QUALITY ASSURANCE PROJECT PLAN (QAPP) FOR THE FORMER SATRALLOY SITE JEFFERSON COUNTY, OHIO

PLAN

Submitted To: Ohio Environmental Protection Agency
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1.0 PROJECT DESCRIPTION

This document is the Quality Assurance Project Plan (QAPP) for the Former Satralloy Site located in Cross Creek Township, Jefferson County, Ohio (the Site).

1.1 Background

The Site consists of approximately 333 acres of land and includes an abandoned ferrochromium alloy processing plant. The Site is located on County Road 74 in Cross Creek Township, Jefferson County, Ohio. Portions of the Site are bordered on the west, south, and east by Cross Creek, a perennial stream which discharges into the Ohio River.

Former processing facilities consisted primarily of two production mills (“Mill Buildings”), baghouses adjacent to the two Mill Buildings (for air pollution control during operation), ancillary support buildings, concrete bins used for unloading rail cars, an office building, a laboratory, a water supply plant, and a wastewater treatment plant. The alloys produced in the Mill Buildings were made from chromium ores by smelting and refining in electric-arc furnaces. Four furnaces and two converters were housed in the Mill Buildings. In addition to these structures in the “Plant Area,” piping used for disposing of by-products from the processing operations is present from the Mill Buildings to areas located in the upland areas north of the Mill Buildings. By-products were either pumped as slurry through this piping or were hauled in trucks to the “Ridge Top Area” and “Former Mine Area” of the uplands.

Byproducts of the ferroalloy plant operations included slag and baghouse dust from the electric arc furnaces. Baghouse dust from the electric arc furnaces is present beneath the baghouses and may be present in and around the Mill Buildings. An estimated 800,000 cubic yards of slag has been deposited across large tracts of both the upland and lowland areas of the Site. The upland area west of the Mill Buildings also includes a 5-acre area where chromite ore was stockpiled (Chromite Ore Storage Area) as part of the U.S. Government’s strategic mineral stockpile program.

Prior to the development of the Site in 1958, the predominant activities at the Site were agricultural in the lowlands adjacent to Cross Creek, and open cut and underground coal mining in the uplands. The remaining portions of the Site were heavily wooded and remain so to this day. In addition to the above activities, oil and gas drilling and exploration activities were also conducted at various locations across the Site and surrounding area. At least 23 oil and gas wells were bored on the Site, predominantly in the northern portion to the west of the town of Kolmont.

1.2 Scope and Objectives

This QAPP addresses activities associated with investigation and monitoring of soil, surface water, groundwater, sediment, biota, and other materials during the Remedial Investigation and Feasibility Study (RI/FS) and interim actions for the Site. The structure and contents of this QAPP are in compliance with the requirements of the Task 2, Section B of the Ohio Environmental Protection Agency (OEPA) *Generic Statement of Work – Remedial Investigation/ Feasibility Study – State Version* (OEPA 1998) and *EPA Requirements for Quality Assurance Project Plans,* EPA QA/R-5 (USEPA 2001). The QAPP is developed for use in conjunction with the *Remedial Investigation/Feasibility Study Workplan for the Former Satralloy Site* (Golder 2012).

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

2.1 Project Responsibilities and Assignments

Primary project responsibilities and assignments are as follows:

Ohio EPA Site Coordinator: Michael Sherron (740) 380-5251

The OEPA Site Coordinator will provide project oversight.

Cyprus Amax Project Manager: Ms. Barbara Nielsen, (602) 366-8270

The Cyprus Amax Project Manager has ultimate responsibility for project performance.

Golder Project Manager: Lee Holder, Golder Associates Inc., (425) 883-0777

The Golder Project Manager for the RI/FS coordinates the planning and implementation of the RI/FS Workplan action items, cost estimates, and scheduling. Golder's Project Manager is also responsible for executing decisions on field change requests.

Project QA Manager / Lead Analytical Chemist: Tom Stapp, Golder Associates Inc.

The Project QA Manager is responsible for preparation, update, and control of this QAPP and all supporting procedures. The Lead Analytical Chemist will be involved in project team activities for collection and handling of samples and coordination with analytical laboratories, data management and validation of data.

Biological Analysis QA Manager: Anne Thatcher, BBL / Arcadis

The Biological Analysis QA Manager is responsible for oversight and quality control of biological investigations and analyses. She will be involved in project team activities for collection and handling of biological samples and coordination with laboratories for biological analyses.

2.2 Field Personnel

Field personnel engaged in the collection of samples, the preparation of samples for field testing, and collection of field measurements will be required to have skills commensurate to standard procedures for acquisition of environmental quality samples. Field personnel will adhere to the requirements of Golder technical procedures, or other procedures authorized by the project manager or the Field Sampling Plan.

2.3 Laboratories

Chemical analyses will be performed by qualified commercial laboratories practiced in application of analytical methodologies from U.S. Environmental Protection Agency (USEPA) method manuals, Standard Methods for the Examination of Water and Wastewater, and other standard methods as applicable to the project needs (Methods anticipated are listed in Tables 1 through 12). The laboratory will have established procedures for applying these methods to soils, sediments, waste water, drinking water or other matrices as applicable to project needs. This will include standard operating procedures (SOPs), a Quality Assurance / Quality Control (QA/QC) Manual, participation in a national or regional accreditation program exhibiting compliance with performance evaluation standards, and established formats for data deliverables.

Although not a requirement for sites not in the Voluntary Action Program (VAP), a laboratory certified under the Ohio VAP will be used when practical. The laboratory often used to date for the Site has been the Test America laboratory in North Canton, Ohio. This laboratory is certified under Ohio VAP, and also under the National Environmental Laboratory Accreditation Program (NELAC).

3.0 SAMPLING PROCEDURES

Detailed, Site-specific sampling plans and procedures are specified in the RI/FS Workplan. Sampling for supplemental investigations may be added in other Site workplans. These workplans will specify sample locations, and analytical suites, sample handling procedures, and shipping methods. This section provides general QA/QC measures that will be used for sampling at the Site. Golder quality and technical procedures selected to support the RI/FS Workplan activities are listed in the Field Sampling Plan.

3.1 Chain of Custody

Formal chain of custody will be implemented as standard procedure to record sample sets, collection date/ times, and applicable analytical methodology. Chain-of-custody forms will be completed for each shipment of samples to a laboratory. The analyses requested for each sample will be identified by USEPA or Standard Methods method number citation on the chain-of-custody forms. Shipping documents and ‘sample condition on receipt’ forms will be maintained by the laboratory for each shipment of samples and included to the laboratory final report.

3.2 Surface Water Collection

Sample containers, container preparation services, preservatives, equipment trip blanks, temperature blank, and sample coolers will be provided by the analytical laboratory. Total and dissolved metal loss from aqueous samples due to adsorption on storage containers will be avoided by using polyethylene or similar containers and acidifying the solution to the proper pH. Sample container type, volume requirements, and preservation requirements are listed by analytical category in Table 15.

Each sample will be sealed and labeled with a unique location identification, along with analytical method, and date, and submitted to the analytical laboratory. Field quality control samples will be collected and analyzed as specified in Section 7.

3.3 Groundwater Collection

Groundwater collection will be performed as specified in the applicable workplan. Well water sampling procedures will be performed to ensure protection of reporting limit requirements listed in Tables 1, 2 and 4 through 6. All samples will be handled in conformance with the applicable procedures specified in this QAPP. Sample container type, volume requirements, and preservation requirements are also listed by analytical category in Table 15.

3.4 Hexavalent Chromium in Water

Hexavalent chromium (Cr^{+6}) may be reduced to trivalent chromium (Cr^{+3}) on some filtering media, particularly at low concentrations, and under acidic conditions. Teflon filters and alkaline solution are most suitable to prevent this reduction. Table 15 provides guidance on sample handling and preservation of water samples in the field for eventual Cr^{+6} testing.

3.5 Surface and Subsurface Soil Collection

Soil collection may include area wide characterizations of near surface and deeper soils, test pile soils, slag pile soils, bag-house accumulations, and over-bank soils and sediments in area water bodies. Soils and in-stream sediments will be collected as specified in the RI/FS Workplan. Analytical procedures will be performed to meet reporting limits as specified in Tables 7, 8, and 10 through 12. Samples that are to be analyzed in the field using x-ray fluorescence (XRF) will be handled and processed using standard procedures, and as cited in EPA Method 6200. Soil sampling procedures will be performed to ensure adherence to the required detection limits. Confirmation samples for the XRF field testing, if employed, will be selected at a frequency of at least 5% for chemical analysis by a qualified laboratory.

3.6 Biological Sampling

Any biological field sampling will be conducted under the supervision of an OEPA approved biologist. Biocriteria sampling may involve macroinvertebrate surveys, fish community surveys, and/or a qualitative habitat assessment. Sampling and analysis protocols are listed in *OEPA Biological Criteria for the Protection of Aquatic Life*, Volumes 1 and 2 (OEPA 1988) and Volume 3 (OEPA 1989), and *The Qualitative Habitat Evaluation Index* (OEPA 1989).

Macroinvertebrate survey samples will be collected using methods such as artificial substrates, sweep net, and grab samplers. The samples will be preserved in the field and sent to a qualified laboratory for sorting and taxonomic identification to the lowest practical taxonomic level (typically genus/species). Ten percent of the samples will be checked for representative invertebrate removal from the sediment/benthic matrix (must be >95% correct) and counting and identification (must be >95% Similarity Index correct). Fish community surveys will be conducted following OEPA protocols using electrofishing gear. Fish will be identified and counted in the field, and voucher specimens will be collected as necessary and/or photographs will be taken for later verification as needed. Aquatic habitat assessments will be conducted by visual observation following OEPA protocols.

3.7 Procedure Change Control

Variations from established technical procedure requirements may be necessary in response to unforeseen field conditions or other unique circumstances. All such variations will be documented on a Field Change Request (Appendix A), including a description of and justification for the change. The FCR will be approved by the Cyprus Amax and Golder Project Managers. All subcontractors will be subject to this directive when associated with sample locating, frequency of sample collection, sample handling and storage, or laboratory method. The Golder Project Manager may authorize field personnel to initiate changes immediately, provided the FCR is submitted for formal approval within one working day of its initiation.

4.0 CALIBRATION PROCEDURES

4.1 Field Calibration Requirements

Calibration of all measuring and test equipment used for the RI/FS will be controlled as required by manufacturers' instruction documentation. Rental equipment will require certifications or other documentation demonstrating acceptable calibration status for the period of use applicable to the project. Field calibration requirements will be in compliance with the manufacturer's instructions issued with the equipment and per the requirements listed in Table 17. Documentation of standard response for each instrument will be recorded on a daily basis in the field sample notebook. At a minimum, each field instrument will have a documented initial calibration record. Also, continuing calibration checks will be applied at least as often as once before the sampling and monitoring period and once after. Standards associated with all calibration procedures will be traceable to National Institute of Standards (NIST) quality, or other appropriate standard as provided by the rental supplier or instrument manufacturer.

4.2 Laboratory Calibration Requirements

Calibration of analytical laboratory equipment will be in accordance with the laboratory's internal procedures, which are subject to approval by Golder. The Quality Assurance document provided by the current contract laboratory will be made available to Golder before analyses will be performed, to assure proper QA/QC requirements are applied to analytical methods requested. These QA/QC specifications are at least as stringent as USEPA's *Contract Laboratory Program National Functional Guidelines for Superfund Inorganic Data Review*, (USEPA, 2010a) and USEPA's *Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review*, (USEPA 2008). However, surrogate recovery, matrix spike/ matrix spike duplicate recovery, laboratory control sample recovery, and relative percent difference (RPD) specific control limits will be as applied by the contracted laboratory, as long as the laboratory can demonstrate that annual or more frequent studies are performed on the instruments involved in sample analysis for the purpose of establishing appropriate control limits for the measurement. Therefore, calibration checks will be monitored and held to the standard applied during the data validation task.

General chemistry parameters are not strictly subject to Data Validation Functional Guidelines, however acceptance criteria are subject to standard QA/QC specifications. These criteria and others are in substantial agreement with QC criteria applied to inorganic metal analysis, as found in the National Functional Guidelines, and the discretion of the data validator will be applied when reviewing general chemistry parameters and in recognizing qualified data.

5.0 ANALYTICAL PROCEDURES

The test methods employed by the laboratory are associated standard methods and are subject to interpretation by the laboratory through standard operating procedures (SOPs), or method recommendations. Substantial changes to analytical methods and extraction procedures will be identified by the laboratory before being applied to a new sample batch, and communicated in writing to the Golder QA manager. The change must be approved by the Golder Project Manager.

Laboratory standard operating procedures (SOP) are maintained by the commercial laboratories at their headquarter offices and are available for review upon request.

5.1 Analytical Methods

Parameters in soils and water will be analyzed using analytical methods as defined in Test Methods for Evaluating Solid Waste (USEPA 2007a), Methods for Chemical Analysis of Water and Waste (USEPA 1983), and Standard Methods for the Examination of Water and Wastewater, (SM 2007). Soil and sediment field monitoring actions may include use of X-Ray Fluorescence (XRF) using guidelines from USEPA Method 6200 (USEPA 2007b).

Screening levels are presented in Table 13 for water and Table 14 for soil. Laboratory detection limit capabilities for water are compared to USEPA Regional Screening Level (RSLs; USEPA 2012), Ohio VAP Rule #8 Generic Numeric Standards, and Ohio EPA Division of Surface Water Quality Standards. Laboratory detection limit capabilities for soil are compared to the RSLs, Ohio VAP residential soil direct contact, and the Ohio Division of Emergency & Remedial Response Sites (Non-VAP).

Asbestos testing of building components will employ USEPA Method 600/R-93/116 Polarized Light Microscopy (PLM) for bulk samples, possibly including the USEPA Point Count method. Periodic ambient air sampling will employ NIOSH Method 7402 which uses transmission electron microscopy (TEM) analysis for asbestos clearance testing of ambient air (see Table 9).

Biological testing will use sampling and testing methods from the OEPA Biological Criteria for the Protection of Aquatic Life, Volumes 1 and 2 (OEPA 1988) and Volume 3 (OEPA 1989), and The Qualitative Habitat Evaluation Index (OEPA 1989).

5.2 Field Testing

Water monitoring actions will include field analysis as necessary for field parameters pH, conductivity, oxidation-reduction, dissolved oxygen, turbidity and temperature. Quality control procedures for selected field testing parameters are provided in Table 17. RI/FS Workplan field testing for soil constituents will include the use, as necessary, of a portable X-Ray Fluorescent device to generate immediate screening data of selected metal elements. Other screening tools for targeted soil and water impacts, including colorimetric ‘kits’ may be employed as information is gained on the Site, however the selection of the screening tool will be determined at a later date.

5.3 Analytical Parameters

Potential analytes include those on the USEPA’s Target Compound List (TCL) for organics (SOM01.2; USEPA 2007c), and Target Analyte List (TAL) for metals (SOM01.2; USEPA 2010b), and general chemistry parameters. Summary lists of analytes associated with these references are provided in Tables 1 through 12. The actual analyses to be performed will be specified in the RI/FS Workplan (Golder 2012) and any subsequent workplans. Not all of the analytical methods or parameters listed in this QAPP will be used during the RI/FS.

5.4 Analytical Data Quality

An objective of the field sampling activities is to provide analytical data that is of known and defensible quality. Analytical data quality objectives are described as follows:

- Precision: Analytical precision will be reported as required by the governing analytical method cited in the tables in this QAPP.
- Accuracy (Bias): Accuracy will be reported as required by the governing analytical method cited in the tables in this QAPP.
- Representativeness: Goals for sample representativeness are addressed in the applicable workplans with collection of sample materials appropriate for the investigation. In addition, the use of standard procedures for sample acquisition (see Section 3) will facilitate the collection of representative data.
- Completeness: Completeness is defined as the percentage of valid analytical determinations with respect to the total number of requested determinations in a given sample delivery group. The completeness goal is 90%.
- Comparability: Approved analytical procedures will require the consistent use of the reporting techniques and units specified by the analytical methods cited in Tables 1 through 12 in order to facilitate the comparability of data sets from sequential sampling rounds in terms of their precision and accuracy. Sample split analyses performed at an alternate laboratory to exhibit confirmatory results will be performed on an ‘as needed’ basis.
- Detection Limits (Reporting Limits): Goals for detection limits will be those provided by normal commercial environmental laboratories.

Tables 1 through 12 list analytical parameters and associated analytical method(s), laboratory minimum reporting limits (RLs), and precision and accuracy requirements. The RLs in these tables are those provided by the Test America laboratory in North Canton, Ohio.

It is desirable that detection limits be below the established cleanup levels or remediation goals for a site. However, Site-specific remediation goals have not yet been established for the Site. For reference, the detection limits in this QAPP are compared to selected screening levels in Tables 13 and 14. Quality control criteria for each target compound list and target analyte list parameters are provided in Tables 18 through 21.

6.0 DATA REDUCTION AND VALIDATION

6.1 Minimum Requirements for Laboratory Analytical Data Packages

All analytical data packages submitted by the analytical laboratory will include the following:

- "Sample condition on receipt" forms, copies of completed chain of custody documentation noting dates of sample receipt and shipping documentation, including identification of field sampling personnel and shipping personnel (or organization).
- Hard copy completed laboratory reports with summary receipt information, per sample analytical data with consistent units and reporting limits, identified analytical methods, testing dates, associated quality control batch identifier with run dates, and case narrative of special analytical procedures and problems.
- Electronic format (Excel or Access) analytical results for each sample containing the reduced results and reporting limits for all analytes/constituents requested in the chain of custody, request for analysis or purchase order.
- Analytical quality control results and summary documents for laboratory method blanks, duplicates, laboratory control samples, blank spike/blank spike duplicates, matrix spike/matrix spike duplicates, per sample surrogate recoveries, and serial dilutions.
- Summary calibration data for initial and continuing calibration actions performed on the date(s) of analysis, including initial calibration verification (ICV) and continuing calibration verification (CCV) check recoveries bracketing the period of analysis of all samples (inorganic, organic analyses, and general chemistry), ICP interference check standards (metals), balance checks (gravimetric analyses), and secondary check standards.
- Sample extraction and preparation data and methodology including dates of sample extraction and analysis.

All data packages for all analytical parameters will be reviewed and approved by the analytical laboratory's QA Officer prior to submittal for validation.

Data packages will include, as appropriate, data qualification codes applied to each individual analytical result deemed to have a detection limit anomaly, or quality control deficiency. The laboratory will summarize qualification code definitions within the laboratory report for each type of qualification applied.

6.2 General Data Validation Requirements

Data will be validated by Golder personnel, based on the applicable elements of the U.S. EPA *Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (USEPA 2010a), USEPA Contract Laboratory Program, *National Functional Guidelines for Superfund Organic Methods Data Review* (USEPA 2008), and other applicable reference method requirements as appropriate. Data validation work will be performed in order to ensure that the laboratory has met all contractual requirements, all applicable reference method requirements, and has met the data quality objectives for the project (see Section 5.4). A sample delivery group may be interpreted as a single hard copy deliverable provided by the laboratory or, all samples listed on a chain of custody and associated with a single hard copy deliverable.

Data validation will include the evaluation of holding times, method validity, laboratory blanks, field blanks, duplicates, matrix spikes/matrix spike duplicates, laboratory control samples, calibration data (as applicable for the specified method), and any re-qualification of analytical results required as a result of the validation exercise.

The data validator will document all contacts made with the laboratory to resolve questions related to the data package. Validated data will be documented on a validation checklist by the validator, with a summary list of qualifications applied to the sample delivery group or individual sample results as appropriate. In some cases, data validation will be reviewed from forms generated with Automated Data Review (ADR) software that has been used in place of hand generated checklists. The final review, by the Quality Assurance manager will be applied to either the hand generated checklists or the ADR forms, with the end result being the appropriate application of data qualifiers to the sample delivery group or individual sample results as required. The validation checklist, laboratory contact documentation, copies of the laboratory sample concentration reports, and the as-reviewed laboratory data package will be routed to the data management specialist for entry to the project specific database. The validation checklist will also be routed to the Quality Assurance manager and the Golder Project Manager as necessary.

7.0 QUALITY CONTROL PROCEDURES

7.1 Water

Aqueous analytical samples will be subject to quality control measures in both the field and laboratory. The following minimum field quality control requirements apply to all water analyses.

- Field duplicate samples. Depending on the availability of sufficient sample quantities, field duplicates will be collected at a minimum of one duplicate for each period of sampling activity or one duplicate sample for each twenty field samples collected, whichever is more frequent. A ‘sampling activity period’ will be identified as one or more field personnel engaged in a specific time of sample collection when one method of sampling is used. Duplicate samples will be retrieved from the same sampling location using the same equipment and sampling technique, and will be placed into identically prepared and preserved containers. All field duplicates will be analyzed independently as an indication of gross errors in sampling techniques.
- Equipment blanks. Equipment blanks will consist of deionized distilled water washed through decontaminated non-dedicated sampling equipment and placed in containers identical to those used for actual field samples. Equipment blanks are used to verify the adequacy of non-dedicated sampling equipment decontamination procedures, and will be collected and analyzed at the same frequency as field duplicate samples, if non-dedicated sampling equipment is used.
- Trip blanks. Trip blanks consist of deionized distilled water added to a like container as those provided for typical samples. Preservative will be added from the same preservative ‘lot number’ to the containers when the trip blank is created in the laboratory clean room and will accompany a batch of samples shipped during a sampling activity or period. Trip blanks will be returned unopened to the laboratory, and are prepared as a check on possible contamination originating from container preparation methods, shipment, handling, storage, or Site conditions.

Appropriate documentation of the field quality control sample will be maintained in the field log, and identified by the assigned sample identification. The laboratory will provide internal quality control checks that meet the following minimum requirements:

- Matrix spike and matrix spike duplicate samples. Matrix spike and matrix spike duplicate samples require the addition of a known quantity of a representative analyte of interest to the sample as a measure of recovery percentage. Sufficient sample will be collected for a select sample location to be available for each sample delivery group (as determined in the field). Replicate samples are separate aliquots removed from the same sample container in the laboratory. Spike compound selection, quantities, and concentrations will be described in the laboratories analytical procedures. One sample will be spiked per analytical batch, or once every 20 samples, whichever is greater and will be represented as a unique field sample to the analytical laboratory.
- Laboratory quality control standard reference material (SRM). A quality control reference standard will be prepared from an independently acquired standard material at a concentration other than that used for calibration, but within the calibration range. The quality control SRM is analyzed after the initial calibration and before any samples are analyzed, and will be run with every analytical batch, or every 20 samples, whichever is greater. SRM are required as an independent check on analytical technique and methodology.

7.2 Soil and Sediments

The following quality control elements apply to soils and sediments submitted for laboratory chemical analysis:

- Field duplicate samples. Field duplicates will be collected at a minimum of one duplicate for each homogeneous soil type for each period of sampling activity or one duplicate sample for each twenty field samples collected, whichever is more frequent. A homogeneous soil type may have distinct characteristics that make it different from other samples and therefore would present a unique analytical data response. A ‘sampling activity period’ will be identified as one or more field personnel engaged in a specific time of sample collection when one method of sampling is used. Duplicate samples will be retrieved from the same sampling location using the same equipment and sampling technique, and will be placed into identically prepared and preserved containers. All field duplicates will be analyzed independently as an indication of soil matrix in-homogeneity or gross errors in sampling techniques.
- Equipment blanks. Equipment blanks will consist of pure deionized distilled water washed through decontaminated non-dedicated sampling equipment used to collect soils, and placed into an appropriate container for water rinsate analysis. Equipment blanks are used to verify the adequacy of non-dedicated sampling equipment decontamination procedures, and will be collected and analyzed at the same frequency as field duplicate samples, if non-dedicated sampling equipment is used.

The laboratory will provide internal quality control checks that meet the following minimum requirements:

- Matrix spike and matrix spike duplicate samples. Matrix spike and matrix spike duplicate samples require the addition of a known quantity of a representative analyte of interest to the sample as a measure of recovery percentage. Sufficient sample will be collected for a select sample location to be available for each sample delivery group (as determined in the field). Replicate samples are separate aliquots removed from the same sample container in the laboratory. Spike compound selection, quantities, and concentrations will be described in the laboratories analytical procedures. One sample will be spiked per analytical batch, or once every 20 samples, whichever is greater and will be represented as a unique field sample to the analytical laboratory.
- Laboratory quality control standard reference material (SRM). A quality control reference standard will be prepared from an independently acquired standard material at a concentration other than that used for calibration, but within the calibration range. The quality control SRM is analyzed after the initial calibration and before any samples are analyzed, and will be run with every analytical batch, or every 20 samples, whichever is greater. SRM are required as an independent check on analytical technique and methodology.

7.3 XRF Analysis

Solids analyzed in the field by X-Ray Fluorescence (XRF) have specific quality control criteria for sample processing techniques as well as analytical technique. Prior to project sample collection and field testing, a number of soil matrices will be selected to represent typical Site soils to determine the range of matrix types that exhibit interference potential in the Site soils. These soils will be analyzed at a qualified laboratory to create Site-specific calibration samples (SSCS). The SSCS will be used throughout the testing period to maintain precision and accuracy data for the project. XRF soil and sediment field monitoring actions will be done using guidelines from USEPA Method 6200 (USEPA 2007b), and Golder Technical Procedure TP-2.2-13; *X-Ray Fluorescence Onsite Measurement* (Appendix B). A summary of guidelines for instrument QC procedures is provided in Table 22.

Specific sample handling requirements will be specified in the applicable Field Sampling Plan. At least 5 of XRF samples collected after the SCSS will be selected at random for chemical analysis at a qualified commercial laboratory at the end of the sampling event for analytical confirmation.

8.0 REFERENCES

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TABLES

TABLE 1

LABORATORY ANALYTICAL SPECIFICS / INORGANIC METAL ANALYTES / WATER

Parameter	CAS Number	Method	Detection Reporting Limit	Method	Detection Reporting Limit	Precision	Accuracy
		Reference	(µg/L)	Reference	(µg/L)	RPD	% Recov.
Aluminum	7429-90-5	EPA 200.7	200	EPA 200.8	--	<20%	75-125%
Antimony	7440-36-0	EPA 200.7	60	EPA 200.8	2	<20%	75-125%
Arsenic	7440-38-2	EPA 200.7	10	EPA 200.8	1	<20%	75-125%
Barium	7440-39-3	EPA 200.7	200	EPA 200.8	10	<20%	75-125%
Beryllium	7440-41-7	EPA 200.7	5	EPA 200.8	1	<20%	75-125%
Cadmium	7440-43-9	EPA 200.7	5	EPA 200.8	1	<20%	75-125%
Calcium	7440-70-2	EPA 200.7	5000	--	--	<20%	75-125%
Chromium, Total	7440-47-3	EPA 200.7	10	EPA 200.8	2	<20%	75-125%
Chromium $^{6+}$	18540-29-9	EPA 7196A	20	SM 3500 Cr. D.		<20%	80-120%
Cobalt	7440-48-4	EPA 200.7	50	EPA 200.8	1	<20%	75-125%
Copper	7440-50-8	EPA 200.7	25	EPA 200.8	2	<20%	75-125%
Iron	7439-89-6	EPA 200.7	100	--	--	<20%	75-125%
Lead	7439-92-1	EPA 200.7	10	EPA 200.8	1	<20%	75-125%
Magnesium	7439-95-4	EPA 200.7	5000	--	--	<20%	75-125%
Manganese	7439-96-5	EPA 200.7	15	EPA 200.8	1	<20%	75-125%
Mercury	7439-97-6	EPA 245.1	0.2	--	--	<20%	75-125%
Nickel	7440-02-0	EPA 200.7	40	EPA 200.8	1	<20%	75-125%
Potassium	9/7/7440	EPA 200.7	5000	--	--	<20%	75-125%
Selenium	7782-49-2	EPA 200.7	35	EPA 200.8	5	<20%	75-125%
Silver	7440-22-4	EPA 200.7	10	EPA 200.8	1	<20%	75-125%
Sodium	7440-23-5	EPA 200.7	5000	--	--	<20%	75-125%
Thallium	7440-28-0	EPA 200.7	25	EPA 200.8	1	<20%	75-125%
Vanadium	7440-62-2	EPA 200.7	50	EPA 200.8	1	<20%	75-125%
Zinc	7440-66-6	EPA 200.7	60	EPA 200.8	2	<20%	75-125%
Cyanide	57-12-5	SM 4500CN	10	--	--	<20%	75-125%

TABLE 2
LABORATORY ANALYTICAL SPECIFICS / GENERAL CHEMISTRY PARAMETERS / WATER

Parameter	Matrix	Method Reference	Detection Reporting Limit	Precision RPD	Accuracy % Recov.
Alkalinity	SW,GW	EPA 310.1	5 mg/l	<20%	90-127%
Ammonia	SW,GW	EPA 350.3	0.2 mg/l	<20%	85-114%
Bicarbonate	SW,GW	SM 2320	5 mg/l	<20%	80-120%
Carbonate	SW,GW	SM 2320	5 mg/l	<20%	80-120%
Hydroxide	SW,GW	SM 2320	5 mg/l	<20%	90-127%
Hardness	SW,GW	EPA 6010, by Calculation	33 mg/l as CaCO3	<20%	NA
Nitrate/Nitrite as N	SW,GW	EPA 353.2	0.1 mg/l	<20%	90-110%
Nitrate	SW,GW	EPA 300.0	0.1 mg/l	<20%	90-110%
Nitrite	SW,GW	EPA 300.0	0.1 mg/l	<20%	90-110%
Phosphate	SW,GW	SM 4500P	0.1 mg/l	<20%	89-115%
Phosphorus (Total)	SW,GW	EPA 365.1	0.1 mg/l	<20%	89-115%
Fluoride	SW,GW	EPA 300.0	1 mg/l	<20%	90-110%
Chlorine	SW,GW	EPA 330.5	0.2 mg/l	<20%	75-125%
Chloride	SW,GW	EPA 300.0	1 mg/l	<20%	90-110%
Sulfate	SW,GW	EPA 300.0	1 mg/l	<20%	90-110%
COD	SW,GW	EPA 410.4	10 mg/l	<20%	90-110%
TOC	SW,GW	EPA 415.1	1 mg/l	<20%	88-115%
Sulfide	SW,GW	EPA 376.1	1 mg/l	<20%	79-104%
TDS	SW,GW	SM 2540 C	10 mg/l	<20%	88-110%
TSS	SW,GW	SM 2540 D	4 mg/l	<10%	73-113%

TABLE 3
LABORATORY ANALYTICAL SPECIFICS / FIELD DATA PARAMETERS / WATER

Parameter	Matrix	Method Reference	Detection Reporting Limit	Precision RPD	Accuracy % Recov.
pH	SW, GW	EPA 150.1	NA	<20%	± 0.1 pH
Temperature	SW, GW	EPA 170.1	NA	<20%	±0.5 deg C
Specific Conductance	SW, GW	EPA 120.1	NA	<20%	±10 mmhos/cm
Turbidity	SW, GW	EPA 180.1	NA	<20%	±1.0 NTU
Dissolved Oxygen	SW, GW	EPA 360.1	NA	<20%	±0.1 mg/l
Water Level	GW	--	--	--	--
Flow Rate	SW	USGS	NA	NA	±5%

TABLE 4
LABORATORY ANALYTICAL SPECIFICS / TARGET COMPOUND LIST VOLATILE ORGANICS / WATER

Parameter	CAS Number	Method Reference	Detection Reporting Limit Low Water (mg/L)	Precision RPD	Accuracy % Recov.
1,1,1-Trichloroethane	71-55-6	EPA 8260B	0.001	0% - 30%	74%-118
1,1,2,2-Tetrachloroethane	79-34-5	EPA 8260B	0.001	0% - 30%	68%-118%
1,1,2-Trichloro,1,2,2-trifluoroethane	76-13-1	EPA 8260B	0.001	0% - 30%	74%-151%
1,1,2-Trichloroethane	79-00-5	EPA 8260B	0.001	0% - 30%	80%-112%
1,1,2-Trichloroethene (1,1,2-Trichloroethylene, Trichloroethene)	79-01-6	EPA 8260B	0.001	0% - 30%	76%-117%
1,1-Dichloroethane	75-34-3	EPA 8260B	0.001	0% - 30%	82%-115%
1,1-Dichloroethene	75-35-4	EPA 8260B	0.001	0% - 30%	78%-131%
1,2,3-Trichlorobenzene	87-61-6	EPA 8260B	0.001	0% - 30%	54%-126%
1,2,4-Trichlorobenzene	120-82-1	EPA 8260B	0.001	0% - 30%	48%-135%
1,2-Dibromo-3-chloropropane	96-12-8	EPA 8260B	0.002	0% - 30%	42%-136%
1,2-Dibromoethane, (EDB)	106-93-4	EPA 8260B	0.001	0% - 30%	79%-113%
1,2-Dichlorobenzene	95-50-1	EPA 8260B	0.001	0% - 30%	81%-110%
1,2-Dichloroethane, (EDC)	107-06-2	EPA 8260B	0.001	0% - 30%	71%-127%
1,2-Dichloropropane	78-87-5	EPA 8260B	0.001	0% - 30%	81%-115%
1,3-Dichlorobenzene	541-73-1	EPA 8260B	0.001	0% - 30%	80%-110%
1,4-Dichlorobenzene	106-46-7	EPA 8260B	0.001	0% - 30%	82%-110%
1,4-Dioxane[a]	123-91-1	EPA 8260B	0.2	0% - 50%	50%-150%
2-Hexanone	591-78-6	EPA 8260B	0.01	0% - 30%	55%-133%
4-Methyl-2-pentanone, (methyl isobutyl ketone)	108-10-1	EPA 8260B	0.01	0% - 30%	63%-128%
Acetone	67-64-1	EPA 8260B	0.01	0% - 30%	43%-136%
Benzene	71-43-2	EPA 8260B	0.001	0% - 30%	83%-112%
Bromochloromethane	74-97-5	EPA 8260B	0.001	0% - 30%	77%-120%
Bromodichloromethane	75-27-4	EPA 8260B	0.001	0% - 30%	72%-121%
Bromoform, (tribromomethane)	75-25-2	EPA 8260B	0.001	0% - 30%	40%-131%

TABLE 4 (continued)
LABORATORY ANALYTICAL SPECIFICS / TARGET COMPOUND LIST
VOLATILE ORGANICS / WATER

Parameter	CAS Number	Method	Detection Reporting Limit Low Water (mg/L)	Precision RPD	Accuracy % Recov.
Bromomethane, (methylbromide)	74-83-9	EPA 8260B	0.001	0% - 30%	11%-185%
Carbon disulfide	75-15-0	EPA 8260B	0.001	0% - 30%	62%-142%
Carbon tetrachloride	56-23-5	EPA 8260B	0.001	0% - 30%	66%-128%
Chlorobenzene	108-90-7	EPA 8260B	0.001	0% - 30%	85%-110%
Chloroethane, (ethyl chloride)	75-00-3	EPA 8260B	0.001	0% - 30%	25%-153%
Chloroform	67-66-3	EPA 8260B	0.001	0% - 30%	79%-117%
Chloromethane, (methylchloride)	74-87-3	EPA 8260B	0.001	0% - 30%	44%-126%
cis-1,2-Dichloroethene	156-59-2	EPA 8260B	0.001	0% - 30%	80%-113%
cis-1,3-Dichloropropene	10061-01-5	EPA 8260B	0.001	0% - 30%	61%-115%
Cyclohexane	110-82-7	EPA 8260B	0.001	0% - 30%	54%-121%
Dibromochloromethane	124-48-1	EPA 8260B	0.001	0% - 30%	64%-119%
Dichlorodifluoromethane	75-71-8	EPA 8260B	0.001	0% - 30%	19%-129%
Ethylbenzene	100-41-4	EPA 8260B	0.001	0% - 30%	83%-112%
Isopropylbenzene	98-82-8	EPA 8260B	0.001	0% - 30%	75%-114%
Methyl acetate	79-20-9	EPA 8260B	0.01	0% - 30%	58%-131%
Methyl cyclohexane	108-87-2	EPA 8260B	0.001	0% - 30%	56%-127%
Methyl ethyl ketone, (2-butanone)	78-93-3	EPA 8260B	0.01	0% - 30%	60%-126%
Methyl tert butyl ether (MTBE)	1634-04-4	EPA 8260B	0.005	0% - 30%	52%-144%
Methylene chloride, (dichloromethane)	75-09-2	EPA 8260B	0.001	0% - 30%	66%-131%
Styrene	100-42-5	EPA 8260B	0.001	0% - 30%	79%-114%
Tetrachloroethylene, (tetrachloroethene), (PCE)	127-18-4	EPA 8260B	0.001	0% - 30%	79%-114%
Toluene	108-88-3	EPA 8260B	0.001	0% - 30%	84%-111%
trans-1,2-Dichloroethylene, (1,2-dichloroethene)	156-60-5	EPA 8260B	0.001	0% - 30%	83%-117%
trans-1,3-Dichloropropene	10061-02-6	EPA 8260B	0.001	0% - 30%	58%-117%
Trichlorofluoromethane	75-69-4	EPA 8260B	0.001	0% - 30%	49%-157%
Vinyl chloride	75-01-4	EPA 8260B	0.001	0% - 30%	53%-127%
Xylene(m-Xylene & p-Xylene)	1330-20-7	EPA 8260B	0.002	0% - 30%	83%-113%
Xylene(o-Xylene)	1330-20-7	EPA 8260B	0.001	0% - 30%	83%-113%

Note: a. Selected compound acceptance ranges are not provided by the laboratory, but are cited from National Functional Guideline (USEPA, 2008) validation criteria.

TABLE 5
LABORATORY ANALYTICAL SPECIFICS / TARGET COMPOUND LIST
SEMI-VOLATILE ORGANICS / WATER

Parameter	CAS Number	Method Reference	Detection Reporting Limit Low Water (mg/L)	Precision RPD	Accuracy % Recovery
1,1'-biphenyl	92-52-4	EPA 8270C	0.01	0% - 30%	50%-130%
1,2,4,5-tetrachlorobenzene[a]	95-94-3	EPA 8270C	0.01	0% - 50%	75%-125%
2,2'-oxybis (1-chloropropane)	108-60-1	EPA 8270C	0.01	0% - 30%	25%-128%
2,3,4,6-tetrachlorophenol[a]	58-90-2	EPA 8270C	0.05	0% - 50%	75%-125%
2,4,5-Trichlorophenol	95-95-4	EPA 8270C	0.01	0% - 30%	39%-110%
2,4,6-Trichlorophenol	88-06-2	EPA 8270C	0.01	0% - 30%	35%-110%
2,4,Dinitrophenol	51-28-5	EPA 8270C	0.05	0% - 30%	17%-112%
2,4-Dichlorophenol	120-83-2	EPA 8270C	0.01	0% - 30%	33%-110%
2,4-Dimethylphenol	105-67-9	EPA 8270C	0.01	0% - 30%	12%-110%
2,4-Dinitrotoluene	121-14-2	EPA 8270C	0.01	0% - 30%	52%-123%
2,6-Dinitrotoluene	606-20-2	EPA 8270C	0.01	0% - 30%	52%-119%
2-Chloronaphthalene, (beta-chloronaphthalene)	91-58-7	EPA 8270C	0.01	0% - 30%	39%-110%
2-Chlorophenol	95-57-8	EPA 8270C	0.01	0% - 30%	27%-110%
2-Methylnaphthalene	91-57-6	EPA 8270C	0.01	0% - 30%	35%-110%
2-Methylphenol, (o-Cresol)	95-48-7	EPA 8270C	0.01	0% - 30%	30%-110%
2-Nitroaniline	88-74-4	EPA 8270C	0.05	0% - 30%	43%-130%
2-Nitrophenol	88-75-5	EPA 8270C	0.01	0% - 30%	29%-110%
3,3'-Dichlorobenzidine	91-94-1	EPA 8270C	0.05	0% - 30%	19%-110%
3-Nitroaniline	99-09-2	EPA 8270C	0.05	0% - 30%	45%-116%
4,6-Dinitro-o-cresol,(4,6-Dinitro-2-methylphenol)	534-52-1	EPA 8270C	0.05	0% - 30%	28%-112%
4-Bromophenyl phenyl ether	101-55-3	EPA 8270C	0.01	0% - 30%	51%-114%
4-Chloroaniline	106-47-8	EPA 8270C	0.01	0% - 30%	10%-110%
4-Chlorophenyl phenyl ether	7005-72-3	EPA 8270C	0.01	0% - 30%	50%-115%
4-Methylphenol, (p-Cresol)	106-44-5	EPA 8270C	0.01	0% - 30%	32%-110%
4-Nitroaniline	100-01-6	EPA 8270C	0.05	0% - 30%	45%-120%
4-Nitrophenol	100-02-7	EPA 8270C	0.05	0% - 30%	12%-130%
Acenaphthene	83-32-9	EPA 8270C	0.01	0% - 30%	40%-110%
Acenaphthylene	208-96-8	EPA 8270C	0.01	0% - 30%	43%-110%
Acetophenone	98-86-2	EPA 8270C	0.01	0% - 30%	50%-130%
Anthracene	120-12-7	EPA 8270C	0.01	0% - 30%	54%-114%
Atrazine	1912-24-9	EPA 8270C	0.01	0% - 30%	50%-130%
Benzaldehyde	100-52-7	EPA 8270C	0.01	0% - 30%	10%-130%
Benzo(a)anthracene	56-55-3	EPA 8270C	0.01	0% - 30%	55%-115%

TABLE 5 (continued)
LABORATORY ANALYTICAL SPECIFICS / TARGET COMPOUND LIST
SEMI-VOLATILE ORGANICS / WATER

Parameter	CAS Number	Method Reference	Detection Reporting Limit Low Water	Precision RPD	Accuracy % Recovery
Benzo(a)pyrene	50-32-8	EPA 8270C	0.01	0% - 30%	43%-116%
Benzo(b)fluoranthene	205-99-2	EPA 8270C	0.01	0% - 30%	43%-122%
Benzo(g,h,i)perylene	191-24-2	EPA 8270C	0.01	0% - 30%	45%-120%
Benzo(k)fluoranthene	207-08-9	EPA 8270C	0.01	0% - 30%	43%-124%
bis(2-chloroethoxy)methane	111-91-1	EPA 8270C	0.01	0% - 30%	39%-110%
bis(2-chloroethyl)ether	111-44-4	EPA 8270C	0.01	0% - 30%	34%-113%
bis(2-ethylhexyl)phthalate, (DEHP)	117-81-7	EPA 8270C	0.01	0% - 30%	36%-163%
Butyl benzyl phthalate	85-68-7	EPA 8270C	0.01	0% - 30%	53%-126%
Caprolactam	105-60-2	EPA 8270C	0.01	0% - 30%	50%-130%
Carbazole	86-74-8	EPA 8270C	0.01	0% - 30%	53%-120%
Chrysene	218-01-9	EPA 8270C	0.01	0% - 30%	55%-115%
Dibenz[a,h]anthracene	53-70-3	EPA 8270C	0.01	0% - 30%	46%-122%
Dibenzofuran	132-64-9	EPA 8270C	0.01	0% - 30%	46%-111%
Diethyl phthalate	84-66-2	EPA 8270C	0.01	0% - 30%	33%-134%
Dimethyl phthalate	131-11-3	EPA 8270C	0.01	0% - 30%	15%-143%
Di-n-butyl phthalate	84-74-2	EPA 8270C	0.01	0% - 30%	55%-122%
Di-n-octylphthalate	117-84-0	EPA 8270C	0.01	0% - 30%	44%-128%
Fluoranthene	206-44-0	EPA 8270C	0.01	0% - 30%	54%-122%
Fluorene	86-73-7	EPA 8270C	0.01	0% - 30%	47%-112%
Hexachlorobenzene	118-74-1	EPA 8270C	0.01	0% - 30%	51%-112%
Hexachlorobutadiene	87-68-3	EPA 8270C	0.01	0% - 30%	13%-110%
Hexachlorocyclopentadiene	77-47-4	EPA 8270C	0.05	0% - 30%	10%-110%
Hexachloroethane	67-72-1	EPA 8270C	0.01	0% - 30%	12%-110%
Indeno[1,2,3-cd]pyrene	193-39-5	EPA 8270C	0.01	0% - 30%	46%-121%
Isophorone	78-59-1	EPA 8270C	0.01	0% - 30%	44%-128%
Naphthalene	91-20-3	EPA 8270C	0.01	0% - 30%	31%-110%
Nitrobenzene	98-95-3	EPA 8270C	0.01	0% - 30%	37%-115%
N-Nitrosodi-n-propylamine	621-64-7	EPA 8270C	0.01	0% - 30%	37%-121%
N-Nitrosodiphenylamine	86-30-6	EPA 8270C	0.01	0% - 30%	53%-113%
p-Chloro-m-cresol, (4-chloro-3-methyl phenol)	59-50-7	EPA 8270C	0.01	0% - 30%	39%-110%
Pentachlorophenol	87-86-5	EPA 8270C	0.01	0% - 30%	26%-110%
Phenanthrene	85-01-8	EPA 8270C	0.01	0% - 30%	52%-114%
Phenol	108-95-2	EPA 8270C	0.01	0% - 30%	14%-112%
Pyrene	129-00-0	EPA 8270C	0.01	0% - 30%	55%-120%

TABLE 6
LABORATORY ANALYTICAL SPECIFICS / TARGET COMPOUND LIST PESTICIDE / PCBs / WATER

Parameter	CAS Number	Method Reference	Detection Reporting Limit Water (ug/L)	Precision RPD	Accuracy % Recov.
4,4'-DDD	72-54-8	EPA 8081A	0.05	0% - 30%	53%-168%
4,4'-DDE	72-55-9	EPA 8081A	0.05	0% - 30%	66%-136%
4,4'-DDT	50-29-3	EPA 8081A	0.05	0% - 30%	42%-140%
Aldrin	309-00-2	EPA 8081A	0.05	0% - 30%	61%-127%
Alpha chlordane	57-74-9	EPA 8081A	0.05	0% - 30%	60%-134%
Alpha-BHC	319-84-6	EPA 8081A	0.05	0% - 30%	65%-132%
beta-BHC	319-85-7	EPA 8081A	0.05	0% - 30%	59%-134%
Delta-BHC	319-86-8	EPA 8081A	0.05	0% - 30%	45%-143%
Dieldrin	60-57-1	EPA 8081A	0.05	0% - 30%	61%-142%
Endosulfan I	959-98-8	EPA 8081A	0.05	0% - 30%	35%-110%
Endosulfan II	33213-65-9	EPA 8081A	0.05	0% - 30%	39%-110%
Endosulfan sulfate	1031-07-8	EPA 8081A	0.05	0% - 30%	54%-143%
Endrin	72-20-8	EPA 8081A	0.05	0% - 30%	57%-148%
Endrin aldehyde	7421-93-4	EPA 8081A	0.05	0% - 30%	44%-116%
gamma chlordane	57-74-9	EPA 8081A	0.05	0% - 30%	59%-139%
gamma-BHC, (lindane)	58-89-9	EPA 8081A	0.05	0% - 30%	58%-140%
Heptachlor	76-44-8	EPA 8081A	0.05	0% - 30%	60%-132%
Heptachlor epoxide	1024-57-3	EPA 8081A	0.05	0% - 30%	60%-138%
Methoxychlor	72-43-5	EPA 8081A	0.1	0% - 30%	45%-139%
Toxaphene[a]	8001-35-2	EPA 8081A	2	0% - 50%	75% - 125%
Endrin ketone	7421-93-4	EPA 8081A	0.05	0% - 30%	52%-135%
Aroclor 1016	12674-11-2	EPA 8082	1	0% - 30%	44%-119%
Aroclor 1221[a]	11104-28-2	EPA 8082	1	0% - 50%	75% - 125%
Aroclor 1232[a]	11141-16-5	EPA 8082	1	0% - 50%	75% - 125%
Aroclor 1242[a]	53469-21-9	EPA 8082	1	0% - 50%	75% - 125%
Aroclor 1248[a]	12672-29-6	EPA 8082	1	0% - 50%	75% - 125%
Aroclor 1254[a]	11097-69-1	EPA 8082	1	0% - 50%	75% - 125%
Aroclor 1260	11096-82-5	EPA 8082	1	0% - 30%	41%-118%
Aroclor 1262[a]	--	EPA 8082	1	0% - 50%	75% - 125%
Aroclor 1268[a]	--	EPA 8082	1	0% - 50%	75% - 125%

TABLE 7
LABORATORY ANALYTICAL SPECIFICS / INORGANIC METAL ANALYTES / SOLIDS

Parameter	CAS Number	Method Reference	Detection Reporting Limit / SOLIDS mg/kg	Precision RPD	Accuracy % Recov.
Aluminum	7429-90-5	EPA 6010 B	20	<20%	80-120%
Antimony	7440-36-0	EPA 6010 B	6	<20%	80-120%
Arsenic	7440-38-2	EPA 6010 B	1[a]	<20%	80-120%
Arsenic, by XRF	7440-38-2	EPA 6200	100	<35%	75-125%
Barium	7440-39-3	EPA 6010 B	20	<20%	80-120%
Beryllium	7440-41-7	EPA 6010 B	0.5	<20%	80-120%
Cadmium	7440-43-9	EPA 6010 B	0.5	<20%	80-120%
Calcium	7440-70-2	EPA 6010 B	500	<20%	80-120%
Chromium, Total	7440-47-3	EPA 6010 B	1	<20%	80-120%
Chromium, by XRF	7440-47-3	EPA 6200	100	<35%	75-125%
Chromium $^{6+}$	18540-29-9	EPA 7199	0.05	<20%	80-120%
Chromium $^{6+}$	18540-29-9	EPA 7196A	0.8	<20%	80-120%
Cobalt	7440-48-4	EPA 6010 B	5	<20%	80-120%
Copper	7440-50-8	EPA 6010 B	2.5	<20%	73-137%
Iron	7439-89-6	EPA 6010 B	10	<20%	80-120%
Lead	7439-92-1	EPA 6010 B	1[a]	<20%	80-120%
Magnesium	7439-95-4	EPA 6010 B	500	<20%	80-120%
Manganese	7439-96-5	EPA 6010 B	1.5	<20%	73-121%
Mercury	7439-97-6	EPA 7471 B	0.1	<20%	80-120%
Nickel	7440-02-0	EPA 6010 B	4	<20%	80-120%
Potassium	9/7/7440	EPA 6010 B	500	<20%	80-120%
Selenium	7782-49-2	EPA 6010 B	0.5[a]	<20%	80-120%
Silver	7440-22-4	EPA 6010 B	1	<20%	80-120%
Sodium	7440-23-5	EPA 6010 B	500	<20%	80-120%
Thallium	7440-28-0	EPA 6010 B	1[a]	<20%	80-120%
Vanadium	7440-62-2	EPA 6010 B	5	<20%	80-120%
Zinc	7440-66-6	EPA 6010 B	2	<20%	68-123%
Cyanide	57-12-5	EPA 9012	0.5	<20%	80-120%

Notes: a - Trace analytical method.

TABLE 8
LABORATORY ANALYTICAL SPECIFICS DETAIL FOR SLAG / GENERAL CHEMISTRY PARAMETERS / SOLIDS

Parameter	Matrix	Method Reference	Detection Reporting Limit SOLIDS mg/kg	Precision RPD	Accuracy % Recov.
Carbonate	Slag	SM 2320	100 mg/kg	<20%	80-120%
Phosphate	Slag	SM 4500P	10 mg/kg	<20%	75-125%
Sulfate	Slag	EPA 300.0	10 mg/kg	<20%	90-110%
Total Sulfur	Slag	ASTM / LECO	10 mg/kg	<20%	75-125%
XRD Minerology	Slag	ASTM	- -	NA	NA

Note - Detection limit assumes 1:1 digestion/ extraction of slag using appropriate method.

TABLE 9
LABORATORY ANALYTICAL SPECIFICS / SUPPLEMENTAL TARGET ANALYTES / SOLIDS

Parameter	CAS Number	Method Reference	Matrix	Reporting Limit & Units SOLIDS	Precision RPD	Accuracy % Recov.	Notes
Asbestos	1332-21-4	OSHA (NIOSH Method #7402)	Ambient Air	AIR – 8hr. TWA 0.2 fiber/cm^3	At least 100 fibers counted	NA	Polarized Light Microscopy followed by TEM
As by XRF	7440-38-2	EPA 6200	Soil	100 mg/kg	35%	75–125%	Field portable X-Ray Fluorescence
Ba by XRF	18540-29-9	EPA 6200	Soil	200 mg/kg	35%	75–125%	Field portable X-Ray Fluorescence
Cd by XRF	18540-29-9	EPA 6200	Soil	50 mg/kg	35%	75–125%	Field portable X-Ray Fluorescence
Cr by XRF	18540-29-9	EPA 6200	Soil	200 mg/kg	35%	75–125%	Field portable X-Ray Fluorescence
Pb by XRF	18540-29-9	EPA 6200	Soil	10 mg/kg	35%	75–125%	Field portable X-Ray Fluorescence
Hg by XRF	18540-29-9	EPA 6200	Soil	20 mg/kg	35%	75–125%	Field portable X-Ray Fluorescence
Se by XRF	18540-29-9	EPA 6200	Soil	20 mg/kg	35%	75–125%	Field portable X-Ray Fluorescence
Ag by XRF	18540-29-9	EPA 6200	Soil	200 mg/kg	35%	75–125%	Field portable X-Ray Fluorescence
Chromium VI	18540-29-9	EPA 7198	Water	10 ug/L	10%	75–125%	Field portable Differential Pulse Polarography

Note: Selected methods may be applied as specified in the governing sampling plan.

TABLE 10
LABORATORY ANALYTICAL SPECIFICS / TARGET COMPOUND LIST VOLATILE ORGANICS / SOLIDS

Parameter	CAS Number	Method Reference	Detection Reporting Limit SOLIDS ug/kg[a]	Precision RPD	Accuracy % Recov.
1,1,1-Trichloroethane	71-55-6	EPA 8260B	5	0% - 30%	77%-126%
1,1,2,2-Tetrachloroethane	79-34-5	EPA 8260B	5	0% - 30%	77%-123%
1,1,2-Trichloro,1,2,2-trifluoroethane	76-13-1	EPA 8260B	5	0% - 30%	82%-138%
1,1,2-Trichloroethane	79-00-5	EPA 8260B	5	0% - 30%	83%-112%
1,1,2-Trichloroethene (1,1,2-Trichloroethylene, Trichloroethene)	79-01-6	EPA 8260B	5	0% - 30%	79%-113%
1,1-Dichloroethane	75-34-3	EPA 8260B	5	0% - 30%	76%-115%
1,1-Dichloroethene	75-35-4	EPA 8260B	5	0% - 30%	75%-135%
1,2,3-Trichlorobenzene	120-82-1	EPA 8260B	5	0% - 30%	61%-121%
1,2,4-Trichlorobenzene	120-82-1	EPA 8260B	5	0% - 30%	64%-124%
1,2-Dibromo-3-chloropropane	96-12-8	EPA 8260B	10	0% - 30%	61%-132%
1,2-Dibromoethane, (EDB)	106-93-4	EPA 8260B	5	0% - 30%	83%-117%
1,2-Dichlorobenzene	95-50-1	EPA 8260B	5	0% - 30%	76%-110%
1,2-Dichloroethane, (EDC)	107-06-2	EPA 8260B	5	0% - 30%	72%-120%
1,2-Dichloropropane	78-87-5	EPA 8260B	5	0% - 30%	87%-113%
1,3-Dichlorobenzene	541-73-1	EPA 8260B	5	0% - 30%	78%-111%
1,4-Dichlorobenzene	106-46-7	EPA 8260B	5	0% - 30%	75%-110%
1,4-Dioxane[b]	123-91-1	EPA 8260B	250	0% - 50%	50% - 150%
2-Hexanone	591-78-6	EPA 8260B	20	0% - 30%	64%-136%
4-Methyl-2-pentanone, (methyl isobutyl ketone)	108-10-1	EPA 8260B	20	0% - 30%	67%-135%
Acetone	67-64-1	EPA 8260B	20	0% - 30%	41%-137%
Benzene	71-43-2	EPA 8260B	5	0% - 30%	79%-112%
Bromochloromethane	74-97-5	EPA 8260B	5	0% - 30%	79%-111%
Bromodichloromethane	75-27-4	EPA 8260B	5	0% - 30%	84%-122%
Bromoform, (tribromomethane)	75-25-2	EPA 8260B	5	0% - 30%	62%-133%
Bromomethane, (methylbromide)	74-83-9	EPA 8260B	5	0% - 30%	42%-136%
Carbon disulfide	75-15-0	EPA 8260B	5	0% - 30%	62%-146%
Carbon tetrachloride	56-23-5	EPA 8260B	5	0% - 30%	71%-129%
Chlorobenzene	108-90-7	EPA 8260B	5	0% - 30%	78%-110%
Chloroethane, (ethyl chloride)	75-00-3	EPA 8260B	5	0% - 30%	58%-117%
Chloroform	67-66-3	EPA 8260B	5	0% - 30%	77%-114%
Chloromethane, (methylchloride)	74-87-3	EPA 8260B	5	0% - 30%	50%-110%
cis-1,2-Dichloroethene	156-59-2	EPA 8260B	5	0% - 30%	76%-113%

TABLE 10 (continued)
LABORATORY ANALYTICAL SPECIFICS / TARGET COMPOUND LIST VOLATILE ORGANICS / SOLIDS

Parameter	CAS Number	Method	Detection Reporting Limit Solids ug/kg[a]	Precision	Accuracy
cis-1,3-Dichloropropene	10061-01-5	EPA 8260B	5	0% - 30%	74%-128%
Cyclohexane	110-82-7	EPA 8260B	10	0% - 30%	66%-110%
Dibromochloromethane	124-48-1	EPA 8260B	5	0% - 30%	72%-127%
Dichlorodifluoromethane	75-71-8	EPA 8260B	5	0% - 30%	26%-113%
Ethylbenzene	100-41-4	EPA 8260B	5	0% - 30%	79%-117%
Isopropylbenzene	98-82-8	EPA 8260B	5	0% - 30%	76%-122%
Methyl cyclohexane	108-87-2	EPA 8260B	10	0% - 30%	70%-126%
Methyl ethyl ketone, (2-butanone)	78-93-3	EPA 8260B	20	0% - 30%	52%-131%
Methyl tert butyl ether (MTBE)	1634-04-4	EPA 8260B	20	0% - 30%	49%-165%
Methyl acetate	79-20-9	EPA 8260B	10	0% - 30%	57%-130%
Methylene chloride, (dichloromethane)	75-09-2	EPA 8260B	5	0% - 30%	75$-118%
Styrene	100-42-5	EPA 8260B	5	0% - 30%	87%-117%
Tetrachloroethylene, (tetrachloroethene), (PCE)	127-18-4	EPA 8260B	5	0% - 30%	79%-114%
Toluene	108-88-3	EPA 8260B	5	0% - 30%	75%-111%
trans-1,2-Dichloroethylene, (1,2-dichloroethene)	156-60-5	EPA 8260B	5	0% - 30%	78%-117%
trans-1,3-Dichloropropene	10061-02-6	EPA 8260B	5	0% - 30%	73%-131%
Trichlorofluoromethane	75-69-4	EPA 8260B	5	0% - 30%	57%-146%
Vinyl chloride	75-01-4	EPA 8260B	5	0% - 30%	57%-114%
Xylene(m-Xylene & p-Xylene)	1330-20-7	EPA 8260B	10	0% - 30%	80%-117%
Xylene(o-Xylene)	1330-20-7	EPA 8260B	5	0% - 30%	80%-120%

Notes:
Low level extraction of soils requires ‘volatile organic analysis’ (VOA) vials, in triplicate.

TABLE 11
LABORATORY ANALYTICAL SPECIFICS / TARGET COMPOUND LIST
SEMI-VOLATILE ORGANICS / SOLIDS

Parameter	CAS Number	Method Reference	Detection Reporting Limit Solids ug/kg	Precision RPD	Accuracy % Recov.
1,1'-biphenyl	92-52-4	EPA 8270C	330	0% - 30%	50%-130%
1,2,4,5-tetrachlorobenzene[a]	95-94-3	EPA 8270C	330	0% - 50%	50%-150%
2,2'-oxybis (1-chloropropane)	108-60-1	EPA 8270C	330	0% - 30%	36%-116%
2,3,4,6-tetrachlorophenol[a]	58-90-2	EPA 8270C	330	0% - 50%	50%-150%
2,4,5-Trichlorophenol	95-95-4	EPA 8270C	330	0% - 30%	42%-110%
2,4,6-Trichlorophenol	88-06-2	EPA 8270C	330	0% - 30%	37%-110%
2,4,Dinitrophenol	51-28-5	EPA 8270C	330	0% - 30%	10%-110%
2,4-Dichlorophenol	120-83-2	EPA 8270C	330	0% - 30%	40%-110%
2,4-Dimethylphenol	105-67-9	EPA 8270C	330	0% - 30%	28%-110%
2,4-Dinitrotoluene	121-14-2	EPA 8270C	330	0% - 30%	56%-116%
2,6-Dinitrotoluene	606-20-2	EPA 8270C	330	0% - 30%	54%-115%
2-Chloronaphthalene, (beta-chloronaphthalene)	91-58-7	EPA 8270C	330	0% - 30%	46%-110%
2-Chlorophenol	95-57-8	EPA 8270C	330	0% - 30%	39%-110%
2-Methylnaphthalene	91-57-6	EPA 8270C	330	0% - 30%	46%-110%
2-Methylphenol, (o-Cresol)	95-48-7	EPA 8270C	330	0% - 30%	36%-110%
2-Nitroaniline	88-74-4	EPA 8270C	1600	0% - 30%	47%-124%
2-Nitrophenol	88-75-5	EPA 8270C	330	0% - 30%	35%-110%
3,3'-Dichlorobenzidine	91-94-1	EPA 8270C	1600	0% - 30%	31%-110%
3-Nitroaniline	99-09-2	EPA 8270C	1600	0% - 30%	44%-110%
4,6-Dinitro-o-cresol,(4,6-Dinitro-2-methylphenol)	534-52-1	EPA 8270C	1600	0% - 30%	21%-110%
4-Bromophenyl phenyl ether	101-55-3	EPA 8270C	330	0% - 30%	53%-112%
4-Chloroaniline	106-47-8	EPA 8270C	330	0% - 30%	25%-110%
4-Chlorophenyl phenyl ether	7005-72-3	EPA 8270C	330	0% - 30%	53%-110%
4-Methylphenol, (p-Cresol)	106-44-5	EPA 8270C	330	0% - 30%	40%-110%
4-Nitroaniline	100-01-6	EPA 8270C	1600	0% - 30%	50%-110%
4-Nitrophenol	100-02-7	EPA 8270C	1600	0% - 30%	24%-117%
Acenaphthene	83-32-9	EPA 8270C	330	0% - 30%	46%-110%
Acenaphthylene	208-96-8	EPA 8270C	330	0% - 30%	47%-110%
Acetophenone	98-86-2	EPA 8270C	330	0% - 30%	50%-130%
Anthracene	120-12-7	EPA 8270C	330	0% - 30%	56%-111%
Atrazine	1912-24-9	EPA 8270C	330	0% - 30%	50%-130%
Benzaldehyde	100-52-7	EPA 8270C	330	0% - 30%	10%-130%
Benzo(a)anthracene	56-55-3	EPA 8270C	330	0% - 30%	58%-111%
Benzo(a)pyrene	50-32-8	EPA 8270C	330	0% - 30%	44%-115%
Benzo(b)fluoranthene	205-99-2	EPA 8270C	330	0% - 30%	43%-124%
Benzo(g,h,i)perylene	191-24-2	EPA 8270C	330	0% - 30%	44%-120%

TABLE 11 (continued)
LABORATORY ANALYTICAL SPECIFICS / TARGET COMPOUND LIST
SEMI-VOLATILE ORGANICS / SOLIDS

Parameter	CAS Number	Method Reference	Detection Reporting Limit Solids ug/kg	Precision RPD	Accuracy % Recov.
Benzo(k)fluoranthene	207-08-9	EPA 8270C	330	0% - 30%	38%-122%
bis(2-chloroethoxy)methane	111-91-1	EPA 8270C	330	0% - 30%	42%-110%
bis(2-chloroethyl)ether	111-44-4	EPA 8270C	330	0% - 30%	41%-110%
bis(2-ethylhexyl)phthalate, (DEHP)	117-81-7	EPA 8270C	330	0% - 30%	56%-123%
Butyl benzyl phthalate	85-68-7	EPA 8270C	330	0% - 30%	57%-121%
Caprolactam	105-60-2	EPA 8270C	330	0% - 30%	50%-130%
Carbazole	86-74-8	EPA 8270C	330	0% - 30%	56%-115%
Chrysene	218-01-9	EPA 8270C	330	0% - 30%	56%-111%
Dibenz[a,h]anthracene	53-70-3	EPA 8270C	330	0% - 30%	45%-122%
Dibenzofuran	132-64-9	EPA 8270C	330	0% - 30%	50%-110%
Diethyl phthalate	84-66-2	EPA 8270C	330	0% - 30%	55%-114%
Dimethyl phthalate	131-11-3	EPA 8270C	330	0% - 30%	54%-112%
Di-n-butyl phthalate	84-74-2	EPA 8270C	330	0% - 30%	57%-119%
Di-n-octylphthalate	117-84-0	EPA 8270C	330	0% - 30%	45%-123%
Fluoranthene	206-44-0	EPA 8270C	330	0% - 30%	55%-118%
Fluorene	86-73-7	EPA 8270C	330	0% - 30%	51%-110%
Hexachlorobenzene	118-74-1	EPA 8270C	330	0% - 30%	51%-110%
Hexachlorobutadiene	87-68-3	EPA 8270C	330	0% - 30%	39%-110%
Hexachlorocyclopentadiene	77-47-4	EPA 8270C	1600	0% - 30%	10%-110%
Hexachloroethane	67-72-1	EPA 8270C	330	0% - 30%	38%-110%
Indeno[1,2,3-cd]pyrene	193-39-5	EPA 8270C	330	0% - 30%	45%-121%
Isophorone	78-59-1	EPA 8270C	330	0% - 30%	46%-117%
Naphthalene	91-20-3	EPA 8270C	330	0% - 30%	42%-110%
Nitrobenzene	98-95-3	EPA 8270C	330	0% - 30%	40%-110%
N-Nitrosodi-n-propylamine	621-64-7	EPA 8270C	330	0% - 30%	40%-114%
N-Nitrosodiphenylamine	86-30-6	EPA 8270C	330	0% - 30%	54%-112%
p-Chloro-m-cresol, (4-chloro-3-methyl phenol)	59-50-7	EPA 8270C	330	0% - 30%	42%-110%
Pentachlorophenol	87-86-5	EPA 8270C	330	0% - 30%	10%-110%
Phenanthrene	85-01-8	EPA 8270C	330	0% - 30%	54%-110%
Phenol	108-95-2	EPA 8270C	330	0% - 30%	39%-110%
Pyrene	129-00-0	EPA 8270C	330	0% - 30%	58%-113%

TABLE 12
LABORATORY ANALYTICAL SPECIFICS / TARGET COMPOUND LIST PESTICIDE / PCBs / SOLIDS

Parameter	CAS Number	Method Reference	Detection Reporting Limit Solids ug/kg	Precision RPD	Accuracy % Recov.
4,4'-DDD	72-54-8	EPA 8081A	1.7	0%-30%	64%-141%
4,4'-DDE	72-55-9	EPA 8081A	1.7	0%-30%	49%-141%
4,4'-DDT	50-29-3	EPA 8081A	1.7	0%-30%	35%-143%
Aldrin	309-00-2	EPA 8081A	1.7	0%-30%	39%-144%
Alpha chlordane	57-74-9	EPA 8081A	1.7	0%-30%	42%-138%
Alpha-BHC	319-84-6	EPA 8081A	1.7	0%-30%	41%-147%
beta-BHC	319-85-7	EPA 8081A	1.7	0%-30%	44%-140%
Delta-BHC	319-86-8	EPA 8081A	1.7	0%-30%	48%-148%
Dieldrin	60-57-1	EPA 8081A	1.7	0%-30%	52%-141%
Endosulfan I	959-98-8	EPA 8081A	1.7	0%-30%	18%-110%
Endosulfan II	33213-65-9	EPA 8081A	1.7	0%-30%	22%-113%
Endosulfan sulfate	1031-07-8	EPA 8081A	1.7	0%-30%	61%-1325
Endrin	72-20-8	EPA 8081A	1.7	0%-30%	44%-143%
Endrin aldehyde	7421-93-4	EPA 8081A	1.7	0%-30%	34%-120%
gamma chlordane	57-74-9	EPA 8081A	1.7	0%-30%	48%-140%
gamma-BHC, (lindane)	58-89-9	EPA 8081A	1.7	0%-30%	44%-140%
Heptachlor	76-44-8	EPA 8081A	1.7	0%-30%	43%-132%
Heptachlor epoxide	1024-57-3	EPA 8081A	1.7	0%-30%	49%-140%
Methoxychlor	72-43-5	EPA 8081A	3.3	0%-30%	38%-143%
Toxaphene[a]	8001-35-2	EPA 8081A	67	0%-50%	50%-150%
Endrin ketone	7421-93-4	EPA 8081A	1.7	0%-30%	44%-135%
Aroclor 1016	12674-11-2	EPA 8082	33	0% - 30%	34%-127%
Aroclor 1221[a]	11104-28-2	EPA 8082	33	0%-50%	50%-150%
Aroclor 1232 [a]	11141-16-5	EPA 8082	33	0%-50%	50%-150%
Aroclor 1242 [a]	53469-21-9	EPA 8082	33	0%-50%	50%-150%
Aroclor 1248 [a]	12672-29-6	EPA 8082	33	0%-50%	50%-150%
Aroclor 1254 [a]	11097-69-1	EPA 8082	33	0%-50%	50%-150%
Aroclor 1260	11096-82-5	EPA 8082	33	0% - 30%	32%-141%
Aroclor 1262 [a]	--	EPA 8082	33	0%-50%	50%-150%
Aroclor 1268 [a]	--	EPA 8082	33	0%-50%	50%-150%

Note: a – Selected compound acceptance ranges are not provided by the laboratory, but are cited from National Functional Guideline (USEPA, 2008) validation criteria.

TABLE 15
WATER SAMPLE CONTAINER TYPES, VOLUMES, HANDLING, PRESERVATION, AND HOLDING TIMES

Analytes	Container Type	Special Handling	Preservation	Maximum Holding Time
Sulfate Chloride' Alkalinity	1, 500 ml narrow mouth polyethylene bottle.	Fill to neck, (Collect an additional 500 mL aliquot for MS/MSD analysis if required)	None, store at 4°C	14 days for Alkalinity analysis, 28 days for others.
pH, Temperature, Conductivity, Dissolved Oxygen, Turbidity	Field Parameters; Sample is not collected	Field Parameters; Sample is not collected	Field Parameters; Sample is not collected	Field Parameters; Sample is not collected
Dissolved Metals, Mercury	1, 1000 mL narrow mouth polyethylene bottle.	Filter through 0.45 um membrane filter into a preserved bottle, fill to neck	HNO_3, pH < 2, store at 4°C.	6 months 28 day for Hg
Total Metals, Mercury	1, 1000 mL narrow mouth polyethylene bottle.	Fill to neck	HNO_3 to ph <2, store at 4°C	28 day for Hg
Dissolved Cr^{+6}	1, 1000 mL narrow mouth polyethylene bottle.	Filter through 0.45 um Teflon membrane filter into a preserved bottle, Fill to neck	Store at 4°C.	24 hour
Total Cr^{+6}	1, 1000 mL narrow mouth polyethylene bottle.	Fill to neck	Store at 4°C.	24 hour
Volatiles	3, 40 ml glass vials, with Teflon lined septa.	Fill to eliminate all bubbles.	None, store at 4°C, or optionally preserve ph <2, and store at 4°C	7 days for non-preserved, 14 days for preserved.
Semi-volatile	1, 1000 ml amber glass bottle.	Fill to neck.	None, store at 4°C	Extract within 7 days of collection, analyze within 40 days of collection.

TABLE 16
SOIL SAMPLE CONTAINER TYPES, VOLUMES, HANDLING, PRESERVATION, AND HOLDING TIMES

Analytes	Container Type	Special Handling	Preservation	Maximum Holding Time
Total Metals	1, 4 oz. Wide mouth soil jar	Fill completely	None, store in dark at 4°C.	6 months
Total Metals by XRF	1, 8 oz. Plastic zip-lock bag	Ensure finely divided soil, and mix thoroughly	None, store in dark	6 months
Total Mercury	1, 4 oz. Wide mouth soil jar	Fill completely	None, store in dark at 4°C.	28 days
Organic Carbon	1, 4 oz. Wide mouth soil jar	Fill completely	None, store in dark at 4°C.	28 days
Soil pH	1, 4 oz. Wide mouth soil jar	Fill completely	None, store in dark at 4°C.	As soon as practical
Ammonia	1, 4 oz. Wide mouth soil jar	Fill completely	None, store in dark at 4°C.	28 days
Nitrate / Nitrate as N	1, 4 oz. Wide mouth soil jar	Fill completely	None, store in dark at 4°C.	28 days
Volatiles	1, 8 oz. Wide mouth soil jar	Fill completely	None, store in dark at 4°C.	14 days
Semi-volatiles	1, 8 oz. Wide mouth soil jar	Fill completely	None, store in dark at 4°C.	Extract within 7 days of collection, analyze within 40 days of collection.

TABLE 17
QUALITY CONTROL SUMMARY – FIELD PARAMETERS

Parameter	Description
Method References	GAI Technical Procedure 1.2-20, Collection of Groundwater Quality Samples Low Flow (Minimal Drawdown) Groundwater Sampling Procedures (EPA, 1996)
Matrix	Groundwater (well sampling).
Analytes	pH, conductivity, dissolved oxygen, turbidity, and temperature.
Maximum Holding Time	Analyze all field parameters immediately upon collection.
Calibration	At least two reference buffers or standards at a high and low concentration are used to calibrate pH, conductivity. A blank and at least one calibration standard shall be used for turbidity, and dissolved oxygen. Verify calibration prior to sample analysis and at the conclusion of sample analysis. A NIST traceable thermometer shall be used for temperature measurements, no field calibration is required.
Method Blank	A method blank sample is analyzed when required to check calibration.
Equipment Blanks	Analyze equipment blanks as appropriate.
QC Check Standards	Reanalysis of standards following field sample analyses is required. Verification of standards values should be ±10%.
Surrogate	NA
Internal Standard	NA
Duplicate Sample	Duplicate sample analyses are not required, however, repeat analysis of a second sample aliquot is recommended for all parameters and required for groundwater sampling to verify stability of field measurements within 10% for all parameters (0.5 °C for temperature).
Spike Sample	Spike sample analyses are not required.
Sample Collection	Minimize both atmospheric contact and delay on analyses of all field parameters. A closed cell sampling configuration may be used.
Other QC Criteria	The working calibration must be verified before and after field sampling analyses. If the response for any analyte varies from the expected value by more than ±10% (0.5 °C for temperature), the test must be repeated using fresh calibration standards.

TABLE 18
QUALITY CONTROL SUMMARY – METAL ANALYSIS

Parameter	Description
Method Reference	EPA CLP SOW for Inorganic Analyses ILM03.0. EPA 6010 and 6000 series, Test Methods for Evaluating Solid Waste, SW-846. EPA Method 7000B series, Test Methods for Evaluating Solid Waste, SW-846. EPA 200.7 and EPA 200.8, U.S. EPA National Exposure Research Laboratory (NERL)
Matrix	Soils, sediments, groundwater.
Analytes	Metals lists as indicated in Tables 1 and 7, including mercury and Cr^{+6}.
Holding Time	6 Months, (28 days for mercury and Cr^{+6}).
Laboratory Instrument Calibration	ICP: A blank and at least one calibration standard. Hg: A blank and 5 level calibration standards. The low level standards must be analyzed at the method specified concentration at the required frequency.
Laboratory Method Blank	Blank sample is analyzed at each analyte parameter and no analytes should be found in the blank. At least one preparation blank must be prepared for each matrix per 20 field samples or each batch whichever is more frequent. If any analyte concentration in the preparation blank is above the reporting limit, the lowest concentration of that analyte in the associated sample must be 10 times the concentration in the blank.
Laboratory Calibration	Laboratory calibration blanks analyzed at beginning and end of analytical batch and after initial and continuing calibration or every 10 samples or two hours, whichever is more frequent.
Field Blanks	SOIL & GROUNDWATER: The equipment blanks will be scheduled in the SAP.
Laboratory QC Check Standards	ICP and AA initial calibration verified with independent standard %R 90-110. Digest an independent LCS with each sample batch for ICP and AA if available %R 80-120.
Duplicate Sample	SOIL & GROUNDWATER: Field duplicates are scheduled for analysis as presented in Table A-2 of the SAP. Each is prepared as a blind field duplicate. Relative percent differences (RPD) between field duplicates are advisory only; ≤20% for water samples ≤35% for soil samples. (MS/MSD or BS/BSD also checked for RPD if included).
Laboratory Matrix Spike/ Matrix Spike Duplicate Sample	Analyze spiked field sample at frequency of one per twenty samples or each batch, whichever is more frequent for soil and groundwater. MS/MSD analyzed for Hg and AA analytes only. Percent recovery (%R) between 80-120%. Use method of standard additions for AA, and Hg if interference is indicated.
Sample Collection	WATER: 1,000 ml polyethylene bottle acidify with HN03 to pH <2. SOIL: sample in 8 oz. wide mouth polyetheylene or glass cool to 4°C.
Other Laboratory QC Criteria	ICP: Analyze ICS at beginning and at end of run or twice during 8 hour shift, whichever is more frequent. Results ±20% of true value. To verify linearity near the detection limit, analyze standard at 2X the limit and analyze at the beginning and end of the run or twice per 8 hours. Serial dilution analysis performed if concentration is 50X limit, must agree ±10% of the original value. Verify linear ranges quarterly. Results must be within ±5% of true value. All measurements minimum of 2 replicate exposures, report average. AA, Hg: Serial dilution analysis performed if concentration is 25X limit, must agree ±10% of the original value. Method of standard additions required if interference is indicated.

TABLE 19
QUALITY CONTROL SUMMARY – VOLATILES ANALYSIS

Parameter	Description
Method Reference	Chemical Methods for the Analysis of Water and Waste EPA CLP SOW for Organic Analyses OLM04.2. EPA 8260B, Test Methods for Evaluating Solid Waste, SW-846.
Matrix	Soils, sediments, groundwater, and surface water (if necessary).
Analytes	Volatiles list as indicated in Organic SOW and in Tables 4 and 10.
Holding Time	14 days for volatiles in preserved water, 14 days for all volatiles in soil and sediment, from date of sampling.
Calibration	SOIL & GROUNDWATER GC/MS: A blank and at least five calibration standards. Instrument tuning criteria must meet SOW limits.
Method Blank	SOIL & GROUNDWATER: No analytes should be found in the blank. At least one preparation blank must be prepared for each matrix per 20 field samples or each batch whichever is more frequent. If any analyte concentration in the preparation blank is above the reporting limit, the lowest concentration of that analyte in the associated sample must be 10 X the concentration (for common lab contaminants, 5X for others) in the blank.
Other Blanks	SOIL & GROUNDWATER: Equipment blank and trip blank recommended per each batch. Analyze calibration blank at beginning and end of analytical batch and after initial and continuing calibration or every 10 samples or two hours, whichever is more frequent.
QC Check Standards	SOIL & GROUNDWATER: Relative response factors and % difference from initial calibration meet SOW limits.
Surrogate	SOIL & GROUNDWATER: Three surrogates tested in samples, blanks, and other QC samples. Recoveries must meet Lab control or SOW limits.
Internal Standard	SOIL & GROUNDWATER: Three internal standards tested in samples, blanks, and other QC samples. Recoveries must meet -50% and +100% or Lab control limits.
Field Duplicate Sample	SOIL & GROUNDWATER: One per matrix specific and sampling method specific batch, blind field duplicate sample recommended. Relative percent differences (RPD) are advisory only. MS/MSD checked for RPD; ≤20% for water samples ≤35% for soil samples.
Spike Sample	SOIL & GROUNDWATER: Analyze matrix spike/ matrix spike duplicate (MS/MSD) sample at frequency of one per twenty samples or each analytical batch, whichever is more frequent for soil and groundwater. Percent recovery (%R) per established laboratory limits.
Sample Collection	Water 3x 40 mL glass vial, teflon-lined silicon septum cap; Soil sample 8 oz. Wide mouth polyetheylene or glass; Cool to 4°C.
Other QC Criteria	SOIL & GROUNDWATER: Laboratory control sample (LCS) required if MS/MSD recoveries exceed laboratory established limits.

TABLE 20
QUALITY CONTROL SUMMARY – SEMI-VOLATILES ANALYSiS

Parameter	Description
Method Reference	Chemical Methods for the Analysis of Water and Waste EPA CLP SOW for Organic Analyses OLM04.2. EPA 8270C, Test Methods for Evaluating Solid Waste, SW-846.
Matrix	Soils, sediments, groundwater, and surface water (if necessary).
Analytes	Semi-Volatiles list as indicated in Organic SOW and in Tables 5 and 11.
Holding Time	7 days to extraction, 40 days after extraction from date of sampling.
Calibration	SOIL & GROUNDWATER GC/MS: A blank and at least five calibration standards. Instrument tuning criteria must meet SOW limits.
Method Blank	SOIL & GROUNDWATER: No analytes should be found in the blank. At least one preparation blank must be prepared for each matrix per 20 field samples or each batch whichever is more frequent. If any analyte concentration in the preparation blank is above the reporting limit, the lowest concentration of that analyte in the associated sample must be 10 X the concentration (for common lab contaminants, 5X for others) in the blank.
Other Blanks	SOIL & GROUNDWATER: Equipment blank and trip blank recommended per each batch. Analyze calibration blank at beginning and end of analytical batch and after initial and continuing calibration or every 10 samples or two hours, whichever is more frequent.
QC Check Standards	SOIL & GROUNDWATER: Relative response factors and % difference from initial calibration meet SOW limits.
Surrogate	SOIL & GROUNDWATER: Six surrogates tested in samples, blanks, and other QC samples. Recoveries must meet Lab control or SOW limits.
Internal Standard	SOIL & GROUNDWATER: Up to six internal standards tested in samples, blanks, and other QC samples. Recoveries must meet Lab control or SOW limits.
Field Duplicate Sample	SOIL & GROUNDWATER: One per matrix specific and sampling method specific batch, blind field duplicate sample recommended. Relative percent differences (RPD) are advisory only. MS/MSD checked for RPD; ≤20% for water samples ≤35% for soil samples.
Spike Sample	SOIL & GROUNDWATER: Analyze matrix spike/ matrix spike duplicate (MS/MSD) sample at frequency of one per twenty samples or each analytical batch, whichever is more frequent for soil and groundwater. Percent recovery (%R) per established laboratory limits.
Sample Collection	Water 1,000 ml amber glass bottle; Soil sample 8 oz. Wide mouth polyetheylene or glass; Cool to 4°C.
Other QC Criteria	SOIL & GROUNDWATER: Laboratory control sample (LCS) required if MS/MSD recoveries exceed laboratory established limits.

TABLE 21
QUALITY CONTROL SUMMARY – PESTICIDE/ PCB ANALYSIS

Parameter	Description
Method Reference	Chemical Methods for the Analysis of Water and Waste EPA CLP SOW for Multi-Media, Multi-Concentration Organic Analyses SOM01.2. EPA 8081B/ 8082A, Test Methods for Evaluating Solid Waste, SW-846.
Matrix	Soils, sediments, groundwater, and surface water (if necessary).
Analytes	Pesticide/ PCBs list as indicated in Organic SOW and in Tables 6 and 12.
Holding Time	7 days to extraction, 40 days after extraction from date of sampling.
Calibration	SOIL & GROUNDWATER GC/MS: Calibration check standard relative response factor must be within 20% of the initial calibration. Calibration standards used with internal or external procedures depending on single column or dual column confirmation.
Method Blank	SOIL & GROUNDWATER: No analytes should be found in the blank. At least one preparation blank must be prepared for each matrix per 20 field samples or each batch whichever is more frequent. If any analyte concentration in the preparation blank is above the reporting limit, the lowest concentration of that analyte in the associated sample must be 10 X the concentration (for common lab contaminants, 5X for others) in the blank.
Other Blanks	SOIL & GROUNDWATER: Equipment blank and trip blank recommended per each batch. Analyze calibration blank at beginning and end of analytical batch and after initial and continuing calibration or every 10 samples or two hours, whichever is more frequent.
QC Check Standards	SOIL & GROUNDWATER: Relative response factors and % difference from initial calibration meet SOW limits.
Surrogate	SOIL & GROUNDWATER: Surrogates monitoring is suggested. Add to samples, blanks, and other QC samples. Recoveries must meet Lab control or SOW limits.
Internal Standard	SOIL & GROUNDWATER: Internal standards are optional. Add to samples, blanks, and other QC samples. Recoveries must meet Lab control or SOW limits.
Field Duplicate Sample	SOIL & GROUNDWATER: One per matrix specific and sampling method specific batch, blind field duplicate sample recommended. Relative percent differences (RPD) are advisory only. MS/MSD checked for RPD; ≤20% for water samples ≤35% for soil samples.
Spike Sample	SOIL & GROUNDWATER: Analyze matrix spike/ matrix spike duplicate (MS/MSD) sample at frequency of one per twenty samples or each analytical batch, whichever is more frequent for soil and groundwater. Percent recovery (%R) per established laboratory limits.
Sample Collection	WATER 1,000 ml amber glass bottle; SOIL sample 8 oz. Wide mouth polyetheylene or glass; Cool to 4°C.
Other QC Criteria	SOIL & GROUNDWATER: DDT and Endrin breakdown testing must be performed before each analytical run. Laboratory control sample (LCS) required if MS/MSD recoveries exceed laboratory established limits.

TABLE 22
QUALITY CONTROL SUMMARY – FIELD XRF ANALYSIS

Parameter	Description
Method Reference	EPA 6200, Test Methods for Evaluating Solid Waste, SW-846.
Matrix	Soils, sediments, elemental solids.
Analytes	Metals lists as indicated in Table 7 and 9, (excludes Cr^{+6}).
Holding Time	6 Months, (28 days for mercury).
Field Instrument Calibration	An SiO2 blank matrix and at least one Site Specific Calibration Soil (SSCS), and at least one National Institute of Standards Testing (NIST) certified reference material tested to confirm empirical calibration, or fundamental parameter calibration at beginning of day. Empirical calibration requires replicate testing and averaging of at least 3 standards for each targeted analyte.
Continuing Calibration Verification	Monitoring SSCS throughout testing procedures ensures instrument consistency and sample handling procedures. Verification of results with SSCS standard %R 80-120.
Field XRF QC Check Standards	NIST certified reference materials will be identified for testing at the beginning and end of each days tests. Verification of results with NIST standard %R 80-120.
Field Instrument Blank	Blank sample is analyzed for each analyte parameter and no analytes should be found in the blank. Blank materials include SiO2 'sand', Teflon disc, or quartz disc. Analyze blank matrix at beginning of each days tests, every 20 samples, and at the end of day testing. If any analyte concentration in the blank is above the reporting limit, the lowest concentration of that analyte in the associated sample must be 10 times the concentration in the blank.
Continuing Calibration Blanks	Monitoring blanks throughout testing procedures ensures contaminants are not adhering to exposure window. Continual detection of analytes at or near the criteria noted above, may require replacement of the exposure window. See manufacturers procedures for completing this step.
Equipment Blanks	Equipment blanks will not be performed. Standard decontamination procedures are recommended on collection equipment, and dedicated storage containers (bags) will be used for sample storage.
XRF Field Duplicates	Select field duplicates from a source container, at a frequency of 1 per 20 field samples. Relative percent differences (RPD) between field duplicates are advisory only (≤35% for soil samples).
Laboratory Split Samples	Select field sample splits from a single source container, when sending samples for laboratory analysis by digestion methods. Split samples are prepared as with the originating source. Relative percent differences (RPD) between field and split sample comparisons will target ≤35% for soil samples.
Matrix Spike/ Matrix Spike Duplicate Sample	MS /MSD analyses will not be performed
Sample Collection	At least 8 oz. sample in plastic zip-lock bag; Finely divided and homogenized. Microwave or air drying is recommended for better homogenizing and representativeness.
Other Field QC Criteria	Analyze manufacturers Fe/Mn elemental check standard at beginning and at end of day to ensure resolution of peak detection. Replicate measurements for each of a high, medium, and low concentration sample are recommended to track matrix variability, and instrument drift.

APPENDIX A
FIELD CHANGE REQUEST

FIELD CHANGE REQUEST

Golder Associates

Job/Task Number: ____________________

Other Affected Documents: ____________________

Requested Change: ____________________

Reason for Change: ____________________

Change Requested by: ____________________ Date ____________

Reviewed by: ____________________ Date ____________
GAI Project Manager

Comments: ____________________

Reviewed by: ____________________ Date ____________
GAI QA Manager

Comments: ____________________

EXHIBIT **F**

FIELD CHANGE REQUEST FORM

TP-1.2-5

IP3 1024/FCR 1.2-5

Golder Associates Inc.

APPENDIX B
GOLDER XRF TECHNICAL PROCEDURE

At Golder Associates we strive to be the most respected global group of companies specializing in ground engineering and environmental services. Employee owned since our formation in 1960, we have created a unique culture with pride in ownership, resulting in long-term organizational stability. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees now operating from offices located throughout Africa, Asia, Australasia, Europe, North America and South America.

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