



U.S. DEPARTMENT OF
ENERGY



SONAR Mapping Technology

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Status Update

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Background

Objectives

- DOE EM Technology Development investigated the potential use of 3D SONAR technology to improve the cost and schedule of sludge waste retrieval at the Savannah River Site.
 - *Entered into a collaborative research project with NuVision Engineering and their international collaborator Fortis Remote Technology.*
- Address the Salt Dispute Resolution Agreement with the State of South Carolina, dated October 31, 2016.
 - *Supplemental Tank Closure Activity #4 SONAR Mapping Technology: DOE will complete a technology demonstration of tank solids SONAR mapping technology for a liquid waste tank and submit documentation of that demonstration to SCDHEC by January 31, 2018.*

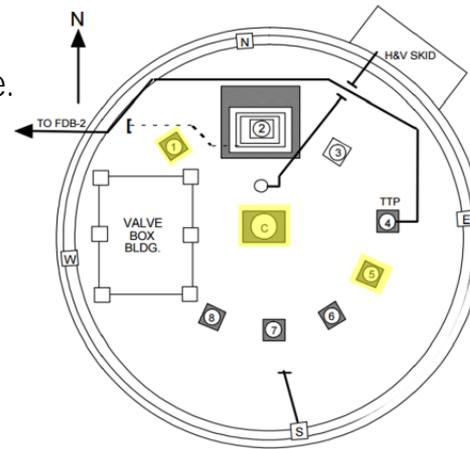
Internal Tank Visibility



View of horizontal and vertical cooling coils inside a Type I tank

Site Support

- Required coordination with the Liquid Waste operating contractor, Savannah River Remediation, in order to prepare the High Level Waste tank for SONAR deployment.
 - Design, manufacture, and installation of deployment tubes.
 - Liquid addition of 150,000 gallons of well water to support demonstration.
 - Perform tank-top activities during demonstration.
- F-Area Tank 7 was chosen as preferred tank for demonstration for the following reasons:
 - Type I tanks chosen as bounding scenario for challenges (cooling coils).
 - Bulk Waste Removal Efforts completed and previously mapped solids heel.
 - Remaining heel waste is sludge solids.
 - Risers available for deployment of SONAR device.



Tank 7 SONAR Riser Locations Relative to Tank-Top



Riser 5 Deployment Tube

Technology Demonstration

- **Physical demonstration occurred the week of December 11th, 2017.**
 - Testing lasted four days.
 - NuVision/Fortis provided the SONAR assembly: control unit, pod, and head.
- **SONAR head was deployed down each of the three Risers for data collection.**
 - Preliminary scans were performed in each tube to ensure proper alignment and seating of the SONAR head (varied per Riser).
 - Each deployment tube location had two SONAR survey scans performed.
 - Each scan lasted approximately one hour.
- **Raw data was compiled and analyzed by NuVision/Fortis.**
 - Timeframe for data analysis and generation of a summary report was six weeks.
 - Includes a volume estimation and level of uncertainty for area of coverage.



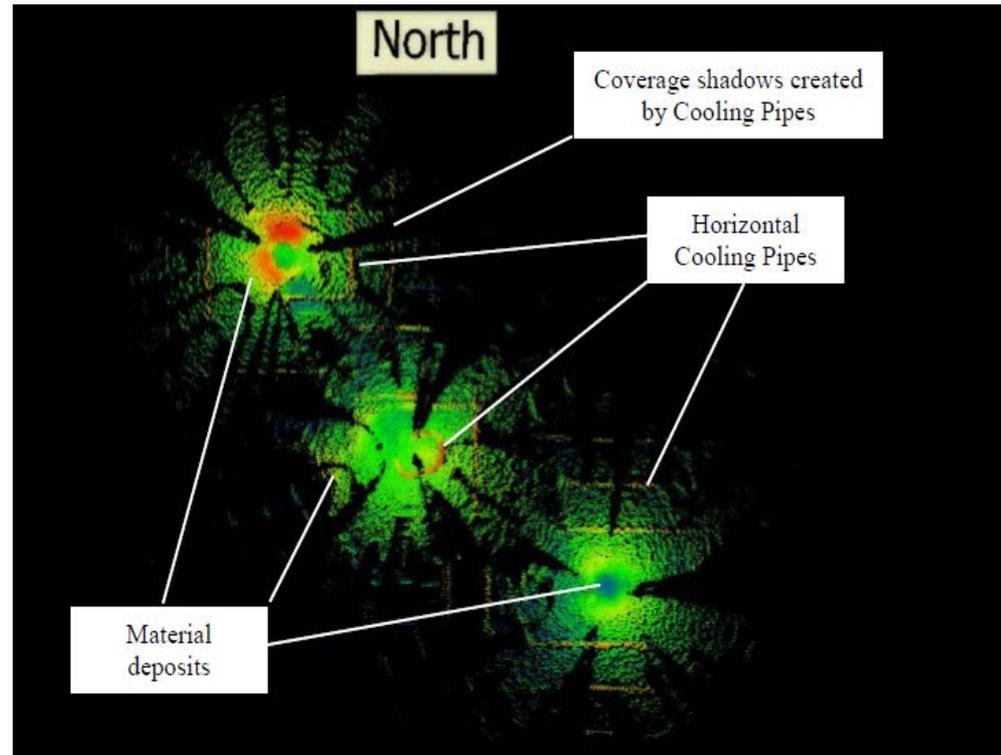
SONAR Control Unit



SONAR Pod (Blue Box) and SONAR Head (Black and Tan Tube)

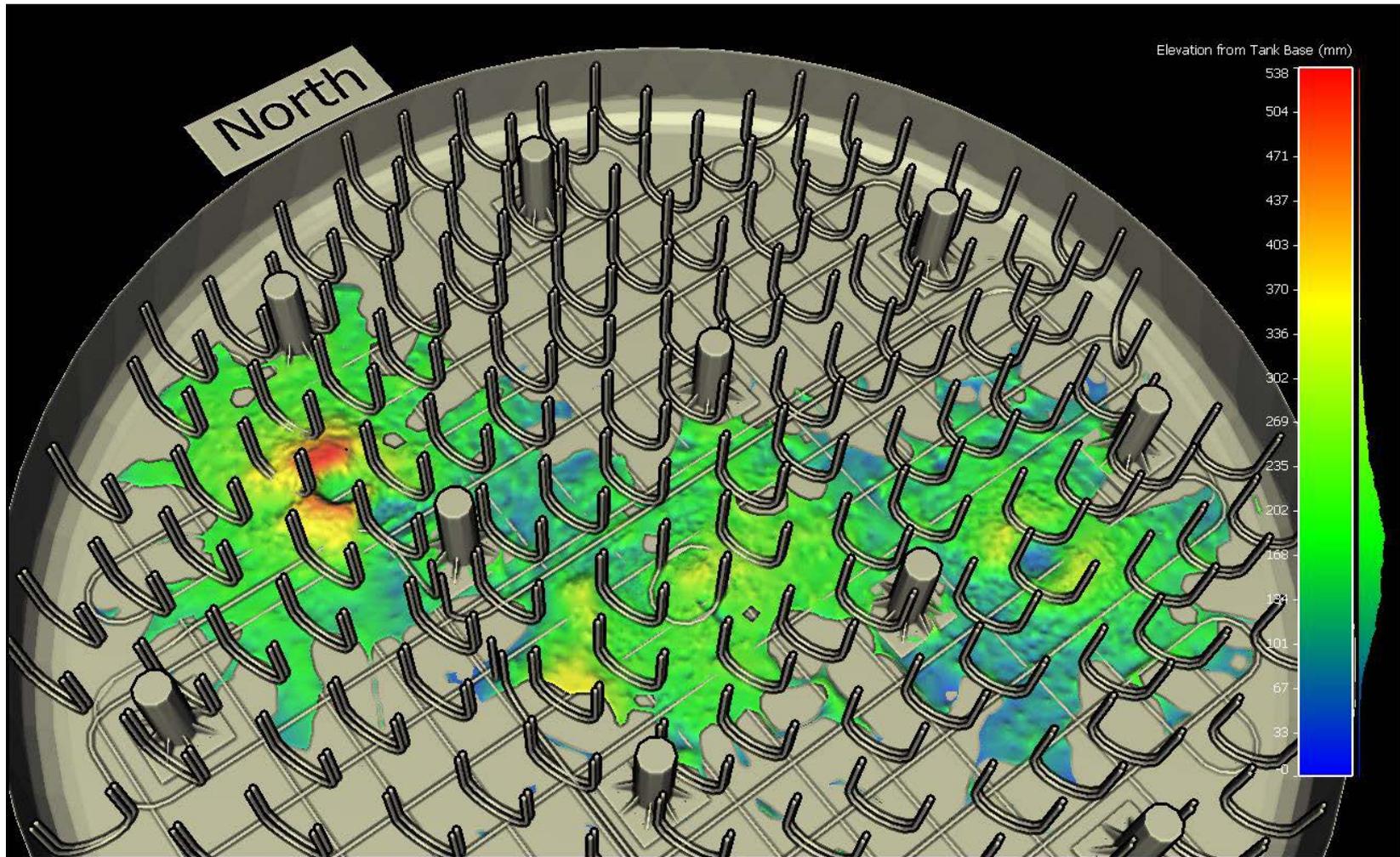
Results: Highlights

- **Coverage area \approx 26% of the tank floor.**
 - Volume estimate = 56.5 ft³ (coverage area).
 - Uncertainty of \pm 12%.
 - Volume estimate for whole tank is possible but the uncertainty level is inversely related to the coverage area.
- **Benefits:**
 - Produces accurate bed profiles and 3-D images.
 - Volumetric estimates with low uncertainty when coverage area is high.
- **Limitations:**
 - Vertical cooling coils create a shadowing effect and limit coverage area (estimated loss of 66% in radial coverage).
 - Non-homogenous supernate composition alters velocity of the SONAR pulse and affects "time of flight" measurement.
 - Limited riser availability (predict 6 locations could produce 79% tank floor coverage).



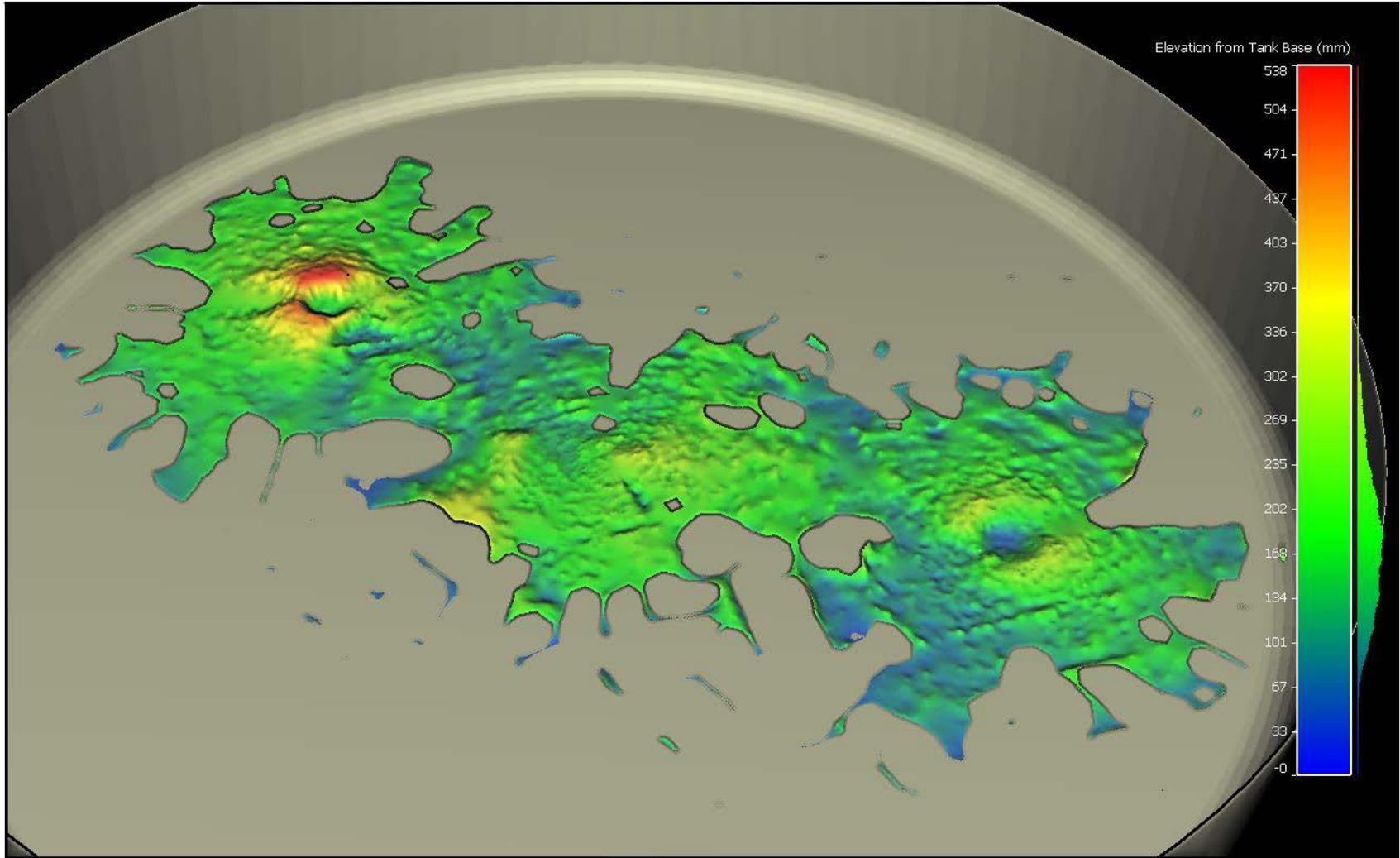
Overview of SONAR Coverage of Tank Base

SONAR Imaging Examples



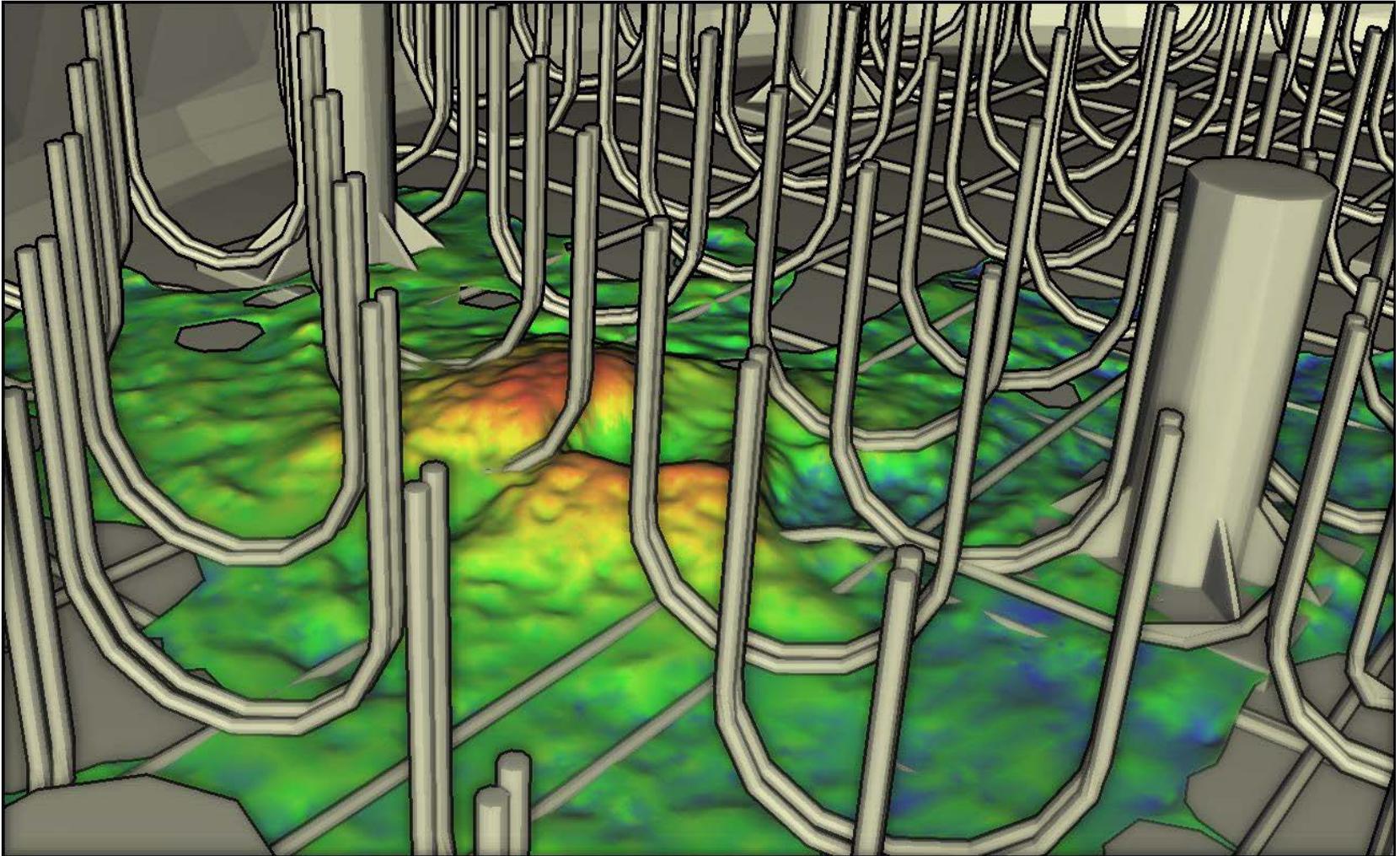
View of bed profile (shows cooling coils and support columns)

SONAR Imaging Examples



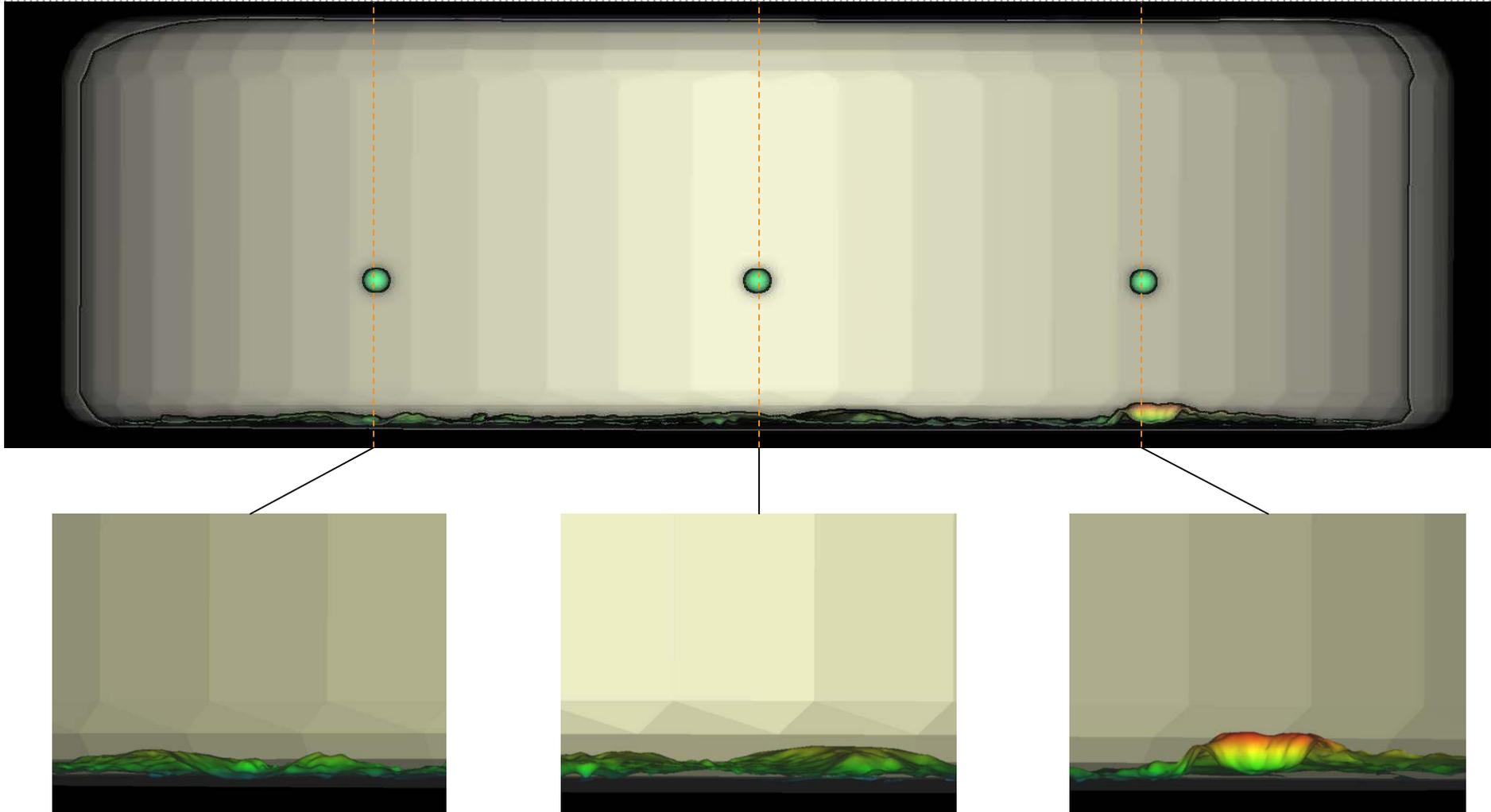
View of bed profile (cooling pipes removed for clarity)

SONAR Imaging Examples



3-D image of the material deposit under Riser 1

SONAR Imaging Examples



Cross section profile through centerlines of Riser 1, 5 and Center Riser

Mapping Method Comparison

- **Current Method: Visual Camera Inspection**

- Waste Removal Efforts Mapping.
 - *Approximate Cost of \$21,000 per campaign*
 - *Approximate Schedule Duration of 3 weeks*
- Tank Closure Sampling and Analysis Mapping.
 - *Approximate Cost of \$41,000*
 - *Approximate Schedule Duration of 6 weeks*

<i>Approximate Tank Closure Sampling & Analysis Mapping Methodology Cost</i>	
Mapping Inspection Plan	\$ 1,600
Capture Still Photos	\$ 2,200
Review/ Log Photo Data	\$ 28,000
Report Drafting	\$ 3,100
Report Review	\$ 3,100
Report Approval	\$ 3,100
Total Cost	\$ 41,100

- **SONAR Method**

- No Difference in Mapping Methodology.
 - *Approximate Cost of \$254,000 for initial campaign*
 - *Approximate Schedule Duration of 6 weeks*

<i>Approximate SONAR Mapping Methodology Cost</i>	
Vendor SONAR Mapping	\$ 100,000
Report Review/ Approval	\$ 4,700
Total Cost	\$ 104,700

<i>Approximate SONAR Ancillary Equipment Cost</i>	
Deployment Tube Design	\$ 95,600
Deployment Tube Fabrication	\$ 53,600
Total Cost	\$ 149,200

Summary

- **Technology Does Work**

- Demonstrated the ability to deploy SONAR technology safely and keep free of radiological contamination.
- Demonstrated ability to map solids coverage on the tank floor.
- Produced solids volume estimation with low uncertainty for coverage area.

- **Not Feasible for Mapping During BWRE or Tank Closure**

- Does not reduce the need for liquid additions between mapping campaigns.
- Does not reduce the mapping campaign schedule.
- Limited Riser availability limits coverage of tank floor.
- Cooling coils significantly reduce SONAR range.
- Volume estimation for entire tank requires improved floor coverage.
- Each mapping campaign would require fabrication of new deployment tubes.

- **Future Potential**

- Even though not feasible for above applications, does not rule out opportunities for improving other Tank Farm applications.