2026 Chlorinated Conference
May 31-June 4, 2026 | Fort Worth, Texas
battelle.org/chlorcon | #Chlorinated2026
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Learning Lab
Wednesday, June 3, 2026

Using an Electrical Hydrogeology Process for Remedial Design Characterization at Chlorinated Solvent Sites

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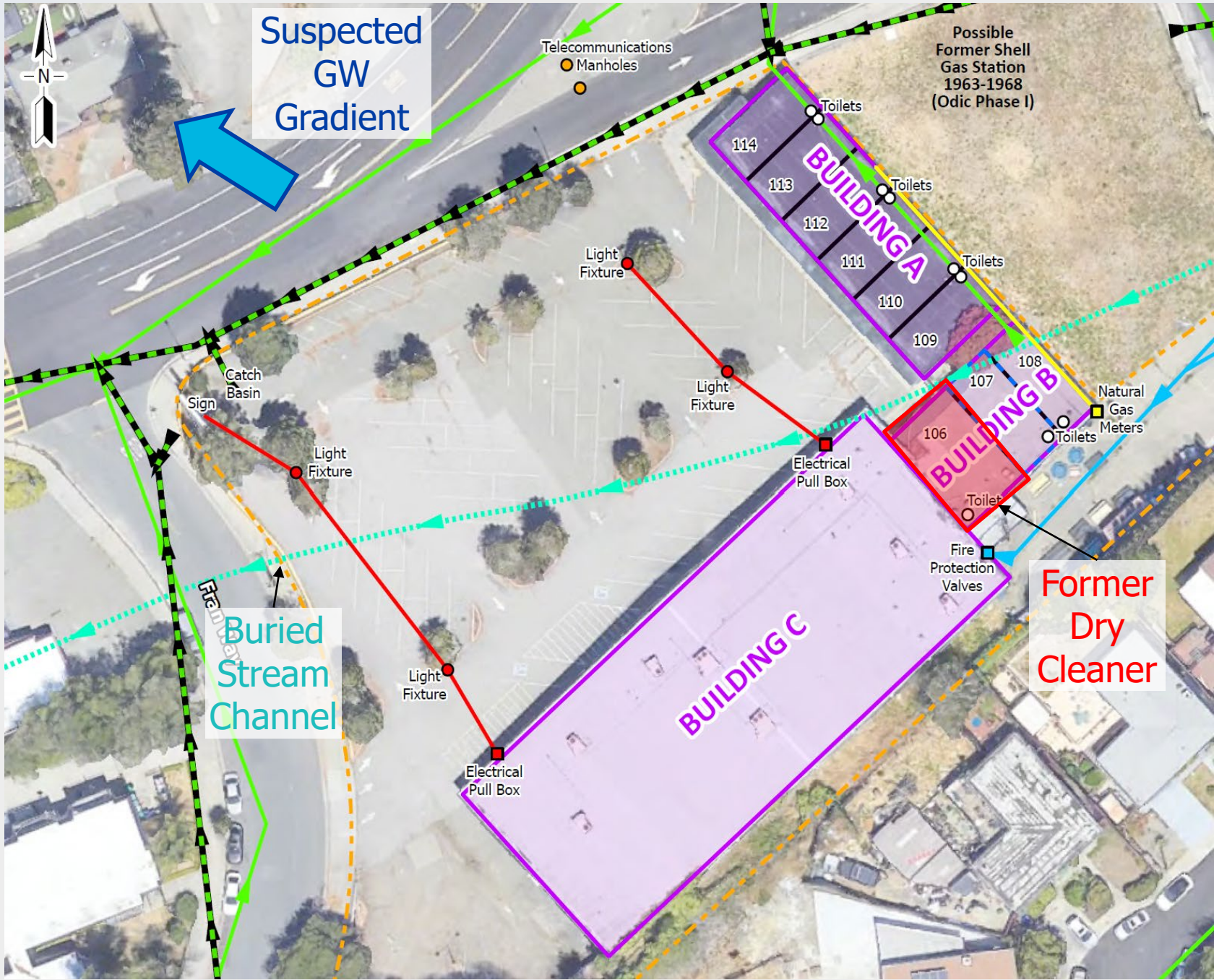
Please Complete the Activity (Predict the Plume) in Your folders as We Get Started!

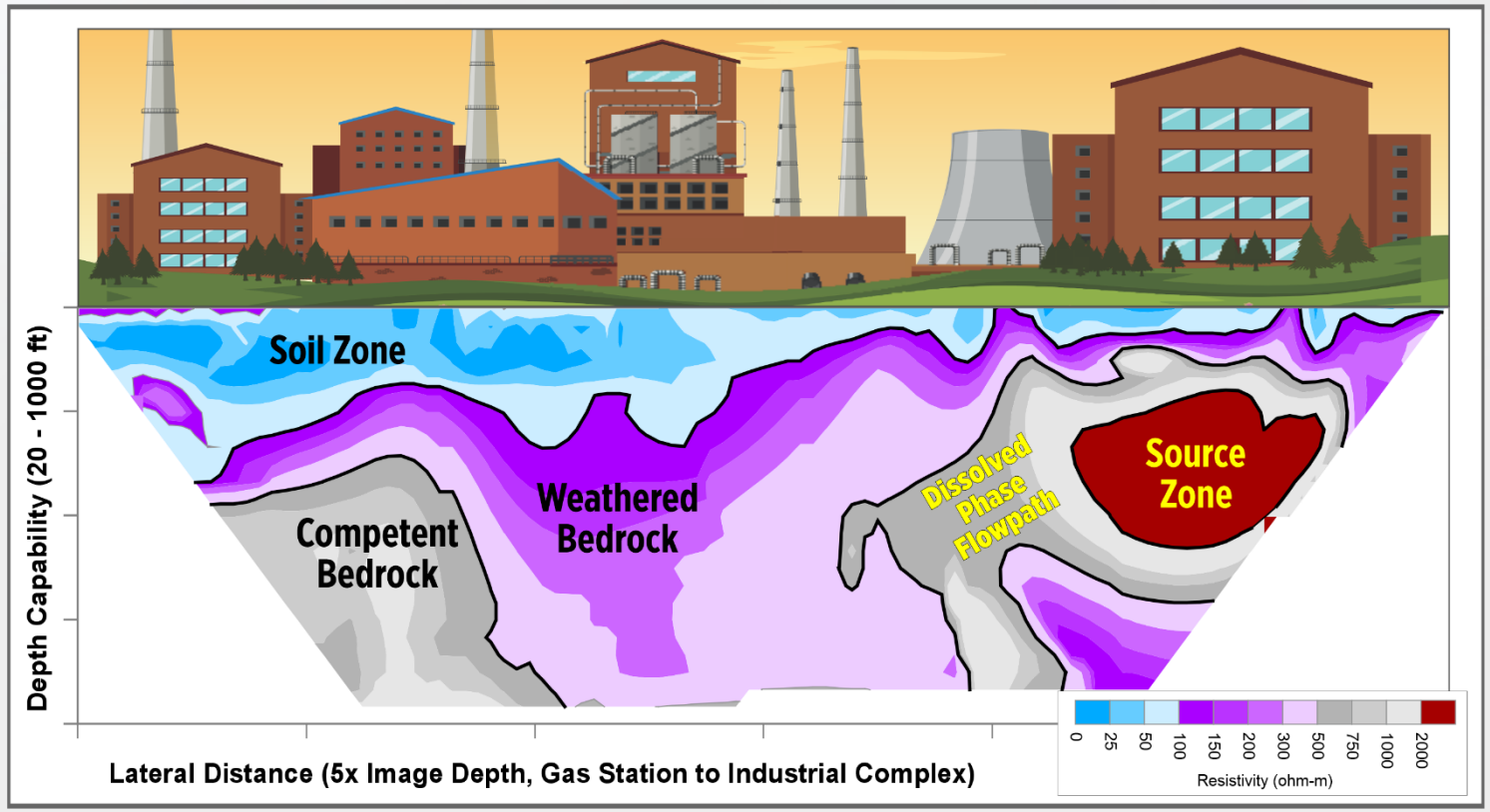
Activity

- Knowns:
  - Former dry cleaner
  - Former stream channel
  - Heterogeneous alluvial and lacustrine deposits in tectonically active area
  - Groundwater gradient suspected to W/NW
- Questions:
  - Where do you think the plume is?
  - Where do you think it's definitely not?



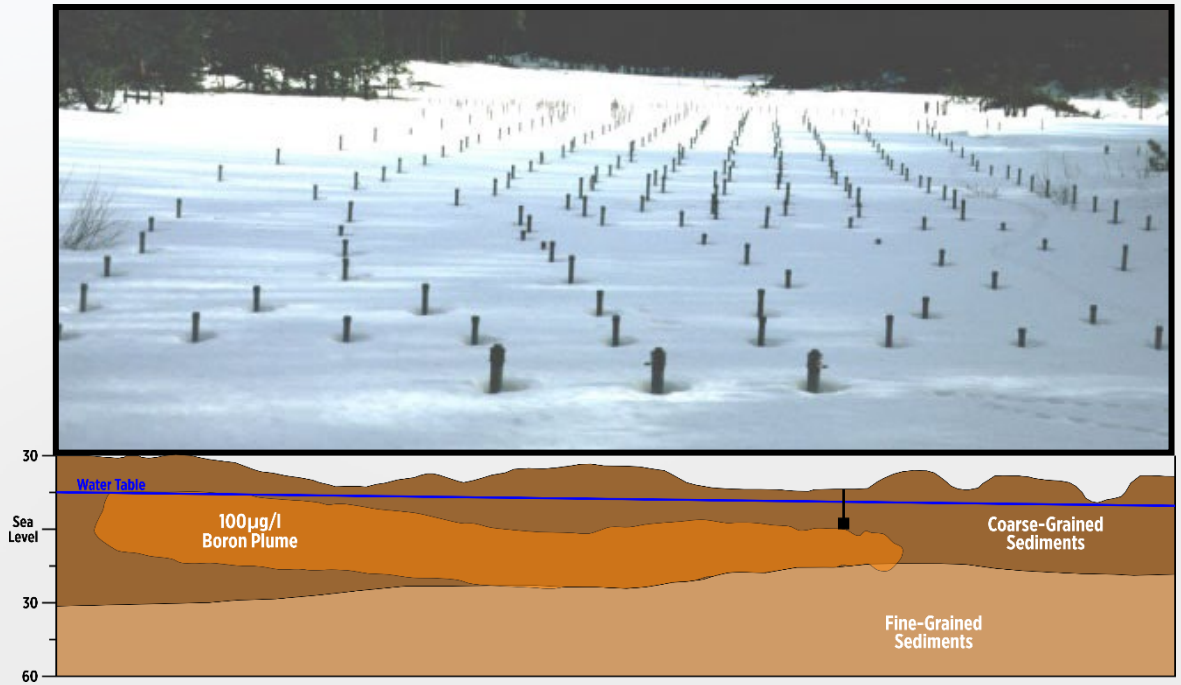
Learning Lab Objective: How and Why You Use Electrical Hydrogeology

1. Is Your MW Helping or Hurting Your CSM?
2. Drilling vs Scanning
3. Electrical Hydrogeology Principles & Applications
4. The GeoTrax Survey™ Difference
5. Closing Remarks
6. Q&A



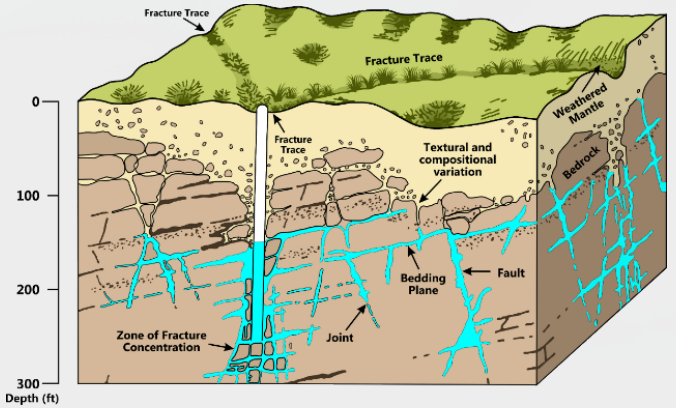
Ultra-HRSC – Continuous vertical images of subsurface

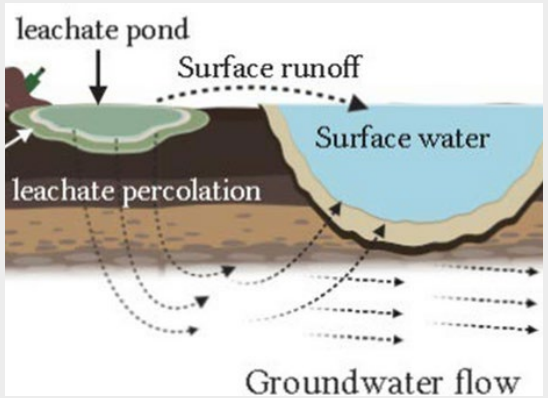
Can Wells Tell Us Enough?



Images after Cape Cod (LeBlanc et al. 1991); Borden (Sudicky et al. 1983)

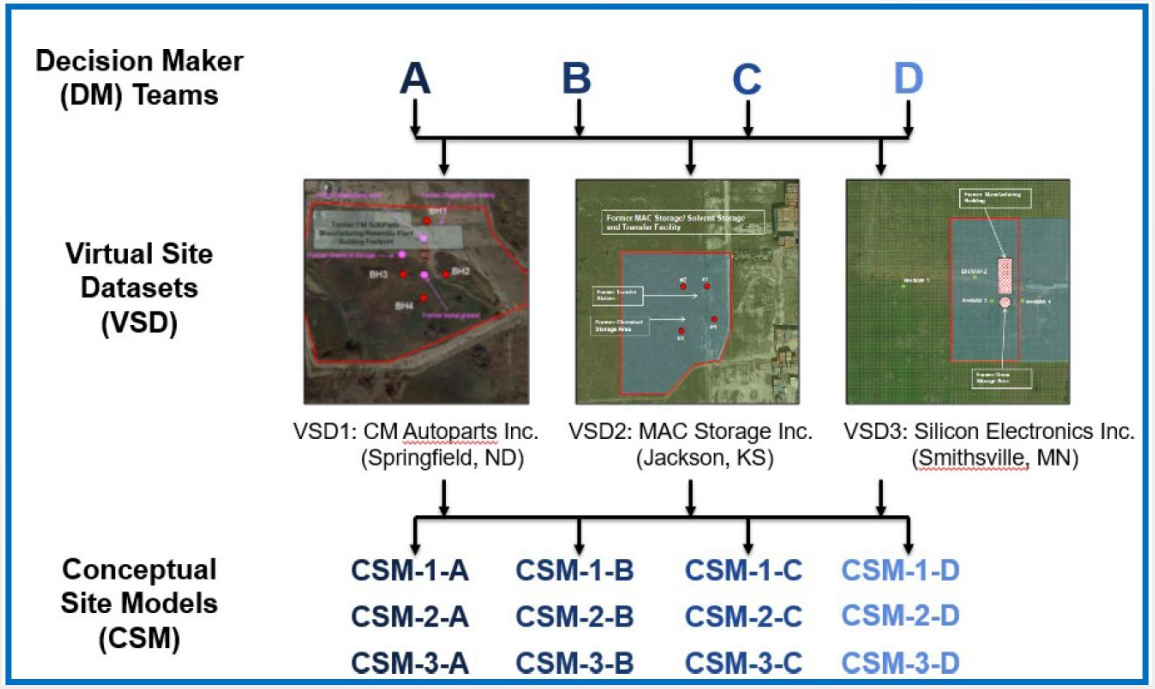
~10,000 wells to "see" this!





How many wells to "see" this?!

Research Says…



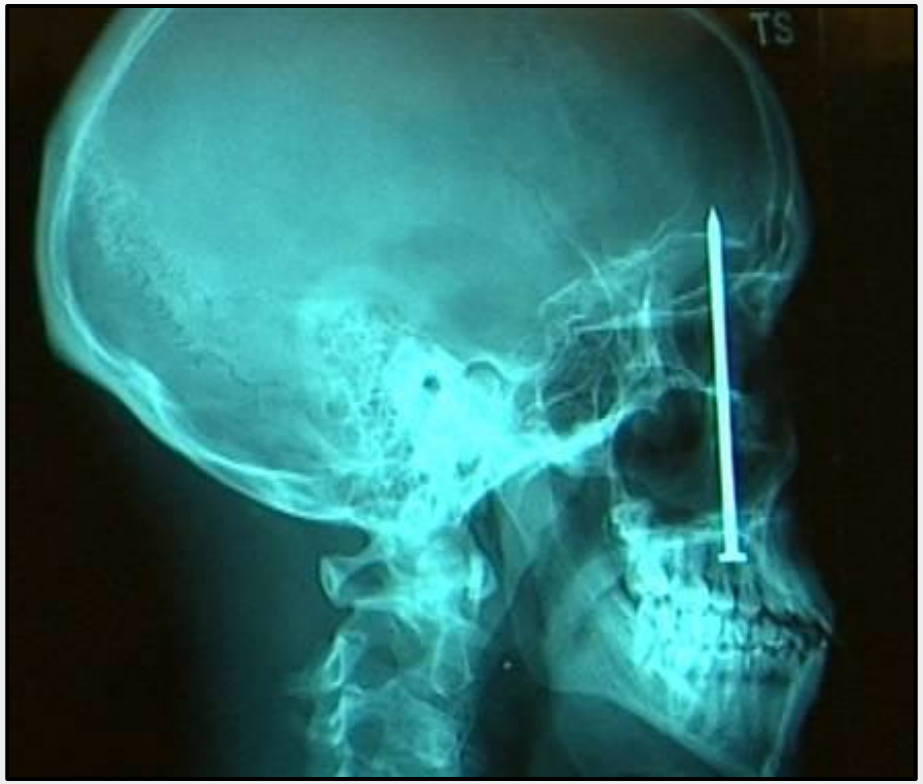
Study completed by the Department of Defense (DoD) Strategic Environmental Research and Development Program (SERDP).

- When only utilizing vertical tools (e.g., monitoring wells and/or MIP/HPT) to investigate a DNAPL site:
  - **0% achieved success at reasonable cost**
  - 75% didn't achieve success
  - **0% had high accuracy for all CSM metrics**
- The most common pitfalls of accurate CSM development are:
  - Underestimating subsurface heterogeneity
  - Insufficient density of subsurface data
  - Poor interpretation of the data

SERDP - Kavanaugh, M., et al, 2022

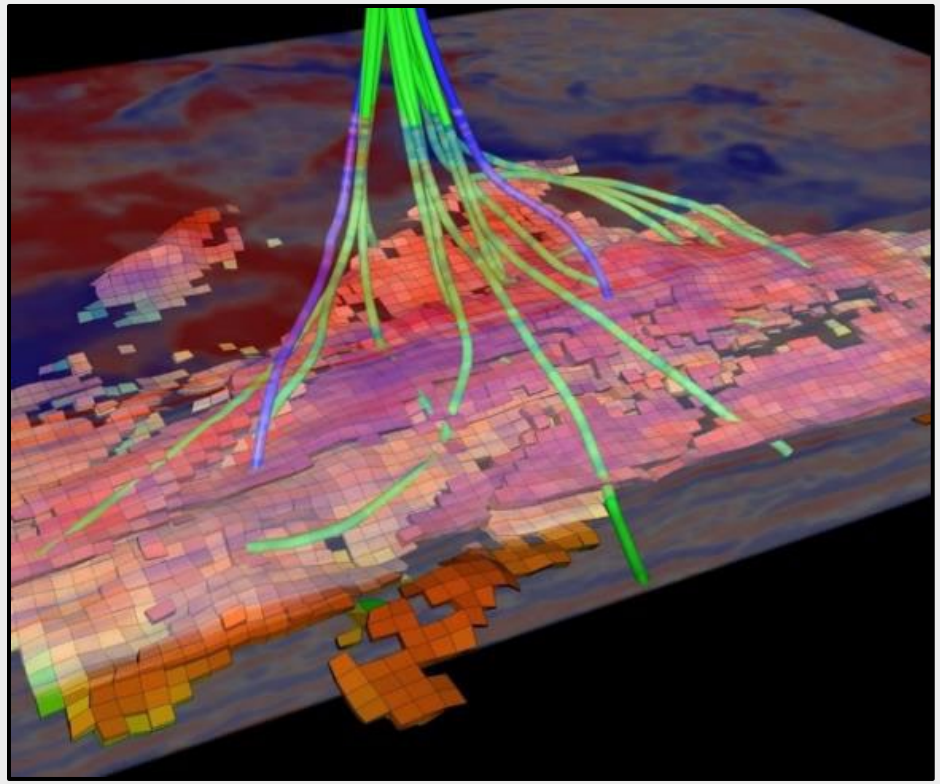
Scan then Target Approach: Aligning with Other Industries

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

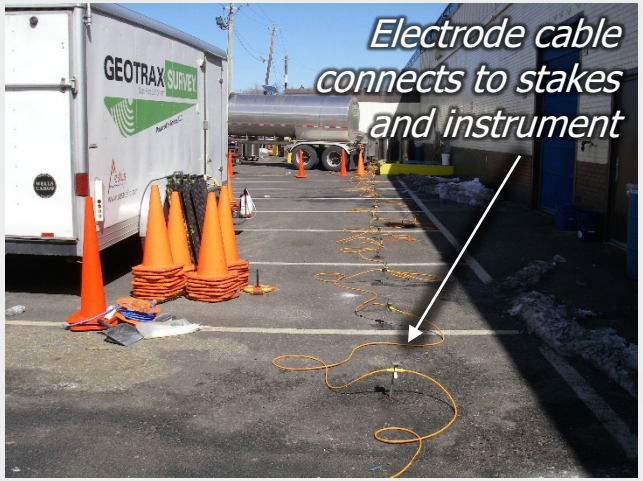
Scanning in the Environmental Industry

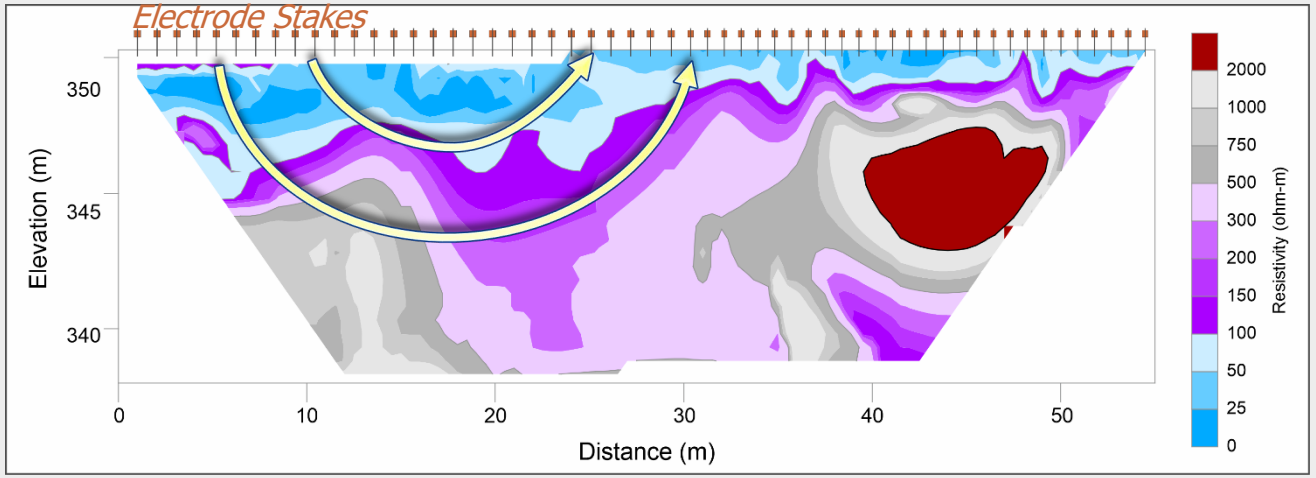
Video found at https://www.youtube.com/watch?v=3WF4LcnBwNQ

Field Deployment - Static Imaging

(single site characterization event, temporary installation)

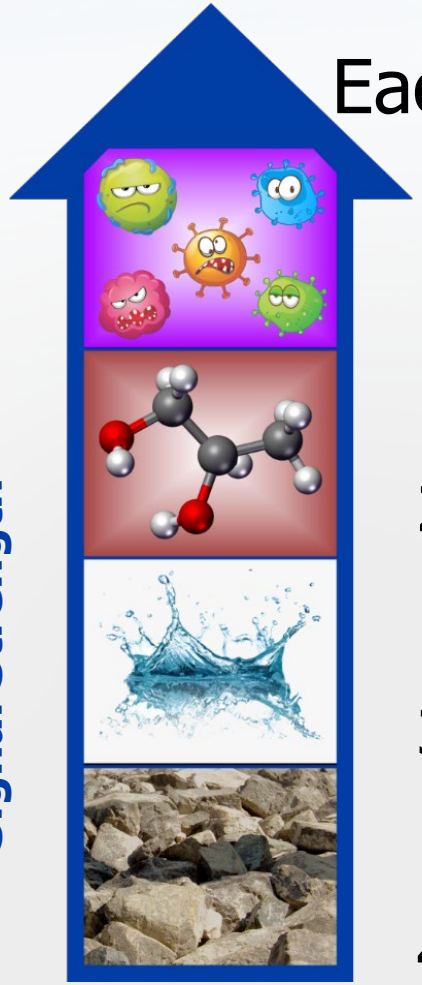
- Must be in a straight line
- Line length=5x imaging depth
- In place for ~3 to 5 hours





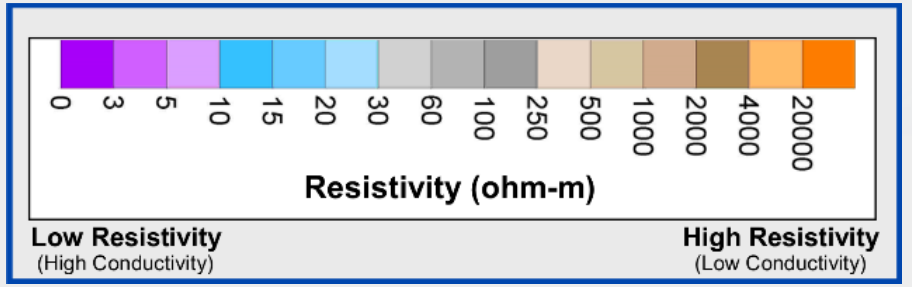
Electrical current flows between electrode pairs
Results in a vertical 2D continuous electrical image of the subsurface

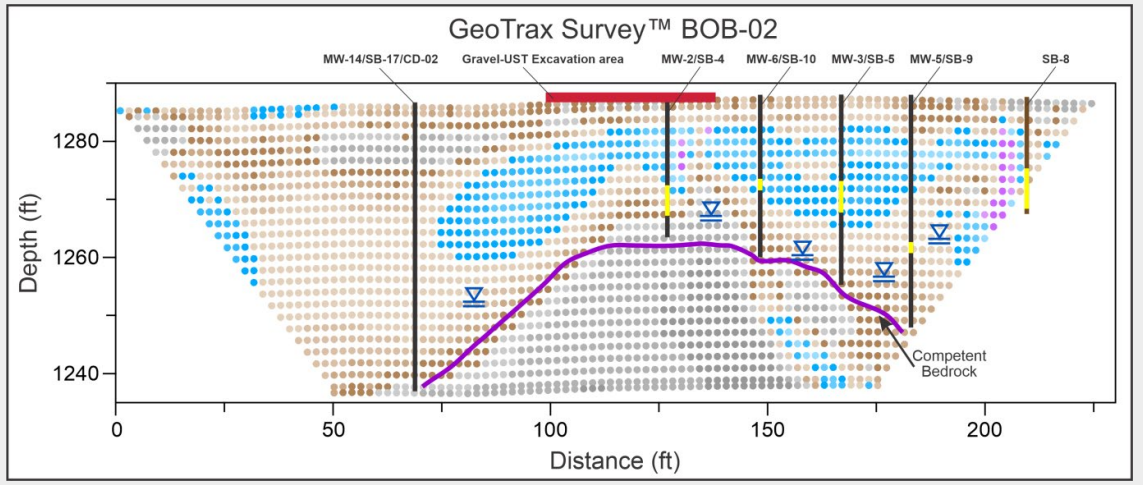
What Do Electrical Images See?



Each data point (pixel) equals the sum of:

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





Electrical Hydrogeology:
Leveraging Integrated Data Sets

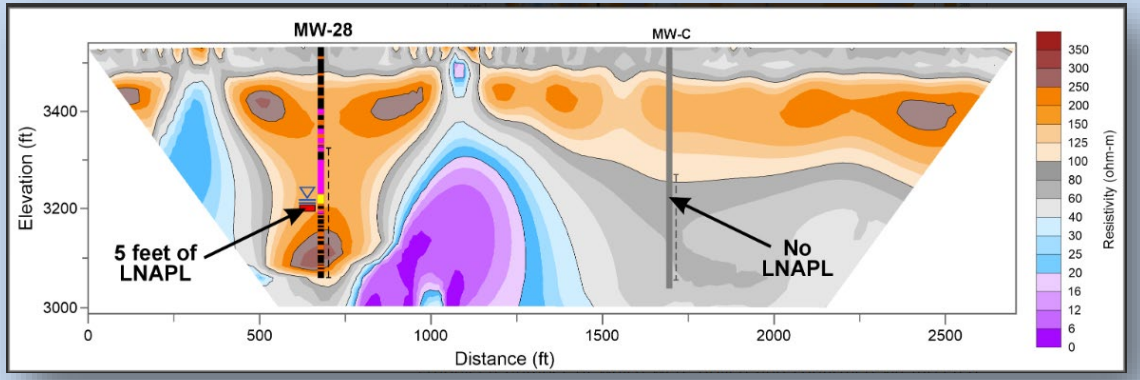
Electrical Hydrogeology =

Traditional Hydrogeology

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

+

Electrical Imagery/Targeted Drilling



Electrical Hydrogeology Process
Remedial Design Characterization

1 — Visualize Existing Site Data in 3D

- Client sends existing site data to Aestus
- Must occur prior to field work (Step 2)

2 — Ultra-High Resolution Electrical Scan

- Field Acquisition: *GeoTrax Survey*™ 2D Imagery
- Use dynamic work strategy with QA/QC

3 — Interim Report (w/Hypotheses)

- Integrate/QC data sets in 2D&3D (*GeoTrax Viz*™)
- Select confirmation drilling (biopsy) locations with client

4 — Confirmation Drilling (by Client)

- Targeted drilling & sampling; test CSM hypotheses
- Client sends final confirmation drilling data to Aestus

5 — Final CSM+ Report

- Integrate confirmation data (*GeoTrax Viz*™)
- Finalize GeoTrax CSM+™

Activity

- Knowns:
  - Former dry cleaner
  - Former stream channel
  - Heterogeneous alluvial and lacustrine deposits in tectonically active area
  - Groundwater gradient suspected to W/NW
- Questions:
  - Where do you think the plume is?
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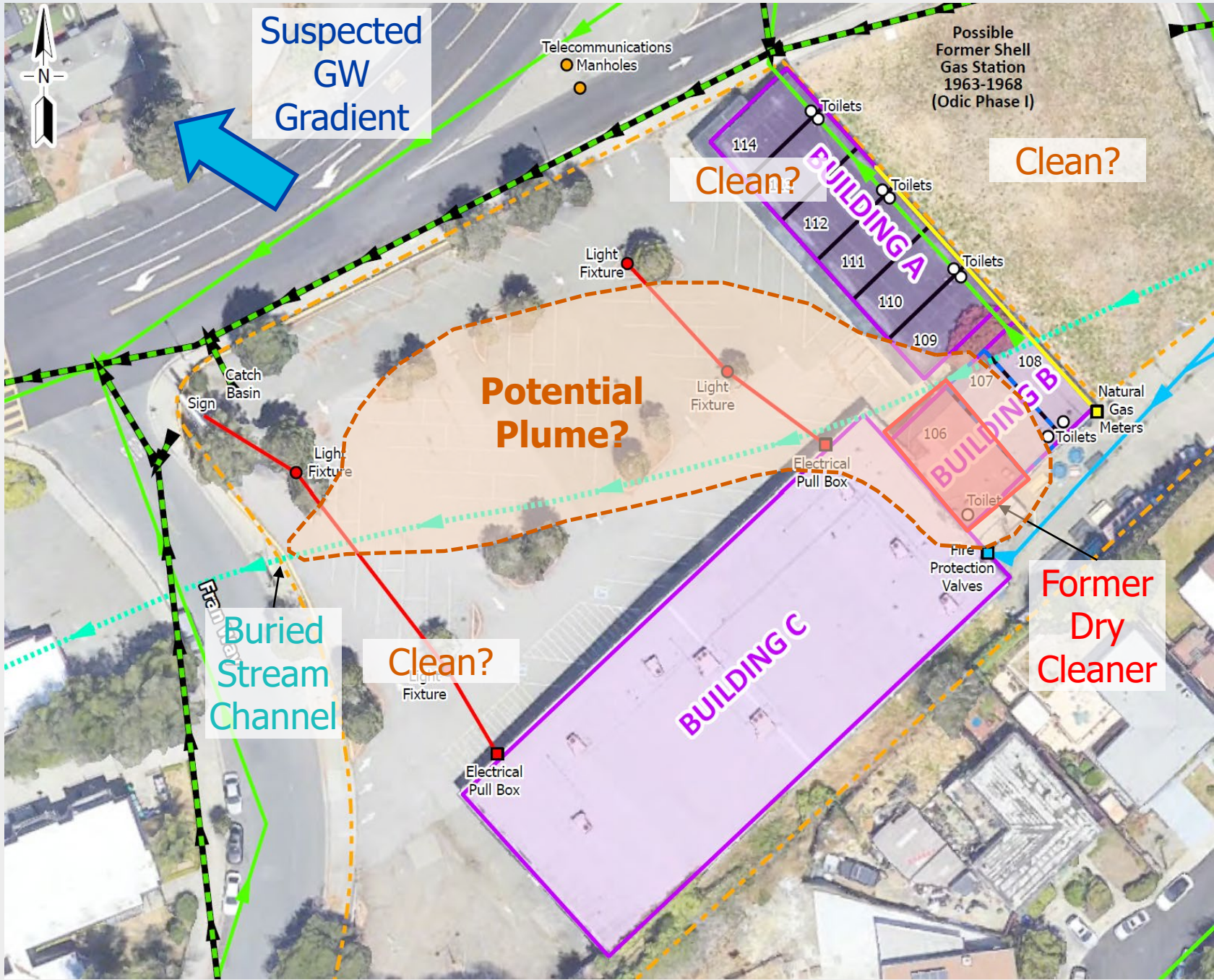
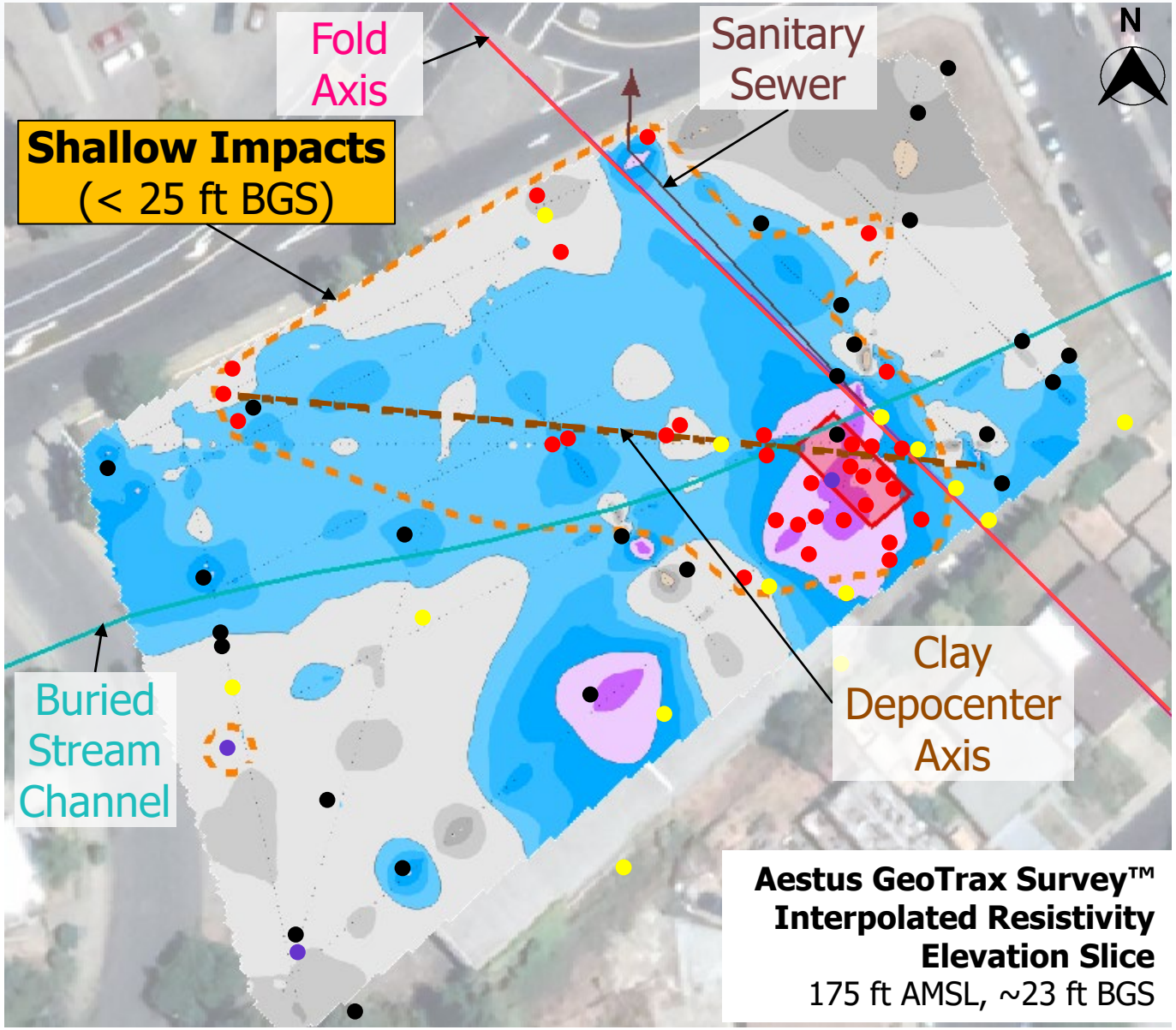


Zones of Impacts

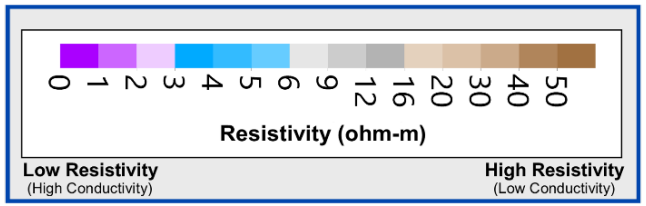
1 Shallow Impacts (0-25 ft bgs)

- ~32,000 ft²; 30,000 yd³



Legend

- Former Dry Cleaners
- Soil and/or GW Above Standards (and soil gas above 1 mg/m³)
- Interpreted MiHPT CVOC Response
- Soil Gas Above Standards for PCE (and below 1 mg/m³)
- Non detect for CVOCs



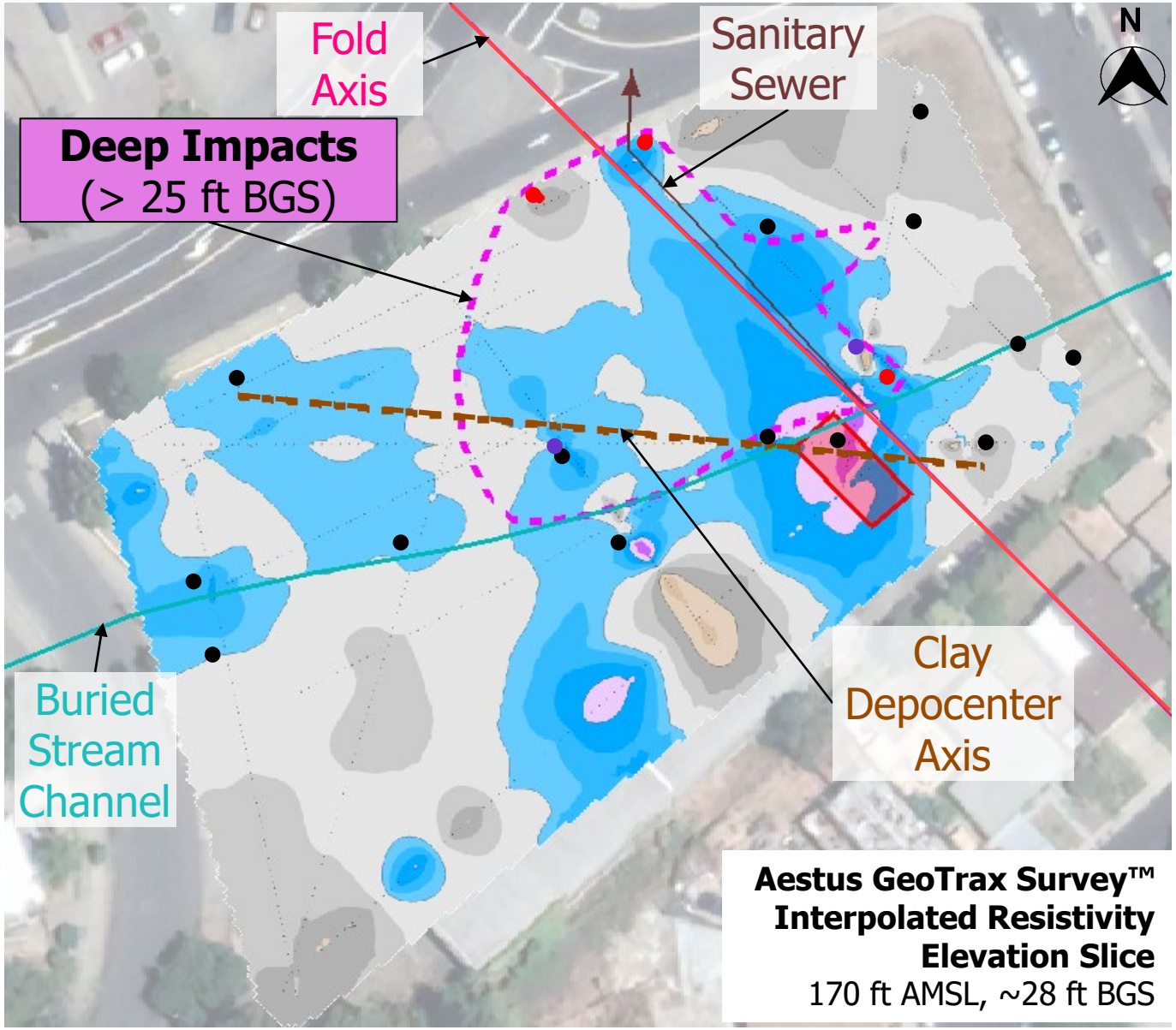
Zones of Impacts

1 Shallow Impacts (0-25 ft bgs)

- ~32,000 ft²; 30,000 yd³

2 Deep Impacts (25-50 ft bgs)

- ~17,000 ft²; 16,000 yd³



Aestus GeoTrax Survey™ Interpolated Resistivity Elevation Slice
170 ft AMSL, ~28 ft BGS

Zones of Impacts

1 Shallow Impacts (0-25 ft bgs)

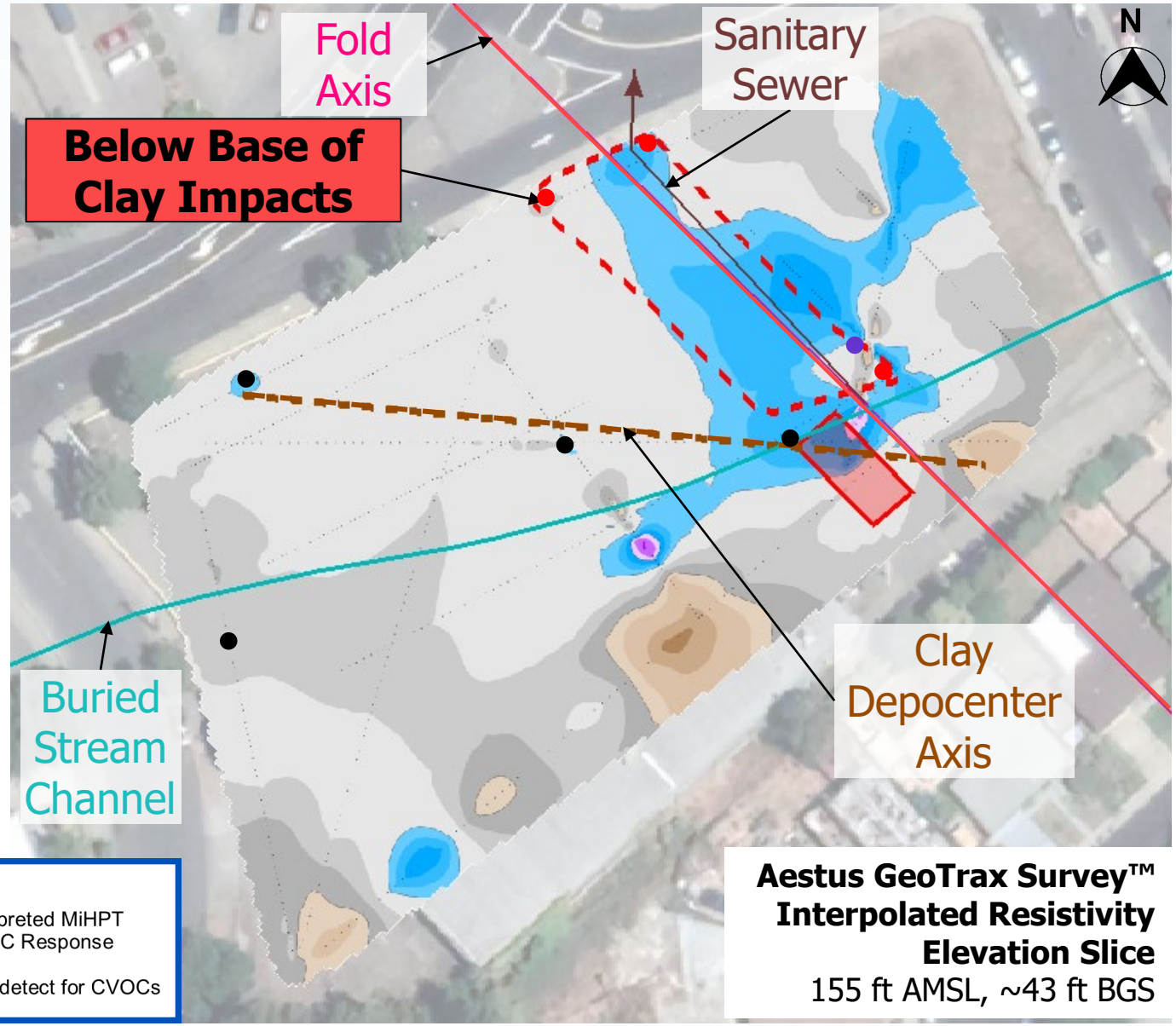
- ~32,000 ft²; 30,000 yd³

2 Deep Impacts (25-50 ft bgs)

- ~17,000 ft²; 16,000 yd³

3 Impacts Below Base of Clay (25-45 ft bgs)

- ~6,000 ft²; 4,500 yd³



Aestus GeoTrax Survey™ Interpolated Resistivity Elevation Slice
155 ft AMSL, ~43 ft BGS

Putting It All Together: Imaging + Integration = Robust 3D CSM

El Sobrante Avenue Site

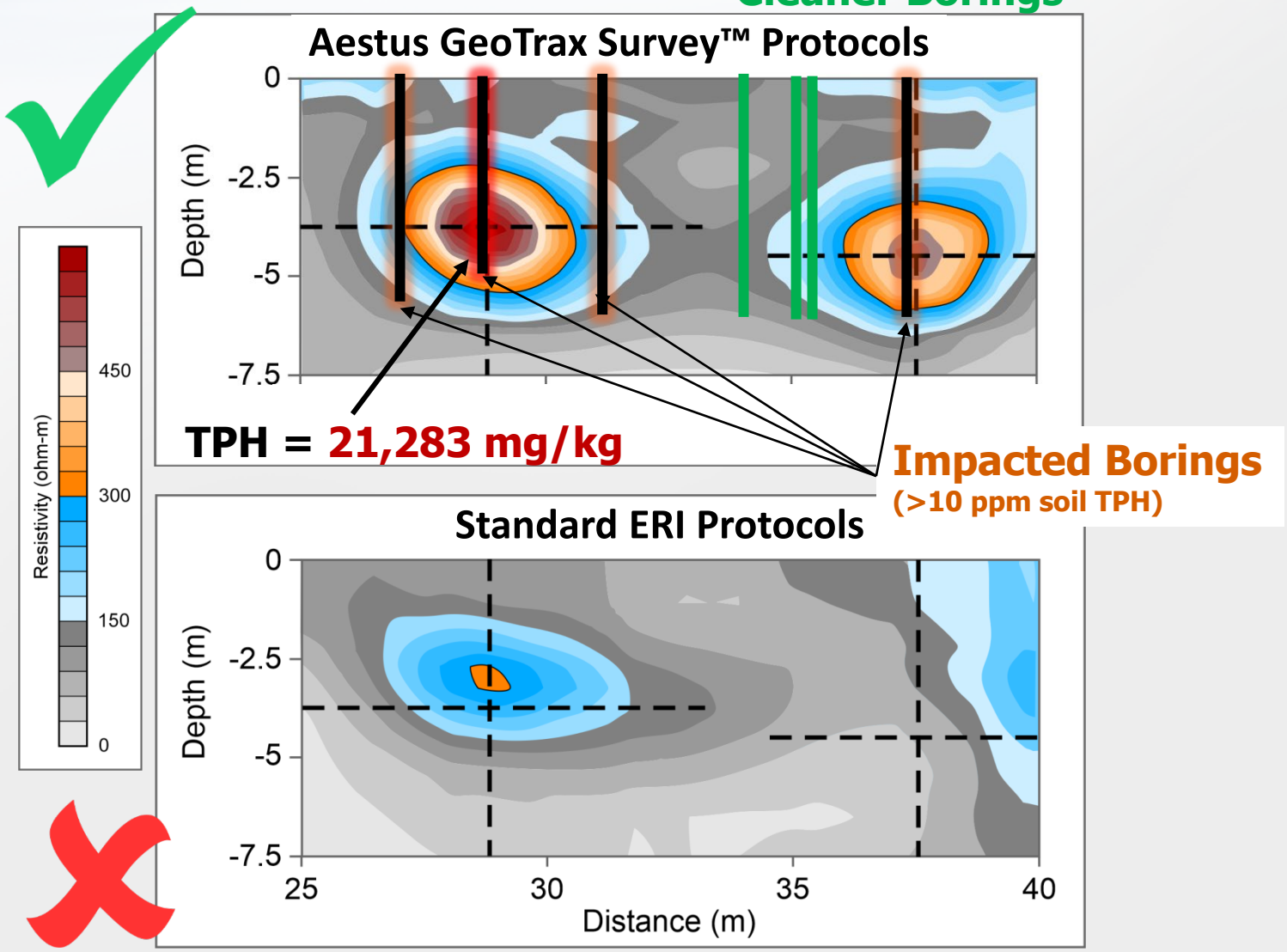
El Sobrante, California, United States

TRINITY source group, inc. Environmental Consultants

Aestus

GeoTrax Survey™ vs Standard ERI

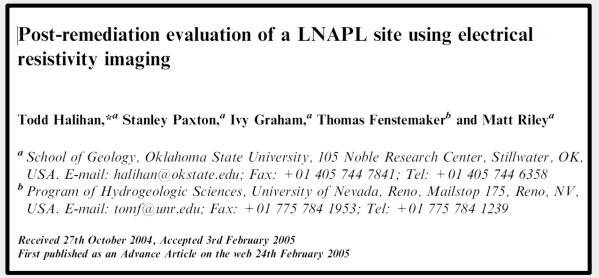
Cleaner Borings



Drillable Image

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

from Halihan et al, 2005



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

Todd Halihan,*[a] Stanley Paxton,[a] Ivy Graham,[a] Thomas Fenstemaker[b] and Matt Riley[a]

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First published as an Advance Article on the web 24th February 2005

Same equipment

Same transect line

Framework for Investing in Electrical Hydrogeology

If your site has one of the below challenges…

Minimize time to project completion

*If a site is more than 2 years old or one remedial method has failed, research shows additional rounds of drilling/sampling won't help**

→

Complex / heterogeneous geology present

Variable bedrock, paleochannels, fractures, etc. make contaminant source zones and flowpaths difficult to characterize

→

Total projected cost of project is ≥ $300K

Total = characterization + remediation

→

Project funding is public and/or limited

The Solution

Scan First

Avoid multiple rounds of "just drill 3 more wells" and/or failed remediations

Have a complete picture of the subsurface

Find source zones and understand how geologic structures connect

Target wells with precision and accuracy

*Estimates show HRSC will pay for itself when total site costs exceed 3x the HRSC investment**

Use funds efficiently with high return on investment possible

ROI up to 40x (4,000%) seen in practice

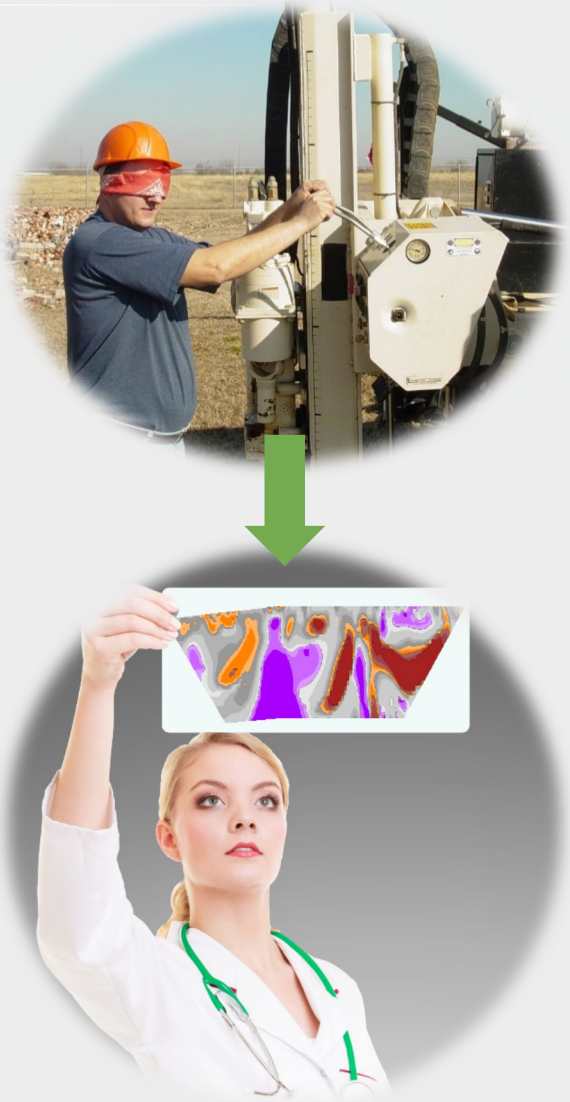
Characterization costs are excessive when drilling requires multiple cycles without success and remediation attempts fail due to insufficient characterization.

*Winner, 2025

Best Practices for Modern Characterization

No More"Poke and Hope"

- Vertical tools alone are not sufficient for good CSM development
  Monitoring Wells ≠ Characterization Wells
- Remedial efficacy is only as good as the underlying CSM
- Scanning first is accepted best-practice in other industries and is widely recognized to increase success and decrease total costs
- Electrical hydrogeology results in:
  - Targeted drilling locations
  - Robust CSM
  - Time and cost savings for characterization AND remediation with minimized trailing liabilities



Acknowledgements & References

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Trinity Source Group

Urban Environmental Partners

Washington State Department of Ecology

Environmental Protection Agency

Eagle Synergistic

California Waterboard

City of Ada, Oklahoma

Greystone Environmental

References:

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Thank you for your Time!

Questions?

Keep up the Conversation:

1. Visit us at Booth #546
2. See Todd's Talk on Monitoring NEXT at 2:15 in Track F – Room 202 C/D
3. Check out our Posters Tonight: #117 & #260

Aestus