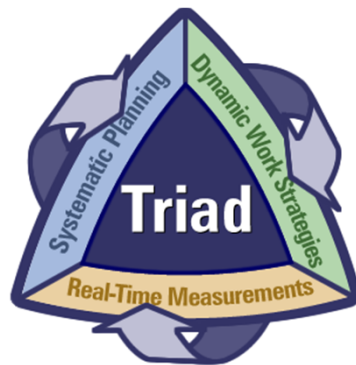


## Module 6

# **Composite/Incremental Sampling:** Case Study - Paducah Site



## Case Study Highlights

- Use of gamma walkover surveys
- Use of dynamic work strategies
- Use of soil sample compositing strategies:
  - Incremental soil sampling for estimating average concentrations
  - Composite search methods for hot spot identification
- Application of real-time analytical methods

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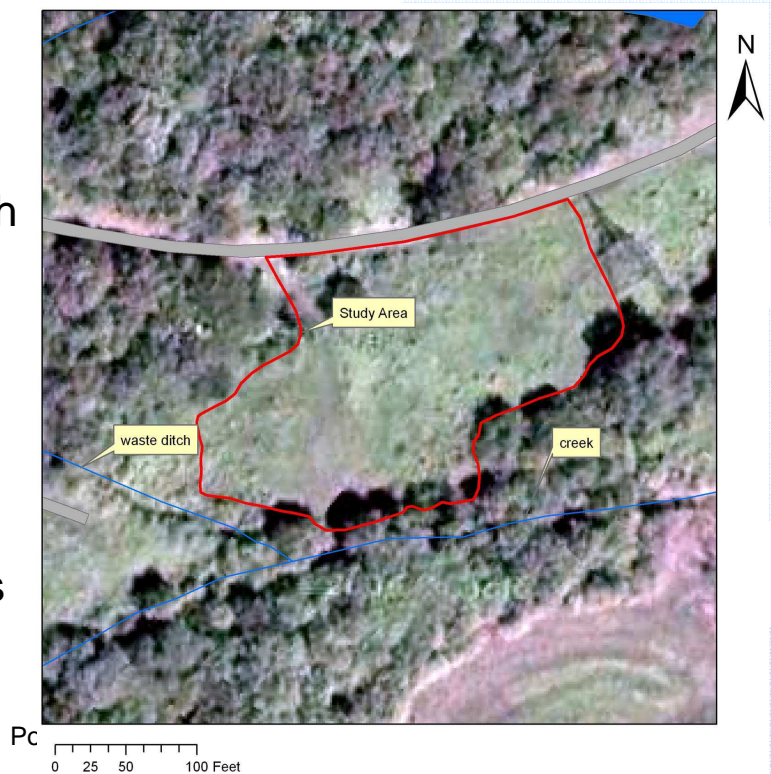
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## Case Study Background

- The Paducah site is an active uranium enrichment facility
- Historical processes resulted in release of PCBs and uranium to the environment
- Ditch and creek with contaminated sediments were dredged, and the spoils were placed along the banks almost 30 years ago
- Present concern is PCB and uranium contamination in soils where dredged materials were placed
- Assumption is that uranium and PCBs are commingled

## Area of Concern

- Approximately 1 acre
- Mostly grassland
- Bordered by waste ditch on west and creek to the south
- Concern is sediment spoils from ditch and creek
- Spoils placement probably 20 to 30 years ago



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## Applicable Criteria

- MARSSIM applies due to radionuclide (uranium) presence
  - Multi-Agency Radiation Survey and Site Investigation Manual
- MARSSIM assumes two criteria:
  - Wide-area averaged criterion applied to an exposure unit (EU)
  - Hot spot criterion applied to much smaller areas
- For this site, those criteria were:

	<b>Area-Averaged</b>	<b>Hot Spot (25 m<sup>2</sup>)</b>
<b>Uranium:</b>	10 ppm	90 ppm
<b>Total PCB:</b>	3.6 ppm	33 ppm

## Analytical Options

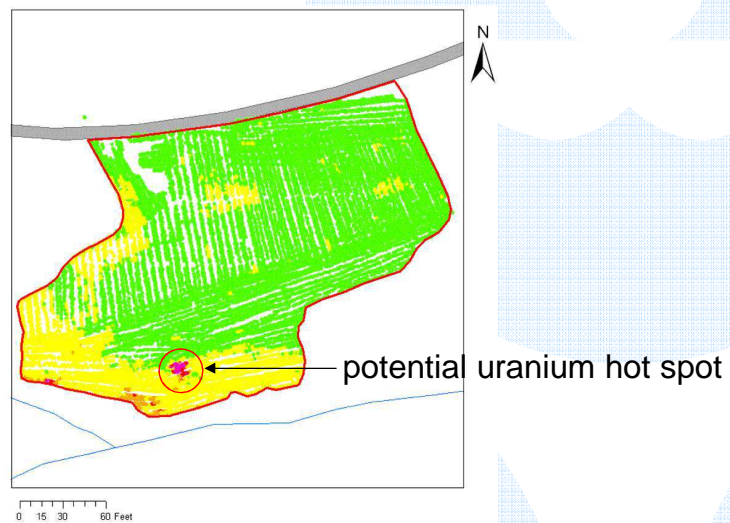
- Uranium (background ~ 3 ppm)
  - Gamma walkover surveys (qualitative)
  - XRF (quantitative, MDC ~ 10 ppm)
  - Alpha spectroscopy (“definitive”)
- Total PCBs (not in background)
  - Test kits (semi-quantitative, MDC ~ 0.5 ppm)
  - GC (“definitive”)

# Gamma Walkover Surveys Provided Unique Data Set



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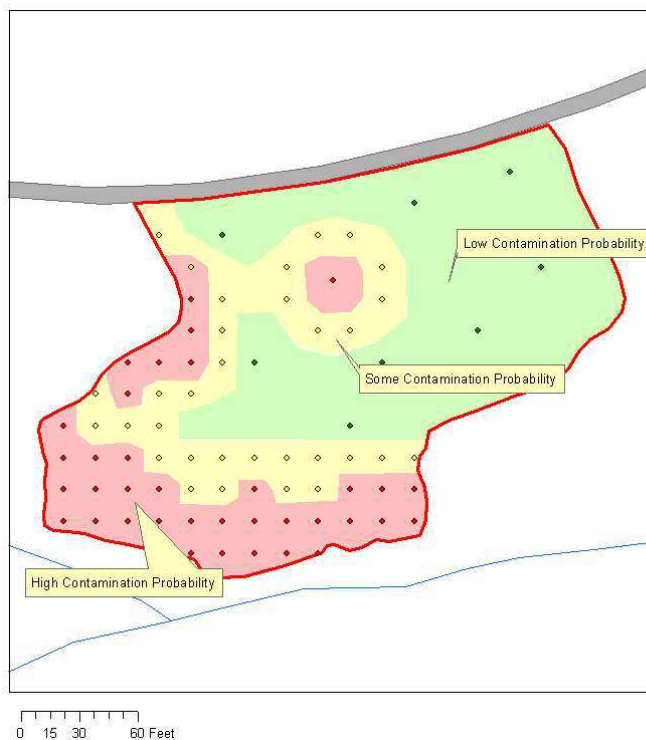
More than 20,000 measurements provided high-density spatial resolution regarding the presence/absence of uranium contamination



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## Decision Unit Layout Based on CSM



- Total area = 0.98 acre
- 3 exposure (decision) units, each reflecting a different level of concern about whether contamination present above criteria
- DUs formed to avoid diluting contamination, if present
- CSM based on assumption of contaminant release mechanism, and on gamma walkover survey results
- Hot spots considered a potential issue for the 2 units with higher probability of contamination

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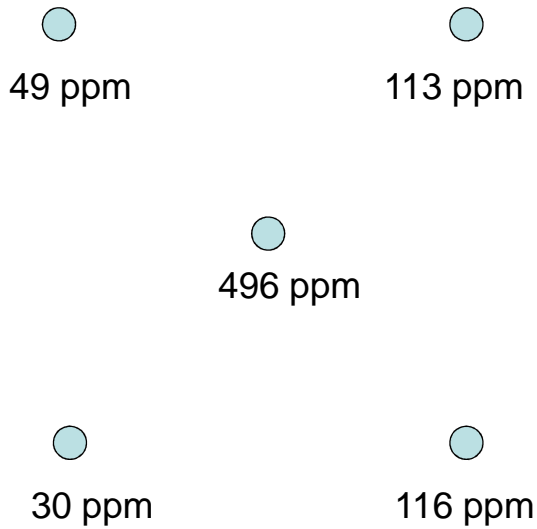
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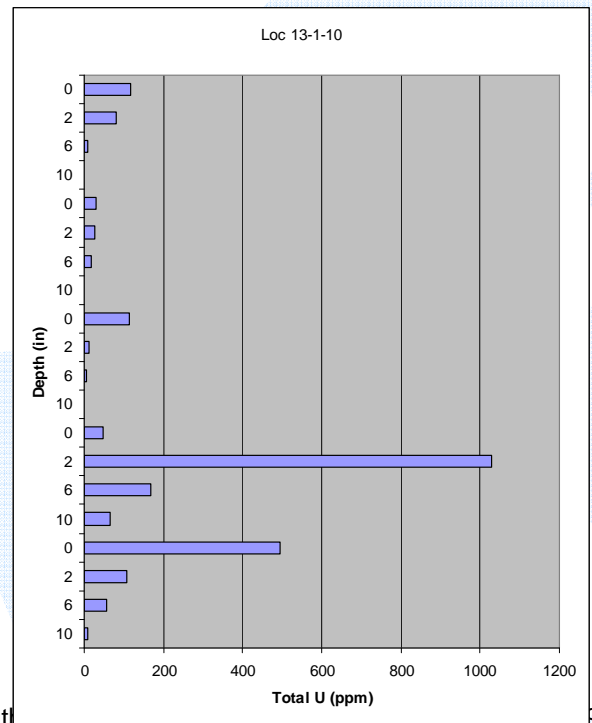
## Contamination Heterogeneity was a Recognized Problem

Total U (XRF) for example 1-ft<sup>2</sup> surface area



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## Sampling Strategy Requirements

- Show compliance with wide area-averaged criteria for uranium and PCBs for each EU (95%UCL comparison)
- Demonstrate that hot spot concerns are not present for the 2 EUs with a higher likelihood of contamination
- Provide data to support surgical soil removal if necessary

## Strategy

### Combine Incremental-Averaging with Composite-Searching

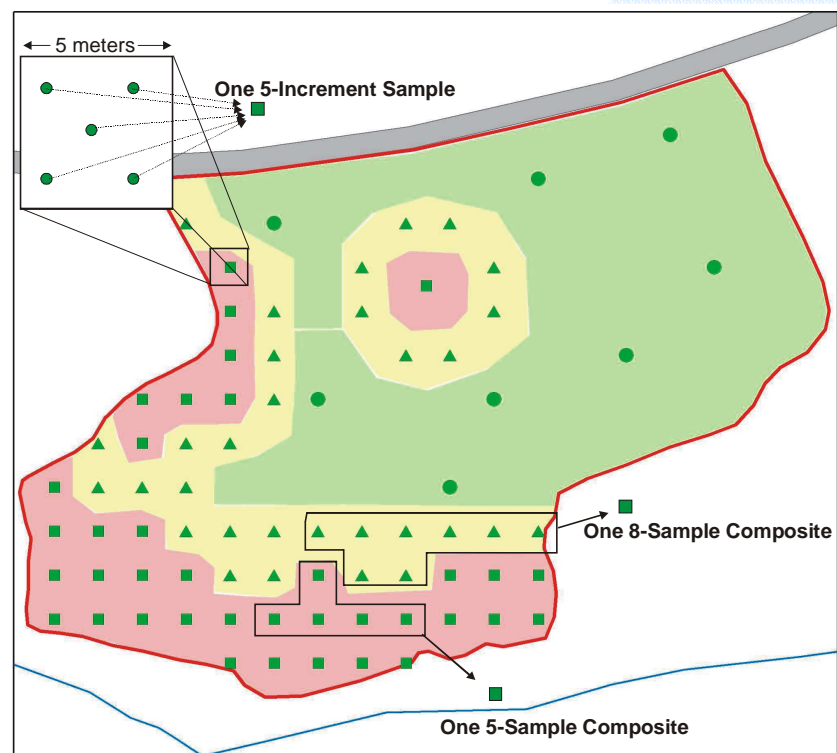
- Gamma-walkover data already indicated at least one uranium hot spot was likely present
- Generally elevated uranium present in one EU that might pose a concern
- Composite-searching to cost-effectively address PCB hot spot concerns
- Incremental-averaging across EUs to show wide-area-average compliance

## Sample Compositing Took Place Over Two Different Spatial Scales

- One 5-increment composite sample per 25 m<sup>2</sup>
  - Each bottom-tier composite sample homogenized and split
  - One half archived, the other half used to form top-tier composites
- # of samples contributing to the top-tier composites depended on possibility of contamination
  - 5 for EU with the greatest chance of contamination
  - 8 for the EU with a medium chance of contamination
- Composites analyzed by XRF and PCB immunoassay kits
- Results compared to decision criterion
  - Decision criterion = (hot spot criterion)/(# of samples in composite)
  - Composite results averaged across EU
  - Average compared to the wide-area-average criteria

## Compositing Strategy...

Area to be checked  
for hotspots = yellow  
& pink with a total  
area of 1700 m<sup>2</sup>  
(68 25-m<sup>2</sup> areas)



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## Results...

- As expected, one composite failed for U, requiring analysis of the archived primary samples
- Its EU as a whole also failed its average comparison (95%UCL > action level)
- Split analysis identified one 25 m<sup>2</sup> “hot spot”
  - Corresponded to hot spot identified by gamma walkover survey (GWS)
- Hot spot remediated, exposed soil re-sampled
- Re-sampled results pooled with original data, EU now passed 95%UCL comparison

## Slide 14

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**JE4** This DU was a "decision unit" in your original slides.  
jody.edwards, 10/8/2009

## Summary of Increment & Composite Numbers

- 385 total soil increments
  - 190 from 1<sup>st</sup> exposure unit (EU) – High contamination probability
  - 155 from 2<sup>nd</sup> EU – Some contamination probability
  - 40 from 3<sup>rd</sup> EU – Low contamination probability
- Resulting in 77 bottom-tier increment-average samples
  - 38 from 1<sup>st</sup> EU
  - 31 from 2<sup>nd</sup> EU
  - 8 from 3<sup>rd</sup> EU
- Producing 11 top-tier search-composites for analysis
  - 7 from 1<sup>st</sup> EU
  - 4 from 2<sup>nd</sup> EU
- 8 increment-average (single tier) composites from 3<sup>rd</sup> EU
- A total of 23 sample analyses
  - Cleared 68 25-m<sup>2</sup> areas of hot spot concerns
  - Demonstrated wide-area average compliance for 3 EUs



## Overall Performance

- GWS provided insights into spatial distribution of contamination
- XRF extremely accurate for uranium and provided quick turn-around results
- Compositing strategies provided significant cost savings
- Analytical costs for 1<sup>st</sup> EU reduced by 68%
- Analytical costs for 2<sup>nd</sup> EU reduced by 88%

# Any Questions?



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