Use of Incremental Sampling for Confirmation of Excavation and Treatment of Agent Orange Contaminated Sediments in Vietnam

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Introduction

- Operation Ranch Hand – herbicides for defoliation
- Agent Orange contained dioxin as 2,3,7,8-TCDD
- Over 100,000 barrels used at Danang
- USAID lead agency for cleanup at Danang
Introduction (cont.)

- Discrete soil and sediment samples collected through January 2010
EA Summary

• Total number of samples (~89 from previous studies)
  – Soil: 34 (11 exceeding standard)
  – Sediment: 28 (11 exceeding standard)

• Volume of material requiring treatment per design
  – Soil: ~42,000 m³
  – Sediment: ~45,000 m³

• Selected Remedy: In-Pile Thermal Desorption
  – Two phases
  – Phasing allows dewatering of sediments while soil treated
Remedy

- Design excavation areas

Sen Lake and Wetland: 110 Ha

Eastern Hot Spot: 19 Ha

Drainage Ditch: 34 Ha

Former Storage Area: 17 Ha

Mixing and Loading Area: 14 Ha
Remedy (cont.)

- Two-phased implementation
- “Upland” in Phase 1
- Primarily sediments in Phase 2
Confirmation Sampling

• Reliable methodology needed to confirm concentrations for each excavation area meet standards
  – Large area
  – Significant heterogeneity
  – High cost of analytical

• Incremental Sampling Methodology (ISM)
ISM Primer

• Following 2012 ITRC guidance
• What is ISM?
  – Structured composite sampling and processing protocol
  – Reduces data variability
  – Provides a single sample for analysis with a concentration representative of the mean concentration of a “decision unit”
ISM Primer (cont.)

- Short-scale heterogeneity
  - Variability at scale of cm to a few m
  - Chance determines analytical result

"Co-located" uranium samples (mg/kg)

Former Storage Area

Former Mixing and Loading Area

Runway (under construction)

10DN957: 193 ppt
SAP646: 5610 ppt
12 m apart

10DN954: 168 ppt
10DN936: 0.396 ppt
6 m apart
ISM Primer (cont.)

- Micro-scale heterogeneity
  - Variability within sample
  - Mineral structure
- Organic carbon content
- Particle size and shape
ISM Primer (cont.)

- ISM minimizes short-scale heterogeneity
  - 30-pt composite in field

Systematic Random
ISM Primer (cont.)

- ISM minimizes micro-scale heterogeneity
  - Sample conditioning
  - Particle size reduction (sieving)
  - 30-pt composite sub-sampling (systematic random)
Application for Confirmation Sampling

- DUs based on understanding of contaminant distribution and conceptual model
- Bottom of excavation is a DU
- Each sidewall is a DU
- Subdivision of DUs to gain additional resolution
Confirmation Sampling Results to Date

- Some DUs clean after design excavation
- Some now clean after additional excavation
- Some still require additional excavation
Summary of ISM Confirmation Sampling

- ISM did NOT “dilute” high concentration hot spots
  - Revealed larger volume requiring treatment than discrete samples
    - Design estimate: 87,000 m³
    - Current estimate: 135,500 m³
  - Confirms discrete samples give many false negatives in moderately contaminated areas
Summary of ISM Confirmation Sampling

- Relative standard deviation for ISM triplicates less than for discrete samples
  - Two field duplicates during EA (discrete): 45% and 11%
  - Mean of 14 triplicate RSDs (ISM): 24%
Application of ISM to Treatment confirmation

- IPTD™ design uses an insulated, above-ground pile to heat up to 45,000 m³ of contaminated material to a minimum temperature of 335°C for 21-28 days
- Soil/sediment in pile is 6 m deep
- Must confirm material reaches average concentration of 150 ppt
Application of ISM to Treatment confirmation

- Pile divided into six, 1-m decision units vertically (DU layers)
- Coring will be used to collect samples
- Triplicate collected for one layer

30 Borings (minimum recommended)
Stay Tuned!

- Phase 1 treatment results expected in January 2015
- Phase 2 treatment will occur in 2016