

Optimizing LNAPL Remediation at a Fractured Bedrock Site Using Electrical Hydrogeology

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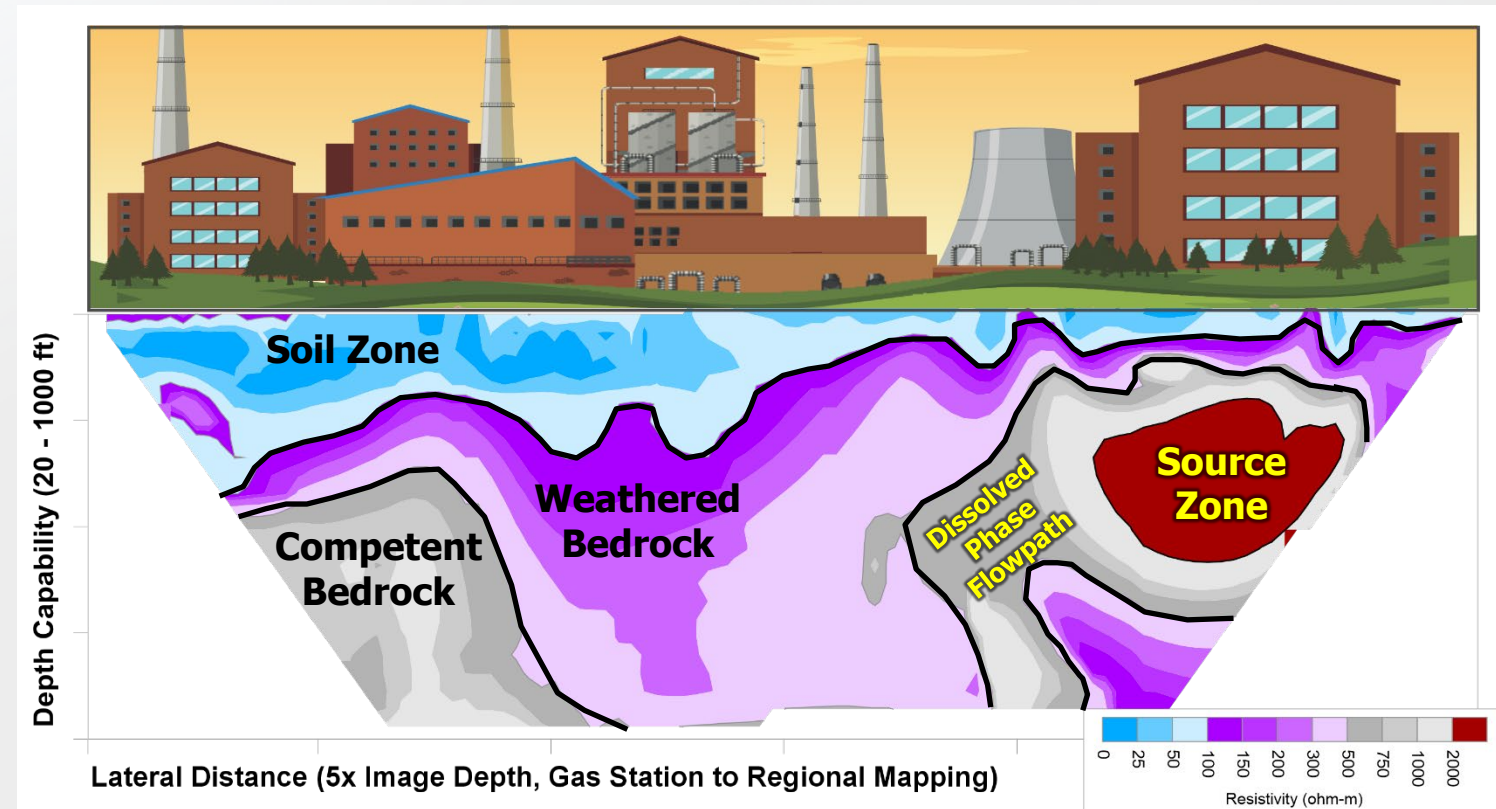
Hydrogeophysicist/Project Manager

Sep. 23, 2025



Today's Topics

1. Electrical Hydrogeology
What, Why, How?
2. Case Study: Fractured Bedrock Site
3. The GeoTrax Survey™ Difference
4. Closing Remarks
5. Q&A



Ultra-HRSC – Continuous vertical images of subsurface

Electrical Hydrogeology™ Process:

Leveraging Scan First Approach & Integrated Data Sets

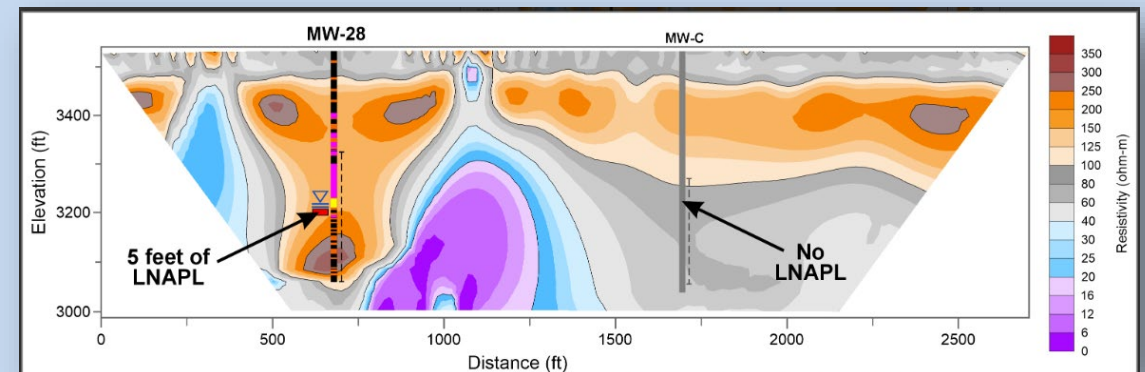
**Electrical
Hydrogeology** =

Traditional Hydrogeology

- Potentiometric surface maps
- Pipe Diagrams
- Aquifer Maps
- Lithology logs
- GW Chemistry
- HPT/MIP Results
- Stiff Diagrams
- GW Flow Models
- Etc.
- Geology Maps



Electrical Imagery/Targeted Drilling/3D Modeling



Applications:

1. Site Characterization (Static Imaging)
2. Site Monitoring (Temporal Imaging)

Industry Challenge & Solution



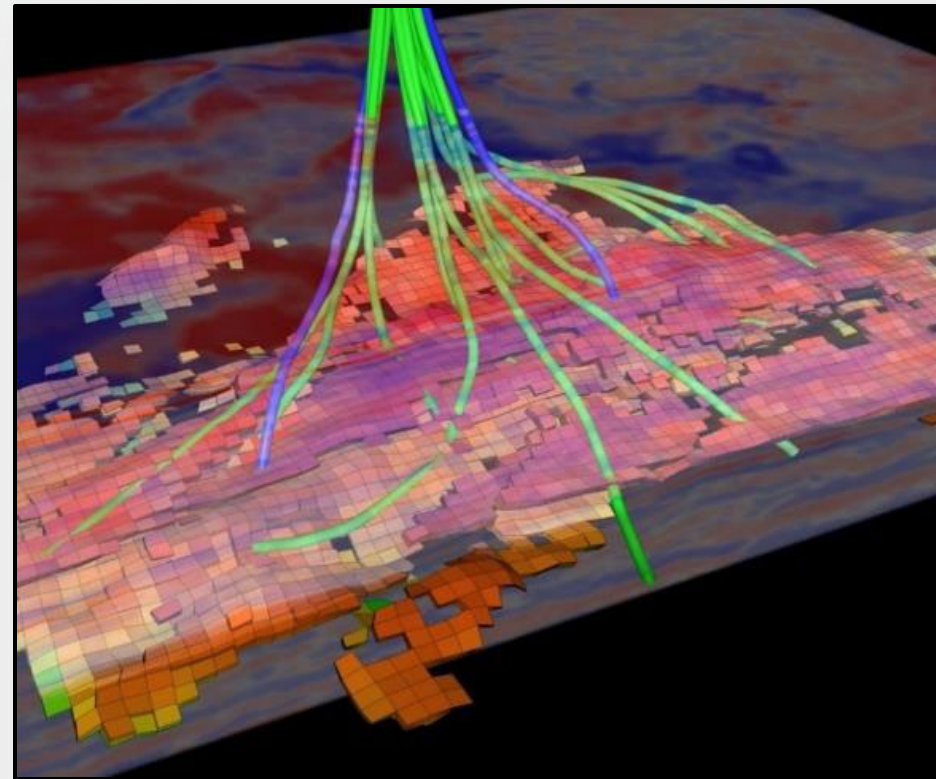
Video found at <https://www.youtube.com/watch?v=FqGjHWf08Io>

Scan then Target Approach: Aligning with Other Industries

Other industries requiring data “below the surface” evolve to scan first then go invasive



X-ray of Skull
nydailynews.com



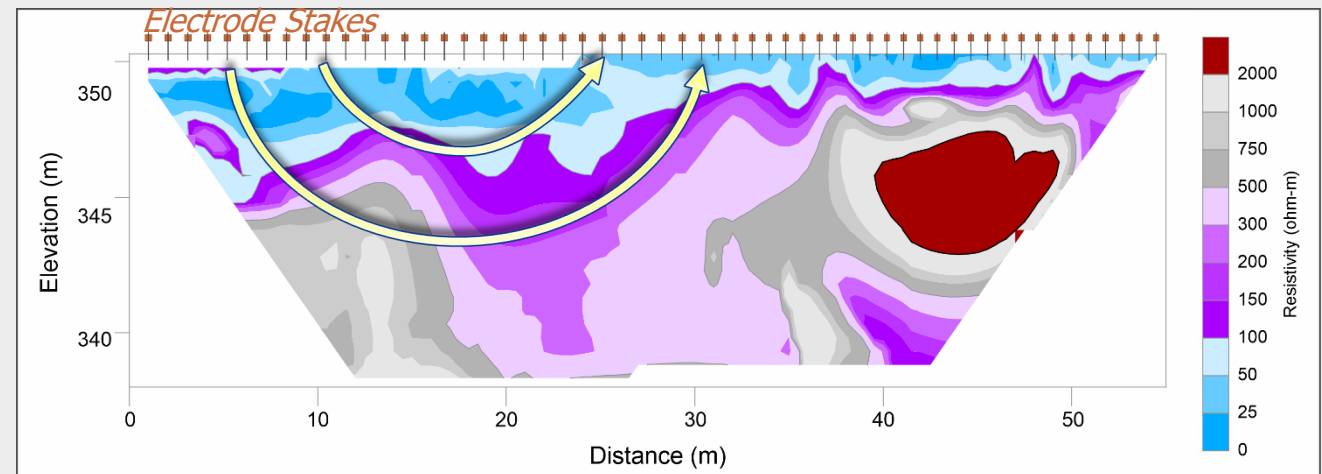
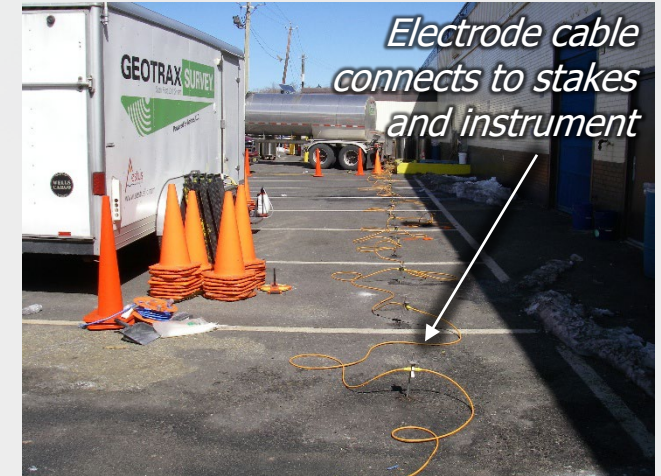
3-D Seismic North Sea
dgi.com

Field Deployment - Static Imaging

(single site characterization event, temporary installation)



- Must be in a straight line
- Line length=5x imaging depth
- In place for ~3 to 5 hours



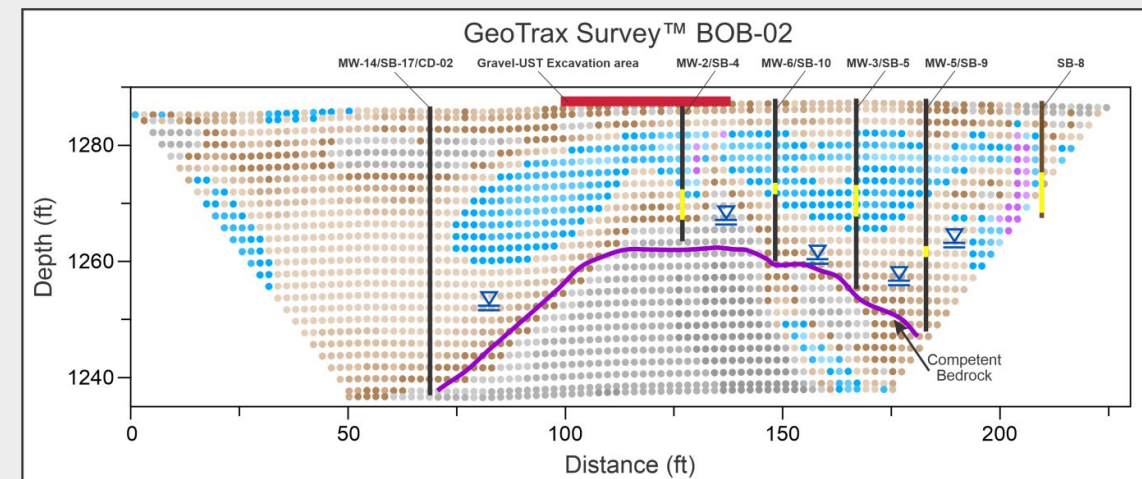
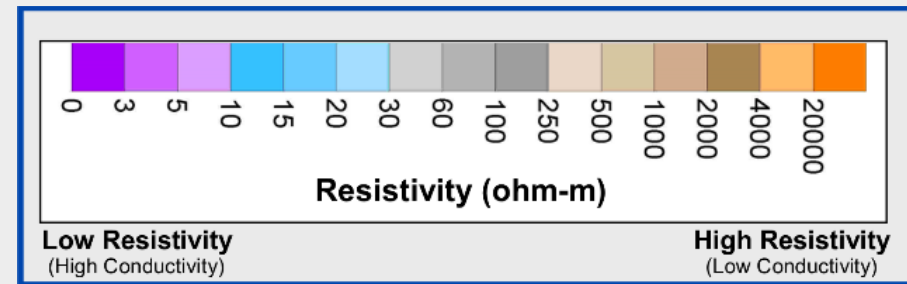
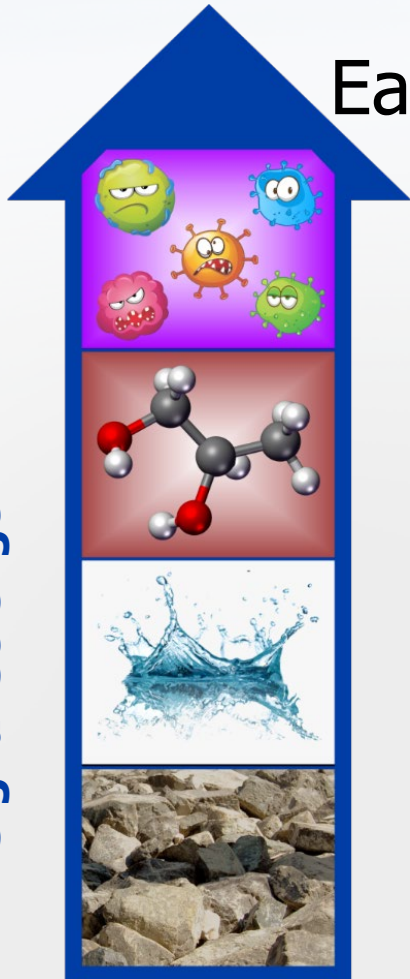
*Electrical current flows between electrode pairs
Results in a vertical 2D continuous electrical image of the subsurface*

What Do Electrical Images See?

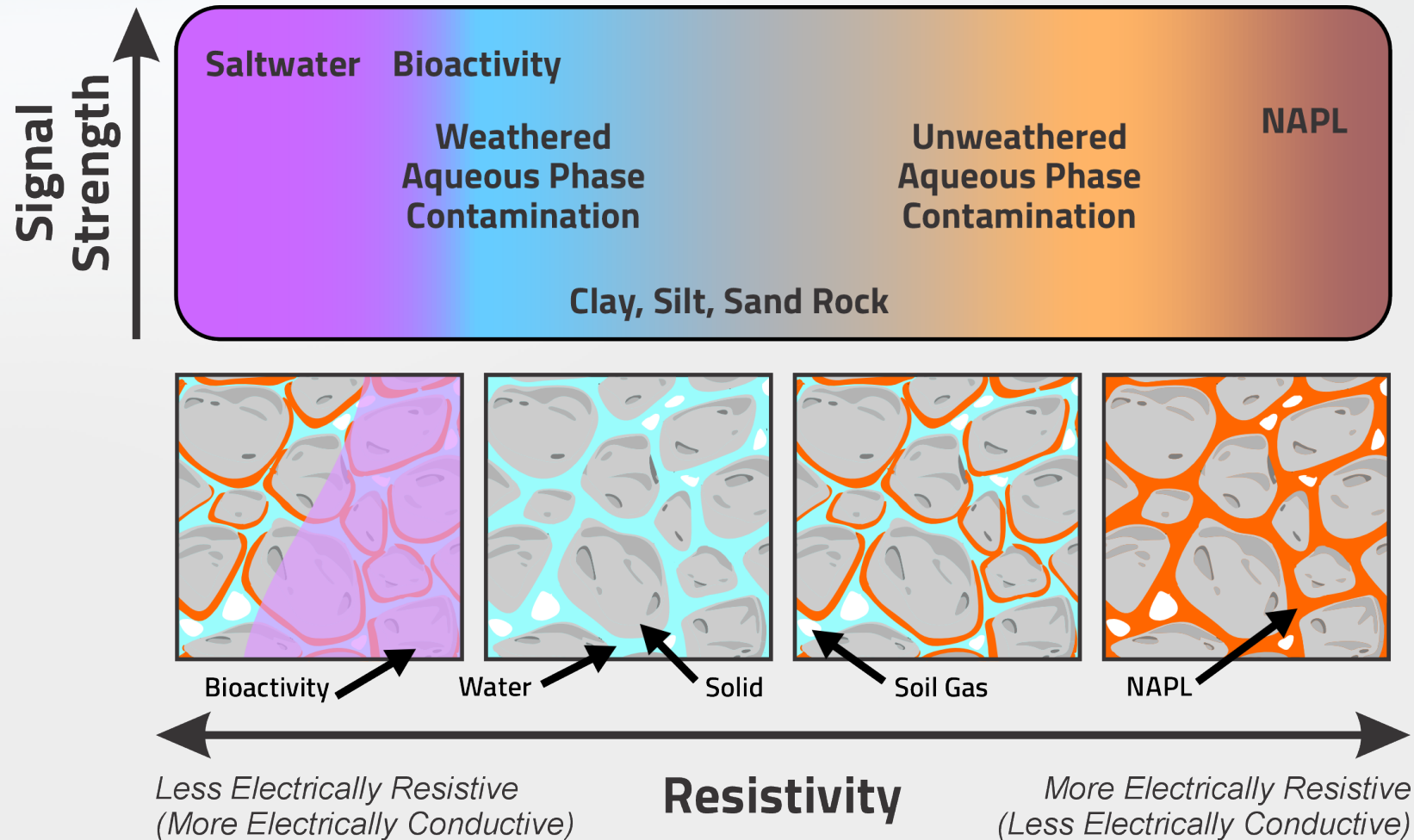
Each data point (pixel) equals the sum of:

1. Biological activity
2. Contamination/ Injectates/etc.
3. Groundwater/Fluids
4. Soil and rocks

Signal Strength



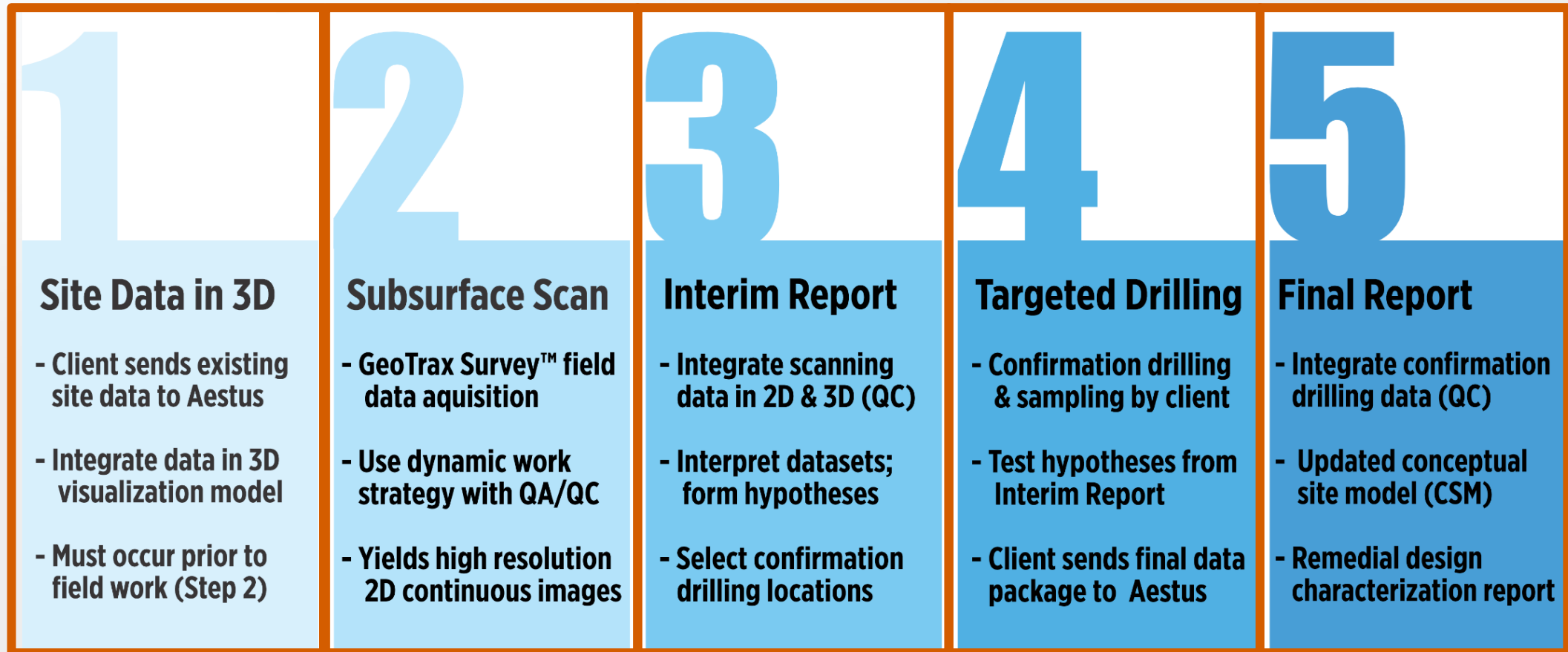
Typical Electrical Properties



After Mowder, 2019

Proven Electrical Hydrogeology™ Process

Remedial Design Characterization



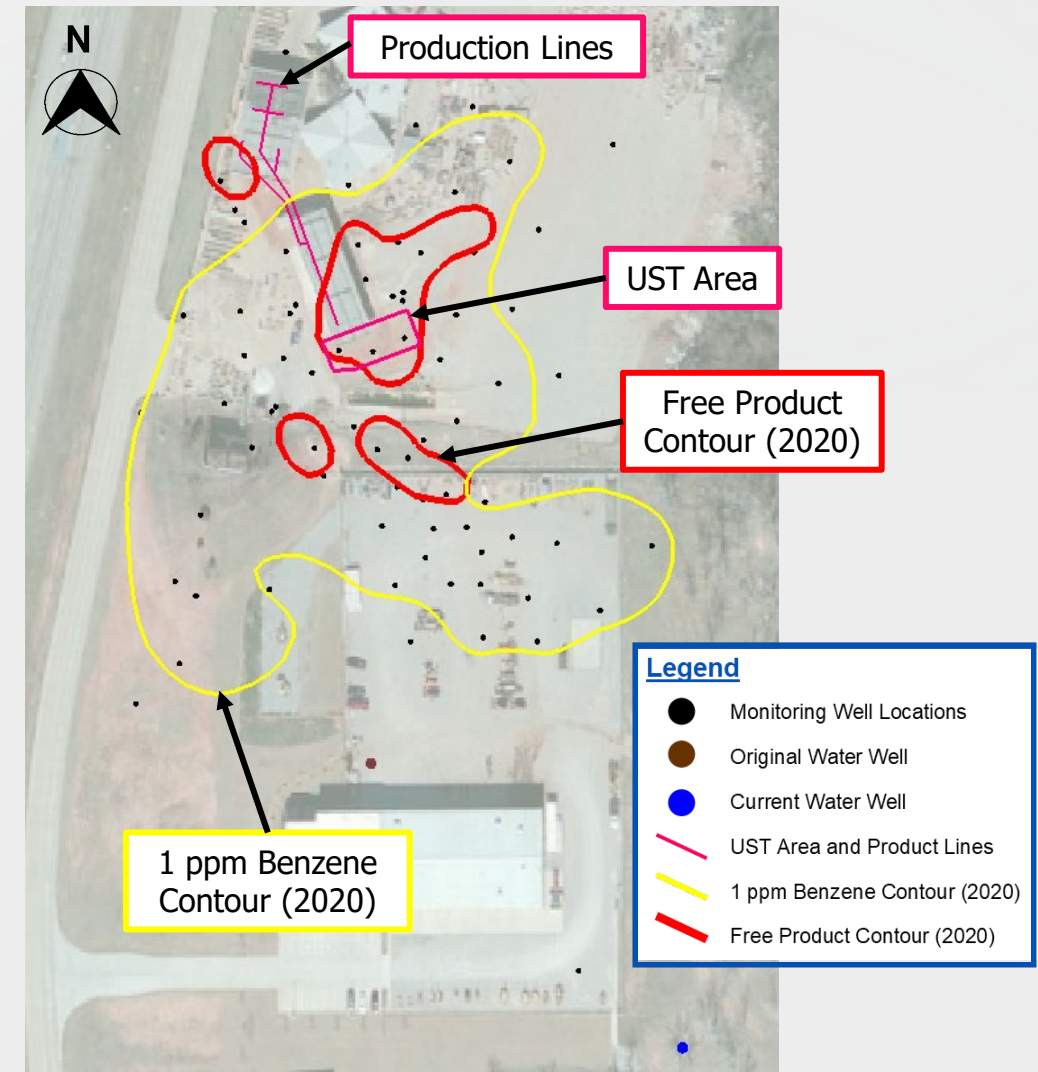
Case Study Overview

- Location: Oklahoma City, OK USA
- Geology:
 - Cross bedded, fine-grained sandstones with interbedded siltstones
 - Underlying fractured sandstone aquifer
- Source: LNAPL, dissolved benzene (former truck stop)
- Problem: preferential flowpaths controlling transport remain unknown

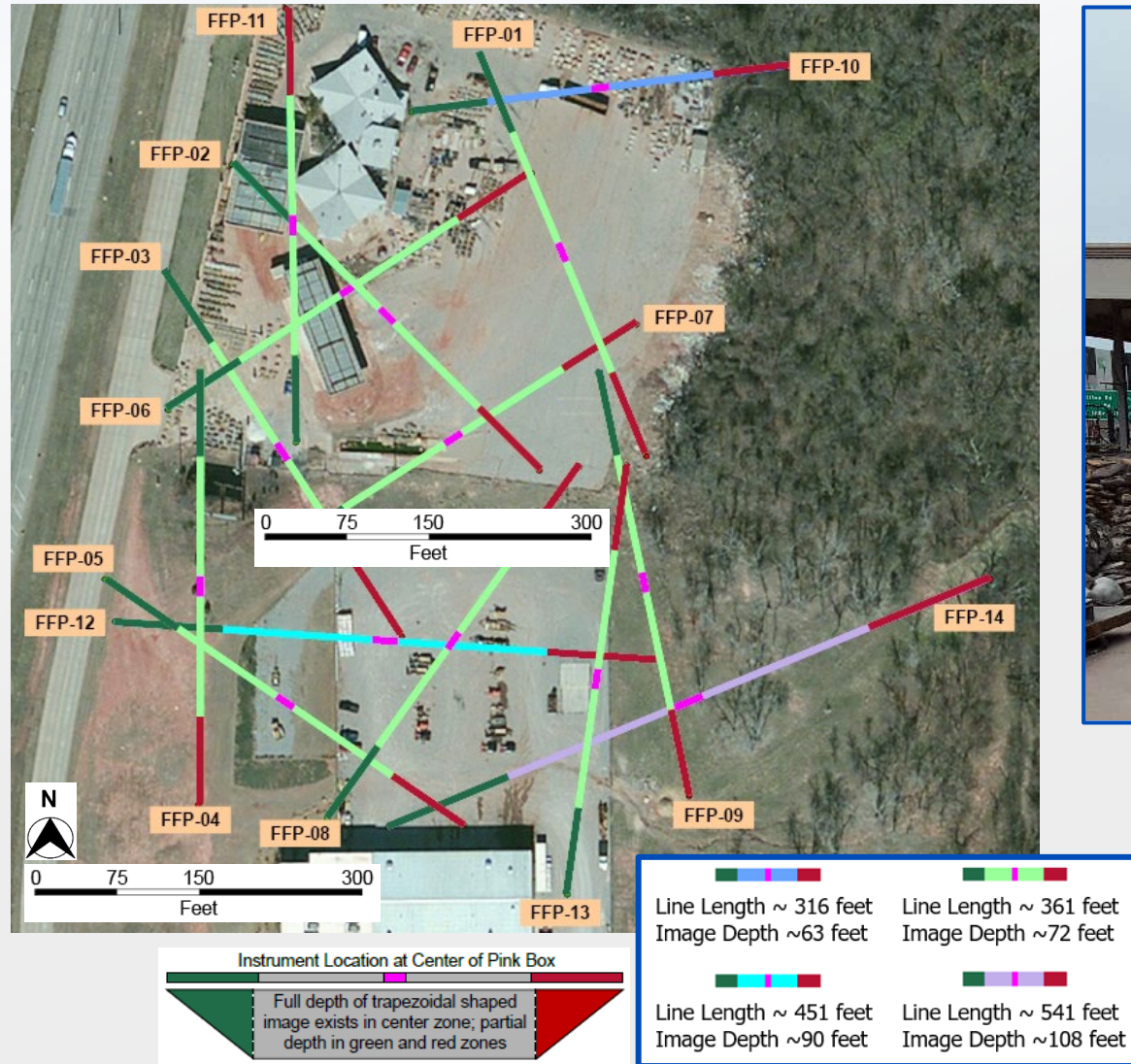


Site History

- Former truck stop with multiple recorded releases during the 1990s (up to ~2,100 gallons)
- Significant historical LNAPL plume (free product thickness ≥ 10 ft)
- Remediation strategies deployed between 2008 and 2017:
 - Free product recovery
 - Enhanced fluid recovery
 - Surfactant injections
- Free product in measurable amounts still present in 2020

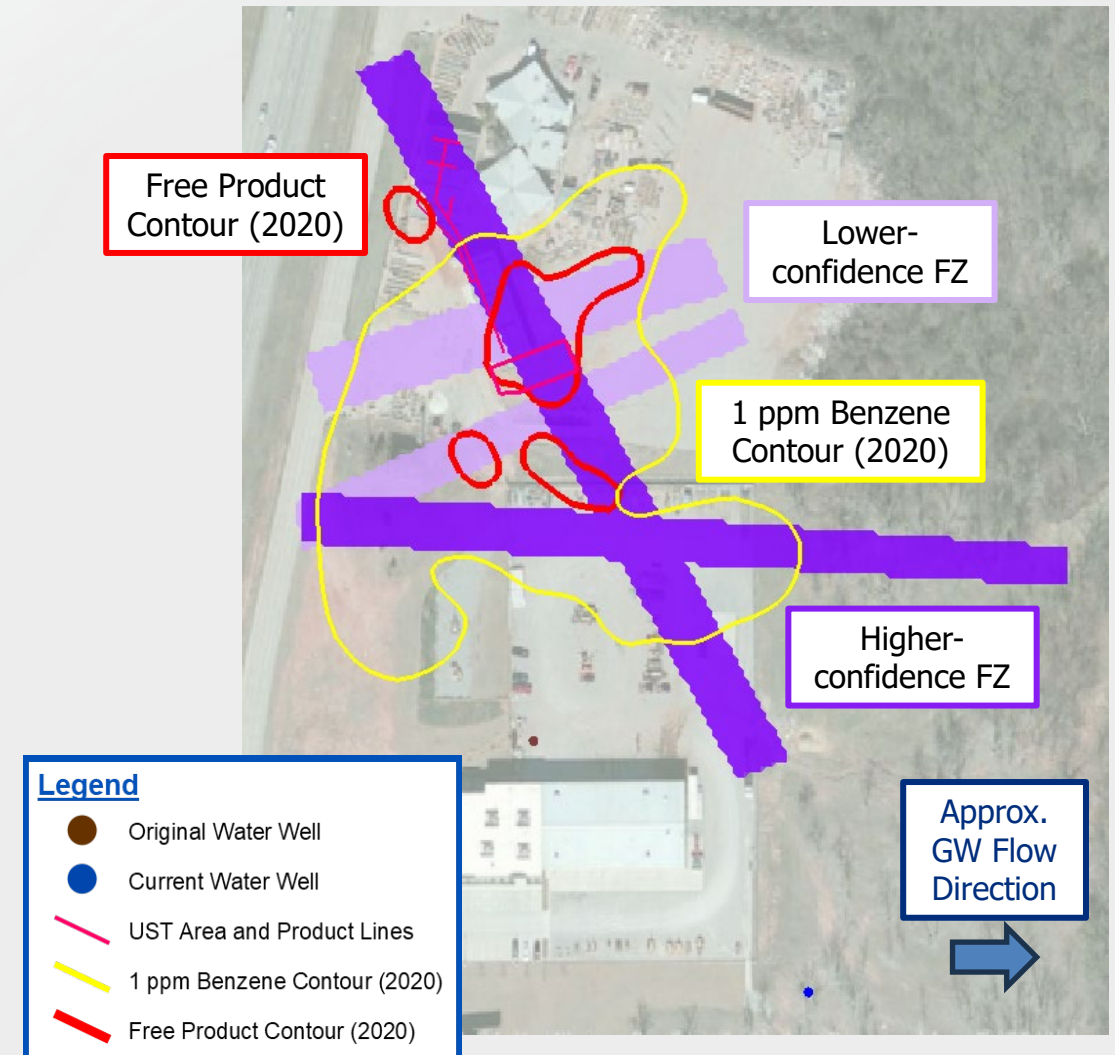


Site Logistics & GeoTrax Survey™ Work



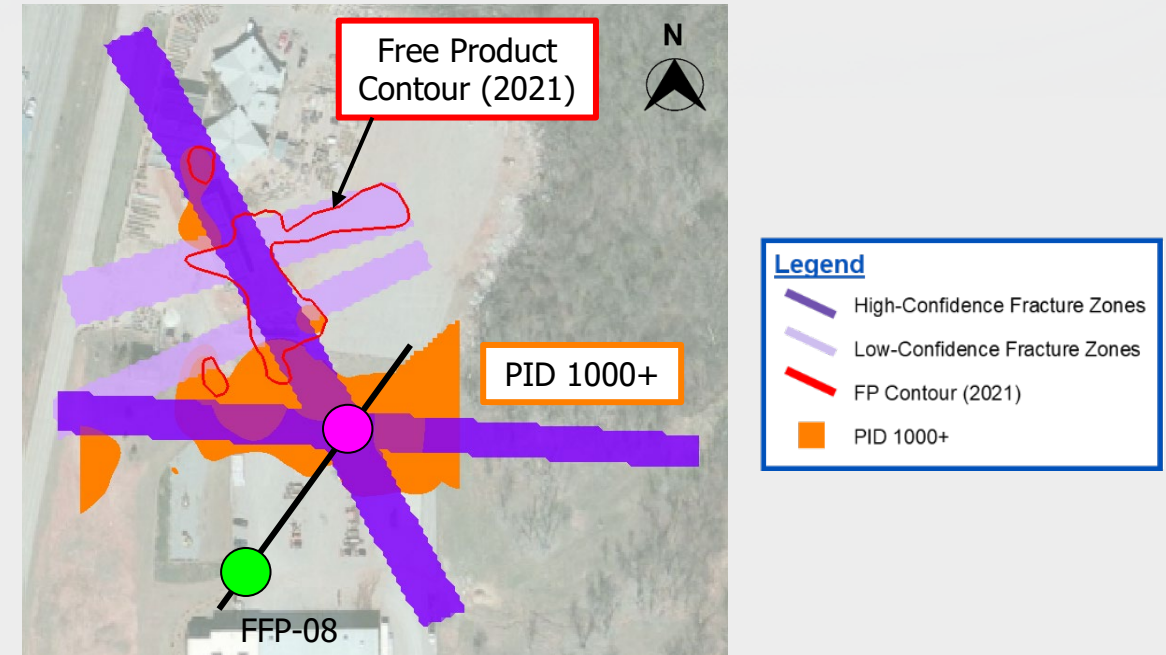
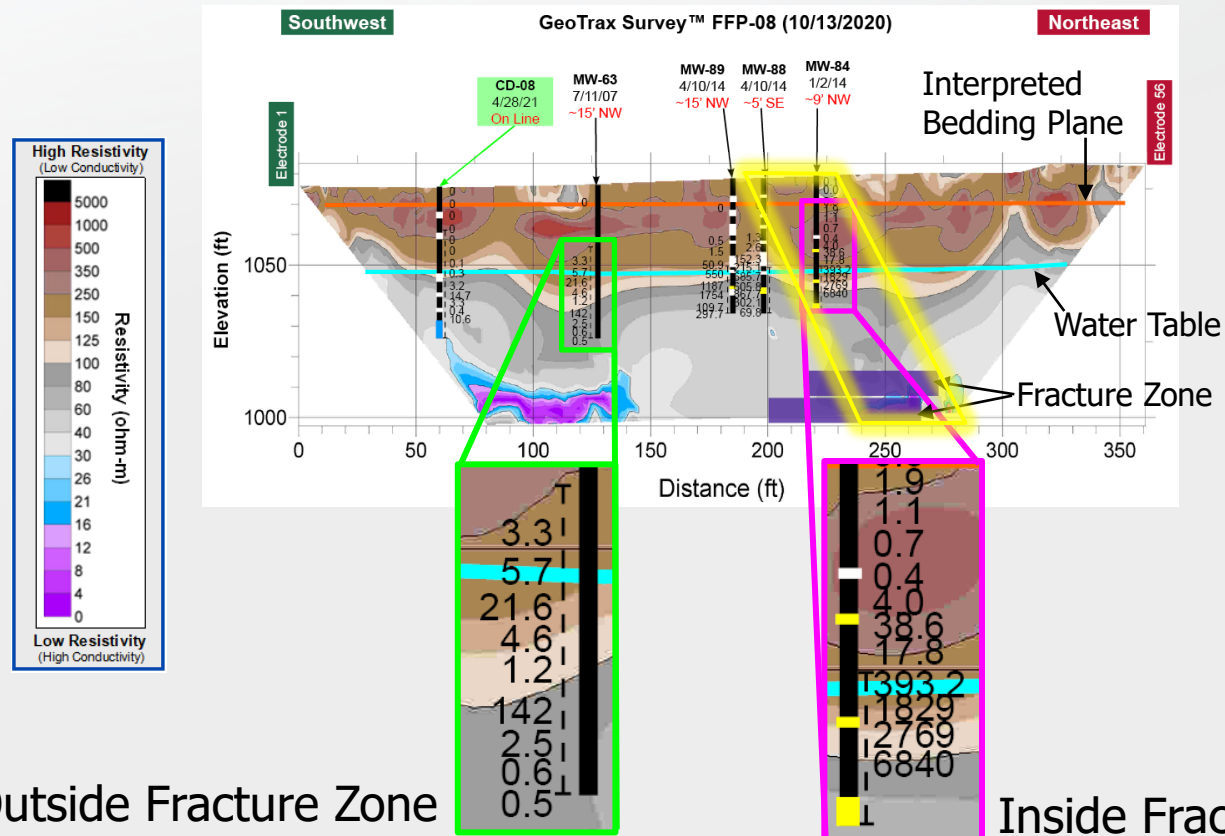
GeoTrax Survey™ Informed CSM Components

- Geology
 - 2 higher-confidence fracture zones (FZ)
 - 2 lower-confidence fracture zones
- Hydrogeology
 - GW flow on site is likely heavily influenced by fracture zones
- Contaminant
 - FP, highest PID values, and dissolved phase benzene plume closely follow fracture zones
- Bio
 - Biodegradation limited by lack of electron acceptors



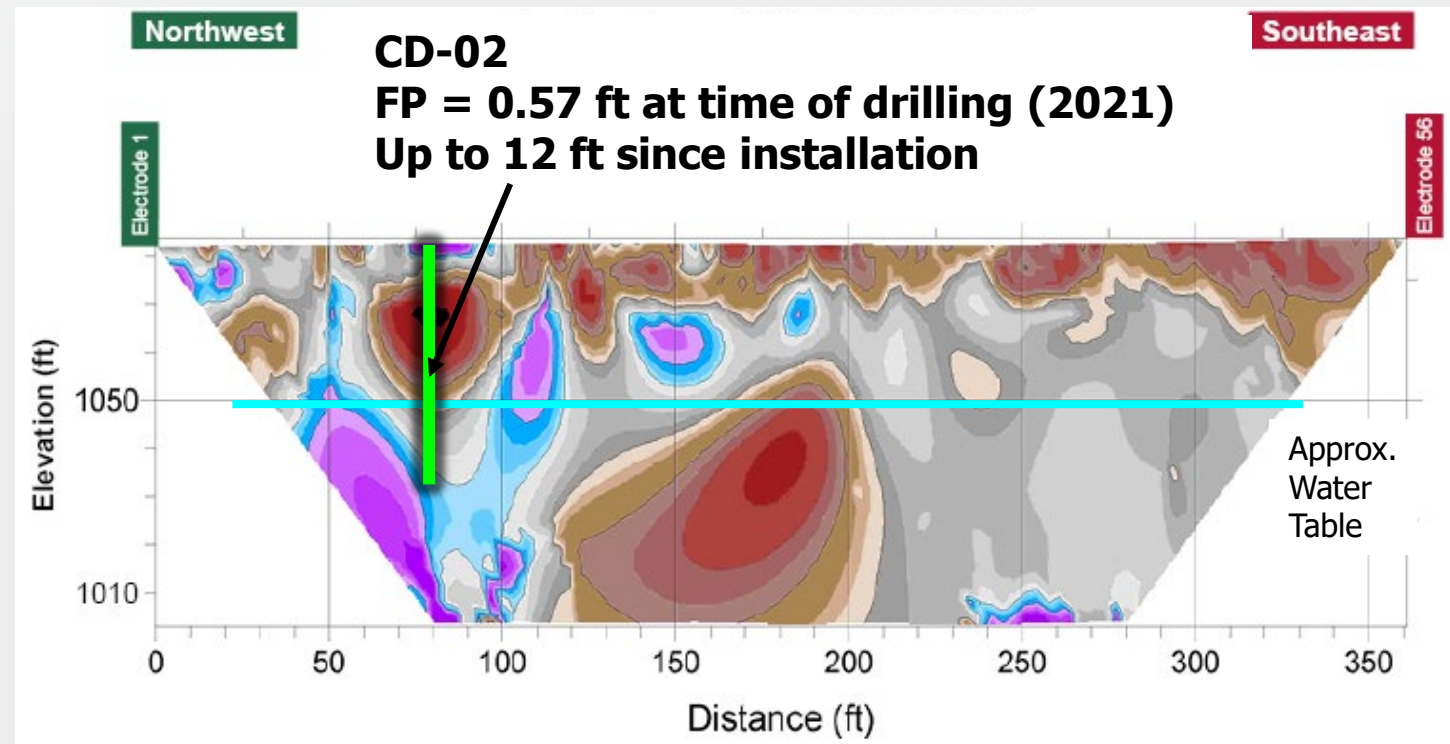
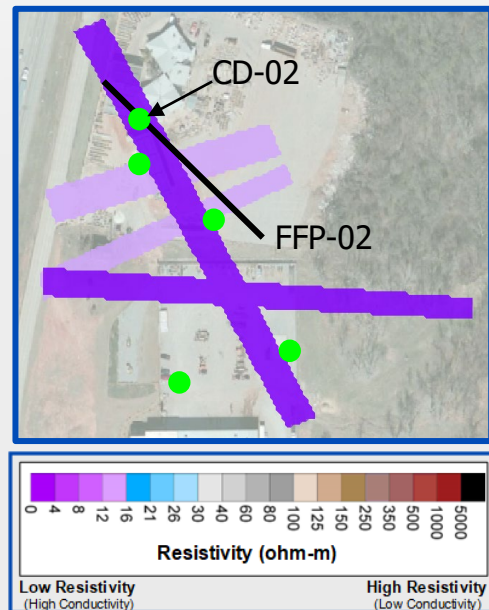
Horizontal and Vertical Contaminant Extents

- PID values higher in fracture zone than outside fracture zone
- Plumes and PID closely follow fracture zone orientation

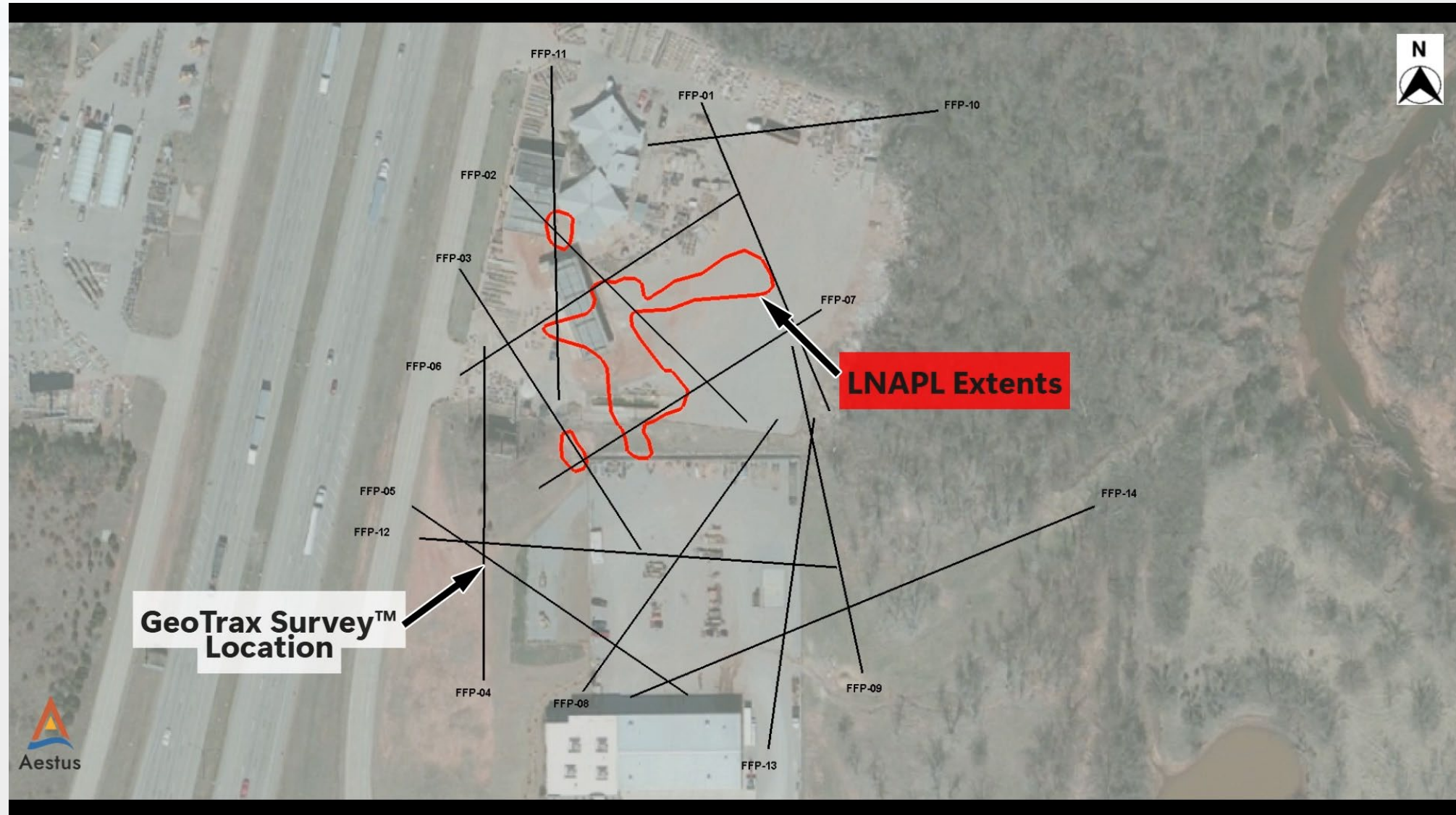


Confirmation Drilling Results

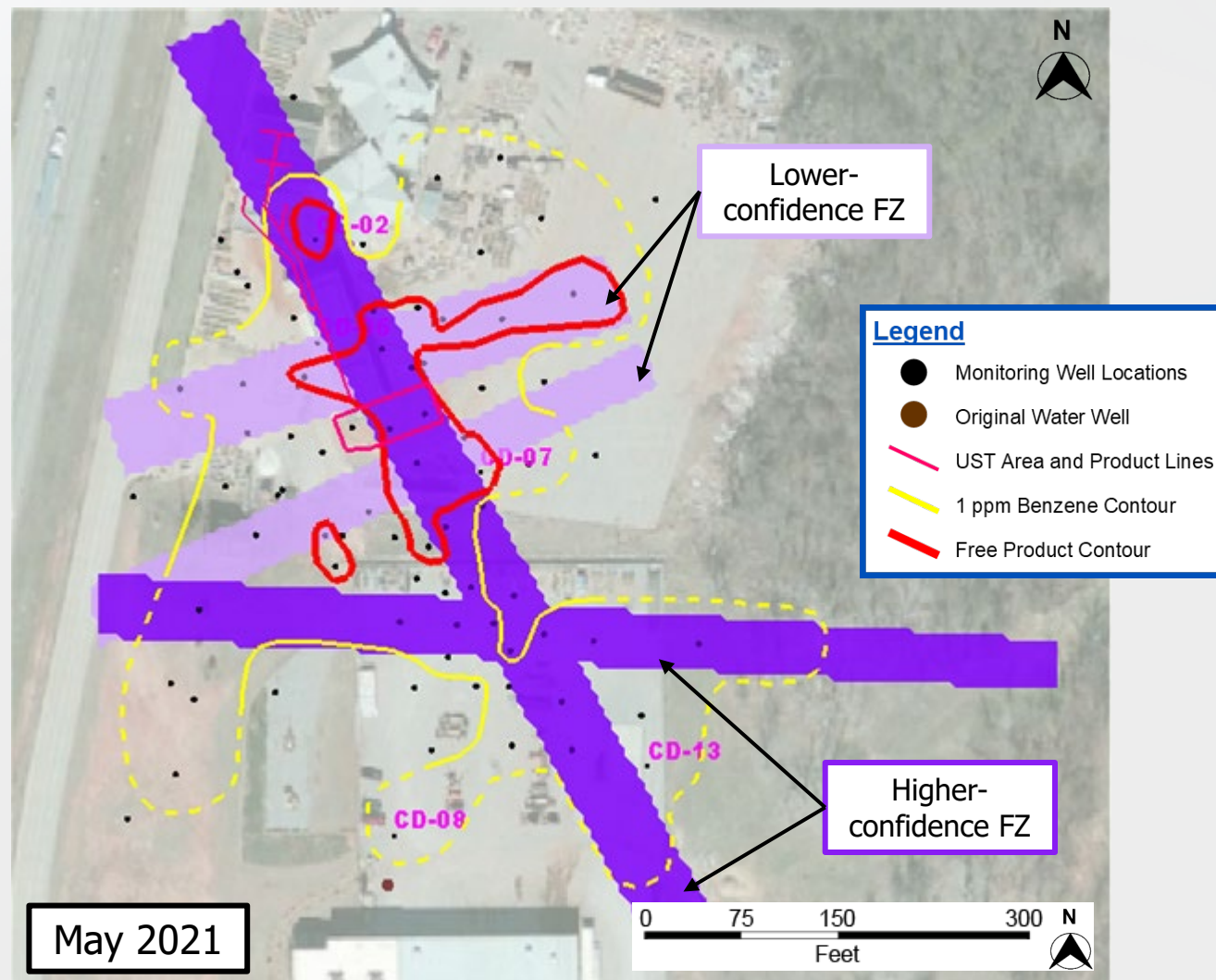
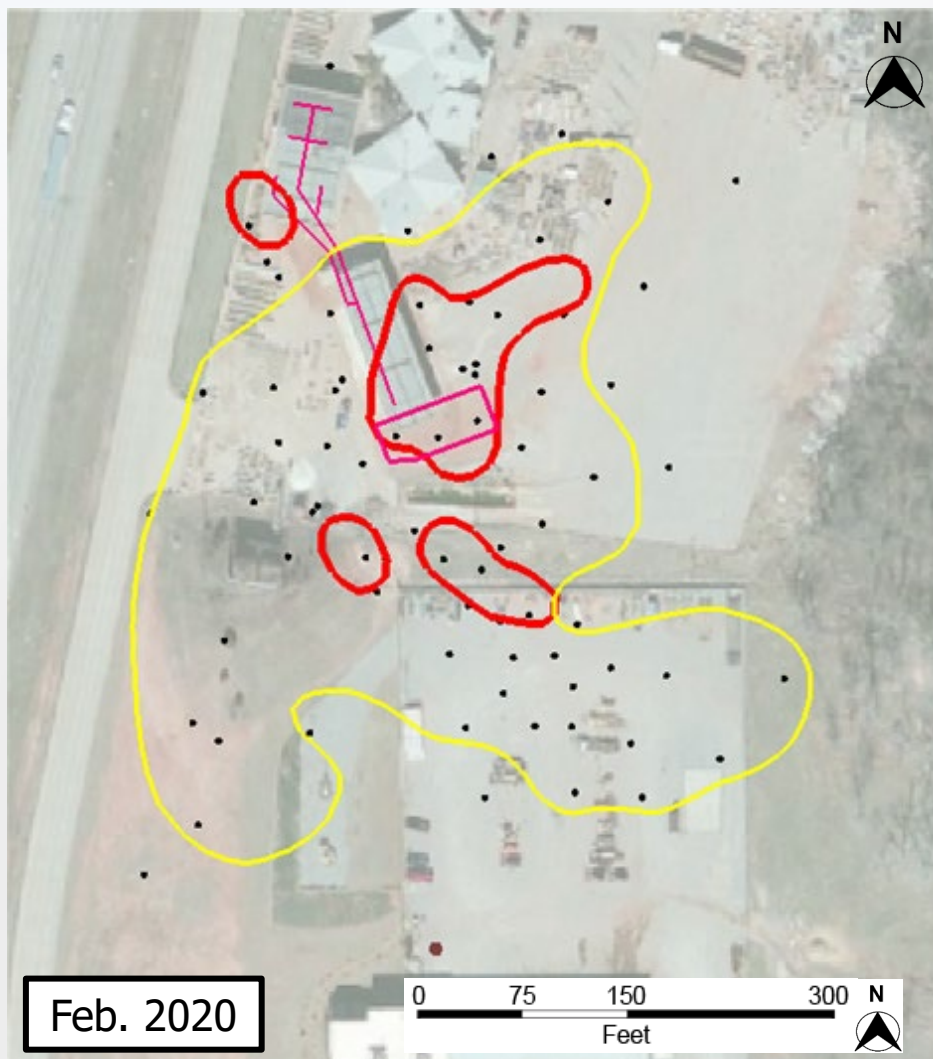
- 5 CDs targeted based on GeoTrax Survey™ data to investigate suspected fracture zones and inform contaminant extents
- 2 CD locations contained free product



Final CSM – Calibrated Data

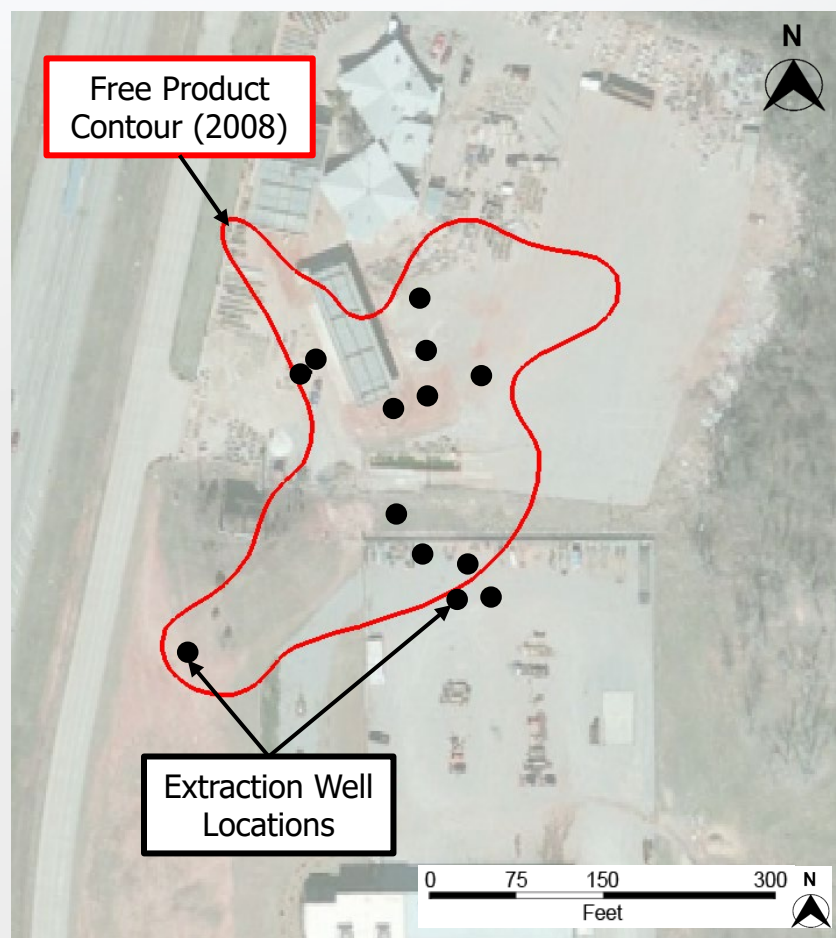


Final CSM Comparison

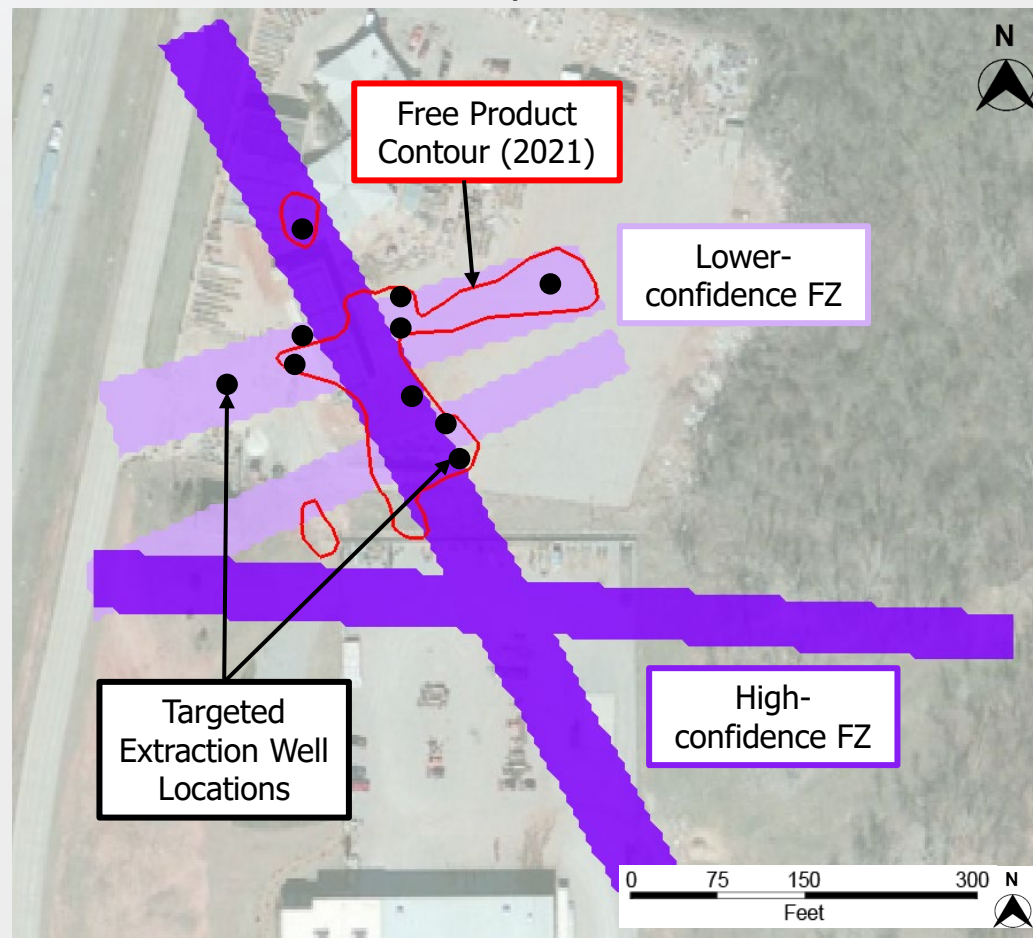


Remedial Design Characterization

2013 High Vacuum Extraction:
212 gallons FP from 13 extraction wells



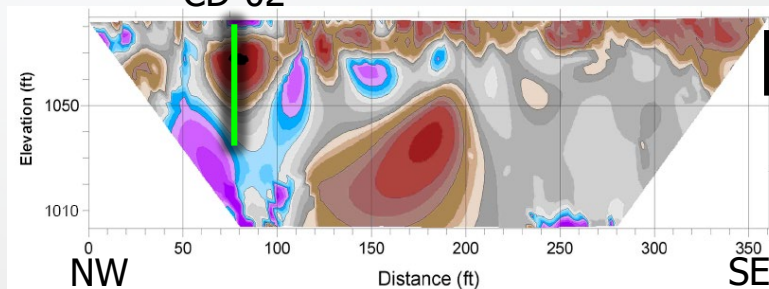
2024 Targeted High Vacuum Extraction:
152 gallons FP from 10 extraction wells
ROI of up to ~40 feet



Monitoring Site Conditions in Source Area with Temporal Data Sets

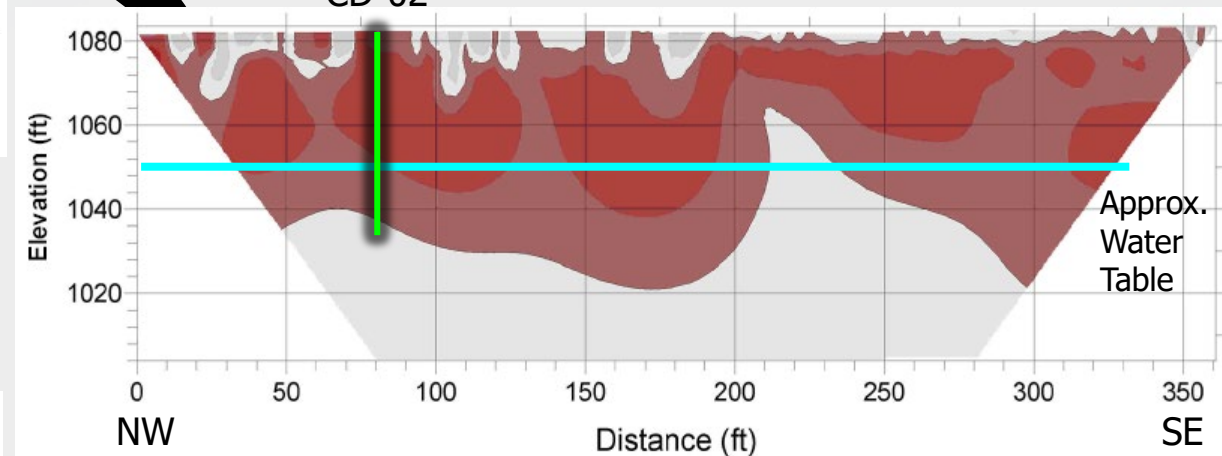
2020 GeoTrax Survey™ Static Image

CD-02



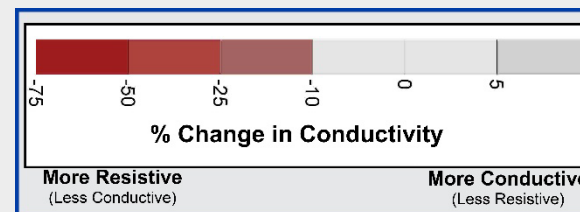
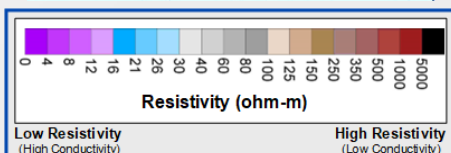
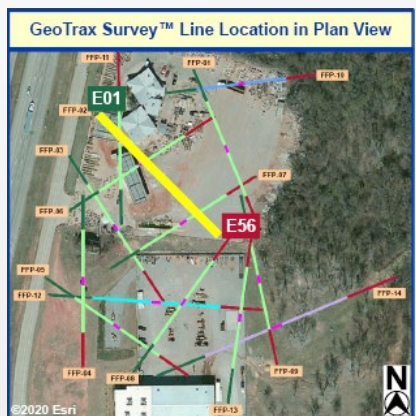
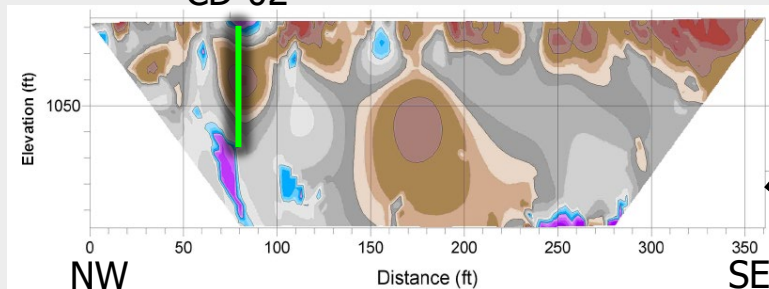
Temporal GeoTrax Monitoring™ Image
 $\Delta T = 5$ Years

CD-02



2025 GeoTrax Survey™ Static Image

CD-02



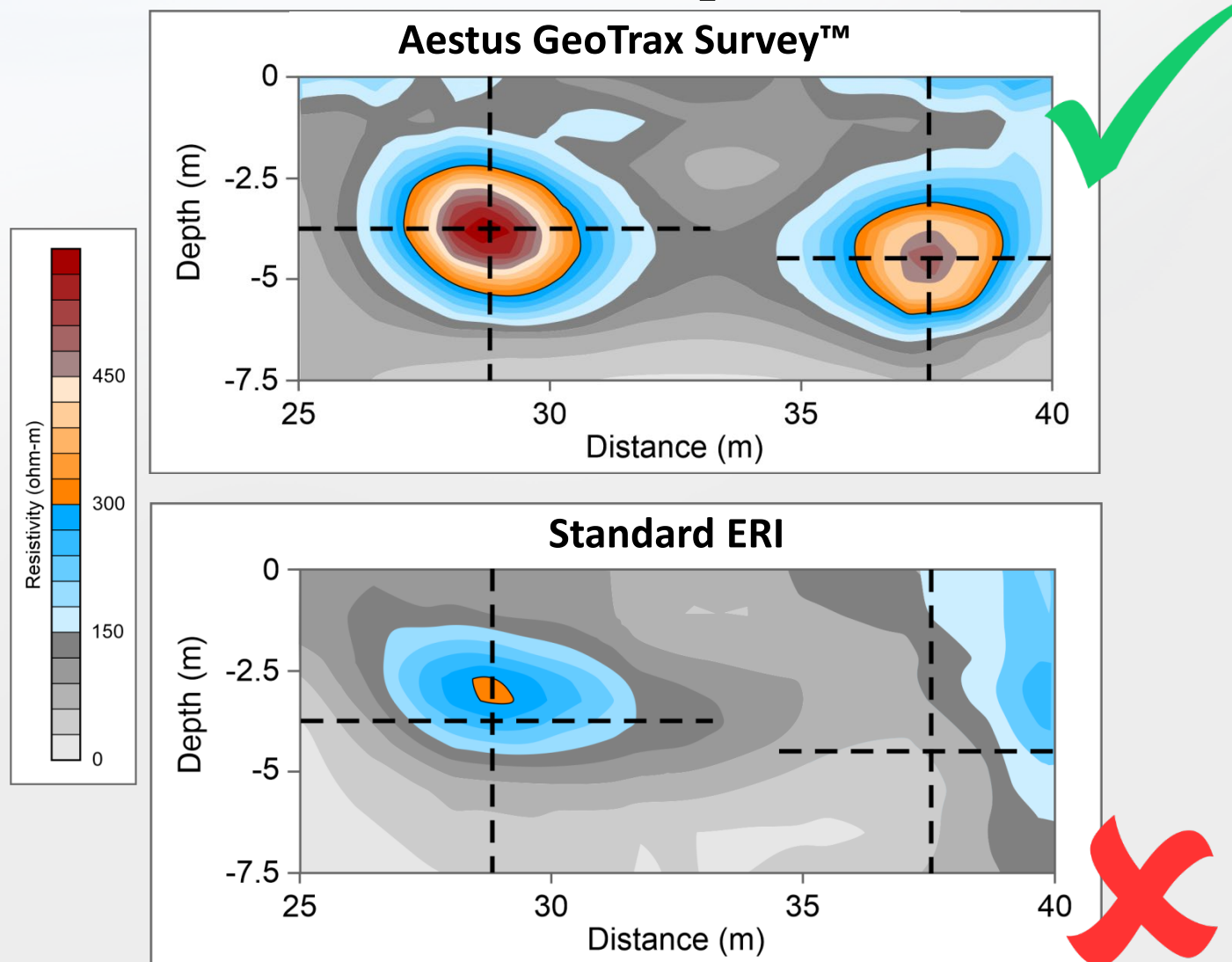
Project Summary: Client Feedback

“GeoTrax Survey™ electrical resistivity survey proved instrumental in understanding hydrocarbon migration patterns within our fractured aquifer system. Their expertise provided crucial insights that traditional methods simply couldn't deliver, allowing us to:

- ✓ **Accurately map the extent and movement of the hydrocarbon plume, even within the complex network of fractures.**
- ✓ **Identify the preferential pathways of migration, which was essential for targeting remediation efforts effectively.**
- ✓ **Make informed decisions about drilling and remediation strategies, saving us time and resources.”**

-Kathy Lippert, Greystone Environmental Services, Inc.

GeoTrax Survey™ vs Standard ERI



Drillable Image

- ✓ *Designed for Environmental Contaminants*
- ✓ *Higher Sensitivity*
- ✓ *Better Quality Image*
- ✓ *Strong QA/QC Protocols*
- ✓ *Confirmed by EPA Ada Lab*

from Halihan et al, 2005

Same equipment
Same transect line

GeoTrax Survey™ vs Standard ERI

- GeoTrax Survey™ designed to accurately see contaminants via higher sensitivity image
- “Drillable” datasets (discrete targets for drilling)

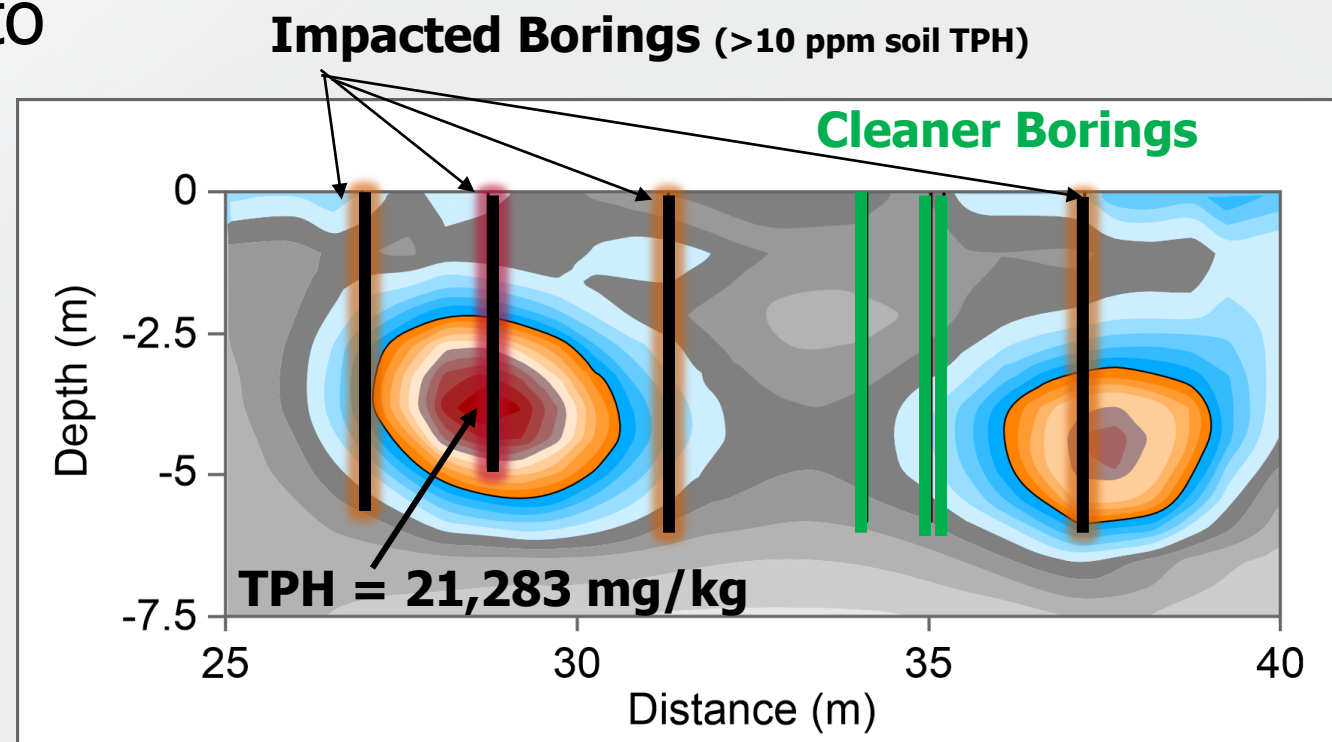
Post-remediation evaluation of a LNAPL site using electrical resistivity imaging

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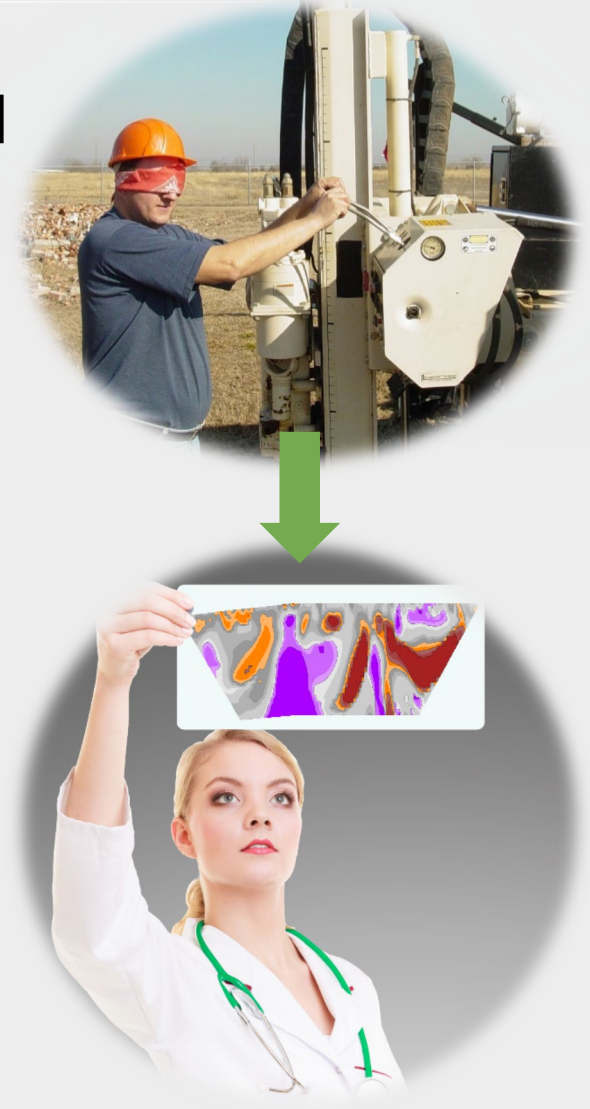
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Key Takeaways

- Electrical hydrogeology process can be successfully applied at any time in a project
- Following the 5-step process ensures
 1. All site data integrated in figures and robust 3D model
 2. High-resolution GeoTrax Survey™ images infill any existing data gaps
 3. CSM components informed: geology, hydrogeology, contaminant, bioactivity
 4. Targeted drilling locations in critical site locations
 5. Updated, data-dense CSM for future decision-making
- Electrical monitoring of sites provides greater certainty





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Better Data, Better Decisions

QUESTIONS?

Email [**Sales-Team@aestusllc.com**](mailto:Sales-Team@aestusllc.com)
with questions or applicability to specific site

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