BEST PRACTICES FOR LARGE-SCALE URBAN LEAD INVESTIGATIONS: CHATTANOOGA CASE STUDY

EPA REGION 4

Tim Frederick, MPH
Region 4 has been involved in several large-scale urban lead soil investigations.

Drawing from these experiences, we’ve worked to:

- Develop best practices for collecting soil samples
- Develop, field test, and improve XRF capabilities for analyzing soil
- Better understand urban background conditions
- Document, share, and improve our approaches
60+ foundries historically located in Chattanooga.

Foundries generated spent sand and baghouse dust over many decades.
FORMER CHATTANOOGA FOUNDRIES
PREVIOUS EPA INVolVEMENT

- 2011: resident presented at ER with lead poisoning
- 2011: EPA removal assessment
- 2012-2013: EPA removal at 84 residences in Read Avenue area
- Limited geographic area
- Extent of contamination beyond removal areas (if any) unknown
UNFINISHED BUSINESS?

During removal action, EPA became aware that additional areas may be similarly impacted
  - Recon
  - Anecdotal

TDEC raised concerns about lead-contaminated foundry waste potentially located in other residential areas
  - TDEC data from Brownfields and local development projects, state voluntary oversight program

Tennessee Department of Health data indicating a relatively high % of children with elevated blood lead *(in some neighborhoods compared to surrounding areas)*.
QUESTIONS:
POTENTIALLY LARGE URBAN LEAD SITE

Is there a “CERCLA release” (vs. anthropogenic background)?

Can this situation be addressed under CERCLA?

What is the potential scope and severity? (Is Pb everywhere?)

Is this a removal or remedial situation?
OBJECTIVES OF THE SITE INVESTIGATION

Establish urban Pb background levels
Identify sampling locations
Collect data to support decisions:
- Identify need for time-critical removal
- Determine eligibility for NPL (HRS scoring)
- “Rule in” or “rule out” each area for further response
Utilize SI data for ER, Risk Assessment and future RI (avoid resampling yards)
Use best practices in sample collection, preparation, analysis
SELECTING STUDY AREAS

Analyzed information from several sources:
- TDEC data
- EPA data from previous studies
- Historical figures; foundries
- Department of Health blood lead information
- Demographic and census data
EXISTING DATA
ADD CENSUS TRACTS
BLOOD LEAD LEVELS BY CENSUS TRACT
RESULT: IDENTIFICATION OF SEVEN PRIORITY AREAS
ESTABLISH CHATTANOOGA URBAN BACKGROUND LEVEL FOR LEAD

- Used SAP/QAPP template from larger R4 urban background study
- 5x5 mile grid; 50 randomly selected cells
- Excluded flood plain areas, study areas, known industry
- Piloted “best practices sampling and analytical” methods
BEST SAMPLING & ANALYTICAL PRACTICES

Sought lessons learned from similar Region 4 sites
Sought lessons learned from other regions
- Region 8 – Pueblo Smelter Site
- Region 10 – Bunker Hill Site
Considered new OLEM Guidance
- Sieving
- In Vitro Bioavailability
Considered draft Region 4 XRF Field Operations Guide
OLEM LEAD SIEVING DIRECTIVE

Recommendations for Sieving Soil and Dust Samples at Lead Sites for Assessment of Incidental Ingestion
OLEM LEAD SIEVING DIRECTIVE

- Lead TRW recommends < 150 μm particle size.
- 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)
DISAGGREGATION AND DRYING
FINE FRACTION
<150 MICRONS
## Foundry Sand: Sieved vs Unsieved

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<th></th>
<th>Unsieved</th>
<th>Sieved</th>
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<tbody>
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<tr>
<td>1434</td>
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<tr>
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<td>2300</td>
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<tr>
<td>591</td>
<td>936</td>
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</table>

![Lead Box Plots](image)
FIELD FUME HOOD
SAMPLE COLLECTION: INCREMENTAL SAMPLING METHODOLOGY (ISM)

Why ISM?

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

One ISM sample is collected for each yard (yard = exposure unit)

Each sample is comprised of 30 same-sized aliquots, and produces one result that represents the entire yard

Statistically defensible data on which to base decisions
COLLECTING SAMPLES: TIME & EFFORT

One 30-point sample from a residential yard takes about 8 minutes to collect.
ANALYSIS: R4 XRF FIELD OPERATING GUIDE (FOG)

Standardized methodology for collecting high-quality field data

Generates real time QA/QC measures

Provides real-time data

Multiple readings lead to reproducible results (especially in conjunction with sieving protocols)

https://www.epa.gov/risk/regional-4-superfund-x-ray-fluorescence-field-operations-guide
## QA DATA ENTRY IN FIELD

### As Element

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<thead>
<tr>
<th>DU or Bag ID: Cell 70 S100</th>
<th>Element: As</th>
<th>Instrument Result (ppm)</th>
<th>Error (as 1 Std Dev)</th>
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<td>3</td>
<td>1129</td>
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<tr>
<td><strong>Mean</strong></td>
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</tr>
<tr>
<td><strong>SD</strong></td>
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<td></td>
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<tr>
<td><strong>Ttr %RSD</strong></td>
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</table>

ProUCL distribution:
- 2-sided Sample 95% t-UCL
- 2-sided Sample 95% t-LCL
- 1-sided Sample 95% t-UCL
- 1-sided Sample 95% t-LCL

Instrument error = 5.08 as %RSD

### Pb Element

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<th>Element: Pb</th>
<th>Instrument Result (ppm)</th>
<th>Error (as 1 Std Dev)</th>
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<td>1129</td>
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<tr>
<td><strong>SD</strong></td>
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<td></td>
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</tr>
<tr>
<td><strong>Ttr %RSD</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ProUCL distribution:
- 2-sided Lower bag limit Mean - 2 SD = 223.5
- 2-sided Upper bag limit Mean + 2 SD = 260.9
- 1-sided Sample 95% t-UCL = 244.7
- 1-sided Sample 95% t-LCL = 258.6

Instrument error = 4.36 as %RSD
CORRELATION XRF VS LAB DATA: LEAD

R Squared = 0.98
Pb: Lab vs XRF

![Graph showing Pb concentration comparison between Lab and XRF methods. The graph displays multiple peaks and troughs, indicating variability in Pb levels.]
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
UNDERSTANDING BIOAVAILABILITY of ARSENIC and LEAD in Soils at Superfund Sites

Arsenic and lead present in soil must be bioavailable in order to pose a risk to your health.

Contaminated soil often contains different forms of arsenic or lead that have different bioavailability.

Bioavailable forms of arsenic and lead will be absorbed into the body and processed or stored following ingestion of contaminated soil.

Bioavailable arsenic or lead (light circle ○)

Non-bioavailable arsenic or lead (dark circle ●)

A contaminant that is not bioavailable is not absorbed, and leaves the body.
BIOAVAILABILITY INFORMS RISK & CLEAN-UP GOALS
RESULTS AND OUTCOMES
REGION 4 URBAN BACKGROUND STUDY
An Inter-Agency Research Project

The U.S. Environmental Protection Agency (USEPA) and Southeastern states are conducting a collaborative research project. The purpose of the project is to document background concentrations of selected environmental parameters in surface soils of urban areas of the Southeastern United States. Surface soil, the top two inches of the soil profile, is assumed to be the primary human exposure source via ingestion. The selected parameters are chemicals that are typically found in all urban environments.

Because the goal is to collect a database of the background concentrations of these chemicals, the study is purposefully designed to avoid sampling areas of known or suspected contaminant releases. The intended use of the data collected from this project is to inform and provide context to environmental investigations conducted by USEPA and its State and local partners. The data will be especially useful for providing background information for Brownfields redevelopment projects, Superfund projects, and other environmental restoration projects that aim to restore contaminated property to beneficial use.

Cities were selected for inclusion in this research project based upon the input and recommendations of representatives from the participating States. Currently data has been collected for eight cities, but there may be additional sampling efforts performed that may add to this database. In each of the cities, potential sampling locations were identified through use of a sampling grid and a random selection process. The potential sample locations were then vetted to the extent possible to ensure that the sampled locations were representative of background urban conditions. If any locations were thought to be unsuitable for the purposes of the project, they were replaced with the next randomly selected grid cell. A summary presentation and the Sampling and Analysis Plan (SAP) can be obtained by clicking on the "Urban Background Study Webinar" hyperlink below. Explanations of the decision process for selecting sampling locations and the methods employed for sample collection are provided in the SAP. All samples are assumed to represent local background conditions and are assumed to not have resulted from releases from contaminated sites.

A map of the Southeast States and sampled cities is provided under the "Locations" worksheet and can be accessed by hyperlink below. From the "Locations" worksheet, one can then access a data summary for "All Cities" or individual city data summaries and sampling grid maps.

Urban Background Study Webinar
Locations

Additional Information:
Tim Frederick
USEPA Region 4
Superfund Division
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604-563-9599
XRF USE GOING FORWARD

- XRF provides reliable, reproducible & defensible data for this project (n = 300+)
- Additional efforts to streamline process tested & implemented
- XRF will be used for decision making at the site going forward with minimal laboratory confirmation
- Lessons learned used to revise the FOG
33 soil samples were analyzed for lead bioavailability

IEUBK default BA = 30%

Chattanooga site soils BA = 29-50%; avg. = 36%

↑BA will ↓health-based remedial level

Site specific cleanup levels: < 400 ppm to well below background levels, depending on target blood lead level used in model: 360 ppm
ISM has been adopted by the team as the method for sample collection.

All samples are dried before analysis by XRF.

Developed protocol to determine when sieving is necessary going forward (greatly reduces field effort).
PROJECT STATUS

Time-critical removal action to address worst yards first (tiered approach used to prioritize residences);

SI complete;

Determined to be eligible for the National Priority List and listed in 2017

Data was used in the Remedial Investigation and Baseline Risk Assessment

Field methods used in SI refined/improved and continued into RI phase

Historical Sampling (Through Dec 2018)

Summary Table

Southside Chattanoga Lead Site

<table>
<thead>
<tr>
<th>Neighborhood</th>
<th>Total Yards</th>
<th>Sampled Yards As of 12/12/18</th>
<th>Yards to Sample As of 12/12/18</th>
<th>Properties &gt; 380 ppm</th>
<th>Properties &gt; 1200 ppm</th>
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<td>62</td>
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<tr>
<td><strong>Totals (To Date)</strong></td>
<td><strong>3619</strong></td>
<td><strong>772</strong></td>
<td><strong>2847</strong></td>
<td><strong>273</strong></td>
<td><strong>39</strong></td>
</tr>
</tbody>
</table>
SOUTHSIDE CHATTANOOGA
TEAM MEMBERS

Cathy Amoroso & Robenson Joseph, RPMs
John Nolen, RPM, TN Coordinator
Perry Gaughan, On-scene Coordinator
Kevin Koporec, Human Health Risk Assessor and Lead TWG
Tim Frederick, Scientific Support Section (XRF FOG; Urban Bkg)
Sydney Chan, Human Health Risk Assessor, XRF FOG, Urban Bkg, and Bioavailability TRW
Glenn Adams, Chief, Scientific Support Section
Stephanie Brown and Ron Tolliver, CICs
Region 4 SESD analytical laboratory
Region 4 START contractor (Tetra Tech, Inc.)
Troy Keith, Tennessee Department of Environment & Conservation
Rebecca Gorham, Tennessee Department of Health
Jennifer Wendel, OSRTI
Matt Jefferson, TIFSD
QUESTIONS

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