

# Industrial applications of real-time electrical monitoring

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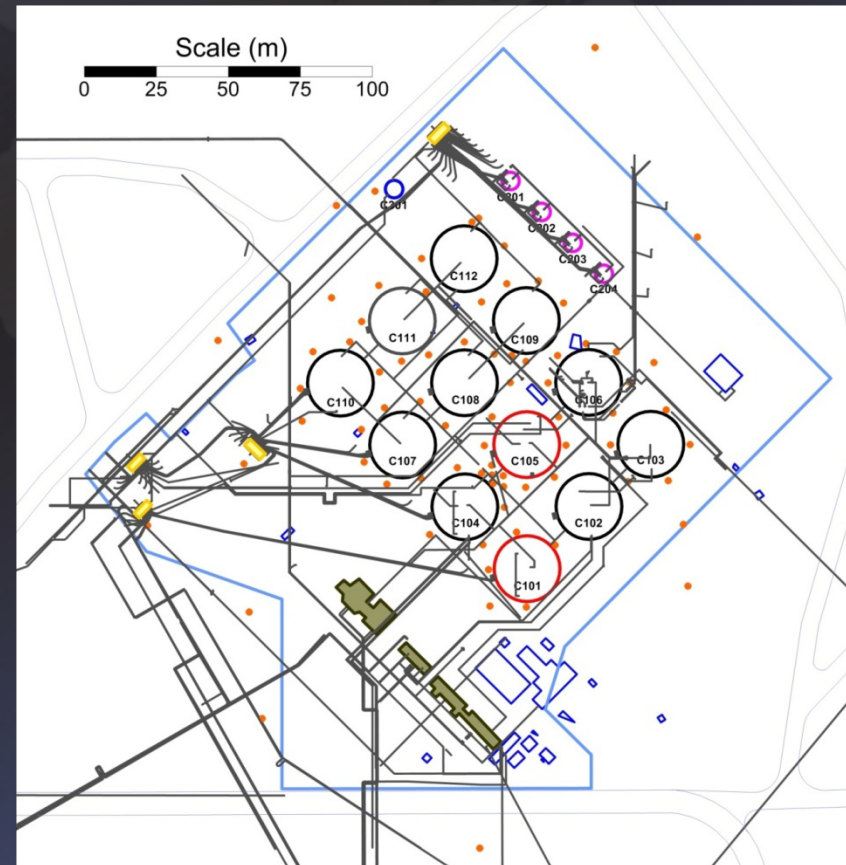
- Geophysical services and research company
- ~50% of business from
  - Leak location
  - Leak detection
  - Monitoring services
- We manufacture equipment





- Nuclear facilities
  - Hanford
  - LANL
  - Calvert Cliffs NPP
- Surface mines
- Chemical facilities
- Landfills

## C Tank Farm, Hanford



# Leak Detection and Monitoring

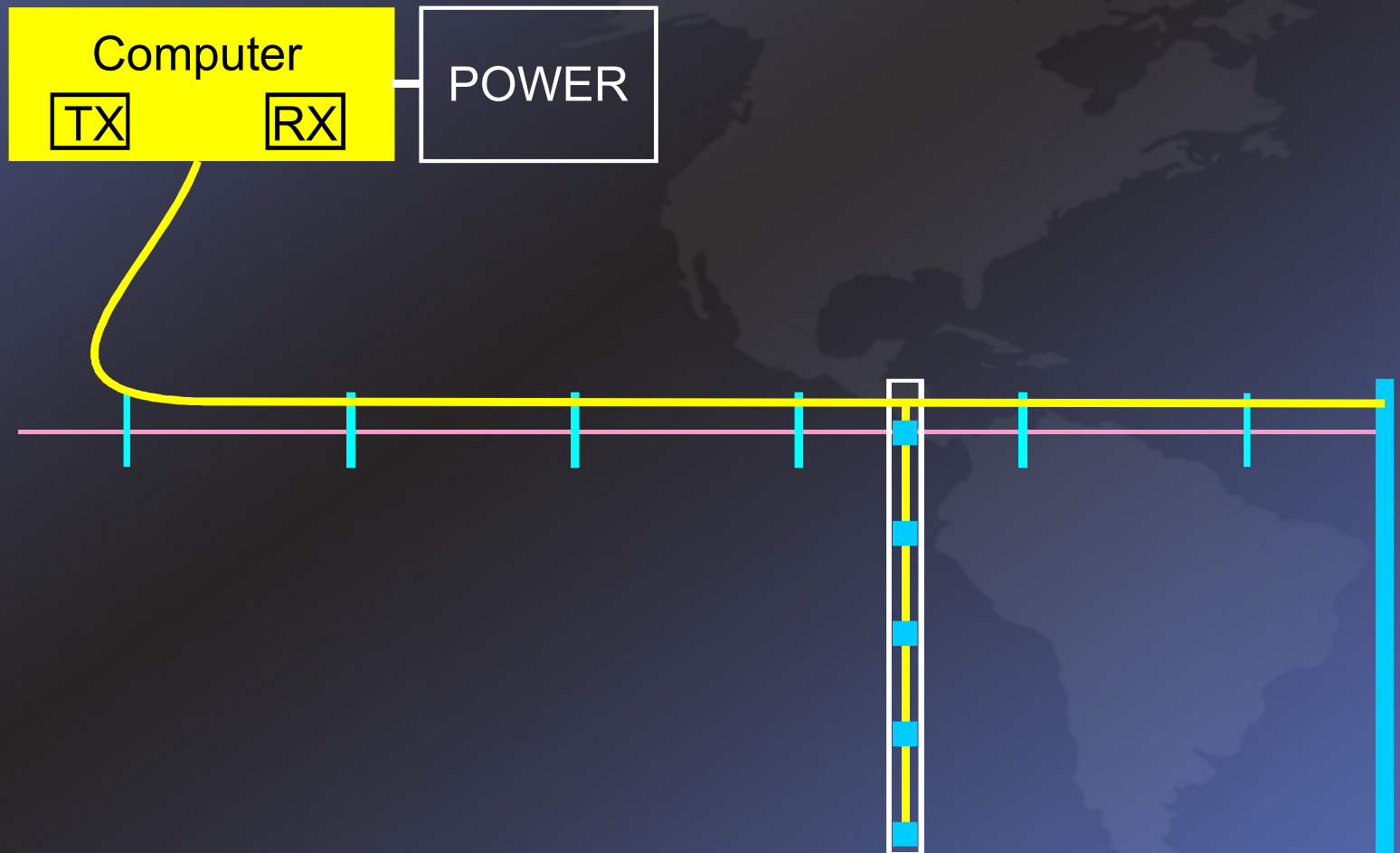
A photograph of a dark, cylindrical pipe buried in a trench. A bright blue and white spray of liquid is leaking from a hole in the pipe, creating a misty cloud. The surrounding soil is dark and moist, with some dry roots visible on the right side of the trench.

1. Leak onset
2. Leak rate
3. Leak location

- Resistivity is sensitive to changes in saturation and concentration
- Sensors (electrodes) are very robust
- Resistivity not directly measured
  - Transmit current (I)
  - Measure voltage (V)
  - Calculate resistivity ( $\rho$ )

# Resistivity measurements

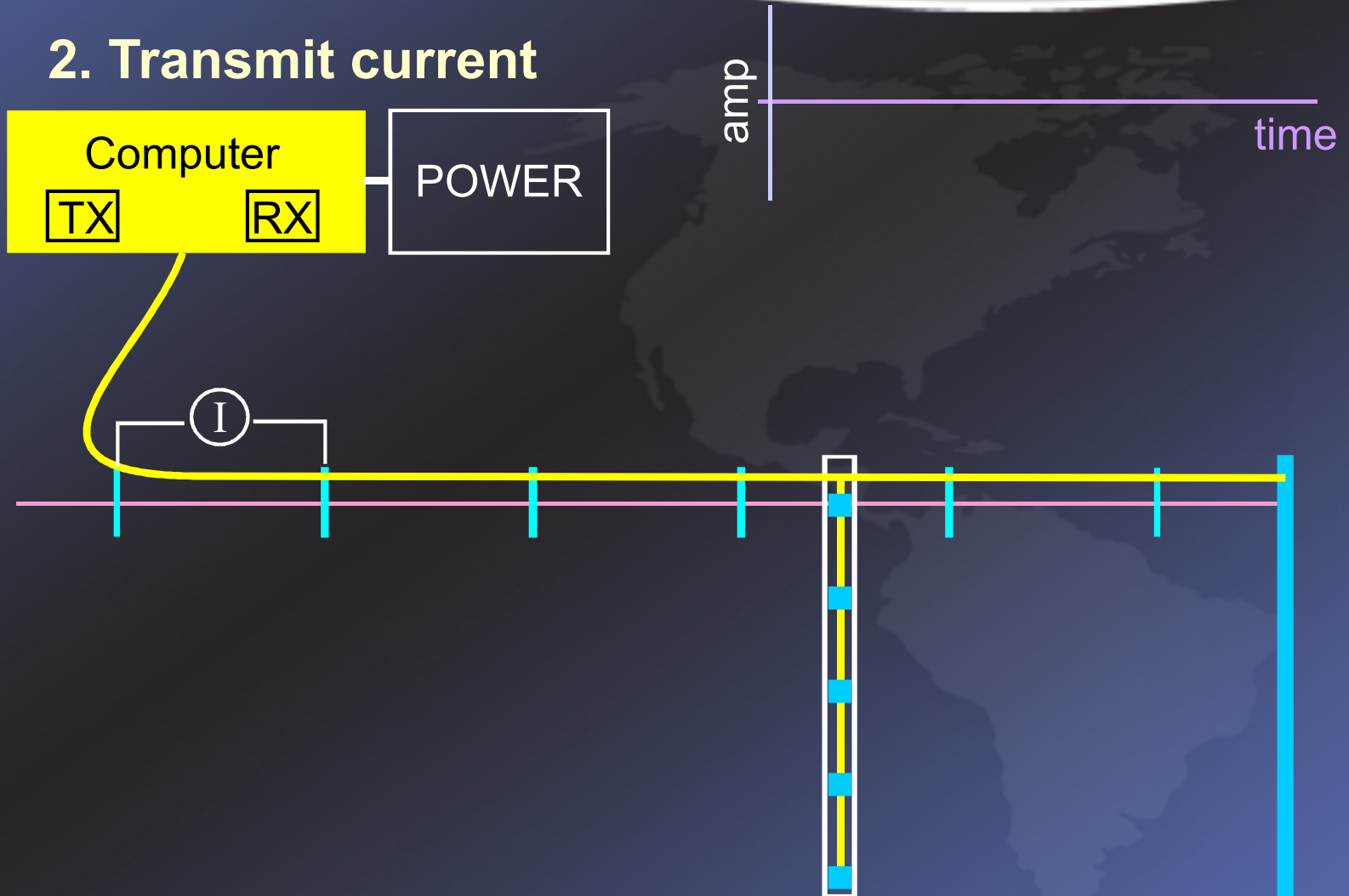
## 1. Set up





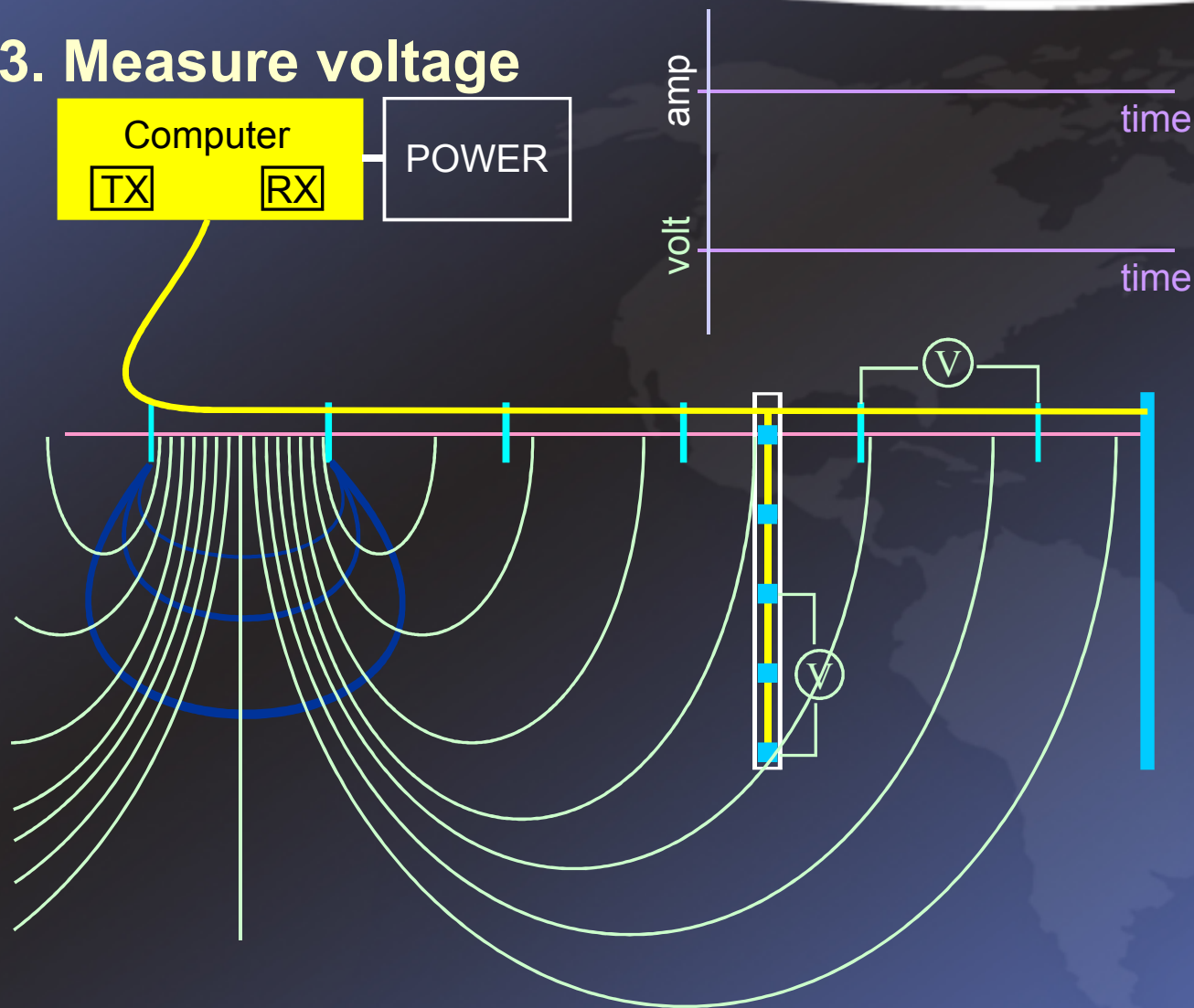
# Resistivity measurements

## 2. Transmit current



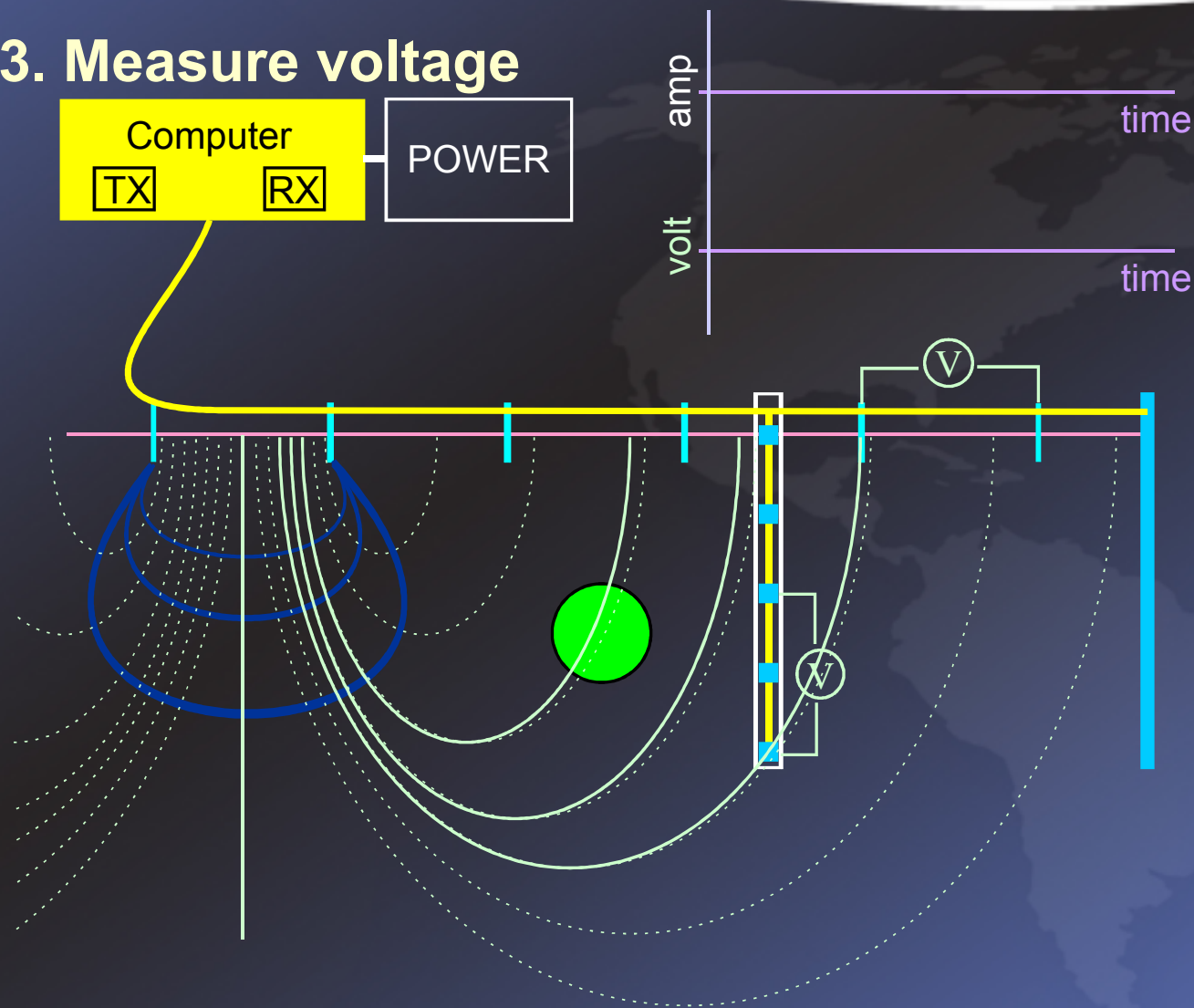
# Resistivity measurements

## 3. Measure voltage



# Resistivity measurements

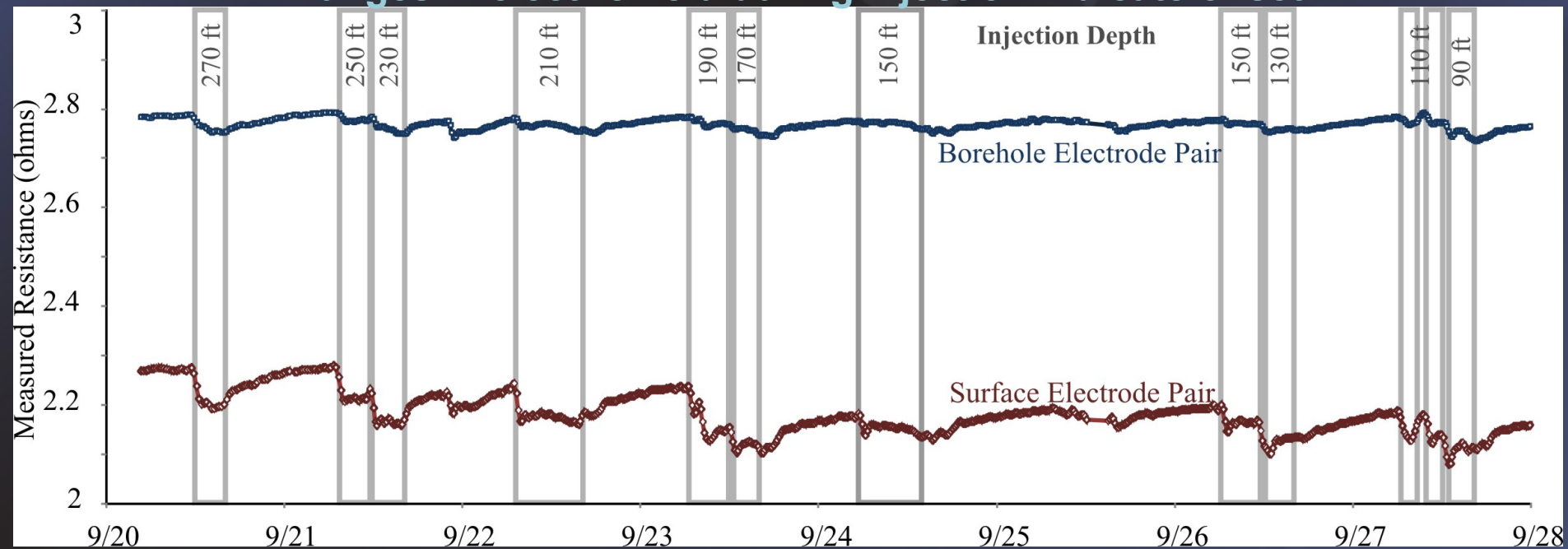
## 3. Measure voltage



# 1. Onset

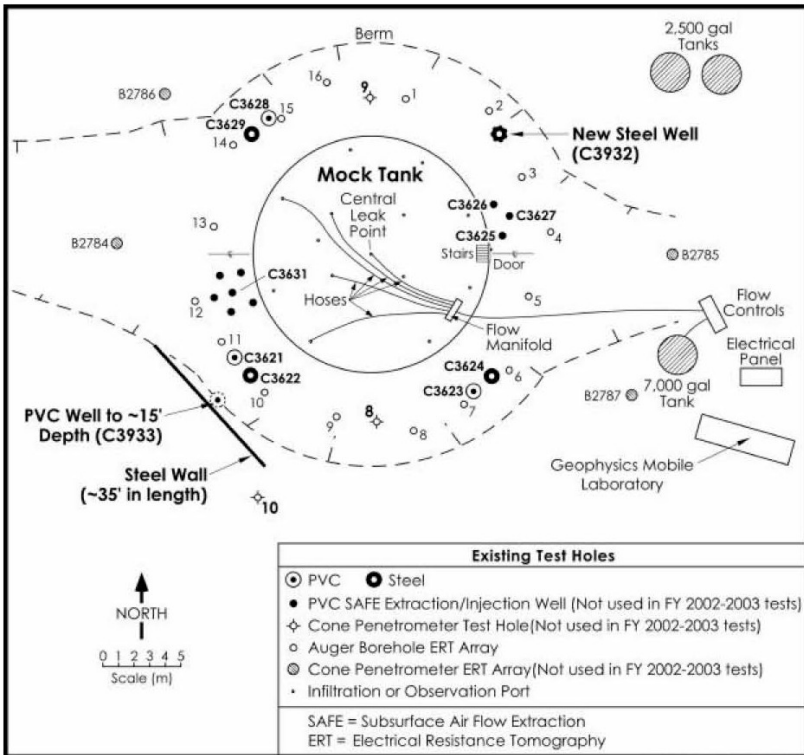


Changes in electric field during injection indicate onset

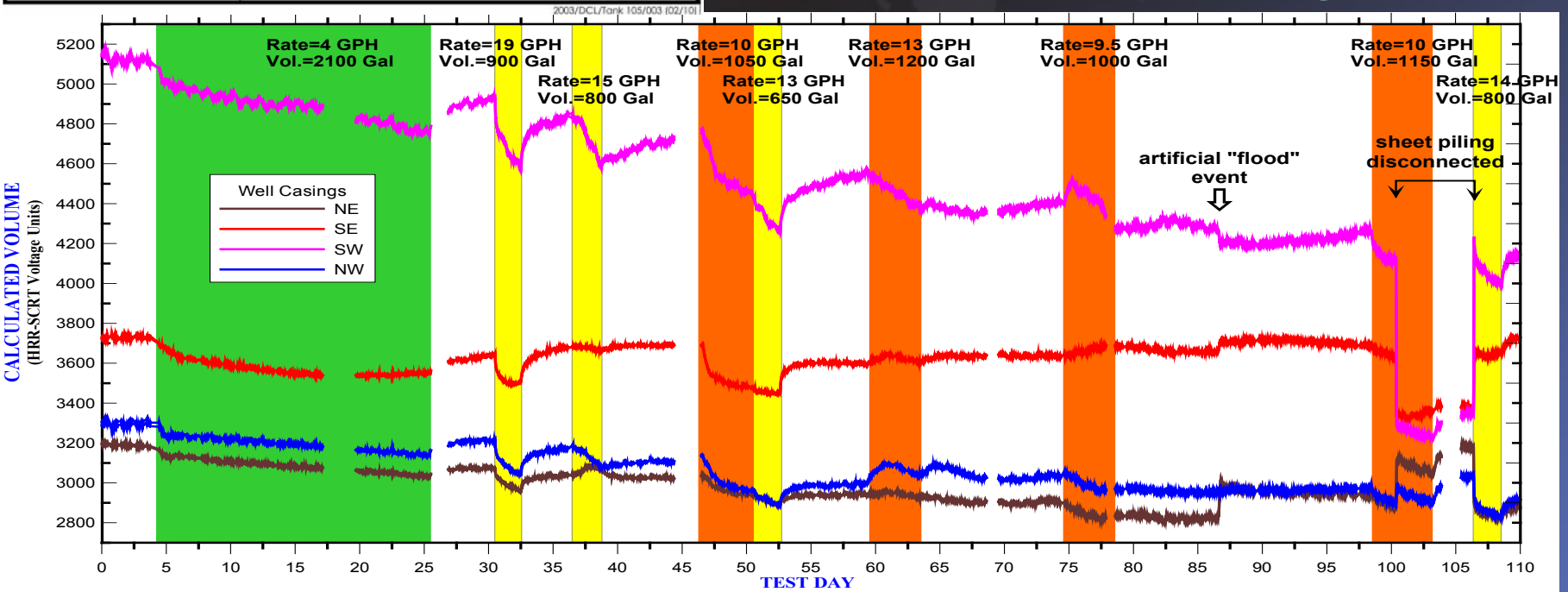




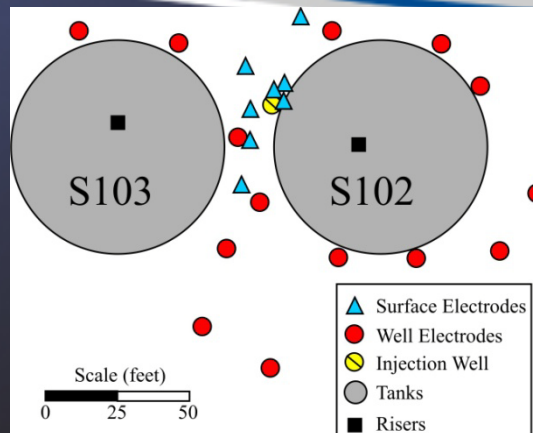
# 1. Onset



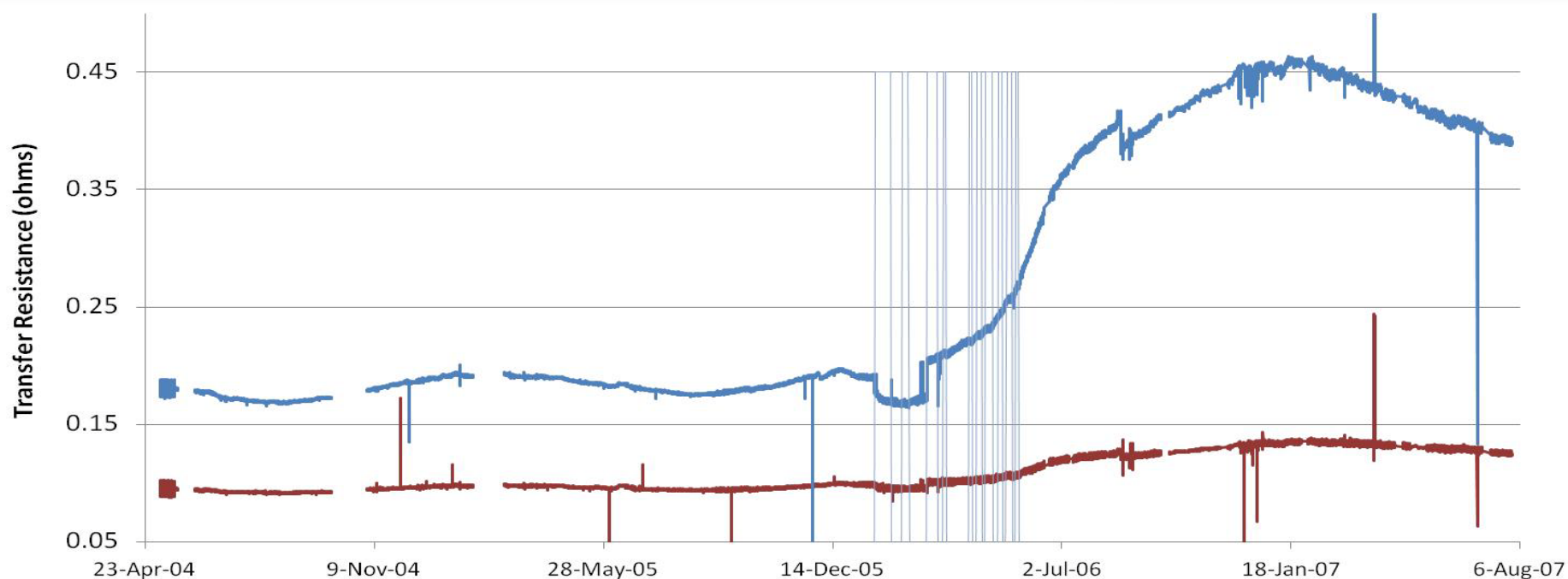
Hanford mock tank monitoring shows onset



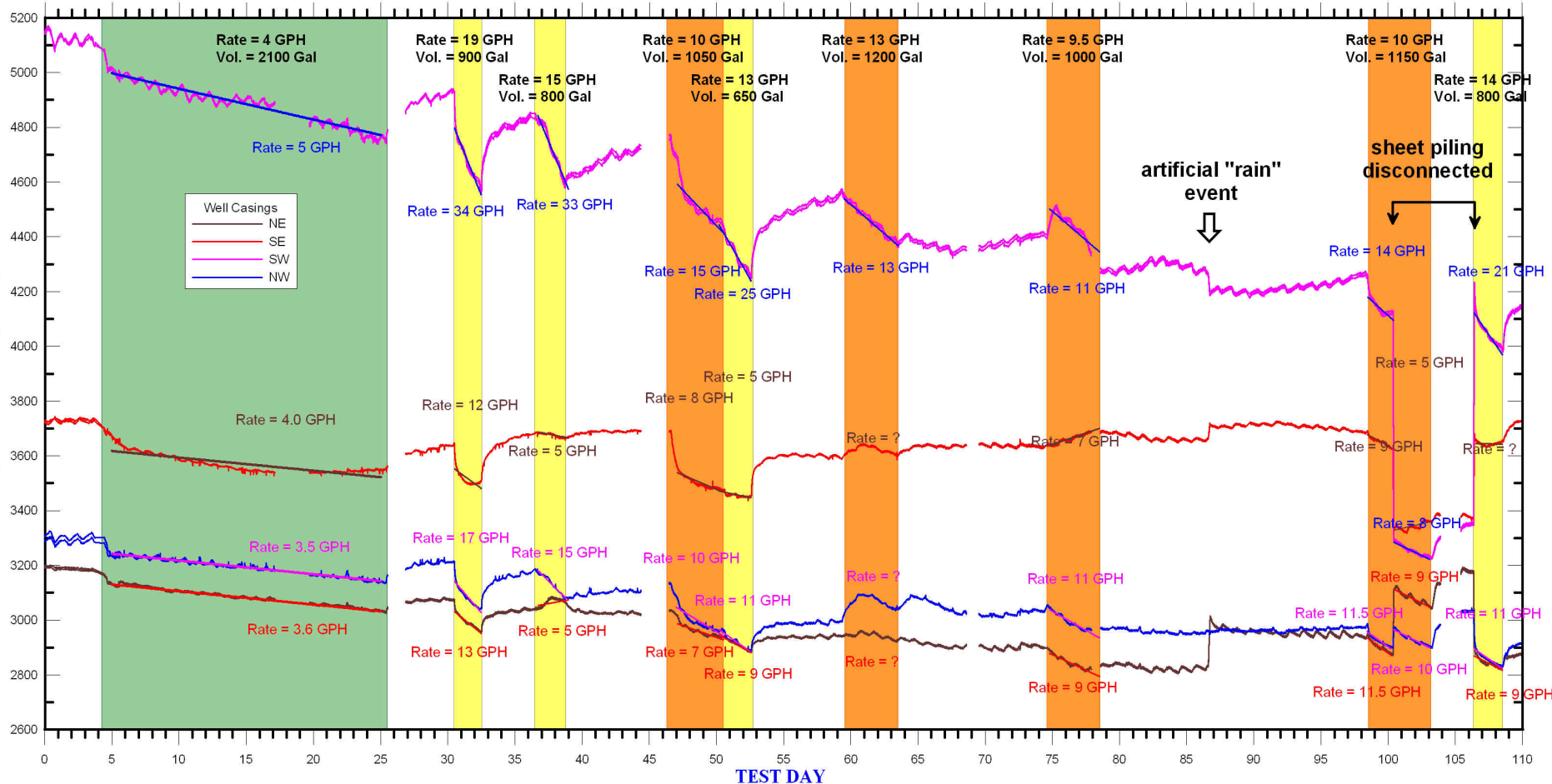
# 1. Onset



Hanford tank farm monitoring (only “leak” from testing in 2005-2006)



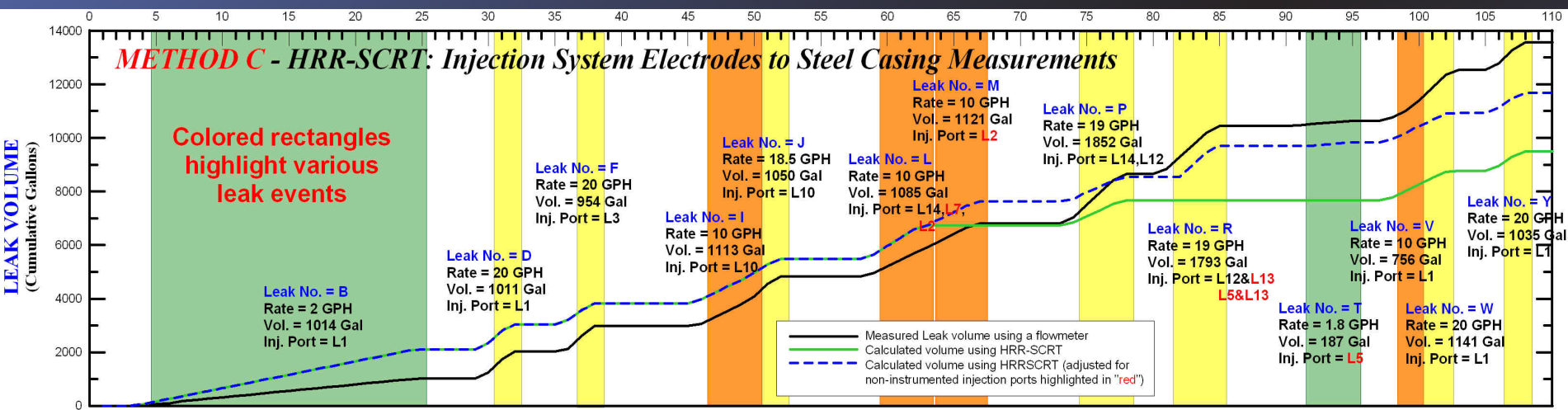
**CALCULATED VOLUME**  
(HRR-SCRT Voltage Units)



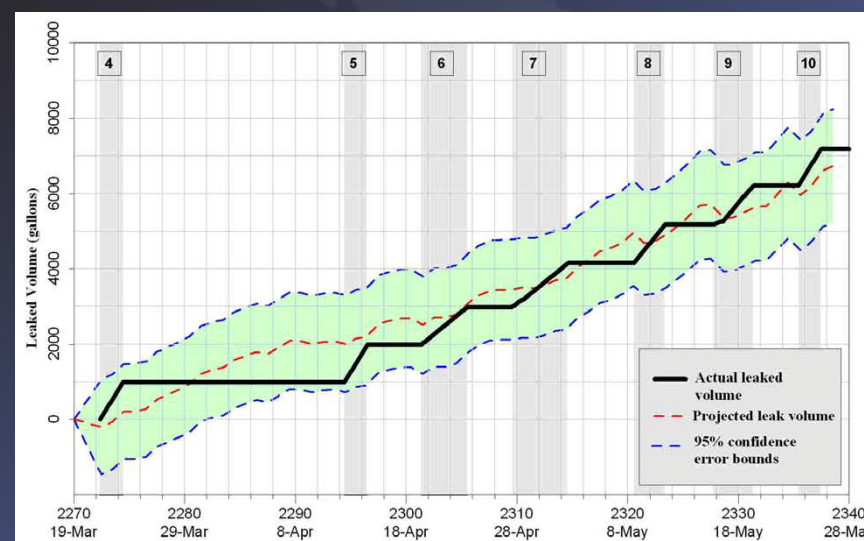
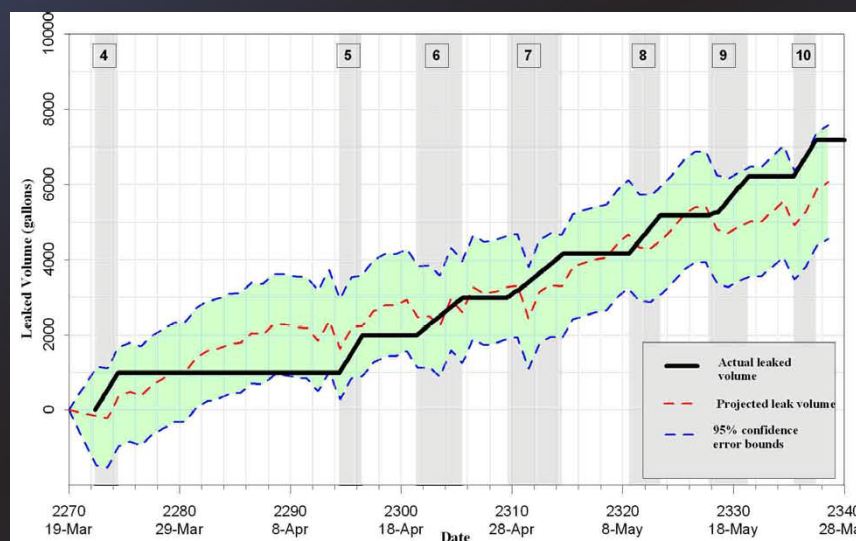


# 2. Leak Rate

## Hanford mock tank monitoring



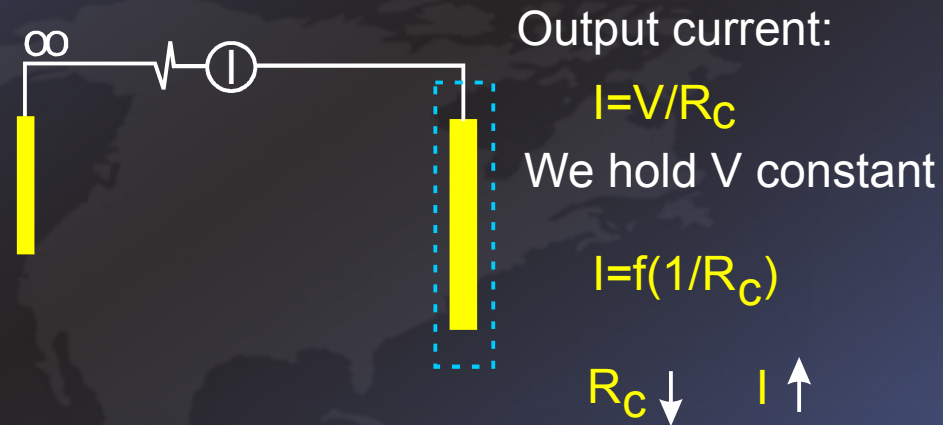
## Hanford tank farm monitoring



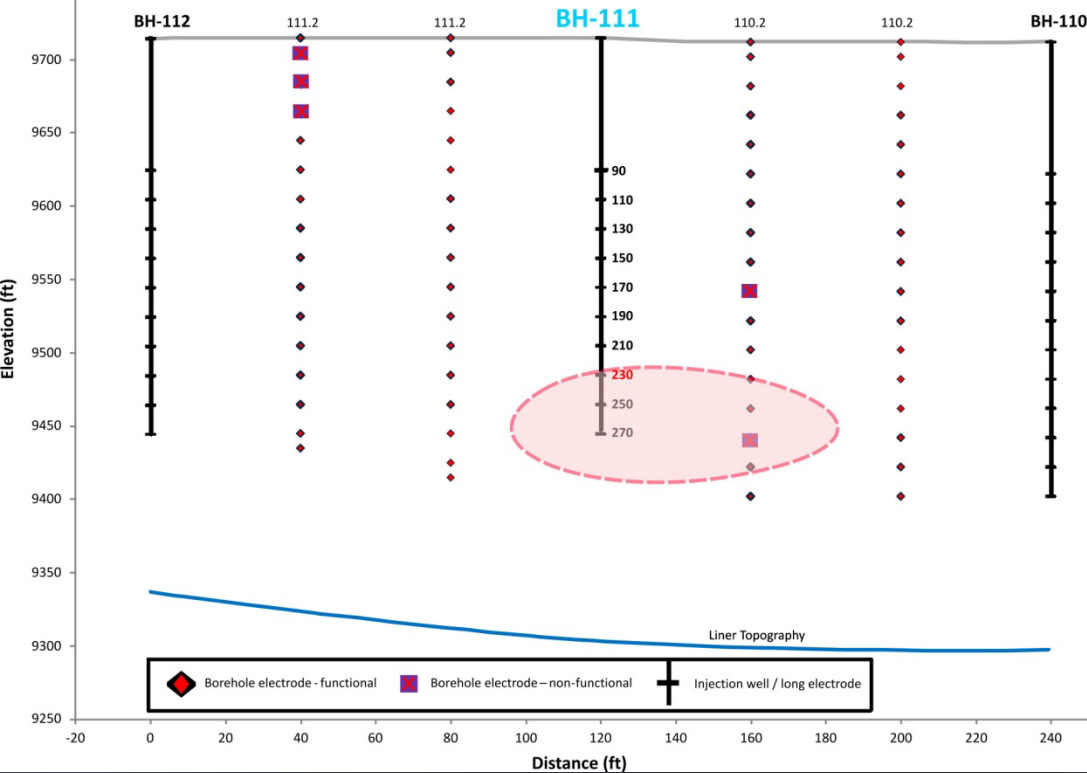


## 3. Leak Location

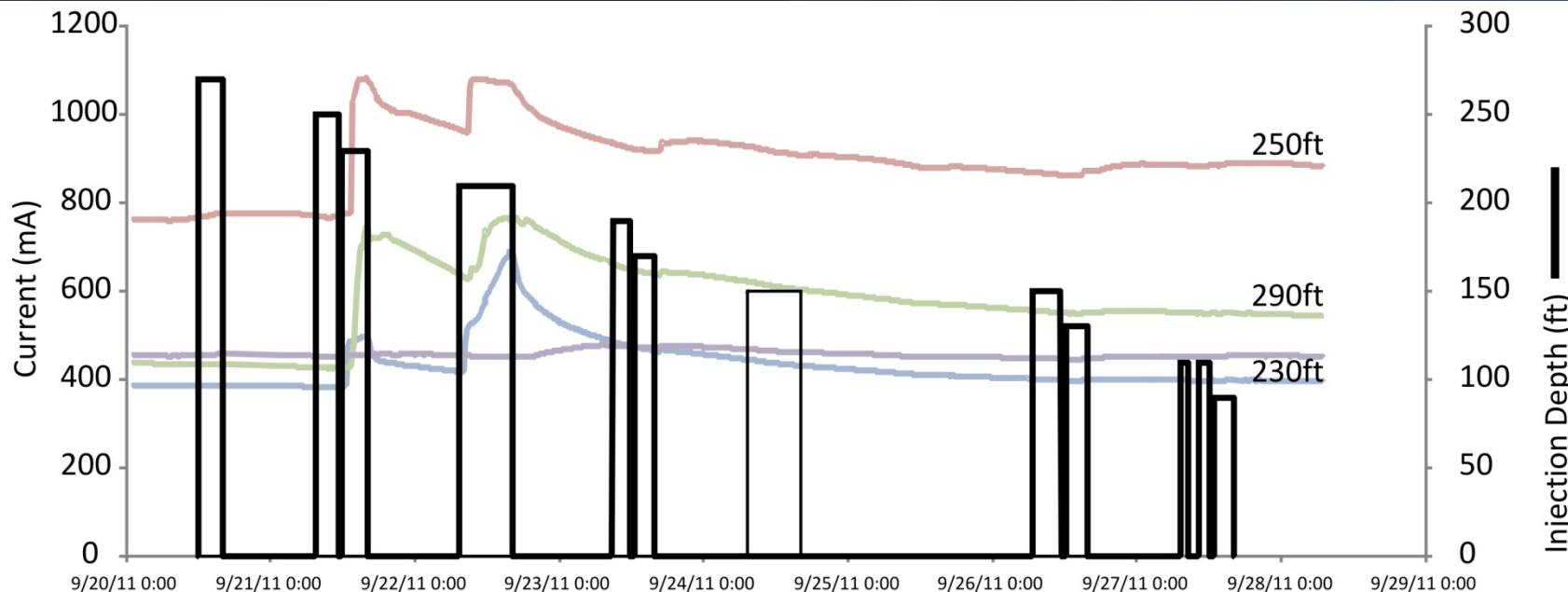
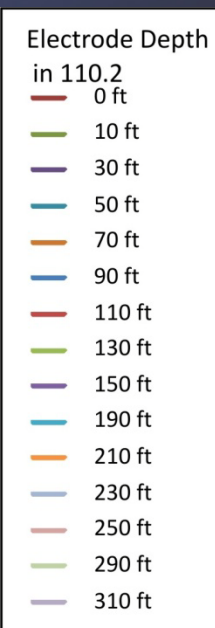
- Real time assessment
  - Measured through current
  - No additional processing
  - Benchmarked at electrode
- Inverse modeling
  - Uses voltage and current data
  - Requires significant processing
  - Produces volumetric images



### 3. Location

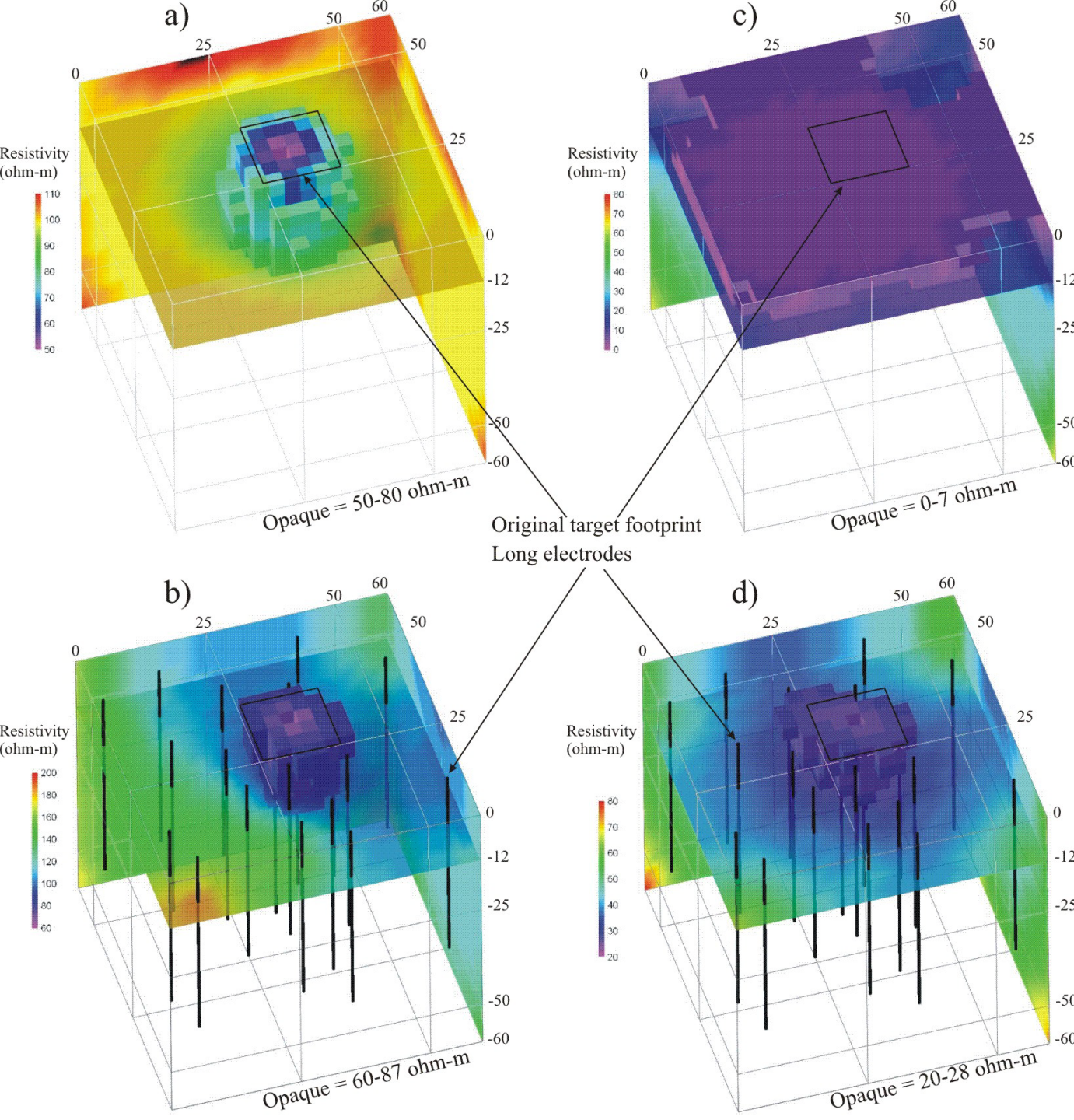


Benchmarking the increase in electrical current





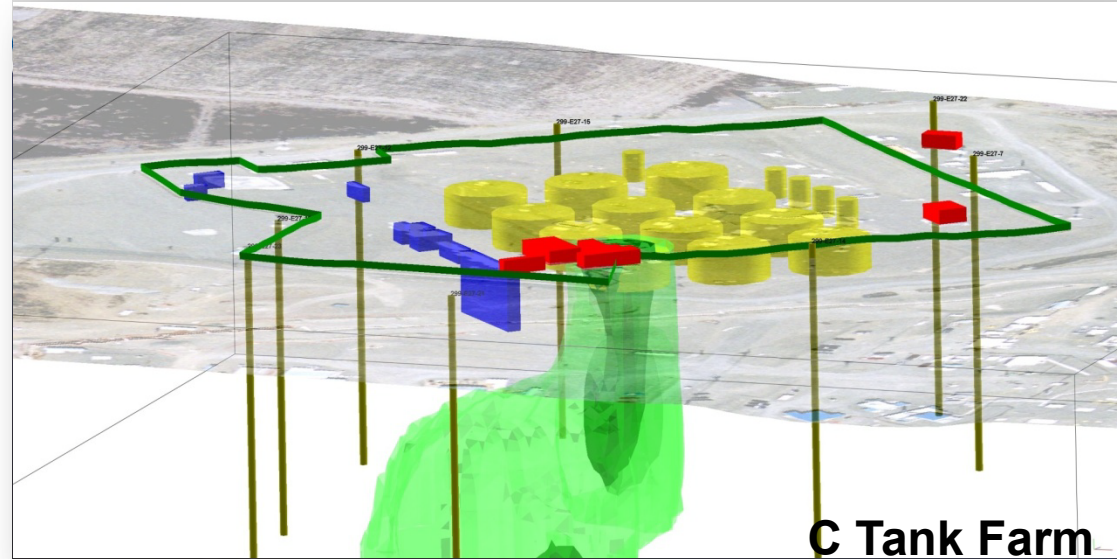
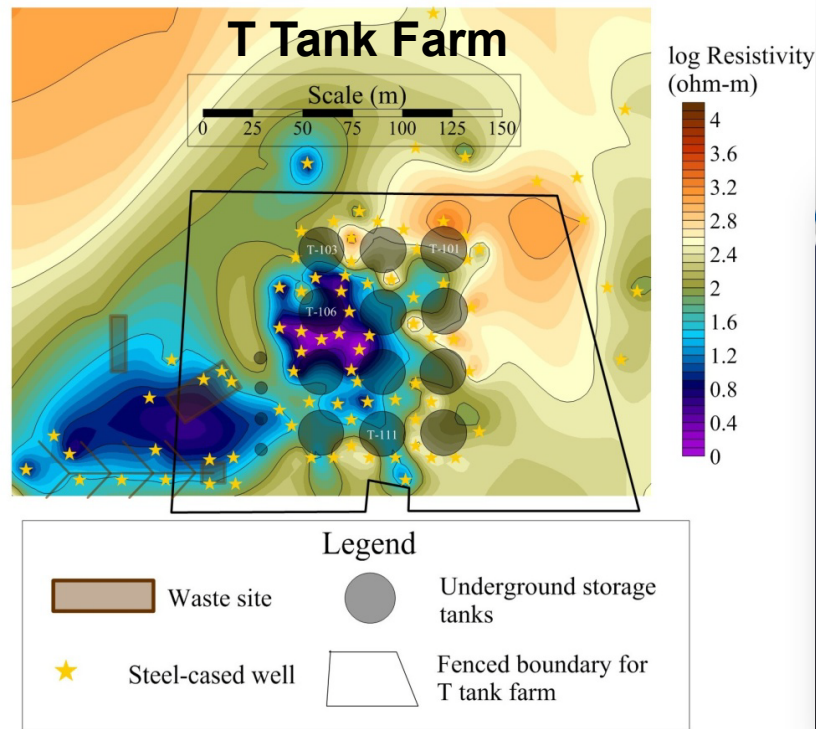
### 3. Location



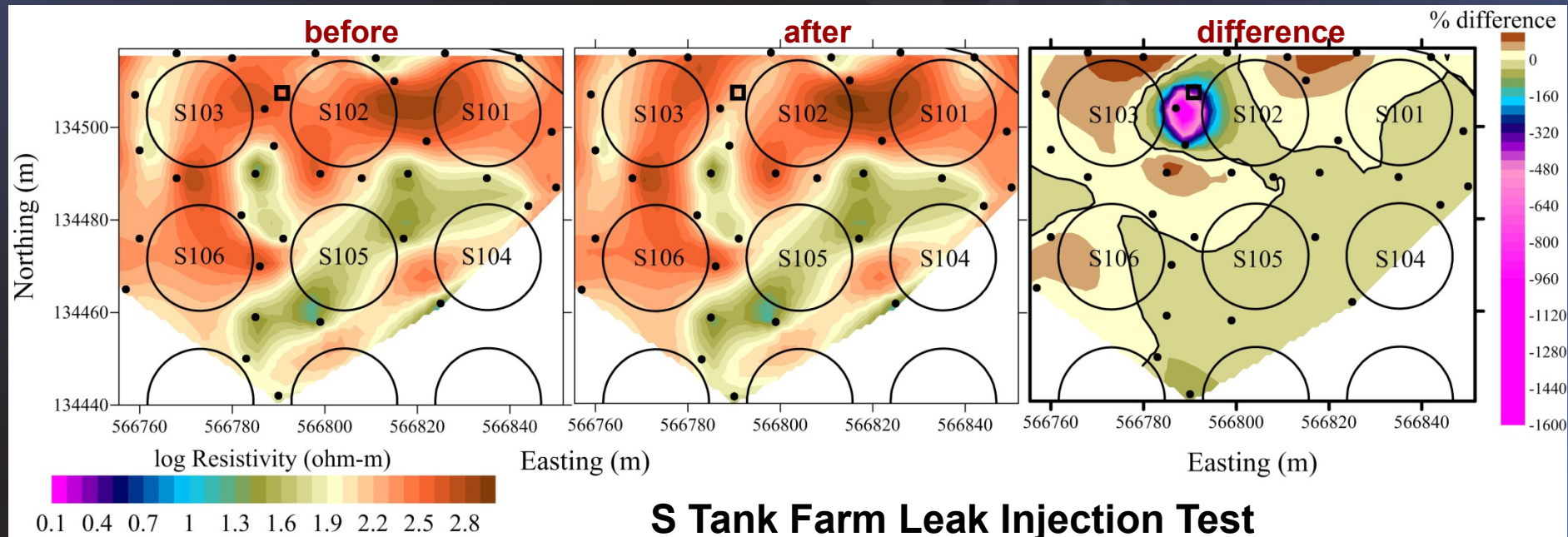
Inverse modeling tests  
comparing surface  
electrodes to wells  
in infrastructure areas



### 3. Location



### Inverse modeling results at Hanford



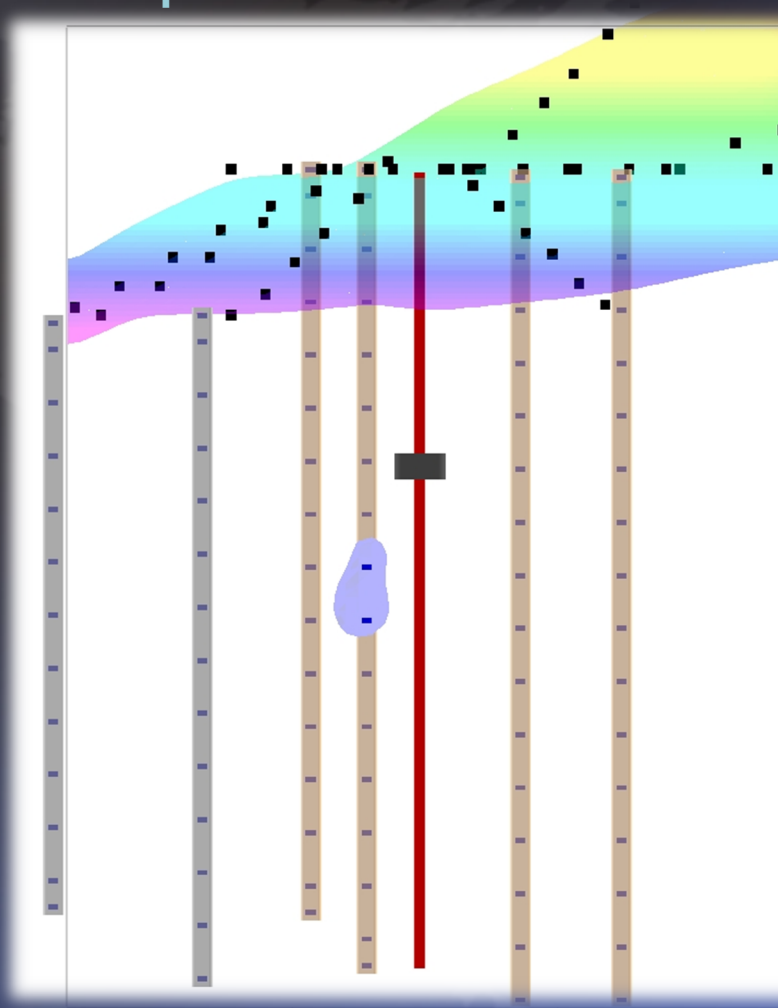
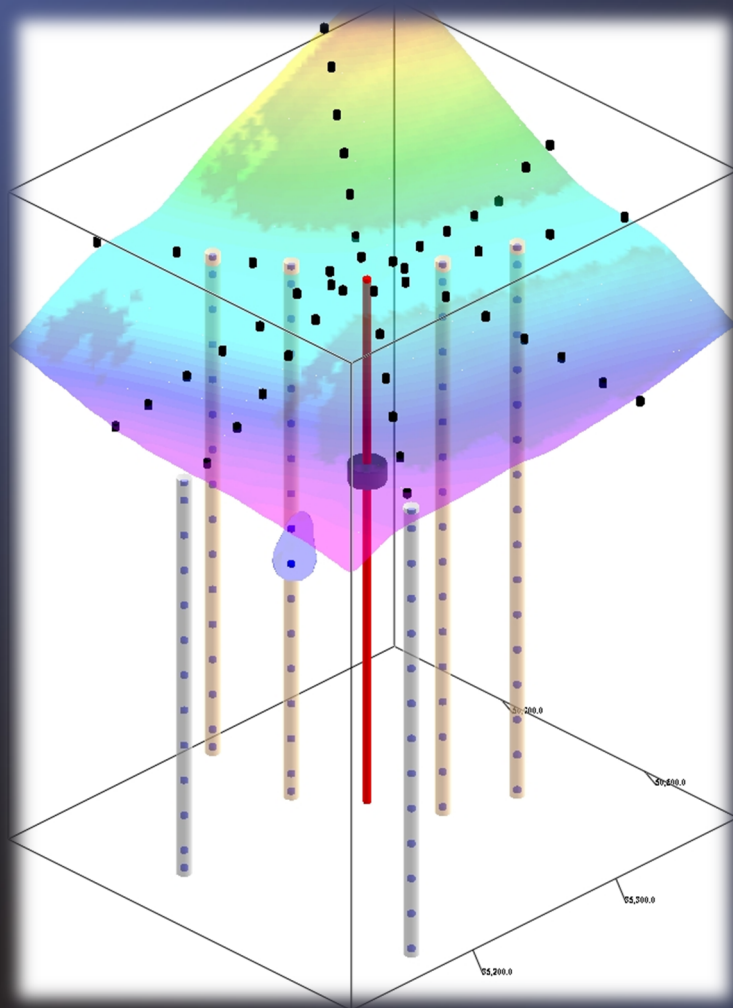


- LDM acquisition systems
  - Installed at Hanford since 2003
  - >99.99% reliable
  - Accurate
  - UL rated
  - NQA-1
- Geotection
  - 180 channels
  - UL Rated
  - Undergoing V&V



# Equipment Capabilities

Time lapse inverse modeling results of injections  
150 electrodes, 18 hours, 74 snapshots





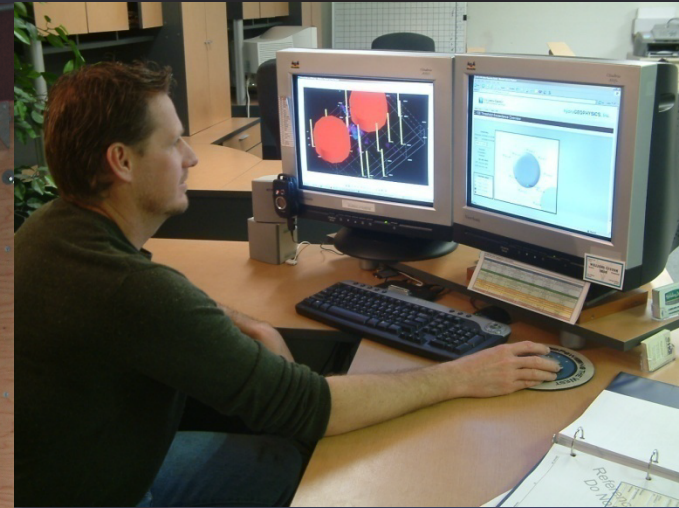
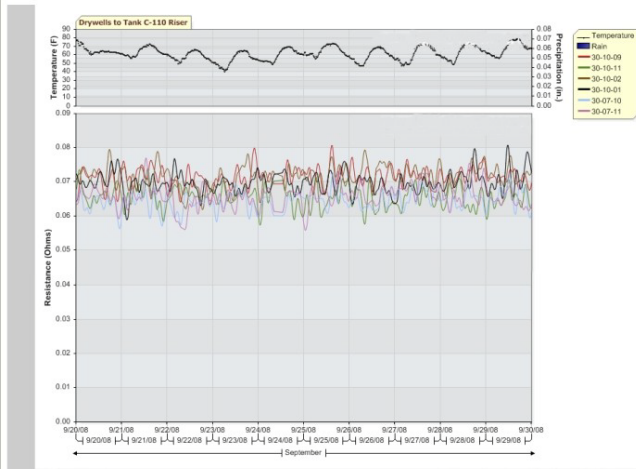
# Program for Nuclear Waste Tank Monitoring

COLUMBIA ENERGY  
& Environmental Services

hydroGEOPHYSICS, Inc.

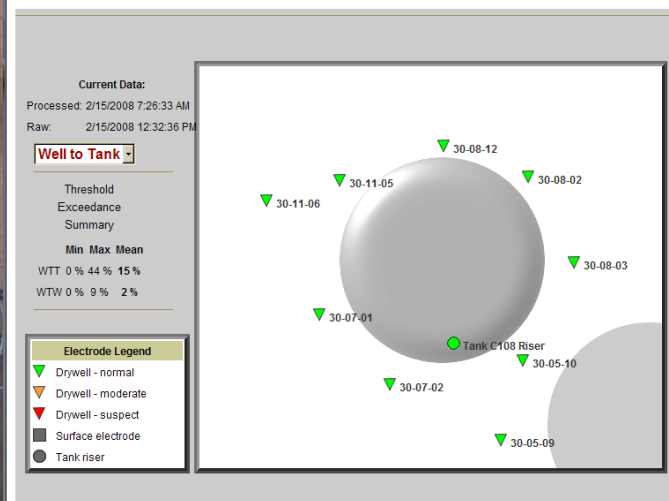
Select Farm > C Farm > Selected Distance Corrected VIFs Displayed

Charted data



Select Farm > C Farm > Tank C-108

C-108 Threshold Exceedance Overview



## LDM Automated System

*LDM AutoPro and AutoView Software:*

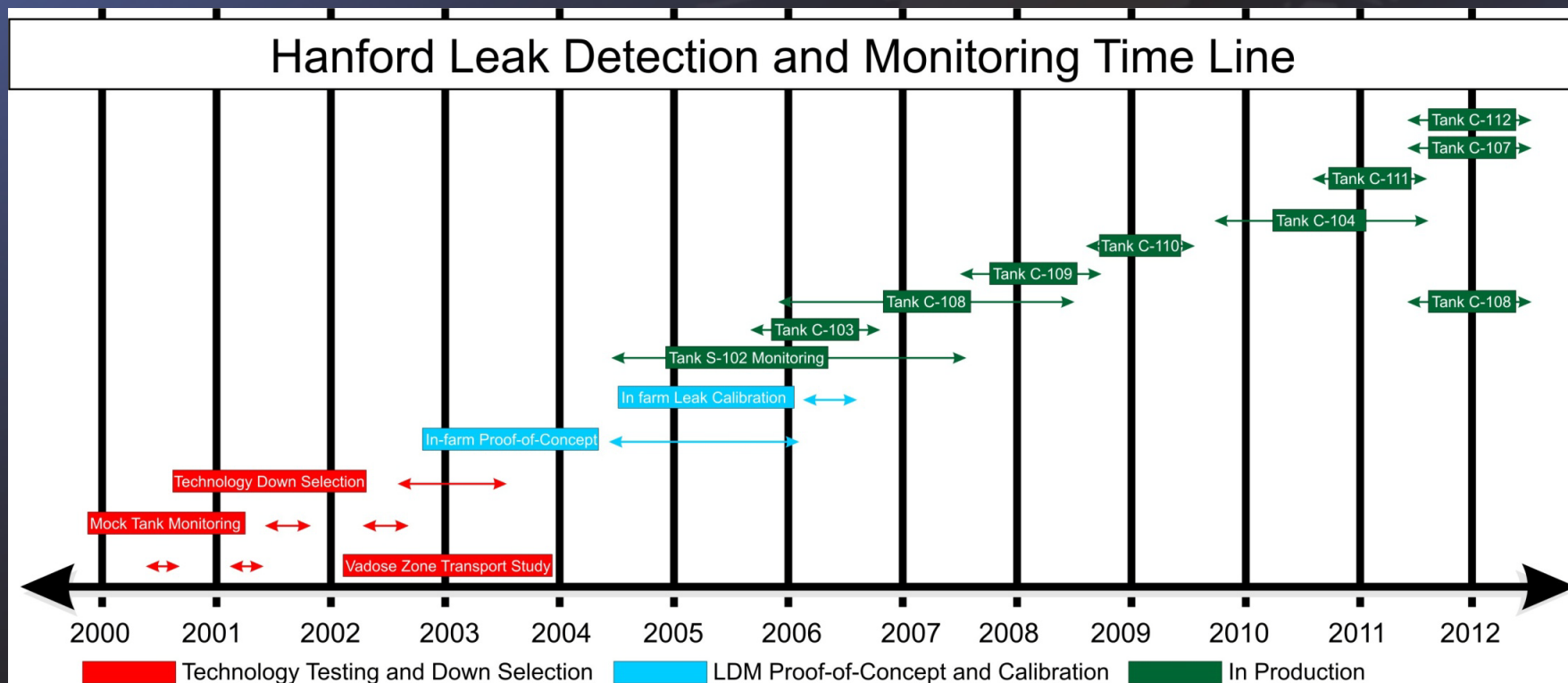
- Near Real Time Data Processing
- Automated Data Assessment
- Web Based for Remote Access

*Operations:*

- 24/7 System Status Monitoring
- Daily Expert Visual Assessment

# Program Development

## Demonstrating longevity of monitoring at Hanford



## Issues

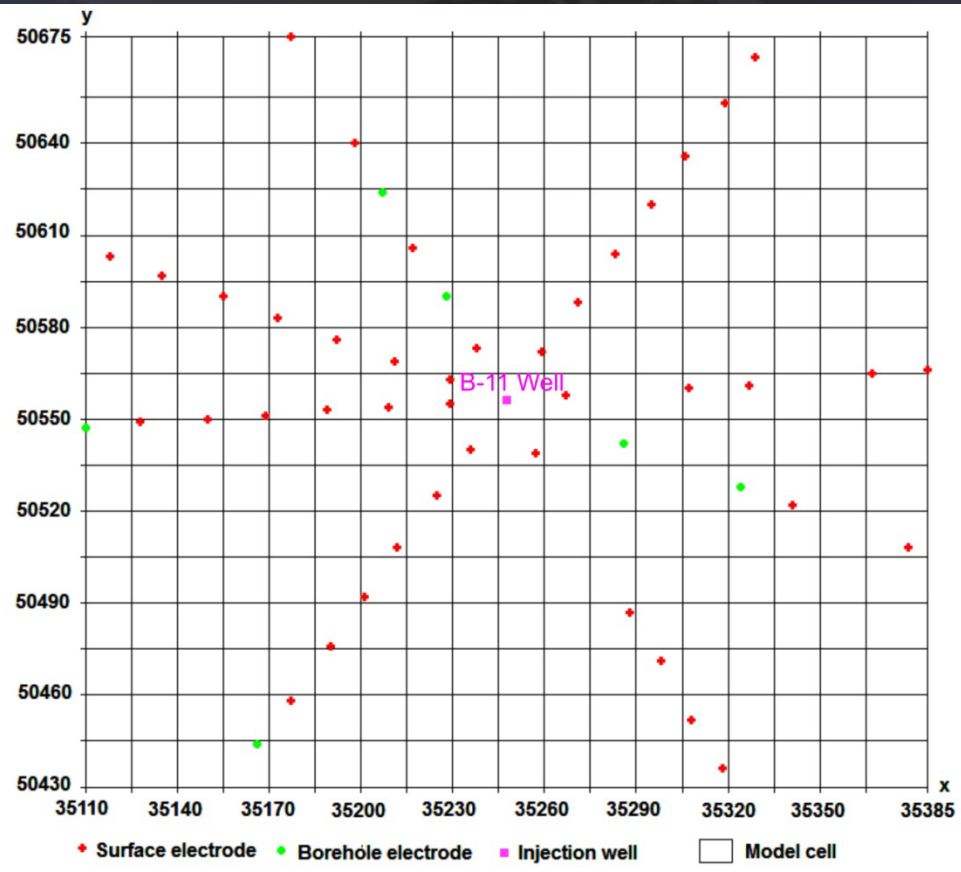
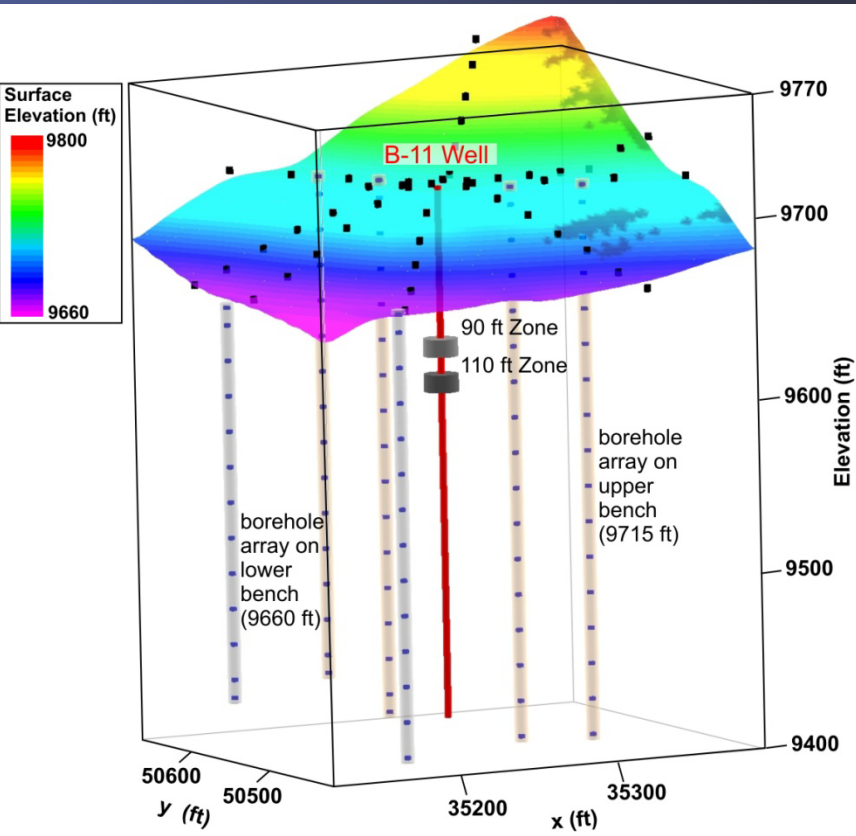
- Installation
- Cathodic Protection
- Precipitation
- Safety
- Reliability
- Integrity

## Solutions

- Use site infrastructure
- Creative electrodes
- Filter random noise
- Turn off for inversion
- On-site weather station
- System alarms
- On-site maintenance
- Yearly calibration
- Redundant systems
- Quality assurance



- Many innovative solutions for
  - Leak onset
  - Leak rate
  - Leak location
- The right equipment is important
  - Temporal context
  - Low noise
- Each site will have unique challenges
  - Testing necessary to understand them
  - Will force us to think creatively



# Wells as Electrodes

- Steel casings are well grounded
- Steel casings are long (deep)
- Part of existing infrastructure
- New and expensive drilling is not required
- Borehole logs are usually available
- Neutron logging can be performed