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Uniform Federal Policy
Quality Assurance Project Plan
For
OU1 Remedial Investigation at
Colorado Smelter

Pueblo, Pueblo County, Colorado

Revision 3

April 18, 2017

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ACRONYMS

As	Arsenic
bgs	below ground surface
CDPHE	Colorado Department of Public Health and Environment
CF & I	Colorado Fuel and Iron Company
CLP	Contract Laboratory Program
COC	chain-of-custody (based on the context in which the acronym is used)
COPC	contaminant of potential concern
CPSA	Community Properties Study Area
CRQL	Contract Required Quantitation Limits
CSM	conceptual site model
DMA	demonstration of methods applicability
DQI	data quality indicator
DQO	data quality objective
DU	decision unit
E2	E2 Consulting Engineers Inc.
EDD	electronic data deliverable
EPA	U.S. Environmental Protection Agency
GIS	geographic information system
GPS	global positioning system
HAZWOPER	Hazardous Waste Operations and Emergency Response
HHRA	human health risk assessment
HASP	Health and Safety Plan
ICP-MS	Inductively coupled plasma-mass spectrometry
ICS	incremental composite sampling
ID	identification number
IVBA	In-Vitro Bioavailability
LCS	laboratory control sample
MDL	method detection limit
mg/kg	milligrams per kilogram
MS/MSD	matrix spike/matrix spike duplicate
NA	not applicable
NS	not specified
OSHA	Occupational Safety and Health Administration
OSRTI	Office of Superfund Remediation and Technology Innovation
Pb	Lead
ppm	parts per million
PRG	preliminary remediation goals
PQL	practical quantitation limit
PQO	project quality objectives
PWT	Pacific Western Technologies, Ltd.
QA	quality assurance
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	quality control
RAC2	Remedial Action Contract 2
RI	Remedial Investigation
RPD	Relative Percent Difference
RPM	Remedial Project Manager
RSD	relative standard deviation
RSL	regional screening levels

Scribe	EPA's software tool used to assist in the process of managing environmental data
SEDD	Staged Electronic Data Deliverable
SOP	standard operating procedure
SOW	statement of work
TAL	Target Analyte List
TBD	to-be-determined
TCLP	Toxicity Characteristic Leaching Procedure)
TIIB	Technology Integration and Information Branch
TtEMI	TetraTech EM Inc.
UCL	upper confidence limit
UFP QAPP	Uniform Federal Policy for Quality Assurance Project Plans
UFP	Uniform Federal Policy
XRF	X-Ray Fluorescence Spectrophotometer

INTRODUCTION

This revised Quality Assurance Project Plan (QAPP) was prepared by Pacific Western Technologies, Ltd. (PWT) under Remedial Action Contract (RAC2) Work Assignment No. 136-RICO-08UA, U.S. Environmental Protection Agency (EPA) Region 8 Contract No. EP-W-06-006, Region 8. This QAPP supersedes the previous QAPP (Revision 0) and supports the Operable Unit 1 Remedial Investigation (RI) for the assessment of soils and indoor dust at up to 1,200 residential properties (PWT 2015d). Properties are located within the Colorado Smelter Community Properties Study Area (CPSA) in the vicinity of the Colorado Smelter Superfund site (Site) located in Pueblo, Colorado. Soils and indoor dust will be assessed for the potential presence of arsenic, lead, and other heavy metals related to the historical Colorado Smelter.

Data generated will support the RI and help the EPA to determine the nature and extent of smelter related contamination at the Site, and to support the EPA in conducting a human health risk assessment (HHRA). Data will also be generated from the focused sampling of the former smelter soils area to determine the relative bioavailability of arsenic and lead in smelter-related soils, further informing site risk assessment and risk management. Data generated will be used to periodically refine the Conceptual Site Model (CSM) and contaminants of potential concern (COPCs) that will be characterized throughout the full RI. The QAPP is considered a “living document” and revisions will be prepared and approved as new data or site information is generated which will allow for updates to the CSM and other parts of the QAPP, as needed, and to meet the annual review requirements.

Site Description, History & Background

The Colorado Smelter (also known as the Colorado Smelting Company and the Eiler's Smelter) was one of five smelters in Pueblo at the turn of the last century. This smelter processed silver-lead ore from the Monarch Pass area and operated from 1883 to 1908. There is a steel mill (Evraz/Rocky Mountain Steel/Colorado Fuel & Iron (CF&I)) located to the south of the Site that is still operating and that is under the jurisdiction of the Colorado Department of Public Health and the Environment (CDPHE) Resource Conservation and Recovery Act program.

In 2006, a Colorado State University-Pueblo professor and co-authors published a paper that described heavy metals in Pueblo surface soils (CDPHE, 2011). The authors found that in some areas, the topsoil in Pueblo has more arsenic, cadmium, mercury and lead than national soil averages and these areas were in low income and minority neighborhoods. The authors recommended more soil sampling to identify hotspots within the city.

The CDPHE investigated the Blende Smelter, Fountain Foundry, and Colorado Smelter sites in Pueblo because they were in, or close to, residential neighborhoods, and previous soil sampling data indicated the need for more detailed sampling of these residential areas. The Blende Smelter was cleaned up using an EPA lead Removal Action. One of the three remaining smelters, Pueblo Smelter/Rockwool facility, is bordered by commercial/industrial properties and was addressed via a removal action in which source material was capped in place. The former New England/Massachusetts Smelter and the Philadelphia Smelters were located on the eastern edge of the steel mill facility. It is unknown if these smelters have impacted any nearby communities, but limited historic sampling suggests these sites appear to pose less of a public health concern (CDPHE, 2011).

Historical data that were collected by the CDPHE in 1994 and EPA contractors in 1995 indicated the presence of elevated levels of lead and arsenic; however, the studies were not systematic and lacked sufficient data density to clearly determine if metals posed a significant threat to residents living near the former smelter. In 2010, CDPHE collected 434 surface soil samples from 47 yards in the Eilers and Bessemer residential neighborhoods surrounding the Colorado Smelter, including the old slag pile area and two background locations. The former smelter site consists of an approximate 700,000 square foot slag pile that is 30 feet high in places and lead and arsenic contaminated residential soils. The lead levels measured using X-Ray Fluorescence (XRF) on composite samples of residential soils collected from the area south and east of the former smelter ranged from 300 to 785 parts per million (ppm). The lead benchmark that EPA and CDPHE set to protect people is 400 ppm. Arsenic concentrations varied from 100 to 340 ppm range in an area immediately south of the former smelter site. Arsenic cleanup levels have ranged from 40 to 70 ppm at similar sites in Region 8. Lead levels in the slag pile ranged from 478 to 26,500 ppm; arsenic from 28 to 1,740 ppm by inductively coupled plasma –mass spectrometry (ICP-MS) (CDPHE, 2011). XRF analysis of the slag pile samples observed lead levels ranging from 332 up to 11,928 ppm with arsenic levels ranging from 33 to 1,193 ppm (CDPHE, 2011). In addition, these concentrations are well above preliminary background levels designated for that field effort (47 ppm for lead and 16 ppm for arsenic).

The 2010 Analytical Results Report (CDPHE, 2011) provides the most recent data for the Site and helped determine the initial scope of the RI. This report will also be used to identify possible prioritization criteria for sampling, as well as possible early actions.

For additional information, refer to UFP QAPP Worksheet #10 that addresses results of historical documentation and data review.

Project Approach Overview

The project approach framework was developed by EPA's Office of Superfund Remediation & Technology Innovation (OSRTI), was tested and refined in the field during the May 2015 Demonstration of Methods Applicability (DMA), and has been customized by PWT in coordination with Region 8 to address site-specific conditions and issues (PWT 2015c).

Figure 1 is a summary flowchart that outlines this process. Where applicable, the figure is supported by a series of attachments that provide additional detail on the project activities to be performed at key milestones on the project. Sequential application of these activities is described in Uniform Federal Policy (UFP) QAPP Worksheet #16 – Project Schedule / Timeline.

The following brief descriptions describe the nature and purpose of each of the project milestones.

Review Historical Information and Data – Between August 2014 and March 2015, the technical project team reviewed relevant site historical information and data to develop a Baseline CSM for the properties that are to be assessed. The CSM is a milestone deliverable developed as a fundamental preparation element for systematic planning of the assessment effort. The Decision Logic Diagram for the Colorado Smelter RI Process is described in Figure 1; Attachment A. The Baseline CSM and the summary results of the data quality assessment of the historical data are discussed in Worksheets #10 and #13.

Diligence in gathering and evaluating key data from previous investigations and other site-related information was required to prepare a thorough and effective Baseline CSM.

Systematic Planning – Between February 2015 and August 2015, the project team engaged in four systematic planning meetings to comprehensively plan and design the implementation of all stages of the assessment project. The two systematic planning meetings held on February 27, 2015 and March 24, 2015 were in support of the DMA and are documented in the DMA QAPP (PWT, 2015a). The two systematic planning meetings held on July 29, 2015 and August 6, 2015 are documented in Worksheets #9A and #9B. The meetings involved planning for known decisions and building in contingencies to accommodate changes in project conditions, so that stakeholders are able to facilitate the project through all key decision-making stages. This RI UFP QAPP and associated site-specific standard operating procedures (SOPs) are the primary products of the systematic planning effort.

A key component of systematic planning was the performance of a data quality assessment as part of US EPA's DQO process to develop data acceptance and other project performance criteria for incorporation in this UFP QAPP (for documentation of the DQO process, see Worksheets #10 and #11 of the QAPP). In addition, a thorough analysis of historical data was performed to determine whether and how previous data could be used to guide assessment planning, or in some cases provide data of adequate quantity and acceptable quality to offset some of the assessment requirements. Specifically, data were reviewed to determine their usefulness in directly supporting the establishment of constituent background concentrations, substituting or augmenting data collection needs, performing a HHRA and providing information for potential future remediation/mitigation planning and engineering.

Specific DQO guidance used to support this effort included:

- EPA Quality Manual for Environmental Programs. (EPA 2000, May).
- Guidance on Systematic Planning Using the Data Quality Objectives Process. (EPA 2006a, February).
- Guidance for Developing Quality Assurance Project Plans. (EPA 2002a, December).
- Uniform Federal Policy for Quality Assurance Project Plans (Manual) (EPA 2005a, March).
- Workbook for Uniform Federal Policy for Quality Assurance Project Plans (Workbook). (EPA 2005b, March).

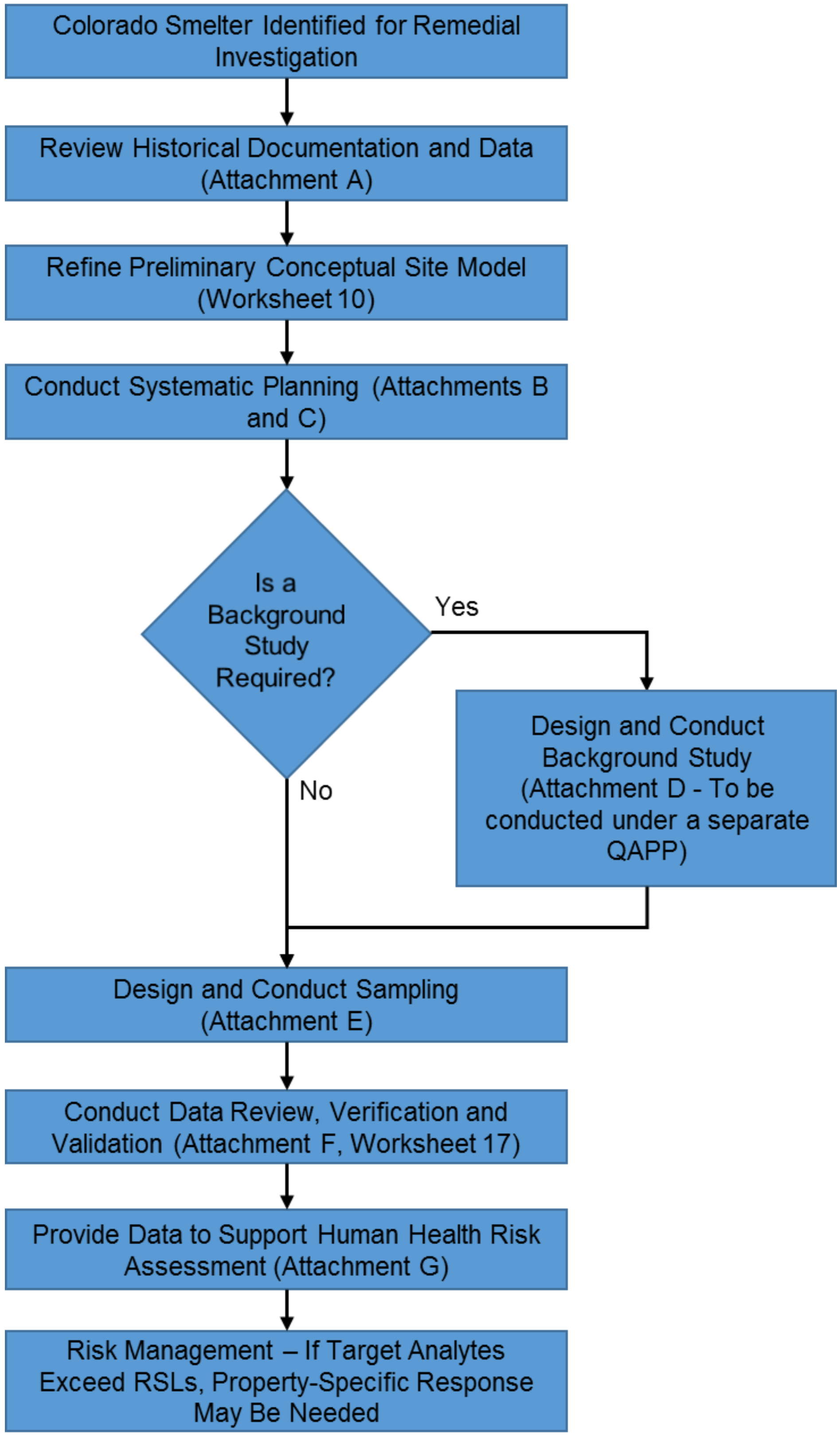
A strong emphasis was placed on developing the Baseline CSM to incorporate project data collected during the DMA. The Baseline CSM is the version that was agreed upon by the stakeholders during systematic planning and subsequently served as the basis for the detailed planning of all phases of this RI project. The Baseline CSM was specifically used to identify data needs, develop the site-specific sampling plan design, and confirm the selection of appropriate data collection, analysis, and use methodologies. Inherent to the sampling design is an explicit recognition that spatial heterogeneity and analytical method variance are likely to be the primary sources of uncertainty affecting confident site decision-making. Data collected in the DMA was used to update the CSM and refine it before continuing the Site RI. The data collected during the RI will be used to refine the baseline CSM to a characterization CSM.

In addition to addressing scientific issues, systematic planning also considered financial, contractual, stakeholder, legal, and regulatory issues; such as budgets, contracts, stakeholder concerns, site reuse, legal and regulatory issues, and relevant social and economic factors.

Design and Conduct Background Study – A background study will be designed and conducted under a separate QAPP to determine naturally occurring and urban background metals concentrations appropriate for the study area and to characterize: (1) naturally occurring substances present in the environment that are not a result of human activities; and (2) anthropogenic substances that are natural and human-made substances in the environment as a result of human activities not related to the Colorado Smelter Site. The background study will include sampling schemes similar to that employed in the RI to allow for data comparison.

Design and Conduct Sampling – As indicated above, the assessment design presented in this UFP QAPP is based on a project approach framework developed by OSRTI, and was customized by Region 8 for site-specific application based on the results of the DMA and the systematic planning efforts. This UFP QAPP provides comprehensive details of the assessment plan and strategy for the site.

Figure 1: Decision Logic Diagram for the Colorado Smelter OU1 RI Process



Attachment A to Figure 1
Colorado Smelter OU1 RI Sampling Design and Strategy
Uniform Federal Policy (UFP) Quality Assurance Project Plan (QAPP)

Historical Documentation and Data Review

Historical Site documentation and data were compiled and reviewed to inform the systematic planning effort and serve as the basis for developing the Baseline CSM. Systematic planning included the evaluation of available historical site data sets for applicability to data needs for the Colorado Smelter DMA (PWT 2015a). As it was compiled, the quality of historical data was assessed from sampling and analytical perspectives. Data quality assessment addressed the following items.

Results of the DMA verified several of the implicit assumptions of the CSM, demonstrating that windblown dust from the waste slag piles, and/or aerial deposition from stack emissions from the former smelter site is a potential source of the metals contamination found in Site soils. Also, in some locations, smelter slag appears to have been placed in residential areas of the Site. Upon completion of the RI, additional refinement of the CSM will be possible.

Evaluation of Historical Sampling Approach

- General sampling strategy
  - o Statistical/probabilistic
  - X **Judgmental**

- Sample representativeness and comparability relative to new data needs
  - o Soil media sampled (sites and sub-sites, soil/waste types, background vs. site)
  - o Sampling density
  - o Depth intervals
  - X **Grab or composite**
  - o Sample processing (sizing, homogenization)

- Data end uses
  - X **Site screening**
  - o Risk assessment
  - o Remedial design/remedial action (engineering evaluations, characterization of treated or removed wastes, confirmation of soil/waste removal)

- Decision uncertainty management approach
  - X **Qualitative/professional judgment**
  - o Analytical Quality Assurance (QA) program only
  - o Classical statistics
  - o Other (e.g., geostatistics, modeling)
  - o Unknown

Data Quality Assessment via Evaluation of Analytical Methods and Quality Assurance Program

- Is the data of known and documented quality; i.e., were samples analyzed and data reported and validated under an EPA QA program or equivalent? Yes
- What was the level of review and the SOP for review at the time? Stage 3 for EPA Contract Laboratory Program (CLP) data; treatment of XRF data at a Stage IIb data verification level.
- Were data qualified and was the review narrative available? Yes
- Status of analytical data in terms of whether it was collected for all COCs for use in Colorado Smelter evaluations. Majority of XRF data focused on lead and arsenic, but other analytes were measured. CLP analysis was for Target Analyte List (TAL) metals.
- Were quantitation/detection limits sufficient for use in prior Colorado Smelter evaluations? Yes
- Did data quality indicators (DQIs) meet method performance requirements and did they indicate sufficient data quality for use in Colorado Smelter evaluations (e.g., precision, bias, completeness, comparability)? Yes
- Were there any applications of field-based or screening methods (e.g., CALUX or immunoassay methods)? No
- If non-traditional methods were used, was there a DMA or other type of pilot study, or subsequent data analysis to establish the comparability between conventional and alternative? Yes, the Colorado Smelter DMA demonstrated that decision quality results could be generated using the sampling and analysis approach described in this QAPP.
- Is data from non-traditional methods sufficiently usable to estimate the variability in concentration over both short and long spatial scales? Yes. Refer to the DMA Report (PWT 2015c) and Worksheets #17 and #38 for additional details. Also, can the data provide indications of hotspots or source areas? Yes, refer to the DMA Report (PWT, 2015c) and Worksheets #11, #17, and #38 for additional details about data use and limitations. Hotspots or source areas if encountered during the OU1 RI will be reported to the EPA and State and local agencies.
- Did any of the DMA analytical methods find matrix interferences that should be considered for future analyses? No, controls were in place to identify matrix interferences (PWT, 2015c)
- Are there quality control (QC) or validation records available for any applications of non-traditional methods? Yes. Refer to the DMA Report (PWT, 2015c) for additional details on verification and validation.

Documentation of Historical Documents and Data Review

Historical data that were collected by the CDPHE in 1994 and EPA contractors in 1995 indicated the presence of elevated levels of lead and arsenic; however, the studies were not systematic and lacked sufficient data density to clearly determine if metals posed a significant threat to residents living near the former smelter. In 2010, CDPHE collected 434 surface soil samples from 47 yards in the Eilers and Bessemer residential neighborhoods surrounding the Colorado Smelter, including the old slag pile area and two background locations. The former smelter site consists of an approximate 700,000 square foot slag pile that is 30 feet high in places. Lead levels in the slag pile ranged from 478 to

26,500 ppm; arsenic from 28.1 to 1,740 ppm. The lead levels measured using X-Ray Fluorescence spectrophotometry (XRF) on composite samples of residential soils collected from the area south and east of the former smelter ranged from 300 to 785 parts per million (ppm). The screening level benchmark that the EPA and CDPHE have typically used for lead is 400 ppm. Arsenic concentrations varied from 100 to 340 ppm range in an area immediately south of the former smelter site. The screening level benchmark that the EPA and CDPHE have typically used for arsenic have ranged from 40 to 70 ppm at similar sites in Region 8. In addition, these concentrations are well above preliminary background levels designated for that field effort (47 ppm for lead and 16 ppm for arsenic).

Source Document	Observed ICP-MS Concentrations	Observed XRF Concentrations
PWT. 2015c. Demonstration of Methods Applicability at Colorado Smelter Data Summary Report. October.	Residential Soil by ICP-MS: As concentrations ranged from 4.9 to 282 mg/kg; Pb concentrations ranged from 37.4 up to 918 mg/kg.	Residential Soil XRF As concentrations ranged from 3.7 up to 150 ppm with an average of 25 ppm for all depths; Pb concentrations ranged from 24.8 up to 2,650 ppm with an average of 353.2 ppm for all depths.
	Slag waste pile samples by ICP-MS: As concentrations ranged from 57 to 431 mg/kg; Pb concentrations ranged from 1,630 up to 4,900 mg/kg.	Slag waste pile samples by XRF: As concentrations ranged from 43 up to 651 ppm with an average of 240 ppm for 0-2 inch depth; Pb concentrations ranged from 1,360 up to 13,300 ppm with an average of 5,450 ppm for 0-2 inch depth.
Colorado Department of Public Health and Environment (CDPHE) (2011, June). Analytical Results Report, Colorado Smelter, Pueblo, Colorado CON000802700.	Residential Soil by ICP-MS: As concentrations ranged from 4.3 to 343 mg/kg; Pb concentrations ranged from 158 up to 962 mg/kg.	Residential Soil XRF As concentrations ranged from 8 up to 430 ppm; Pb concentrations ranged from 147 up to 1,053 ppm.
	Slag waste pile samples by ICP-MS: As concentrations ranged from 28.1 to 1,740 mg/kg; Pb concentrations ranged from 478 up to 26,500 mg/kg.	Slag waste pile samples by XRF: As concentrations ranged from 33 to 1,193 ppm; Pb concentrations ranged from 332 up to 11,928 ppm.

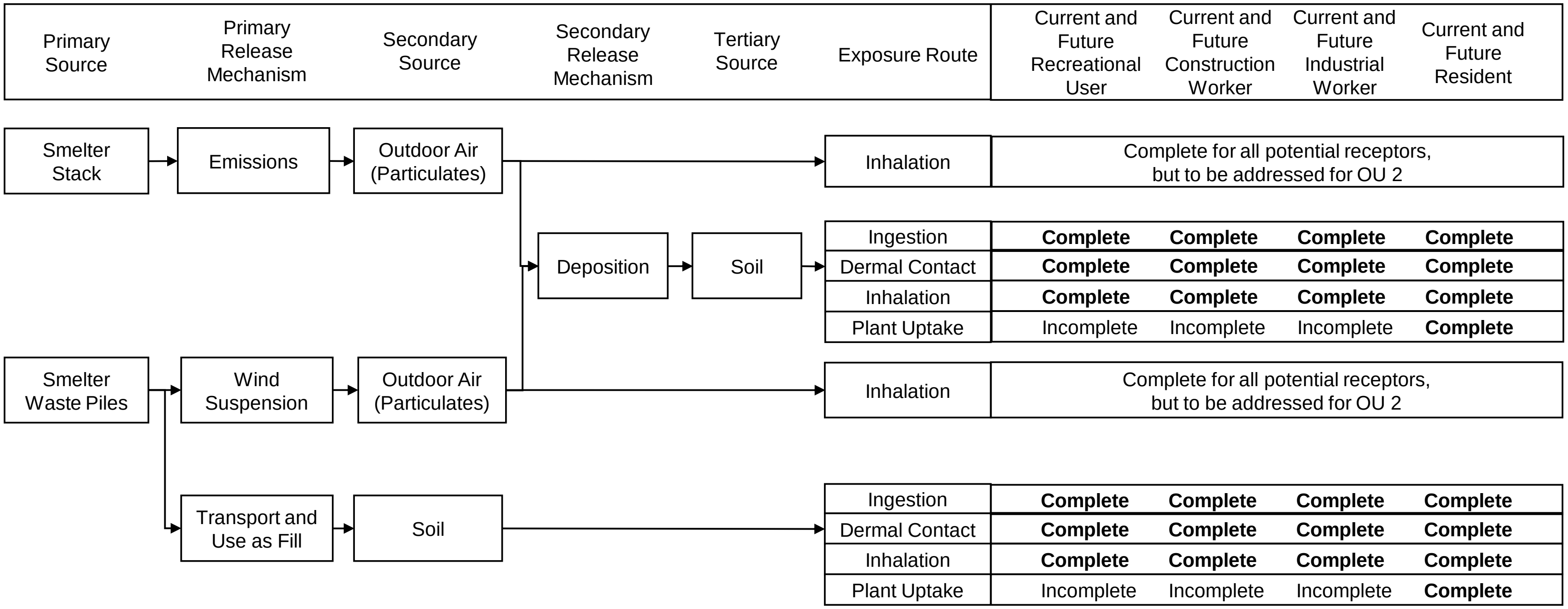
Findings from previous screening investigations indicate high levels of lead and arsenic in several residential soil samples and the remaining slag area. Due to the large area needing additional detailed characterization, the site will be addressed using the Superfund RI process. Worksheet #10 provides the Baseline CSM.

Colorado Smelter DMA Sampling Design and Strategy
Uniform Federal Policy (UFP) Quality Assurance Project Plan (QAPP)

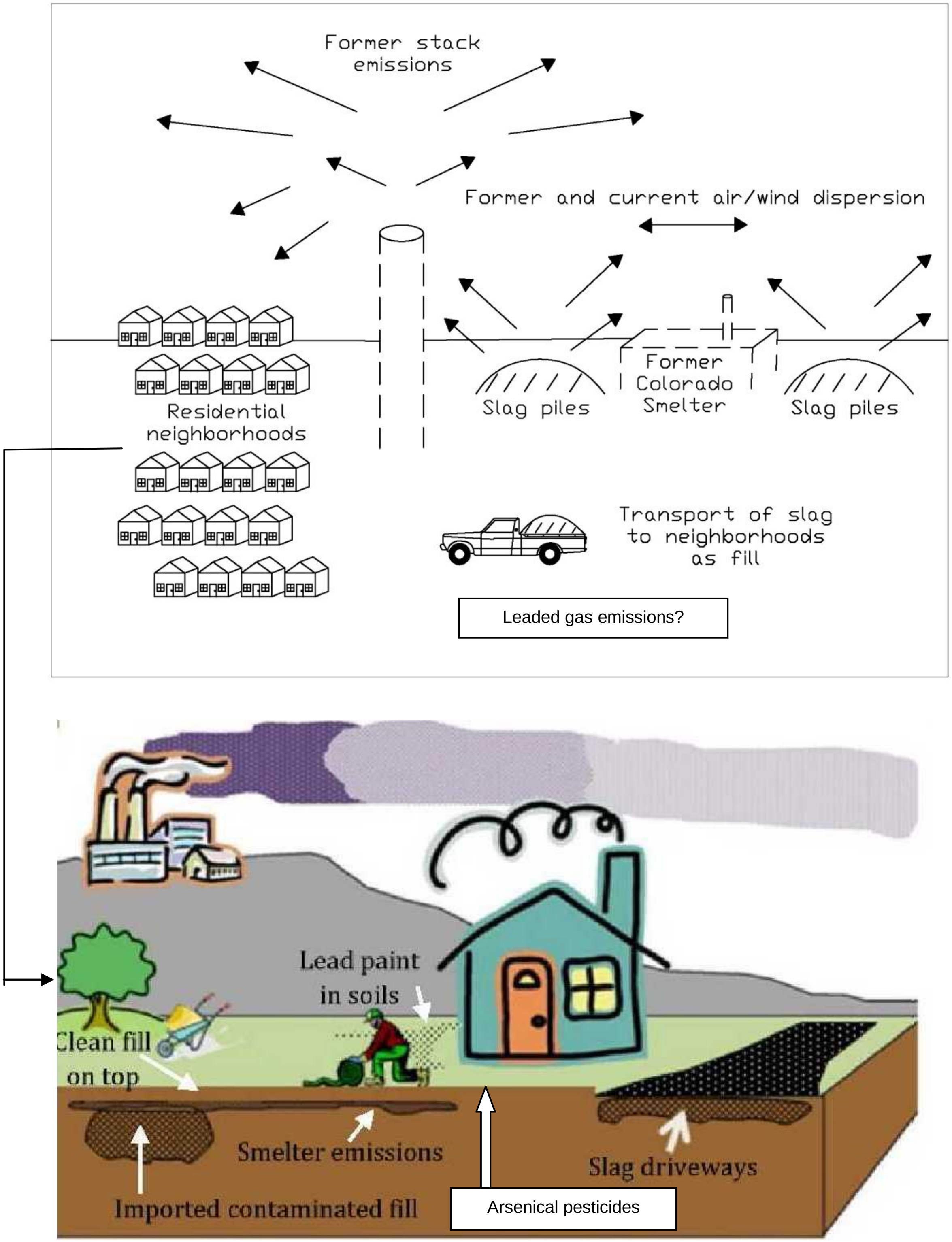
ATTACHMENT B TO FIGURE 1 - Systematic Planning Meeting Agenda

1. Systematic planning for the RI involved discussion of the DMA findings, and occurred in a series of meetings between July and August 2015 (Worksheets #9A and 9B). The DMA report summarizes the discussion that occurred, and included discussion of the following items:
2. Did XRF technology demonstrate adequate data quality relative to ICP-MS methods to ensure adequate support for long-term decision-making at the site?
3. Is 30-point incremental sampling necessary, or does 5-point composite sampling adequately address matrix heterogeneity and provide decision quality data for the site?
4. Are triplicate samples necessary for all DUs and depths, or can triplicate samples be collected at a lower frequency?
5. Is sampling at all four depth ranges investigated during the DMA necessary?

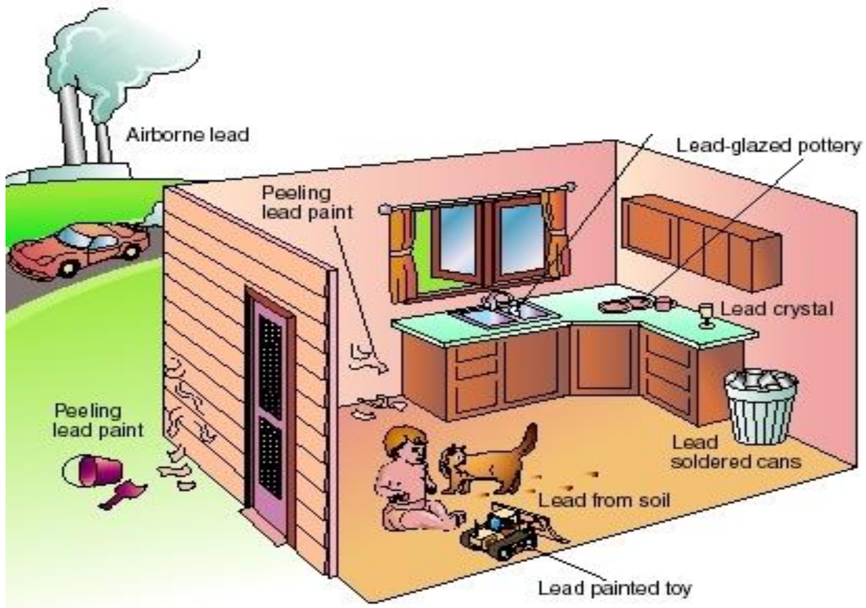
Attachment C to Figure 1 Pathway Network Receptor Diagram



Attachment C to Figure 1 Conceptual Site Model for OU1



Attachment C to Figure 1 Conceptual Site Model for OU1 Residential Dust



Attachment D to Figure 1 - Background Study Design and Performance

A background study will be designed and conducted under a separate QAPP to determine naturally occurring and urban background metals concentrations appropriate for the CPSA study area and to characterize: (1) naturally occurring substances present in the environment that are not a result of human activities; and (2) anthropogenic substances that are natural or human-made substances in the environment as a result of human activities not related to the Colorado Smelter Site. The data from this background study, along with other appropriate data, will be used to refine the site boundary as described in Worksheet #11. The background study will include sampling schemes similar to that employed in the RI to allow for data comparison.

Attachment E to Figure 1
Colorado Smelter OU1 RI Sampling Design and Strategy
Uniform Federal Policy (UFP) Quality Assurance Project Plan (QAPP)

SUMMARY OF OU1 RI SAMPLING APPROACH, OBJECTIVES AND ASSUMPTIONS

The residential properties and sampling locations within the former smelter area/slag contaminated soils to be selected for inclusion in the RI will span the approximate range of conditions expected to be encountered within the CPSA. The 1/2-mile initial study area surrounding the main stack of the Colorado Smelter was based on the observation that "Major smelter deposits exist primarily within a 0.5 km radius of the stack, although some studies have found elevated soil-Pb concentrations as far away as 30 km" and drop to 200 mg/kg and below by distances of approximately 3-5 km (EPA, 2006b), as well as the local topography and land use. Soil lead concentrations decrease dramatically with distance from the source, and depend greatly on wind speed and wind direction (EPA, 2006b). Spatial locations and historic wind directions will be factored into the property selection process. Sampling areas will include up to 1,200 residential properties ranging in size from approximately 0.05 to 0.5 acres, and three city-owned parks, one county-owned park, two school properties, select commercial properties, and 85 unpaved alley ways (see Worksheet #17). Approximately 1,200 to 1,900 homes will be drawn from the preliminary study area, which is a ½-mile radius centered on the Colorado Smelter stack. Data collected from the RI will be used to support the HHRA which will include an assessment and analysis of the collected data, exposure assessment, toxicity assessment, risk characterization, and uncertainty analysis. The risk assessment will also quantify the risks for each complete source-pathway-receptor as appropriate.

Sampling Strategy Elements

- Contaminant Types to be Assessed
  - Target analytes are TAL metals in soil samples, which includes imported inorganic fill material collected from high use areas in parks and playgrounds. Lead and arsenic will be analyzed by XRF. Additional analytes may be added to XRF analysis if ICP-MS data indicates that these analytes should be reported by XRF, and comparability of XRF and ICP-MS data is demonstrated.
  - TAL metals in soil and indoor dust samples from residential properties via EPA CLP ICP-MS analysis using EPA method 6020B, under CLP contract ISM 02.4,
  - Mercury in soil samples via EPA CLP cold-vapor atomic absorption (CVAA) analysis using EPA method 7471B, under CLP contract ISM 02.4.
  - Bioavailability analysis for lead in site-specific matrices using US EPA's "Standard Operating Procedure for an *In Vitro* Bioaccessibility Assay for Lead in Soil" (EPA 9200.2-86, April 2012),
  - Bioavailability analysis for arsenic in site-specific matrices using University of Colorado and EPA's "Standard Operating Procedure VBA) Procedure for Arsenic" (EPA, 2012c), and

   - Geospeciation of select samples lead and arsenic via special analytical services at the University of Colorado

- Exposure Scenario
   - Residential, industrial, recreational, other specific scenarios (e.g., construction and utility worker exposure)
   - Direct contact with surficial soil (within the 0–1.5 feet below ground surface (bgs) interval) and indoor dust (e.g., ingestion, inhalation, dermal contact)
   - Historical use of leaded gasoline along the I-25 traffic corridor.
   - Historical use of arsenical pesticides.
   - Historical use of lead-based paint.

- Decision Units (DUs) should be delineated so as to be consistent with site type and exposure scenario. A residential property may have three to eight DUs, and the typical residential property is expected to have approximately six DUs. School and park properties will be divided into a minimum of five DUs each based on natural divisions of use, possible statistical analysis, and manageable DU sizes. Special consideration will be given to high use areas such are playgrounds or urban gardens. Unpaved alleys will be parsed into approximately one block long DUs. Unpaved Streets will also be parsed into block long segments and sampled.

- Five-point composite sampling locations and sample distribution:
   - The majority of residential DUs will be characterized using four individual 5-point composite samples from a systematic random sampling grid with one composite sample collected from each of four horizons (0-1", 1-6", 6-12", and 12"-18").
   - Specific sample points within the DU will be loosely arranged in a systematic random 5-point star pattern, adjusted as necessary to take yard features into account.
   - Unpaved alley or street segments will be characterized using a single 5-point composite sample in a random start linear systematic pattern. Paved alley ways or streets will not be sampled.

- Incremental composite sampling (ICS) locations and sample distribution:
   - A subset of residential DUs including those units with the largest areas (greater than 5000 ft^2), will be sampled via ICS.
   - For each DU sampled by ICS, 30 specific sample aliquot points within the DU will be determined via random start systematic grid method with one sample taken from each of four horizons (0-1", 1-6", 6-12", and 12"-18").
   - Individual school and park properties will be parsed into a minimum of five DUs each based on natural divisions of use, possible statistical analysis, and manageable DU sizes. Special consideration will be given to high use areas such are playgrounds or urban gardens. and sampled via 30-point ICS. If a small area within the park or school property is identified for additional characterization, a 30-point incremental sampling approach or a 5-point composite sampling approach may be used.

- Replicate quantities

- Field replicate samples will be collected in triplicate (two replicate samples collected along with one associated investigative sample) from selected DUs at a frequency of 5% (one triplicate set per 20 investigative samples). Triplicate samples will typically be collected such that triplicates are collected from all four depths at a given DU. The current strategy of selecting one DU for a field-replicate sample set per 20 DUs has ensured that triplicates are available for a range of distances and directions from the smelter, a wide range of concentrations, and a variety of DU types. A small number of replicate samples (approximately 5% of samples) will be collected for mercury analysis only. These samples will be discrete samples that are not processed for XRF analysis to prevent volatilization of mercury. The samples will be sent to a CLP laboratory for analysis by CVAA using EPA method 7471B, under CLP contract ISM 02.4. Mercury sampling was terminated based on a data evaluation which found detectable mercury to be statistically insignificant and should not be retained as a COPC (PWT, 2016c).
- After the first 100 properties have been sampled, differences between measured concentrations within triplicate sample sets will be evaluated to identify sources of variability; possible soil heterogeneity, matrix interference effects, sampling errors, or laboratory errors or other sources. If results of this evaluation indicate that variability is significant, corrective actions will be developed. See Worksheet #17 for more details on variability evaluation. A decision error evaluation of 1710 triplicate sample results collected through March 2017 was conducted. This evaluation found that false negative rates are below the goal of 5% for As (1.8%) and Pb (2.8%) and false positives are below the goal of 20% for As (4.1%) and Pb (9.0%) using the preliminary decision limits of 30 ppm for As and 400 ppm for Pb. Therefore, no corrective actions are warranted.

Attachment F to Figure 1
Colorado Smelter OU1 RI Sampling Design and Strategy

Uniform Federal Policy (UFP) Quality Assurance Project Plan (QAPP)

Conduct Data Review, Verification and Validation

Historical data review allowed the site investigation and risk screening program to focus on selected constituents and supported streamlining of the sampling and analytical program, eliminating several categories of contaminants to focus on Site-specific smelter related metals. However, additional COPC screening still remains to be completed. COPC screening will take place during the TAL metals analysis of soil samples collected during the OU1 RI from select residential properties and former smelter area via EPA CLP inductively coupled plasma (ICP) analysis using EPA methods 6020B and 7471B, under CLP contract ISM 02.4.

In accordance with Figure 1, the analytical results from soil samples previously collected at the Colorado Smelter site may be used to assist the RI. The sampling design and rationale is presented in detail in Worksheet #17 of this UFP QAPP and the sampling methodology is described in the attached SOPs.

- Because of the possibility of reanalysis, holding times for archived samples will be tracked to ensure that the proposed holding time of 6 months is not exceeded.
- Measured concentrations (by XRF and/or ICP-MS) for all target analytes will be compared to the residential Regional Screening Levels (RSLs) or site-specific project remediation goals (PRGs) once they are developed.

If the sensitivity analysis shows that sample reporting limits impede screening evaluations for one or more sample analyses, the affected samples may be reanalyzed to assess whether the elevated reporting limits are due to laboratory or matrix issues. If reanalysis confirms matrix interferences, the laboratory will be consulted to identify and undertake corrective actions. If matrix problems cannot be corrected, the original analytical results may be subjected to statistical evaluation to assess data usability and application.

Attachment G to Figure 1
Colorado Smelter OU1 RI Sampling Design and Strategy

Uniform Federal Policy (UFP) Quality Assurance Project Plan (QAPP)

Human Health Risk Assessment

The project team is coordinating with EPA and CDPHE risk assessors to ensure that the OU1 RI data will meet the needs of the HHRA. The HHRA will include an assessment and analysis of the collected data, exposure assessment, toxicity assessment, risk characterization, and uncertainty analysis. The risk assessment will also quantify the risks for each complete source-pathway-receptor as appropriate.

REFERENCES

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QAPP WORKSHEET #1
Title and Approval Page

UNIFORM FEDERAL POLICY
QUALITY ASSURANCE PROJECT PLAN
OU1 REMEDIAL INVESTIGATION

COLORADO SMELTER SUPERFUND SITE
PUEBLO, PUEBLO COUNTY, COLORADO

April 18, 2017

Revision 3

Prepared for:

U.S. EPA Region 8
Denver, Colorado

Prepared by:

PACIFIC WESTERN TECHNOLOGIES, LTD.
3000 Youngfield Street, Ste. 300
Wheat Ridge, Colorado 80215
303-274-5400

Prepared by:

Mark Wood, PG 4/19/2017

Pacific Western Technologies, Ltd. Date
Mark Wood, PG
Senior Geologist

Approved by:

Robin M. Witt (SHS) 4/21/17

Pacific Western Technologies, Ltd. Date
Robin Witt, P.E.
Quality Assurance Manager

4/20/17

Pacific Western Technologies, Ltd. Date
Stephen Singer, P.G.
Project Manager

DAO Sabrina Forrest for 04/19/17

U.S. EPA Date
Linda Himmelbauer
Region 8 Quality Assurance Manager, EPA

Sabrina Forrest 04/19/17

U.S. EPA Date
Sabrina Forrest, RPM, EPA

QAPP WORKSHEET #2
QAPP Identifying Information

Site Number/Code:	CON000802700/08UA
Operable Unit:	OU1
Contractor Name:	Pacific Western Technologies, Ltd.
Contractor Number:	EP-W-06-006
Contract Title:	Remedial Action Contract
Work Assignment Number:	136-RICO-08UA

1. Identify guidance used to prepare QAPP:

UFP QAPP USER GUIDE, US EPA; Office of Superfund Remediation and Innovative Technology (OSRTI); Technology Innovation and Field Services Division (TIFSD), September 2011; The EPA's Guidance on Systematic Planning Using the Data Quality Objective Process (EPA, 2006a).

2. Identify regulatory program:

Comprehensive Environmental Response, Compensation and Liability Act

3. Identify approval entity:

US EPA Region 8 Superfund Remedial Program

4. Indicate whether the QAPP is a generic or a <u>project-specific QAPP</u>.

This UFP QAPP is specific to the Colorado Smelter CPSA OU1 RI

5. List dates of systematic planning sessions that were held:

July 29, 2015; August 6, 2015

6. List dates and titles of QAPP documents from previous site work, if applicable:

Title	Received Date
Colorado Department of Public Health and Environment Generic Quality Assurance Project Plan for Site Assessment under Superfund. Revision 1.	March 17, 2000
Colorado Department of Public Health and Environment Preliminary Assessment Colorado Smelter	April 28, 2008
Colorado Department of Public Health and Environment Sample and Analysis Plan Colorado Smelter	May 2010

Pacific Western Technologies	
Uniform Federal Policy Quality Assurance Project Plan for Demonstration of Methods Applicability at Colorado Smelter	May 2015
Pacific Western Technologies	
Demonstration of Methods Applicability at Colorado Smelter Data Summary Report	October 2015

7. List organizational partners (stakeholders) and connection with lead organization:

U.S. Environmental Protection Agency:

Ms. Sabrina Forrest, Remedial Project Manager (RPM)

Dr. Charles Partridge, EPA Region 8 Toxicologist

Mr. Stephen Dyment, EPA ORD Region 8 Superfund and Technology Liaison

Mr. Donald Goodrich, EPA Contract Laboratory Program/Sample Management Office Liaison

Colorado Department of Public Health and Environment:

Ms. Alissa Schultz, CDPHE Project Officer

Pacific Western Technologies, Ltd.:

Dr. Ram Ramaswami, RAC2 Program Manager

Mr. Steve Singer, PG, PMP, Project Manager

Mrs. Robin Witt, PE, Quality Assurance Officer (QAO)

Mr. Craig Walker, PWT Team Project Chemist

Mr. Mark Wood, PWT Data Manager, Field Team Coordinator

Tetra Tech EM Inc. (TtEMI):

Dr. Rob Tisdale, Field Team Leader

8. List data users:

Ms. Sabrina Forrest, Remedial Project Manager (RPM)

Dr. Charles Partridge, EPA Region 8 Toxicologist

Mr. Stephen Dyment, EPA ORD Region 8 Superfund and Technology Liaison

Mr. Steve Singer, PG, PMP, Project Manager

Mrs. Robin Witt, PE, Quality Assurance Officer (QAO)

Mr. Craig Walker, PWT Team Project Chemist

Mr. Mark Wood, PWT Data Manager, Field Team Coordinator

Dr. Rob Tisdale, Field XRF Laboratory Lead

9. If any required QAPP elements and required information are not applicable to the project, then circle the omitted QAPP elements and required information on the attached table. Provide an explanation for their exclusion below:

Note: This table does not apply to the RI QAPP, since a UFP format QAPP has been provided, rather than a traditional narrative QAPP following EPA QA R-5.

Required QAPP Element(s) and Corresponding QAPP Section(s)	Crosswalk to Related Documents	QAPP Worksheet # in QAPP Workbook	Required Information
Project Management and Objectives			
2.1 Title and Approval Page		1	- Title and Approval Page
2.2 Document Format and Table of Contents 2.2.1 Document Control Format 2.2.2 Document Control Numbering System 2.2.3 Table of Contents 2.2.4 QAPP Identifying Information		2	- Table of Contents - QAPP Identifying Information
2.3 Distribution List and Project Personnel Sign-Off Sheet 2.3.1 Distribution List 2.3.2 Project Personnel Sign-Off Sheet		3 4	- Distribution List - Project Personnel Sign-Off Sheet
2.4 Project Organization 2.4.1 Project Organizational Chart 2.4.2 Communication Pathways 2.4.3 Personnel Responsibilities and Qualifications 2.4.4 Special Training Requirements and Certification		5 6 7 8	- Project Organizational Chart - Communication Pathways - Personnel Responsibilities and Qualifications Table - Special Personnel Training Requirements Table
2.5 Project Planning/Problem Definition 2.5.1 Systematic Planning Meeting 2.5.2 Problem Definition, Site History, and Background		9 10	- Project Planning Session Documentation (including Data Needs tables) - Systematic Planning Participants Sheet - Problem Definition, Site

Required QAPP Element(s) and Corresponding QAPP Section(s)	Crosswalk to Related Documents	QAPP Worksheet # in QAPP Workbook	Required Information
			History, and Background - Site Maps (historical and present)
2.6 Project Quality Objectives (PQOs) and Measurement Performance Criteria 2.6.1 Development of Project Quality Objectives Using the Systematic Planning Process 2.6.2 Measurement Performance Criteria		11 12	- Site-Specific PQOs - Measurement Performance Criteria Table
2.7 Secondary Data Evaluation		13	- Sources of Secondary Data and Information - Secondary Data Criteria and Limitations Table
2.8 Project Overview and Schedule 2.8.1 Project Overview 2.8.2 Project Schedule		14 15A, 15B, and 15C 16	- Summary of Project Tasks - Reference Limits and Evaluation Table - Project Schedule/Timeline Table
Measurement/Data Acquisition			
3.1 Sampling Tasks 3.1.1 Sampling Process Design and Rationale 3.1.2 Sampling Procedures and Requirements 3.1.2.1 Sampling Collection Procedures 3.1.2.2 Sample Containers, Volume, and Preservation 3.1.2.3 Equipment/Sample Containers Cleaning and Decontamination Procedures 3.1.2.4 Field Equipment Calibration, Maintenance, Testing, and Inspection Procedures 3.1.2.5 Supply Inspection and Acceptance Procedures 3.1.2.6 Field Documentation Procedures		17 18 19 20 21 22 38	- Sampling Design and Rationale - Sample Location Map - Sampling Locations and Methods/ SOP Requirements Table - Analytical Methods/SOP Requirements Table - Field Quality Control Sample Summary Table - Sampling SOPs - Project Sampling SOP References Table - Field Equipment Calibration, Maintenance, Testing, and Inspection Table

Required QAPP Element(s) and Corresponding QAPP Section(s)	Crosswalk to Related Documents	QAPP Worksheet # in QAPP Workbook	Required Information
3.2 Analytical Tasks 3.2.1 Analytical SOPs 3.2.2 Analytical Instrument Calibration Procedures 3.2.3 Analytical Instrument and Equipment Maintenance, Testing, and Inspection Procedures 3.2.4 Analytical Supply Inspection and Acceptance Procedures		23 24 25 38	- Analytical SOPs - Analytical SOP References Table - Analytical Instrument Calibration Table - Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table
3.3 Sample Collection Documentation, Handling, Tracking, and Custody Procedures 3.3.1 Sample Collection Documentation 3.3.2 Sample Handling and Tracking System 3.3.3 Sample Custody		26 and 27	- Sample Collection Documentation Handling, Tracking, and Custody SOPs - Sample Container Identification - Sample Handling Flow Diagram - Example Chain-of-Custody (COC) Form and Seal
3.4 Quality Control Samples 3.4.1 Sampling Quality Control Samples 3.4.2 Analytical Quality Control Samples		28A, 28B, 28C, 28D, and 28E	- QC Samples Table - Screening/Confirmatory Analysis Decision Tree
3.5 Data Management Tasks 3.5.1 Project Documentation and Records 3.5.2 Data Package Deliverables 3.5.3 Data Reporting Formats 3.5.4 Data Handling and Management 3.5.5 Data Tracking and Control		29 30	- Project Documents and Records Table - Data Management SOPs - Analytical Services Table
Assessment/Oversight			
4.1 Assessments and Response Actions 4.1.1 Planned Assessments 4.1.2 Assessment Findings and Corrective Action Responses		31 32	- Assessments and Response Actions - Planned Project Assessments Table - Audit Checklists - Assessment Findings and Corrective Action Responses Table
			- QA Management Reports

Required QAPP Element(s) and Corresponding QAPP Section(s)	Crosswalk to Related Documents	QAPP Worksheet # in QAPP Workbook	Required Information
4.2 QA Management Reports		33	Table
4.3 Final Project Report			
Data Review			
5.1 Overview			
5.2 Data Review Steps 5.2.1 Step I: Verification 5.2.2 Step II: Validation 5.2.2.1 Step IIa Validation Activities 5.2.2.2 Step IIb Validation Activities 5.2.3 Step III: Usability Assessment 5.2.3.1 Data Limitations and Actions from Usability Assessment 5.2.3.2 Activities		34 35 36 37	- Verification (Step I) Process Table - Validation (Steps IIa and IIb) Process Table - Validation (Steps IIa and IIb) Summary Table - Usability Assessment
5.3 Streamlining Data Review 5.3.1 Data Review Steps To Be Streamlined 5.3.2 Criteria for Streamlining Data Review 5.3.3 Amounts and Types of Data Appropriate for Streamlining			

QAPP WORKSHEET #3
Distribution List

QAPP Recipients	Title	Organization	Telephone Number	E-mail Address
Sabrina Forrest	Remedial Project Manager	EPA, Region 8	Office: 303-312-6484	forrest.sabrina@epa.gov
Charles Partridge	Toxicologist	EPA, Region 8	Office: 303-312-6094	partridge.charles@epa.gov
Steve Dyment	ORD Region 8 Superfund and Technology Liaison	EPA	Office: 303-312-7044	dyment.stephen@epa.gov
Don Goodrich	Environmental Scientist	EPA, Region 8	Office: 303-312-6687	goodrich.don@epa.gov
Alissa Schultz	Project Officer	CDPHE	Office: 303-692-3324	alissa.schultz@state.co.us
Raj Goyal	Toxicologist	CDPHE	Office: 303-692-2634	raj.goyal@state.co.us
Steve Singer	Project Manager	PWT	Office: 303-274-5400 x53 Fax: 303-274-6160	ssinger@pwt.com
Rob Tisdale	Field XRF Laboratory Lead (TtEMI Project Manager)	TtEMI	Office: 303-312-8843 Fax: 303-295-2818	rob.tisdale@tetratech.com
Robin Witt	Project QAO	PWT	Office: 303-274-5400 x35 Fax: 303-274-6160	rwitt@pwt.com
Mark Wood	Data Manager, Field Team Coordinator	PWT	Office: 303-274-5400 x14 Fax: 303-274-6160	mark.wood@pwt.com
Ram Ramaswami	RAC2 Program Manager	PWT	Office: 303-274-5400 x19 Fax: 303-274-6160	rramaswami@pwt.com

QAPP WORKSHEET #4
Project Personnel Sign-Off Sheet

Organization: EPA and CDPHE

Project Personnel	Title	Telephone Number	Signature	Date QAPP Read Email Receipt
Sabrina Forrest	RPM	303-312-6484		
Charles Partridge	EPA Toxicologist	303-312-6094		
Steve Dyment	EPA ORD Region 8 Superfund and Technology Liaison	303-312-7044		
Alissa Schultz	CDPHE	303-692-3324		

Organization: PWT, TtEMI, E2

Project Personnel	Title	Telephone Number	Signature	Date QAPP Read Email Receipt
Ram Ramaswami	RAC2 Program Manager	303-274-5400 x19		
Steve Singer	Project Manager	303-274-5400 x53		
Robin Witt	Project QAO	303-274-5400 x35		
Mark Wood	Data Manager, Field Team Coordinator	303-274-5400 x14		
Rob Tisdale	Field XRF Laboratory Lead (TtEMI Project Manager)	303-312-8843		

QAPP WORKSHEET #5

Project Organizational Chart

Lead Organization:
United States Environmental Protection Agency

Lead Organization Project Manager:
Sabrina Forrest
303-312-6484

Supporting Organization:
Colorado Department of Public Health and Environment

Supporting Organization Project Officer:
Alissa Schultz
303-692-3324

Investigative Organization:
Pacific Western Technologies, Ltd. with Team Subcontractors: TTEMI and E2
Project Manager:
Stephen Singer, P.G.
303-274-5400 x53
Data Manager, Field Team Coordinator:
Mark Wood, P.G.
303-274-5400 x14

PWT QA Officer:
Robin Witt., P.E.
303-274-5400 x45

PWT Health & Safety Coordinator:
Travis Austin
303-274-5400 x34

PWT Property Access and Survey Lead:
Travis Austin

Survey Subcontractor:
Clark Land Survey
Justin Crosson
719-582-1270

TTEMI Field XRF Laboratory Lead:
Rob Tisdale, PhD.
303-312-8843

PWT GIS Lead:
David Mathias
303-274-5400 x49

PWT Project Chemist:
Craig Walker
303-274-5400 x58

E2 Data Verification/Validation:
Ruth Siegman
510-428-4736

Bioavailability Subcontractor:
Dr. John Drexler
University of Colorado
303-492-5251

QAPP WORKSHEET #6
Communication Pathways

Communication Drivers	Responsible Entity	Name	Telephone Number	Procedure
Project Management	PWT Project Manager	Stephen Singer	303-274-5400 x53	Project manager will manage field and project personnel, and serve as liaison to the EPA, team members, and all subcontractors.
Quality Management	PWT QA Officer	Robin Witt	303-274-5400 x35	QAO will remain independent of direct project involvement and day-to-day operations. The QAO will ensure implementation of the quality assurance elements outlined in this QAPP. The QAO will be the point of contact with the PWT Project Manager for quality matters. The QAO is responsible for maintaining the official, approved QAPP.
Coordination and communication of fieldwork activities	PWT Field Team Coordinator	Mark Wood	303-274-5400 x14	Field team coordinator will communicate relevant field information to the project manager, team members, and subcontractors.
Field data and quality control reports	PWT Field Team Coordinator	Mark Wood	303-274-5400 x14	Field Team Coordinator will generate and report data and documents as required by this UFP QAPP along with quality control reports to the Site project manager.
Coordination of sampling supplies for field activities				The Field Team Coordinator will acquire all sample containers and appropriate shipping materials (such as coolers and bubble wrap) before field sampling begins and throughout the project. Refer to SOPs for supplies and consumables lists: PWT-COS-302, PWT-COS-303, PWT-COS-0427, PWT-ENSE-406, PWT-ENSE-423, PWT-ENSE-424, and PWT-ENSE-430
Submittal of samples to the field laboratory				Sampling personnel will package and deliver samples in accordance with this QAPP.
Submittal of samples to CLP Laboratory	Field Team Coordinator	Mark Wood	303-274-5400 x14	Submit selected samples to analytical laboratories in accordance with this QAPP.
Submittal of samples for geospeciation and bioavailability analysis	Field Team Coordinator	Mark Wood	303-274-5400 x14	Submit selected samples to analytical laboratories in accordance with this QAPP.
Internal COC records and sampling documentation	Field Team Coordinator	Mark Wood	303-274-5400 x14	Internal COC records and sampling documentation will be submitted to the field laboratory at the end of each day that samples are collected.
External COC records and shipping documentation	Field Team Coordinator	Mark Wood	303-274-5400 x14	Copies of external COC records and shipping documentation will be kept on file. Original copies shall accompany sample

				shipping containers for laboratory use.
Field and analytical corrective actions	Field Team Coordinator TtEMI Field XRF Laboratory Lead	Mark Wood Rob Tisdale	303-274-5400 x14 303-312-8843	The TtEMI Field XRF Laboratory Lead and/or Field Team Coordinator will immediately notify the QAO in writing of any field or analytical procedures that were not performed in accordance with this QAPP. The QAO or designee will complete documentation of the non-conformance and corrective actions to be taken. The TtEMI Field XRF Laboratory Lead and/or Field Sample Lead will verify that the corrective actions have been implemented.
Sample shipping/receipt issues	Laboratory Project Manager	TBD	TBD	The laboratory project managers will report all sample shipping and receipt issues associated with the investigation to the PWT Field Team Coordinator and/or TtEMI Field Laboratory Lead within 2 business days.
Reporting laboratory data and quality issues	Laboratory Project Manager	TBD	TBD	Report documents and data in an electronic format as required by this UFP QAPP and report QA and QC issues.
Minor deviations from QAPP procedures identified during field activities	Field Team Coordinator TtEMI Field XRF Laboratory Lead	Mark Wood Rob Tisdale	303-274-5400 x14 303-312-8843	The PWT Field Team Coordinator or Field XRF Laboratory Lead will prepare a field change request for any minor changes in sampling procedures that occur as a result of conditions in the field. This request will be submitted to the QAO for approval before the change is initiated.
QAPP amendments	PWT Project Manager EPA RPM	Stephen Singer Sabrina Forrest	303-274-5400 x53 303-312-6484	Any changes to the QAPP will require the QAO to prepare an addendum that will be approved by the PWT PM and EPA RPM before any changes are implemented. The PWT PM will deliver the most current copy of the approved QA Project Plan to those on the distribution list.
QAPP - Data Management	PWT Data Manager	Mark Wood	303-274-5400 x14	Primary point of contact to ensure Scribe field and analytical data meet Region 8 DMP and EPA requirements of the QAPP. Monitors field data and reports data discrepancies to PWT QAO and PM regarding data corrective actions. Monitors and tracks electronic analytical data and validation and reports problems or deficiencies with field or analytical data to the PWT PM.
QAPP – routine communications regarding analyses during implementation	PWT Project Chemist	Craig Walker	303-274-5400 x58	Primary point of contact to ensure that analytical services comply with the QAPP so that resulting data will meet data quality objectives.

QAPP WORKSHEET #7
Personnel Responsibilities Table

Name	Title/Role	Organizational Affiliation	Responsibilities
Steve Singer	PWT Project Manager	PWT	Responsible for providing management and technical oversight during RI activities. Review and sign-off on QAPPs and any future modifications to the plans; provides quality-related direction through the EPA RPM to the Site QAO; and has authority to suspend affected project or Site activities if approved quality requirements are not adequately met.
Robin Witt	PWT Program QA officer	PWT	Overall QA and QC of technical work at the Site; remains independent of data collection activities, responsible for maintaining the official, approved QA Project Plan, develops and maintains a comprehensive QA program and is responsible for audits, reviews of work performed, and recommendations to project personnel regarding quality. Verifies compliance with required QC procedures and reviews deliverables to verify conformance with QA and QC procedures. Provides oversight of the QA program and has authority to suspend affected project or Site activities if approved quality requirements are not adequately met.
Travis Austin	Health and Safety officer	PWT	Responsible for implementing the health and safety plan and accident prevention plan; authority to correct and change Site control measures and the required level of health and safety protection.
Mark Wood	Field Team Coordinator	PWT	Responsible for ensuring coordination between PWT staff and Team Subcontract resources and that they are available to conduct the RI as described in this QAPP. Also responsible for development of field related work plans, and adherence to field task schedules and deliverables. The Field Team coordinator will serve as the main point of contact for the Field Team Leader. Implementation of field-related work plans, assurance of schedule compliance, and adherence to management-developed study requirements. Coordination and management of field staff. Implementation of QC for technical data provided by the field staff, including field sample collection and measurement data. Adherence to field work schedules. Generation, review, and approval of text and graphics required for field team efforts. Coordination of technical efforts of subcontracted sampling staff. Identification of problems at the field-team level and discussion of resolutions between the field team and upper management.
Craig Walker	Project Chemist	PWT	Reviewing analytical data to ensure conformance with QA testing and standards, reviewing data validation and verification reports provided by third party validation team member, E2, and approving analytical data. Interfacing with the EPA Analytical Program Manager on matters concerning chemical sampling and analysis, laboratory reports, verifications and validation of data, and the resolution of nonconforming activities or data.
Mark Wood	Data Manager	PWT	Responsible for Scribe field and analytical data. Monitor field data. Report data discrepancies to PWT QAO and PM for correction. Monitors and tracks electronic analytical data and validation. Inputs final validation data into Scribe to meet Region 8 DMP and EPA requirements of the QAPP. Reports problems or deficiencies with field or analytical data to the PWT PM.
Travis Austin	Property Access and Survey Lead	PWT	Responsible for community outreach and access agreements; oversight of property survey activities; review of property survey deliverables; main point of contact for survey subcontractor. Coordinates and prepares DU designations and sample location maps. Also serves as PWT health and safety officer.

Name	Title/Role	Organizational Affiliation	Responsibilities
Rob Tisdale	Field XRF Laboratory Lead	TtEMI	Implementation of field-related work plans, assurance of schedule compliance, and adherence to management-developed study requirements. Coordination and management of field staff. Implementation of QC for technical data provided by the field staff, including field sample collection and measurement data. Adherence to field work schedules. Coordination and oversight of technical efforts of subcontracted sampling staff. Identification of problems at the field-team level and discussion of resolutions between the field team and upper management.

QAPP WORKSHEET #8

Special Personnel Training Requirements Table

All staff associated with this project will have sufficient training to safely, effectively, and efficiently perform their assigned tasks. Training will be provided to project personnel to insure compliance with the project-specific PWT Health and Safety Plan (HASP) (PWT 2015b), or other applicable HASP(S) and technical competence in performing the work effort.

All field personnel will read this QAPP and the PWT HASP (PWT 2015b) (at a minimum) and will have sufficient training to assure compliance with health and safety protocols and to meet the technical requirements of this project. The Field Team Lead will ensure that a hard copy of this QAPP and the HASP are kept in each field vehicle for ready access during all field operations.

In accordance with the HASP, field personnel will have satisfactorily completed either the Occupational Safety and Health Administration (OSHA) 24-hour or the 40-hour Health and Safety Course for Hazardous Waste Operations and Emergency Response (HAZWOPER) Training in accordance with Sections e and p of the OSHA 29 Code of Federal Regulations (CFR) 1910.120. This certification will be maintained with annual HAZWOPER Refresher Training as required by Sections e and q of 29 CFR 1910.120. The determination of whether 24-hour or 40-hour training is appropriate for field personnel is described further in the project-specific HASP.

Field staff will have completed and maintain certification in First Aid and Adult Cardio-Pulmonary Resuscitation Training. All personnel will also have a minimum of three days of actual field experience under the direct supervision of a trained, experienced supervisor. The Field Team Lead and Field Team Coordinator will also have completed the OSHA eight-hour HAZWOPER Supervisor Training prior to field activities.

Personnel operating Portable XRF Analyzers will have completed the appropriate equipment maintenance and use safety trainings prior to the start of field work.

The Project Manager will ensure all on-site personnel have the appropriate training and maintain copies of the training certificates in the PWT Wheat Ridge, Colorado office and in the Pueblo field office. EPA staffs' certificates are kept by individual staff and the EPA Region 8 Health and Safety Officer. State and local staff are responsible for ensuring they have the appropriate training and certification to be on site.

Organization: PWT, TtEMI

Project Personnel	Title	Education/Experience	Specialized Training/Certifications	Signature/Date
Ram Ramaswami	RAC2 Program Manager	PhD Engineering, 30+ years experience	Professional Engineer,	
Steve Singer	Project Manager	MS, BS Geology, 26 years experience	Certified Project Manager, Certified Professional Geologist, OSHA 40-hr HAZWOPER, OSHA eight-hour HAZWOPER Supervisor Training	
Mark Wood	Data Manager, Field Team Coordinator, and Field Sample Lead	MS, BS Geology, 20 years experience	Certified Professional Geologist, OSHA 40-hr HAZWOPER, OSHA eight-hour HAZWOPER Supervisor Training, XRF Analysis, First Aid and CPR training	
Robin Witt	Project QAO	BS Environmental Engineering BA Applied Geology	Professional Engineer, OSHA 40-hr HAZWOPER, OSHA eight-hour HAZWOPER Supervisor Training, XRF Analysis, First Aid and CPR training	
Craig Walker	Project Chemist	MS,BS Applied Chemistry, 20 years experience	OSHA 40-hr HAZWOPER, OSHA eight-hour HAZWOPER Supervisor Training, XRF Analysis, First Aid and CPR.	
Travis Austin	Property Survey Lead	BS Geology, 10 years experience	OSHA 40-hr HAZWOPER, OSHA eight-hour HAZWOPER Supervisor Training, XRF Analysis, First Aid and CPR training	
Rob Tisdale	Field Laboratory Lead (TtEMI Project Manager)	BS Chemical Physics, PhD Chemistry, 20+ years experience	OSHA 40-hr HAZWOPER, OSHA eight-hour HAZWOPER Supervisor Training, XRF Analysis, First Aid and CPR training	

QAPP WORKSHEET #9A
Systematic Planning Meeting Participants Sheet

Project Name: Colorado Smelter OU1 RI **Project Manager:** Steve Singer	**Site Name:** Colorado Smelter **Site Location:** Pueblo, Colorado

Date of Session: July 29, 2015
Systematic Planning Meeting Purpose: Evaluate DMA data and refine site specific plan for OU1 RI sample collection, processing, and analysis.

Name	Title	Affiliation	Phone #	E-mail Address
Sabrina Forrest	EPA RPM	EPA	303-312-6484	forrest.sabrina@epa.gov
Charles Partridge	Toxicologist	EPA	303-312-6094	partridge.charles@epa.gov
Deana Crumbling	OSRTI TIIB	EPA	703-603-0643	crumbling.deana@epa.gov
Steve Dyment	ORD Region 8 Superfund and Technology Liaison	EPA	303-312-7044	dyment.stephen@epa.gov
Alissa Schultz	Project Officer	CDPHE	303-692-3324	alissa.schultz@state.co.us
Raj Goyal	Toxicologist	CDPHE	303-692-2634	raj.goyal@state.co.us
Steve Singer	Project Manager	PWT	303-274-5400 x53	ssinger@pwt.com
Robin Witt	Project QAO	PWT	303-274-5400 x35	rwitt@pwt.com
Rob Tisdale	Field XRF Laboratory Lead	TtEMI	303-312-8843	rob.tisdale@tetratech.com

Agenda:

Update where we are with the data analysis overall

Questions about the correlation curves R. Tisdale has sent out

Reporting – mean vs UCL

Adjustments

5-pt vs 30-pt

Results for depth ranges

Shallow intervals comparison discussion

Action Items:

Include bioavailability and geospeciation report to QAPP

Consensus Decisions:

Provide adjustment factor for lead and arsenic based on XRF-ICP correlations.

Scribe database to contain 95%UCL, raw result, and adjusted mean result for XRF results.

5-pt vs 30-pt decision errors are acceptable for false positives and false negatives.

Review XRF vs ICP correlation after the first 100 homes sampled in the RI.

Triplicates from all four depth intervals, one triplicate set per 20 investigative sample sets.

QAPP WORKSHEET #9B

Systematic Planning Meeting Participants Sheet

Project Name: Colorado Smelter OU1 RI **Project Manager:** Steve Singer	**Site Name:** Colorado Smelter **Site Location:** Pueblo, Colorado

Date of Session: August 6, 2015
Systematic Planning Meeting Purpose: Evaluate DMA data and refine site specific plan for OU1 RI sample collection, processing, and analysis.

Name	Title	Affiliation	Phone #	E-mail Address
Sabrina Forrest	EPA RPM	EPA	303-312-6484	forrest.sabrina@epa.gov
Charles Partridge	Toxicologist	EPA	303-312-6094	partridge.charles@epa.gov
Deana Crumbling	OSRTI TIIB	EPA	703-603-0643	crumbling.deana@epa.gov
Steve Dyment	ORD Region 8 Superfund and Technology Liaison	EPA	303-312-7044	dyment.stephen@epa.gov
Raj Goyal	Toxicologist	CDPHE	303-692-2634	raj.goyal@state.co.us
Alissa Schultz	Project Officer	CDPHE	303-692-3324	alissa.schultz@state.co.us
Steve Singer	Project Manager	PWT	303-274-5400 x53	ssinger@pwt.com
Robin Witt	Project QAO	PWT	303-274-5400 x35	rwitt@pwt.com
Rob Tisdale	Field XRF Lab Lead	TtEMI	303-312-8843	rob.tisdale@tetratech.com

Agenda:

Data analysis status update

XRF versus ICP review

5-pt triplicate vs 30-pt mean

5-pt individual vs 30-pt mean

5-pt individual vs 5-pt mean

Reporting vs UCL

Shallow interval comparison

Action Items:

QAPP needs to have wording explaining the comparability requirements (between XRF results for the 2 gram CLP subsamples and original XRF results)

Draft RI QAPP by end of August 2015

Draft property resident letters template from EPA in 2 weeks.

DMA report by end of August 2015

Consensus Decisions:

As and Pb are the primary COPCs based on data from DMA, continue to evaluate other metals with ICP.

Reporting mean is acceptable for everyone instead of the UCL.

Wording in Worksheet #37 (data usability) is acceptable for everyone.

Resident letters reporting mean for each depth and each DU, CAD map figures with each DU, mean for As and Pb for each depth.

QAPP WORKSHEET #10

Colorado Smelter Baseline Conceptual Site Model (CSM)

The CSM, as shown in Attachment C to Figure 1 (multiple figures), will be updated over time to incorporate new data about the Site. Primary sources of contamination which are considered for the Colorado Smelter Superfund Site include fugitive dust and particulate air emissions from the historic smelter stack and waste slag piles, solid wastes such as slag and slag-impacted soils, and liquid wastes such as process solutions, acids, and rinsates from historic facility operations. Secondary sources of contamination from the historic use of lead-based paint, leaded gasoline, and potential historic use of arsenical pesticides will also be considered. Findings from previous screening investigations indicate high levels of lead and arsenic in several residential soil samples and the remaining slag areas (see Attachment A). Due to the large area needing additional detailed characterization, the site will be addressed using the Superfund RI process. This baseline CSM will be used to refine and update the CSM and help the EPA identify data that are needed to perform a Risk Assessment. A detailed HHRA will be performed at a later date.

A background study will be conducted because multiple other sources of metals are present in the environment both naturally and as a result of human activities which may be additional potential sources of metals present in Pueblo. The background study will be used to support the HHRA for the OU1 RI and the Site and compare site concentrations of metals to background as part of final COPC and PRG determinations.

Release mechanisms considered for the RI:

Through the mechanisms of air dispersion and deposition, air emissions from the former smoke stacks, slag piles, and historic use of unleaded gas had the potential to impact surface soils and surface water, potentially contaminating these media. Historic air emissions from the smelter stacks are not a current source of contamination to the air to the CPSA; however, fugitive dust emissions caused by wind or human activity may still occur. The ½ mile initial study area surrounding the main stack of the Colorado Smelter was established based on the observation that “Major smelter deposits exist primarily within a 0.5 km radius of the stack, although some studies have found elevated soil-Pb concentrations as far away as 30 km” and drop to 200 mg/kg and below by distances of approximately 3-5 km (EPA, 2006b) as well as the local topography and land use. Soil lead concentrations decrease dramatically with distance from the source, and depend greatly on wind speed and wind direction (EPA, 2006b).

Solid wastes had (and still have) the potential to impact surface water of the Arkansas River through the mechanisms of surface runoff and erosion. Waste piles of slag have the potential to impact surface soils through direct contact, and the potential to impact subsurface soils and groundwater under the site by infiltration of rain or snowmelt that leaches metals contamination out of the slag, transporting this contamination down the soil column. Surface water and groundwater will be addressed by the OU2 CSM and OU2 RI. Particulate solid waste can also become entrained in the air as a result of wind or human activities.

Pre-1980 use of leaded gas and emissions along the I-25 corridor are a concern and will be evaluated. Arsenical pesticide use is a consideration for residential sampling locations. Statistical analysis, spatial analysis, metal ratios and possibly arsenic speciation will be used to evaluate potential elevated arsenic levels identified in OU1 and background soil samples (Folkes, et.al. 2001). Historic use of arsenic or lead based paint will also be evaluated.

Potential receptors and exposure pathways: After site-related contamination migrated from its original sources to the outdoor exposure media being evaluated for this RI (surface soil and subsurface soil), interactions between these media provide ongoing pathways for contaminant transport.

The potential exposure routes by which potential human receptors may come in contact with the contaminants include inhalation of the air-entrained particles/dust; ingestion (eating or drinking); and dermal contact (or direct physical contact). Potential exposure routes and receptors will be described in more detail in the human health risk assessment. Ecological risk assessment will be performed within the RI for OU2. They will be performed as part of the overall RI.

The problem to be addressed by the project (note that this corresponds to traditional DQO process question 1, "State the problem"): The problem to be addressed by the project is to determine the nature and extent of metals contamination associated with the Colorado Smelter in the neighborhoods surrounding it.

Land Use Considerations: The study area consists of approximately 1,900 homes and other properties (three city-owned parks, one county-owned park, two school properties, unpaved alleys, unpaved roads, and commercial properties) located within a 0.5-mile radius of the former smelter, primarily in the Eilers and Bessemer neighborhoods. The preliminary study area was based on the CSM and the distance between the Colorado Smelter stack and the edges of the neighborhoods to the north, west, south, and east. The study area boundary and number of residences investigated may be increased or decreased as data provide more information about the area affected by the Colorado Smelter.

In addition to residential properties, parks, schools, commercial properties, and unpaved alleys and unpaved roads will be sampled as part of the RI. Larger DUs such as the three city-owned parks, one county-owned park, two school properties, and commercial properties will normally be sampled using the ICS approach, unless an area of 5,000 square feet or less is identified for additional characterization, in which case the area may be sampled using a 5-point composite approach. Unpaved alleys and roads will be sampled using a linear 5-point composite approach. Unpaved alleys and roads will be split into segments the length of a block, with the composite increments spread along the length of the block.

The environmental questions being asked (data gaps and uncertainties):

What are the preliminary COPCs for the Site (COPC determination will be made as part of the risk assessment)?

Are the concentrations of preliminary COPCs at each DU above human health risk screening levels or background concentrations?

Are the concentrations of preliminary COPCs at each DU related to the Colorado Smelter or to other anthropogenic sources such as unleaded gasoline, arsenical pesticides or lead-based paint?

What are the concentrations of preliminary COPCs in indoor and attic dust within the Site?

Are the concentrations of preliminary COPCs in indoor and attic dust above human health risk screening levels or background concentrations and are they at levels which pose an immediate threat to human health?

Can concentrations of preliminary COPCs measured in indoor or attic dust be correlated with concentrations measured in outdoor soil such that indoor dust concentrations could be estimated for homes without dust data?

Are the concentrations of preliminary COPCs in indoor and attic dust, if found, related to the Colorado Smelter or to other anthropogenic sources such as lead-based paint?

Should the study area boundary and number of residences investigated be increased or decreased?

Are QC procedures continuing to ensure that XRF data collected and samples submitted for laboratory analysis are not only of known and documented analytical quality but also of known and documented sampling quality?

Current Interpretation of nature and extent of contamination:

- **Observations from any site reconnaissance reports:** See Attachment A - Historical Documentation and Data Review
- **A synopsis of secondary data or information from site reports:** See Attachment A - Historical Documentation and Data Review
- **The classes of contaminants and the affected matrices:** Pb, As, other possible heavy metals associated with the historic smelter. Matrices include surface and subsurface soil, and indoor dust. To maintain consistency with the August 2003 EPA *Superfund Lead-contaminated Residential Sites Handbook*, depths will consist of: Surface 0-1 inches bgs; Subsurface 1-6 inches bgs; 6-12 inches bgs; and 12-18 inches bgs.
- **The rationale for inclusion of chemical and nonchemical analyses:** Previous sampling described in the Analytical Results Report produced by the State (CDPHE 2011) has indicated the potential for elevated metals concentrations for the soil and surface water pathways from historical smelting operations associated with the Site. The Site was listed on the National Priorities List on December 11, 2014.
- **Information concerning various environmental indicators:** Based on the soil and dust sample results from the first 302 properties As and Pb are present at high levels in the study area (PWT, 2017). Based on results presented in the dust and soil geospeciation technical memorandums the As and Pb contamination is associated with the historic smelter and occurs at levels in residential soils and indoor dust that pose a threat to human health (PWT, 2016a, PWT 2016b, PWT, 2016c, and PWT, 2017). When As and/or Pb are observed at levels in residential dust or soil samples that pose an immediate threat to human health and the environment (using the screening levels for dust: As $\geq$ 160 ppm

and/or Pb $\geq$ 275 ppm; and soil: As $\geq$ 11 ppm and/or Pb $\geq$ 400 ppm), the Project Manager will notify the EPA RPM who will then notify the supporting organizations.

QAPP WORKSHEET #11

Project Quality Objectives/Systematic Planning Process Statements

Who will use the data? EPA Region 8, EPA HQ, CDPHE and EPA's RAC (PWT, TtEMI, and E2)

What will the data be used for (note that this also corresponds to traditional DQO process question 2, "Identify the goal of the study")? Data generated from the RI will help the EPA to determine the nature and extent of smelter related contamination at the Site. Surficial soil and indoor dust sampling methodologies that ensure that data will be of a sufficient quality for decision making will be utilized. These data will support the EPA in conducting a HHRA. Data generated from the RI will be used to determine the COPCs that will be used to characterize the Site and PRGs that will guide cleanup decisions.

What type of data are needed (matrix, target analytes, analytical groups, field screening, on-site analytical or off-site laboratory techniques, sampling techniques; note that this corresponds to traditional DQO process step 3 and 5, "Identify the information inputs" and "Develop the analytical approach")? Data for metals in soil and indoor dust from residential properties are needed to assess risk potentially associated with the Colorado Smelter site.

Data will consist of XRF analytical results and ICP-MS results. XRF will be used to analyze for target analytes (Pb/As) and potentially for accessory analytes (Cu, Mn, and Zn) in surface and subsurface soil. Accessory analytes may be analyzed by XRF if results indicate that they routinely exceed screening levels and can reliably be analyzed by XRF. Data for all other metals will be obtained using a subset of samples analyzed by ICP-MS. ICP-MS analysis will be performed on 20% of all samples initially. If results indicate that a lower percentage of analysis by ICP-MS is acceptable, the percentage may be reduced to as low as 5%, provided that preliminary COPC determination and XRF to ICP correlations have been satisfactorily documented.

Based on the DMA findings, which indicated that XRF results could be adjusted to be comparable to ICP-MS results, adjustments will continue to be made as was done during the DMA. This may be done on an instrument-specific basis if results indicate this is necessary (see Worksheet #37 for additional discussion of adjustments to XRF data).

ICP-MS will be used to analyze for all TAL metals in surface, soil, subsurface soil, and indoor dust (via EPA Methods 7471B and 6020B as defined by CLP SOW ISM 02.4). Analyses will be conducted by laboratories certified in the methods of concern. Raw data information should be retained in the project file in case a need for its use arises. In particular, all analytical quality control checks should be retained.

Sampling will be performed at a DU using either a 5-point systematic random composite or a 30-increment systematic grid approach. Most DUs will be sampled using the 5-point systematic random composite approach, but larger DUs (those 5,000 square feet or larger) will be sampled using the 30-increment systematic grid approach. During the DMA, it was shown that both approaches provided acceptable decision error rates for making decisions for DUs.

Soil samples will be archived at the Pueblo field laboratory or other appropriate secure storage location after XRF analysis and subsampling is complete.

In addition to soil data from residential properties, background data for soil will be collected during a background study (discussed in greater detail in a separate Background Study QAPP), which will help the EPA to determine the nature and extent of smelter-related contamination at the Site for the RI, and support the EPA in conducting a HHRA and ERA. If Site related contamination is found to be present in OU1 soils or indoor dust at levels which pose an unacceptable risk to human health and the environment, as established by project health based benchmarks, then further action may be required. This action could include additional confirmatory sampling, and/or mitigation or remediation of contaminated soils or dust.

What are the boundaries of the study (this corresponds to traditional DQO process step 4, "Define the boundaries of the study")? The study area consists of approximately 1,900 homes, three city-owned parks, one county-owned park, two school properties, and other properties located within the preliminary study area, a 0.5-mile radius of the former smelter (Figure 7, Worksheet #17). Runyon Field Park, a county-owned park, has been added as the fourth park at the request of the County of Pueblo to be included in the park sampling. The 0.5-mile radius is a preliminary study area based on the distance between the Colorado Smelter and the edges of the neighborhoods to the west, north, east, south, and southeast. The 1/2-mile study area surrounding the main stack of the Colorado Smelter was based on the observation that "Major smelter deposits exist primarily within a 0.5 km radius of the stack, although some studies have found elevated soil-Pb concentrations as far away as 30 km" and drop to 200 mg/kg and below by distances of approximately 3-5 km (EPA, 2006b). Soil lead concentrations decrease dramatically with distance from the source, and depend greatly on wind speed and wind direction (EPA, 2006b). Boundaries will be adjusted based on establishing site specific clean up levels from the HHRA and the results of the background study which will help to define natural and anthropogenic levels of metals in soils in the region. If metals concentrations near the perimeter of the study area are below health based bench marks, then the study area will not need to be increased. However, if metals concentrations near the perimeter of the study area are above health based bench marks, then additional data from the background study and geospeciation analysis will be considered to determine whether the study area should be increased. Surface and subsurface soil and indoor dust are the matrices of concern within this project boundary. Each of these matrices is detailed separately below for the remainder of the PQOs.

Matrix: Surface and subsurface soil.

How "good" do the data need to be in order to support the environmental decision (note that this corresponds to traditional DQO process question 6, "Specify the performance or acceptance criteria")? Data results will be calculated to be expressed as parts per million (ppm or milligrams per kilogram [mg/kg]) that can be confidently compared to a soil RSL (or site-specific PRG) in units of ppm or mg/kg (at HQ=0.1) in the risk assessment. Soil data need to include measures of sampling and analytical variability (i.e., definitive data). Overall statistical variability in the data needs to be small enough so that decision error rates are below 5% for false negatives and 20% for false positives. Detection limits need to be low enough to statistically compare on-site with background concentrations. See Worksheets # 12, 15 and 37.

How much data are needed (number of samples for each analytical group, matrix, and concentration; note that this question and the following four questions all correspond to traditional DQO process question 7, "Develop a plan for obtaining data)")?

Based on the expected number of DUs and depth intervals for the RI effort, approximately 30,000 residential soil samples are estimated for collection. This estimate is based on 1,200 properties, 6 DUs at each property, 4 depths at each DU, and triplicate samples collected at all four depths for 1 of every 20 DUs. Each of these samples will be analyzed via XRF while a subset (initially approximately 20%) will also be analyzed by CLP using method 6020B. Any changes in the frequency of samples analyzed via Method 6020B will be discussed with project stakeholders prior to implementation and will be documented in the RI report.

Unpaved alleys and unpaved streets will be separated into DUs consisting of one block lengths, and sampled using one 5-point random start linear systematic composite sample per linear block. It is anticipated that approximately 340 samples will be collected from unpaved alleys and unpaved streets (based on 85 unpaved DUs and up to 4 depths for each DU).

Three city-owned parks, one county-owned park, and two school properties will each be divided into a minimum of five DUs and sampled using the 30-point incremental approach unless an area is identified for additional characterization, in which case either the 30-point incremental or the 5-point composite approach will be utilized, as appropriate. It is anticipated that approximately 100 incremental composite samples will be collected from the three city-owned parks, one county-owned park, and two school properties based on approximately five DUs with four sample depths for each DU.

Commercial properties will be divided into DUs and sampled using either 5-point or 30-point incremental approach depending on the size of the DUs selected. DUs greater than 5000 ft^2 will be sampled using the incremental approach. Smaller DUs will be sampled using the 5-point composite approach. It is anticipated that approximately 180 samples will be collected from select commercial properties based on four sample depths for each DU.

Where, when, and how should the data be collected/generated? Samples will be collected and prepared on site. See Attachment E, Worksheets 17 and 18

Who will collect and generate the data? PWT and TtEMI,

How will the data be reported? Both XRF and ICP data will be reported electronically. Results for individual properties will be reported to residents in letter format.

XRF sample results for each sample bag will include a mean concentration, a relative standard deviation, and an upper confidence limit on the mean (UCL). XRF raw data will be exported from the instrument as excel spreadsheets, processed in a spreadsheet program, and imported into Scribe (access database) in accordance with the U.S. EPA Region 8 Superfund Remedial Data Management Plan (EPA, 2016a).

The mean XRF concentration for each sample bag will be reported. When triplicates are collected, the mean for the three triplicates will be reported. The XRF field laboratory will provide electronic data deliverables (EDDs).

The CLP laboratory will provide electronic data deliverables (EDD) for Method 6020B ICP-MS data and Method 7471B CVAA data in accordance with the CLP contract.

How will the data be archived? Data collected during the RI will be archived electronically using a Scribe database in accordance with the U.S. EPA Region 8 Superfund Remedial Data Management Plan (EPA, 2016a). Hardcopies will be archived and managed by SEMS Document Management System R8 Records Center in accordance with the U.S. EPA Region 8 Superfund Remedial Data Management Plan (EPA, 2016a).

Matrix: Indoor dust.

How "good" do the data need to be in order to support the environmental decision? Data results will be calculated to be expressed as parts per million (ppm or milligrams per kilogram [mg/kg]) that can be confidently compared to a soil RSL ppm or mg/kg (at HQ=0.1) in the risk assessment. Indoor dust data need to have provided with it measures of its sampling and analytical variability (i.e., definitive data). Overall statistical variability in the data needs to be small enough that the chance of decision error is acceptable to the risk manager. Acceptable decision error rates have been set at 5% for false negatives and 20% for false positives. Detection limits need to be low enough to statistically compare concentrations with risk-based screening levels. See Worksheets # 12, 15 and 37.

How much data are needed (number of samples for each analytical group, matrix, and concentration)?

Based on the expected number of homes and rooms per home to be sampled for indoor dust during the RI effort, up to 7,200 indoor dust samples are planned for collection. This estimate is based on 1,200 homes, 5 rooms per home, and one replicate sample per 20 homes. No dust samples will be analyzed via XRF, all dust samples will be analyzed by CLP using method

6020B. After 100 homes have been sampled and validated data received, dust data will be evaluated for hot spots and to see if there is any correlation between the levels observed in the home compared to the levels in surface soil collected at the home (0-1" and 1-6").

Where, when, and how should the data be collected/generated? Samples will be collected and shipped to the offsite laboratory**.** See Attachment E, and Worksheets 17 and 18

Who will collect and generate the data? PWT and TtEMI

How will the data be reported? The CLP laboratory will provide EDDs for Method 6020B ICP-MS data and Method 7471B CVAA data in accordance with the CLP contract. Results for individual properties will be reported to property owners and to residents in letter format.

How will the data be archived? Data collected during the RI will be archived electronically using a Scribe database in accordance with the U.S. EPA Region 8 Superfund Remedial Data Management Plan (EPA, 2016). Hardcopies will be archived and managed by SEMS Document Management System R8 Records Center in accordance with the U.S. EPA Region 8 Superfund Remedial Data Management Plan (EPA, 2016a).

QAPP WORKSHEET #12
Measurement Performance Criteria Table

Matrix	Soil				
Analytical Group[1,6]	Pb, As, other TAL metals				
Concentration Level	All Levels[7]				
Sampling Procedure[2]	**Analytical Method/SOP[3]**	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria[6]**	**QC Sample and / or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
Incremental-Composite Surface Sampling SOP (PWT-COS-427, see Worksheet #17)	XRF: PWT-COS-303	Analytical Precision Instrument Precision	Instrument duplicate results – used for instrument troubleshooting only.	Instrument duplicate, used only for instrument troubleshooting as necessary, no specific requirement. LCS (Standard reference material - Pb and As)	A (evaluates instrument stability and repeatability)
		Measurement (instrument and operator) Precision	LCS results within control chart limits (2 standard deviations)		A (Instrument and operator performance)
		Accuracy (bias)	LCS results within control chart limits (2 standard deviations) Blank results	LCS Silica or sand blank, no detections of target analytes	A
		Sensitivity	For NDs: Pb DL < background Pb concentration (XRF typically able to report DL at <10ppm Pb) As DL <background As concentration (XRF typically able to report DL at <10ppm As)	For NDs: Instrument reported DLs for the silica blank and SRMs and field samples	A
Incremental-Composite Surface Sampling SOP	XRF: PWT-COS-303	Completeness	95% (depends on number of DUs in sampling design)	Data review and validation	S&A

(PWT-COS-427, see Worksheet #17)		Representativeness	Sample bag will represent the concentration of the <250 micrometer fraction of the DU – Triplicate incremental or composite samples - RSD<25% Particle size will represent the exposure pathway Reported result will be representative of the whole bag concentration with 95% statistical confidence, or within 75-125% of the whole bag concentration.	At a frequency of once per 20 investigative samples (5%), two replicate samples will be collected and associated with a single paired investigative sample. Sieve using 60 mesh. Analyze fraction < 250 microns. Repeated measurements to control subsampling error until either 95% statistical confidence or within 75-125% of the whole bag concentration. An excel worksheet programmed for this real time evaluation is provided.	S&A S A
		Comparability (XRF to ICP)	See discussion regarding assessment of XRF comparability to ICP in Worksheet #37	Linear regression of paired analyses of the same sample. Subsampling error affecting comparability analyses will be minimized by analyzing 1-2 g soil samples via XRF and submitting the entire sample for digestion and analysis via ICP method. Subsamples sent for analysis by ICP-MS may be analyzed by multiple XRFs to help establish comparability between XRF and ICP-MS data using consistent data sets.	S&A A
		Comparability (between multiple XRFs used during the project).	Comparability between XRFs will be addressed indirectly.	If comparability between XRF and ICP-MS is established for each individual XRF, the XRFs will have been established to be comparable to each other after adjustment to ICP-MS-like concentrations.	A

Matrix	Soil
Analytical Group[1,6]	Pb, As, other TAL metals, Mercury
Concentration Level	All Levels[7]

Sampling Procedure[2]	Analytical Method/SOP[3]	Data Quality Indicators (DQIs)	Measurement Performance Criteria[6]	QC Sample and / or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Incremental-Composite Surface Sampling SOP (PWT-COS-427, see Worksheet #17)	CLP SOW ISM 02.4 and TAL metals (6020B), Mercury (7471B)	Analytical (Laboratory) Precision Sampling Precision	RPD < 25% Does not apply- laboratory will not be sub-sampling.	Laboratory sub-sampling replicates and LCS/LCSD Field replicates at the DU level; and field/laboratory sample preparation replicates.	A
		Accuracy (bias)	%Recovery 70-130% Pb/As < PQL[4] Pb/As < PQL[4]	LCS Method blank Equipment blank	A A S&A
		Sensitivity	TAL metals SDL < PQL[5]	CLP SOW ISM02.4	A
		Completeness	95%	Data review and validation	S&A
		Representativeness	Result will be representative of the true concentration of the sample because the entire mass submitted will be digested and analyzed.	Subsampling error eliminated	S
		Comparability	ICP comparability will be established by using a standard EPA analytical method and assessing whether the laboratory followed that method.	NA	NA

Matrix	Dust
Analytical Group[1,4]	Pb, As, other TAL metals
Concentration Level	All Levels[7]

Sampling Procedure[2]	Analytical Method/SOP[3]	Data Quality Indicators (DQIs)	Measurement Performance Criteria[6]	QC Sample and / or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Indoor and Attic Dust Sampling SOP (see Worksheet #17)	CLP SOW ISM 02.4	Analytical (Laboratory) Precision	RPD < 25%	Laboratory LCS/LCSD	A
		Accuracy (bias)	%Recovery 70-130%	LCS	A
			Pb/As < PQL[4]	Method blank	A
			Pb/As < PQL[4]	Equipment blank	S&A
		Sensitivity	TAL metals SDL < PQL[5]	CLP SOW ISM02.4	A
		Completeness	95% of collected samples have valid analytical results	Data review and validation	S&A
		Representativeness	RPD < 35%	Field duplicates	S
		Comparability	ICP comparability is established by using standard CLP method.	NA	NA

[1] If information varies within an analytical group, separate by individual analyte.

[2] Reference number from QAPP Worksheet #21 (see Section 3.1.2).

[3] Reference number from QAPP Worksheet #23 (see Section 3.2).

[4] Detected blank contaminants must be less than the Practical Quantitation Limit (PQL) Goal listed in Worksheet #15. For samples analyzed according to CLP SOW , blank concentrations up to 3 times the PQL are allowable for Pb, As, >>>.

[5] The sample detection limit must be less than the PQL Goal (see Worksheet #15).

[6] These criteria apply to each individual target analyte reported by the analytical methods.

[7] A maximum RSD criteria of 25% is specified for all samples including low concentration samples. If this criterion cannot be met, the ability to assess uncertainty at low levels may be technology limited.

CLP	Contract Laboratory Program
LCS	Laboratory control sample
LCSD	Laboratory control sample duplicate
MS	Matrix spike
MSD	Matrix spike duplicate
RPD	Relative Percent Difference
RSD	Relative Standard Deviation
SOP	Standard operating procedure
SOW	Statement of Work

QAPP WORKSHEET #13
Secondary Data Criteria and Limitations Table

Secondary Data	Data Source (originating organization, report title and date)	Data Generator(s) (originating organization, data types, data generation / collection dates)	How Data Will Be Used	Limitations on Data Use
XRF and CLP data from 2010 sampling conducted by CDPHE under Cooperative Agreement with EPA	CDPHE, Analytical Results Report, June 2011	CDPHE, XRF and CLP metals Sampling Event conducted Sampling activities included the collection of waste pile samples, residential yard soil samples, indoor and attic dust samples, public access road right-of-way and vacant lot samples, and background soil samples, all for metals analysis. Surface water and sediment samples were also collected and analyzed for metals. All samples were collected June 21 – 23, 2010.	These data will not be used for risk screening and risk assessment. Data will be used to establish expected contaminant concentration ranges.	Data will not be used for risk screening or risk assessment.
County property parcel information	Pueblo County	Unknown	Visual presentation of information	Parcel information does not include survey data, therefore may not provide accurate information.
XRF and CLP data from 2015 DMA conducted by PWT under contract to EPA(PWT 2015c)	PWT, Demonstration of Methods Applicability at Colorado Smelter, Data Summary Report, October 2015	PWT, XRF and CLP metals, May and June 2015	Data were used to plan the RI sampling approach, and will be used to guide RI work.	None

QAPP WORKSHEET #14
Summary of Project Tasks

Sampling Tasks: Sample collection per PWT-COS- 427 and PWT-ENSE-430

Sample Processing Tasks: Sample preparation per PWT-COS- 302

Analysis Tasks:

- Metals in soil via XRF analysis per SOP PWT-COS-303
- Metals in soil and dust via CLP SOW method ISM 02.4, EPA SW846/ICP methods 6020B and 7471B
- Metals in waste soil and water via TCLP (Toxicity Characteristic Leaching Procedure)(EPA SW846 methods 1311) and by EPA CLP method 6020B, under CLP contract ISM 02.4
- Arsenic and lead bioavailability and geospeciation analysis of soil by EPA Method 9200.2-86 for IVBA Lead and IVBA Arsenic

Quality Control Tasks: Full EPA QA program including field and laboratory QC checks, auditing/oversight, and data review/validation. All of the CLP data will be verified and validated (100%). XRF data for As, Cu, Pb, Mn, and Zn will be verified.

Secondary Data: Establish expected ranges of contaminant concentrations. Compile and review of historical site data for development of preliminary and baseline CSM. Obtain parcel layers from Pueblo County.

Other Data: Survey data will be collected from each DU per the Statement of Work for subcontracted services.

Data Management Tasks: Sample tracking and documentation, field data entry, data mapping, statistical analyses, data verification, data qualifier entry, and database upload.

Documentation and Records: Per EPA QA and CLP requirements (per CLP SOW and EPA requirements (EPA, 2016a).

Assessment / Audit Tasks: Field and laboratory audits as determined by project chemist and QA staff.

Data Review Tasks: Data verification and completeness checks for 100% of data, data verification and validation in accordance with EPA National Functional Guidelines for Inorganic Superfund Data Review (EPA 2014) for 100% of the CLP data. Verification of XRF data for As, Cu, Pb, Mn, and Zn utilizes the checklist provided in Appendix B.

QAPP WORKSHEET #15A

Reference Limits and Evaluation Table – Metals by XRF

Matrix: Soil
Analytical Group: Metals by XRF
Concentration Level: All levels definitive analysis per PWT-COS-303

Analyte	CAS Number	Project Action Limit (i.e. Decision Criteria) * (mg/kg)	XRF Project Quantitation Limit	Achievable XRF Limits	
				Device Detection Limits (ppm)	Quantitation Limit
Arsenic	7440-38-2	3.5 *	TBD	3	TBD
Lead	7439-92-1	400 *	TBD	5	TBD

TBD To be determined by the field XRF instrument; actual detection limits reported by the instrument for each sample are the quantitation limits.

* Regional Soil Screening Level – non-carcinogenic (EPA, 1996b, 2016b). The project action limit may be adjusted based on factors such as background study results, bioavailability results, or changes to EPA policy for screening levels. Instrument performance will be documented at a range of concentrations to permit these adjustments to be made.

QAPP WORKSHEET #15B

Reference Limits and Evaluation Table – Metals by ICP-MS

Matrix: Soil / Dust
Analytical Group: Target Analyte List (TAL) Metals by CLP Method 6020B
Concentration Level: Low-level definitive analysis by CLP-SOW ISM 02.4/1.2 Method 6020B

Analyte	CAS Number	Analytical Method		Achievable Laboratory Limits	
		MDLs	CRQLs (mg/kg)	MDL[1] (mg/kg)	MRL[1] (mg/kg)
Antimony	7440-36-0	ND	1	0.02	0.05
Arsenic	7440-38-2	ND	0.5	0.2	0.5
Barium	7440-39-3	ND	5	0.02	0.05
Beryllium	7440-41-7	ND	0.5	0.005	0.02
Cadmium	7440-43-9	ND	0.5	0.009	0.02
Chromium	7440-47-3	ND	1	0.07	0.2
Cobalt	7440-48-4	ND	0.5	0.009	0.02
Copper	7440-50-8	ND	1	0.04	0.1
Lead	7439-92-1	ND	0.5	0.02	0.05
Manganese	7439-96-5	ND	0.5	0.02	0.05
Nickel	7440-02-0	ND	0.5	0.04	0.2
Selenium	7782-49-2	ND	2.5	0.2	1
Silver	7440-22-4	ND	0.5	0.005	0.02
Thallium	7440-28-0	ND	0.5	0.002	0.02
Vanadium	7440-62-2	ND	2.5	0.08	0.2
Zinc	7440-66-6	ND	1	0.2	0.5

1. Typical Achievable Laboratory Limits MDL and MRL; source ALS Laboratories.

MDL Method Detection Limit
CRQL Contract Required Quantitation Limit
MRL Method Reporting Limit
NA Not applicable
ND Not developed (laboratory-dependent)

QAPP WORKSHEET #15C

Reference Limits and Evaluation Table – Metals by CVAA

Matrix: Soil
Analytical Group: Mercury by CLP Method 7471B
Concentration Level: Low-level definitive analysis by CLP-SOW ISM 02.4/1.2 Method 7471B

Analyte	CAS Number	Analytical Method		Achievable Laboratory Limits	
		MDLs	CRQLs (mg/kg)	MDL[1] (mg/kg)	MRL[1] (mg/kg)
Mercury	7439-97-6	ND	0.1	0.02	0.05

1. Typical Achievable Laboratory Limits MDL and MRL; source ALS Laboratories.

MDL Method Detection Limit
CRQL Contract Required Quantitation Limit
MRL Method Reporting Limit
NA Not applicable
ND Not developed (laboratory-dependent)

QAPP WORKSHEET #15D

Reference Limits Table – TCLP Metals by ICP-MS

Matrix: Waste (Water / Soil / Dust)
Analytical Group: TCLP Target Analyte List (TAL) Metals by Method 1311
Concentration Level: Low-level definitive analysis by CLP-SOW ISM 02.4/1.2 EPA SW846 Method 1311

Analyte	CAS Number	Waste Soil / Dust		Waste Water	
		MDLs	CRQLs (mg/kg)	MDLs	CRQLs (µg/L)
Aluminum	7429-90-5	NA	NA	ND	20
Antimony	7440-36-0	ND	1	ND	2
Arsenic	7440-38-2	ND	0.5	ND	1
Barium	7440-39-3	ND	5	ND	10
Beryllium	7440-41-7	ND	0.5	ND	1
Cadmium	7440-43-9	ND	0.5	ND	1
Calcium	7440-70-2	NA	NA	ND	500
Chromium	7440-47-3	ND	1	ND	2
Cobalt	7440-48-4	ND	0.5	ND	1
Copper	7440-50-8	ND	1	ND	2
Iron	7439-89-6	NA	NA	ND	200
Lead	7439-92-1	ND	0.5	ND	1
Magnesium	7439-95-4	NA	NA	ND	500
Manganese	7439-96-5	ND	0.5	ND	1
Nickel	7440-02-0	ND	0.5	ND	1
Potassium	7440-09-7	NA	NA	ND	500
Selenium	7782-49-2	ND	2.5	ND	5
Silver	7440-22-4	ND	0.5	ND	1
Sodium	7440-23-5	NA	NA	ND	500
Thallium	7440-28-0	ND	0.5	ND	500
Vanadium	7440-62-2	ND	2.5	ND	5
Zinc	7440-66-6	ND	1	ND	2

MDL Method Detection Limit
CRQL Contract Required Quantitation Limit
NA Not applicable
ND Not developed (laboratory-dependent)

QAPP WORKSHEET #16
OU1 Project Schedule / Timeline Table

Activities	Organization	Anticipated Date(s) of Initiation	Anticipated Date of Completion	Deliverable	Deliverable Due Date
Review Historical Documentation and Data (see Figure 1, Attachment)	PWT, TtEMI	2014	March 2015	Preliminary CSM and Supporting Information	NA
Systematic Planning Meeting	PWT, TtEMI, EPA, CDPHE	January 2015	August 2015	DMA QAPP	September 2015
DMA Field Work	PWT, TtEMI, EPA	March, 2015	June, 2015	DMA Data Summary Report	October, 2015
Systematic Planning Meeting for RI	PWT, TtEMI, EPA, CDPHE	July 29, 2015	August 6, 2015	RI QAPP	November 2015
RI Property Access Verification	PWT, EPA	September 11, 2015	Will occur on an ongoing basis throughout the project	List of approved properties	TBD
RI Property Recon and DU designation	PWT, EPA, CDPHE	September 21, 2015	September 30, 2017	Ongoing basis	Ongoing basis
RI QAPP completion – attach PWT and EPA HQ/ERT (as applicable) SOPs	PWT/TtEMI, EPA HQ staff (EPA R8 delegated approving official)	September 1, 2015	November 13, 2015	RI UFP QAPP	November 13, 2015
Laboratory Procurement - CLP	PWT	September 15, 2015	November 13, 2015	Approved LSRs	November 13, 2015
Laboratory Procurement – CU	PWT	September 15, 2015	November 30, 2015	CU acknowledgement of analytical work	November 30, 2015

Activities	Organization	Anticipated Date(s) of Initiation	Anticipated Date of Completion	Deliverable	Deliverable Due Date
RI Field Laboratory restocked and equipment calibration checks	PWT, TtEMI	November 2, 2015	November 13, 2015	XRF control charts, other equipment logs	Ongoing basis
RI Sampling Effort(s)	PWT, TtEMI, EPA HQ staff Steve Dyment or Deana Crumbling	November 16, 2015	TBD	XRF data	Ongoing basis
Selection of samples for CLP analysis	PWT, TtEMI, EPA	November 23, 2015	TBD	Field log, SCRIBE documentation of which samples should be submitted to CLP	Ongoing basis
Selection of samples for Bioavailability/ Geospeciation	PWT, TtEMI, EPA	November 23, 2015	TBD	Field log, SCRIBE documentation of which samples should be submitted to CU for Bioavailability/ Geospeciation	Ongoing basis
XRF data validation	E2	November 23, 2015	TBD	XRF validation report	Ongoing basis
CLP data validation	E2	November 30, 2015	TBD	CLP validation report	Ongoing basis
Receipt and analysis of Bioavailability and Geospeciation data	CU – John Drexler to PWT; PWT/TtEMI, EPA (Charles Partridge)	January 1, 2016	TBD	Bioavailability and Geospeciation Report	Ongoing basis
RI Completion	PWT, TtEMI	September, 2016	TBD	RI Report	December, 2017

QAPP WORKSHEET #17

OU1 Sampling Design and Rationale

17.1 Describe and provide a rationale for choosing the sampling approach (e.g., grid system, biased statistical approach):

Based on results from the DMA, sampling teams will collect 5-point systematic random composite samples at most DUs (PWT 2015c). Triplicate 5-point composites will be collected at a frequency of one triplicate sample set per 20 investigative samples. For DUs with an area exceeding 5,000 square feet at the site, 30-point incremental approach will be used, with triplicate 30-point composites to be collected from approximately 5% of such DUs.

The number and size of DUs planned for a typical residential property at the Site were evaluated during the systematic planning process, and the sampling design (number and size of DUs to be sampled at each residential property) is site-specific based on the Site's CSM (See Worksheet #10) and sampling objectives (See Figure 1, Attachment A, Worksheets #9A, #9B, and #11).

A DU is defined as the smallest area about which a risk-based decision can be made. For residential use at the site, DUs are designated based on the attributes of the property and apparent use as it relates to risk. Most properties anticipated to be evaluated in the RI are <0.5 acres in size (the properties investigated during the DMA ranged from 0.07 to 0.47 acres). Properties are further segregated into DUs such as front yard, side yard, back yard, and street apron. Special DUs such as house drip zone, garden, and play areas may also be designated at certain properties. See Worksheet #27 for DU designations. Determining appropriately sized DUs is a critical function of systematic planning, and the approach to determining DU areas for the RI was developed in consultation with risk assessors and other key technical team members to ensure DUs match exposure units (EUs) and exposure assumptions.

A property database has been created to track property ownership and access permissions for properties within the site. This database includes: unique property ID, address, year built, area (sq. ft.), size in acres, sensitive population data, and structure building material. The Preliminary Study Area is shown in Figure 7 of this section.

The OU1 RI soil sampling will consist of a blend of complementary approaches, with a majority of samples collected using a five-point composite procedure and a subset of samples collected using a 30-point ICS procedure. This blended sampling approach was selected because sampling designs using 30 or more increments have lower variability than discrete sample data and a higher level of reproducibility (HDOH, 2011), and during the 2015 DMA, incremental samples were shown to outperform the 5-point composite technique in terms of estimating the mean concentration and using the UCL on the mean for statistical confidence in decision making within DUs (PWT 2015c). However, the DMA showed that the improvement was small, and that decision errors are expected to be within an acceptable range of 5% false negatives and 20% false positives using a 5-point approach, which will expedite sample collection and analysis effort at the Site. Due to the need to accommodate property specific attributes (size of the DU, layout, and configuration) the sampling team will utilize the systematic random sampling approach for 5-point composite DUs and a systematic grid with a random start for 30-point DUs (ITRC, 2012).

Composite samples will consist of 5 increments combined into a single composite sample. All DUs within a property except special DUs (defined below) will have one 5-point composite sample collected at each of four depth intervals between ground surface and up to18 inches (0-1 inch, 1-6 inch, 6-12 inch, and 12-18 inch) depending on sample recovery and ability to penetrate the subsurface. Special DUs include the following:

- DUs where subsurface utilities do not allow safe collection of samples to full depth. These DUs will be sampled using the 5-point composite approach, but may not be collected to full depth.
- DUs where a competent weed barrier is known to be present (this was common in garden DUs during the DMA, but sometimes occurred for other DU types also). These DUs will be sampled using the 5-point composite approach, but may not be collected to full depth.
- DUs with areas greater than 5,000 square feet will be sampled using the 30-point incremental approach.
- Park and School DUs: Each area (either park or school) will be divided into a minimum of five DUs and each DU sampled at 4 depths using the 30-point ICS systematic grid with a random start approach. If an area identified for additional characterization is less than 5000 square feet, a 5-point composite sample approach may be utilized.
- Unpaved alleys and streets will be parsed into block long DUs. Unpaved DU's will be sampled using a single 5-point systematic random composite sample collected in a linear pattern. Paved alleyways and streets will not be sampled. Unpaved alleys and streets will be sampled at 4 depths up to a total depth of 18 inches using either a hand tools depending on site conditions and utility clearance.

The three city parks, one county park, and two school properties to be sampled with hand tools are listed below:

- Bessemer Academy (Elementary) School, 1125 East Routt Avenue
- Bessemer Academy School Park, 524 West Mesa Avenue
- Bessemer Park, 720 Northern Avenue
- Benedict Park, 100 Block of East Mesa Avenue
- Stauter Field Park, 601 East Abriendo Avenue
- Runyon Field Park, 400 Stanton Avenue

For every 20 investigative samples collected, one replicate sample set will be collected. A replicate sample set consists of the investigative sample, (either 5-point or 30-point) and two associated replicate samples which were collected using the same methodology (5-point or 30-point) as the investigative sample. Because the samples were collected in triplicate, data from these replicate sample sets will allow an estimation of the DU/depth mean concentration, calculation of a UCL on the mean and an estimate of variability.

Individual soil increments (that make up an incremental sample) are expected to typically weigh between 5 and 50 grams each.

The entire sample preparation, subsampling and analysis process was taken into consideration during DQO development (see Worksheets #10 and #11) when the target increment mass and target soil particle size was determined. The mass of the composite sample is a function of the number of increments collected, the depth interval over which samples were collected, the size of the sample collection tool utilized, the total number and type of analyses planned, and the laboratory digestion/analysis mass required for each test. Consideration of these factors is recorded in Worksheet #17, Section 17.2.2. As discussed below, the mass of the incremental and composite samples will be reduced by sieving to <250 microns in size prior to analysis via XRF or submittal to the laboratory. The < 250 micron sized soil particles are of most interest for contaminant analysis due to exposure considerations, while larger particles are unlikely to be mistakenly ingested.

Indoor dust will be sampled at select properties. Dust sampling will be performed in accordance with PWT-ENSE-430, the PWT Team indoor dust sampling SOP. A minimum of one and a maximum of five discrete dust samples may be collected in the living areas of each residence. If there is not sufficient sample volume available to perform discrete sampling, the living areas of the home may be combined to create a single composite living area sample. Attic areas will not be composited with living areas. One composite sample will be collected from the attic, if an attic exists, is used for storage, and the resident can routinely access the attic (by stairway, ladder/trap door, etc). If collected, the attic sample will be collected by vacuuming the exposed horizontal surfaces in the attic, such as rafter tops or flooring. If possible, dust will be collected from portions of the attic which appear relatively undisturbed. If vermiculite or suspected/known asbestos is visually observed in the attic or noted by the homeowner, no sampling will occur.

Areas sampled inside the home will vary by residence, but generally, samples will be collected from the main entryway (front door or preferred entry), the floor area in the most frequently occupied room (usually the kitchen or living room), and the floor in a child's bedroom (or any bedroom if there are no children living in the home).

In order to correctly identify sampling areas, a pre-sampling questionnaire will be completed by the residents (or with the residents) before sampling begins. Copies of this questionnaire and the indoor dust sampling form are included with the SOP in Appendix A.

The total floor area vacuumed for each dust sample will depend on the volume of dust present in each sampling area. The target sample mass is a minimum of 20 grams of sample, but at a minimum, enough dust to completely cover the bottom of the sample container must be collected. The floor area from which dust is collected will be measured and recorded to calculate the dust and metals loading for different parts of the home. If there is not enough dust present in the living spaces of the home to send discrete samples for analysis, the discrete living space samples will be composited. Under no circumstances will attic samples be mixed with discrete or composite living area samples.

17.2 Describe the sampling design and rationale in terms of what matrices will be sampled, what analytical groups will be analyzed and at what concentration levels, the sampling locations (including QC, critical, and background samples), the number of samples to be taken, and the sampling frequency (including seasonal considerations) [May refer to map or Worksheet #18 for details]:

At most DUs, a single 5-point systematic random composite sample will be collected at four intervals between ground surface and 18” bgs, with depth horizons of 0-1 inch, 1-6 inches, 6-12 inches, and 12-18 inches. Once per twenty investigative samples, a sample and two replicate 5-point composite samples will be collected to generate a triplicate sample set. In selected DUs, a single ICS will be collected for the 0-1 inch soil horizon, and 5-point composites will be collected for all four depth horizons.

Samples will be dried, disaggregated, sieved to <250 microns, measured via XRF in a larger bag and 1-2 grams placed in a small sample bag. Each bag will be analyzed via XRF in the field laboratory, (including replicates/triplicates) for calculation of a sample mean and UCL and a percentage of the bag samples will be submitted for analysis via ICP methods where the entire 1-2 gram soil mass will be digested and analyzed. If samples are also needed for bioavailability or metals speciation the procedure is repeated starting with collection of the 1-2 gram sample (these methods also require and will digest the entire 1-2 gram mass).

Properties within the Preliminary Study Area will be chosen based on logistics, schedule, and access, and preliminary DUs will be assigned based on property layout and apparent use. Properties in the DMA ranged in size from 0.1 acres to 0.5 acres in size with most in 0.1 to 0.2 acre range; a similar range is expected in the RI (PWT 2015c). The number of DUs identified for the DMA properties ranged from 3 to 6 depending on the property layout, exposed soil (i.e., unpaved), and the presence of specialty DUs like drip zones, gardens, and play areas. A similar range of DUs per property is expected during the RI. DU designations and sample identification is provided in Worksheet #27.

17.2.1 Sample Collection Procedure for a DU

To collect incremental samples from each DU, a systematic random transect walk or a systematic random grid, is the general approach to the 30-point increment collection scheme. The incremental layout scheme will be determined manually and will result in generally equal distribution of increment collection points across the DU. Field samplers may also walk the DU, collecting increments as they pace the area in a systematic way. For example, a square-shaped DU may be divided into five rows, with six increments collected from each row in a systematic random fashion, with an initial random starting point. For more rectangular-shaped DUs, fewer rows might be used, with more increments per row collected. Row lengths and increments per row may be modified as needed to accommodate a variety of DU shapes and orientations. Figures 1 and 2 provide examples of how 30-point ICS systematic grid incremental and incremental triplicate samples may be oriented, flagged, and sampled. Due to the property specific attributes (size of the DU, layout, and configuration) the sampling team will utilize the systematic random sampling approach with a random start for 5-point composite DUs. Figures 3-5 show common point orientations used in 5-point systematic random composite schemes. In each case increments or points will be offset for the collection of triplicate samples.

Figure 1. Single DU with 30 Increments Going into a Single ICS Sample

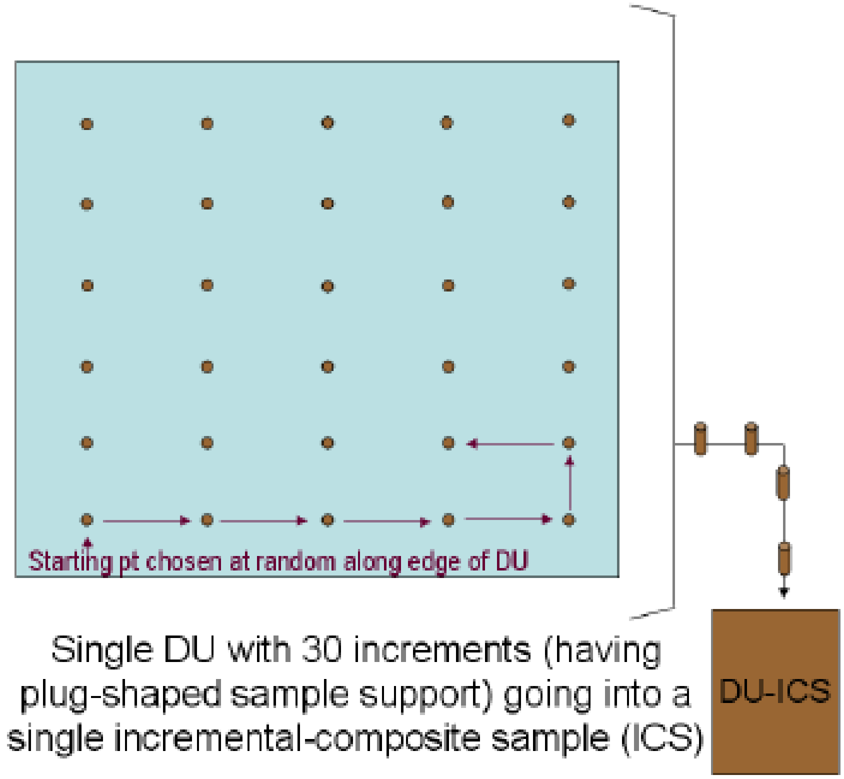
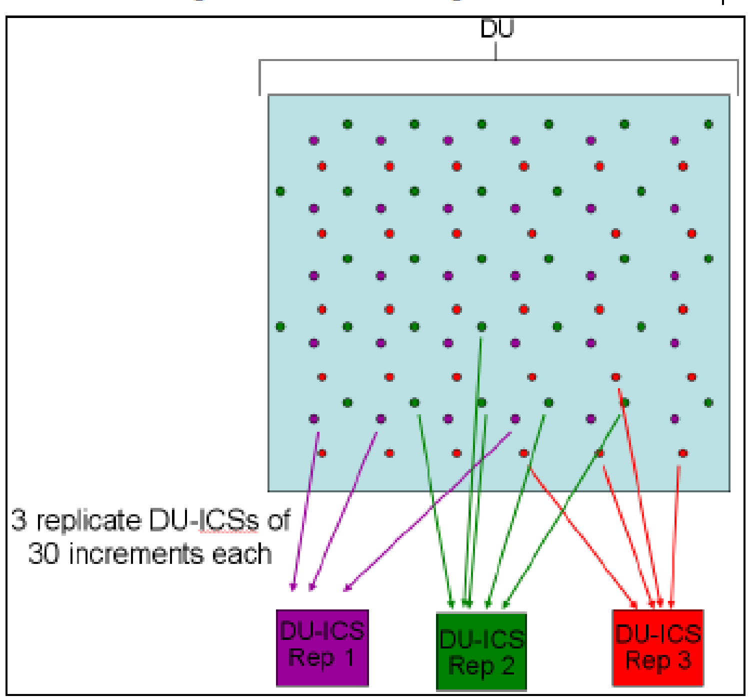


Figure 2. Three Replicate DU-ICS Samples of 30 Increments Each



Figures 3, 4, and 5 Examples of Commonly Used 5-point systematic random composite aliquot orientation

From the EPA Superfund Lead-Contaminated Residential Sites Handbook OSWER 9285.7-50

Figure 3

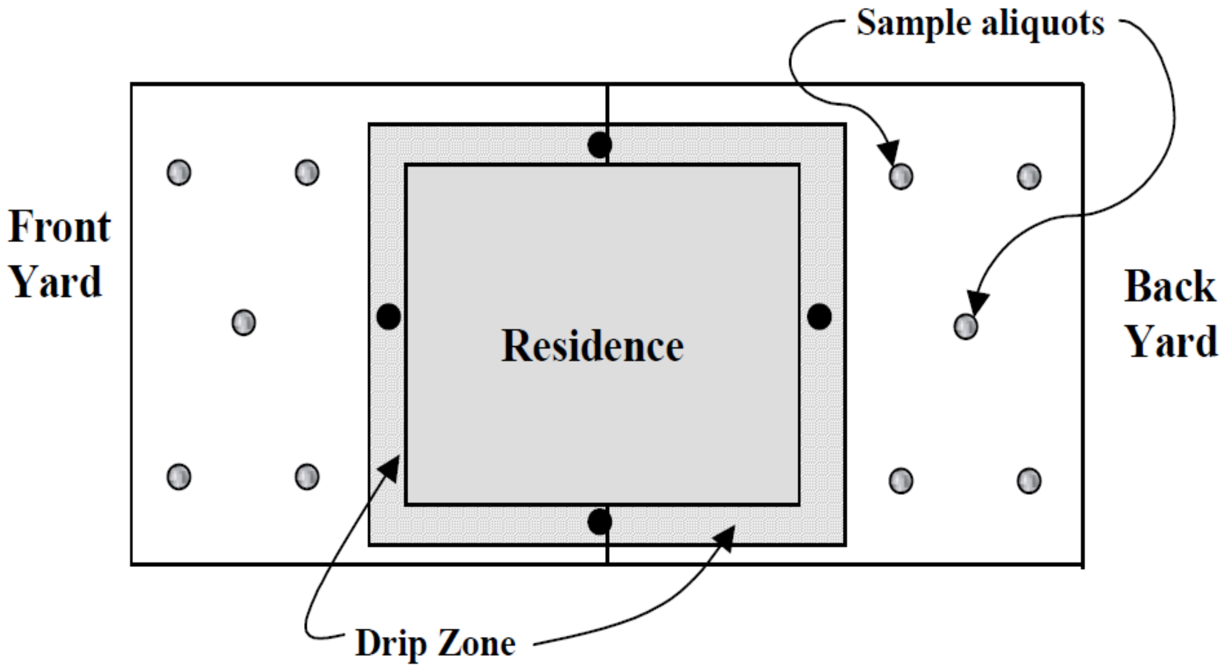


Figure 4

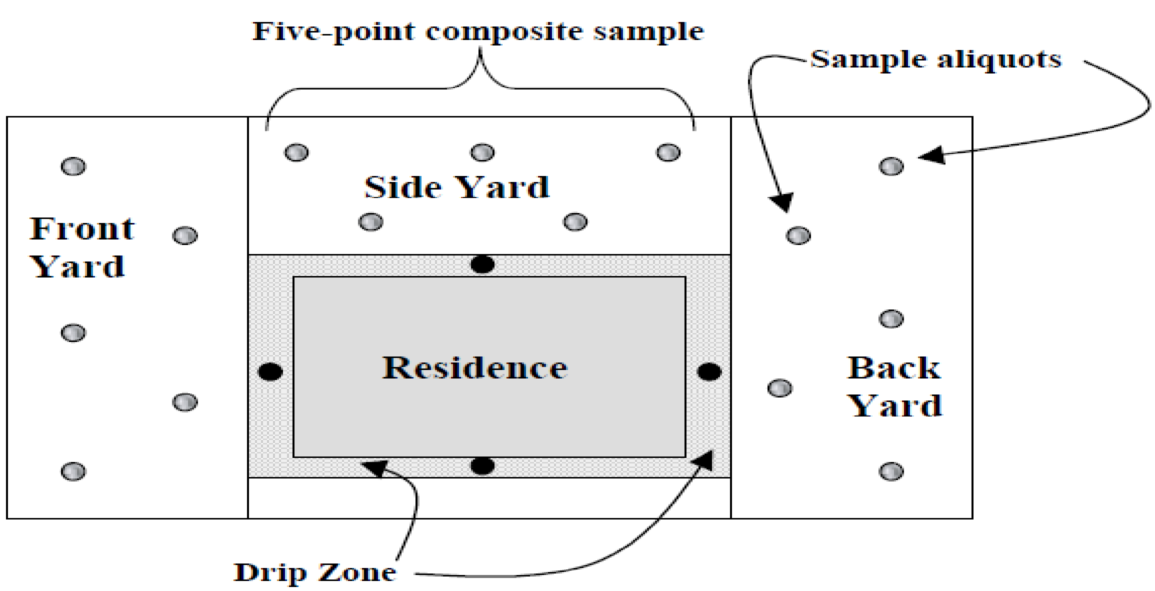
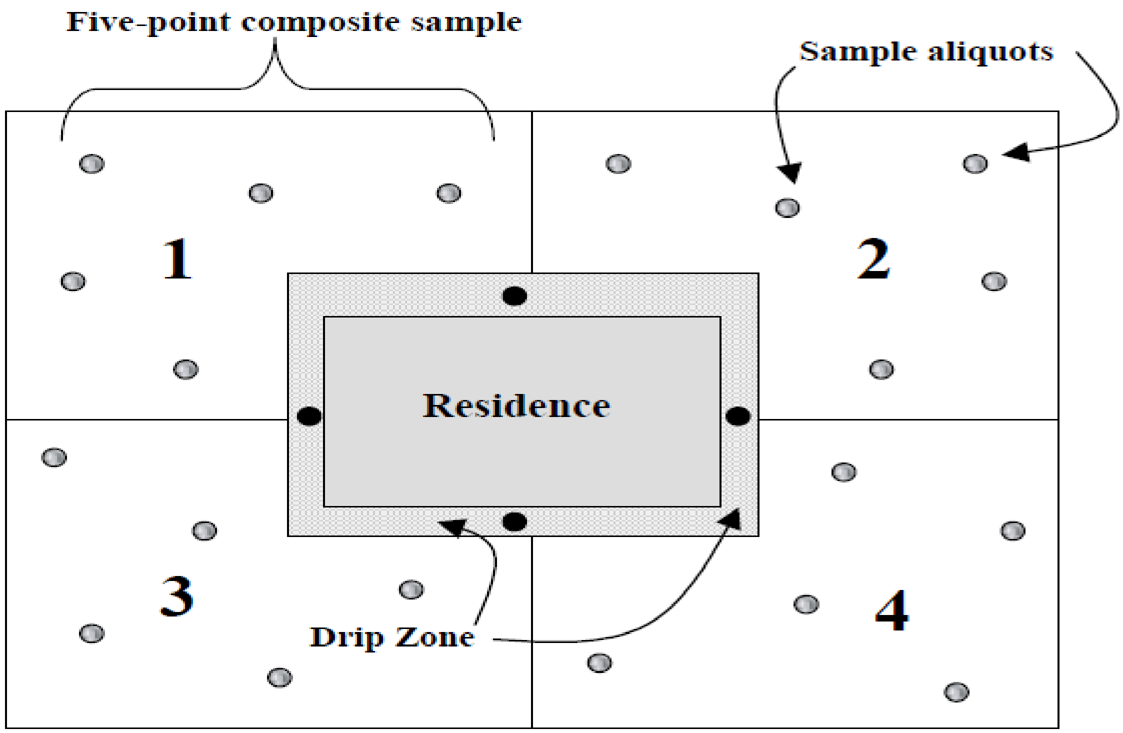


Figure 5



The ends of each row will be marked with flags to help establish approximate lines for the collection of the 30 increments. Flags will also be placed along the edges of the DU parallel to the rows to help ensure approximate spacing. Flags will be placed at every increment collection point. Global Positioning System (GPS) technology or surveys consistent with methodology approved in the DMA QAPP will be used to document the DU location and to create maps for the RI soil investigation. With the exception of cases where a modified mapping need is identified, only the center point of the DU will be located via GPS with the DU and other property features measured by hand and tied in with additional GPS coordinates. The accuracy of GPS location information (+/- 5 feet or more) was considered when establishing DQOs for the investigation.

For a systematic random walk collection of an ICS sample, locations of the 30 individual soil increments are determined by “pacing” a set distance along the rows of the DU, and not individually measured.

For a systematic random walk with grid blocks increment collection, 30 equal-sized blocks are first established (e.g., a grid established across the DU), then a random location would be selected in each grid block to collect a single increment.

Increments will be collected in a manner that produces a cylindrical or core-shaped sample to the extent possible.

One goal of the DMA was to determine the best approach for collecting increments including the requirement to obtain increments from 4 distinct soil horizons (0-1 inch, 1-6 inches, 6-12 inches, 12-18 inches). For incremental and composite samples collected from within the 0-18 inches interval bgs, the tools described in the DMA Sample Collection SOP were proved to be adequate for the RI (PWT 2015a). If problems with soil sample collection are unexpectedly encountered during implementation of the RI, the PWT-COS-427 sample collection SOP will be revisited, and any necessary and appropriate revisions to the procedure will be considered at that time.

A significant source of variability is the non-homogeneous nature of the soil itself. Several processes will be used to minimize this variability. Care will be taken to collect samples that contain the same amount of soil particles from the top of the sampled depth interval as the bottom. Care will be taken to collect equal volumes of soil from each location for all composite samples. The soil for each increment and each depth horizon will be placed in a large bag along with all the other increments for that depth horizon. Soil will be processed in the field laboratory by drying, disaggregating, and sieving to <250 microns before analysis.

The sample preparation process of drying, disaggregation and sieving will be used as the method for mass reduction as well as a further control on soil particle variability within each sample. Subsampling to generate representative 1-2 gram samples of a uniform particle size for XRF and ICP analysis will be conducted in accordance with the SOPs for sample preparation (PWT-COS-302) and sample analysis (PWT-COS-303). All sample containers will be labeled and stored as described in Worksheet #27.

17.2.3 Field Replicates

When the number and spacing of field increments are adequately "representative," repeat measurements within the same DU are expected to provide similar estimates of the average contaminant concentration. Field replicate results (planned as triplicates) will be used as a QC check to evaluate acceptable performance of the sampling and analysis chain, including having an appropriate number of increments and adequate homogenization in sample preparation (see Figure 6). This data will be used to assess decision error rates and confirm that they remain within the target goals of 5% false negatives and 20% false positives.

Determining whether the estimate of average contaminant concentration(s) will be adequately representative for the area under investigation (per the established DQO criteria for the statistical evaluation of the ICS analytical data) was a primary goal of the DMA (PWT 2015c). For this project, field replicates (triplicates) will be collected for approximately 5% of non-specialty DU samples. There are a number of options available for determining what measure of data variation from the mean will be used when evaluating the field replicate measurements and comparing the data to applicable criteria. If the increment density, or some other aspect of the sampling and analytical design is not sufficient to support DU decision-making, this will show up mathematically when evaluating the decision error rates.

The usual link between variability and decision-making is the UCL. The greater the variability between the replicates, the higher the UCL on the mean will be. The greater the numerical gap between the mean of the replicates and the UCL from the replicates, the greater the amount of uncertainty in the data. The standard deviation (SD) for the replicates will be calculated using preprogrammed spreadsheets provided by EPA OSRTI/TIFSD/TIIB. The SD will be used in the equation to calculate the UCL and to calculate the relative standard deviation (RSD). The equation for the RSD is the SD of the replicates divided by the average of the replicates times 100%. The UCL may be used qualitatively. During the DMA, it was demonstrated that the variability associated with both the 5-point composite approach and the 30-point incremental approach were low enough that decision error rates were acceptable. These decision error rates will continue to be monitored during the RI.

Side by side replicate samples will be used to assess variability in indoor dust and to assess sampling and analytical precision. A replicate sample pair will consist of two indoor dust samples collected from immediately adjacent floor surfaces in the same room. For each replicate sample pair, one of the samples is labeled with the investigative sample identification and the other is labeled with the replicate sample identification in accordance with the naming convention described in Worksheet #27, Section 27.2. This sample pair is then submitted to the same laboratory and analyzed as two separate samples.

Precision will be evaluated by calculating the RPD between the field replicate samples. For field replicate pairs whose measured values are both greater than the MRL. The RPD is expected to be less than 35 percent for replicate dust sample pairs, with RPD higher than 35 percent indicating a high level of heterogeneity in the solid matrix. If highly variable dust is encountered, as evidenced by RPDs consistently above 35 percent, then the duplicate frequency in the subsequent sampling event may be increased to ensure that representative data are collected. The frequency for replicate dust samples will be one per 20 homes.

At this time, no different statistical data assessment procedures are planned; however, if they are determined to be needed, a QAPP Addendum will be attached that will explain why different statistical data assessment procedures were needed.

17.2.3.1 Relative Standard Deviation (RSD)

The RSD is a measure of the variation among a group of sample results. It will be used to assess the degree of variability between a set of DU replicates. The degree of variability is also related to the shape of the data distribution. A skewed shape (where one side is pulled out, for example, a lognormal distribution) has a higher RSD than a normal distribution. Therefore the RSD can be used as an indicator of the parent distribution from which the replicates came. RSD is the only statistical test that can be applied to determine distribution shape, since all standard statistical techniques require more than 3 data results. Computer simulations have led statisticians to make the following recommendations, which can be used to aid data assessment:

- If the RSD is low (i.e., less than 1.5), the Student’s t-distribution will be used to calculate the 95% UCL for the concentration.
- If the RSD is between 1.5 and 3, the non-parametric Chebyshev 95% UCL will be used.
- If the RSD is high (greater than 3), the non-parametric Chebyshev 99% UCL will be used. Although this is a 99% UCL by calculation, it is treated as a 95% UCL for the purposes of decision-making when the RSD is high.

17.2.3.2 Calculating the 95 Percent Upper Confidence Limit for a DU

$$UCL_{95\%,Students-t} = \bar{C} + \frac{t_{0.95} \times s}{\sqrt{n}}$$

Where:

$UCL_{95\%,Students-t}$ = 95% UCL based on Student's t distribution
C = mean concentration for the samples in the DU
$t_{0.95}$ = one-sided Student's t factor, based on 95% confidence and the number of samples
s = standard deviation for the samples in the DU
n = number of samples collected in the DU

$$UCL_{95\%,Chebyshev} = \bar{C} + \frac{4.359 \times s}{\sqrt{n}}$$

$$UCL_{99\%,Chebyshev} = \bar{C} + \frac{9.950 \times s}{\sqrt{n}}$$

Unacceptably high data variability (i.e., high RSDs for triplicates and associated high decision error rates) may suggest that the DU's matrix heterogeneity requires denser incremental sampling coverage to ensure an accurate representation of the DU's average, or it may indicate that sample preparation and homogenization procedures were not rigorous enough for this matrix. If necessary, the source of high variability can be evaluated with a series of field and laboratory replicates as shown in Figure 6 below.

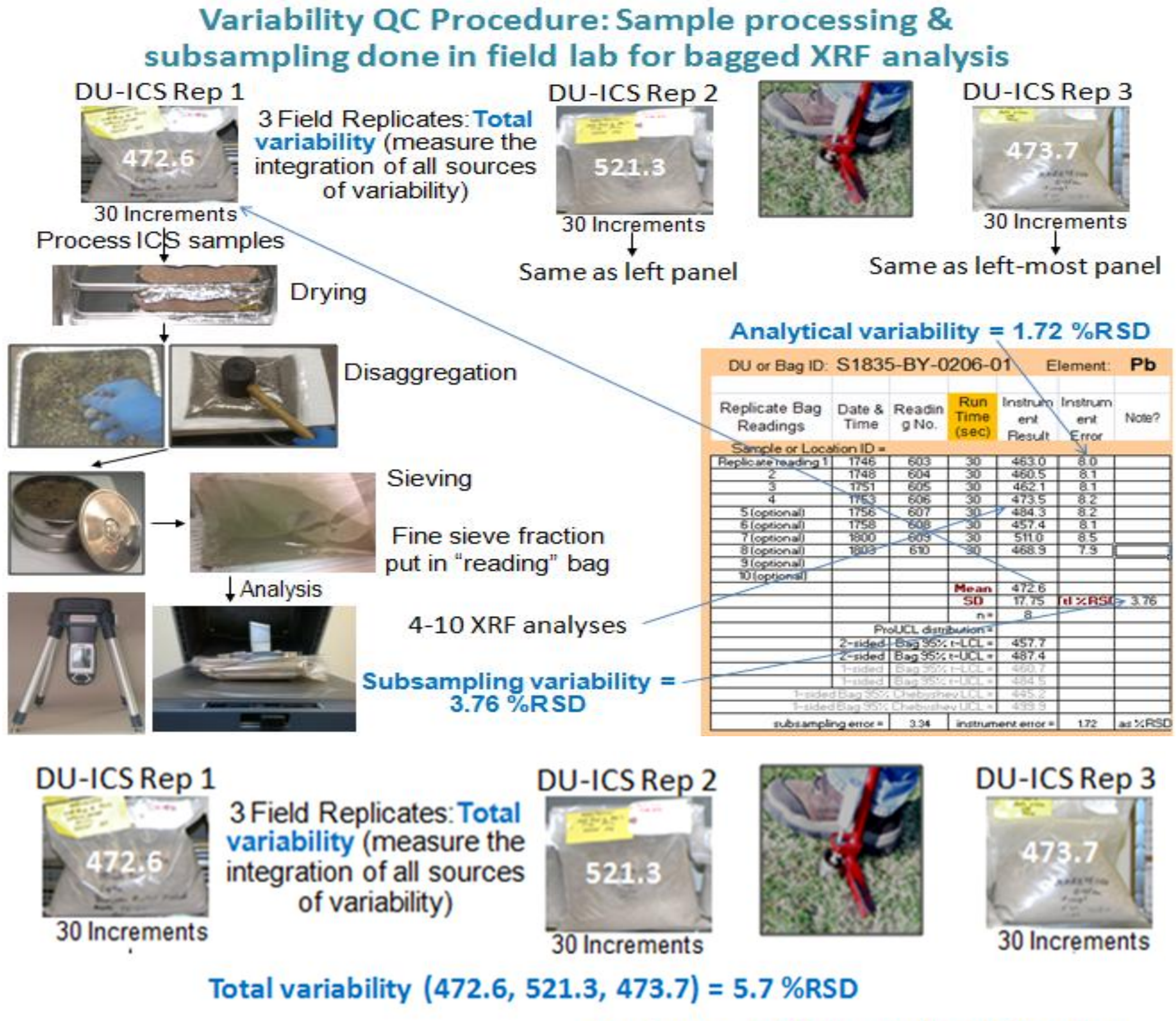
This procedure evaluates which steps in the sampling and analytical procedures are contributing the most to overall variability. If the source of variability is in sample preparation (which will be revealed through the analysis of the sample preparation replicates), increasing the number of increments will not address the problem.

For this project, the mean of measurements for a particular DU/depth interval will be compared directly with the applicable threshold value. Triplicate results will be used to assess whether decision error rate targets are being met. If the triplicate data indicate that decision error rates are not being met, then additional evaluation of the field data and the "variability source" QC data may be performed, and corrective or preventative action may be taken to reduce data variability and decision uncertainty.

17.2.3.3 Sample Collection Procedure for Collecting DU Replicates

DU replicates (triplicates) will be collected at the same time that original DU samples are collected at a frequency of one triplicate set per twenty investigative sample sets. An identical number of increments (5 or 30) as used in the investigative sample will be collected for each of two field replicates.

Figure 6 Variability Source QC Procedure: Measure Sources of Data Variability



DU or Bag ID: S1835-BY-0206-01				Element:		Pb
Replicate Bag Readings	Date & Time	Reading No.	Run Time (sec)	Instrument Result	Instrument Error	Note?
Sample or Location ID =						
Replicate reading 1	1746	603	30	463.0	8.0	
2	1748	604	30	460.5	8.1	
3	1751	605	30	462.1	8.1	
4	1753	606	30	473.5	8.2	
5 (optional)	1756	607	30	484.3	8.2	
6 (optional)	1758	608	30	457.4	8.1	
7 (optional)	1800	609	30	511.0	8.5	
8 (optional)	1803	610	30	468.9	7.9	
9 (optional)						
10 (optional)						
			Mean	472.6		
			SD	17.75	Itd %RSD	3.76
			n =	8		
	ProUCL distribution =					
	2-sided	Bag 95% t-LCL =		457.7		
	2-sided	Bag 95% t-UCL =		487.4		
	1-sided	Bag 95% t-LCL =		460.7		
	1-sided	Bag 95% t-UCL =		484.5		
1-sided Bag 95% Chebyshev LCL =				[illegible]		
1-sided Bag 95% Chebyshev UCL =				499.9		
subsampling error =		3.34	instrument error =		1.72	as %RSD

17.2.4 Sample Collection for Anomalous Locations

During the field sampling efforts, if areas are noticeably different than surrounding areas, or have been previously identified by the CSM as a potential anomalous area, a separate DU will be formed specifically for this area (specialty DUs such as drip zones, play areas, gardens). These areas may be sampled by collecting either typical composite samples or ICS depending on the size of the area and ability to collect aliquots or increments to form an independent DU sample. All sample bags will be labeled and stored as described in Worksheet #27.

Play areas and playgrounds are often covered with sand, pea gravel, mulch, or other distinct, imported material. In these areas, soil below the imported material will be sampled by removing the imported material and using the top of the native soil profile as the surface (0”). The imported material will also be sampled as a separate composite sample. This sample of imported fill material will be representative of the full depth of the material present over native soil. . Sampling imported material in play areas and playgrounds is described in PWT-COS-427.

17.2.5 Sample Collection for Waste Characterization

Investigation derived waste (IDW) materials in the form of potentially contaminated soil, water, or dust are expected to be generated during the field sampling efforts and will be managed per State and Federal guidelines in accordance with PWT-ENSE-423. IDW may be characterized for metals analysis in waste soil and water via TCLP (EPA SW846 methods 1311) or by EPA method 6020B, CLP ISM 02.4, if required for waste disposal.

Colorado Smelter Preliminary Study Area

FIGURE 7

CO_Smelter_Site_Limit (OU2)

Preliminary Study Area Boundary (OU1

ColoParcels_Master

0 445 890 1,780 2,670 3,560 Feet

QAPP WORKSHEET #18

Sampling Locations and Methods/SOP Requirements Table

Sampling Location / ID Number	Matrix	Depth (" = inches bgs)	Analytical Group	Concentration Level	Number of Samples	Sampling SOP Reference	Rationale for Sampling Location
Approximately 1,200 properties within Eilers/Bessemer (estimated number, subject to ability to obtain access). See Figure 7 for study area.	Soil	Surface and subsurface soil sample depths: 0"-1", 1"-6", 6"-12", 12"-18"	Inorganic (Metals)	Low to Moderate	30,000	PWT-COS-427 (Rev 4, 3/23/17)	See Worksheet #17
Approximately 1,200 properties within Eilers/Bessemer opting for indoor dust sampling (estimated number, subject to data evaluation and ability to obtain access)	Dust	Surface	Inorganic (Metals)	Low to Moderate	7,200	PWT-ENSE-430 (Rev 1, 12/6/16)	See Worksheet #17
Four parks and two school properties within Eilers/Bessemer study area	Soil	Surface and subsurface soil sample depths: 0"-1", 1"-6", 6"-12", 12"-18"	Inorganic (Metals)	Low to Moderate	100	PWT-COS-427 (Rev 4, 3/23/17)	See Worksheet #17
Approximately 85 unpaved alleys or roads within Eilers/Bessemer	Soil	Surface and subsurface soil sample depths: 0"-1", 1"-6", 6"-12", 12"-18"	Inorganic (Metals)	Low to Moderate	340	PWT-COS-427 (Rev 4, 3/23/17)	See Worksheet #17
Up to 15 commercial properties within Eilers/Bessemer (subject to ability to obtain access)	Soil	Surface and subsurface soil sample depths: 0"-1", 1"-6", 6"-12", 12"-18"	Inorganic (Metals)	Low to Moderate	180	PWT-COS-427 (Rev 4, 3/23/17)	See Worksheet #17

QAPP WORKSHEET #19
Analytical SOP Requirements Table

Matrix	Analytical Group	Concentration Level	Analytical and Preparation Method / SOP Reference	Sample Size	Containers (number, size, and type)	Preservation Requirement[1] (chemical, temperature, light protected)	Maximum Holding Time (preparation / analysis)
Soil	Metals	All	XRF Analysis SOP PWT-COS-303	Varies (see PWT-COS-427)	Approved Plastic bags	None	Up to 6 months
Soil	Metals	All	CLP SOW method ISM02.4, EPA SW846/ICP method 6020B	Analytical aliquot volume 1-2 grams	Approved Plastic bags	Cool, 4+/- 2˚ C, dark	Up to 6 months
Dust	Metals	All	CLP SOW method ISM02.4, EPA SW846/ICP method 6020B	Analytical aliquot volume 20 grams	Polyethylene or fluorinated ethylene propylene sample bottles, 250-mL	Cool, 4+/- 2˚ C, dark	Up to 6 months
Waste Soil or Soil for Metals and Hg	Metals	All	CLP SOW ISM 02.4 EPA Method 1311	Analytical aliquot volume 100 grams	8 oz short, wide mouth, straight sided, glass jar	Cool, 4+/- 2˚ C, dark	Up to 6 months
Waste Water	Metals	All	CLP SOW ISM 02.4 EPA Method 1311	Analytical aliquot volume 1 liter	1 L high density polyethylene, cylinder-round bottle	Cool, 4+/- 2˚ C, dark, Acidify to pH < 2 with HNO_3	Up to 6 months
Soil	Lead and Arsenic bioavailability	All	ICP method 6020B	Analytical aliquot volume 1.5 grams	Approved Plastic bags	Cool, 4+/- 2˚ C, dark	Up to 6 months
Soil	Lead and Arsenic geospeciation	All	Metal Speciation SOP	Analytical aliquot volume 1.5 grams	Approved Plastic bags	Cool, 4+/- 2˚ C, dark	Up to 6 months

1- Temperature Preservation will not be employed during sample preparation. See SOP PWT-COS-302

QAPP WORKSHEET #20

Field Quality Control Sample Summary Table

Matrix	Analytical Group	Conc. Level	Analytical and Preparation SOP Reference	No. of Field Samples	No. of Field Replicate Sets	No. of MS/MSD	No. of Source Blanks	No. of Equip. Blanks	Total No. of Samples to Lab
Soil	XRF Metals	Low Level	PWT-COS-302 and PWT-COS-303	~24,400	One sample per 20 investigative samples	Not applicable	Not applicable	Not applicable	~25,300
Soil	CLP Metals	Low Level	CLP SOW method ISM02.4, EPA SW846/ICP method 6020B	~2,440	Not applicable	Minimum 5% of sampling areas	1 per change in decontamination water supply	1 per sampling week	~3,000
Soil	Mercury	Low Level	CLP SOW method ISM 02.4, EPA SW846/CVAA method 7471B	~1,220	One per 20 investigative samples	Minimum 5% of sampling areas	1 per change in decontamination water supply	1 per sampling week	~1,300
Dust	CLP Metals	Low Level	CLP SOW method ISM02.4, EPA SW846/ICP method 6020B	~7,200	1 per 20 homes sampled	Minimum 5% of samples	Not applicable	1 per 20 homes sampled	~7,680

Note: For ICP data

- ICP data will be validated per EPA National Functional Guidelines, except that laboratory duplicates will not be performed.
- There is no need for laboratory duplicate QC because the ICP laboratory will not be performing any subsampling.
- The function of matrix spikes for XRF data (checking for aberrant matrix behavior) will be accomplished during XRF-ICP comparability analysis. Any XRF-ICP pair that significantly deviates from the general relationship observed between XRF and ICP pairs will be flagged as a potential instance of matrix interference. If evaluation for matrix interference does not find evidence of it, evidence that an error affected the aberrant pair will be sought. If an error is found to occur, the data pair will be removed from comparability analysis. Potential matrix interference will be evaluated by
- Looking in the field notebook to determine the type of matrix, and compare the suspicious pair to other paired sample analyses from matrices that might be similar;
- Comparing the XRF spectrum for that sample to spectra from samples from a similar matrix; and
- Obtaining and investigating the ICP spectrum for unusual behavior.

QAPP WORKSHEET #21
Project Sampling SOP References Table

Reference Number	Title, Revision Date and / or Number	Originating Organization	Equipment Type	Modified for Project Work? (Y/N)	Comments
PWT-COS-302 (Rev 0, 9/10/15)	XRF Sample Preparation	EPA/PWT	NA	Y	SOPs are included as Attachments A and B
PWT-COS-303 (Rev 1, 12/10/15)	XRF Sample Analysis	EPA/PWT	Niton XL3t 955 GOLDD Ultra	Y	
PWT-ENSE-402 (Rev 2, 4/1/12)	Spatial Data Submittals	PWT	NA	N	
PWT-ENSE-406 (Rev 2, 3/1/12)	Sample Handling	PWT	NA	N	
PWT-ENSE-413 (Rev 1, 3/1/12)	Utility Clearance	PWT	NA	N	
PWT-ENSE-423 (Rev 1, 3/1/12)	Investigation Derived Waste Management	PWT	NA	N	
PWT-ENSE-430 (Rev 1, 12/6/2016)	Indoor and Attic Dust Sampling	PWT	HVS3 and Magnehelic gage	N	
PWT-ENSE-424 (Rev 2, 3/1/12)	Personnel and Equipment Decontamination	PWT	NA	N	
PWT-COS-427 (Rev 4, 3/23/17)	Surface and Shallow Sub-Surface Soil Sampling for Inorganics (Project Specific Procedure)	PWT	Varies, see SOP	Y	

QAPP WORKSHEET #22

Field Equipment Calibration, Maintenance, Testing, and Inspection Table

Field Equipment	Calibration Activity	Maint. Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Resp. Person	SOP Reference
Digital balance	Per manual	Per manual	Per manual	Per manual	Daily	Per manual	Per manual	Field Sample Lead / Field Laboratory Lead	User Manual
Sieve Shaker	NA	Per Manual	NA	Per manual	Per manual	NA	Per manual	Field Laboratory Lead	User Manual
Magnehelic gage	Per manual	Not applicable	Calibration	Not applicable	Daily	Per manual	Per manual	HVS3 Operator	PWT-ENSE-430

QAPP WORKSHEET #23
Analytical SOP References Table

Reference Number	Title, Revision Date, and / or Number	Definitive or Screening Data	Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
EPA 9200.2-86	Standard Operating Procedure for an *In Vitro* Bioaccessibility Assay for Lead in Soil, April 2012	Definitive	IVBA Lead	ICP-MS or ICP-AES	Drexler/CU Boulder	No
SOP 25 (Bratten et al, 2013)	Standard Operating Procedure: Arsenic IVBA Measurement, Rev. 0, 9/25/2012	Definitive	IVBA Arsenic	ICP-MS or ICP-AES	Drexler/CU Boulder	No
NA	Rev 2 October 2007	Definitive	Metal Speciation SOP	Electron Microprobe	Drexler/CU Boulder	No

Reference Number	Title, Revision Date, and / or Number	Definitive or Screening Data	Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
PWT-COS-303	Rev 1 April 2015	Definitive	Metals (Arsenic and Lead)	Niton XL3t 955 GOLDD Ultra	PWT / TtEMI Field Laboratory	Yes
PWT-COS-303	Rev 1 April 2015	TBD	Metals (other than Arsenic and Lead)	Niton XL3t 955 GOLDD Ultra	PWT / TtEMI Field Laboratory	Yes

Reference Number	Title, Revision Date, and / or Number	Definitive or Screening Data	Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
6020B	EPA Contract Laboratory Program, Statement of Work For Inorganic Superfund Methods Multi-Media, Multi-Concentration ISM02.4, Rev 2.4 October 2016	Definitive	Metals	ICP-MS	Assigned CLP Laboratory	NO
1311	EPA Contract Laboratory Program, Statement of Work For Inorganic Superfund Methods Multi-Media, Multi-Concentration ISM02.4, Rev 2.4 October 2016	Definitive	Metals	ICP-MS	Assigned CLP Laboratory	NO
7471B	Rev 2 February 2007	Definitive	Mercury	CVAA	Assigned CLP Laboratory	NO

SOP Standard operating procedure

QAPP WORKSHEET #24
Analytical Instrument Calibration Table

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
Niton XL3t 955 GOLDD Ultra Portable XRF Analyzer	Internal calibration	Prior to start of work	Not applicable	Not applicable	Manufacturer	PWT-COS-303 (Rev 1, 12/10/15)
	Control charting	Prior to start of work	Not applicable	Not applicable	XRF Analyst	
	Instrument Blank	Start of each sample batch (<10 samples)	No detectable amount of target analytes	Repeat blank analysis. If still out of compliance, troubleshoot instrument, and repeat blank analysis until corrected	XRF Analyst	
	Laboratory Control Samples	Start and end of each sample batch (< 20 samples)	Measured concentrations of each target analyte within ±2 standard deviations of the mean from control chart data	Repeat LCS analysis. If still out of compliance, troubleshoot instrument, repeat LCS analysis until corrected	XRF Analyst	
	Instrument Duplicates	Start of each day	None	None – used only as diagnostic information for troubleshooting	XRF Analyst	
Magnehelic gage	Flow check	Start of each day	Within 3% of primary calibration standard (inclined manometer)	Service instrument to correct problem, per manual	HVS Operator	PWT-ENSE-430 (Rev 1, 12/6/16)

QAPP WORKSHEET #25

Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table

Instrument / Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
XRF-Niton XL3t 955 GOLDD Ultra	Not applicable	System Performance Check	Per manual	Per manual	Per manual	Per manual	XRF Analyst	PWT-COS-303 (Rev 1, 12/10/15)
HVS3	Routine Startup Maintenance	Leak test	Per manual	Per property	Per manual	Per manual	HVS3 Operator	PWT-ENSE-430 (Rev 1, 12/6/16)
Inclined manometer	Fluid replacement	Not applicable	Per manual	Annually or as needed	Not applicable	Per manual	HVS3 Operator	PWT-ENSE-430 (Rev 1, 12/6/16)
Analytical balances	Routine Startup Maintenance	Not applicable	Per manual	Daily	Per manual	Per manual	XRF Prep Staff or XRF Analyst	PWT-COS-303 (Rev 1, 12/10/15)
	Not applicable	Calibration mass checks	Per manual	Prior to and following each prep batch	Mass within 1% of known mass	Troubleshoot instrument	XRF Prep Staff or XRF Analyst	PWT-COS-303 (Rev 1, 12/10/15)

Note: Spare parts will be obtained and kept in stock as recommended in the applicable instrument/equipment manuals.

XRF X-ray Fluorescence Spectrophotometer
SOP Standard operating procedure

QAPP WORKSHEET #26
Sample Handling System

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): Field Sample Team, PWT and TtEMI
Sample Documentation (Personnel/Organization): Field Sample Lead, TtEMI
Sample Packaging (Personnel/Organization): Field Laboratory Lead, TtEMI
Type of Shipment (Personnel/Organization): Overnight carrier
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): Laboratory sample custodian
Sample Custody and Storage (Personnel/Organization): Laboratory sample custodian
Sample Preparation (Personnel/Organization): Laboratory Analyst
Sample Determinative Analysis (Personnel/Organization): Laboratory Analyst
SAMPLE ARCHIVING
Field Sample Storage (No. of days from sample collection): 365 days
Sample Extract/Digestate Storage (No. of days from extraction/digestion): Per CLP contract requirements
SAMPLE DISPOSAL
Personnel/Organization: Field Laboratory Lead, TtEMI
Number of Days from Analysis: 180 days
Personnel/Organization: Laboratory sample custodian, CLP Laboratory
Number of Days from Analysis: 365 days
Personnel/Organization: John Drexler/ CU Boulder
Number of Days from Analysis: 365 days

QAPP WORKSHEET #27

Sample Custody Requirements

27.1 Sample Documentation

To minimize common problems such as labeling errors, COC errors, transcription errors, or preservation failures, detailed procedures for properly recording sample information and analytical requests on COC records, for preserving samples as appropriate, and for sample packaging and shipment are described below.

27.2 Sample Naming Convention

The sample naming convention has been designed to maximize the useful information recorded while minimizing opportunity for clerical errors in the field or at the laboratory. Each sample name will consist of up to four parts separated by hyphens.

The first part of the sample name is the letter “S” designating the matrix sampled as soil or the letter “D” for dust, followed by a unique four digit property code assigned by the PWT Team. Property codes will be used instead of addresses for privacy. The Property code is not the same as the county parcel ID number. The second part of the sample name identifies the feature sampled at the property. The third part of the soil sample name refers to the depth interval sampled, and the final part of the soil or dust sample name is a letter to designate other sample information, including the sampling methodology (incremental or 5-point composite) and whether the sample is the primary, replicate, or triplicate from the DU. Five-point composite samples will be assigned the trailing numbers 01, 02, and 03, to indicate primary, replicate, and triplicate samples, while incremental samples will be assigned the trailing numbers 31, 32, and 33..

For example, the sample name S1402-FY-0612-01 refers to a soil sample collected from the front yard at property 1402. The sample was collected from the 6 to 12 inch interval, and it is a primary incremental sample, as indicated by the trailing number “01”. The DUs which might be sampled and the associated feature codes assigned are as follows:

For Soil:

FY = front yard
BY = back yard
SY = side yard
AP = apron (area between sidewalk and roadway)
DY = dog yard
DZ = drip zone
PA = play area
FG = flower garden
GA = garden
ED = earthen drive
VL = vacant lot
WP1= waste pile 1, waste pile 2, etc.
AC= alley segment
(if more than one of a given DU type is present at a property, a cardinal direction should be used to identify location, e.g. SYN, SYE, SYS, or SYW)

For Dust:

E = main entryway
K = kitchen
L = living room
B = bedroom (if more than one bedroom is present a sequential numeral will be given to identify location, e.g. B1, B2, etc)
A = attic
BM = basement
C = composite
S = study
UL = upstairs living area
O = office

A unique CLP number will be assigned to each sample in addition to its sample identification as described above. Both identifications will be recorded on the sample label and the COC in accordance with CLP requirements as identified in the *Contract Laboratory Program Guidance for Field Samplers* (EPA 2014).

27.3 Sample Labeling

Sample labeling will be completed in accordance with PWT's Sample Handling SOP (PWT-ENSE-406) provided in Appendix A. Sample labels will be generated from Scribe in advance of sampling, and completed in the field using water-proof ink. Labels will be attached to the sample bags/containers at the time each sample is collected. The following information will be included on the sample label:

- Sample identification and unique CLP number (if designated for CLP analysis)
- Date and time of sample collection
- Preservation (if used)
- Analyses to be performed
- Sampler's initials.

27.4 Sample Field Forms

Sample field forms will be completed for soil samples at each sampled property and for dust samples when applicable. All sample field forms are to be completed at the time of sampling and will accompany samples from the field to the field soils laboratory. Signature lines on the sample list included on the soil sampling form shall document the transfer of custody from the field sampler to the field soils laboratory. Field forms for environmental sampling are attached to their respective sampling SOPs and are included in Appendix A for reference.

27.5 COC Records and Procedures

To ensure that samples are identified correctly and remain representative of the environment, careful sample documentation and custody procedures will be used to maintain and document sample integrity during collection, transportation, storage, and analysis.

27.6 Field COC Procedures

Field sampling personnel will be responsible for ensuring that proper documentation and custody procedures are initiated at the time of sample collection and followed until custody of the samples is transferred to the field soils laboratory. Field laboratory personnel will be responsible for ensuring that proper documentation and custody procedures are maintained until samples are transferred to an analytical laboratory, a commercial freight carrier, or disposed of in accordance with applicable regulations. Field sampling personnel and field soils laboratory personnel will be required to become familiar with this QAPP and PWT's Sample Handling SOP (PWT-ENSE-406) (provided in Appendix A) prior to initiating field work. The analytical laboratories will be responsible for maintaining sample custody and documentation, in accordance with their CLP contract. The procedures outlined below generally describe this process from the time the analytical laboratory receives the samples until final sample disposition.

The COC procedures provide an accurate written record of the possession of each sample from the time it is collected in the field through laboratory analysis. Secure sample storage will be maintained at the PWT Team Pueblo Field Office. A sample is considered in custody if one of the following applies:

- It is in an authorized person's immediate possession
- It is in view of an authorized person after being in that person's physical possession
- It is in a secure area after having been in an authorized person's physical possession
- It is in a designated secure area, restricted to authorized personnel only.

All samples to be analyzed through the EPA Analytical Program will have a COC/trip report record generated in the EPA SCRIBE database program, and will be signed by the field laboratory personnel prior to shipment. Signed shipping company waybills will serve as evidence of custody transfer between field laboratory personnel and the courier, and between the courier and the analytical laboratory. Copies of the COC record and the waybill will be retained and filed by field personnel prior to shipment. Multiple coolers may be sent to a laboratory in one shipment, with one COC record, provided the COC record clearly indicates which samples are included in which cooler. This way, if there is a quality problem with the holding time with a single cooler in the shipment, the data quality of unaffected samples are not implicated. The outside of the coolers will be marked to show the number of coolers in the shipment. At a minimum, each COC form will contain the following information:

- Sample identification and unique CLP sample number for each sample
- Analytical laboratory information
- Date and time of sample collection
- Sample matrix (i.e., soil, dust, water)
- Number and type of containers per sample
- Preservative (if applicable)
- Analyses to be performed
- Sampler's name and initials
- Release and acceptance information including date, location, and sampler's signature.

The carrier will relinquish samples to the laboratory upon arrival, and the laboratory personnel will then complete the COC.

27.7 Laboratory COC Procedures

A signed COC form will be completed by the laboratory custodian after the samples have been received and their condition checked. For samples shipped by commercial carrier, the waybill will serve as an extension of the COC. File copies of the COC and waybills will be retained. An example COC form is provided in Appendix A.

Upon receipt in the laboratory, samples will be carefully checked to ensure that there are not any broken or leaking sample containers, proper preservation methods have been followed (including receipt at 4°C ± 2°C when applicable), and labels and custody seals are intact. Each COC will be verified for accuracy and completeness, and any discrepancies will be brought to the attention of the EPA Analytical Program Manager. If there are no deficiencies or discrepancies identified, the sample COC will be signed, and a copy will be returned to the PWT Team along with the analytical case narrative. From the time of receipt, the laboratory will use its standard internal COC procedures to ensure that the samples are appropriately tracked through completion of the analytical process.

If the samples and documentation are acceptable, each sample container will be assigned a unique laboratory identification number and entered into the laboratory's sample tracking system. Sample tracking will be documented in the laboratory information management system. Other information that will be recorded includes date and time of sampling, sample description, and required analytical tests.

When sample log-in has been completed, the samples will be transferred to limited-access temperature controlled storage areas. The sample storage areas (coolers, refrigerators) will be kept at 4°C ± 2°C and their temperatures will be recorded daily with thermometers calibrated against National Institute of Standards and Technology thermometers. Storage blanks will be used to assess the cleanliness of sample storage areas.

Sample custody will be maintained within the laboratory's secure facility until the samples are disposed. Laboratories will be instructed to hold or return to the PWT Team the remaining sample quantities for the duration of the holding time or 6 months, whichever is longer. The laboratory will be responsible for sample disposal, which will be conducted in accordance with all applicable local, state, and federal regulations. Disposal of all samples from the PWT field laboratory will be documented in accordance with applicable local, state, and federal regulations per PWT-ENSE-423. The laboratory will maintain records in the project file.

QAPP WORKSHEET #28A

Field Fixed Laboratory QC Samples Table – XRF metals

Matrix	Soil
Analytical Group	Metals via XRF
Concentration Level	Low Level
Analytical Method / SOP Reference	PWT-COS-303

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Blank analysis	Start of each Batch (20 samples)	SOP-COS-303	SOP-COS-303	XRF Analyst	Accuracy/Bias	See SOP-COS-303 (Rev 1, 12/10/15)
LCS	Before and after batch (minimum 1 in 10 samples)	SOP-COS-303	SOP-COS-303	XRF Analyst	Accuracy/Bias	See SOP-COS-303 (Rev 1, 12/10/15)
Instrument Duplicate analysis	Once per day	SOP-COS-303	SOP-COS-303	XRF Analyst	Precision	See SOP-COS-303 (Rev 1, 12/10/15)
Interference checks	Once per lot of plastic bags	SOP-COS-303	SOP-COS-303	XRF Analyst	Precision	See SOP-COS-303 (Rev 1, 12/10/15)

LCS Laboratory control sample/laboratory control sample duplicate
SOP Standard operating procedure
XRF X-ray fluorescence spectrophotometer
SRM Standard Reference Material

QAPP WORKSHEET #28B

QC Samples Table – CLP Metals

Matrix: Soil / Dust	**Concentration Level:** Low to High
Analytical Group: Metals	**Analytical Method/ SOP Reference:** Per CLP SOW method ISM02.3, EPA SW846/ICP method 6020B

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	1/Extraction Batch (20 samples)	CLP SOW method ISM02.3, EPA SW846/ICP method 6020B	Per CLP SOW method ISM02.3, EPA SW846/ICP method 6020B	Laboratory Analyst	Accuracy/Bias-Contamination	No Target Compounds>PQL Goal
LCS/LCSD	1/Extraction Batch (20 samples)	CLP SOW method ISM02.3, EPA SW846/ICP method 6020B	Per CLP SOW method ISM02.3, EPA SW846/ICP method 6020B	Laboratory Analyst	Accuracy/Bias	%RSD ≤ 25%, percent recoveries of target analytes 70-130%, See CLP SOW method ISM02.3, EPA SW846/ICP method 6020B
Internal Standards/ labeled compounds	Spiked into every sample and QC sample	CLP SOW method ISM02.3, EPA SW846/ICP method 6020B	Per CLP SOW method ISM02.3, EPA SW846/ICP method 6020B	Laboratory Analyst	Accuracy/Bias	25-150% Recovery, or See CLP SOW method ISM02.3, EPA SW846/ICP method 6020B
MS/MSD	1/20 samples or per request of project team	CLP SOW method ISM02.3, EPA SW846/ICP method 6020B	Per CLP SOW method ISM02.3, EPA SW846/ICP method 6020B	Laboratory Analyst	Interferences - Accuracy/Bias - Precision	%RSD ≤ 35%, percent recoveries of target analytes 70-130%, See CLP SOW method ISM02.3, EPA SW846/ICP method 6020B

CLP	Contract Laboratory Program
%RSD	Percent relative standard deviation
LCS/LCSD	Laboratory control sample/laboratory control sample duplicate
MS/MSD	matrix spike/matrix spike duplicate
SOP	Standard operating procedure

QAPP WORKSHEET #28C
QC Samples Table – Mercury

Matrix: Soil			**Concentration Level:** Low to High			
Analytical Group: Mercury			**Analytical Method/ SOP Reference:** Per CLP SOW method ISMO1.3, EPA SW846/ICP method 7471B			
QC Sample	**Frequency / Number**	**Method / SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
Method Blank	1/Extraction Batch (20 samples)	CLP SOW method ISM02.3, EPA SW846/ICP method 7471B	Per CLP SOW method ISM02.3, EPA SW846/ICP method 7471B	Laboratory Analyst	Accuracy/Bias-Contamination	No Target Compounds>PQL Goal
LCS/LCSD	1/Extraction Batch (20 samples)	CLP SOW method ISM02.3, EPA SW846/ICP method 7471B	Per CLP SOW method ISM02.3, EPA SW846/ICP method 7471B	Laboratory Analyst	Accuracy/Bias	%RSD ≤ 25%, percent recoveries of target analytes 70-130%, See CLP SOW method ISM02.3, EPA SW846/ICP method 7471B
Internal Standards/ labeled compounds	Spiked into every sample and QC sample	CLP SOW method ISM02.3, EPA SW846/ICP method 6020B	Per CLP SOW method ISM02.3, EPA SW846/ICP method 7471B	Laboratory Analyst	Accuracy/Bias	25-150% Recovery, or See CLP SOW method ISM02.3, EPA SW846/ICP method 7471B
MS/MSD	1/20 samples or per request of project team	CLP SOW method ISM02.3, EPA SW846/ICP method 7471B	Per CLP SOW method ISM02.3, EPA SW846/ICP method 7471B	Laboratory Analyst	Interferences – Accuracy/Bias – Precision	%RSD ≤ 35%, percent recoveries of target analytes 70-130%, See CLP SOW method ISM02.3, EPA SW846/ICP method 7471B

CLP	Contract Laboratory Program
%RSD	Percent relative standard deviation
LCS/LCSD	Laboratory control sample/laboratory control sample duplicate
MS/MSD	matrix spike/matrix spike duplicate
SOP	Standard operating procedure

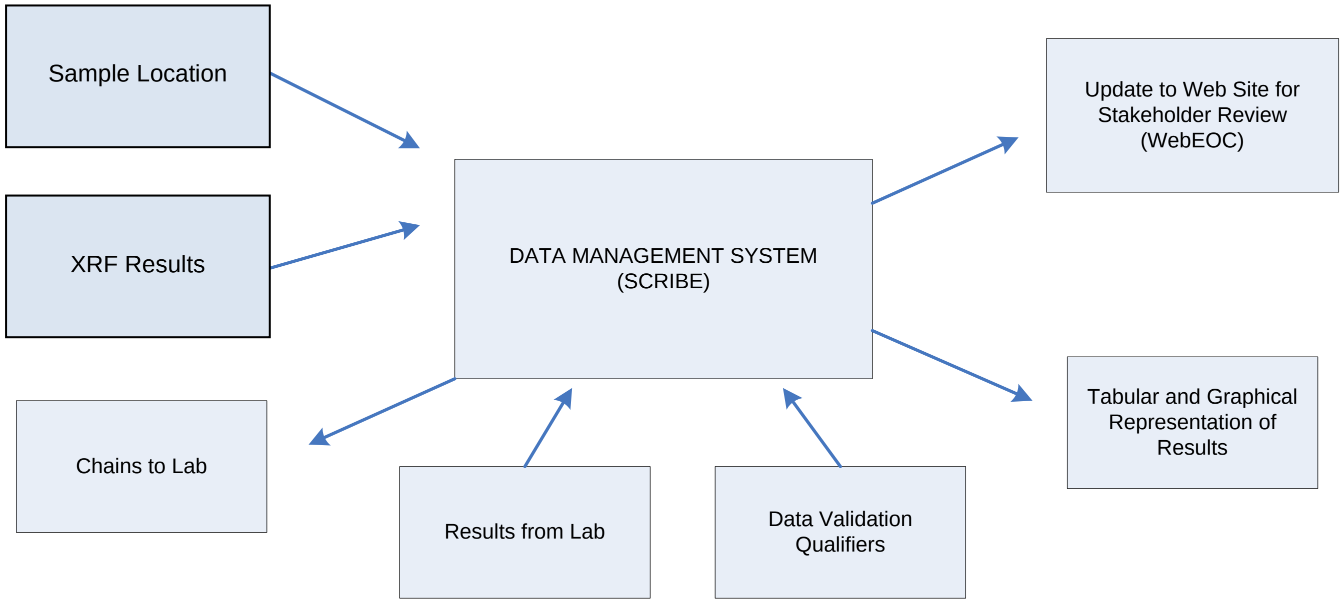
QAPP WORKSHEET #29
Project Documents and Records Table and Data Management Information

EPA Region 8, Superfund Data Management Plan (EPA, 2016a):

Sample Collection Documents and Records	On-Site Analysis Documents and Records	Off-Site Analysis Documents and Records	Data Assessment Documents and Records[1]	Other
• Field notes • Property inventory maps • Daily quality control reports • Chain of custody • Photo documentation • GIS files • Airbills	• XRF sample analysis forms • Instrument data files • Daily quality control reports • Logbooks • Field notes • Sample storage	• Sample login and tracking information • Sample prep and instrument logs • Calibration and maintenance data • QA program data (checks, audits, reviews) • Analytical raw data and instrument output • Sample storage and disposal • Electronic data deliverable (SEDD) • Laboratory QA Plan, SOPs, and certification documentation • Chain of custody forms • Corrective action forms	• Sampling and analytical data in required format (SEDD/Scribe-compatible) • Laboratory full data and documentation packages (including raw data as provided by CLP Sample Management Office) • Data entry and upload into project database (Scribe) • Data download from Scribe; data reduction and visualization work-products (e.g., FIELDS, SADA, ProUCL, ArcView, EVS/MVS, statistical analysis) • External audit records (laboratory, file) • Data validation reports • Project reports • Meeting notes and collaborative work products/tools (e.g., project web portals and file sharing sites) • Site Administrative Record • XRF data files • Corrective action forms	• RI final report

DATA MANAGEMENT CONSIDERATIONS

The following diagram illustrates the basic concepts of data flow for the site assessment process based on using Scribe as the project database management system.



The following describes the flow of data to and from Scribe the central Data Management System which will be performed to meet or exceed the data standards and best management practices as described in the EPA Region 8, Superfund Data Management Plan (EPA, 2016):

Scribe is a data management decision support tool (DST) developed by EPA's Environmental Response Team (ERT) that allows a greater number of project teams working at sites to realize the benefits of maintaining data in a relational database. Scribe can import electronic data, including analytical laboratory results in EDD format and sampling location data such as global positioning system (GPS) coordinates. Scribe can print sample labels and COC documents. Scribe can be integrated with software packages to capture and import sampling and monitoring data collected using handheld devices during field work. The ERT EDD Generator for Scribe SOP may be found at http://www.epaosc.org/sites/ScribeGIS/files/xrf%20edd%20for%20scribe.zip

Additionally, the Superfund Enterprise Management System (SEMS) will also be used as the document repository to store and facilitate transmission of PDFs and paper documents. The PWT Project Manager will be responsible to ensure that documents are submitted to the EPA Records Center for entry into SEMS. Hard copies generated during the investigation will be maintained at the PWT office for 30 years. The permanent record will be archived in the Regional Records Center.

The following describes key elements of a field-based data collection and entry system.

Sample Location – GPS location coordinates are recorded at the approximate geographic center of each yard component sampled. This data is uploaded to scribe.

Sample COC – COCs are generated in Scribe. The following is an example of the steps to be taken to generate a COC:

- Click on **COC** under the Sample Management section of the navigation pane.
- Click the **Add a COC** button.
- Scribe automatically assigns the next sequential COC #.
- Enter the date for the **date shipped.**
- Click the **Assign Samples to COC** button to select which samples are in the bin.
- Select the **COC** Layout.
- **Highlight the samples to be assigned** to the COC and **click the Assign Samples to COC** button at the bottom of the screen.
- Click **Yes** to assign the samples to the COC .
- Click the **Print COC** button and select **Preview.**
- Click the printer icon to send the COC to the printer and save as PDF.
- Place the COC in the paperwork box for the crew.
- Save XML version of COC file and send file to the SMO Portal.

XRF Results – Sample information to be recorded with XRF results includes:

- Project name, number and location
- Sample ID number
- Sample Location Coordinates
- Date and time of sample collection
- Sample collector's initials/Name
- Number and type of containers filled
- Analysis requested
- Sample type (incremental or five-point composite sample)

Analytical Laboratory Results – Analytical results from the laboratory are downloaded from the SMO by E2 and PWT and undergo a QC review before they are made available to end users.

Data Validation Results – Data qualifiers from the data validation shall be input into the EDD by E2 to document data usability for data end users and final work products. Validated analytical results from the laboratory are loaded into the Scribe database by PWT and undergo a QC review before they are made available to end users. Scribe provides a quick turnaround of preliminary sample results.

Tabular and Graphical Representation of Results – Scribe's data querying capabilities allow for flexible data analysis and integration into visual software packages like Automated Computer Aided Design/Drafting or geographic information system (GIS).

Project records will be stored electronically at the PWT Wheat Ridge office for 10 years after the end of the project. The PWT server is backed up weekly to a secure offsite location.

QAPP WORKSHEET #30
Analytical Services Table

Matrix	Analytical Group	Concentration Level	Sample Locations/ ID Number	Analytical SOP	Data Package TAT	Laboratory Options
Soil	Metals via XRF	All	All	PWT-COS-303	7-day	PWT/TtEMI field laboratory
Soil / Dust	Metals via CLP	All	All	CLP SOW ISM 02.4 EPA Method 6020B	7-day	To be assigned by EPA, Don Goodrich
Water	Metals via CLP	All	All	CLP SOW ISM 02.4 EPA Method 6020B	7-day	To be assigned by EPA, Don Goodrich
Soil	Mercury via CLP	All	5%	CLP SOW ISM 02.4 EPA Method 7471B	7-day	To be assigned by EPA, Don Goodrich
Waste (Soil / Water / Dust)	TCLP Metals via CLP	All	All	CLP SOW ISM 02.4 EPA Method 1311	7-day	To be assigned by EPA, Don Goodrich
Soil	Arsenic & Lead bioavailability and geospeciation	All	All	EPA 8290A/1613B and 1668A	TBD	CU – John Drexler

QAPP WORKSHEET #31
Planned Project Assessments Table

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment (title and organizational affiliation)	Person(s) Responsible for Responding to Assessment Findings (title and organizational affiliation)	Person(s) Responsible for Identifying and Implementing Corrective Actions (CA) (title and organizational affiliation)	Person(s) Responsible for Monitoring Effectiveness of CA (title and organizational affiliation)
Field Readiness Review	Before mobilization for the RI	Internal	Project Team	PWT QAO	PWT Project Manager	PWT Project Manager	PWT Project Manager PWT QAO
Field Sampling Surveillance*	Once during the first 45 days of RI field sampling activities	Internal	Project Team	PWT QAO	PWT Project Manager XRF Laboratory Lead, TtEMI	PWT Project Manager	PWT Project Manager PWT QAO
Field Laboratory Surveillance*	Once during the first 45 days of RI field laboratory activities	Internal	Project Team	PWT Project Chemist	PWT Field Coordinator	PWT Field Coordinator	PWT Project Manager PWT Project Chemist

Note: follow-up surveillances will be scheduled if necessary/appropriate.

QAPP WORKSHEET #32
Assessment Findings and Corrective Action Responses

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (name, organization)	Timeframe of Notification	Person Responsible for Corrective Action Response	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response (name, organization)	Timeframe for Response
Field Readiness Review	Email documentation	Steve Singer, PWT Rob Tisdale, TtEMI	2 days	Robin Witt, PWT	Email documentation	Steve Singer, PWT Robin Witt, PWT	2 days
Field Sampling Surveillance	Email documentation	Steve Singer, PWT Mark Wood, PWT Rob Tisdale, TtEMI	2 days	Robin Witt, PWT	Email documentation	Steve Singer, PWT Robin Witt, PWT Mark Wood, PWT	2 days
Laboratory Surveillance	Email documentation, checklist	Steve Singer, PWT Craig Walker, PWT Mark Wood, PWT Robin Witt, PWT	5 days	Rob Tisdale, TtEMI	Email documentation, corrective action memorandum	Steve Singer, PWT Craig Walker, PWT Mark Wood, PWT	5 days
Any observed deficiency or issue that will impact data quality	Anyone may stop work until corrected, email documentation	Steve Singer, PWT Robin Witt, PWT Mark Wood, PWT	Immediate	Rob Tisdale, TtEMI	Email documentation	Steve Singer, PWT Robin Witt, PWT Mark Wood, PWT	2 day

QAPP WORKSHEET #33
QA Management Reports Table

Type of Report	Frequency	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation	Report Recipient(s)
Audit Report of Field inspections and sampling procedures[1]	One time for each field QA inspection	30 days after inspection	Robin Witt, PWT	Steve Singer, PWT Ram Ramaswami, PWT Sabrina Forrest, EPA Region 8
Data Verification Repor t[1]	For 100% of data	Ongoing	Ruth Siegman, E2	Steve Singer, PWT Craig Walker, PWT Mark Wood, PWT
Data Validation Report[1]	For 10% of data	Ongoing	Ruth Siegman, E2	Steve Singer, PWT Craig Walker, PWT Mark Wood, PWT
Analytical Data Review [1]	Weekly	Ongoing	Craig Walker, PWT	Steve Singer, PWT
Weekly Progress Report	Weekly	5:00pm on Tuesday for the previous week	Rob Tisdale, TtEMI	Robin Witt, PWT or Steve Singer, PWT
Monthly Status Report	Monthly	At the end of each month	Steve Singer, PWT	Sabrina Forrest, EPA Region 8

[1] Reports and documentation for audits/assessments and data review/validation activities are further documented in Worksheets #32, #34, and #35.

QAPP WORKSHEET #34
Verification (Step I) Process Table

Verification Input	Description	Internal / External	Responsible for Verification (name, organization)
Audit/assessment reports	When the report is complete, a copy of all audit reports will be placed in the project file. If corrective actions are required, a copy of the documented corrective action taken will be attached to the appropriate audit report in the project file. At the beginning of each week and at the completion of the site work, project file audit reports will be reviewed internally to ensure that all appropriate corrective actions have been taken and that corrective action reports are attached. If corrective actions have not been taken, the project manager will be notified to ensure action is taken.	I	Robin Witt, PWT
Field notes, logbook, sampling records	Field notes will be reviewed internally and placed in the project file. A copy of the field notes will be attached to the final report.	I	Rob Tisdale, TtEMI Mark Wood, PWT
Sample receipt	For samples shipped via commercial carrier, the chemist will verify receipt of samples by the laboratory the day following shipment.	I	Craig Walker, PWT Mark Wood, PWT
Sample logins	Sample login information will be reviewed and verified for completeness in accordance with the COC forms.	I, E	Craig Walker, PWT CLP Laboratory Manager, TBD
COC records	COC forms will be reviewed internally when they are completed and verified against the packed sample coolers they represent. The shipper’s signature on the COC form should be initialed by the reviewer, a copy of the COC form will be retained in the project file, and the original and remaining copies will be taped inside the cooler for shipment.	I, E	Craig Walker, PWT CLP Laboratory Manager, TBD
Laboratory data prior to release	Laboratory data will be reviewed and verified for completeness against analyses requested on the COC forms.	E	CLP Laboratory Manager, TBD
Laboratory data due at turnaround time listed on chain of custody	Laboratory data will be verified that the analyses reported are consistent with the analytical suite requested on the COC forms.	I, E	Craig Walker, PWT Mark Wood, PWT CLP Laboratory Manager, TBD
Laboratory data completeness and accuracy	All laboratory data packages will be verified for completeness and technical accuracy by the laboratory performing the work. Data packages will then be reviewed by the E2 and PWT for completeness.	I, E	Craig Walker, PWT CLP Laboratory Manager, TBD Ruth Siegman, E2

Verification Input	Description	Internal / External	Responsible for Verification (name, organization)
Laboratory data consistency verification	Select analyses that will undergo a data consistency review and verification. Perform consistency review of data transfer from the original laboratory bench sheets and instrument data to the result reports.	I, E	Craig Walker, PWT Ruth Siegman, E2]
Field and electronic data verification and upload	One hundred percent of manual data entries (in the field or from field forms) will be reviewed against the hardcopy information, and 10 percent of electronic uploads will be checked against the hardcopy.	I, E	Mark Wood, PWT Ruth Siegman, E2
Data upload verification	Verify the correct transfer of results from the laboratory deliverables into the Database.	I	Mark Wood, PWT

QAPP WORKSHEET #35
Validation (Steps IIa and IIb) Process Table

Step IIa / IIb	Validation Input	Description	Responsible for Validation (name, organization)
IIa	Field documentation	Field logbooks and forms will be reviewed weekly for accuracy associated with each sampling event. The inspection will be documented in weekly QC reports.	Mark Wood, PWT Rob Tisdale, TtEMI
IIa	COC forms	COC forms will be reviewed daily to ensure that project information, sample analyses requested, number of field QC samples collected, and percent level III or IV validation chosen is accurate and in accordance with the requirements in this UFP-QAPP	Mark Wood, PWT CLP Laboratory Manager, TBD John Drexler
IIa	Sample receipt	The sample cooler will be checked for compliance with temperature and packaging requirements.	Mark Wood, PWT CLP Laboratory Manager, TBD John Drexler
IIa	Sample logins	Sample login will be reviewed for accuracy against the COC form.	Mark Wood, PWT CLP Laboratory Manager, TBD John Drexler
IIa	Laboratory data prior to release	Laboratory data will be reviewed to ensure that the data are accurate and meets the requirements in this QAPP. Before they are released, data will be validated as follows:	CLP Laboratory Manager, TBD
		100 percent of the data comply with the method- and project-specific requirements; any deviations or failure to meet criteria are documented for the project file.	CLP Laboratory Manager, TBD
		100 percent of manual entries are free of transcription errors and manual calculations are accurate; computer calculations are spot-checked to verify program validity; data reported are compliant with method- and project-specific QC requirements; raw data and supporting materials are complete; spectral assignments are confirmed; descriptions of deviations from method or project requirements are documented; significant figures and rounding have been appropriately used; reported values include dilution factors; and results are reasonable.	CLP Laboratory Manager, TBD
		Data reported comply with method- and project-specific QC requirements; the reported information is complete; the information in the report narrative is complete and accurate; and results are reasonable.	CLP Laboratory Manager, TBD
		Data reported comply with method- and project-specific QC; analytical methods are performed in compliance with approved SOPs. (This review may be conducted after release of data since they involve only on 10 percent of the data.)	CLP Laboratory Manager, TBD

Step IIa / IIb	Validation Input	Description	Responsible for Validation (name, organization)
IIa	Laboratory data due at turnaround time listed on chain of custody	Laboratory data will be reviewed to ensure that the data reported met the analyte list and limits listed in Worksheet #15.	Craig Walker, PWT Ruth Siegman, E2
IIa, III	Laboratory data packages	All laboratory data packages will be validated by the laboratory performing the work for technical accuracy before they are submitted.	CLP Laboratory Manager, TBD
		Data packages will then be reviewed for accuracy against the laboratory data that were faxed or e-mailed at the turnaround time listed on the chain of custody.	Craig Walker, PWT
		Data packages will be evaluated externally by undergoing data validation at a frequency of 10%.	Ruth Siegman, E2
IIb, III	Data validation reports	Data validation reports will be reviewed in conjunction with the project DQOs and DQIs. Validation checklists provided in Appendix B.	Craig Walker, PWT

QAPP WORKSHEET #36

Validation (Steps IIa and IIb) Summary Table

Step IIa / IIb[1]	Matrix	Analytical Group	Concentration Level	Validation Criteria	Data Validator (title and organizational affiliation)
IIa	Soil	XRF Metals	All levels	In accordance with this QAPP, and PWT-COS-303	Ruth Siegman, E2
IIb,III	Soil	ICP-MS Metals, Mercury	All levels	In accordance with this QAPP, CLP SOW ISM02.3 , 6020B, 7471B	Ruth Siegman, E2
IIa	Soil	Arsenic and Lead bioavailability and geospeciation	Low level	In accordance with this QAPP, CU-John Drexler requirements	John Drexler, CU Ruth Siegman, E2

Notes:

1 IIa=compliance with methods, procedures, and contracts [see Table 10, page 117, UFP-QAPP manual, V.1, March 2005.].
IIb=comparison with measurement performance criteria in the QAPP [see Table 11, page 118, UFP-QAPP manual, V.1, March 2005].

QAPP WORKSHEET #37
Usability Assessment

Describe the procedures / methods/activities that will be used to determine whether data are of the right type, quality, and quantity to support environmental decision-making for the project. Describe how data quality issues will be addressed and how limitations on the use of the data will be handled.

Summarize the usability assessment process and all procedures, including interim steps and any statistics, equations, and computer algorithms that will be used:

XRF Data

- The XRF data generated will be validated as usable via real-time QC activities that monitor instrument and operator performance. This will be accomplished by real-time charting of LCS QC and real-time verification that instrument duplicate QC results are acceptable (See the relevant SOPs for more information). If QC results are not acceptable, real-time trouble-shooting and correction of any problems will be performed before data are reported. Samples analyzed during out-of-control periods for the XRF will be reanalyzed prior to reporting.
  - All reported XRF data are required to be bounded by in-control QC results. Thus, no reported XRF data should be rejected at a later time due to QC non-conformance.
- During field work, the XRF Laboratory Lead will perform spot-checks to ensure field staff are following XRF operation and XRF data entry procedures. Any observed deviations from procedures will be addressed by the XRF Laboratory Lead or designee, and if needed, staff will be retrained.
  - LCS control charts (these are paper) will be inspected by the supervisor to ensure real-time charting is being performed and control chart documentation is adequate. Completed paper control charts and their accompanying “Notes/Troubleshooting” sheets will be stored in a safe location and scanned into electronic files as soon as possible.
  - Past and current Instrument Duplicate QC Calculator files will be checked for complete entry information. Completed files (these are electronic Excel files) should be properly stored and backed up. This may involve password protection to avoid accidental changes to a completed file.
  - Previous and current DU-Bag Concentration Calculators (electronic Excel spreadsheets) will be inspected to ensure that all required spreadsheet inputs are filled out, and that statistical significance was attained for each final bag sample concentration result. Completed files should be properly stored and backed up. This may involve password protection to avoid accidental changes.
  - Written entries in field notebooks covering the relevant time periods will be scanned into electronic files that are stored with the relevant, completed spreadsheet files so that meta information is readily accessible.
  - On a daily basis, operators will create data packages documenting all data collected on that their instrument on that day. The data packages will be

submitted for verification by an independent validator. After verification, the data will be uploaded into Scribe.

ICP data

- ICP data will be validated following QAPP Worksheets #35 and #36 and the National Functional Guidelines for Inorganic Superfund Data Review (EPA 2014). The validation will follow normal validation procedures, except that laboratory duplicates will not be performed. Only validated ICP data will be loaded into Scribe.
    - There is no need for laboratory duplicate QC because the ICP laboratory will not be performing any subsampling.
    - The function of matrix spikes (checking for aberrant matrix behavior) will be accomplished during XRF-ICP comparability analysis. Any XRF-ICP pair that significantly deviates from the general relationship observed between XRF and ICP pairs will be flagged as a potential instance of matrix interference. If evaluation does not find evidence of matrix interference, then evidence of an error that affected the aberrant pair will be sought. If an error is identified, the data pair will be removed from comparability analysis. Potential matrix interference will be evaluated by:
        - Looking in the field notebook to determine the type of matrix, and compare the suspicious pair to other paired sample analyses from matrices that might be similar;
        - Comparing the XRF spectrum for that sample to spectra from samples from a similar matrix; and
        - Obtaining and investigating the ICP spectrum for unusual behavior.

Scribe database

- Spot checks will confirm accurate input of field data into the Scribe database.
- Spot checks will confirm accurate electronic transfer of ICP data into the Scribe database.
- Spot checks will confirm accurate electronic transfer of XRF data into the Scribe database.
- Some information that is vital to interpreting the DU results will need to be preserved in Scribe. This may have to be manually entered, such as the DU surface area, the number of increments comprising the DU sample, or whether the sample is part of a QC replicate/triplicate set.
- In addition, the final bag sample result (which is an average calculated by the Bag Concentration spreadsheet) and the 95% UCL and LCL on the bag mean should be entered into Scribe.
    - It should be possible to use the Student's t UCL and LCL for repeated XRF readings on a sieved sample bag that has been mixed to ensure the particles are not segregated by size.

    - However, if high within-bag heterogeneity persists after corrective action efforts, it may be necessary to use the Chebyshev UCL and LCL.

Describe the documentation that will be generated during usability assessment and how usability assessment results will be presented so that they identify trends, relationships (correlations), and anomalies:

A data validation report will be created for the project, including a summary of all quality assurance/quality control results from the project to provide documentation that the analytical methods were in control throughout sample analysis.

Comparability between XRF and ICP methods will be performed to allow all XRF data to supply information relevant to risk assessment. Since subsampling error is minimized, comparability analysis will reflect the difference between total metal content (read by the XRF) and metal content able to be solubilized by the nitric acid/peroxide/hydrochloric acid/heat digestion procedure used for ICP analysis.

- Normal Q-Q statistical plot(s) will be used to evaluate the data distribution for each data set.
    - If there are indications that different data populations might be present in the ICP data set (perhaps reflecting the different solubilities of different matrices), this will be noted.
    - If linear regression of the entire data sets is unsatisfactory, separate statistical analysis of each subpopulation may be attempted if the statistical subpopulations can be correlated with different matrix types (as recorded in the field notebook).
- Non-parametric (Wilcoxon Signed-Rank Test) or parametric (2-sample t-test) hypothesis tests of population means will be done to determine whether the XRF data set and ICP data set represent different populations.
- Regression analysis will be performed using the regression technique best suited to the data sets to quantitatively compare the XRF and ICP methods. This is expected to be linear regression, but the appropriateness of linear regression must be confirmed.
    - If the regressions appear to show outlier data pairs, the possible reason will be explored, including:
        - Concentration extremes outside the instrument’s linear range (an effort will be made to ensure this will not happen);
        - Spectral interference from the matrix (see discussion above under “ICP data”);
        - Differences in digestion/solubilization that can be correlated with matrix type,
        - Clerical error with sample ID or recording of results.
    - If a justifiable reason for exclusion of outliers from the main data set is identified, the outlier pair will be removed.

- After removal of outliers, as described above, the upper and lower prediction limits for the best fit regression line will be determined. These will be used to calculate the range of ICP results predicted by a certain XRF result, and the XRF concentration that could be used as a decision threshold when making risk decisions with specified statistical confidence while using XRF to analyze property samples.
- If any outliers had been removed, it will be necessary to repeat the hypothesis test mentioned above. If the hypothesis test finds that the XRF and ICP data sets are not different at the 95% confidence level, an equation to adjust XRF results for the solubilization bias will not be performed.
- If the hypothesis test finds that the XRF and ICP data sets are different at the 95% confidence level, an equation to adjust XRF for the solubilization bias will be developed. Since the goal is to transform an XRF result to be more “ICP-like,” the XRF results will be the independent variable (the x-axis) and the paired ICP results will be the dependent variable (the y-axis).
- The effectiveness of the adjustment equation will be evaluated by repeating the hypothesis test with the ICP and adjusted XRF data. If adjustment was successful, those two data sets should not show a statistical difference at the 95% confidence level. If the ICP and adjusted-XRF data sets show a statistical difference, assistance from a professional statistician will be sought to determine the reason for this unexpected behavior.

Describe the procedures used to assess overall measurement error associated with the project:

Overall measurement error will be assessed by measuring the amount of sampling error attributable to soil heterogeneity by periodically (1 per 20 DUs) taking three independent replicate (triplicate) samples at certain DUs.

- It is critical that these field replicates be independent, which means that they are collected as three separate, but identical increment collections. The only difference is the increment layout, which must cover the same area, but be offset so that two increments do not fall on the exact same spot.
- Ideally, the increments from each of the three field replicates will evenly cover the DU.
- Each sample must have the same number of increments, and to the extent possible, the same increment mass.
- Overall measurement error is calculated as the %RSD for the three replicate field samples.

Identify the personnel responsible for performing the usability assessment:

Craig Walker (PWT) with assistance from Dr. Rob Tisdale, (TtEMI), Steve Dyment (EPA ORD Region 8), and CDPHE personnel.

QAPP WORKSHEET #38
Inspection/Acceptance for Supplies and Consumables Table

Item	Supply Source	Rental/Purchase	Quantity [1]	Storage Requirements
Ziplock type quart Freezer bags (for samples)	Uline or local super market	P	700	Store in dry conditions
Ziplock type gallon Freezer bags (for ice)	Uline or local super market	P	500	Store in dry conditions
Nitrile Gloves	grainger.com	P	30	None
Spray Bottle	homedepot.com	P	4	None
Decon brush	homedepot.com	P	4	None
Shipping Coolers	Walmart	P	10	None
Decon sprayer	grainger.com	P	2	None
Decon 5 gallon bucket	homedepot.com	P	5	None
Alconox- 1 gallon container	grainger.com	P	3	Store in dry conditions
Paper towels	homedepot.com	P	10	Store in dry conditions
Deionized water - 5 gallon container	Test America	P	10	Do not allow to freeze
Measuring Wheel	grainger.com	P	1	None
Engineering tape	grainger.com	P	2	None
Slide Hammer Sampling Tool	AMS, Inc	P	24	None
Disposable tips for sampling tool	AMS, Inc	P	100	None
Stainless Hand Trowel	homedepot.com	P	4	None
Stainless Steel Bowls and Spoons	grainger.com	P	4	None
Munsell Color chart	PWT	NA	1	Protected from moisture and weather
Blank Sample Labels	PWT	P	Batch	None
Utility knife	homedepot.com	P	2	None
1 L HDPE cylinder-round bottles (for rinsate blanks)	ESS	P	40	Protected from moisture and weather
High Volume Small Surface Sampler (HVSS)	PWT	P	1	Protected from moisture and weather
HVSS Attic Sampling attachment	PWT	P	1	Protected from moisture and weather
Digital scale to weigh dust samples	grainger.com	P	1	Protected from moisture and weather
Stopwatch	grainger.com	P	2	Protected from moisture and weather
Measuring tapes	homedepot.com	P	2	Protected from moisture and weather

Item	Supply Source	Rental/Purchase	Quantity [1]	Storage Requirements
Masking tape or sampling templates	homedepot.com	P	4 templates or 30 rolls of tape	Protected from moisture and weather
Manila envelopes for leak test	PWT	P	300	Protected from moisture and weather
Thermometer	grainger.com	P	2	Protected from moisture and weather
Brush for cleaning	grainger.com	P	2	Protected from moisture and weather
Screwdriver	PWT	P	2	Protected from moisture and weather
250 ml LDPE bottles (for dust samples)	Thermo Scientific	P	1200	Protected from moisture and weather
Digital Camara	PWT	NA	1 per sampling crew	Protected from moisture and weather
Field Forms	PWT	NA	one set per property sampled	Protected from moisture and weather
Logbook	grainger.com	P	10	Protected from moisture and weather
Indelible Pens	grainger.com	P	50	None
Trash bags (plastic sheeting)	homedepot.com	P	100	None

[1] All quantities listed herein are estimates. Actual quantities will be appropriate to sampling event