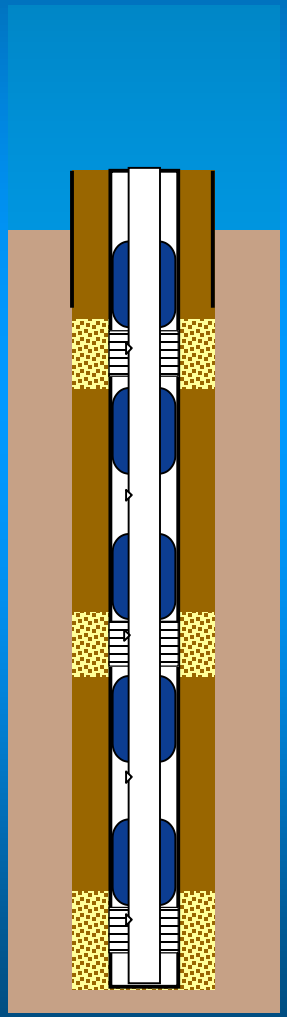
# Fort Ord Carbon Tetrachloride Plume Lower 180-Foot Aquifer - Cross Section



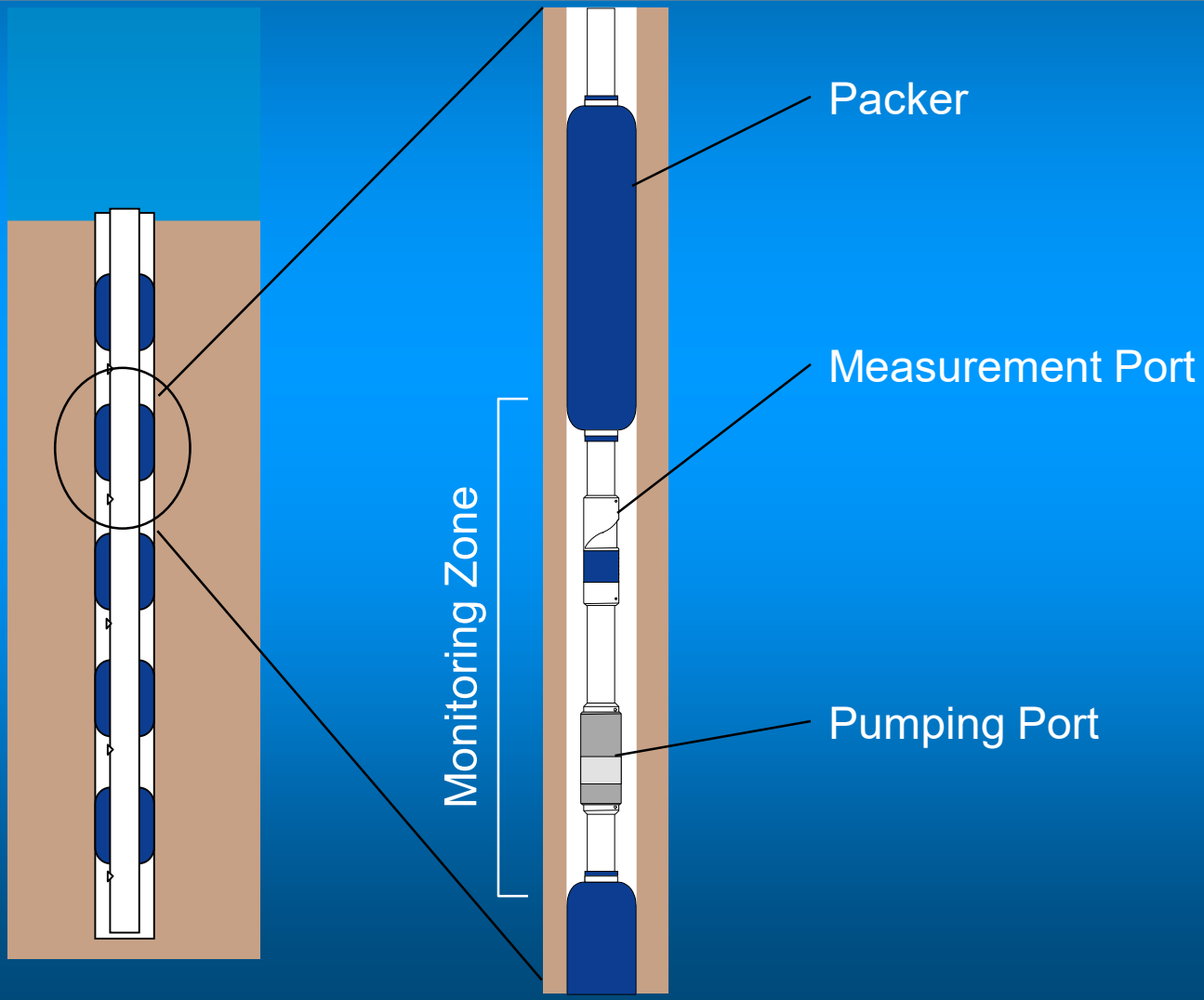
# Fort Ord Groundwater Elevations
# Lower 180-Foot Aquifer - Cross Section



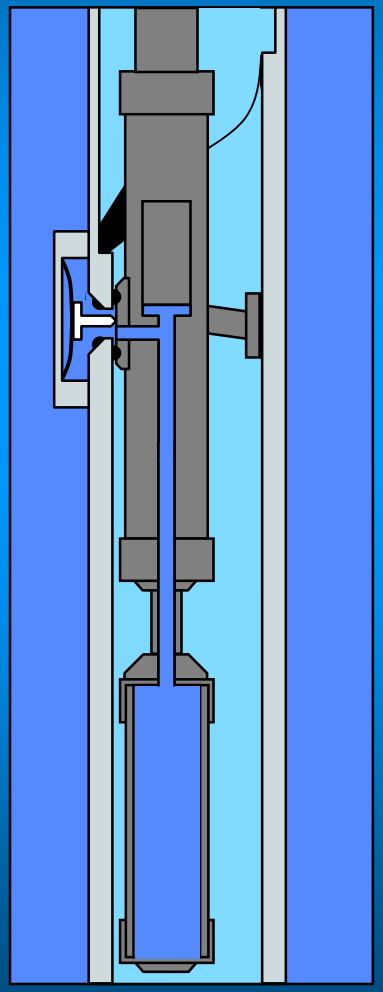
# Completion Method -Cased Well

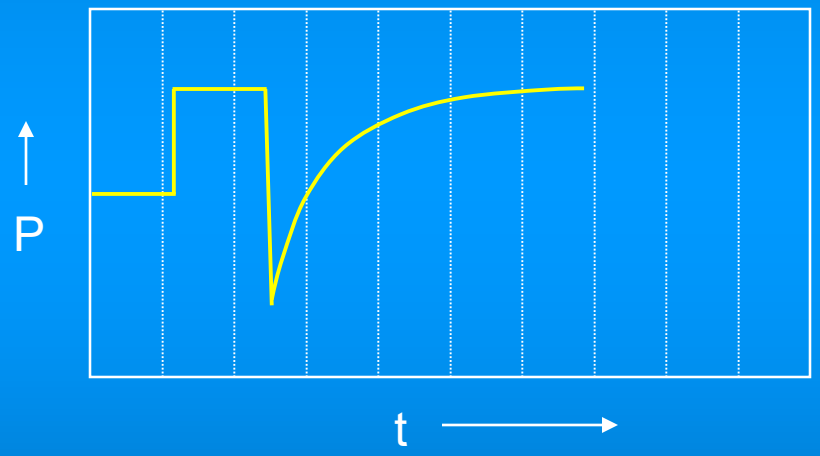


# Multi-port System



# Operation of Westbay Sampler

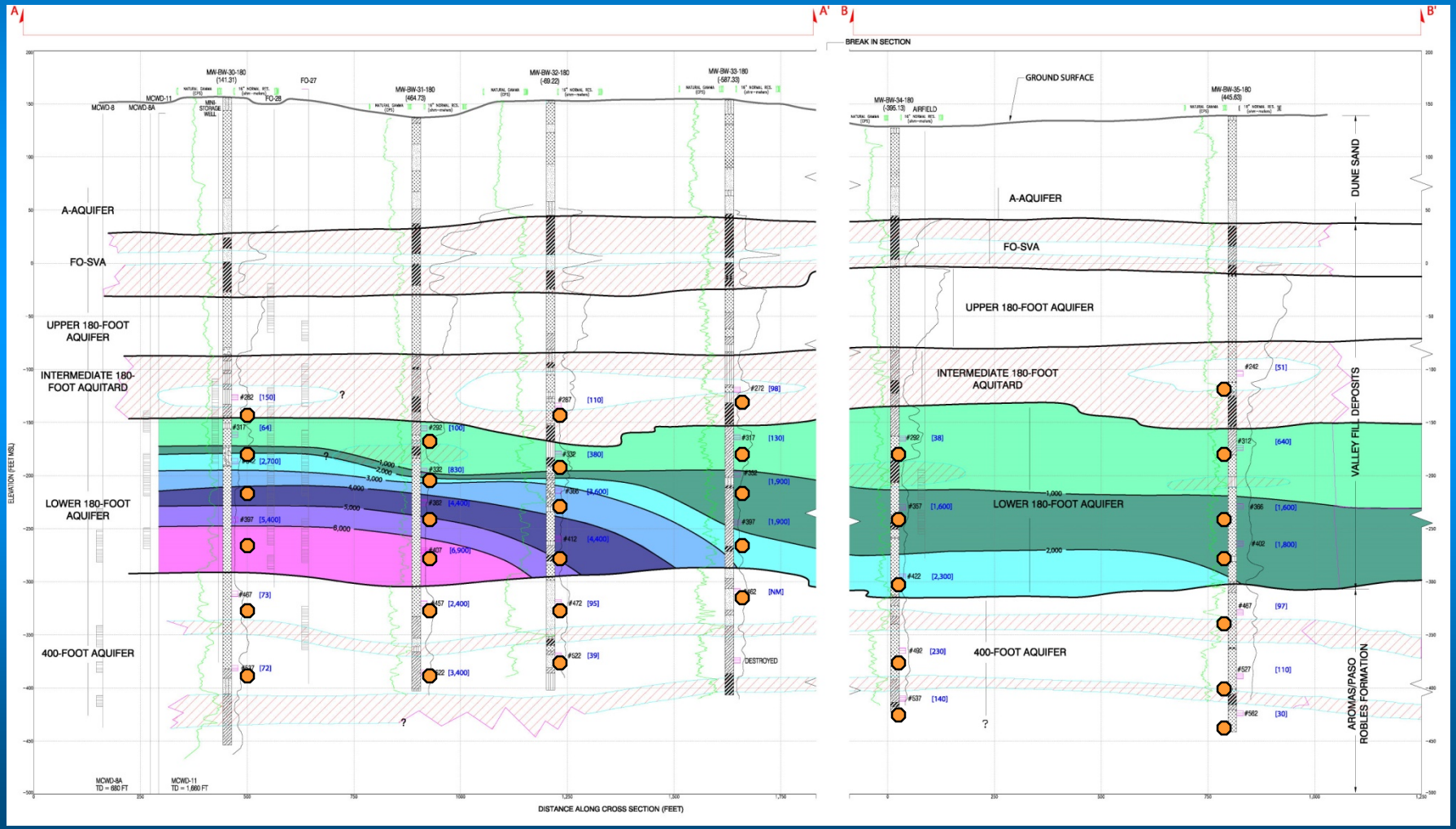




# Summary

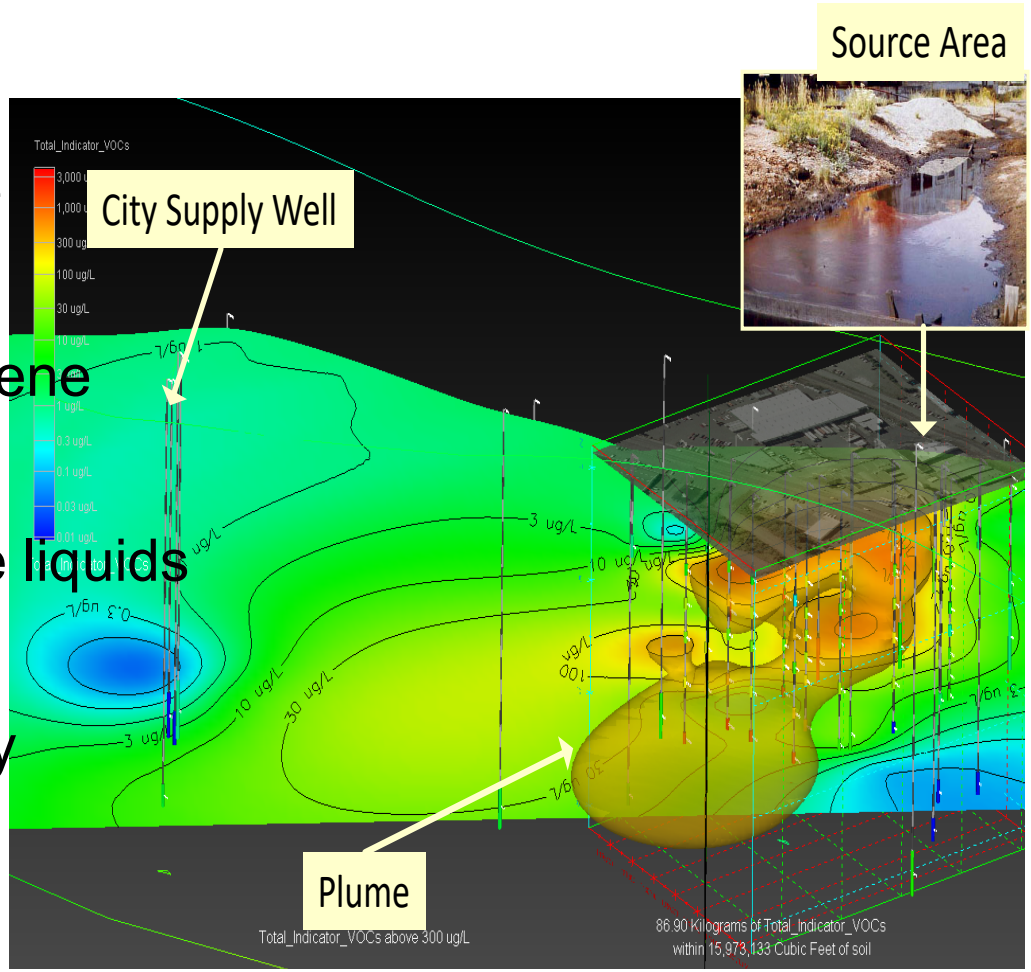
- New CSM allowed the consultant to carry out agreed remediation.
- Data quality superior to standard purge/bail samples
- Cost per port was about half cost per screen
- 12 ports sampled per day versus 2 per day for standard wells

# Bonus- Chloride Concentrations



# Well 12A Superfund Site, Tacoma, WA

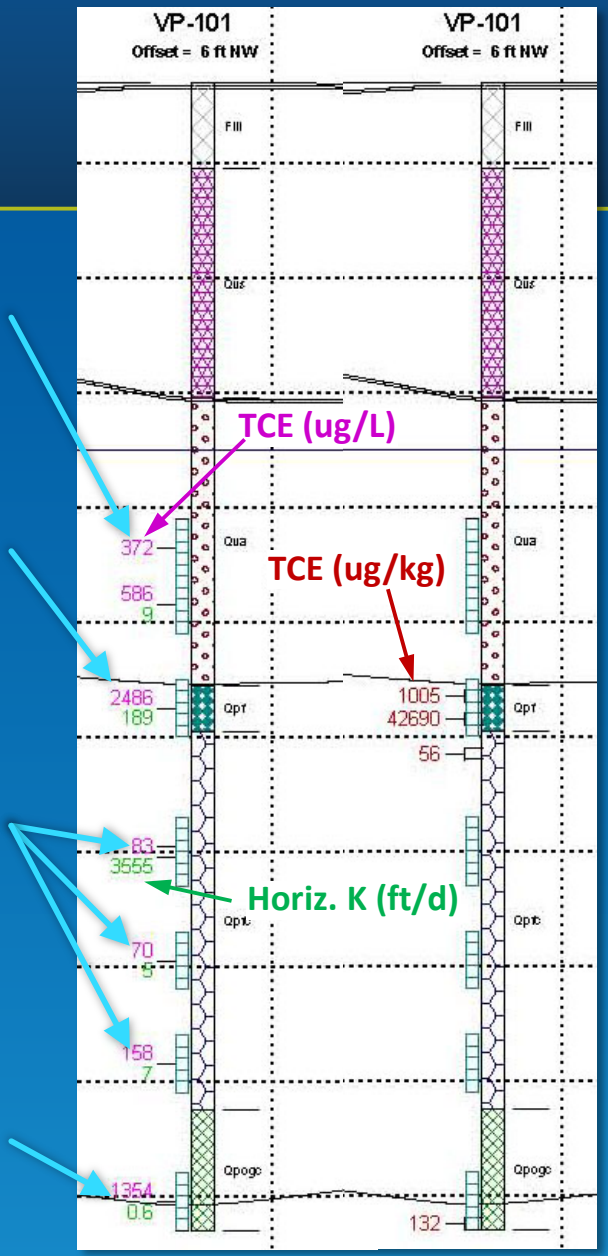
- Primary COCs –
  - 1,1,2,2-tetrachloroethane
  - Tetra- and trichlorethene
  - Cis and trans dichloroethene
  - Vinyl chloride
  - Light non-aqueous phase liquids
- Source area -
  - High and low permeability
  - Groundwater 33 ft bgs
- Goal - 90% reduction



# Summary of Site Characterization

- 34 soil borings to reduce uncertainty and delineate sources
- 12 locations for vertical profiling
- Depth discrete samples:
  - Groundwater
  - Soil
  - Slug testing
  - Stratigraphy
- Gradient assessment

# Vertical Characterization



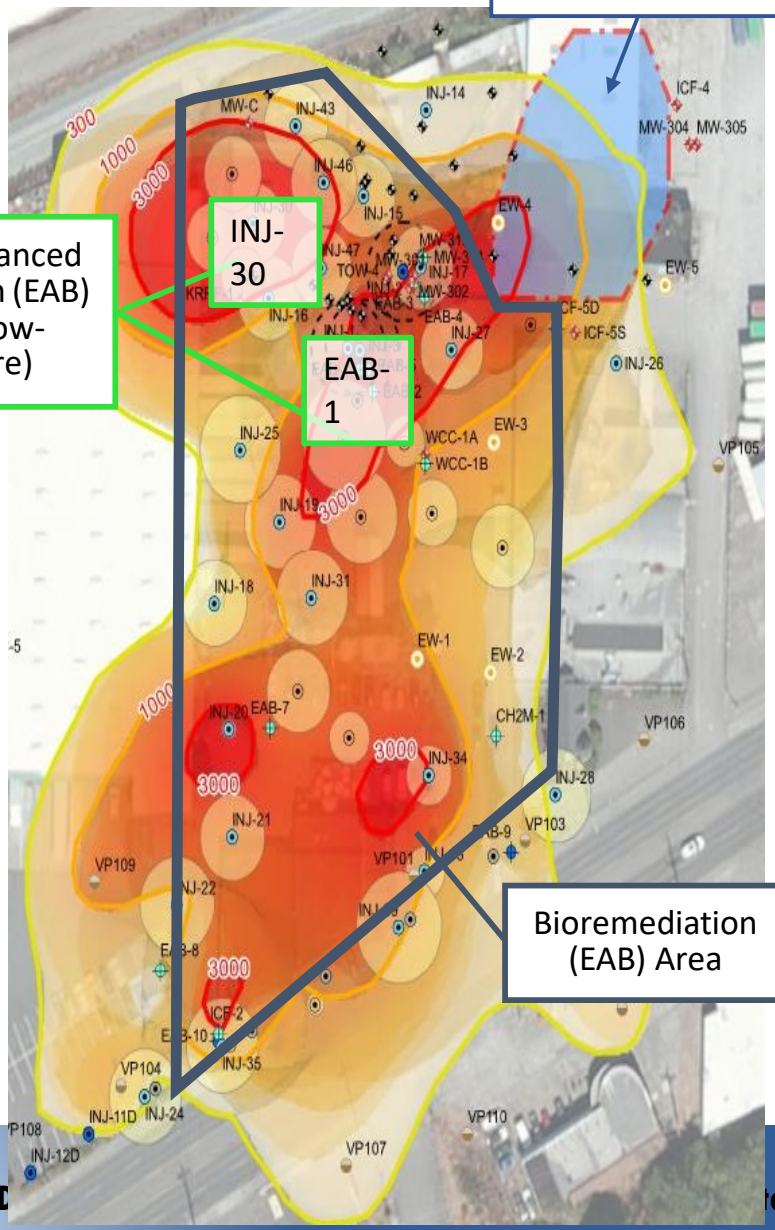
# Combined Remedies – Well 12A Superfund Site

**Final** Source Remedy – reduce mass discharge 90%

**Multi-technology** remedy, including:

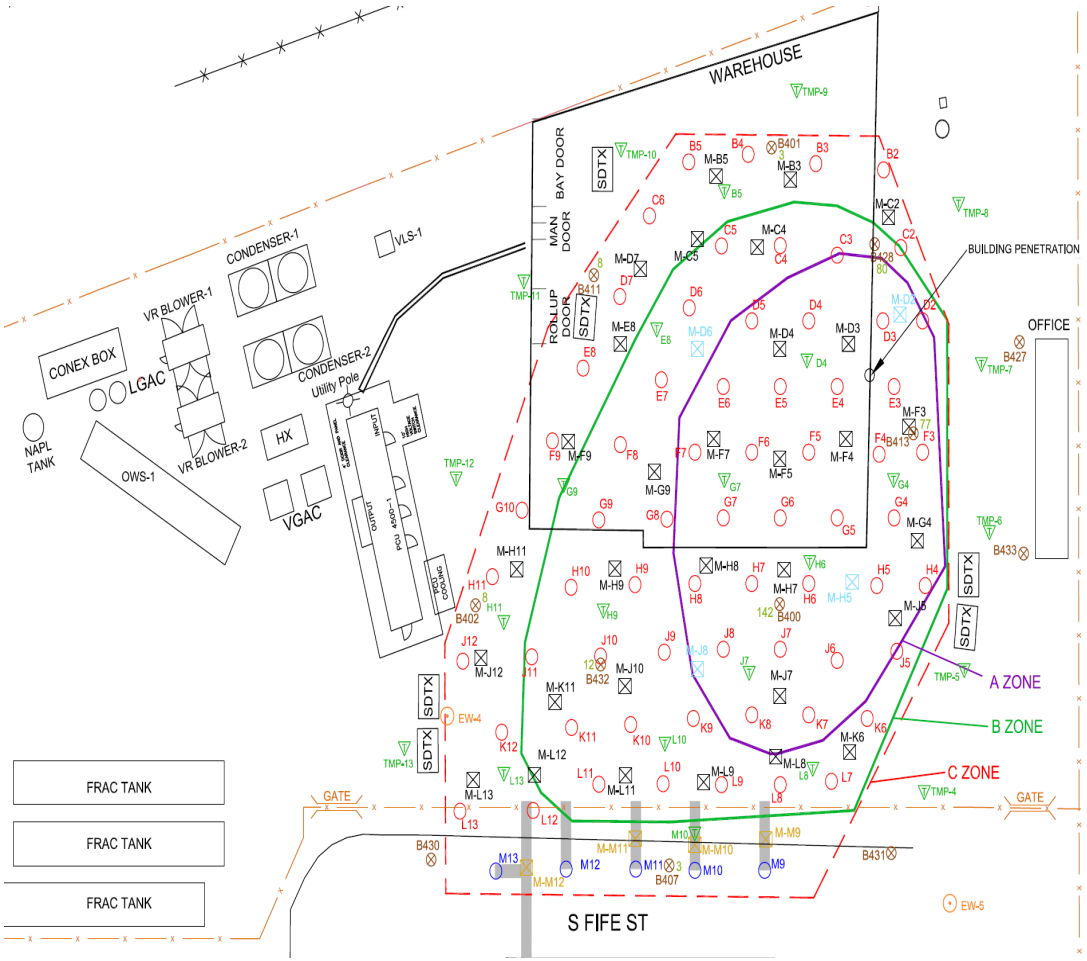
| Zone | Surface Area ($ft^2$) | VOC Mass (kg) | Discharge to GETS |
|---|---|---|---|
| Excavation Zone | 3819 | 510 | NA |
| Thermal Treatment Zone | 13,000 | ~242 | 224 g/day (53%) |
| *In Situ* Bioremediation Zone | 162,000 | ~462 | 199 g/day (47%) |

Courtesy of CDM Smith, EPA Region 10, Kemron, Seattle USACE

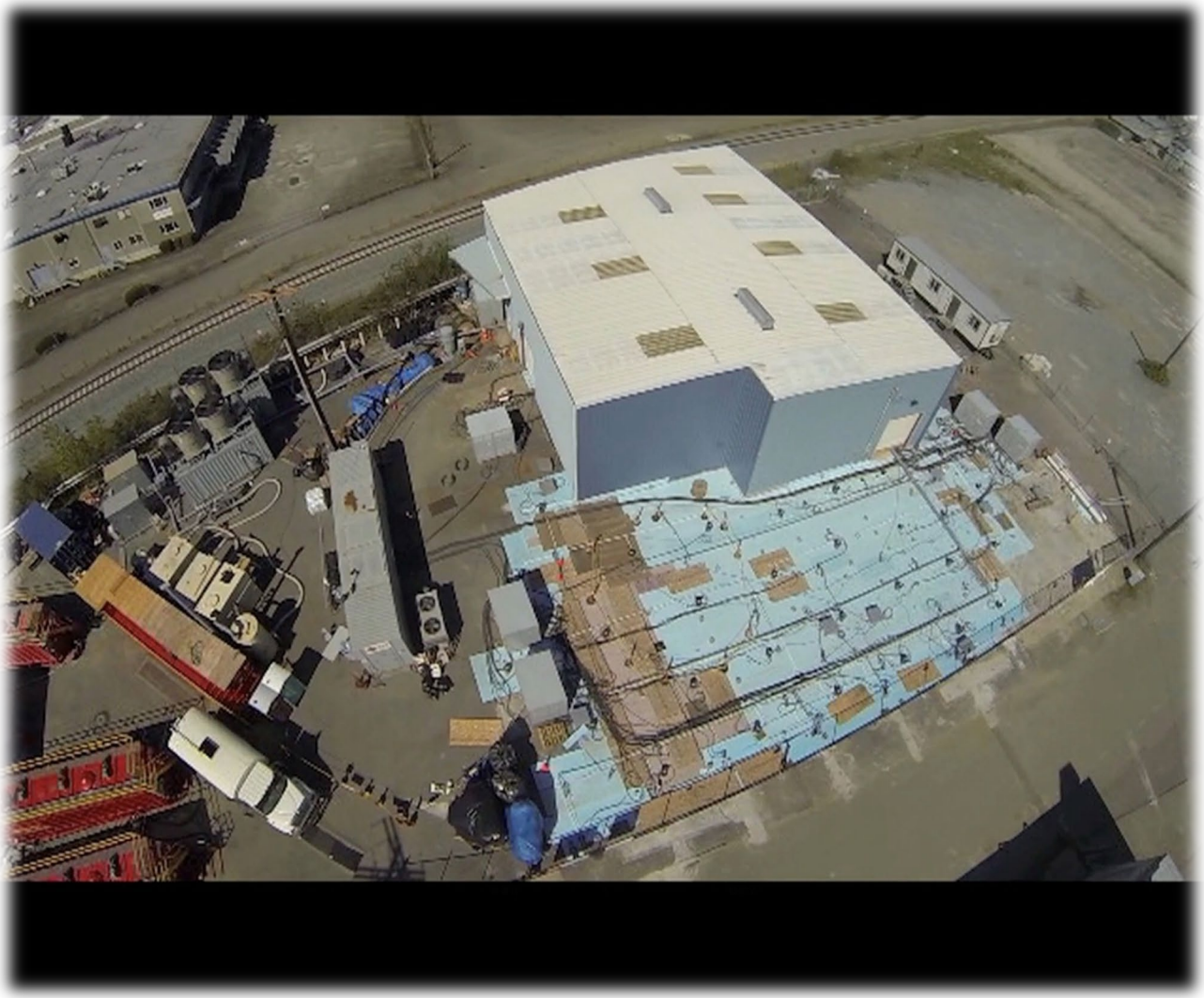


# Source Area - Electrical Resistance Heating

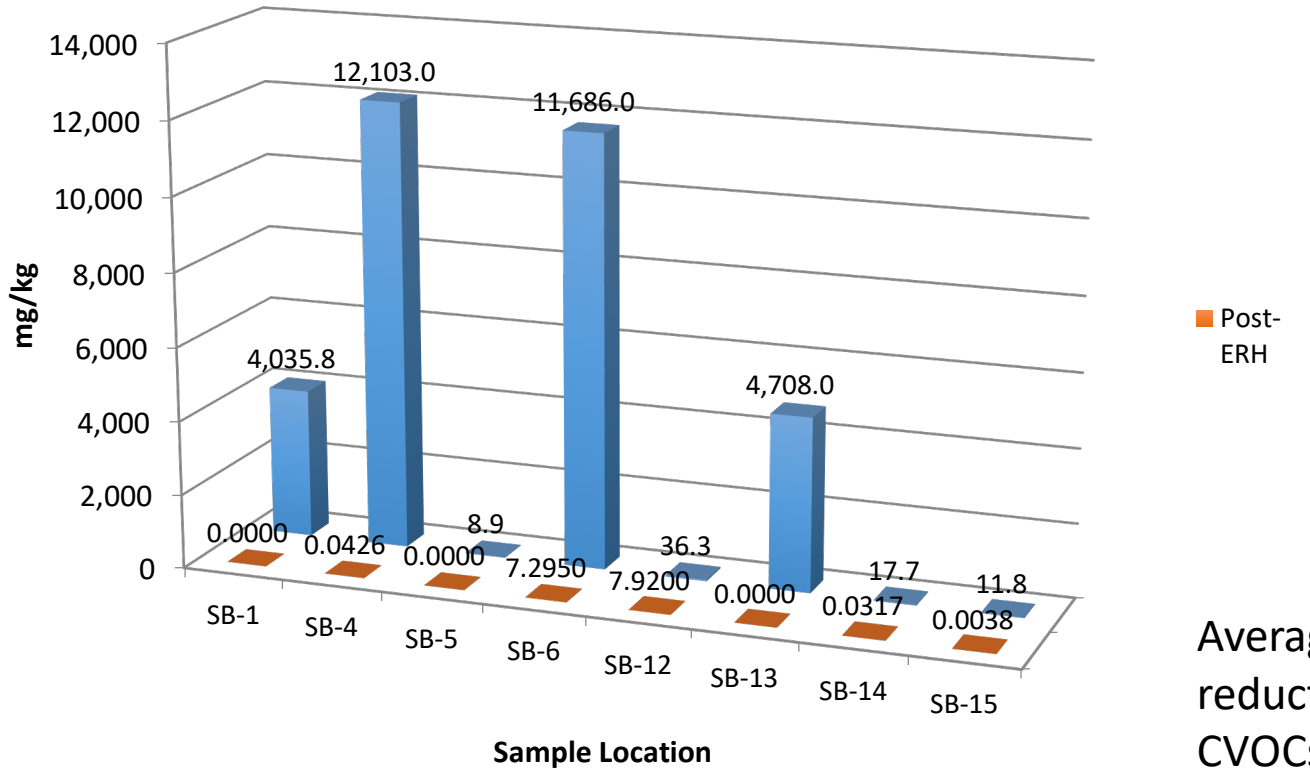
- 71 electrodes-not evenly spaced-3 zones
- Steam stripping
- VR & multi-phase extraction
- 117 days operation
- 9,591 lbs CVOCs and
- 12,709 lbs NAPL removed



# Well 12A Superfund Site, Tacoma, WA



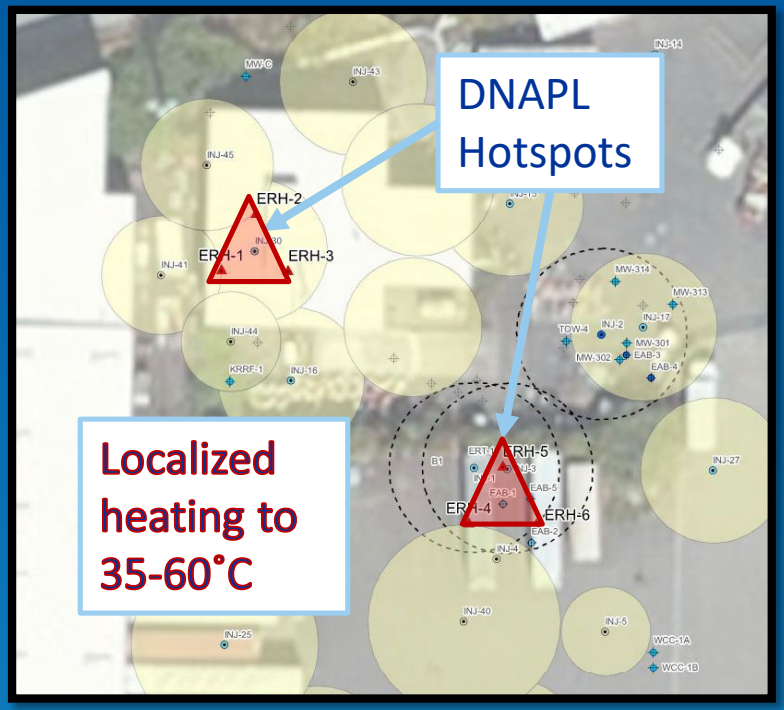
# Results, CVOCs in Soil
# Well 12A Superfund Site, Tacoma, WA




Average 99.95% reduction in total CVOCs in soil

# Optimize EAB in DNAPL Hotspots

- Heat Enhanced Plume Attenuation - (HEPA®)
- low-energy ERH to increase temperatures to 35-60˚C to accelerate EAB within the DNAPL hotspots.
  - Enhance dissolution of DNAPL
  - Enhance biodegradation kinetic rates
  - Enhance abiotic degradation rates



# Treatment Zones: Focused remediation was made possible by continued high resolution characterization before and during remedial activities.