HIGH-RESOLUTION RESISTIVITY FOR CHARACTERIZATION AND LEAK DETECTION AT TWO SINGLE-SHELL TANK FARMS AT THE HANFORD SITE

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Hanford Site Location Map
Washington State
D/DR
H
N
F
KW/KE
B/C
100 Areas
200 West Area
200 East Area
Rattlesnake Mt.
400 Area
300 Area
Hanford Site
560 Square Miles

THE PROBLEM

149 Single-Shell Tanks contain both high-level radioactive and dangerous waste

Tanks are unfit for use

- Decades past design life
- No double-containment

Buried ~8 ft. below ground; 150-200 ft. above unconfined aquifer

Unconfined aquifer discharges to Columbia River

SST Closure Objectives

Reduce risk, protect natural resources

Waste Retrieval Objectives

- Immobilization
  - Vitrify
  - Alternative technology
- Retrieve tank waste contents
  - Limits of technology
  - Target <1% residual

Past Releases from SSTs

- 67 of 149 SSTs are assumed leakers
  - Cumulative estimated total loss of up to 1,000,000 gallons
- Known tank leaks up to 115,000 gallons
- Releases from pipes and ancillary equipment
- Unplanned releases to surface soil

Waste Characteristics

- Sludge
  - Very low solubility
- Saltcake
  - Water soluble
- Interstitial liquid

Waste Retrieval

- Dissolution and pumping to Double-Shell Tanks
  - Liquids added to tank
    - Water
    - Oxalic acid
    - Supernatant
  - Dissolved / Suspended waste pumped to DST
- Disaggregate and vacuum

Risk to Groundwater from SSTs

Past releases drive the risk to the groundwater pathway

- Large inventory of mixed waste contaminants, some mobile
- Retrieval could lead to more releases
- Residual waste in tanks after retrieval is relatively lower risk factor

Leak Detection Objectives

- Timely detection
- 95/5 probability
- Determine leak rate
- Determine leak volume
- Monitor fate of leaked waste

→Target: 24 hr.

→95% +; 5% -

→Target: 24-48 hr.

→Target: 24-48 hr

→Validate fate and transport models

TECHNOLOGY EVALUATION

Several leak detection technologies selected for testing

5 were tested at a Mock Tank facility

- Also evaluated at past disposal sites

Electrical methods better

- Longest successful track record
- High Resolution Resistivity chosen

CHALLENGES TO USE OF HRR IN TANK FARMS

Abundant Infrastructure

- Tanks—reinforced concrete
- Piping—miles of underground steel pipes
- Operating electrical equipment
- Worker safety rules
- Limitations on electrode placement (location and depth)

DETERMINE CORRECTION FACTORS

Ground Penetrating Radar to find structures

Magnetometry, Electromagnetic Induction with GPS to get electrical properties of infrastructure

Determine the magnitude of electrical interference to correct HRR recordings

TEST & INSTALL SURFACE ELECTRODES

Infrastructure limitations

Develop and test modified surface electrodes

Remote electrodes for depth coverage

Location of Drywells at S-102

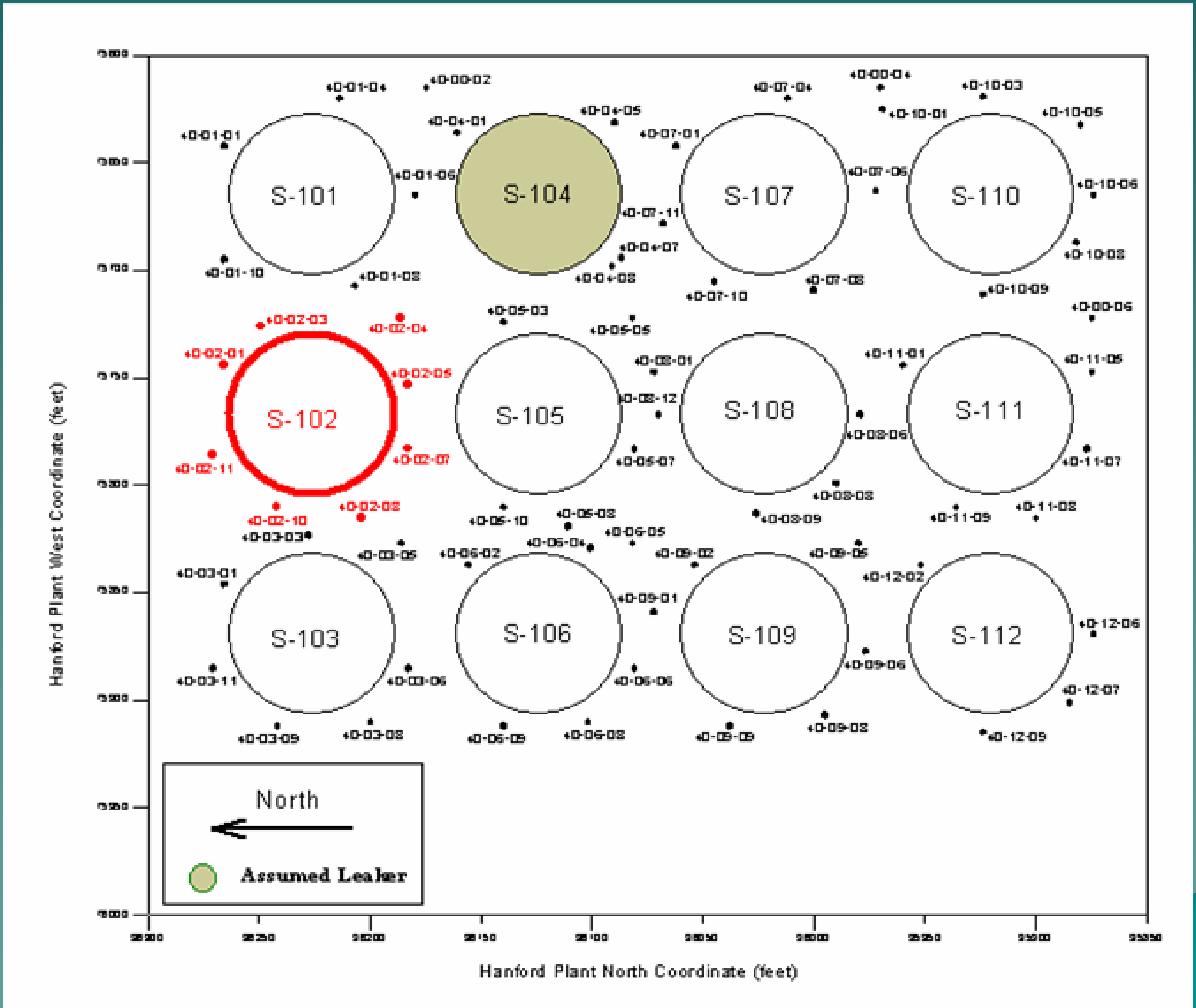
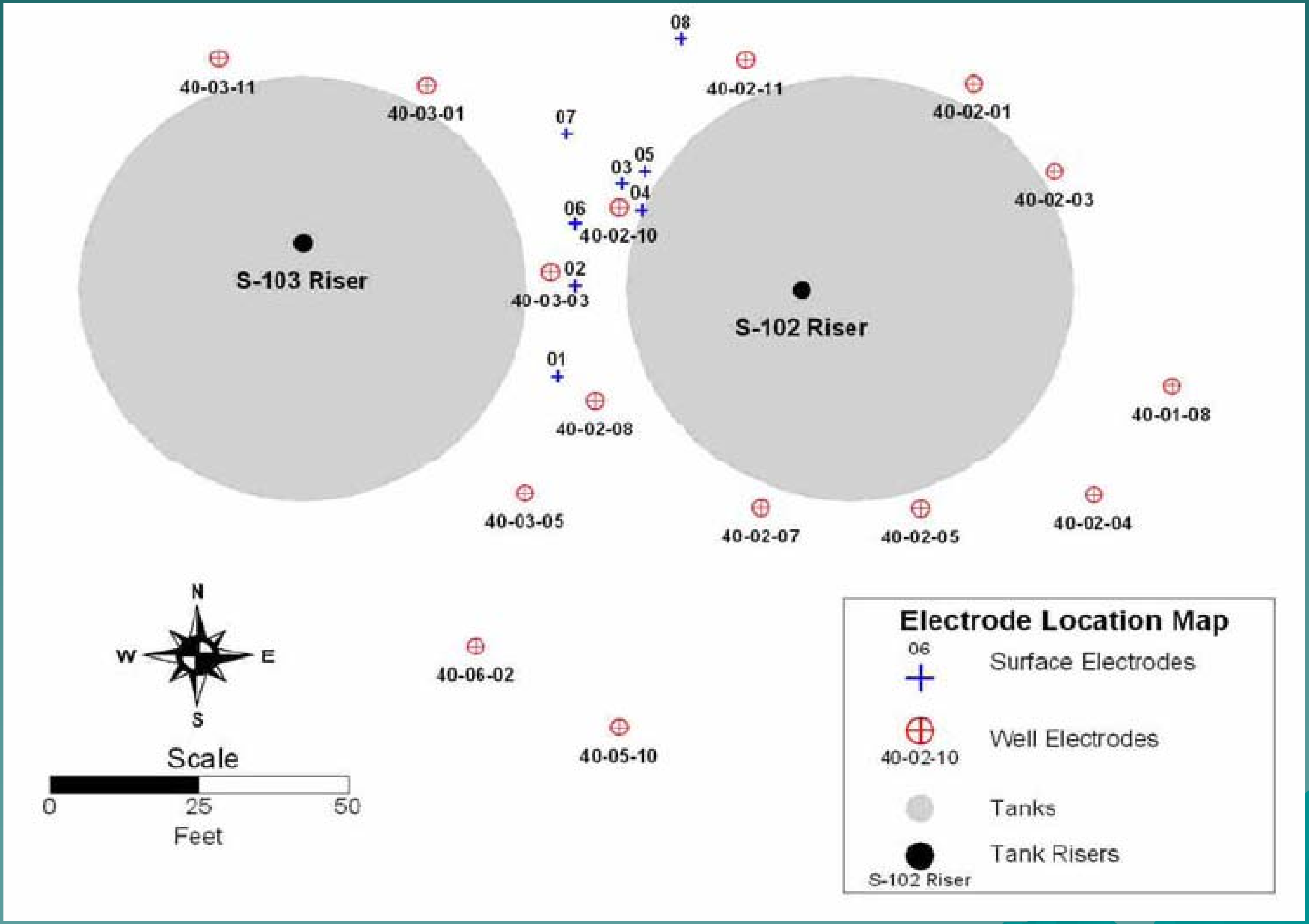


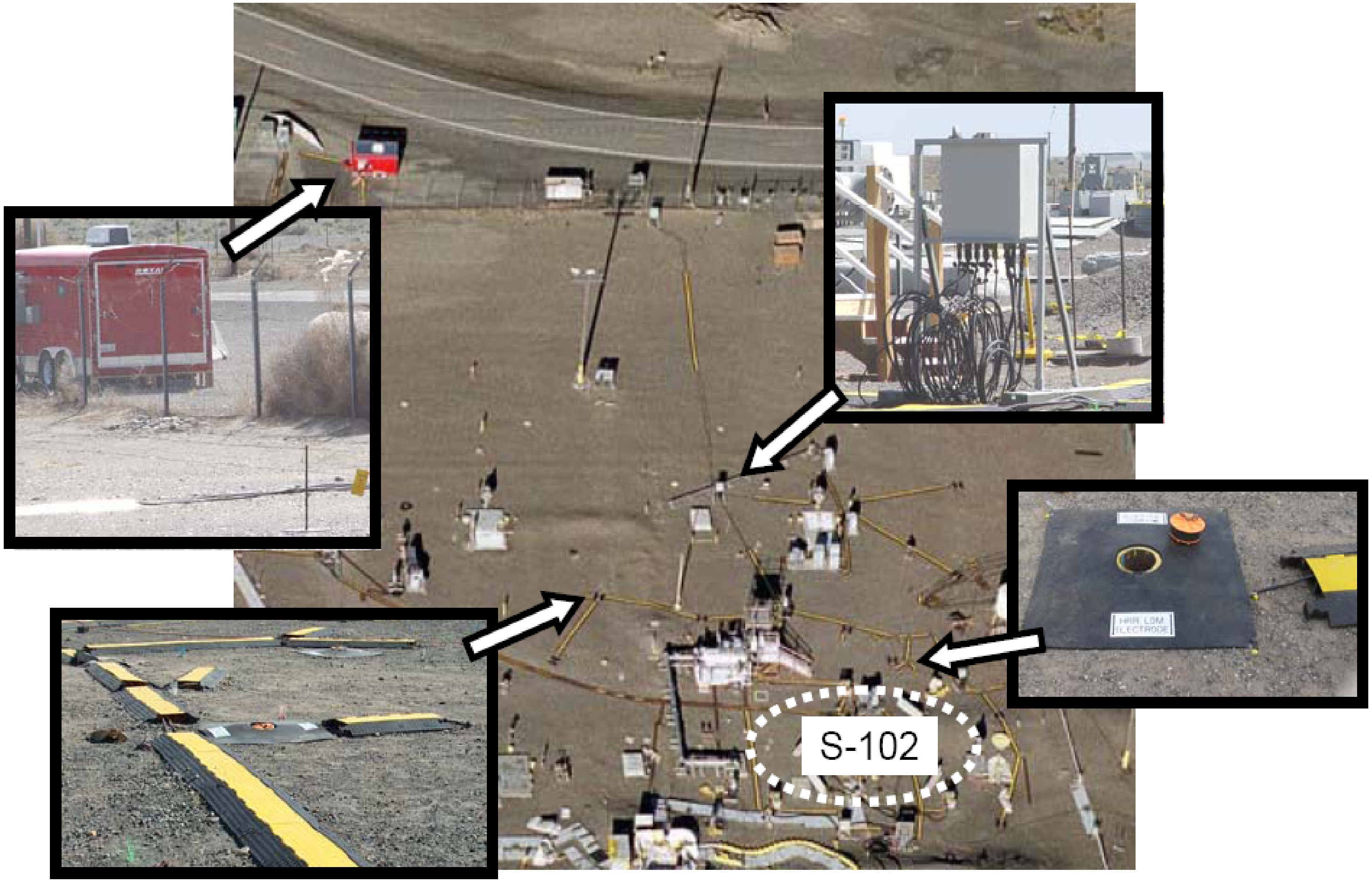
Figure 2. Plan View of Tanks and Boreholes in the S Tank Farm

Drywell and Electrode Locations



HRR DEPLOYMENT AT S-102

Figure A-7. HRR LDM System on Tank 241-S-102.



SIMULATED TANK

Modified Drywell for Injection to simulate leak

- Partially decommission drywell
- Perforate at tank bottom
- Injection through perforations

INJECTION TEST EVENTS

10 INJECTIONS OF WASTE SIMULANT

- Duration 2 to 17 days, most 2-6 day
- Leak rate from 5 to 20 gal/hr
- Volume per test 1000 to 3050 gal
- Cumulative injected volume 13,150 gal
- Data read and analyzed remotely by HGI in Tucson

PROGRESSION OF LEAK TEST RESULTS

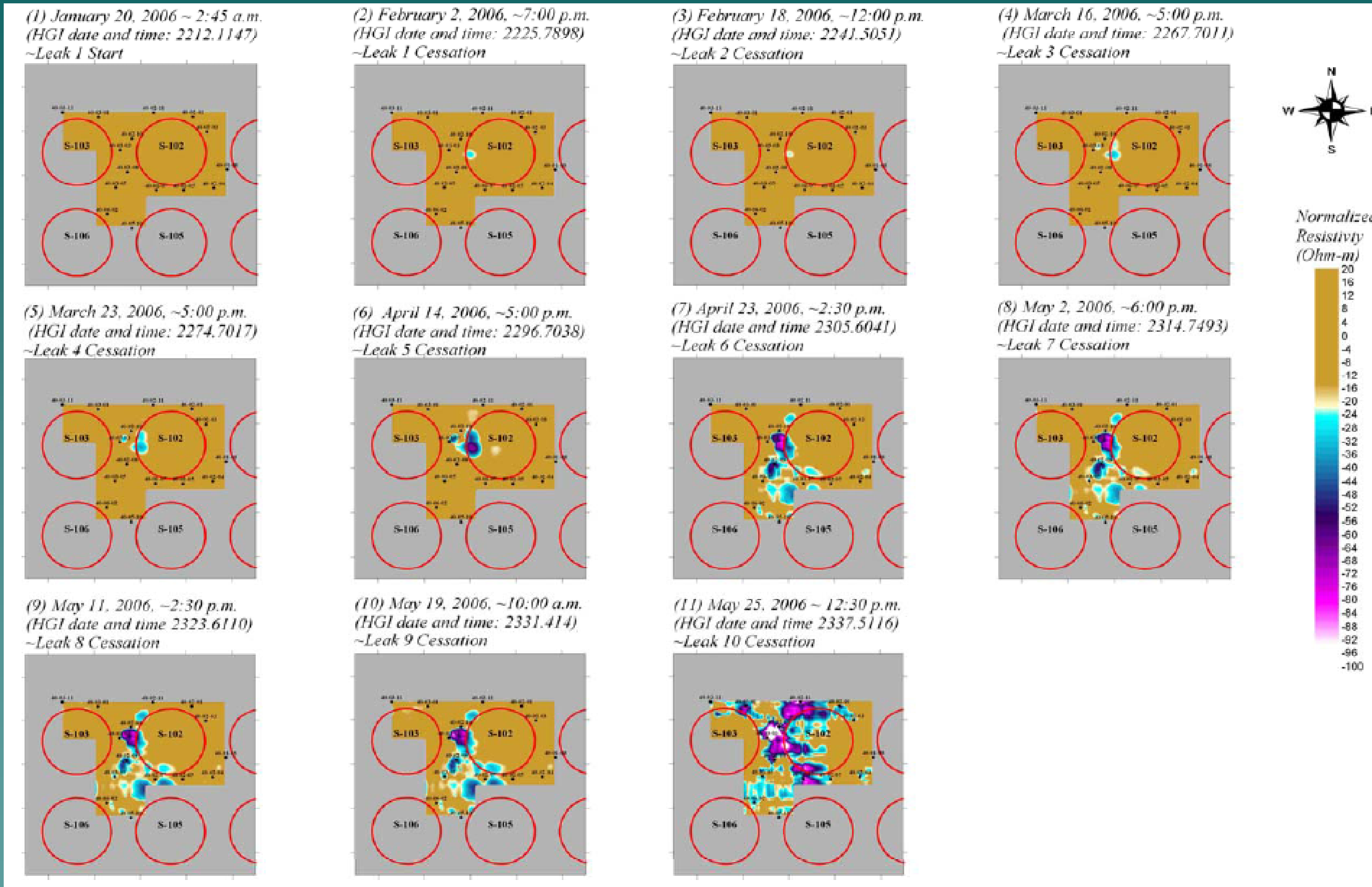
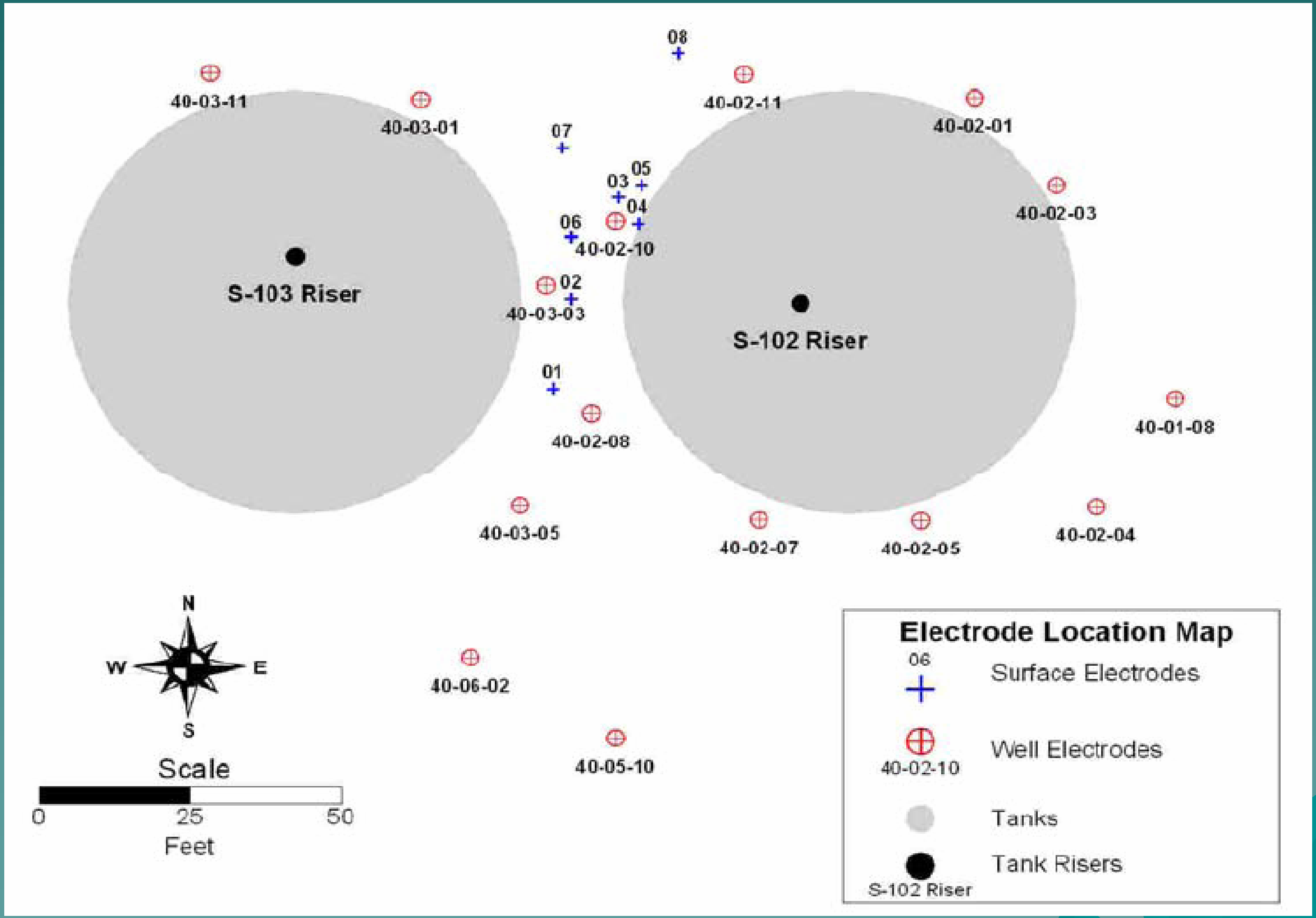


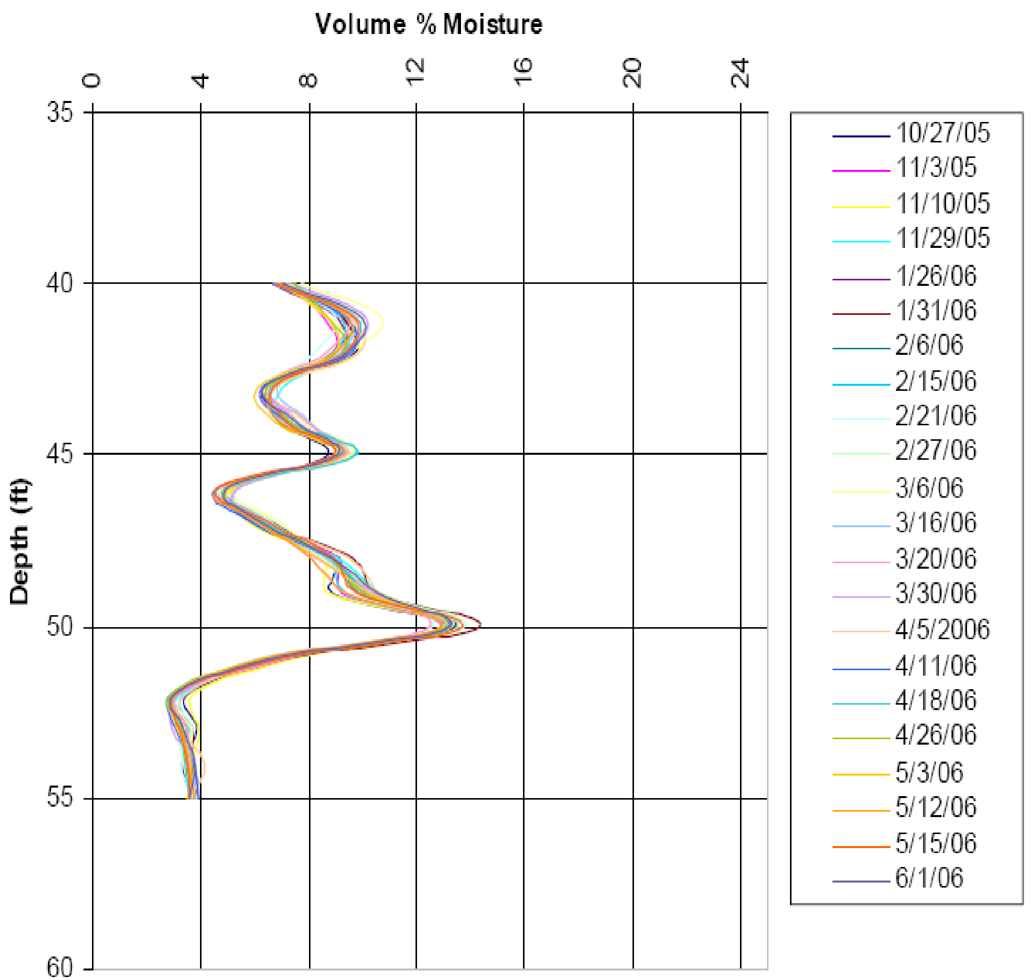
Figure 2-15. Summary Inversion Tomogram Images Representing the Duration of the Leak Injection Test (January to May 2006)

DRYWELL LOCATIONS



Test Results-HRR vs. Drywell Logging

Figure 2-33. Drywell 40-02-11 Moisture Logging Data.



Neutron Log Moisture Profiles

Figure 2-34. Drywell 40-03-01 Moisture Logging Data.

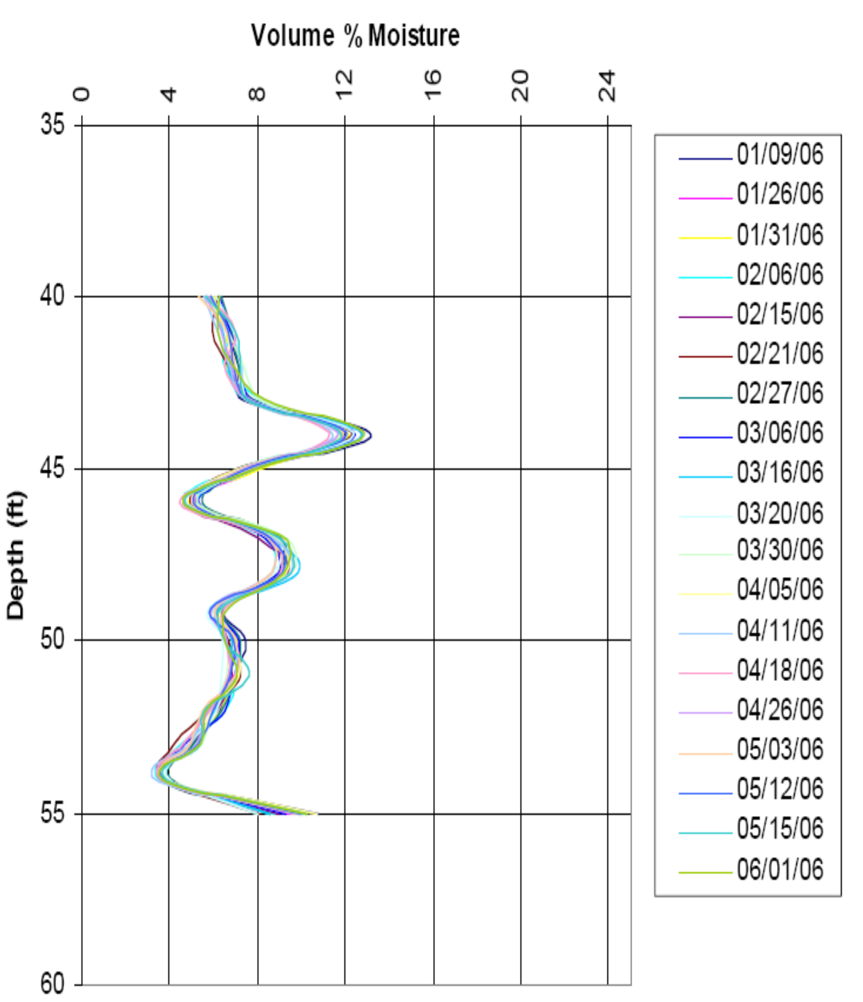
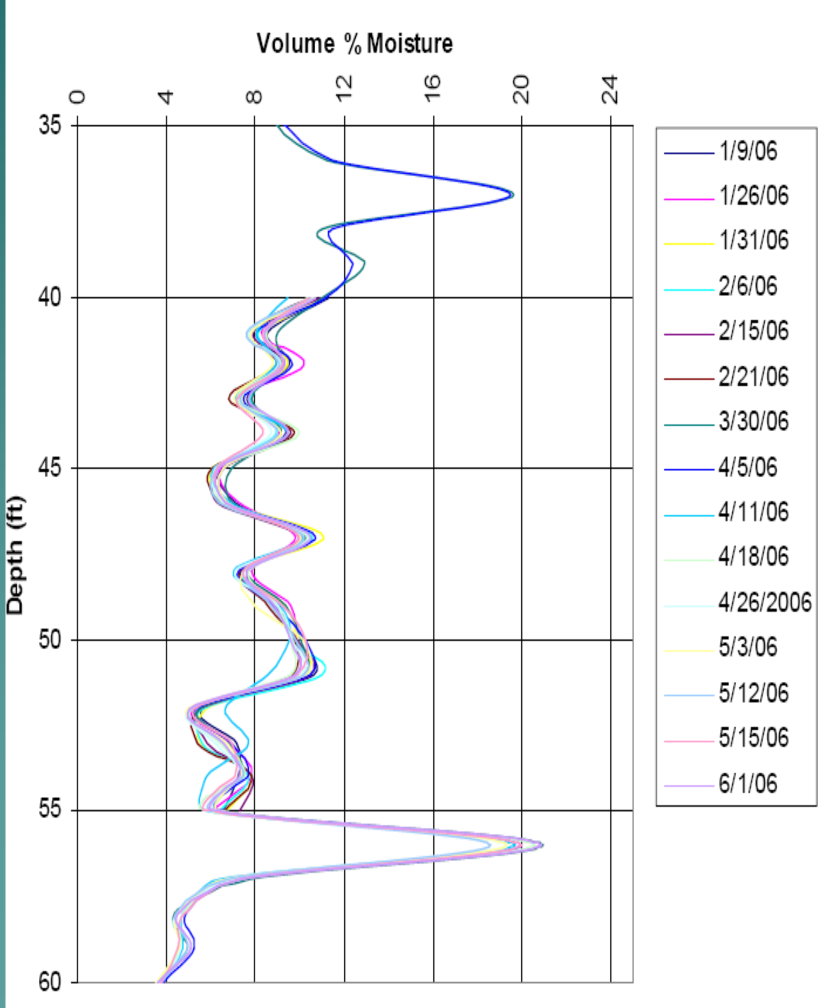


Figure 2-35. Drywell 40-03-03 Moisture Logging Data.



Recharge Events

- Analysis of HRR data was able to distinguish precipitation events from releases of simulated waste

Leak Detection Selection

Proposed baseline Leak Detection (neutron logging in drywells) ineffective

- Failure to detect release
- Timeliness inadequate

HRR preferred

- Timely detection (~24 hrs)
- Allows estimate of volume released

HRR for Characterization Planning

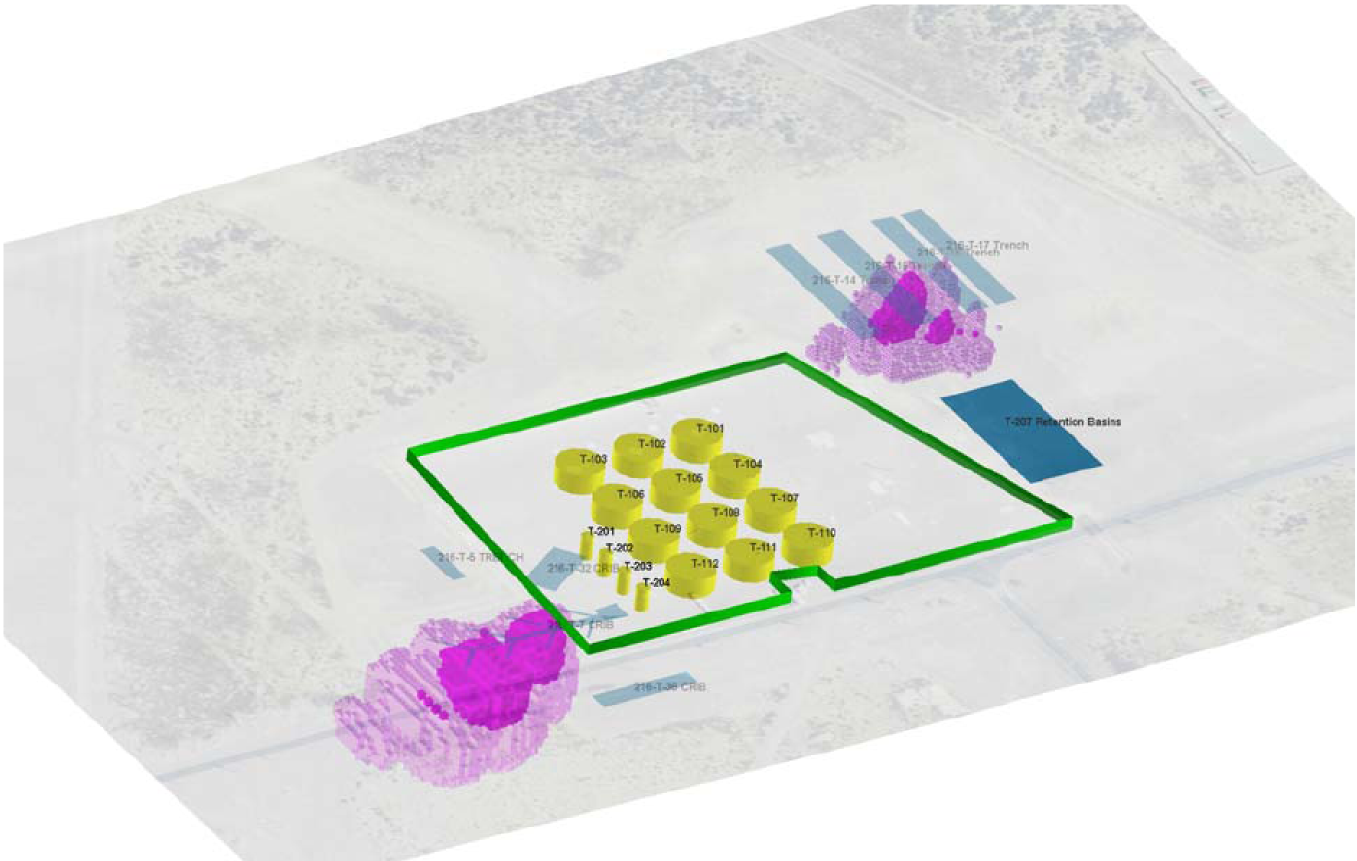
Objective: Map 3-D extent of contaminant plume in vadose zone and groundwater

Reality: HRR maps a “resistivity plume” in soil/GW

- Maps a resistivity contrast (probably NO_3)
- Maps plume to detection limit
- Maps plume of most mobile/conductive contaminants
  - Does not provide distribution of other contaminants
  - Needs boreholes to validate
  - Locates “hot spots” for further characterization
- Vertical dimension of plume needs better validation

RESISTIVITY PLUMES BENEATH LIQUID WASTE DISPOSAL SITES SURROUNDING T FARM

Figure ES-2. Resistivity Data beneath the Northeast Trenches and Western Cribs.



WELL TO WELL INVERSION OF DRYWELLS, T FARM AREA

Figure ES-1. Well-to-Well Inversion of Drywells in and Around the T Tank Farm.

QUESTIONS ABOUT HRR

- What analyte(s) contribute most to anomaly?
- What is the minimum concentration that produces an anomaly?
- What is the depth of anomalies?

BENEFITS & SHORTCOMINGS

HRR BENEFITS

- Maps 3-D resistivity plume likely showing mobile contaminant extent
- Useful to target future investigation sites

HRR CHALLENGES

- Detection limit TBD
- Confirmatory holes needed for less mobile contaminants
- Vertical plume dimension needs further study

SUMMARY OF HRR

- Improves Leak Detection Capability
- Minimizes Leak Loss During Retrieval
- Useful for 2 Dimensional Resistivity Plume Mapping
- Useful for Planning Further Characterization

QUESTIONS ?

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Injection Test Events

Activity	Start Date/Time	Stop Date/Time	Approximate Leak Rate (gallons per hour)	Operating Duration (hours)	Approximate Volume (gallons)	Approximate Cumulative Volume (gallons)
Leak Test 1	1/20/06 at 1820	2/2/06 at 0620	10	300	3050	3050
Leak Test 2	2/13/06 at 1015	2/18/06 at 0915	15	119	1750	4800
Leak Test 3	3/7/06 at 1210	3/15/06 at 1320	5	193.17	1000	5800
Leak Test 4	3/21/06 at 0815	3/23/06 at 0950	20	49.58	1000	6800
Leak Test 5	4/12/06 at 1000	4/14/06 at 1200	20	50	1000	7800
Leak Test 6	4/19/06 at 0825	4/23/06 at 1140	10	99.25	1025	8825
Leak Test 7 [a]	4/27/06 at 1230	5/2/06 at 1400	10	117	1200	10,025
Leak Test 8	5/8/06 at 1300	5/11/06 at 0920	15	68.33	1050	11,075
Leak Test 9 [b]	5/15/06 at 1700	5/19/06 at 0800	5/15	18/63	1050	12,125
Leak Test 10	5/23/06 at 1000	5/25/06 at 1030	20	48.5	1025	13,150

INJECTION TEST

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