



# Industrial applications of real-time electrical monitoring

Dale Rucker – Chief Technical Officer

- 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

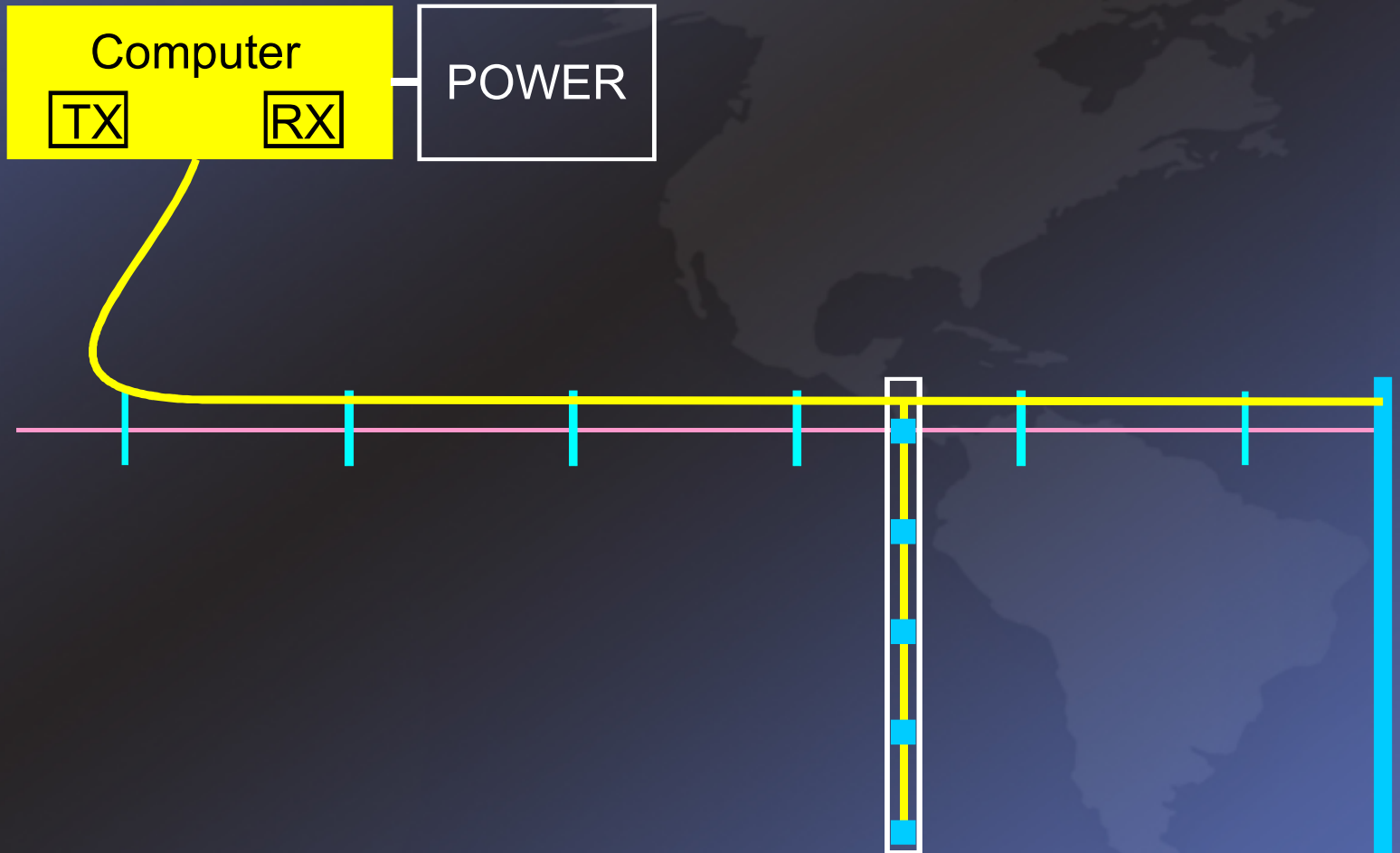
A photograph showing a blue pipe in a trench. A white, frothy substance is leaking from a hole in the pipe, indicating a leak. The background is dark soil.

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

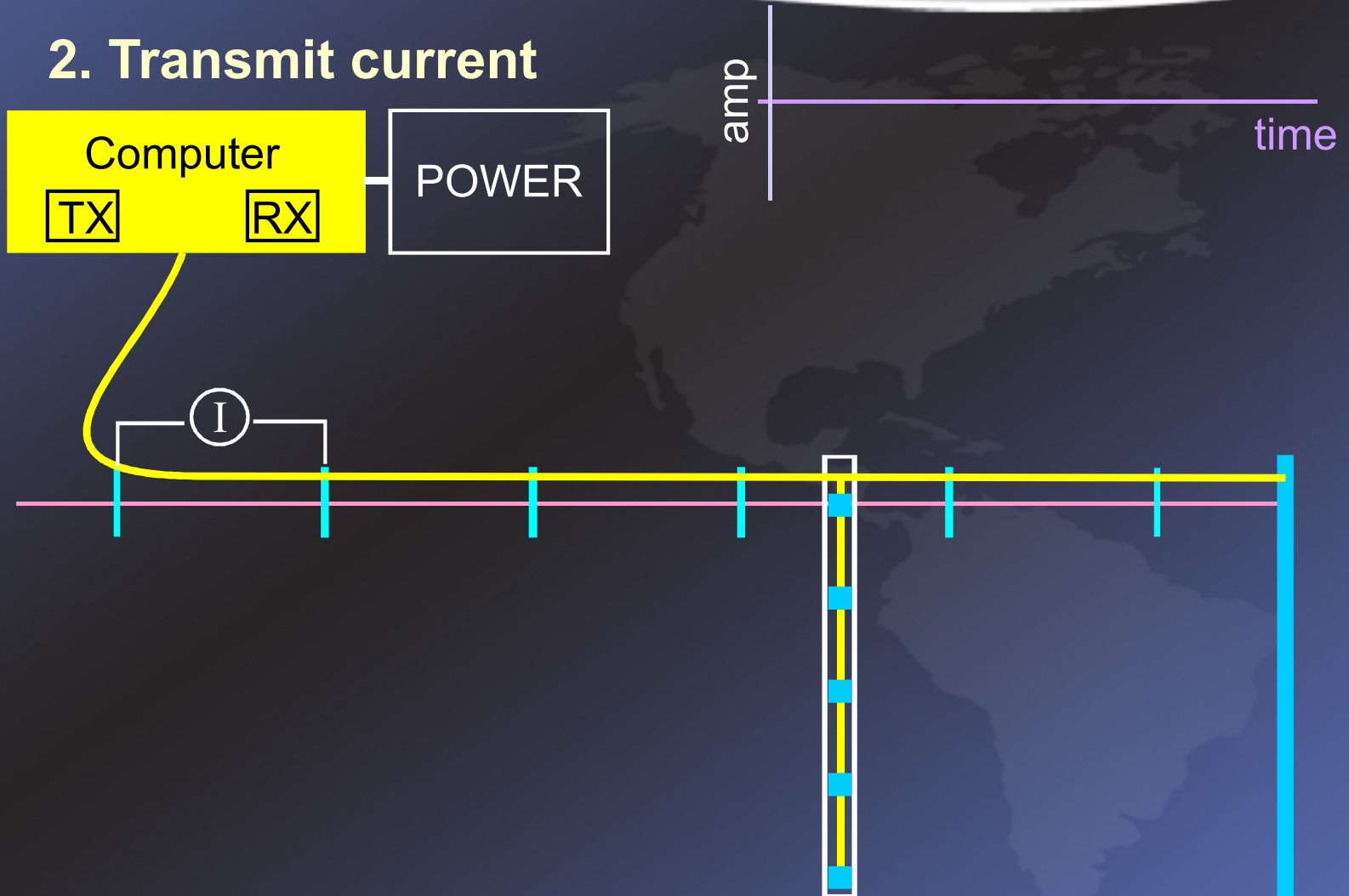
## 1. Set up





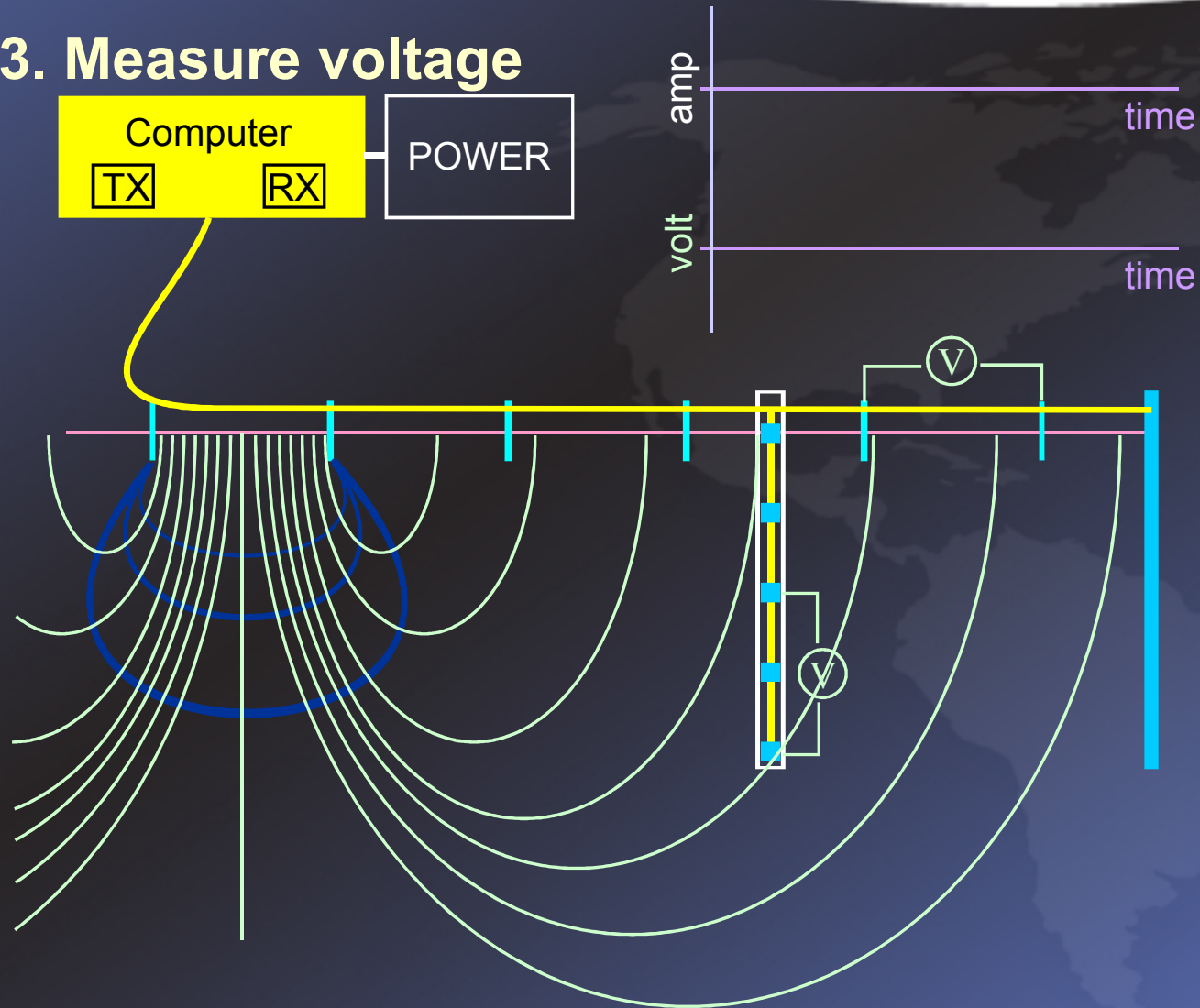
# Resistivity measurements

## 2. Transmit current



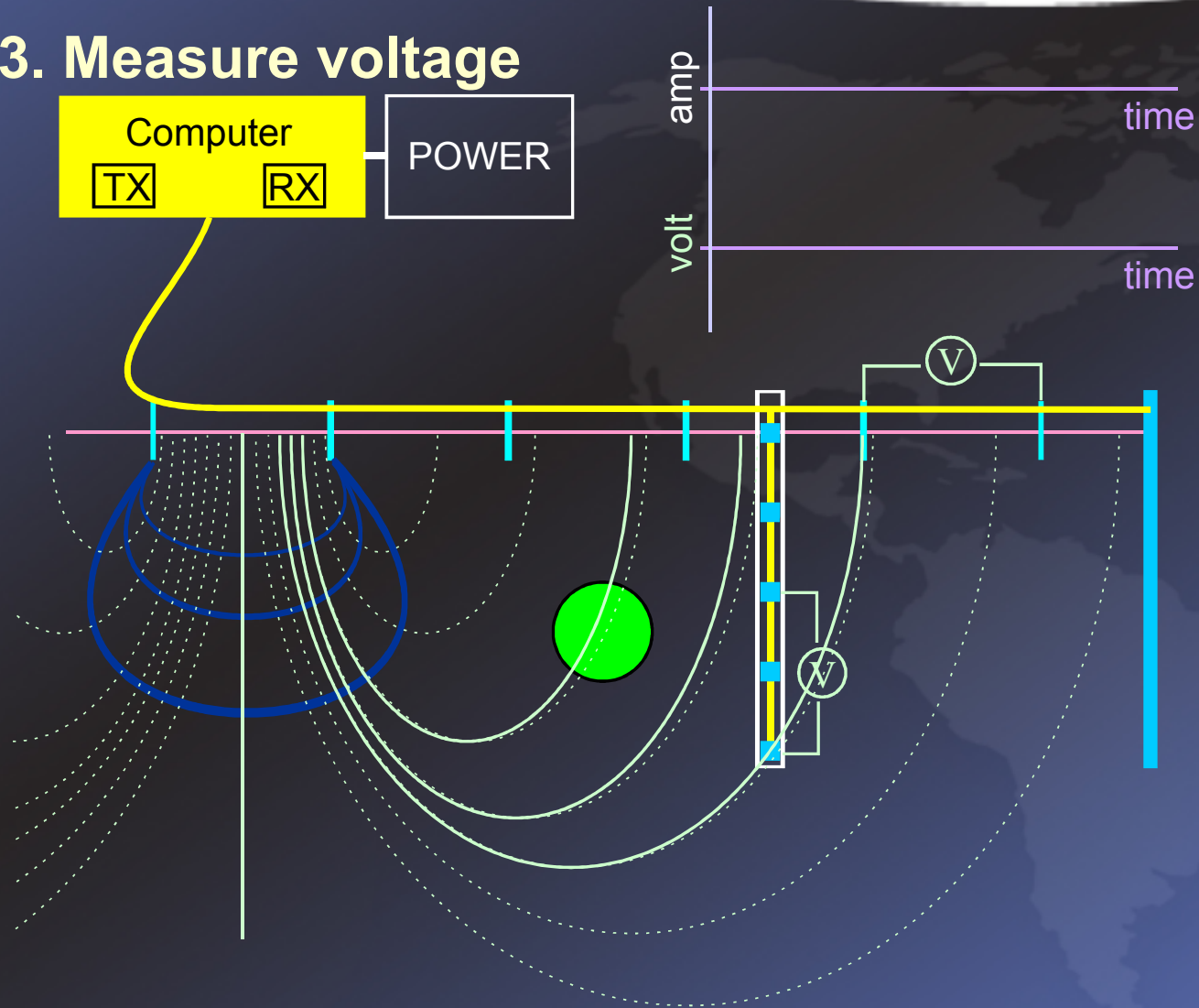
# Resistivity measurements

## 3. Measure voltage



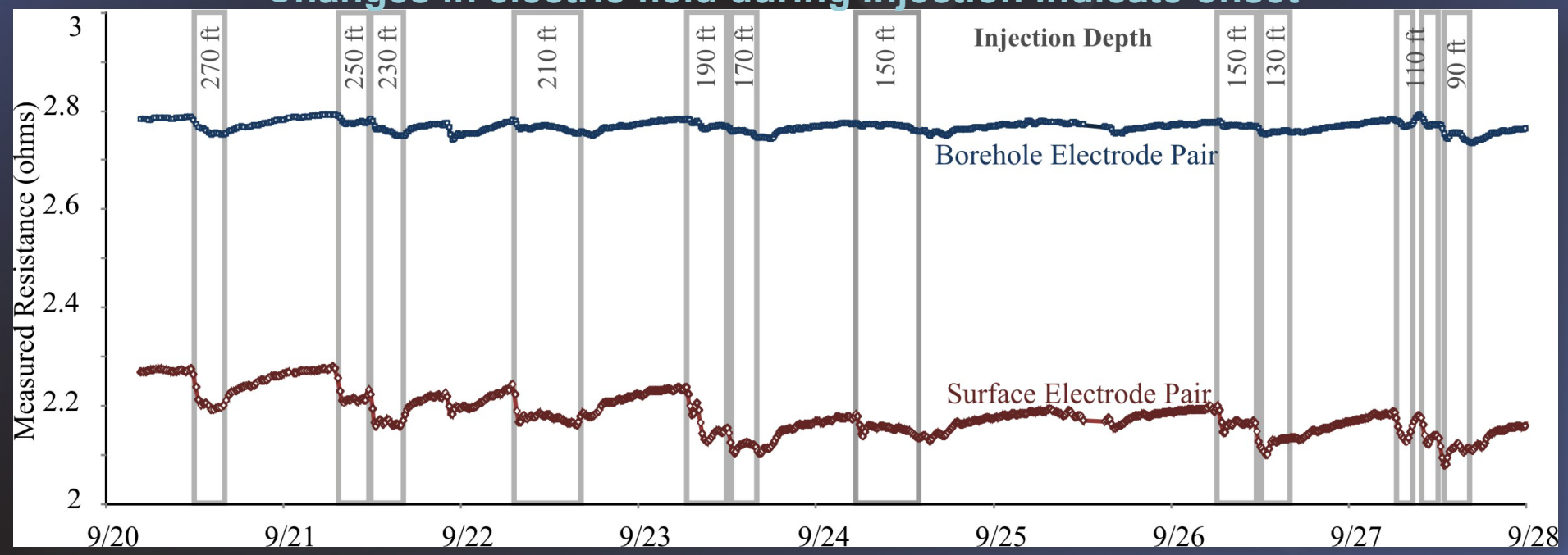
# Resistivity measurements

## 3. Measure voltage



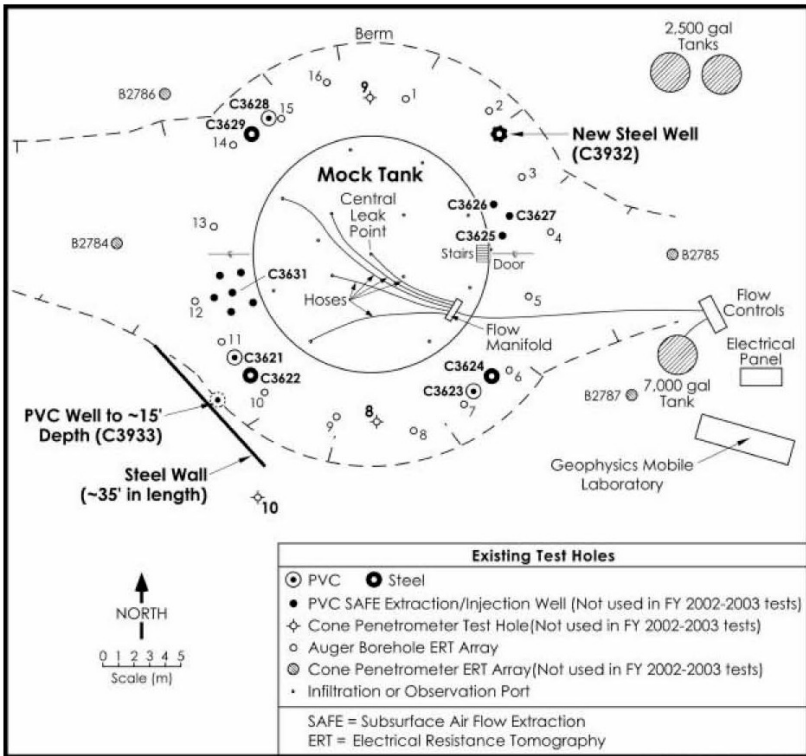


Changes in electric field during injection indicate onset

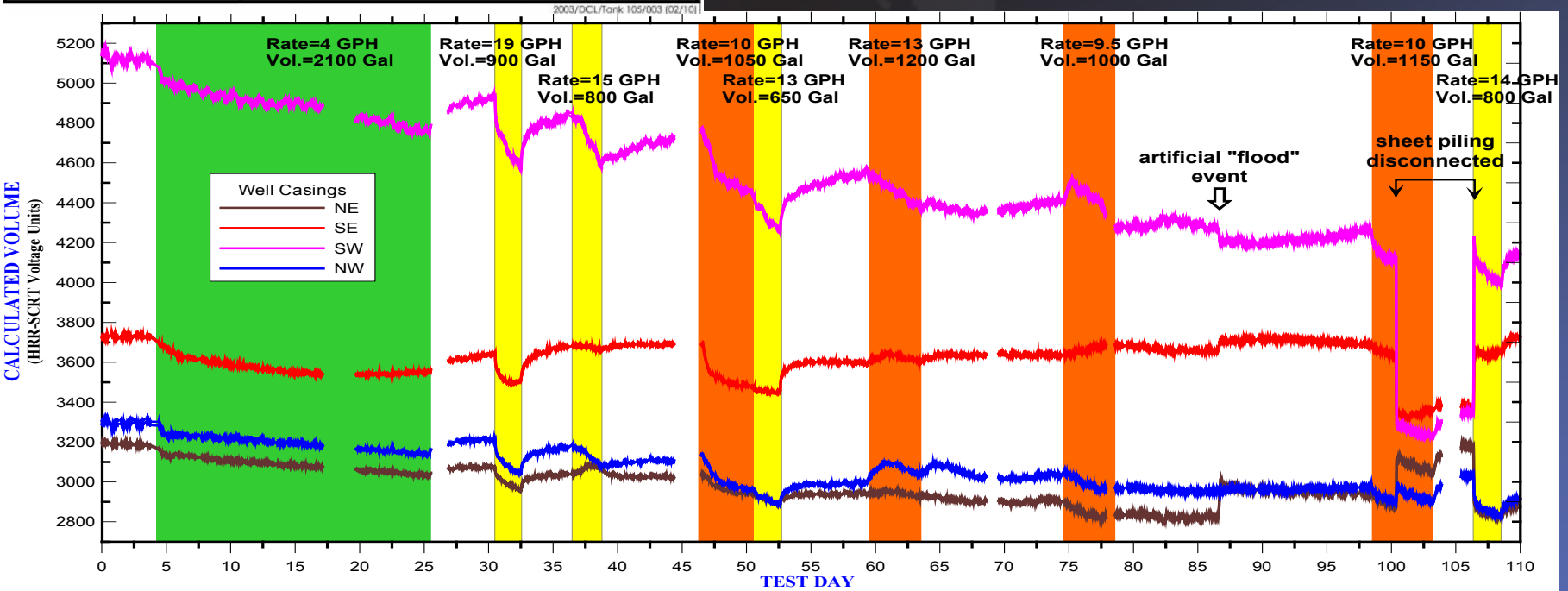


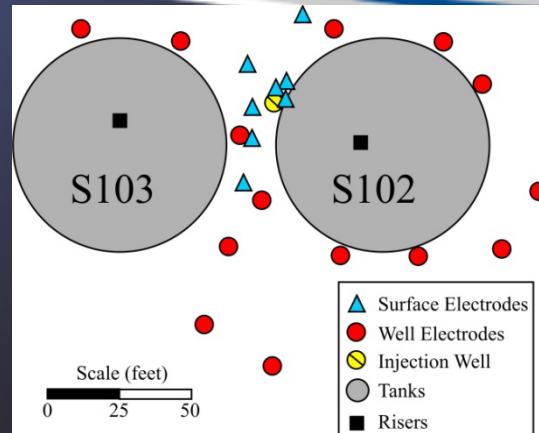


# 1. Onset

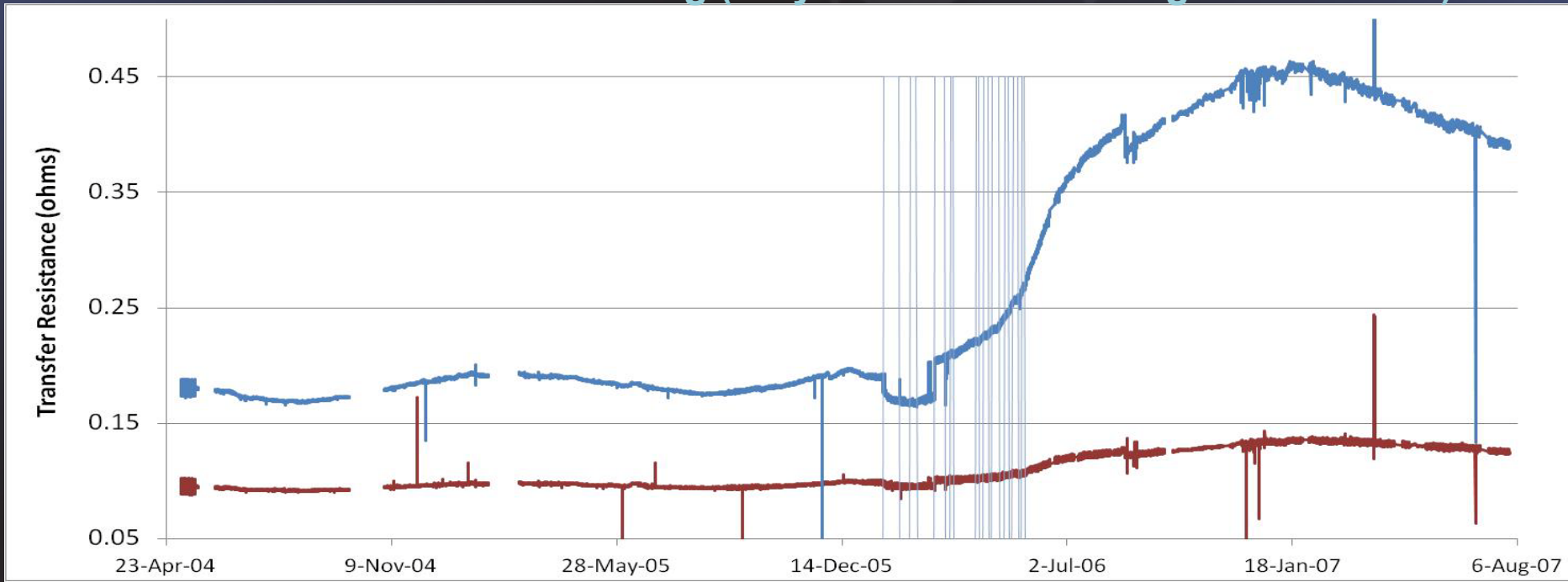


Hanford mock tank monitoring shows onset

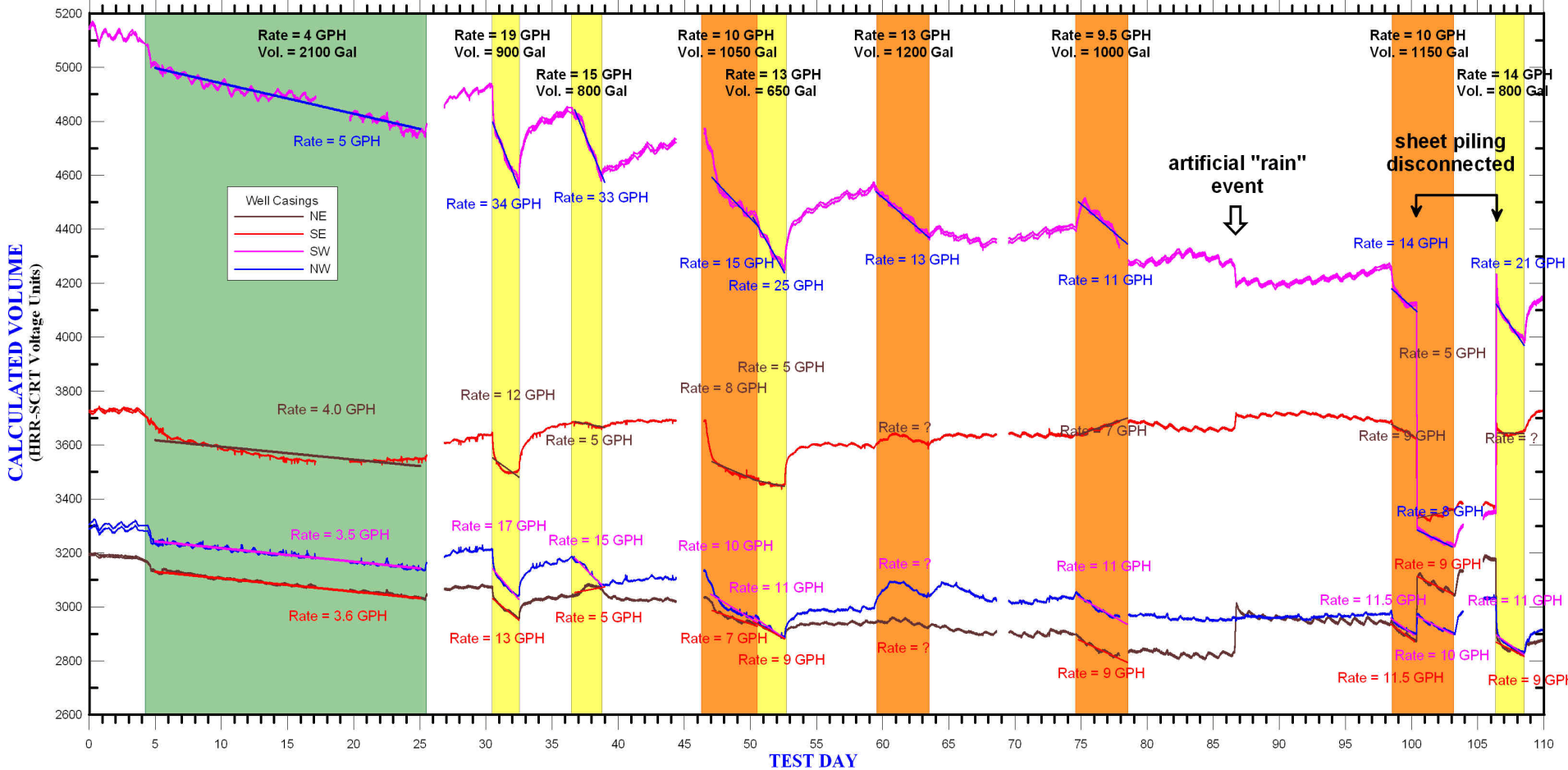




Hanford tank farm monitoring (only "leak" from testing in 2005-2006)



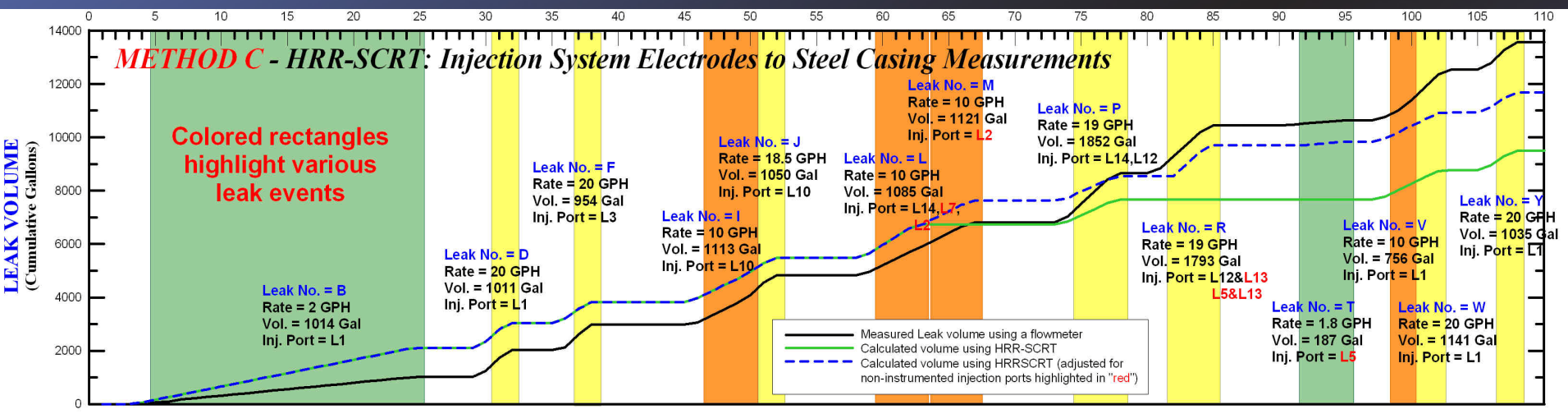
## Hanford mock tank monitoring (voltage slope proportional to leak rate)



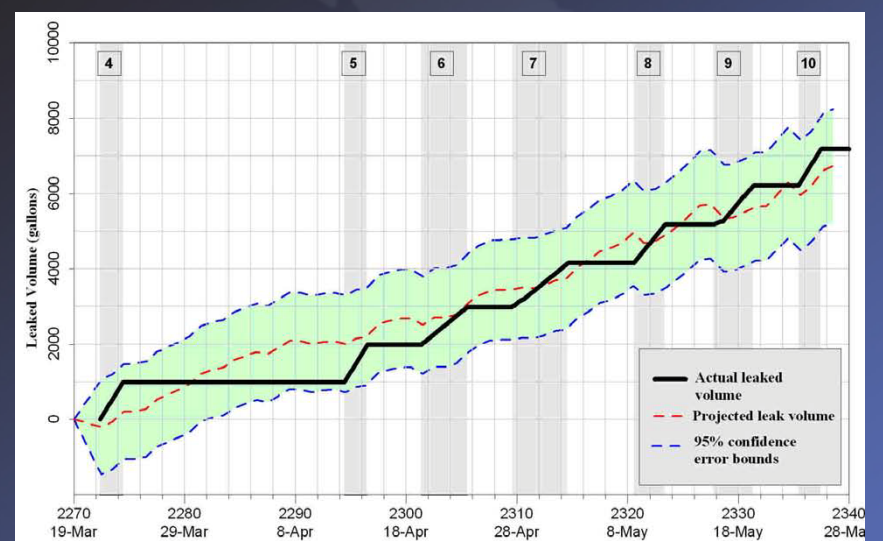
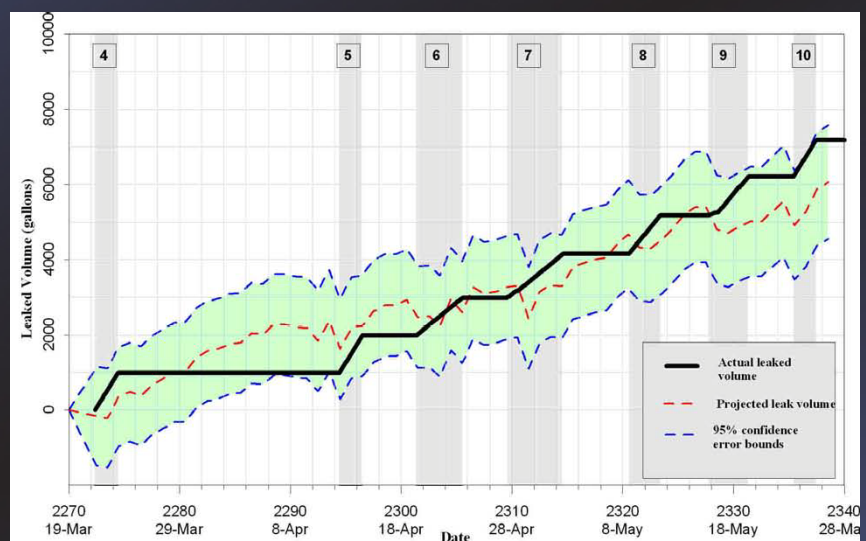


# 2. Leak Rate

## Hanford mock tank monitoring



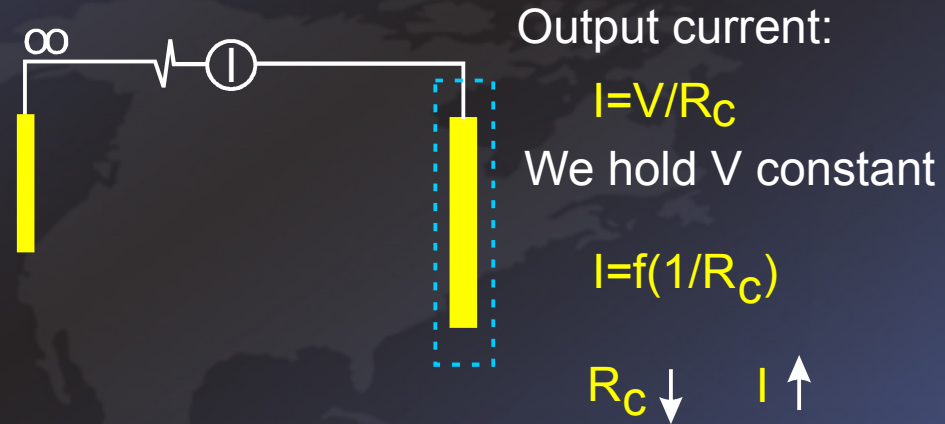
## Hanford tank farm monitoring



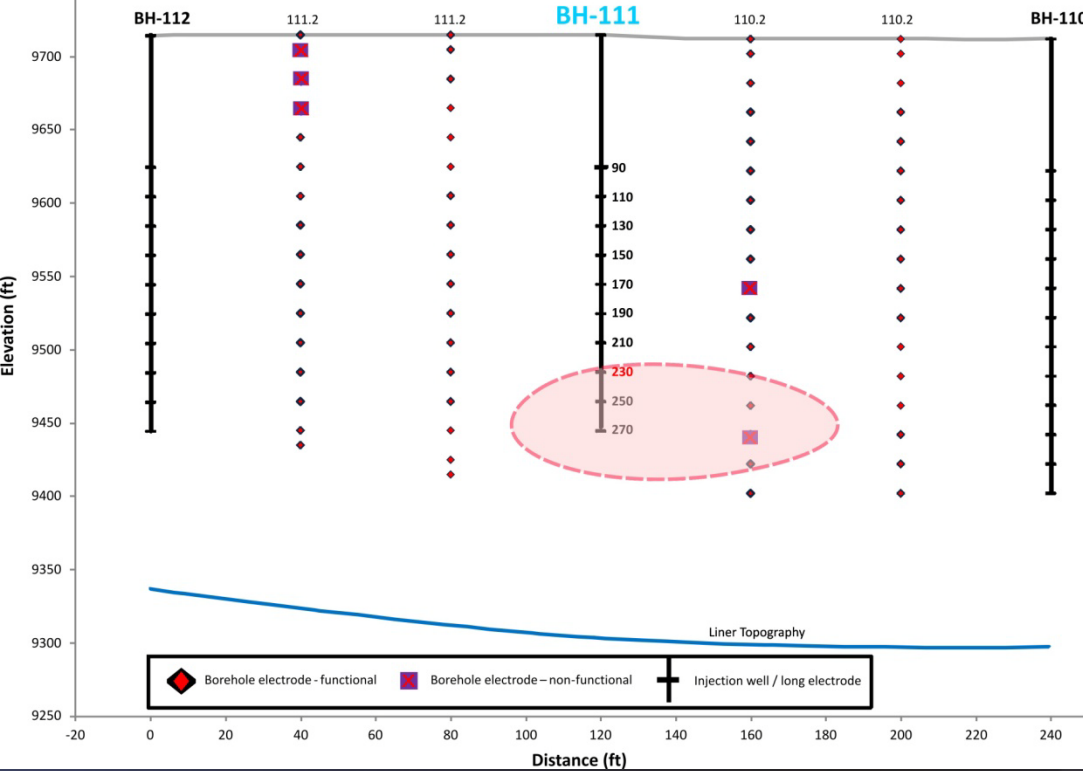


## 3. Leak Location

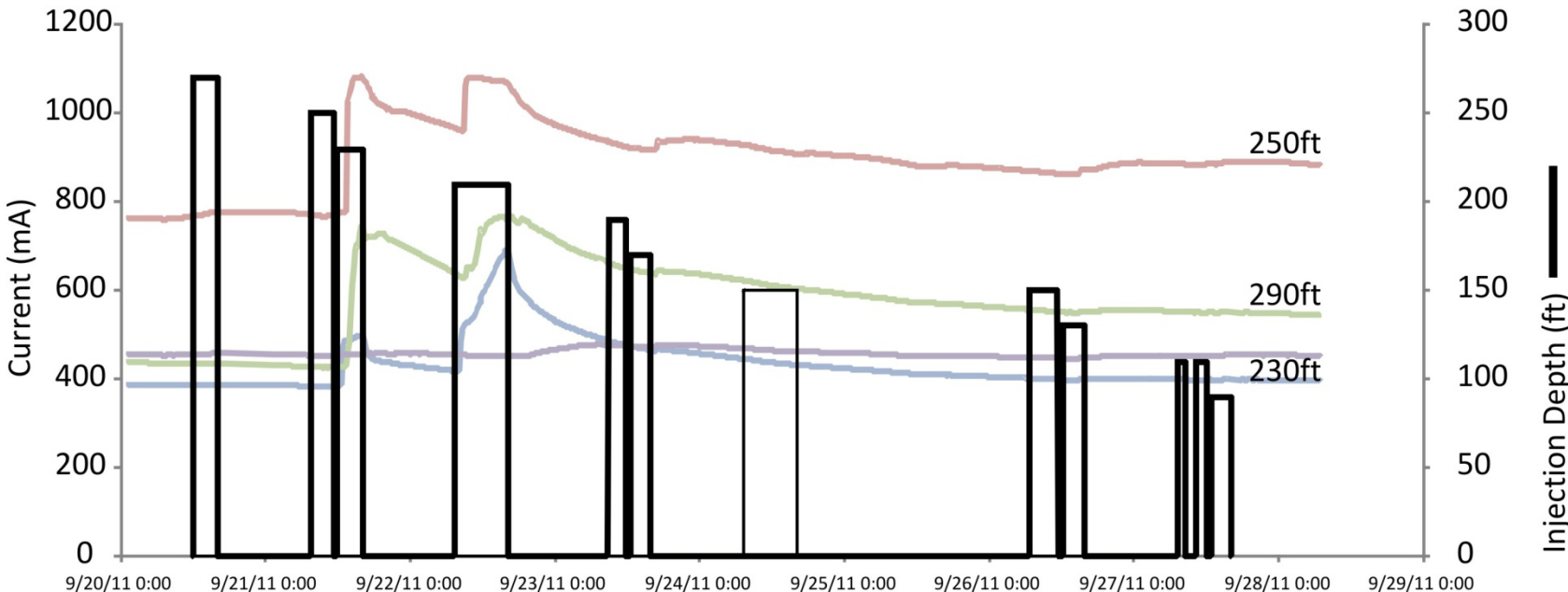
- Real time assessment
  - Measured through current
  - No additional processing
  - Benchmarked at electrode
- Inverse modeling
  - Uses voltage and current data
  - Requires significant processing
  - Produces volumetric images



# 3. Location

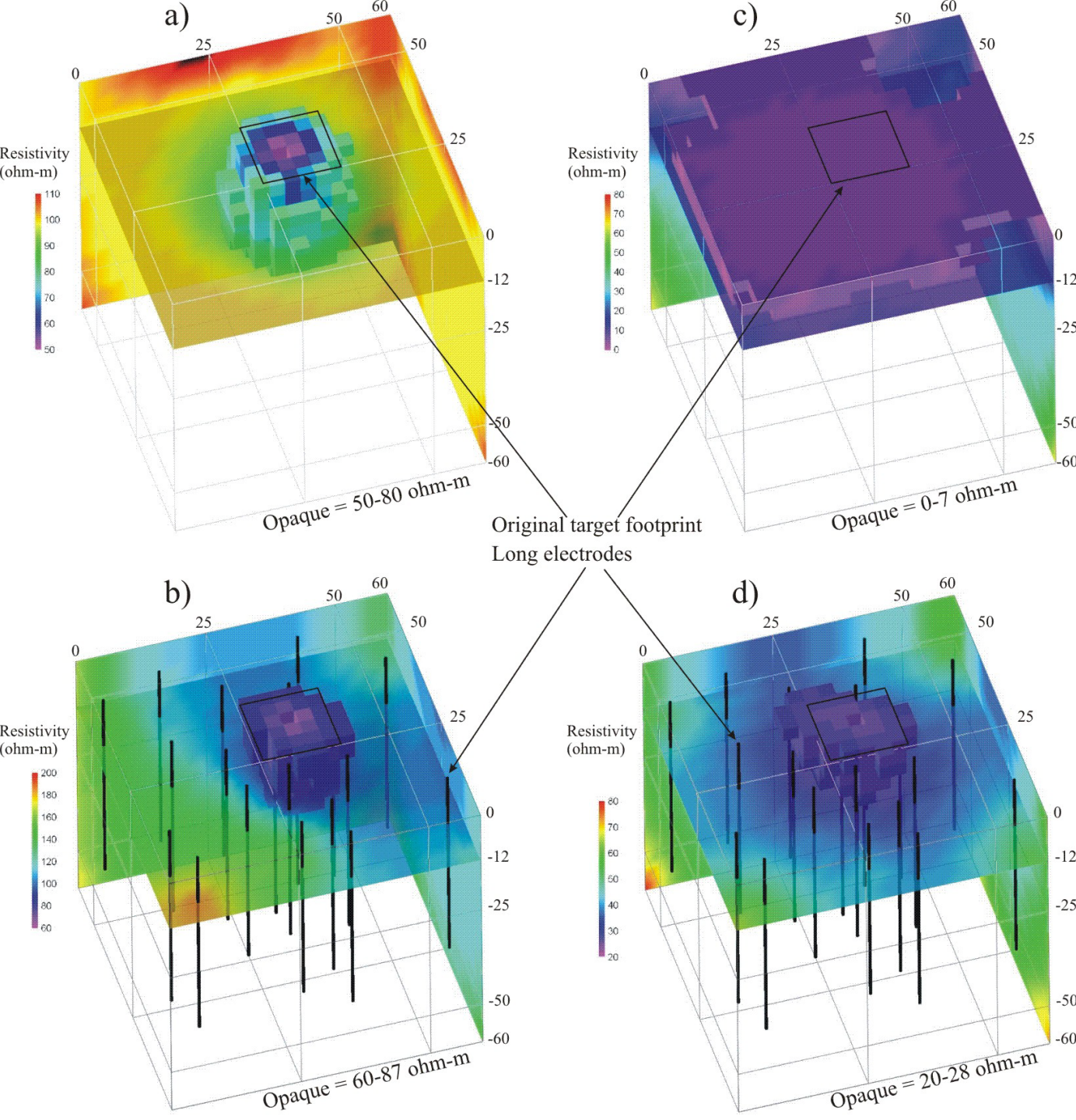


Benchmarking the increase in electrical current





# 3. Location

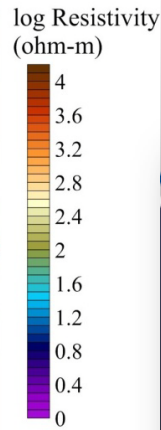
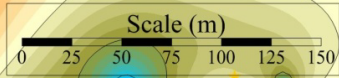


Inverse modeling tests comparing surface electrodes to wells in infrastructure areas



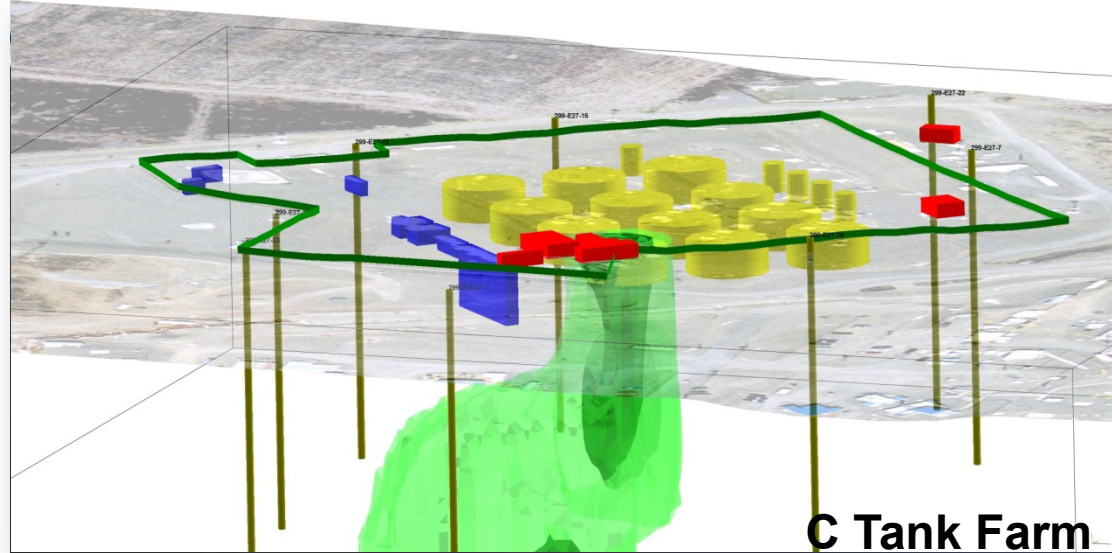
# 3. Location

## T Tank Farm

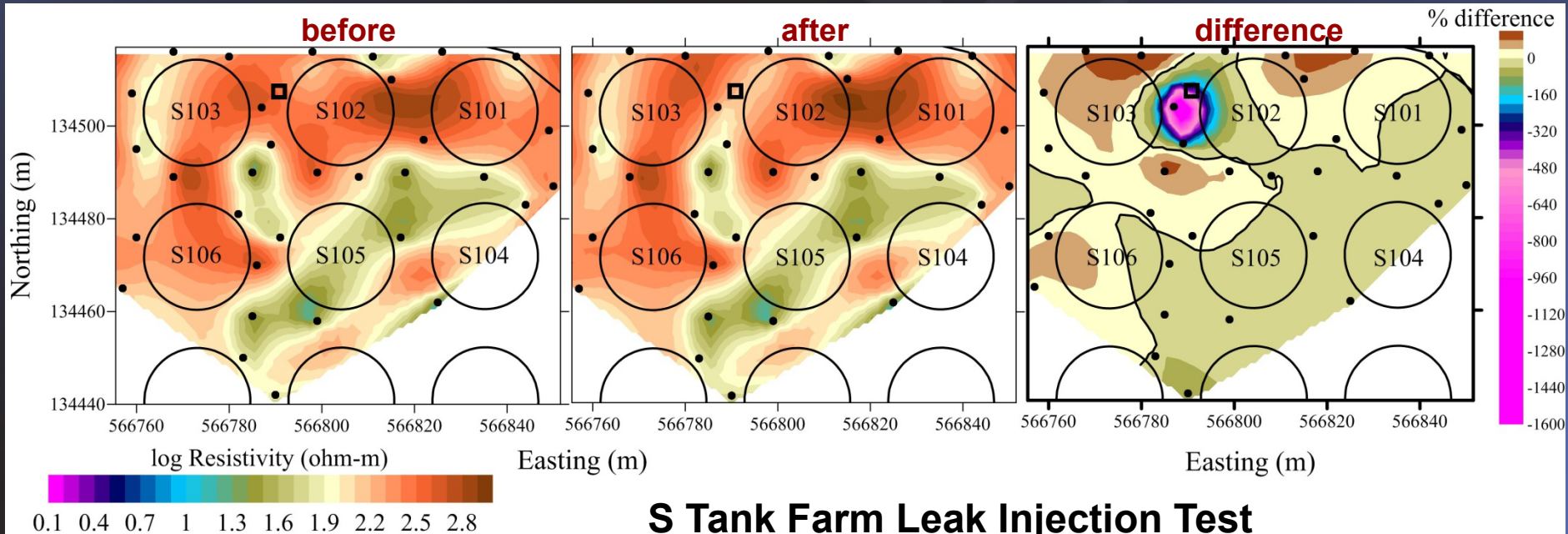


### Legend

- Waste site
- Underground storage tanks
- Steel-cased well
- Fenced boundary for T tank farm



## Inverse modeling results at Hanford



## S Tank Farm Leak Injection Test

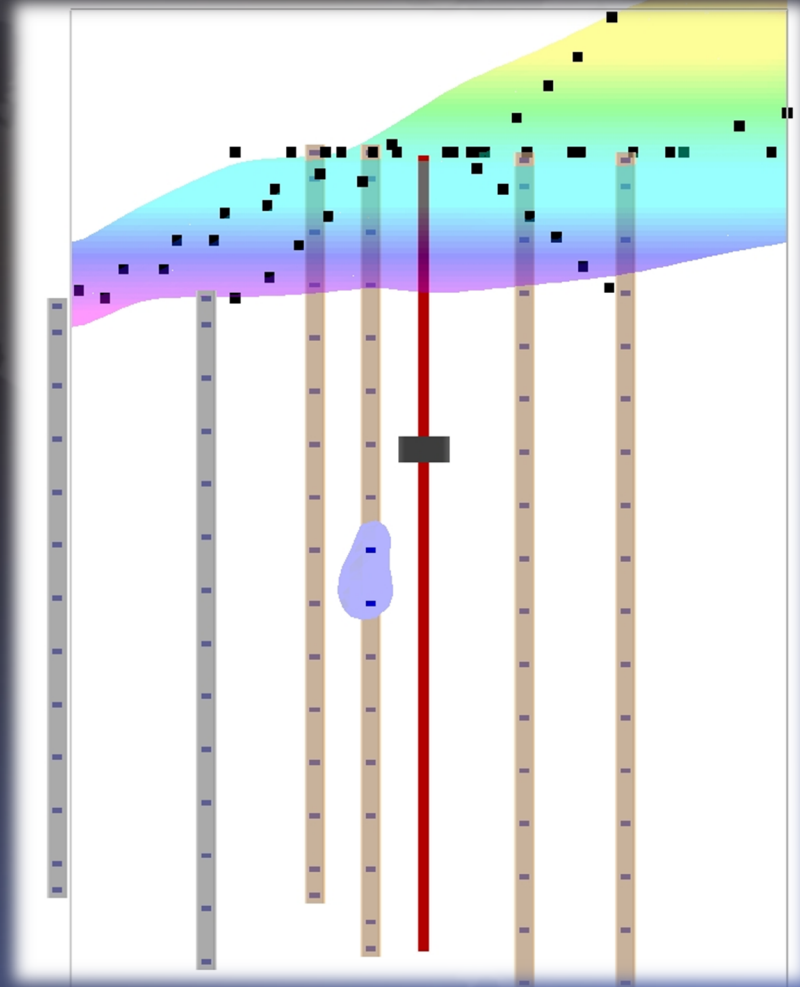
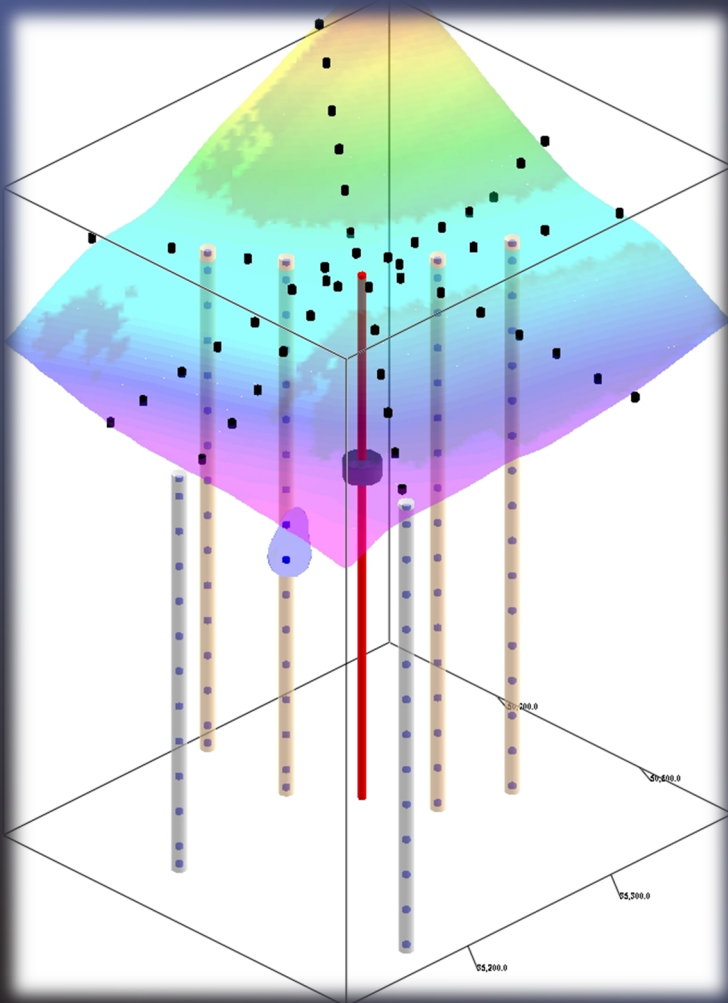


- LDM acquisition systems
  - Installed at Hanford since 2003
  - >99.99% reliable
  - Accurate
  - UL rated
  - NQA-1
- Geotection
  - 180 channels
  - UL Rated
  - Undergoing V&V

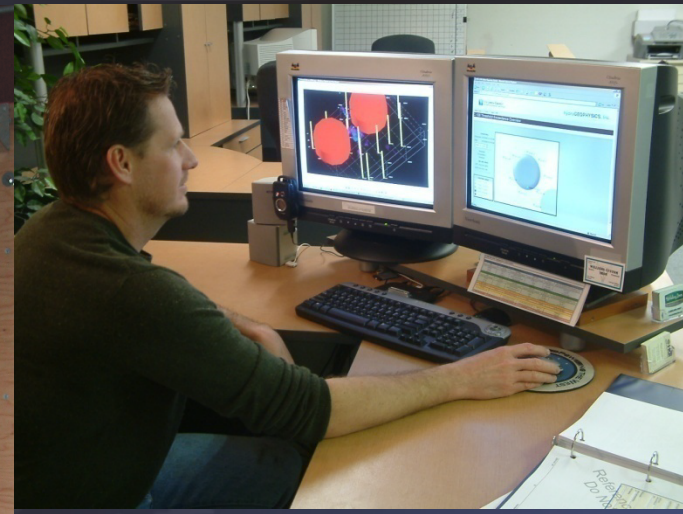
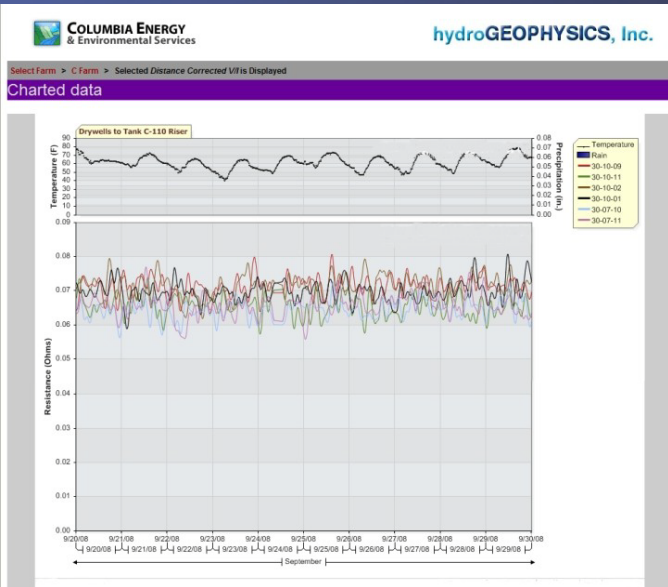


# Equipment Capabilities

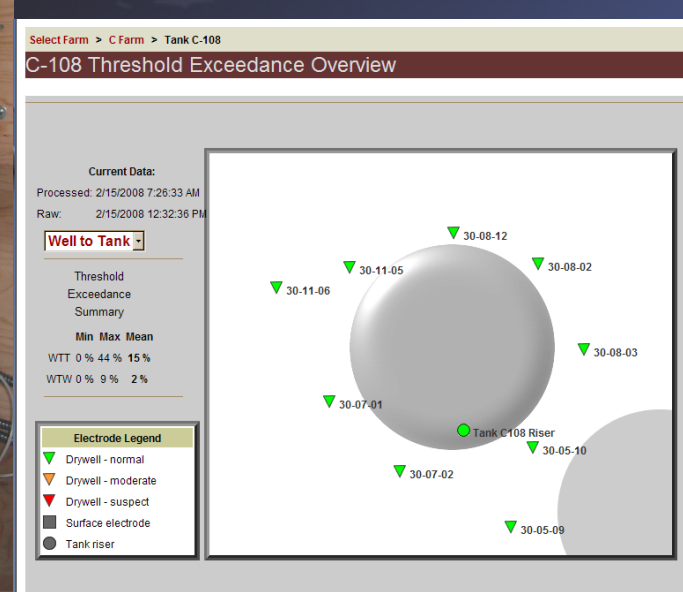
Time lapse inverse modeling results of injections  
150 electrodes, 18 hours, 74 snapshots



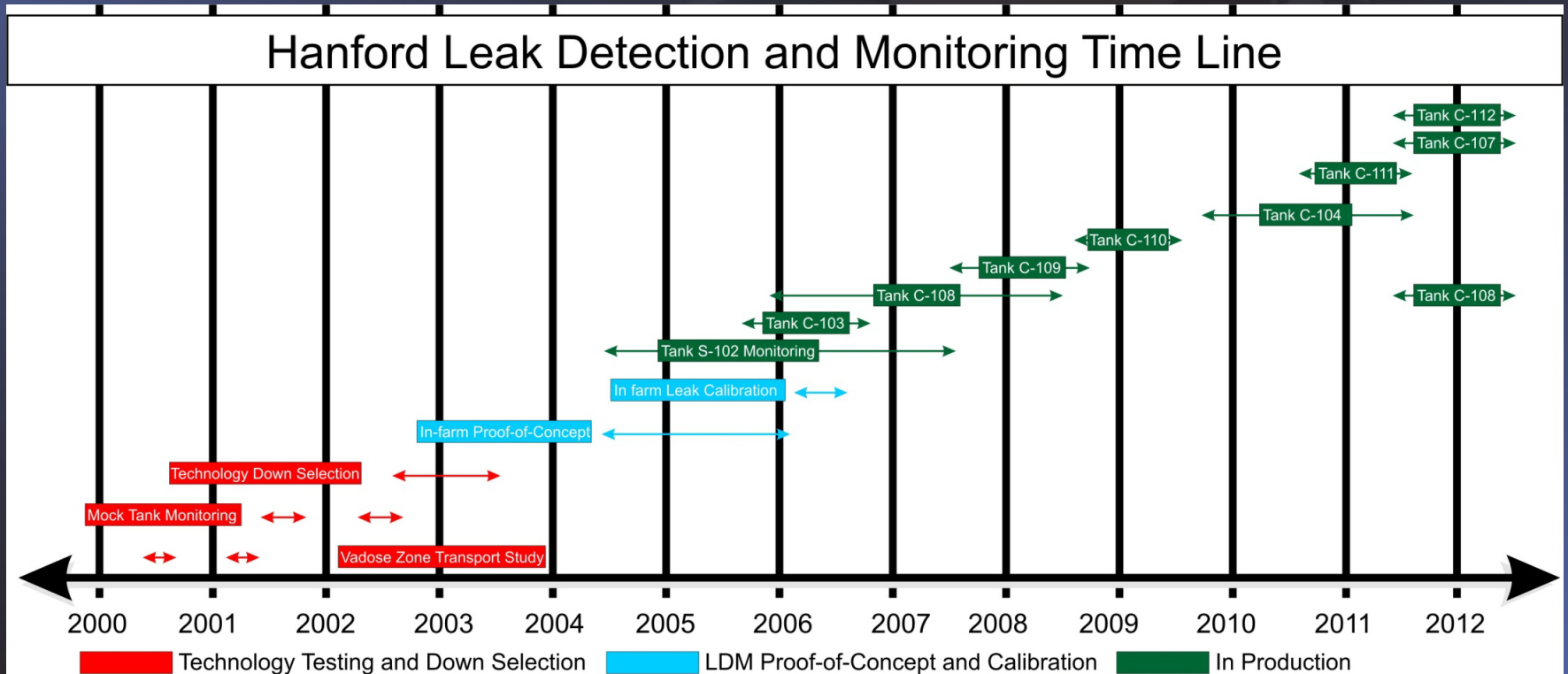




- ## LDM Automated System
- LDM AutoPro and AutoView Software:*
- Near Real Time Data Processing
  - Automated Data Assessment
  - Web Based for Remote Access
- Operations:*
- 24/7 System Status Monitoring
  - Daily Expert Visual Assessment



## Demonstrating longevity of monitoring at Hanford





## Issues

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

## Solutions

- Use site infrastructure
- Creative electrodes

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- Filter random noise
- Turn off for inversion

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- On-site weather station

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- System alarms

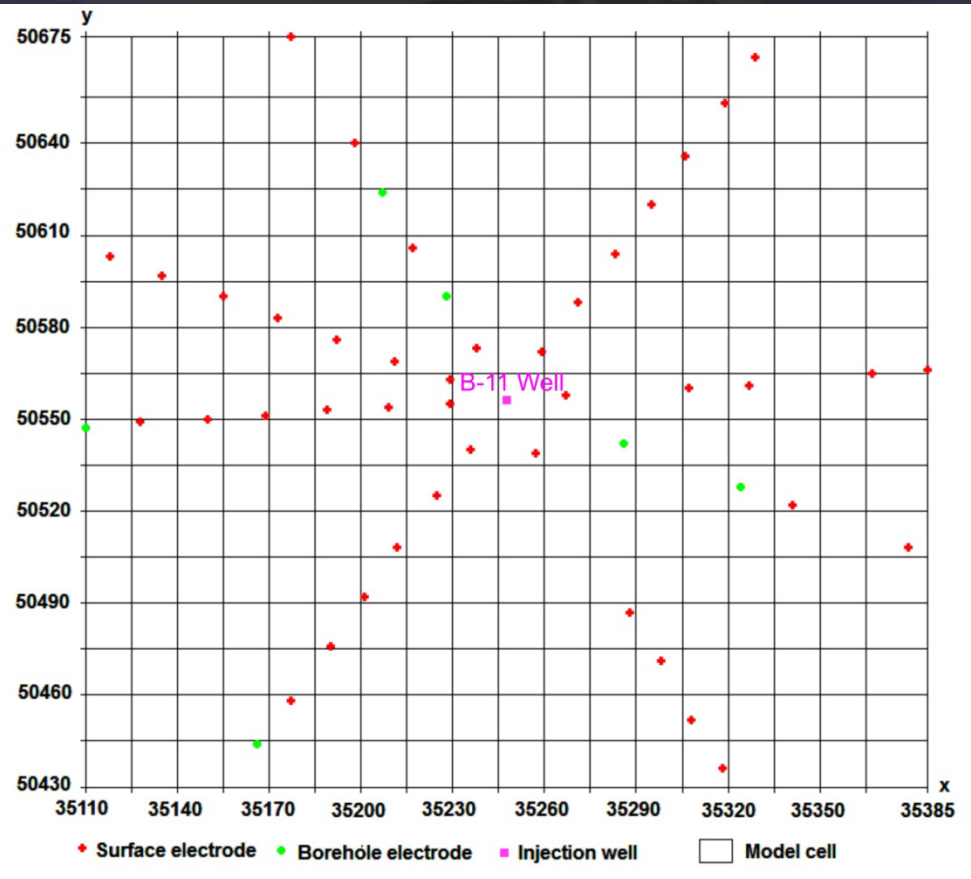
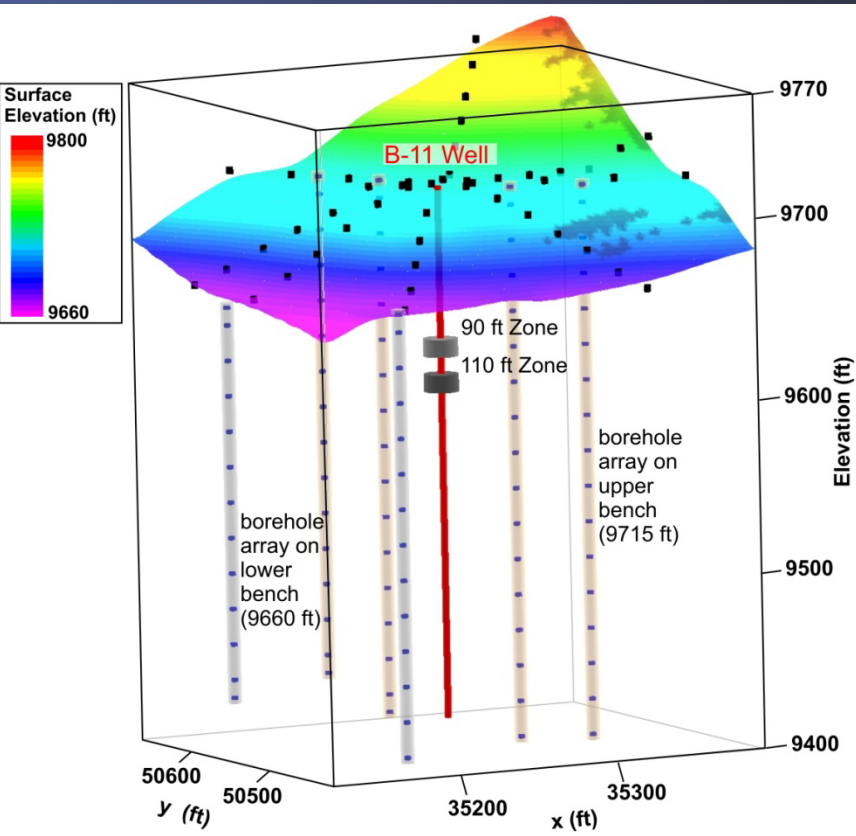
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- On-site maintenance
- Yearly calibration
- Redundant systems

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- 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



- 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