# Incremental Sampling & Best Practices for Lead Investigations

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**Superfund Division**

# Former Chattanooga Foundries

- 60+ foundries historically located in Chattanooga
- Generated spent sand and baghouse dust over many decades

# Former Chattanooga Foundries

# Foundry-related Waste Material

- Foundry-related waste material: spent sand, bag house dust, other byproducts
- Heterogeneous; can contain lead
- Waste material was used as fill (1890's – 1970's)

# Initial EPA Involvement

- 2011: resident presented at ER with Pb poisoning
- 2012: EPA removed Pb contaminated soil at 84 residences
- Limited geographic area
- Extent of contamination undefined
- Other residential areas may be similarly impacted
- Risk undefined

# Potential Large Urban Lead Site: Where to Begin?

*Is all of downtown Chattanooga contaminated?*

**NO**

# Objectives of the Investigation

- Collect high quality data to support risk management decisions
- Produce defensible, actionable data that can be used for multiple purposes:
  - Site characterization
  - Time-critical removal decisions
  - Potential NPL listing or other response
  - Future CERCLA Remedial Investigation & Risk Assessment

Defensible Actionable Multiple Uses

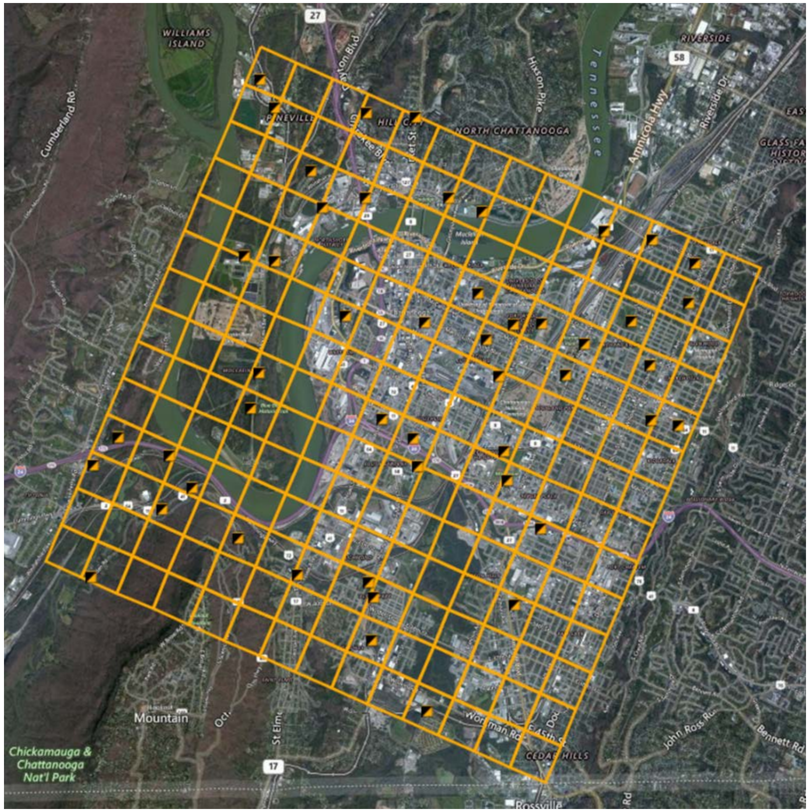
# Best Practices for Sampling for Lead in Soil

- Establish robust background concentration/range
- Incremental Sampling Method (ISM)
- OLEM Directive for sieving soil at lead sites
- EPA Superfund XRF Field Operating Guide
- OLEM Directive "*Updating Scientific Considerations for Lead in Soil Cleanups,*" *Dec. 22, 2016*
  - Lead bioavailability testing
  - Develop site-specific cleanup level for lead

# Best Practice: Establish Background Level for Lead

Chattanooga Urban Bkg Study

- 5x5 mile grid; 50 randomly selected cells
- Used SAP/QAPP template from larger R4 urban background study
- 7 metals associated with foundries: Pb, As, Cd, Cr, Cu, Ni, Zn; plus PAHs

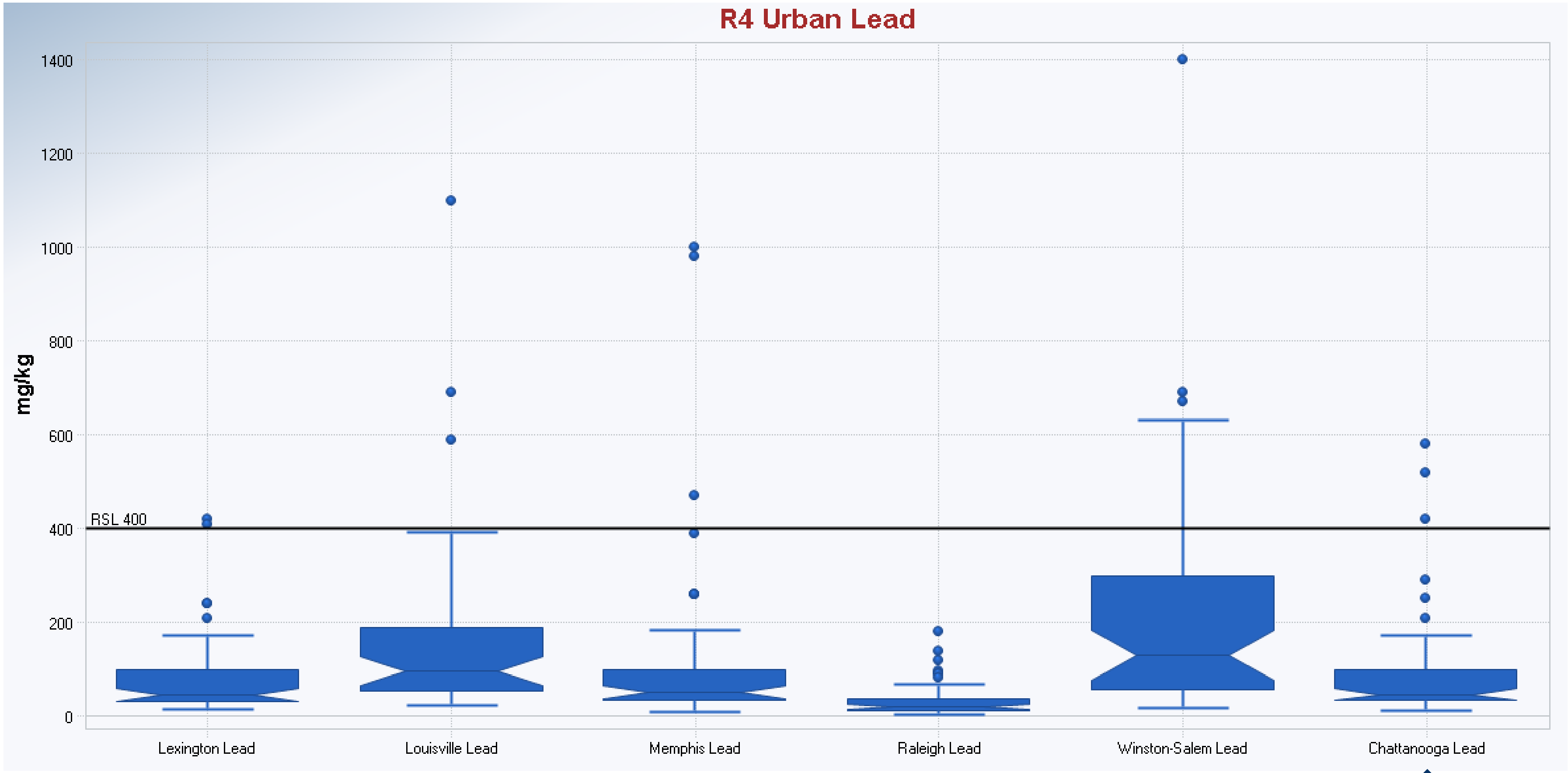


# Urban Background Results

| | RSL | Mean Bkg (mg/kg) | | Urban background 95% UTL (mg/kg) |
|---|---|---|---|---|
| Lead | 400 | 60 | | 175 |
| Arsenic | 0.68 | 3.4 | | 7 |
| Chromium | | 25 | | 33 |

- Background lead consistent with other cities in SE U.S.
- Robust background dataset ready for RI
- Elevated lead concentration **NOT** “everywhere”

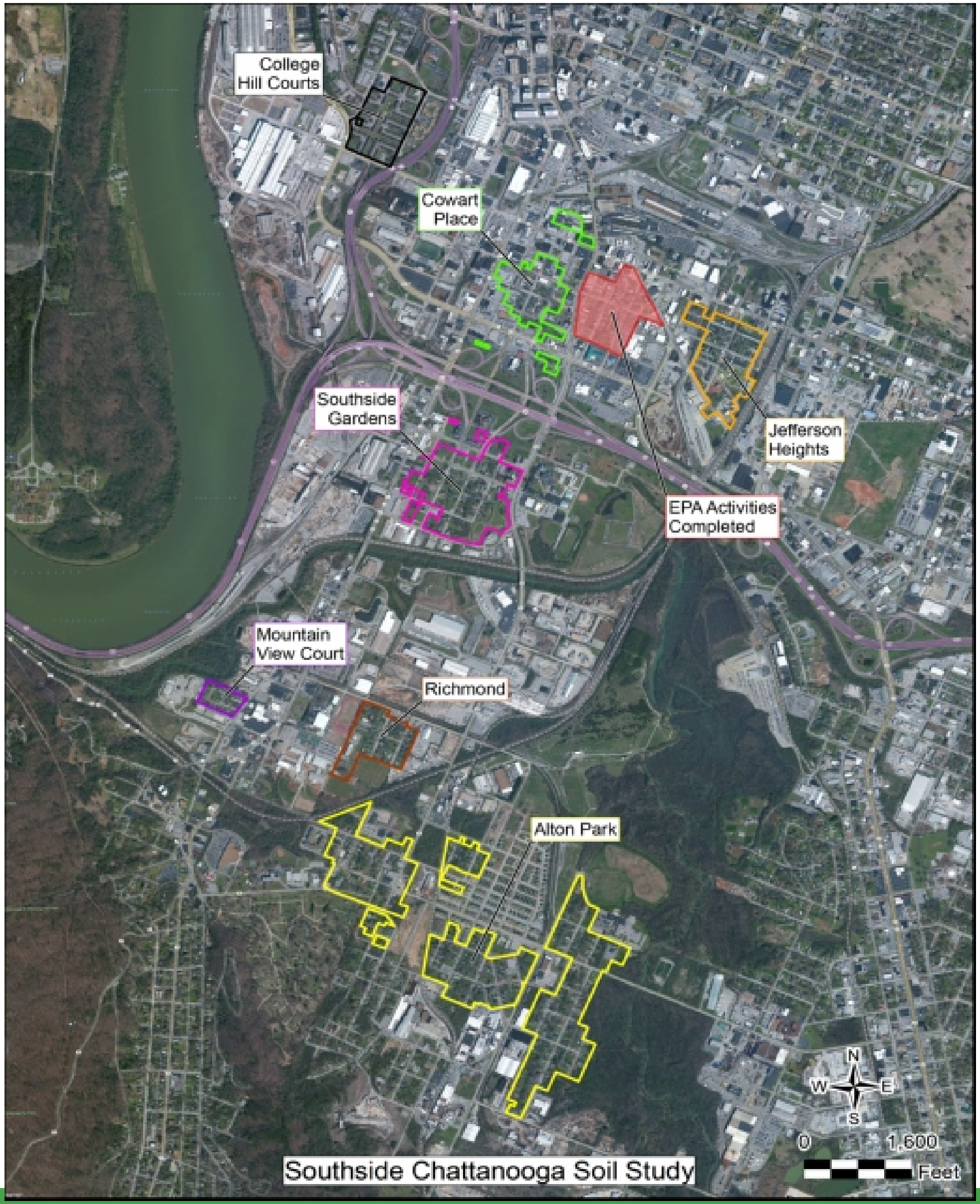
# Chattanooga Lead Background vs. 5 Cities




Lexington Louisville Memphis Raleigh Winston-Salem

Chattanooga

# Identify Study Areas



# Field Operation


# Best Practice: Incremental Sampling Methodology (ISM)

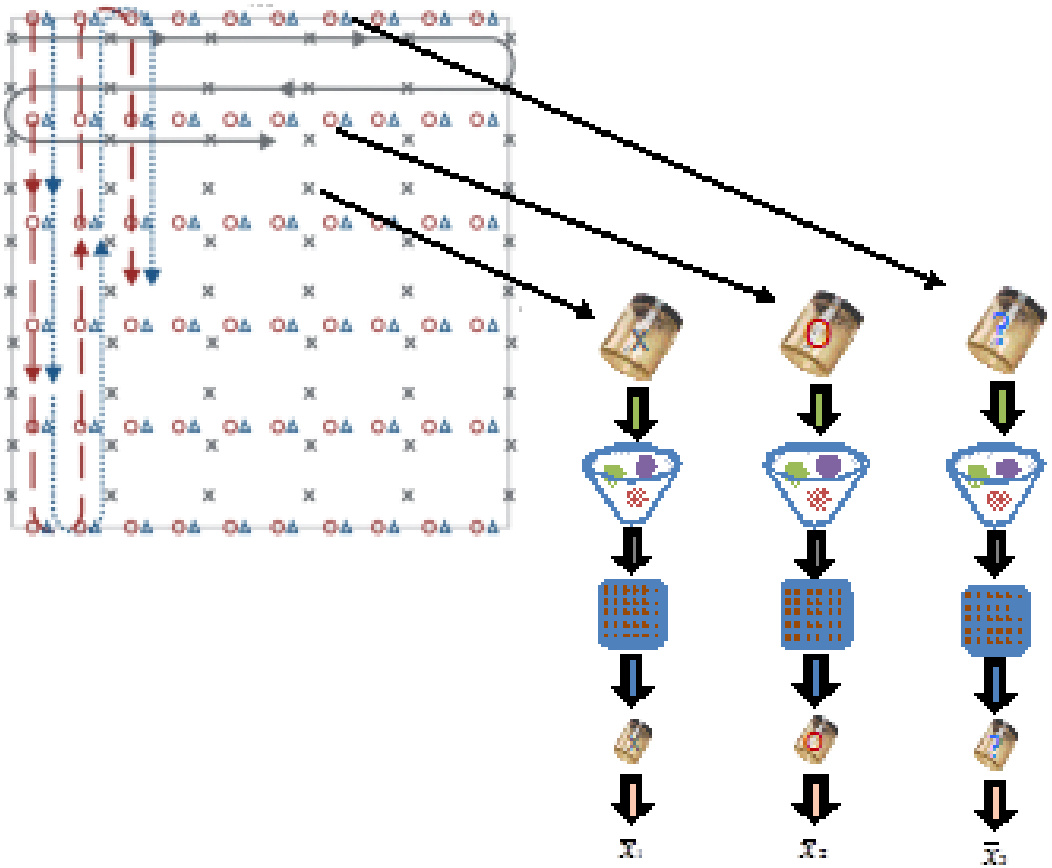
**Why ISM?**

Superior method to derive an unbiased estimate of the mean concentration of a given area (i.e. decision unit)

One ISM sample is collected for each decision unit

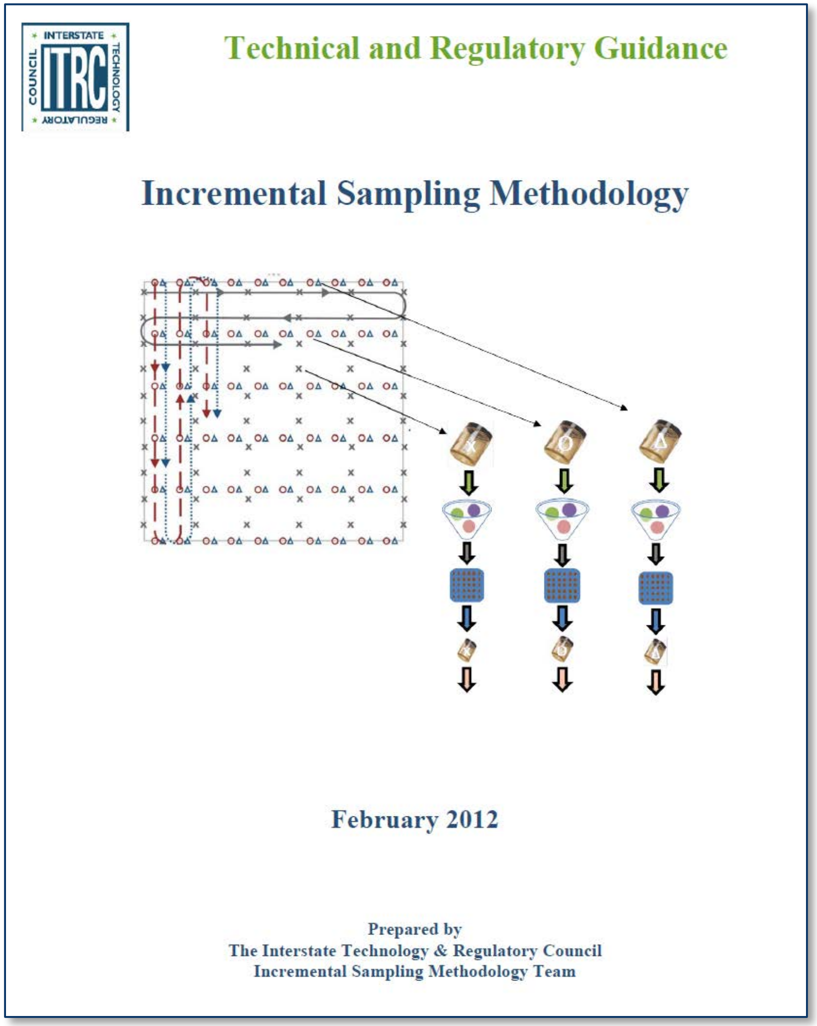
Each sample is comprised of 30 aliquots, and produces one concentration that represents the entire decision unit (yard)

Statistically defensible data on which to base decisions



https://www.itrcweb.org/ism-1/pdfs/ism-1_021512_final.pdf

https://www.itrcweb.org/ism-1/


Technical and Regulatory Guidance

Incremental Sampling Methodology

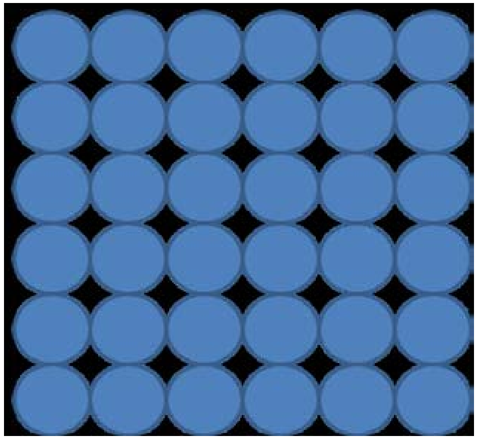
February 2012

Prepared by
The Interstate Technology & Regulatory Council
Incremental Sampling Methodology Team

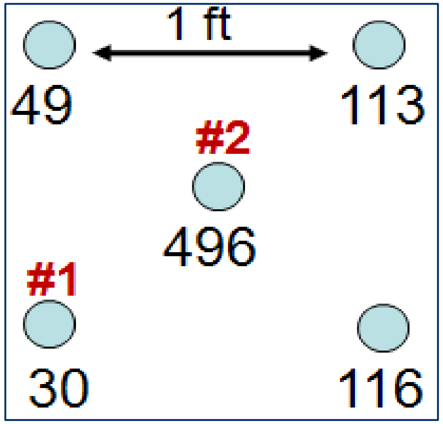
# Best Practice: Incremental Sampling Methodology (ISM)

Addresses heterogeneity in soils and variation in contaminant concentrations:

- "microscale" heterogeneity
- "Short-scale" and large scale heterogeneity



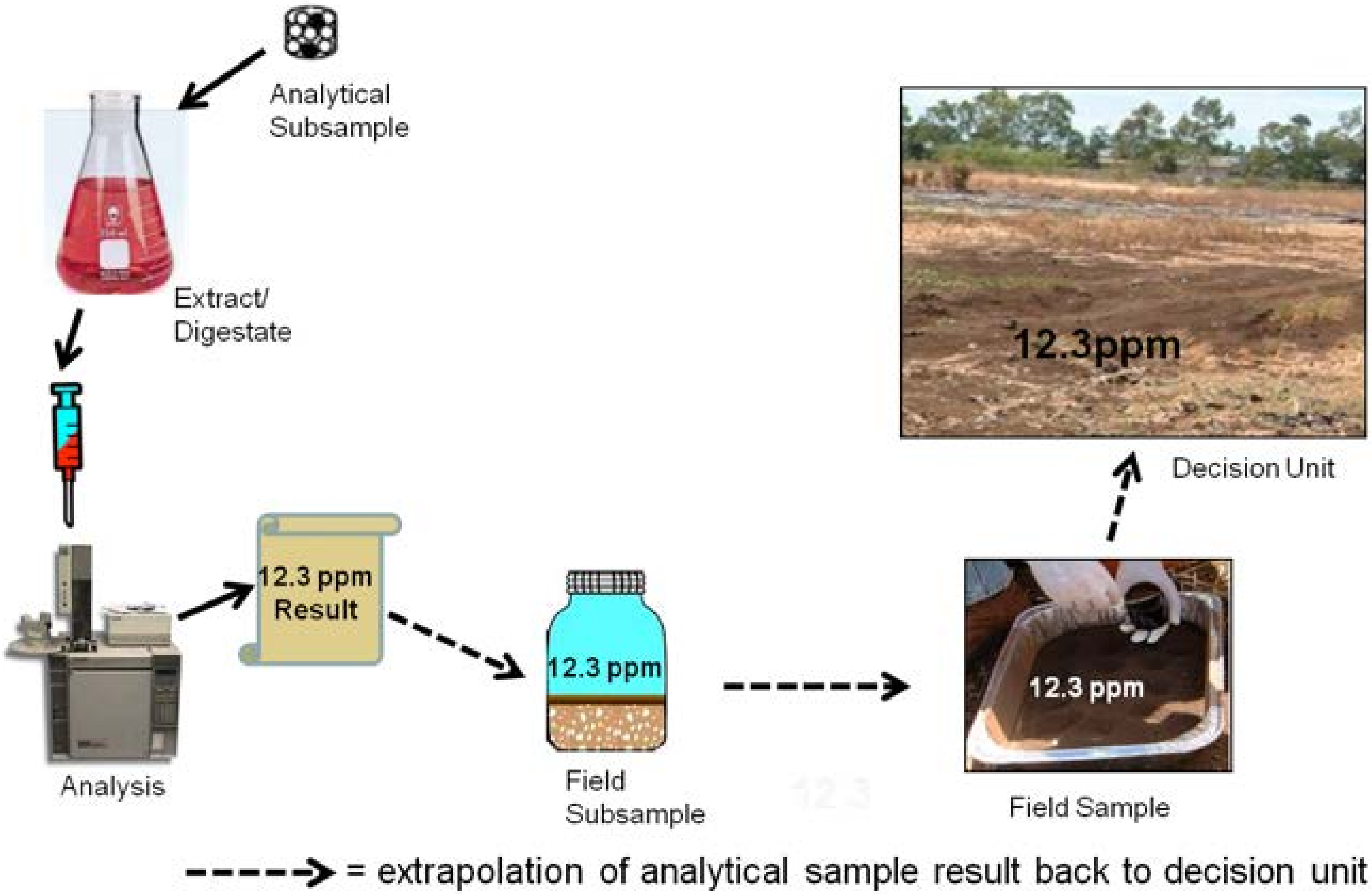
**1 ft$^2$ area of surface soil contains 36 possible 2" diameter core sample locations**




**Observed short-scale heterogeneity with uranium sample results**

IRTC *Incremental Sampling Methodology*, February 2012, Figures 2-5 & 2-6

# Extrapolating Analytical Result to Decision Unit




IRTC *Incremental Sampling Methodology*, February 2012, Figure 2-7

EPA/600/R-03/027
November 2003

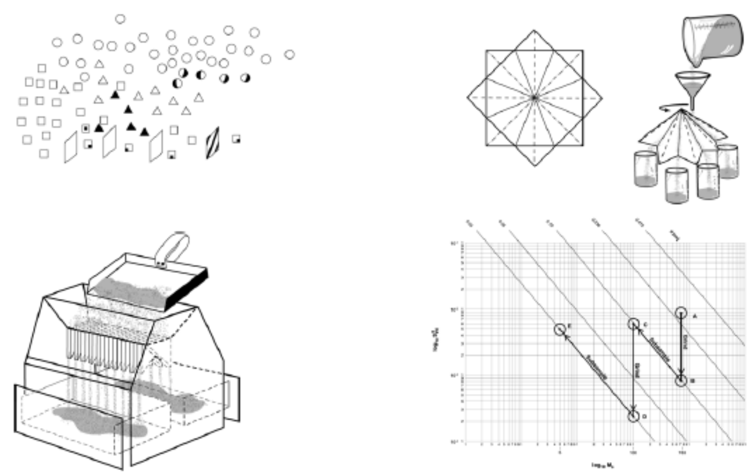
# Guidance for Obtaining Representative Laboratory Analytical Subsamples from Particulate Laboratory Samples

by

Robert W. Gerlach
Lockheed Martin Environmental Services

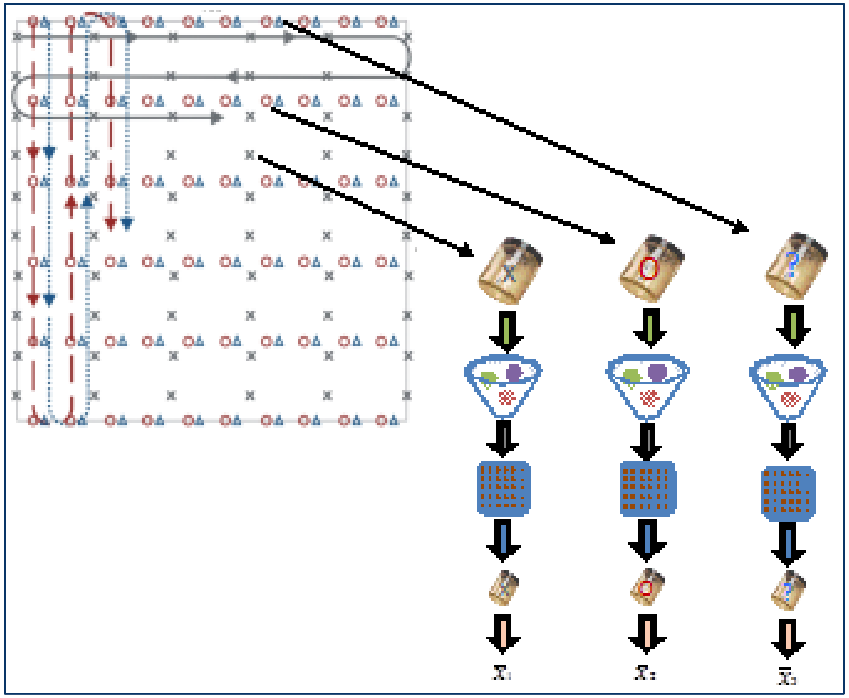
and

John M. Nocerino
U.S. Environmental Protection Agency



223CMB03.RPT ❖ 10/27/03

https://itrcweb.org/ism-1/references/guidancerl.pdf



30 aliquot field sample

Subsampling for analysis

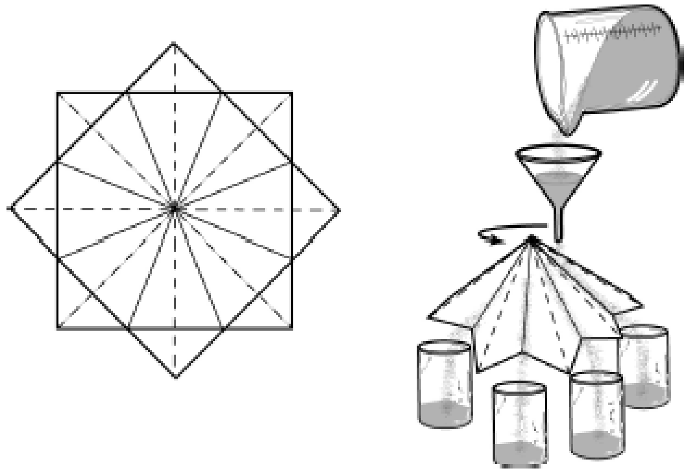
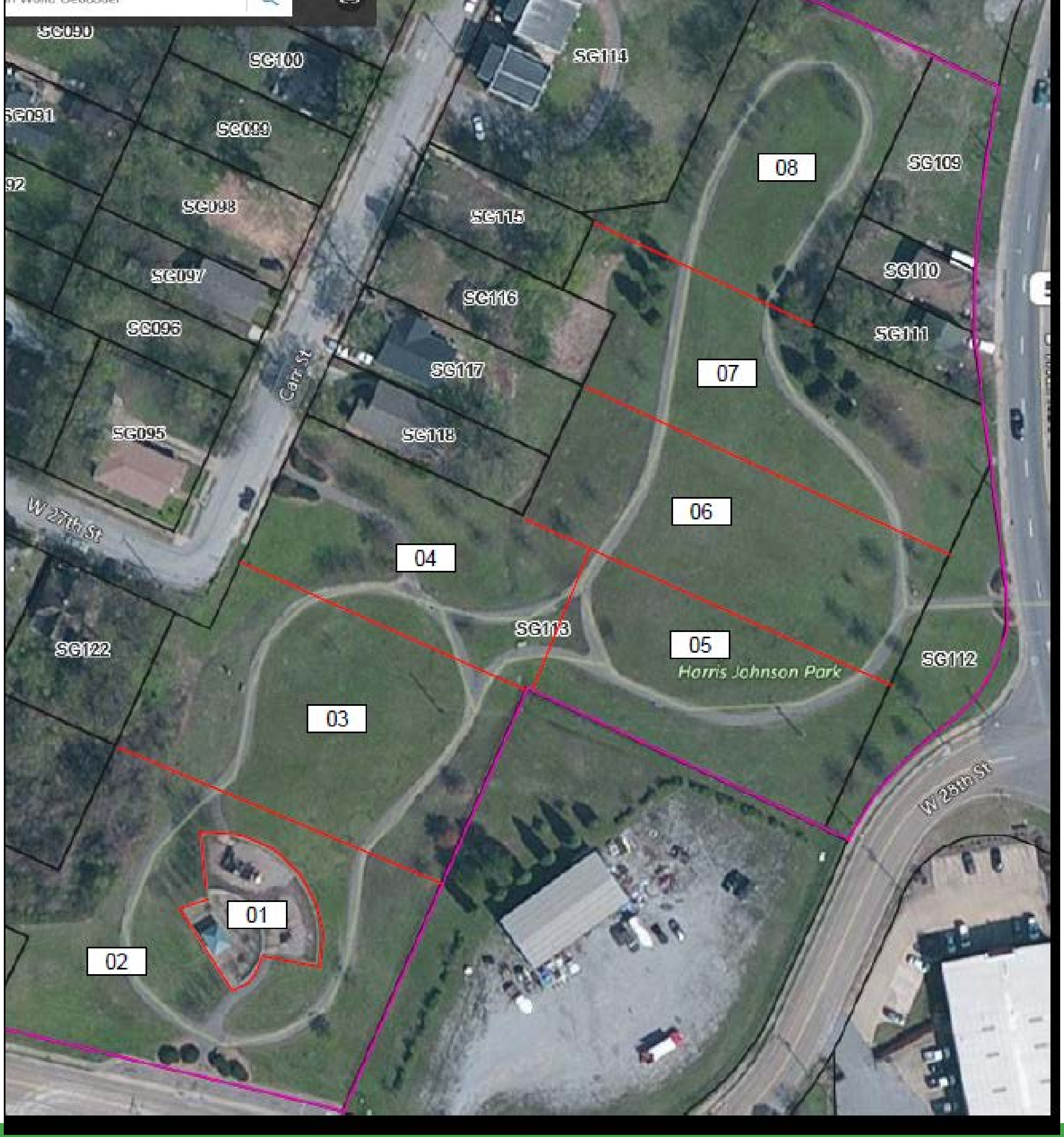


Figure 15. A paper cone sectorial splitter with eight sectors.

*Guidance for Obtaining Representative Subsamples, Nov. 2003*

# ISM:
# Decision Units


JH097
JH075
JH079
JH080
JH081
JH082
JH083
JH084
JH085
01
02
03
04
05
Jefferson Street Park
JH096
JH121
JH122
JH123
JH124
JH125
JH126
JH127
JH128
JH129
E 19th St
Madison St
JH092
JH093
JH094
JH095



SG090
SG100
SG114
SG091
SG099
SG098
SG115
SG097
SG116
SG096
SG117
Carr St
SG095
SG118
SG109
SG110
SG111
08
07
06
05
04
03
02
01
W 27th St
SG113
SG112
SG122
Harris Johnson Park
W 28th St

# Incremental Sampling in Chattanooga

# Collecting ISM: Time & Effort


***One 30-point composite from a residential yard takes 8 minutes to collect***

# Disaggregation and Drying

# OLEM Lead Sieving Directive

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

JUL 1 - 2016

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MANAGEMENT

**MEMORANDUM** **OLEM Directive 9200.1-128**

**SUBJECT:** Recommendations for Sieving Soil and Dust Samples at Lead Sites for Assessment of Incidental Ingestion

*Recommendations for Sieving Soil and Dust Samples at Lead Sites for Assessment of Incidental Ingestion,* OLEM Directive 9200.1-128

# OLEM Lead Sieving Directive

- Recommends  < 150 µm particle size (#100 mesh)
- Incidental ingestion greater for fine particles.
- Dermal adherence greater for fine particles.
- Increased contaminant concentration, mobility, and bioavailability in fine particles.

# Dermal Adherence

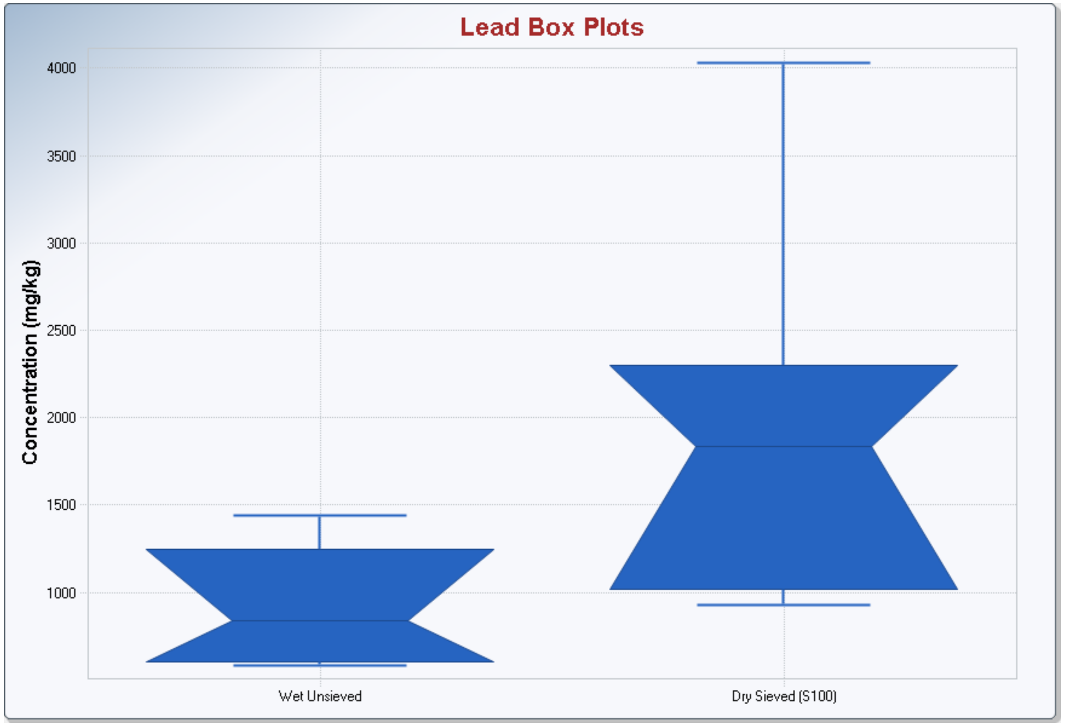
# Sieve of Stacked Mesh (#10 and #100)

# Fine Fraction <150 microns

# Lead Concentrates in the Fine Fraction

Pb in mg/kg

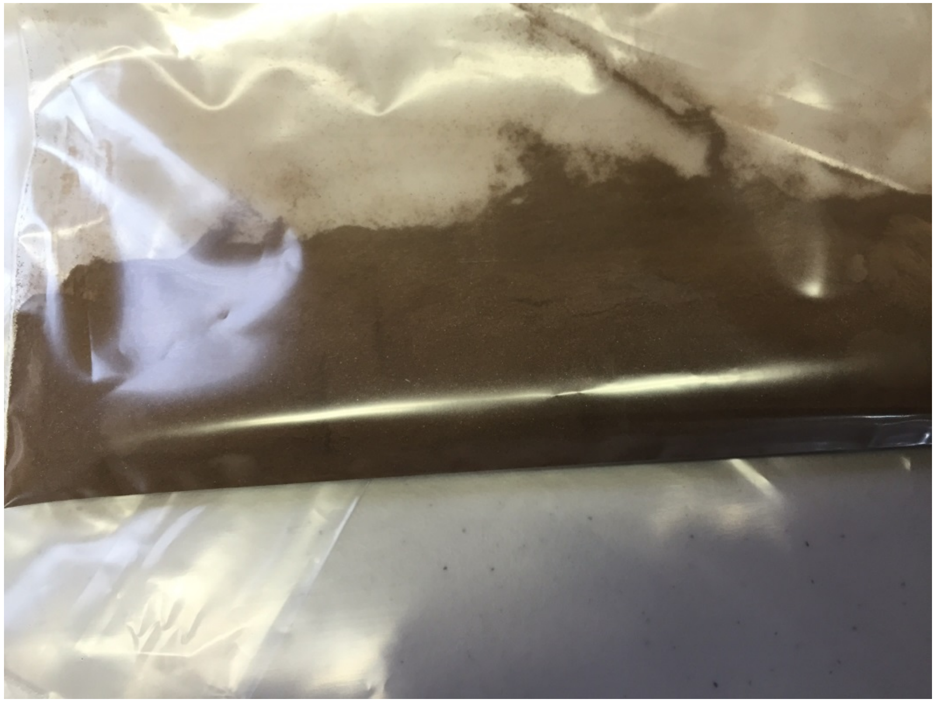
| Unsieved | Sieved |
|---|---|
| 603 | 1016 |
| 837 | 1832 |
| 1434 | 4021 |
| 1245 | 2300 |
| 591 | 936 |



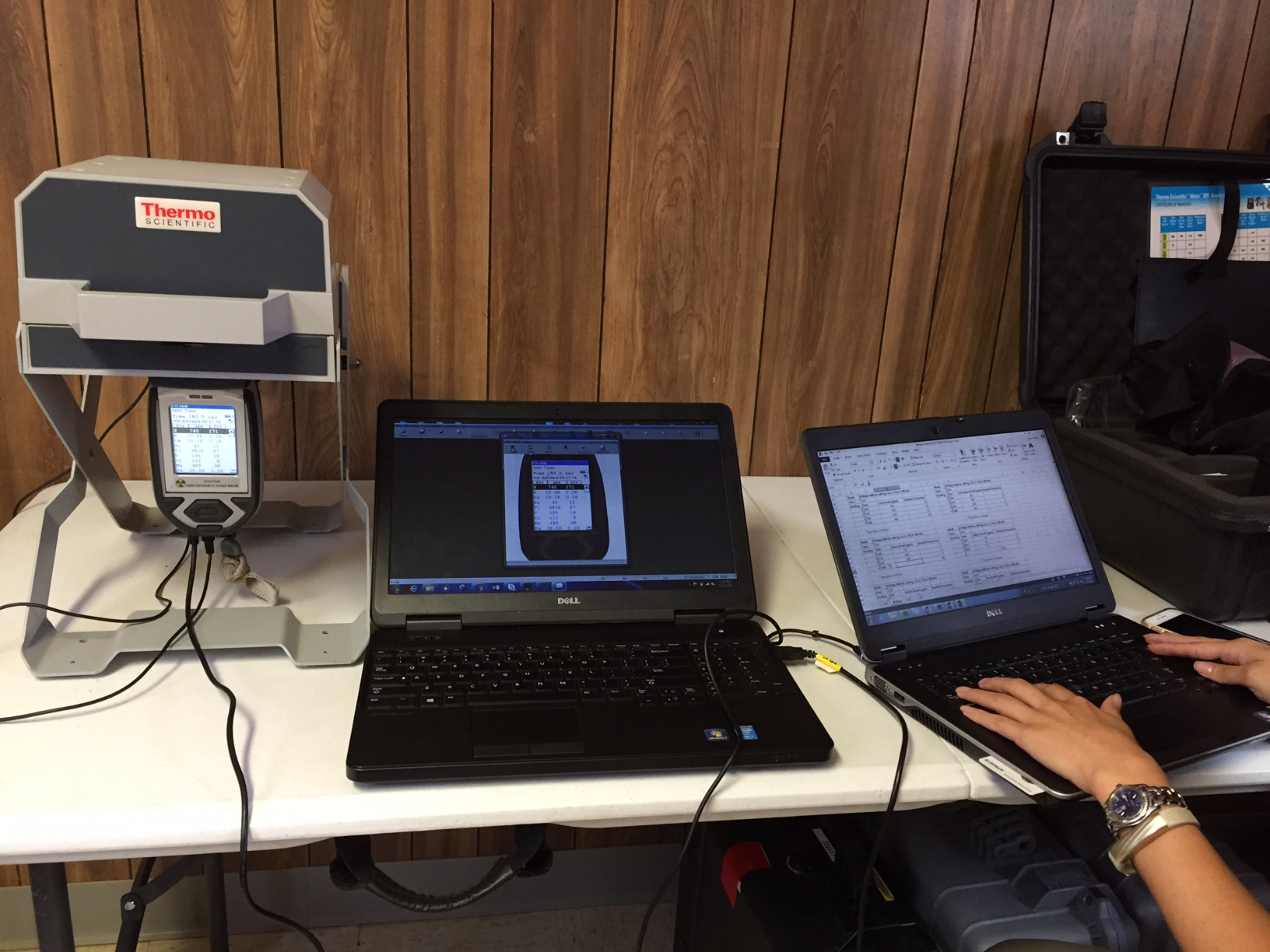

At this site, sieved soil has approximately 100 ppm higher concentration than in unsieved.

# ISM Includes Representative Subsampling

"One-Dimensional Slab Cake" procedure



# Representative subsamples for analysis

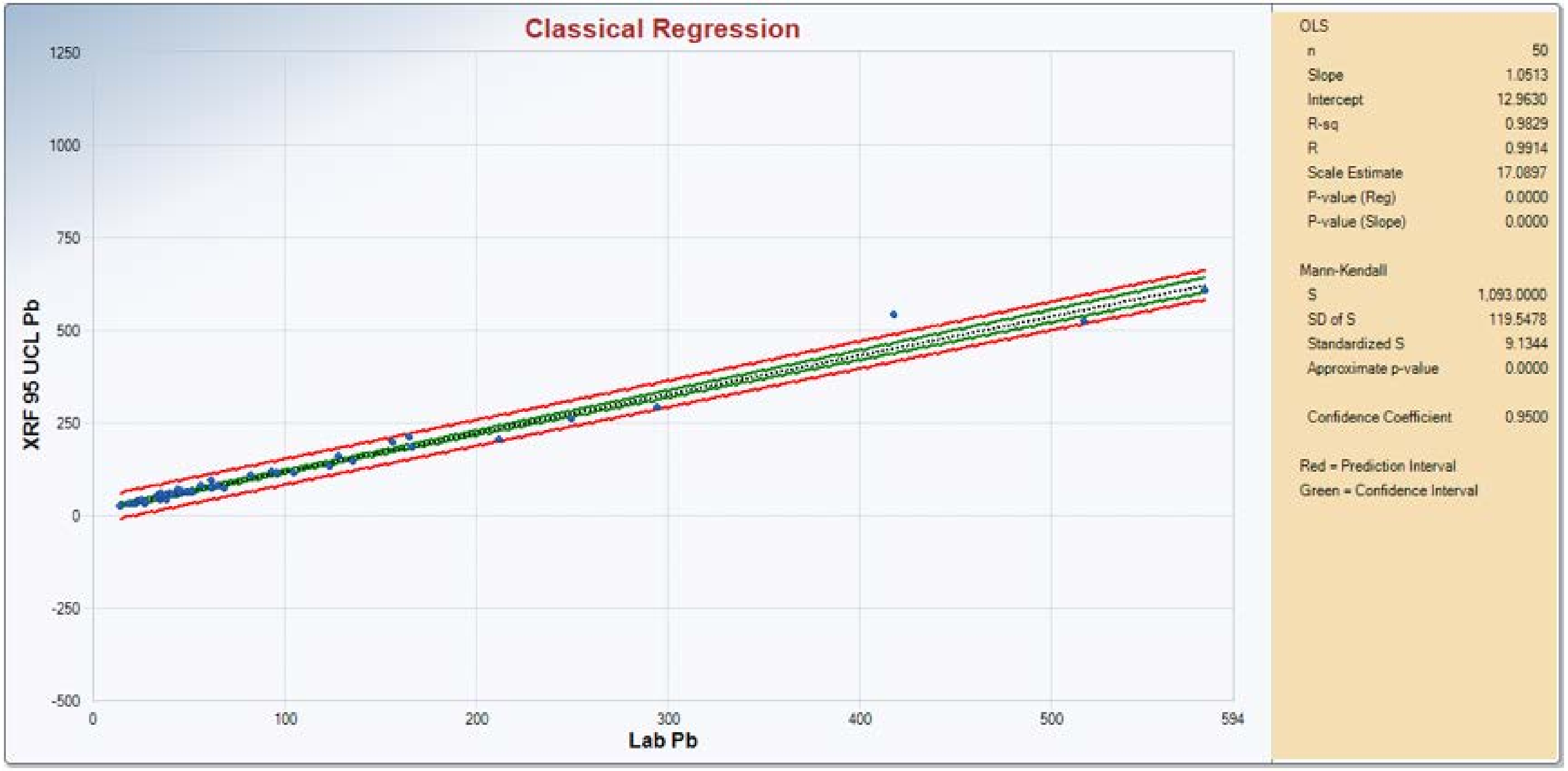


Thermo
SCIENTIFIC
DELL
DELL

# Best Practice:
# X-Ray Fluorescence Field Operations Guide

*Superfund X-Ray Fluorescence Field Operations Guide*, EPA Region 4, July 19, 2017 (SFDGUID-001-R0)

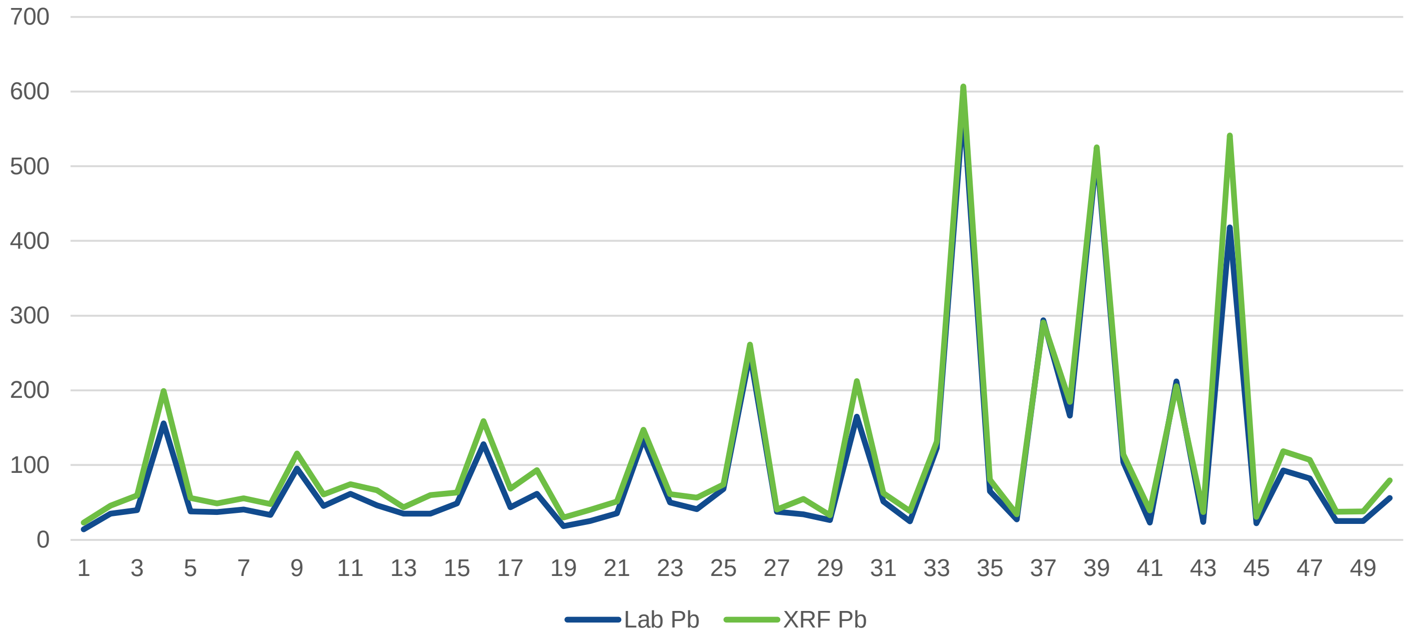
- Tool for OSCs and RPMs
- Methodology to collect high quality XRF data for lead and arsenic
- Provides real-time data
- Multiple readings and QA/QC measures
- Produces "definitive" data = data of sufficient quality to use in remedial and removal decisions and in the BLRA

# XRF vs Lab Data: Lead




**R Squared = 0.98**
**Excellent agreement between XRF data and lab data.**

# XRF vs. Lab: Pb

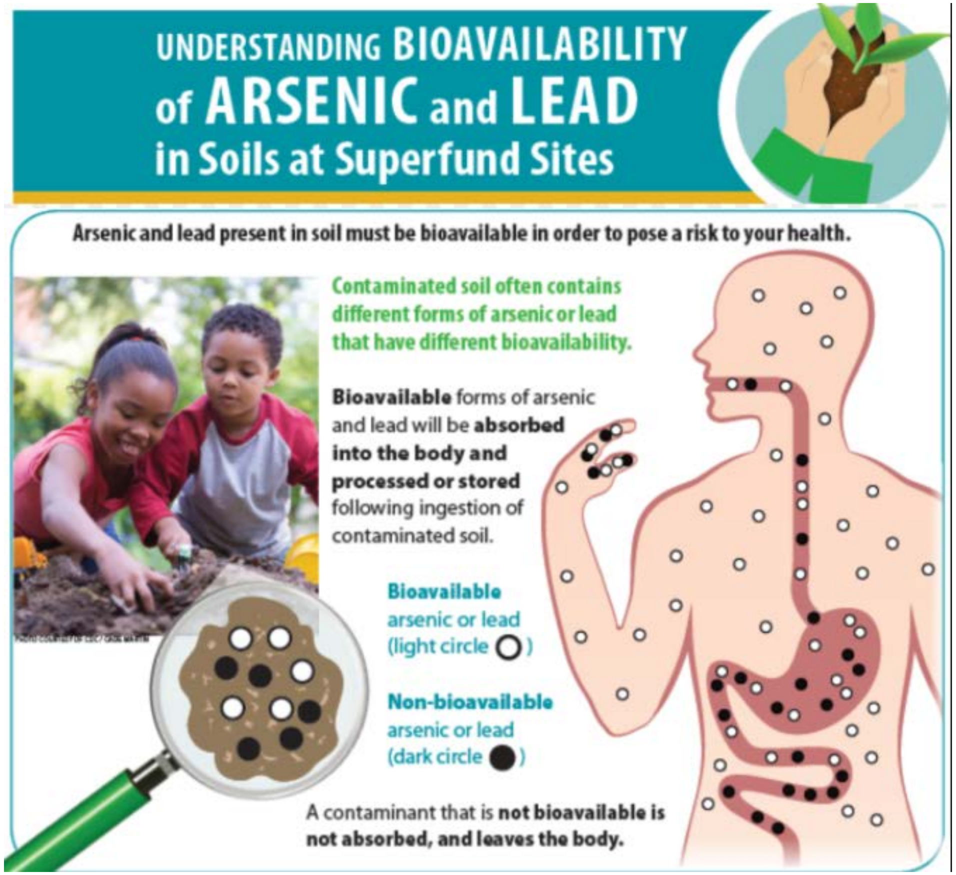



XRF provides reliable, reproducible & defensible data for Pb for this project (n = 300+)

# Best Practice:
# Site-specific Clean-up Levels for Lead


OLEM Directive: *Updated Scientific Considerations for Lead in Soil Cleanups,* Dec. 22, 2016

# Best Practice: Lead Bioavailability



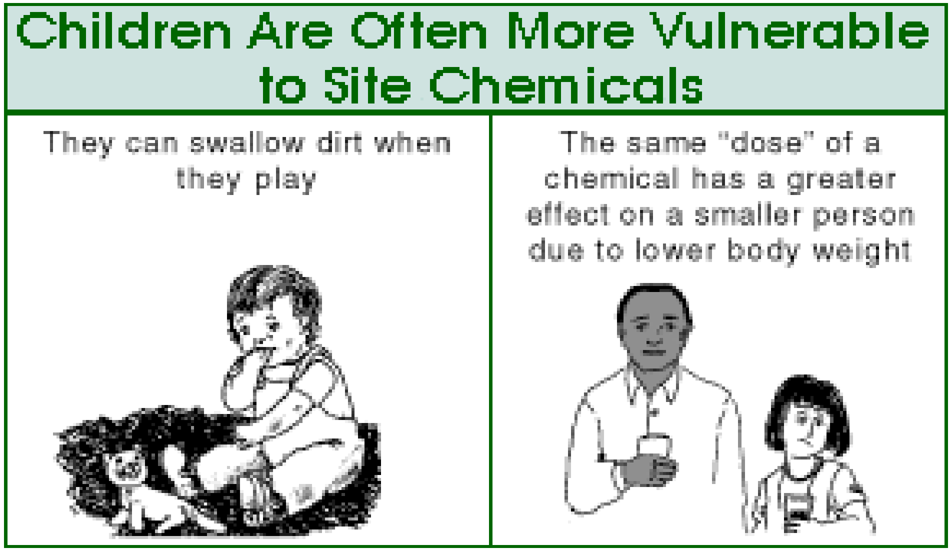

**Bioavailability**

- **A measure of the amount of lead absorbed into bloodstream**
- **Important input in clean up level**

# Integrated Exposure Uptake Biokinetic (IEUBK) Model

**Predicts blood lead levels in children resulting from environmental exposures.**

**Utilized by EPA to set cleanup goals for lead in soil.**



# Best Practice:
# Site-specific Clean-up Levels for Lead

- Use site-specific lead bioavailability in the IEUBK model
- ↑BA will ↓health-based clean-up level
- IEUBK default BA = 30%
- In this case, 33 soil samples were analyzed for lead bioavailability
- Chattanooga site soils BA = 29-50%; mean = 36%
- Other updated inputs to IEUBK used, esp. target blood lead level and ingestion rate

# SOP for *In Vitro* Lead and Arsenic Testing

**UNITED STATES ENVIRONMENTAL PROTECTION AGENCY**
WASHINGTON, D.C. 20460

MAY - 5 2017

OFFICE OF
SOLID WASTE AND
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NOW THE
OFFICE OF LAND AND
EMERGENCY MANAGEMENT

**MEMORANDUM**

**SUBJECT:** Release of Standard Operating Procedure for an In Vitro Bioaccessibility Assay for Lead and Arsenic in Soil and Validation Assessment of the In Vitro Arsenic Bioaccessibility Assay for Predicting Relative Bioavailability of Arsenic in Soils and Soil-like Materials at Superfund Sites

*Standard Operating Procedure*… OLEM, May 5, 2017

# Conclusion of Chattanooga Soil Study

- ✓ Elevated lead is not “everywhere; can distinguish between suspect material and urban background
- ✓ Data supports risk management decisions
- ✓ Unacceptable risk at some properties
- ✓ Removal warranted at some properties
- ✓ Remedial action planned
- ✓ Site-specific cleanup level “options” developed

# Q & A