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Overview of Electrical Resistivity In Tank Farms

Presented by

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Project by

hydroGEOPHYSICS

Columbia Energy & Environmental

CH2M Hill Hanford Group

Fluor Hanford

PNNL

Characterization of Hanford Tank Farms

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Characterization Goals

- Non-invasive
- In-expensive technology
- Easily confirmed
- Take advantage of site conditions
  - tank waste is electrically conductive
  - pervasive site infrastructure
- Adaptive

GEOPHYSICS

What is Geophysics?

Drilling – direct characterization

- 1D Information
- Deep information
- Perfect knowledge of geology/lithology, chemistry, hydrogeology

Geophysics – indirect characterization

- 3D Information
- Relatively shallow from surface measurements
- Imperfect knowledge of subsurface

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Characterization Techniques

Direct Measurements

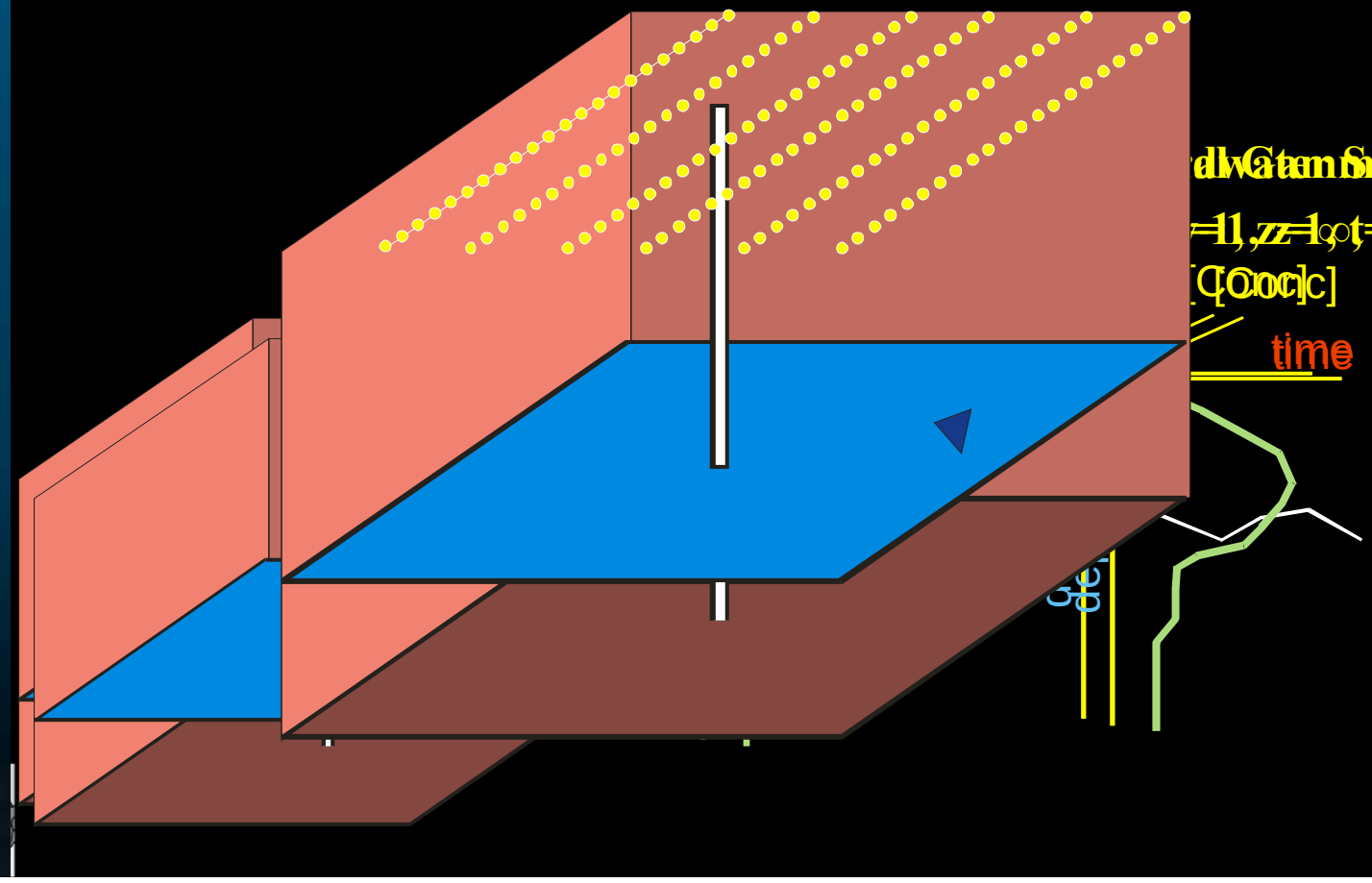
- Core Sampling
- Groundwater Sampling

Indirect Measurements

- Neutron Logging
- Spectral Gamma Logging

Resistivity Methods

$(x=\infty, y=\infty, z=\infty, t=\infty, c=1)$



What Can Geophysics Do?

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Cans

- Characterize site inexpensively and rapidly
- Highlight geophysical targets
- Monitor sites for more unique characterization

Cannots (or should nots)

- Be used exclusively; needs confirmation
- Over relied upon; only one tool of many
- Analyzed by non-experts

Resistivity Methodology

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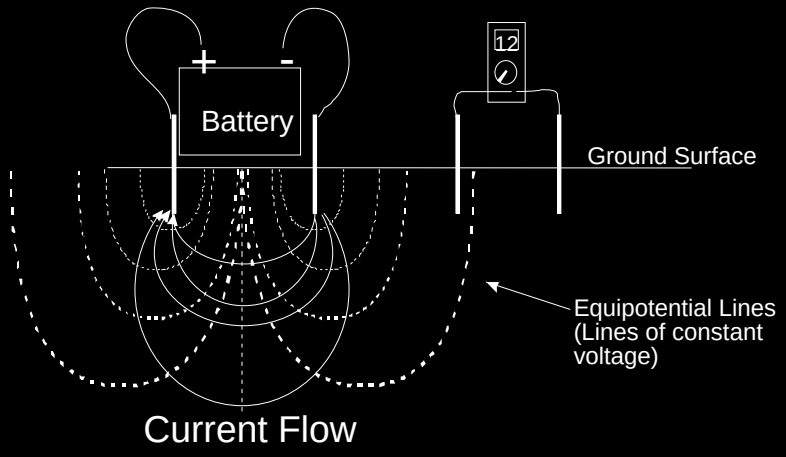
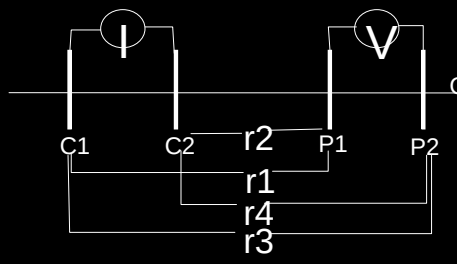
Set up



Governing Equation

$$\nabla \cdot \left(\frac{1}{\rho} \nabla V \right) + I = 0$$

Material Property Evaluation



$$\rho_a = \frac{2\pi V}{I} \left[\left(\frac{1}{r_1} - \frac{1}{r_2} \right) - \left(\frac{1}{r_3} - \frac{1}{r_4} \right) \right]$$

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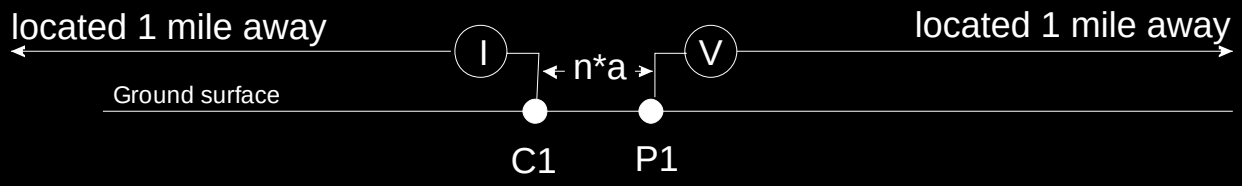
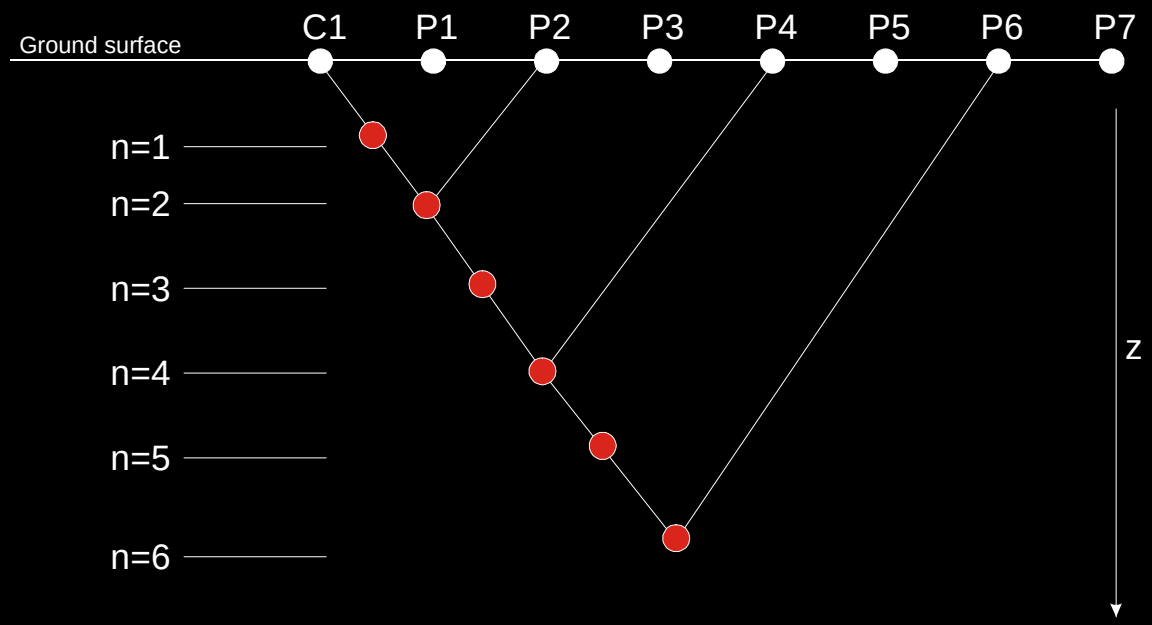
Hanford Measurement Strategy

Pole-Pole Electrode Arrangement



Sequential Measurement Strategy



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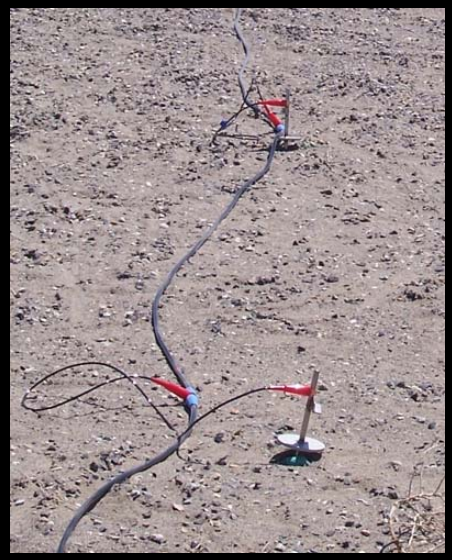
Resistivity Data Acquisition

Electrode Arrays and Types

- STS (surface to surface)
- WTW (well-to-well)
- WTS (well-to-surface)



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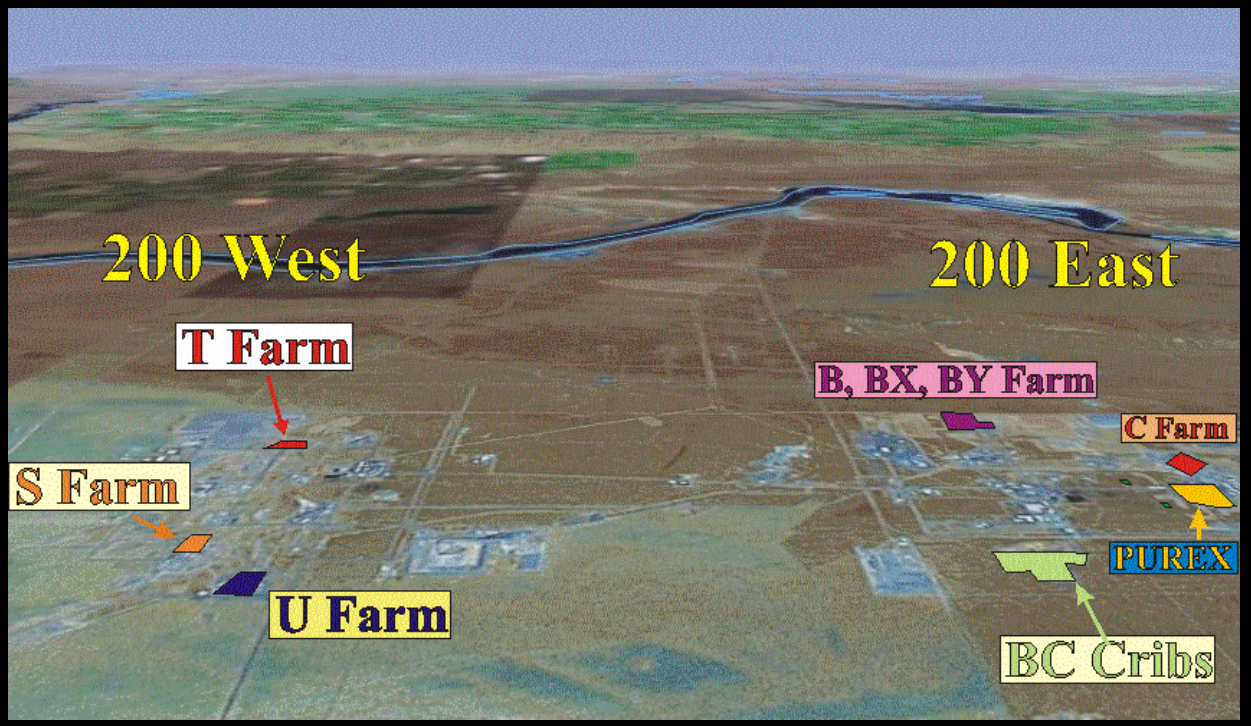
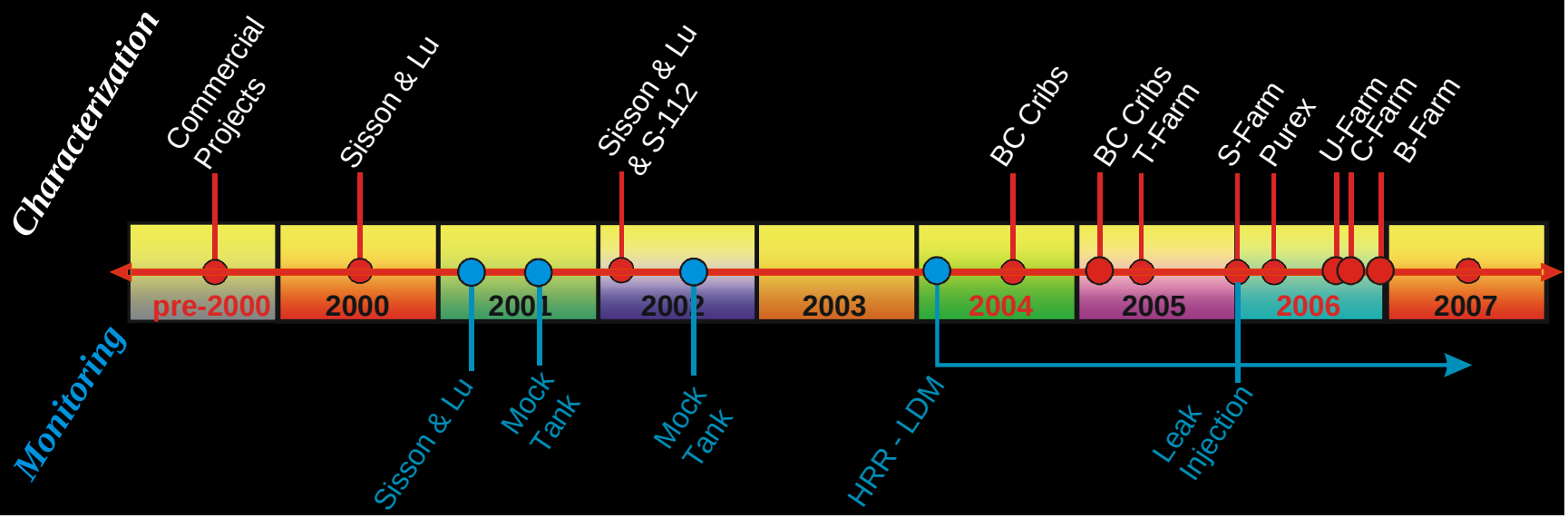
Overview of Hanford Projects





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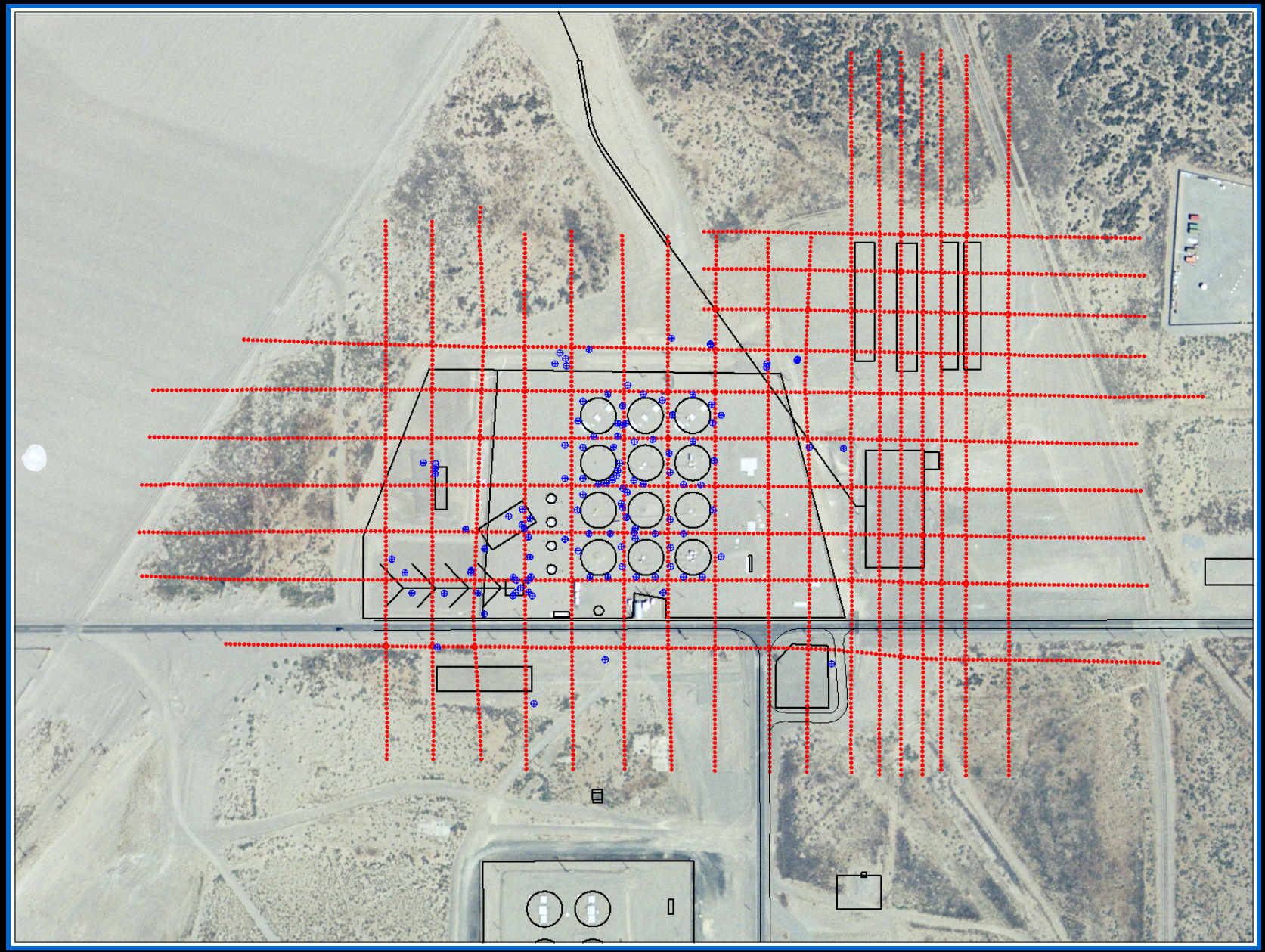
T Farm Coverage Map



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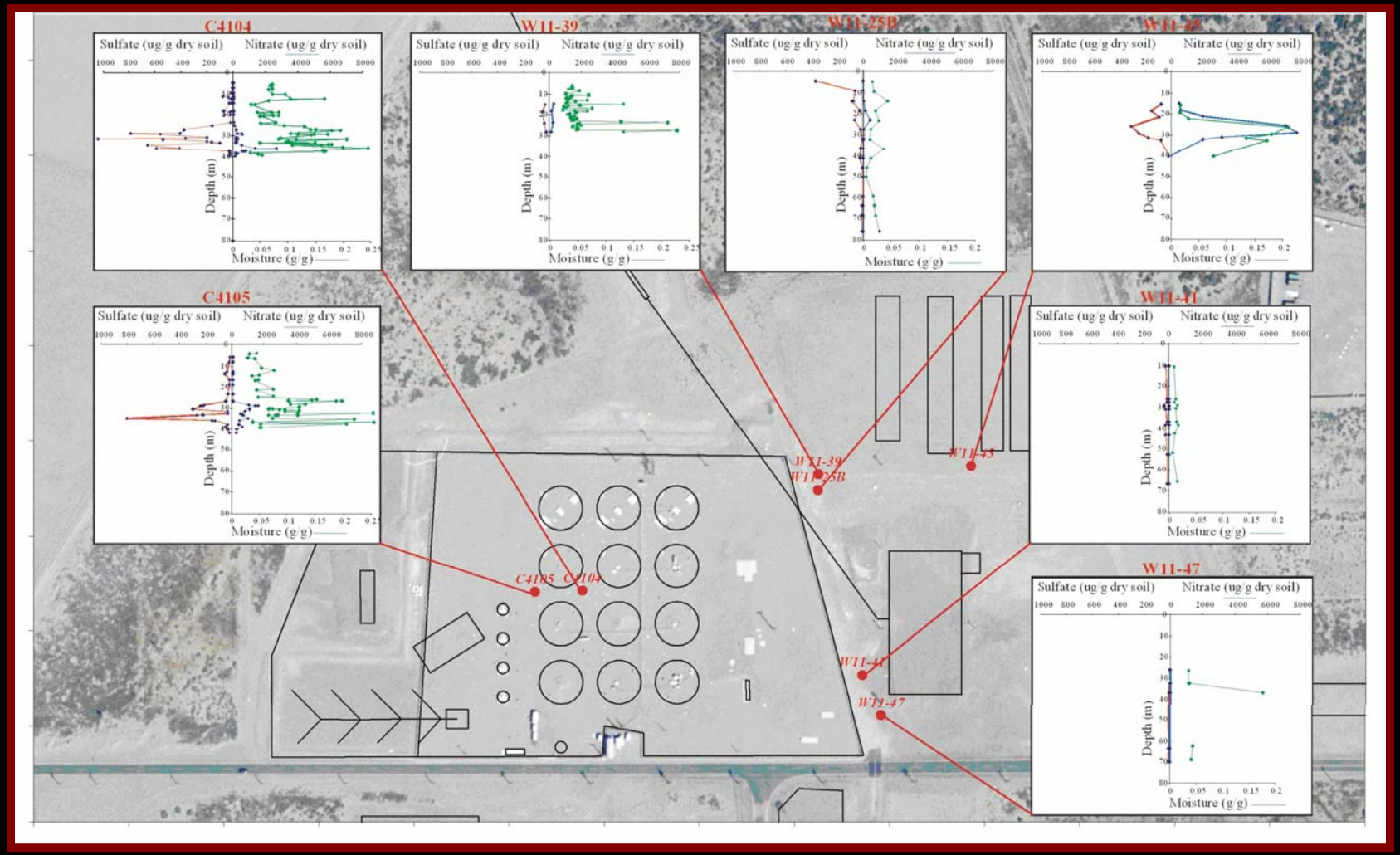
Consequences (Vadose Zone)



Resistivity at T Farm

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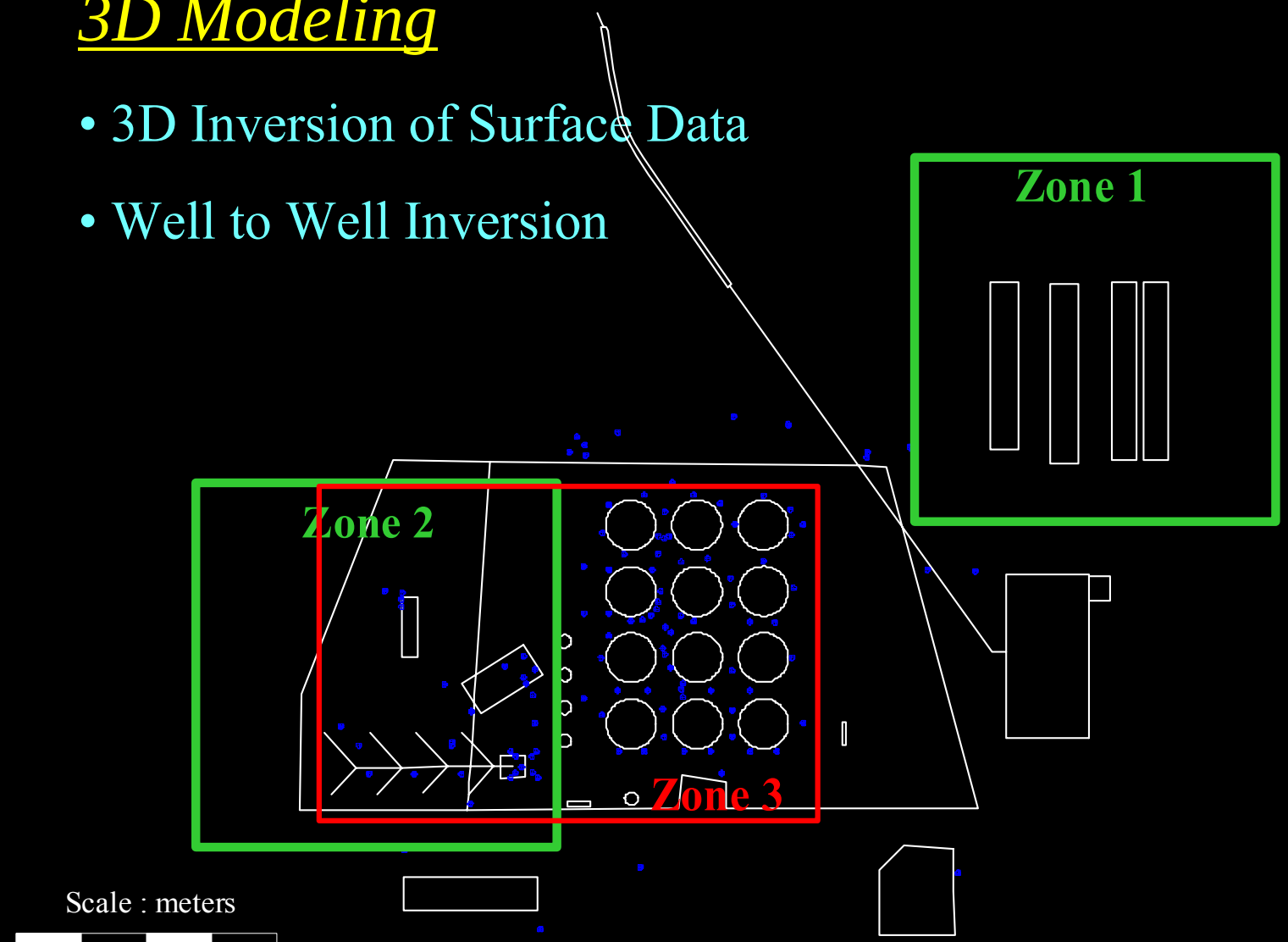
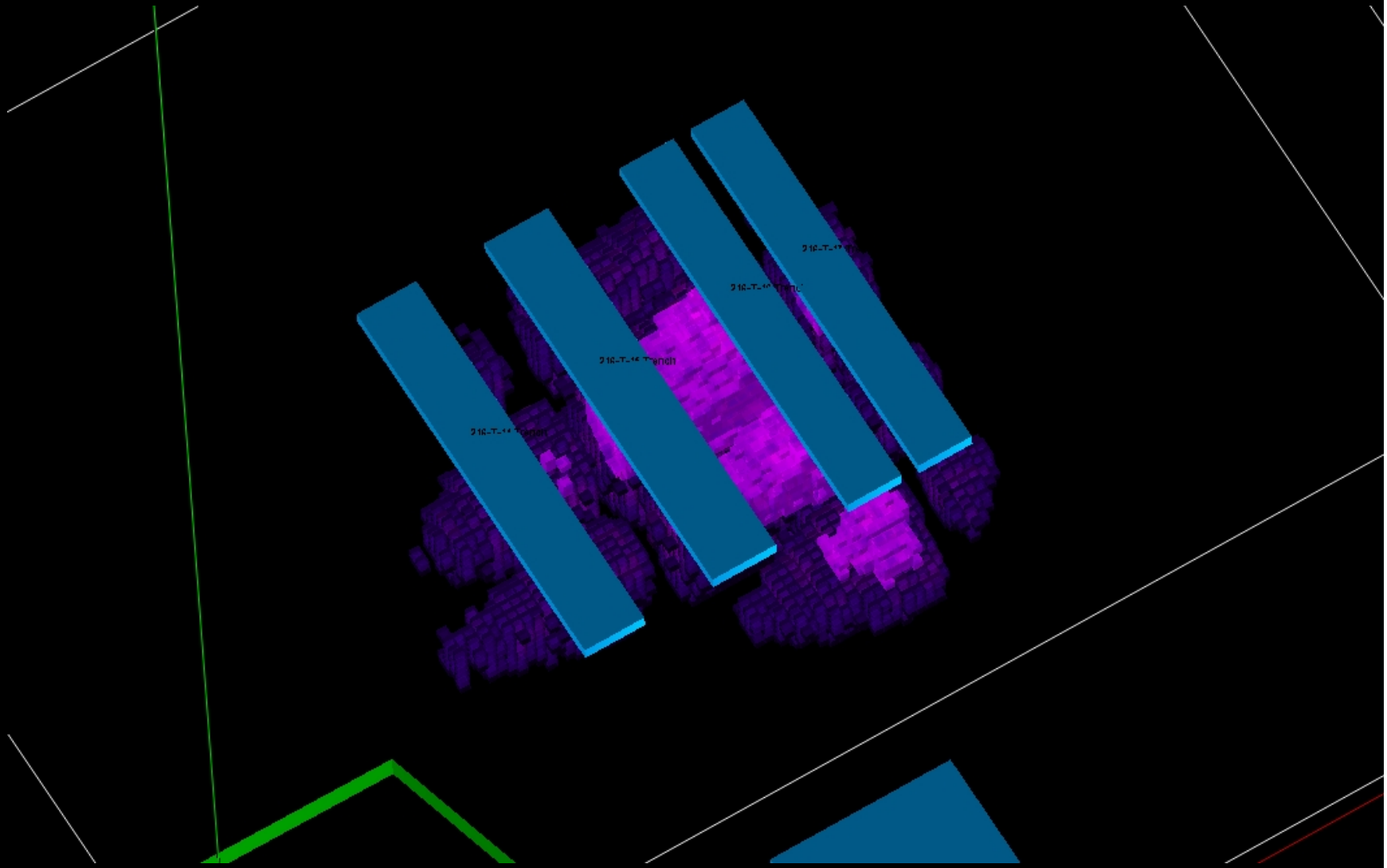
3D Modeling

- 3D Inversion of Surface Data
- Well to Well Inversion



Results – Area 1



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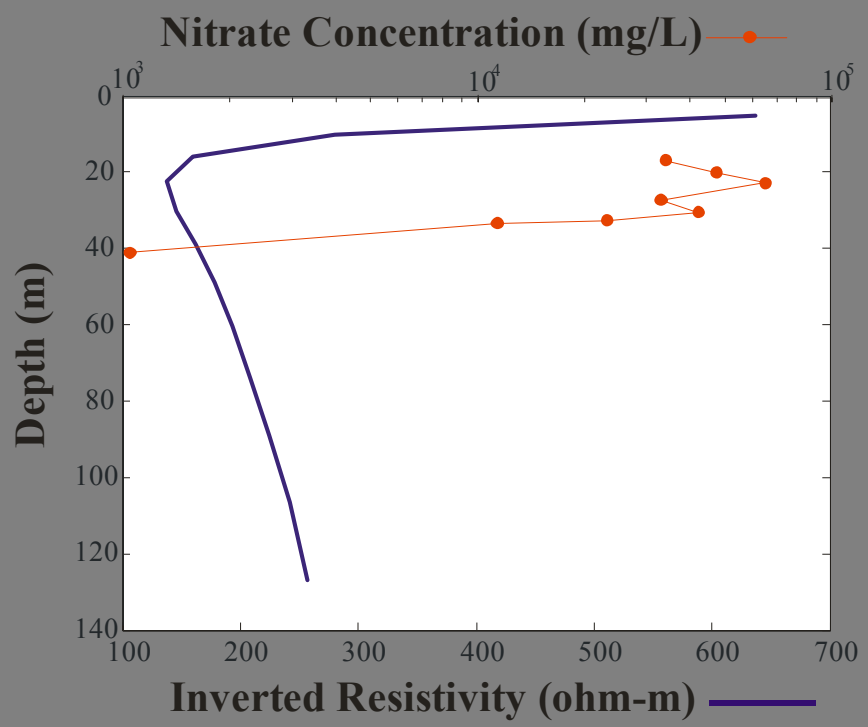
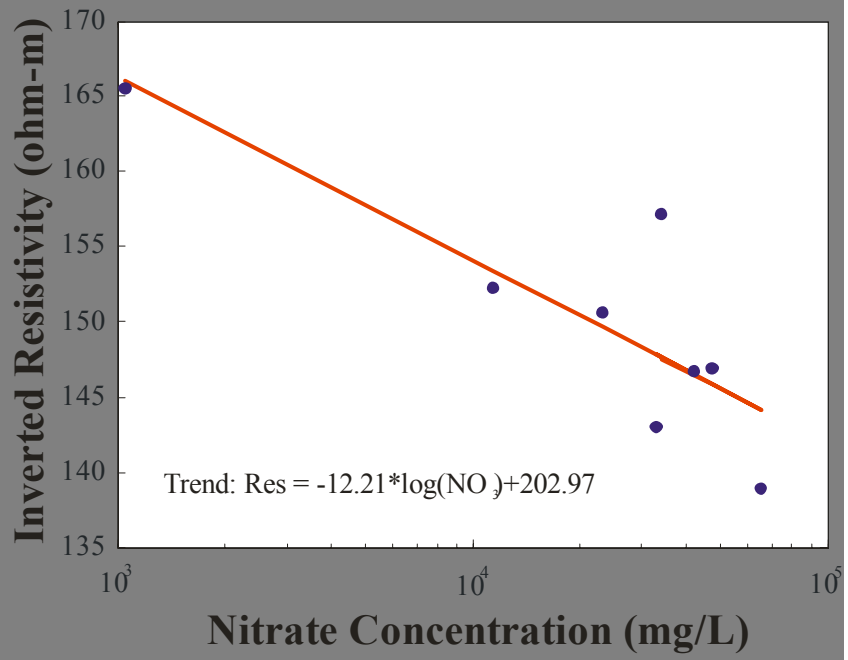
Direct vs. Indirect Data Comparison





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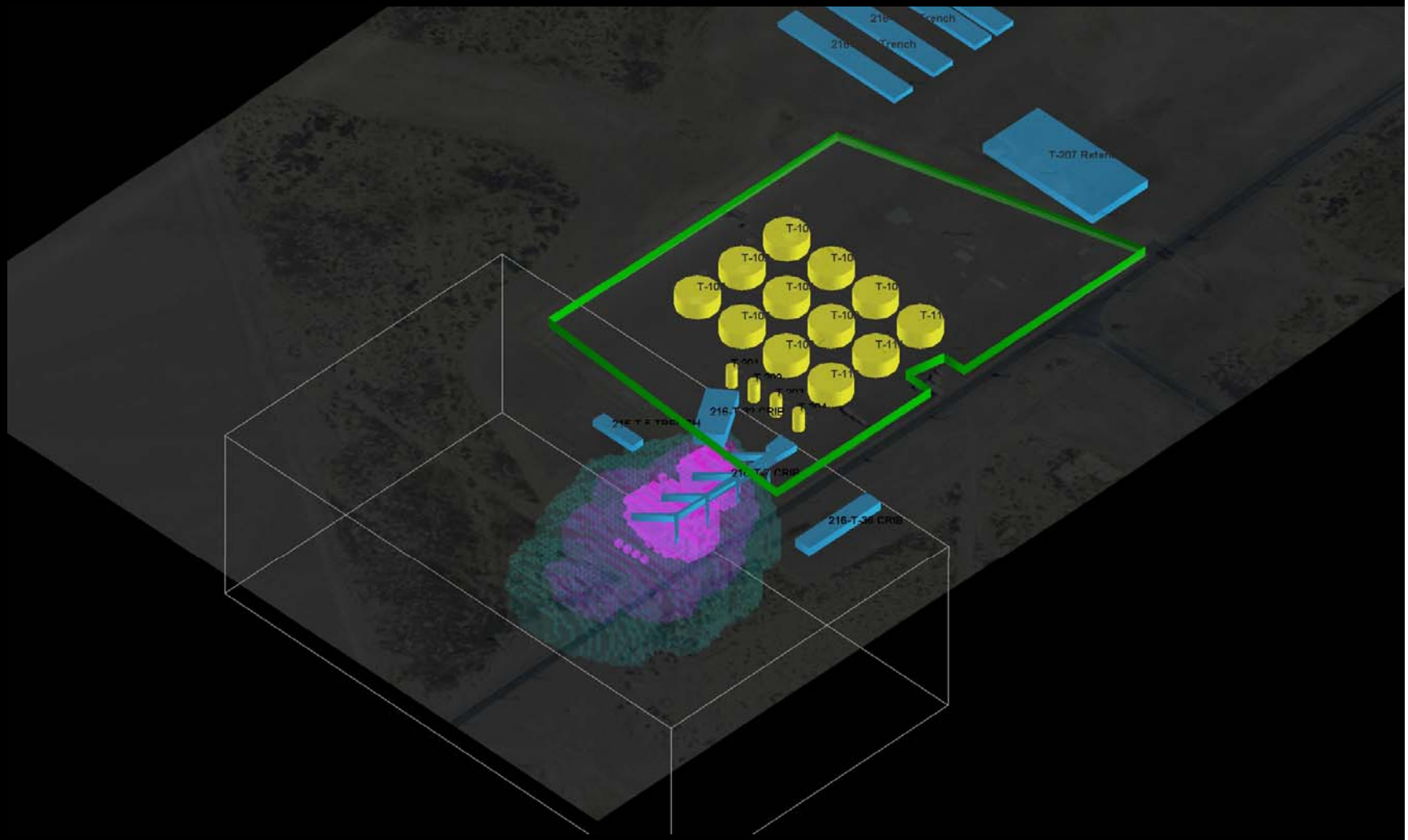
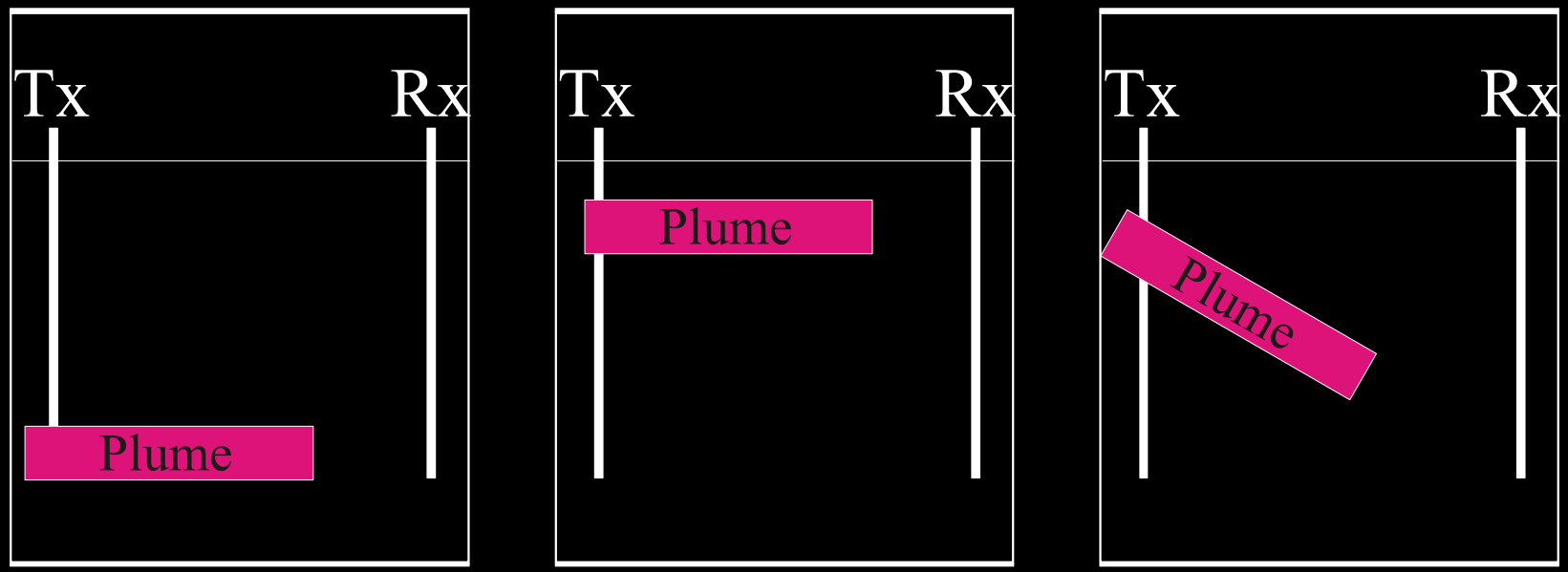
Results – Area 2



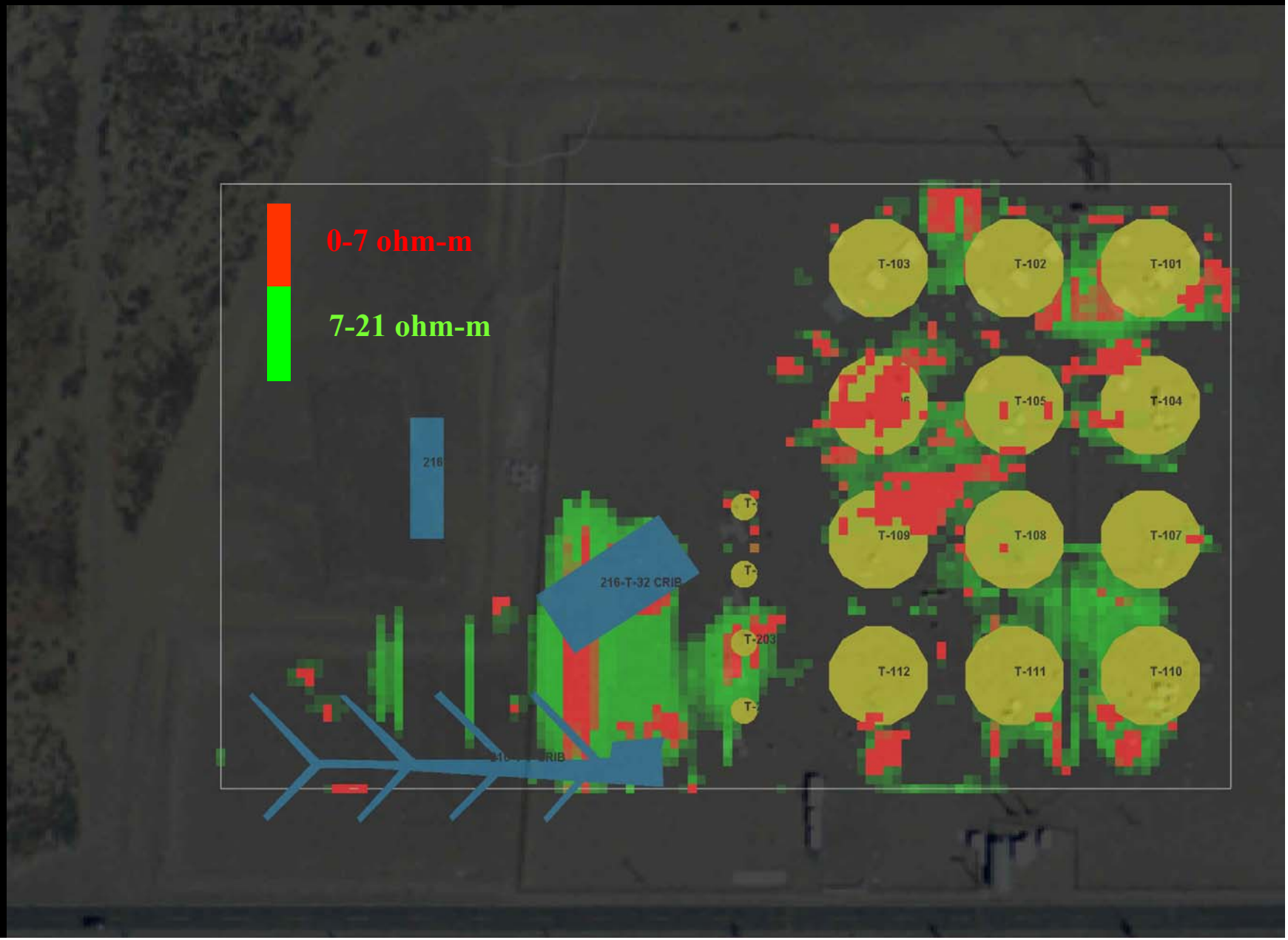
Well-to-Well Inversion

Theory

- Based on work by Bill Daily et al.
- Used linear conductors to simulate transmission along wells
- Results shown as footprint of plume (loss of 3D)



Results – Vadose Zone Wells



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S Tank Farm Leak Injection

- Main purpose – validate tank waste retrieval monitoring technology
- Secondary purpose – image known plume in tank farm with resistivity
- Pre and post leak imaging only

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S Farm Injection Experiment

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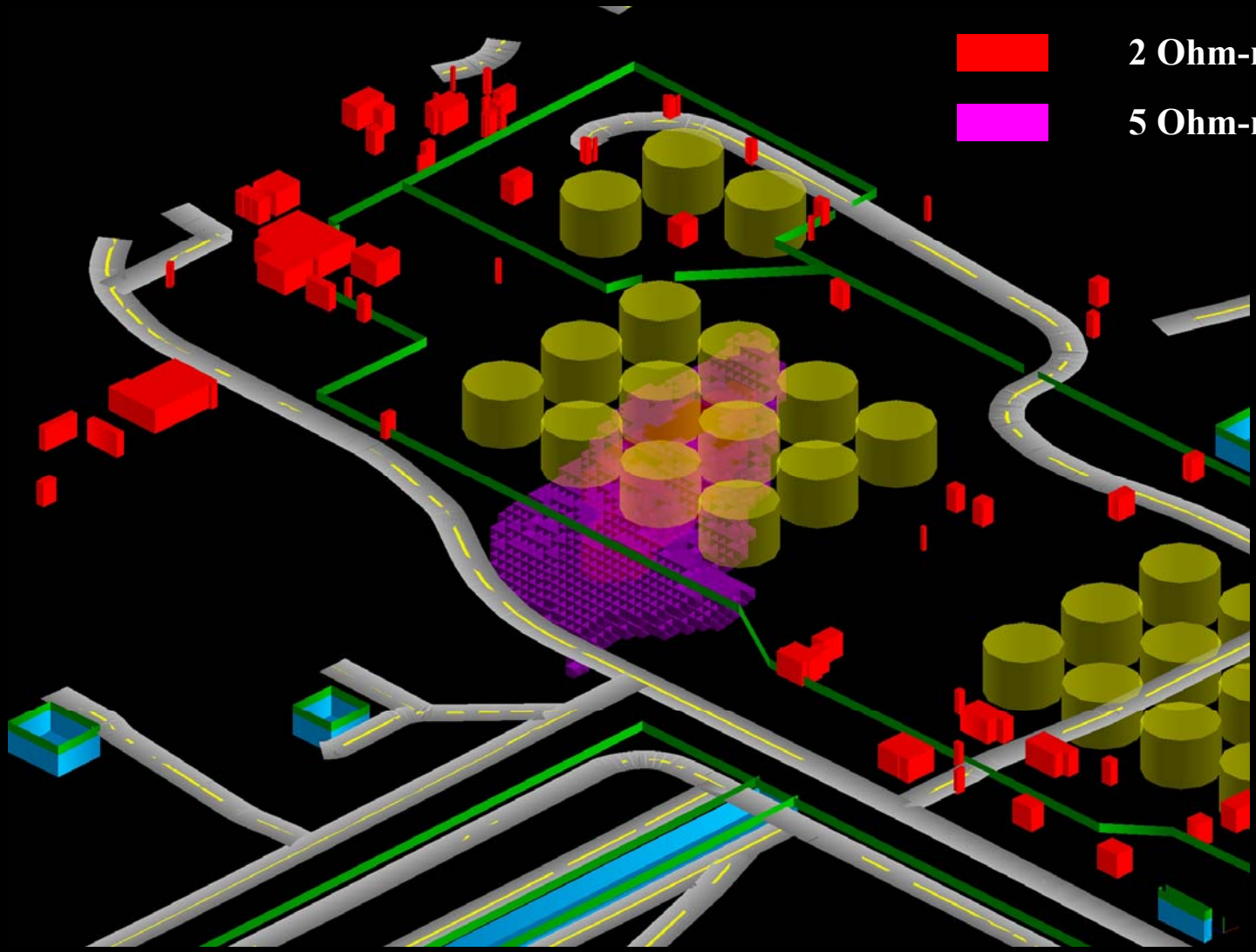
STS Inversion Results (Pre-Injection)



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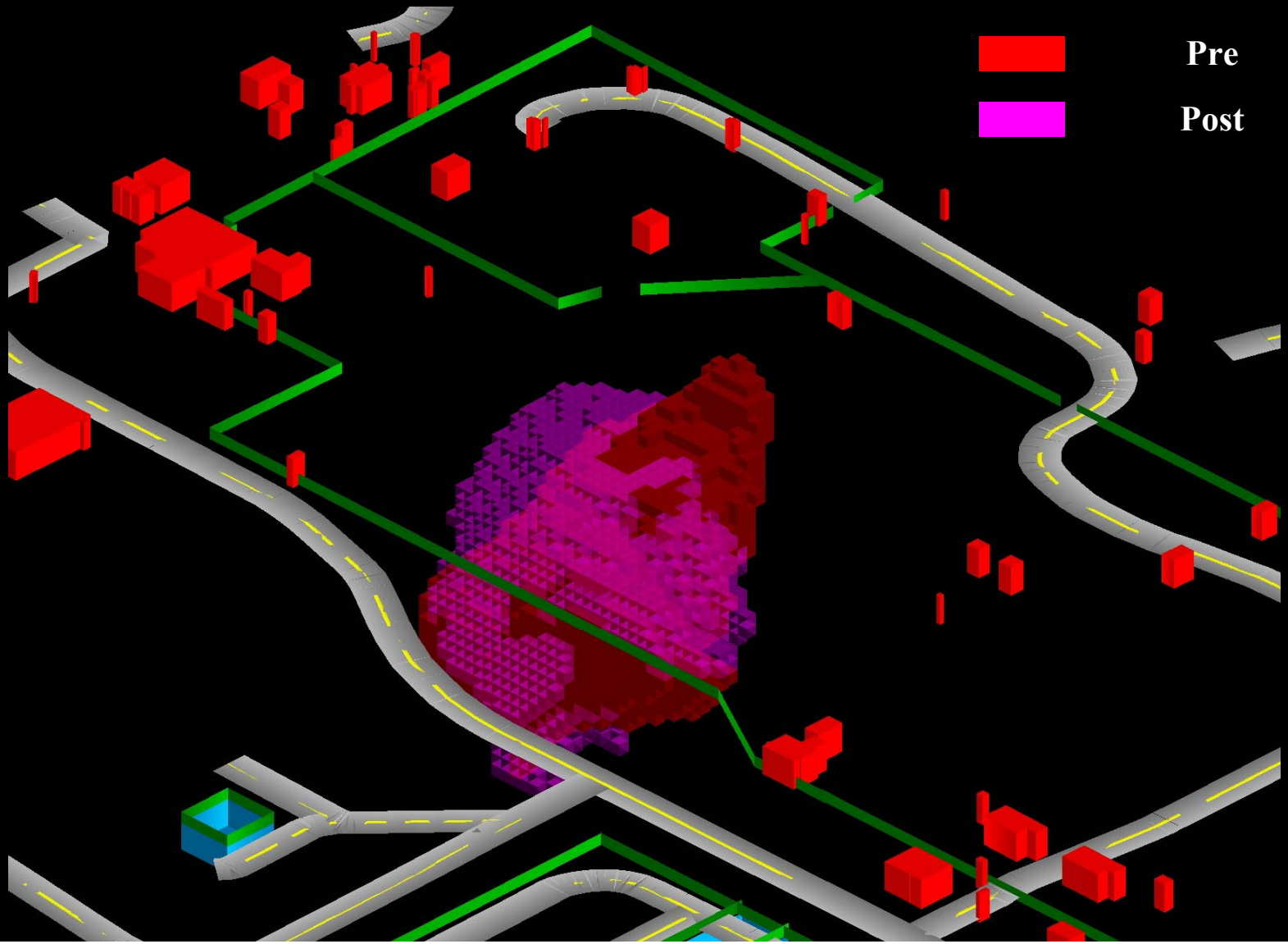
STS Inversion Results (Pre & Post)



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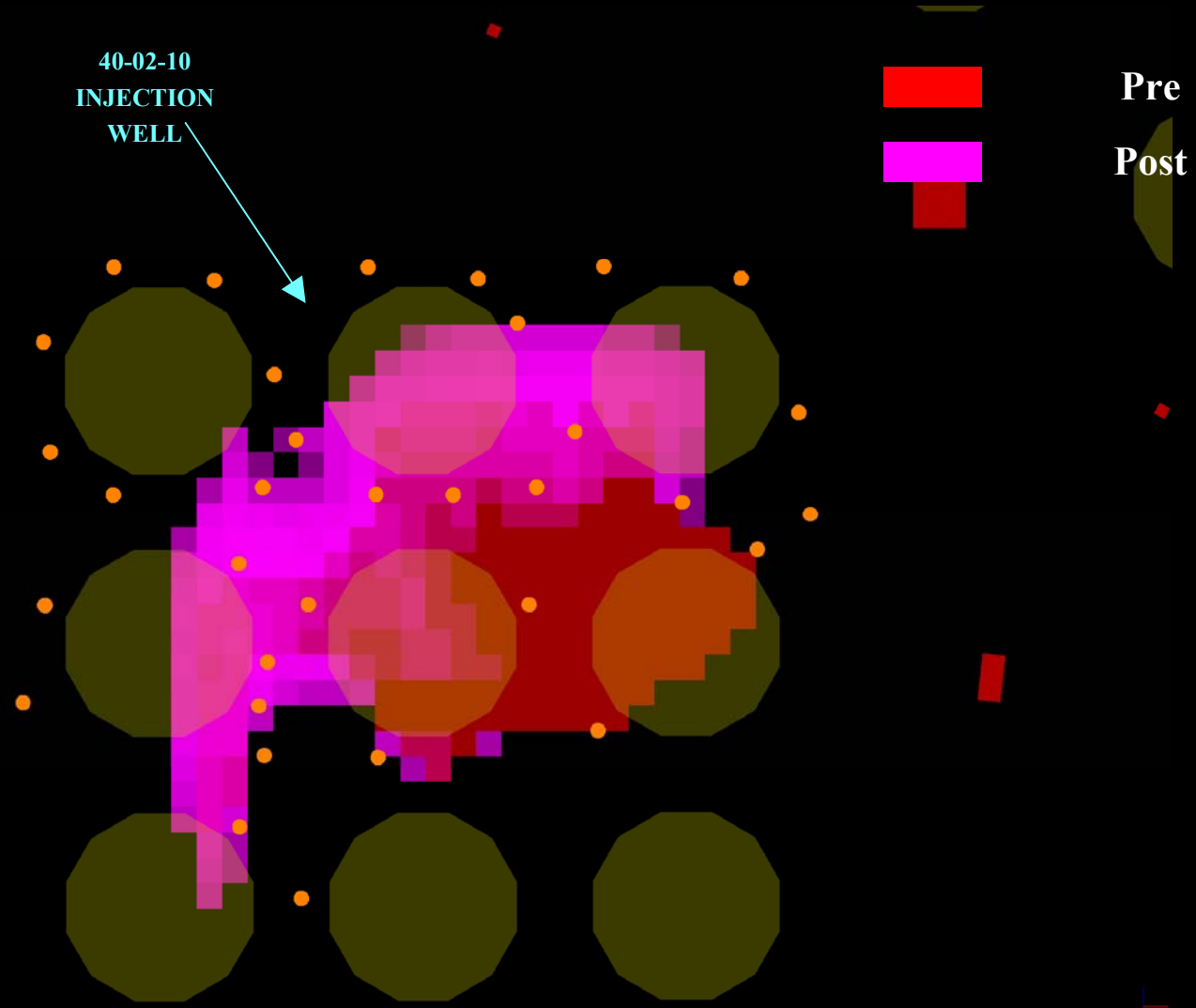
STS Inversion Results (Pre & Post)



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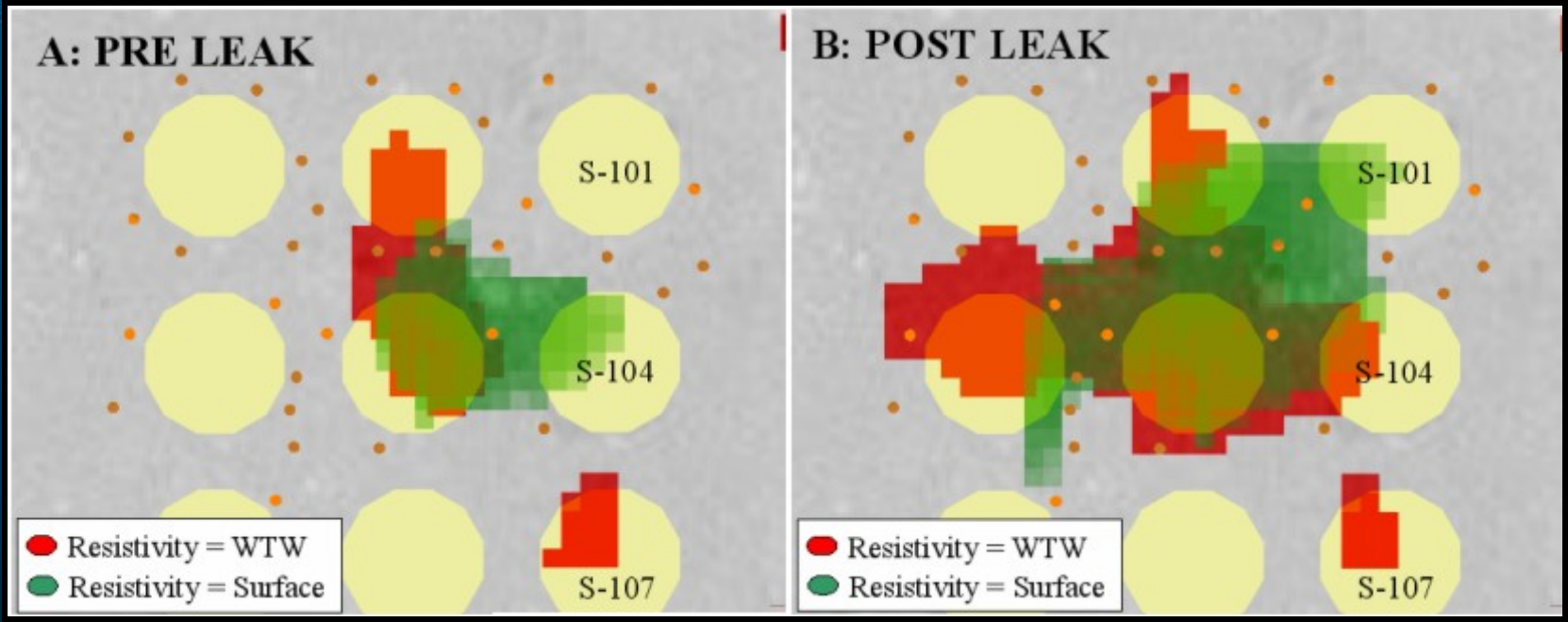
WTW & STS Comparison



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Conclusion

- Resistivity data can be collected in a Hanford tank farm
- Surface resistivity data met hydrologic expectations
- Confirmed through drilling
- WTW results correlated with STS
- In areas of infrastructure, WTW collection may provide good alternative