

**Advantages and Lessons Learned
Using GPS-Enabled Gamma
Scanning for the Characterization
Survey of a Large
Thorium/Uranium Site**

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Overview

- Site logistics and contaminants
- Survey objectives and general scope
- Land area gamma scan characterization procedures
- Scanning MDCs
- Process evaluation
- Lessons Learned

Site Logistics and Contaminants

- 195 hectares (483 acres) land area, 4% Class 1, 58% Class 2, and 38% Class 3
- Thorium-232 primary radionuclide of concern with proposed soil DCGL of 0.11 Bq/g (2.9 pCi/g)
- U-238 lesser radionuclide of concern, proposed DCGL of 0.08 Bq/g (2.2 pCi/g)



Land Area Characterization Survey Objectives and General Scope

- Collect gamma scan data to assess site's radiological status
- Confirm or eliminate suspect anomalies identified during scoping survey
- Ensure gamma scanning data quality was sufficient to satisfy final status survey (FSS) requirements for areas requiring no further action (estimated to be > 99 % of the site).

Land Area Characterization Survey Objectives and General Scope (cont.)

- Capture gamma data for presentation as characterization and FSS data
- Minimize need for site clearing and redundant survey costs during FSS.

Gamma Scan Procedures

- 100 % coverage of Class 1 areas
- Up to 75 % coverage of Class 2 areas, graded approach surveys
- Up to 30 to 40 % coverage of Class 3 areas, graded approach surveys
- 5 cm × 5 cm NaI detector couple to ratemeter-scaler and GPS/data logger unit, data logged at 1-sec intervals
- Open windowed, no background stripping of data.

Gamma Scan Procedures (cont.)

- Initial procedural recommendation was to maintain detector at 1-meter with minimal deflection
- Audio of satellite link rather than detector response
- Intended to maximize positional accuracy
- Data plot examined for anomalies
- Procedure evaluated against “standard” approach---audio of detector, minimize surface to detector spacing.

Surveying former J & K Lines



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Scanning MDCs

- Scan MDCs estimated at 0.05 Bq/g (1.3 pCi/g) for Th-232 and 0.08 Bq/g (2.2 pCi/g) for U-238
- Based on contaminated area of 3 m², 1 meter source-to-detector distance, scan speed of 0.3 meters sec⁻¹, no surveyor efficiency
- Varies from MARSSIM parameters which includes a factor for surveyor efficiency.

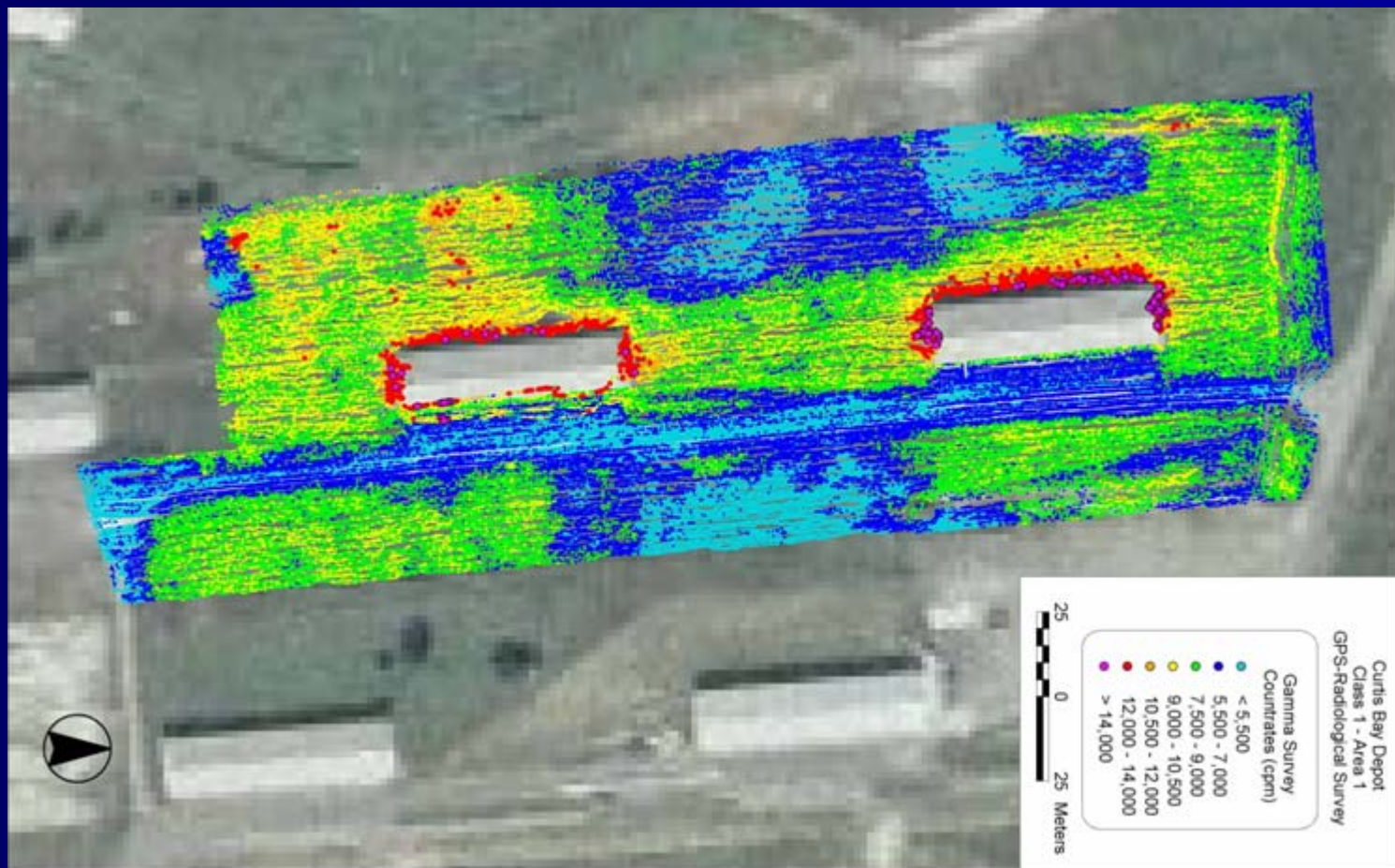
Procedure Evaluation

- Scoping survey had identified numerous locations with elevated Th-232 contamination
- Most anomalies were localized ($< 5 \text{ m}^2$) with Th-232 concentrations $< 0.74 \text{ Bq/g}$ (20 pCi/g)
- Two locations selected for evaluation at concentrations of 0.73 Bq/g (19.6 pCi/g) and 0.65 Bq/g (17.6 pCi/g)
- Locations were surveyed using both procedures and processed data examined.

Evaluation Results

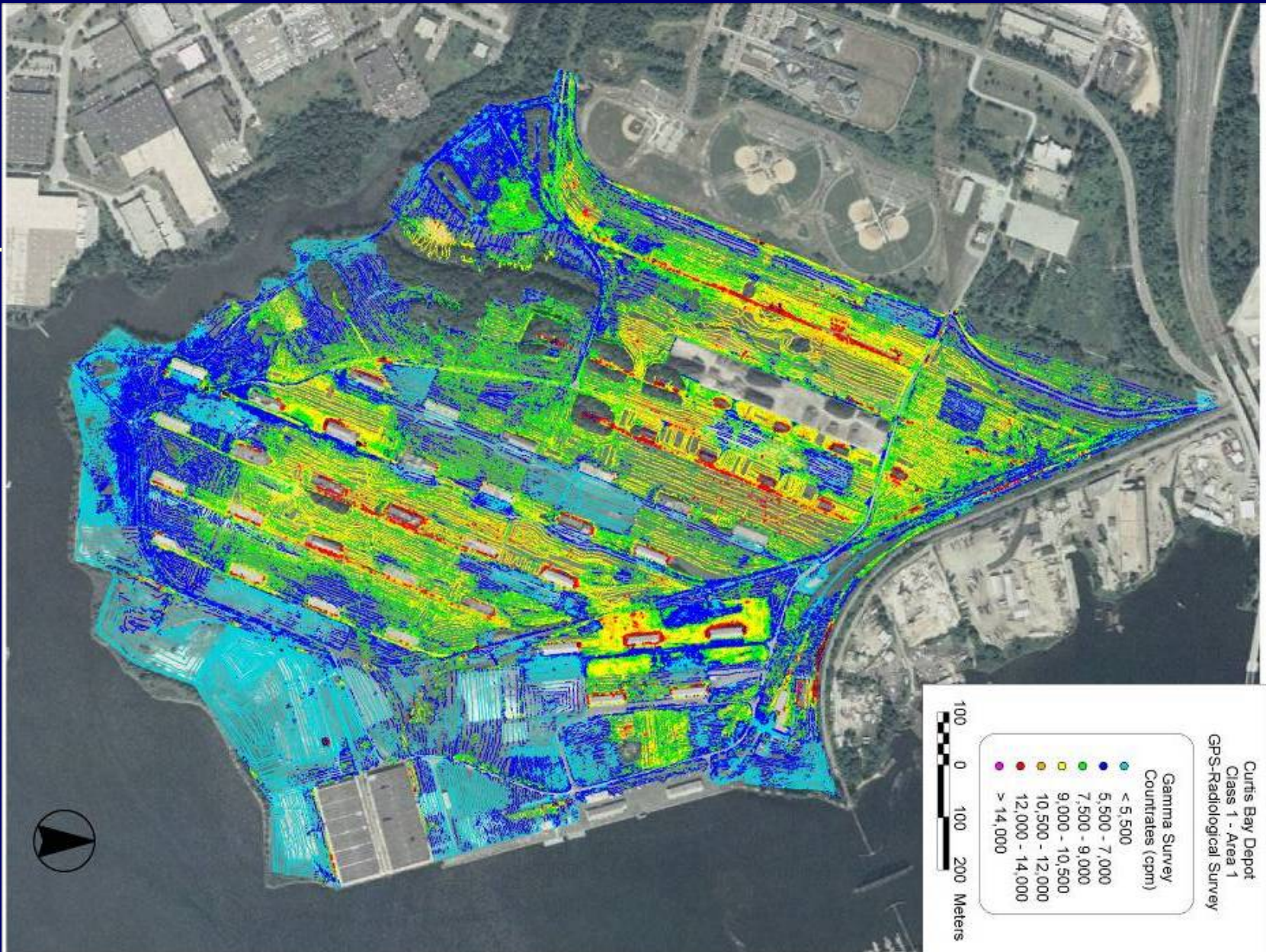
- Locations were not readily identifiable when examining the plotted data from detector at 1 meter
- Locations were audibly and more visibly (when plotted) distinguishable with detector held at < 10 cm
- These results combined with expected similar conditions elsewhere, resulted in procedure change, emphasis on audible with less concern for positional accuracy.

Evaluation Results (cont.)



Evaluation Results (cont.)

- Apparent additional anomalies investigated
- These areas confirmed to be due to background variability due to other residual ores, no contamination in samples
- Similar variable background conditions anticipated throughout the site, would result in excessively high false positive rate
- Therefore, imperative to rely on surveyor performance for investigative decisions.



Curtis Bay Depot
Class 1 - Area 1
GPS-Radiological Survey

Gamma Survey Count Rates (cpm)
< 5,500
5,500 - 7,000
7,500 - 9,000
9,000 - 10,500
10,500 - 12,000
12,000 - 14,000
> 14,000

Evaluation Results (cont.)

- > 1 M data points collected while traversing over 800 km (500 miles)
- 100 anomalies audibly distinguishable from background were investigated, over 400 samples collected
- Visual investigations determined 44 were false positives, judgmental samples collected from 56 areas
- 12 of the 56 areas exceeded the DCGL(s)

Lessons Learned

- *A posteriori* scan MDC determined from data to be 0.05 Bq/g (1.3 pCi/g) above background for Th-232 and 0.08 Bq/g (2.2 pCi/g) for U-238
- Surveyor evaluation minimized potential excessive false positive rate and minimized follow-up investigations
- Representation of graphical data improves when surveyors pause liberally---increases positional accuracy and allows for full scale on ratemeter.

Conclusion

- Combination of GPS/gamma count rate data capture with surveyor involvement provides a synergistic approach for real-time site evaluation
- Data captured provides excellent documentation of scanning density and results for regulatory review
- Allows for documentation as FSS data, significant future cost savings in site preparation and additional survey time.