TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

REMEDIATION DIVISION

VOLUME I

REQUIREMENTS FOR PROPOSAL AND CONTRACT DOCUMENTS

ATTACHMENTS TO SPECIFICATIONS

Relating to

FY 06 REMEDIAL INVESTIGATION AND REMOVAL SERVICES
(Service Type)

582-6-49217
(Requisition Number)

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TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
SUPERFUND CLEANUP SECTION
REMEDIATION DIVISION

QUALITY ASSURANCE PROJECT PLAN
FOR THE
SUPERFUND PROGRAM

DOCUMENT CONTROL NUMBER *(200919.3)*

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
SUPERFUND CLEANUP SECTION
REMEDIATION DIVISION

QUALITY ASSURANCE PROJECT PLAN
FOR THE
SUPERFUND PROGRAM

DOCUMENT CONTROL NUMBER *(200919.3)*

QUALITY ASSURANCE PROJECT PLAN FOR THE SUPERFUND PROGRAM

APPROVAL:

Name (printed)	Signature	Date
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A.0 GROUP A: PROJECT MANAGEMENT

A.1 Title and Approval Sheet

The title and approval page shall be completed for the project and is included in the Field Sampling Plan (FSP). An example FSP/QAPP title and approval page is shown in Figure A.1.

This QAPP and a site-specific FSP shall constitute, by definition, a Superfund Sampling and Analysis Plan (SAP), which presents in specific terms the policies, organization, functions, and QA/QC requirements designed to achieve routine data quality objectives for the project. This QAPP: (1) has been prepared for use by project team members to assure the data are scientifically valid and defensible, and (2) establishes the analytical protocols and documentation requirements to assure the data are collected, reviewed, and analyzed in a consistent manner.

This QAPP may not be used without the accompanying, approved FSP which presents the data quality objectives and specifies the data needed to meet the specific objectives. The FSP identifies all additions or modifications to this QAPP that are necessary to meet the specific project objectives. Guidelines followed in the preparation of this QAPP are:

- EPA Requirements for Quality Assurance Project Plans, Final, EPA QA/R-5 (U.S. EPA, latest version)
- EPA Guidance for Quality Assurance Project Plans, Final, EPA QA/G-5 (U.S. EPA, latest version)
- U.S. EPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (U.S. EPA, latest version)
- U.S. EPA Contract Laboratory Program National Functional Guidelines for Organic Data Review (U.S. EPA, latest version)
- The National Environmental Laboratory Accreditation Program Standards (NELAC, May 2001)
- Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (U.S. EPA SW-846, most recent update)
- RG-366/TRRP-13 Regulatory Guidance (TCEQ, December 2002)

This QAPP, the site-specific FSP, and all pertinent project documents are required reading for all staff participating in the project. The QAPP and the FSP shall be in the possession of all laboratories performing analytical methods for the project. All contractors and subcontractors shall be required to comply with the procedures documented in this QAPP and the FSP to ensure comparability and representativeness of the data produced are maintained.

A schematic presentation of the project documents and the location of key planning components is included in Section 1 of the FSP.

Figure A.1: Example title and approval page for FSP/QAPP

[Project Name]
FIELD SAMPLING PLAN AND QUALITY ASSURANCE PROJECT PLAN

As noted by my signature below, I have reviewed the FSP for the project and this QAPP. I affirm that I understand my responsibility and my authority for implementing the QAPP on this project.

Name (printed)	Signature	Date
Project Manager [insert company name]		
Project QA Specialist, [insert company name]		
Contract Manager [insert company name]		
Manager, [insert laboratory name]		
Project Manager, TCEQ		
QA Specialist, TCEQ		
Remedial Project Manager, EPA (for Federal Superfund sites)		

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LIST OF ACRONYMS AND ABBREVIATIONS

2,4-D	2,4-dichlorophenoxy acetic acid
2,4-DB	4-(dichlorophenoxy) butyric acid
2,4,5-T	(2,4,5-trichlorophenoxy) acetic acid
2,4,5-TP	Silvex
% R	percent recovery
% D	percent difference
µg	microgram
AA	atomic absorption
AO	Administrative Order
ASTM	American Society for Testing Materials
BFB	bromofluorobenzene
BHC	benzene hexachloride
Br^-	bromide ion
BTEX	benzene, toluene, ethylbenzene, xylenes
CCB	continuing calibration blank
CCC	calibration check compound
CCV	continuing calibration verification
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CF	calibration factor
CFR	Code of Federal Regulations
Cl^-	chloride ion
COC	chemical of concern
C-O-C	chain-of-custody document
COD	coefficient of determination (R^2)
CVAA	cold vapor atomic absorption
DCA	dichloroethane
DCB	dichlorobenzene
DCBP	decachlorobiphenyl
DCE	dichloroethene
DDD	dichlorodiphenyl dichloroethane
DDE	dichlorodiphenyl dichloroethylene
DDT	dichlorodiphenyl trichloroethane
DFTPP	decafluoro triphenyl phosphine
DOT	Department of Transportation
DQO	data quality objective
DUS	Data Usability Summary
ECD	electrolytic conductivity detector
EDB	ethylene dibromide
EICP	extracted ion current profile
EPA	Environmental Protection Agency
ER	Exception Report

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

F^-	fluoride ion
FSP	field sampling plan
FLAA	flame atomic absorption
FS	Feasibility Study
G	glass
GC	gas chromatography
GFAA	graphite furnace atomic absorption
H_2SO_4	sulfuric acid
HCl	hydrochloric acid
ECD	electron capture detector
HNO_3	nitric acid
IC	ion chromatography
ICAL	initial calibration
ICP/MS	inductively coupled plasma/mass spectrometry
ICP-AES	inductively coupled plasma - atomic emission spectroscopy
ICV	initial calibration verification
IDL	instrument detection limit
IS	internal standard
kg	kilogram
L	liter
LCS	laboratory control sample
LORP	level of required performance
LRC	Laboratory Review Checklist
MB	method blank
MCPA	2-methyl-4-chlorophenoxy acetic acid
MCPP	2-(2-methyl-4-chlorophenoxy) propanic acid
MDL	method detection limit
mg	milligram
ml	milliliter
MQL	method quantitation limit
MS	matrix spike
MS	mass spectrometry
MSD	matrix spike duplicate
MTBE	methyl tertiary butyl ether
NA	not applicable
$Na_2S_2O_3$	sodium thiosulfate
NaOH	sodium hydroxide
NO_2^-	nitrite ion
NO_3^-	nitrate ion
NPL	National Priorities List
NTU	nephelometric turbidity units

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

O&M	Operations and Maintenance
P	polyethylene
PAHs	polynuclear aromatic hydrocarbons
PB	preparation blank
PCBs	polychorinated biphenyls
PCE	perchloroethene
PID	photoionization detector
PM	Project Manager
PO_4^{-3}	phosphate ion
PRP	Potentially Responsible Party
QA	quality assurance
QAPP	Quality Assurance Project Plan
QAS	Quality Assurance Specialist
QC	quality control
r	correlation coefficient
RA	Remedial Action
RD	Remedial Design
RF	response factor
RI	Remedial Investigation
MQL	method quantitation limit
RPD	relative percent difference
RRT	relative retention time
RSD	relative standard deviation
RT	retention time
SCS	Superfund Cleanup Section
SO_4^-	sulfate ion
SOP	standard operating procedure
SPCCs	system performance check compounds
SPLP	Synthetic Precipitation Leaching Procedure
SQL	sample quantitation limit
SSF	State Superfund Program
SW	SW846
SWDA	Solid Waste Disposal Act
T	brass sleeve
TAC	Texas Administrative Code
TCA	trichloroethane
TCDD	tetrachloro-dibenzo-p-dioxin
TCDF	tetrachlorodibenzofuran
TCE	trichloroethene
TCEQ	Texas Commission on Environmental Quality
TCLP	Toxicity Characteristic Leaching Procedure

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

TCMX	tetrachloro-m-xylene
TDS	total dissolved solids
TIC	tentatively identified compounds
TOC	total organic carbon
TPH	total petroleum hydrocarbons
TRRP	Texas Risk Reduction Program
TSS	total suspended solids
VOC	volatile organic compound

A.3 Distribution List

The project distribution list follows the title and approval page in the Field Sampling Plan (FSP). All the individuals and their organizations who will receive copies of the approved QAPP and FSP and any subsequent revisions are included on the distribution list. All project files that will receive a copy of the QAPP and FSP and any subsequent revisions are included on the distribution list. The individuals responsible for approving the QAPP and FSP are identified in the distribution list.

Controlled distribution of the QAPP and FSP shall be implemented by the prime contractor to ensure the current version is being used. The individual(s) responsible for maintaining and distributing the QAPP and FSP is identified on the distribution list. Controlled copies shall be provided to the applicable TCEQ project managers, contractor/subcontractor project managers, and QA coordinators as identified on the distribution list. A sequential numbering system shall be used to identify who is the intended recipient of each controlled copy of the QAPP and FSP. The distribution list for controlled copies is maintained by the prime contractor. Whenever revisions are made or material added to the QAPP, the QAPP will be revised to include a new revision number which will be reflected on the title page of the QAPP and in the document control entry for the section(s) which is (are) affected. The Table of Contents shall reflect the revision number and the applicable sections for that revision. The prime contractor shall assure that (1) all persons holding a controlled copy of the QAPP shall receive the revisions/additions and (2) outdated material is removed from circulation and archived. The document control system does not preclude making and using copies of the QAPP; however, the holders of controlled copies are responsible for distributing additional material to update any copies within their organizations. Changes required due to any revisions/additions to the QAPP will not be required for work being conducted under a previously approved version of the QAPP, unless warranted by the severity of the problem being addressed by the revision.

A.4 Project/Task Organization

Section 1 of the FSP contains the project organization and the task(s) organization. The key individuals of the project team (i.e., the principal data user(s), the decision-maker, project manager, QA manager, and all persons responsible for implementation of the QAPP) are identified in Section 1 of the FSP. The role(s) and responsibilities for each individual are explicitly stated in Section 1 of the FSP to allow for a clear understanding by each identified individual. The organization chart for this project is in Section 1 of the FSP. The chart outlines the key individuals identified in Section 1 of the FSP and includes 1) the individual's telephone number, physical location (i.e., city and state); 2) the lines of communication to be used in the project, including lines of communication within and between organizations; and 3) the lines of authority and responsibility for the project, including internal lines of authority and responsibility within organizations. The organization chart in Section 1 of the FSP identifies the project Quality Assurance Specialist (QAS), documents that the QAS is independent of the individuals

and team collecting, generating, and/or using the data, and documents that the QAS has a direct line of communication with management. Where direct contact between key individuals for the project does not occur, such as between a project consultant for a Potentially Responsible Party and the TCEQ risk assessment staff, the project organization chart shows the route by which information is exchanged. The individuals with signatory approval responsibility are clearly identified in the organization charts.

All entities and individuals involved in the collecting, analyzing, assessing, processing, and reporting of data for the project are responsible for ensuring that these activities are carried out in accordance with the provisions of this QAPP and the FSP, TCEQ rules and policies, other applicable state, federal or local laws and applicable guidance documents. Element C.2 of this QAPP specifies the procedures to follow when deviations are made from the project plans that might affect the quality of the data.

A.4.1 Responsibilities of the Laboratory Generating Data for the Project

The laboratory's QA program shall be consistent with the National Environmental Laboratory Accreditation Conference (NELAC) standards. The laboratory is responsible for reviewing this QAPP and the FSP to ensure that the laboratory is capable of generating data that will meet the project objectives.

The project team should identify the analytical/measurement objectives for the project. The default analytical quality objectives are specified in Element B.5. The laboratory can propose to the contractor to modify these default objectives, based upon the laboratory's routine analytical performance for the specified methods and matrices. If these modifications are approved by the project team, the modifications shall be described in Section 8 of the FSP. The laboratory should be familiar with the sections within the FSP that are referenced in the QAPP concerning the performance standards for the laboratory. If the QAPP does not contain the information needed by the laboratory, the laboratory shall contact the TCEQ Quality Assurance Specialist identified on the approval page. The laboratory's responsibilities associated with project-specific reporting procedures are specified in Element A.9 of this QAPP, and the laboratory's responsibility for data review are included in Element D.2.1.1 of this QAPP.

A.4.2 Contractor Responsibilities

The contractor, in consultation with the TCEQ PM, shall choose a TCEQ direct contract laboratory, a subcontracted laboratory or a laboratory participating in EPA's Superfund Contract Laboratory Program (CLP). EPA assumes the cost of using the CLP for regional clients in federal Superfund lead projects. Samples submitted to either a CLP Laboratory or the Houston Region VI Laboratory shall follow the analysis and reporting requirements specified in the applicable EPA Superfund Contract Laboratory Program Statement of Work (SOW) or the requirements of the Houston Region VI Laboratory, respectively. The Contract Laboratory

Program Guidance for Field Samplers is included in Attachment 4 of this QAPP. In addition, Attachments 5 and 6 are the Quick Reference Fact Sheets for organic and inorganic analytical service, respectively, under the CLP.

The contractor is responsible for communicating the project objectives and measurement objectives to all of his or her subcontractors, including the laboratory. As stated above, the default analytical quality objectives are specified in Element B.5. The contractor shall determine if the laboratory can meet the proposed project and measurement objectives. Other contractor responsibilities specific to the project are detailed in Section 1 of the FSP.

A.4.3 TCEQ Project Manager

The primary point of contact within the TCEQ for all site related issues is the TCEQ Project Manager (PM). The individual TCEQ PM is responsible for the overall direction and implementation of the project in accordance with the provisions of this QAPP and the FSP. Specific data quality responsibilities of the TCEQ PM include:

- coordinating the DQO process and communicating the results to the Project Team;
- reviewing and approving field activities, reports, and other data;
- collecting samples or instructing the TCEQ consultant to collect samples for analyses by laboratories contracted directly with the TCEQ;
- ensuring that all data submitted to the TCEQ are collected, analyzed, evaluated and documented according to the requirements of this QAPP;
- communicating and coordinating with the public, other governmental entities and other interested parties, as required;
- distributing the project documents, including the QAPP and FSP, to the TCEQ Central Records and site repositories as part of the site files in the local area of the site;
- explaining the requirements of the Superfund QA program to TCEQ consultants and PRPs; and
- final approval of the analytical chemistry data based upon his/her review and, if applicable to the project, the recommendations of the TCEQ Quality Assurance Specialist (QAS).

The data review responsibilities of the TCEQ PM are specified in Element D.3.1.

A.4.4 TCEQ Quality Assurance Specialist

The TCEQ Quality Assurance Specialist (QAS) serves the TCEQ PM as a resource on analytical chemistry and QA/QC. The responsibilities of the TCEQ QAS include: maintaining the Superfund Program QAPP; distribution of the current Superfund Program QAPP; review of the QAPP and associated FSP; technical assistance in the resolution of QA/QC or analytical chemistry issues; and the review of data packages and Data Usability Summary (DUS) Reports at the request of the TCEQ PM. (Note: The responsibilities of the QA Specialist **do not** include data validation, which is the responsibility of the TCEQ consultant or PRP.)

If requested, the QAS will review the draft and final data packages and DUS to ensure that data collection was conducted and documented, problems have been satisfactorily resolved and documented, and data review/validation has been performed in accordance with this QAPP. Any problems discovered during review of the data packages or DUS by the QAS will be reported to the TCEQ PM. The QAS will be available to assist the TCEQ PM in the resolution of any problems.

The data review responsibilities of the TCEQ QAS are specified in Element D.3.2.

A.5 Problem Definition/Background

The definition of the problem and the background for the project is contained in Section 2 of the FSP and includes:

- a description of the problem as currently understood, indicating the project's importance and programmatic and regulatory context;
- a summary of existing information on the problem, including any conflicts or uncertainties that are to be resolved by the project;
- a discussion of initial ideas or approaches for resolving the problem that were considered before selecting the approach described in Element A6;
- the identification of the principal data user or decision maker.

A.6 Project/Task Description

The summary of the project and the project tasks, including the descriptive information for the following items, is contained in Section 2 of the FSP:

- Descriptions of the characteristics or properties to be studied and the measurement processes and techniques to be used.
- The regulatory standards and/or criteria pertinent to the project.
- Descriptions of special personnel or equipment required for the specific type of work being planned or for the specific type of measurements being taken.
- The project schedule, which includes the anticipated start and completion dates for the project and the approximate schedule of important project milestones, such as the start of field work and/or environmental measurement activities.
- The degree of quality assessment activity needed for the project, which depends upon the project's complexity, duration, and objectives, and a discussion of the timing of each planned assessment, including a brief outline of the roles of the different parties to be involved.

A description of project and QA record requirements, including those requirements for field operation records, laboratory data packages and turn-around time requirements, document retention time and location, reporting format, and document control are contained in Element A.9 below.

A.7 Quality Objectives and Criteria

The type, quality, and quantity of data needed for the specific project shall be defined. Default accuracy and precision limits are specified in Elements B.5.1 and B.5.2. The completeness requirement is 95 percent for aqueous samples and 90 percent for soil samples. The project-required data quality and sensitivity requirements shall be determined and compared to the default specifications given in Element B5 of this QAPP to evaluate whether the quantitation limits and QC criteria for the analytical methods requested by the TCEQ will meet the individual project requirements. Any needs, such as lower or higher method quantitation limits, different analyte lists, or additional analytical methods, are addressed in Section 8 of the FSP.

Section 8 of the FSP clearly states whether or not the LCS or MS/MSD shall be spiked at a concentration at, or below, the level of required performance or regulatory limit against which the results will be compared.

Detected results (adjusted for sample characteristics, sample preparation, and/or laboratory adjustments) greater than the MDL that meet the qualitative identification criteria specified in the analytical method shall be reported, with those results detected between the MDL and the MQL flagged to indicate the compound is present but the reported value is estimated. Non-detected results shall be reported as less than the value of the SQL.

A.8 Special Training/Certification

All certificates or documentation representing completion of specialized training shall be maintained in personnel files during the active and archived life of this project.

All persons constructing a water well (an artificial excavation constructed for the purpose of exploring for or producing groundwater) shall be licensed by the Texas Water Well Drillers Board. Appropriate licensure should be verified prior to using a subcontractor to construct a water well.

The project files shall contain the documentation of training (e.g., a copy of applicable training certificate(s)) specified in EPA's Standard Operating Safety Guides, 29 CFR 1910.120(e) for all persons working on-site. The level of training required is dependent upon the person's on-site activities and the potential for exposure to hazardous substances and/or other hazards encountered during hazardous waste operations. This documentation of training shall remain in the project files throughout the life of the project. Any specialized training or certification required for the project is specified in Section 2 of the FSP.

A.9 Documents and Records

A.9.1 Field Operation Records

The information contained in these records shall document overall field operations and consists of the following items:

- Sample collection records. These records shall document the sampling protocol performed in the field. At a minimum, this documentation should include the names of the persons conducting the activity, sample number, sample collection points, the date and time of sample collection, maps and diagrams, site photographs, equipment/method used, climatic conditions, and unusual observations. Bound field notebooks shall be used to record raw data and entries shall be made to reference prescribed procedures and changes in planned activities. The field notebooks shall be formatted to include pre-numbered pages with date and signature lines.

- Chain-of-custody records. Chain-of-custody records shall be used to document the progression of samples as they travel from the original sampling location to the laboratory and finally to their disposal area. Chain-of-custody procedures are described in Element B.3.

- QC sample records. These records shall document the generation of QC samples, such as field, trip, and equipment rinsate blanks and duplicate samples. The records shall also

include documentation of sample integrity and preservation, field instrument calibration, and standards' traceability documentation capable of providing a reproducible reference point. Quality control sample records shall contain information on the frequency, conditions, level of standards, and instrument calibration history.

- General field procedures. General field procedures used in the field to gather data shall be documented, including the procedures used in areas where it was difficult to collect samples.

- Field corrective action reports. Field corrective action reports shall document what methods were used in situations where general field practices or procedures specified in the Standard Operating Procedures were not followed. The field corrective action reports shall include the methods used to resolve a noncompliance. If applicable, to show regulatory compliance in disposing of waste generated during the field operation, procedures, manifests and testing contracts shall be included in Section 2 of the FSP.

A.9.2 Laboratory Data Package

The laboratory data package to be submitted to the TCEQ project manager shall contain the Laboratory Review Checklist(s), as described in Element A.9.2.1, and the required reportable data, as described in Element A.9.2.2 below.

A.9.2.1 Laboratory Review Checklists (LRC)

The laboratory shall complete Laboratory Review Checklists that substantively meet the specifications given in the example Laboratory Review Checklist included in Attachment 1 of the QAPP. The laboratory data package shall include the Laboratory Review Checklists (LRCs) and the reportable data identified in Element A.9.2.2. The laboratory can elect to complete the LRC(s) on a batch basis, project basis, or laboratory-defined basis provided that each LRC clearly and unambiguously lists the project samples associated with that LRC. The LRC shall be substantively complete enough to provide an independent reviewer with enough information to be able to independently assess the magnitude of the potential inaccuracy or imprecision, the direction of potential bias, and other potential effects on the quality or documentability of the reported results based on the technical review by the laboratory.

A.9.2.1.1 Exception Reports

Each LRC shall contain an Exception Report (ER) for each "No" or "NR" (i.e., not reviewed) entry on the LRC. The associated ERs shall identify any problems or anomalies the laboratory observed during the receipt, handling, preparation, and/or analysis of a sample. The ERs shall briefly but concisely include the identification and description of all deviations from the analytical method, the laboratory's QAP and SOPs, and Element B.5 of this QAPP. The ERs

shall also include identification of all instances in which QC measure results failed to meet acceptance criteria along with a brief, but complete, description of the QC measure involved, the acceptance limit, and the value for the QC measure that was outside of acceptance limits. Descriptions in the ERs should include the samples affected by the problem(s)/anomalies and the direction and estimated magnitude of the bias, if possible.

A.9.2.1.2 Release Statement

Each LRC shall contain a release statement that shall be signed by the laboratory manager or his designee. Unless otherwise approved by the TCEQ, the release statement text shall read:

> "I am responsible for the release of this data package. This laboratory package has been reviewed by the laboratory and is complete and technically compliant with the requirements of the methods used, except where noted by the laboratory in the attached exception reports. By my signature below, I affirm to the best of my knowledge that all problems/anomalies observed by the laboratory as having the potential to affect the quality of the data have been identified by the laboratory in the Laboratory Review Checklist, and no information or data have been knowingly withheld that would affect the quality of the data."

The release statement shall include the printed name and official title and the signature of the person signing the statement and shall include the date of the signature.

A.9.2.2 Required Reportable Data

The laboratory data package released by the laboratory (the Laboratory Data Package) shall contain those items listed on the signature page of the Laboratory Review Checklist in Attachment 1. Specifications of the reportable data to be delivered within the laboratory data package are outlined below. A brief summary of these requirements is also provided below. The "(R#)" notations are provided to match those used in the example Laboratory Review Checklist included in Attachment 1.

The required reportable data are:

- Completed chain-of-custody (C-O-C) documentation (R1)
- Sample identification cross-reference (R2)
- Test reports for samples (R3)
- Surrogate recovery data (R4)
- Laboratory blank sample data (R5)
- Laboratory control sample (LCS) data (R6)
- Matrix spike/matrix spike duplicate (MS/MSD) data (R7)
- Analytical duplicate data (R8)

- Method quantitation limits (R9)
- Other problems and/or anomalies observed by the laboratory (R10)

A.9.2.2.1 Completed Chain-of-Custody (C-O-C) Documentation (R1)

The laboratory data package shall include copies of the completed chain-of-custody (C-O-C) forms and documentation. Information to be supplied includes field sample identification, method of preservation, analytical methods requested and/or analytes requested, signatures of all personnel having custody of the samples prior to delivery to the laboratory, signature of laboratory personnel receiving samples, sample condition upon receipt including temperature upon receipt, presence/condition of C-O-C seals on coolers/samples, laboratory assigned job number and sample numbers, and other pertinent log-in information, as applicable, such as missing samples, broken containers, etc. The C-O-C documentation reported in the package shall include a copy of the C-O-C form used by the field personnel, and may also include forms which the laboratory uses to document condition upon receipt.

A.9.2.2.2 Sample Identification Cross-Reference (R2)

The laboratory data package shall include a listing of all field sample identification numbers (sorted alphanumerically) cross-referenced to the associated laboratory sample identification numbers. This listing shall also include the laboratory batch number(s) associated with each sample analysis reported in the data package. The data package shall include an easy and unambiguous means by which all of the field samples associated with a specific QC sample (e.g., the laboratory duplicate, the MS/MSD samples, and the laboratory control sample) can be identified.

A.9.2.2.3 Test Reports for Samples (R3)

The laboratory data package shall include the annotated test reports for all samples including field samples, dilutions, reanalyses from which data are being reported, method/preparation blanks, matrix spikes, matrix spike duplicates (or laboratory duplicates), and laboratory control samples. Analytical results shall be reported on a dry weight basis for soil and sediment samples with the percent solids (or percent moisture) also reported on the test reports to allow back-calculation of the result on a wet weight basis. The test report shall include all information noted on the signature page of the Laboratory Review Checklist (found in Attachment 1 of this QAPP).

A.9.2.2.3.1 Tentatively Identified Compounds

If the reporting of Tentatively Identified Compounds (TICs) is specified in Section 8 of the FSP for volatile or semivolatile organic compound analysis by GC/MS, requirements associated with TIC identification and quantitation shall be met. These requirements are specified below in the paragraphs that follow. For each sample, the sample test report or the TIC identification

summary report shall include the following for each TIC: 1) the CAS number; 2) the compound name; 3) the retention time; and 4) the estimated concentration. When TICs are required, the laboratory data package shall include chromatograms, spectral comparisons, computer generated data on the closeness of the match, and the analyst's TIC identification.

Requirements for TIC reporting are as follows:

A library search shall be executed for non-target organic sample components for the purpose of tentative identification. The organic compounds of greatest apparent concentration not listed in Tables B.5.1.9-1 and B.5.1.10-1 for the volatile organic fraction or for the semivolatile fraction, respectively, excluding the system monitoring compounds and internal standard compounds, shall be tentatively identified via a forward search of the NIST/EPA/NIH (May 1992 release or later) and/or Wiley (1991 release or later), or equivalent mass spectral library. Only after visual comparison of sample spectra with the nearest library searches will the mass spectrometrist assign a tentative identification. NOTE: Computer generated library search routines must not use normalizations which would misrepresent the library or unknown spectra when compared to each other. Guidelines for making tentative identification include:

- Relative intensities of major ions in the reference spectrum (ions greater than 10 percent of the most abundant ion) should be present in the sample spectrum.
- The relative intensities of the major ions should agree within ± 20.0 percent. Example: For an ion with an abundance of 50.0 percent of the reference spectra, the corresponding sample ion abundance must be between 30.0 and 70.0 percent.
- Molecular ions present in reference spectrum should be present in sample spectrum.
- Ions present in the sample spectrum but not in the reference spectrum should be reviewed for possible background contamination, interference or presence of coeluting compounds.
- Ions present in the reference spectrum but not in the sample spectrum should be reviewed for possible subtraction from the sample spectrum because of background contamination or coeluting compounds. Data system library reduction programs can sometimes create these discrepancies.
- For multi-peak materials (e.g., gasoline or mineral spirits) which are not calibrated, but are easily recognized, all the peaks related to the material should be reported as a single TIC, not as individual peaks, such as methylpentane, hexane, etc.

    - Performing a library search for non-target volatile organic sample components for the purpose of tentative identification. Up to 10 volatile organic compounds of greatest apparent concentration not listed in Table B.5.1.9-1 for the volatile organic fraction shall be reported. The following are <u>not to be reported for volatile analyses</u>: (1) substances with responses less than 10 percent of the internal standard (as determined by inspection of the peak areas or height); (2) substances which elute earlier than 30 seconds before the first purgeable compound or three minutes after the last purgeable compound listed in Table B.5.1.9-1 has eluted;

(3) carbon dioxide; and (4) semivolatile target compounds listed in Table B.5.1.10-1.

- Performing a library search for non-target semivolatile organic sample components for the purpose of tentative identification. Up to 20 semivolatile organic compounds of greatest apparent concentration not listed in Table B.5.1.10-1 for the semivolatile organic fraction shall be reported. The following are not to be reported for semivolatile analyses: (1) substances with responses less than 10 percent of the internal standard (as determined by inspection of the peak areas or heights); (2) substances which elute earlier than 30 seconds before the first semivolatile compound or three minutes after the last semivolatile compound listed in Table B.5.1.10-1 has eluted; and (3) volatile compounds listed in Table B.5.1.9-1. Peaks that are suspected to be aldol-condensation reaction products (i.e., 4-methyl-4-hydroxy-2-pentanone and 4-methyl-3-pentene-2-one) shall be searched, reported, and counted as part of the 20 most intense non-target semivolatile compounds, and qualified with an "A" flag on the laboratory report. The laboratory shall also report pesticide target compounds listed in Table B.5.1.5-1 that appear as semivolatile tentatively identified compounds.

- Additionally, up to 20 semivolatile alkane/alkene peaks of greatest apparent concentration (as determined by inspection of peak areas or heights) that are suspected to be straight-chain, branched, or cyclic alkanes, alone or part of an alkene series shall be library searched. Documentation for the tentative identification must be supplied. When alkanes are tentatively identified, the concentrations are to be estimated and reported in the LRC as alkanes by class (i.e., straight-chained, branched, or cyclic). Peaks that are suspected to be part of an alkane series (e.g., C_5-C_9) may be library searched and reported as a single entry with an estimate given for the total concentration of the series.

A.9.2.2.4 Surrogate Recovery Data (R4)

The laboratory data package shall include the surrogate data as applicable to the analytical method performed. The surrogate can be included on the test report for each sample, or can be included on a separate sheet, provided that the surrogate results are clearly and unambiguously linked to the sample from which the results were measured. The surrogate data shall include the percent recovery between the amount added and the amount measured and the laboratory's quality control limits, as documented on the laboratory's control charts.

A.9.2.2.5 Laboratory Blank Sample Data (R5)

The laboratory data package shall include test reports or summary forms for all blank samples (e.g. method and preparation blanks) pertinent to the sample analyses. If a target analyte was

detected in any of the blanks associated with an analytical and/or preparation batch that includes samples from the project, the type of blank, the level of the contamination, the environmental samples affected, and the potential effect on the associated data shall be described in an ER. Blank sample test reports should contain all of the information required for sample test reports (e.g., surrogate recoveries). Sample data should not be blank corrected. Results for blank analyses for which the blank does not go through the method preparation and extraction procedures, such as solvent blanks, system blanks, calibration blanks, etc., may be reported on blank summary forms instead of on test reports.

A.9.2.2.6 Laboratory Control Sample (LCS) Data (R6)

The laboratory data package shall include the LCS test reports or LCS results summary forms. The LCS shall be taken through the entire preparation, cleanup and analysis procedure. The LCS samples shall contain all chemicals of concern identified in Section 4 of the FSP. When the chemicals of concern are not identified for the project, as in phase 1 assessments, the LCS shall contain all analytes for which data are reported. The LCS test report, or LCS results summary form, shall include the amount of each analyte added to the sample, the amount measured during the analysis, the percent recovery (%R) between the amount added and the amount measured, and QC limits for each analyte in the LCS. If specified in Section 8 of the FSP, the LCS shall be spiked at, or below, the analytical level of interest. If applicable to the laboratory's QAP and/or SOPs, the %R and relative percent difference (RPD) data for each analyte in the laboratory control sample duplicate (LCSD) shall be reported.

A.9.2.2.7 Matrix Spike/Matrix Spike Duplicate (MS/MSD) Data (R7)

The laboratory data package shall include the MS/MSD test reports or summary forms. The MS/MSD samples shall be spiked with all chemicals of concern identified in Section 4 of the FSP. When the chemicals of concern are not specified for the project, as in phase 1 assessments, the MS/MSD shall be spiked with a subset of the analytes included in the laboratory's initial calibration standard mixture(s) that are representative of the range and characteristics of the calibrated analytes. The MS/MSD test reports or results summary forms shall include identification of the compounds in the spike solution, the amount of each compound added to the MS and the MSD, the parent sample concentration, the concentration measured in both MS and MSD, the calculated percent recovery (%R), the calculated relative percent difference (RPD), and the QC limits for both %R and RPD. The form shall also include the laboratory batch number and the identification number of the sample spiked. The data package shall include an easy and unambiguous means by which the samples associated with that particular MS/MSD can be identified, such as a sample identification cross-reference table.

The Laboratory Review Checklist or MS/MSD summary form shall identify whether the sample selected for the MS/MSD analyses was from the project. If a non-project sample is used for the MS/MSD analysis, an ER shall provide the justification (e.g., "Non-project sample spiked. Lab

received insufficient project sample volume for MS/MSD"). When either, or both, MS/MSD recovery and precision are outside of QC or advisory limits, an ER shall include the actual recovery/precision values and a brief description of measures taken by the lab in attempting to alleviate the interference.

If specified in Section 8 of the FSP, the MS/MSD shall be spiked at, or below, the analytical level of interest. If applicable to the laboratory's QAP and/or SOPs, the %R and relative percent difference (RPD) data for each analyte in the matrix spike duplicate (MSD) shall be reported.

A.9.2.2.8 Analytical Duplicate Data (R8)

If an analytical duplicate (or laboratory duplicate) sample was analyzed, the laboratory data package shall include the duplicate sample test report or analysis summary form. The duplicate sample test report or analysis summary form shall include the calculated relative percent difference (RPD) between the sample and the sample duplicate results and the QC limits for the RPD. The test report or summary form shall also include the laboratory batch number and the identification number of the sample spiked. The laboratory data package shall include an easy means by which the samples associated with that particular duplicate analysis can be identified.

A.9.2.2.9 Method Quantitation Limits (R9)

The laboratory data package shall include the method quantitation limit (MQL) for each chemical of concern specified in Section 4 of the FSP or, when the chemicals of concern are not specified, each analyte included in the laboratory's initial calibration standard mixture(s). The MQL is defined as the concentration of the lowest non-zero standard (adjusted for final volume or weight) in the laboratory's initial calibration curve. See Element B.5.5 of this QAPP for requirements related to acceptable concentrations for the MQL.

A.9.2.2.10 Other Problems/Anomalies (R10)

The laboratory shall document and report all other problems and/or anomalies observed by the laboratory that might affect the quality of the project data in the Laboratory Review Checklist(s).

A.9.2.2.11 Validation Results for Non-Reference Methods

If the laboratory uses an analytical method other than those reference methods published by a nationally recognized organization, the laboratory data package shall include all validation data documenting that the non-reference method can produce data of known quality that meet the project objectives for each chemical of concern specified in Section 4 of the FSP. Additionally, the non-reference method shall be included in Section 8 of the FSP. The laboratory's procedures shall be documented in the laboratory's SOPs. If the laboratory cites a reference method, which is published by the TCEQ or a nationally recognized organization, and deviates from that method

beyond the modifications allowed in that method, the data generated by that method are considered suspect until the laboratory validates the data against the reference method. The data package shall include the performance data demonstrating that the modified method meets the QC performance criteria of the reference method. The data package shall include the comparison of the results obtained from the proposed method with those obtained for the approved reference method, interference studies, method and instrument detection limit studies, multiple-level matrix spikes studies of representative sample types, and precision and accuracy determinations, as applicable to the modifications being made. These method modifications shall be documented in Section 8 of the FSP.

A.9.3 Laboratory Performance Criteria (Supporting Data)

The laboratory performance criteria form the basis for the supporting data. These items shall be thoroughly reviewed by the laboratory . The results of that review shall be documented in the Laboratory Review Checklists and associated ERs which are included in the laboratory data package submitted for each project or phase. The laboratory data package shall only contain descriptions of these QC measures if the results fail to meet the control limits specified in the analytical methods, the laboratory QAP and SOPs. The laboratory performance criteria include the following and are noted with a (S#) for referencing to "supporting data" itemized on the Laboratory Review Checklist included in Attachment 1:

- Initial calibrations (S1)
- Initial and continuing calibration verifications and continuing calibration blank (S2)
- Mass spectral tuning for GC/MS analyses (S3)
- Evaluation of internal standards (S4)
- Transcription and calculation from raw data on sample preparation and analysis, maintenance of laboratory logbooks and calculation sheets, and maintenance of an audit trail (S5)
- Sample chromatogram review (S5)
- Dual column confirmation for GC analyses (S6)
- Tentatively Identified Compounds for GC/MS analyses (S7)
- Interference check sample results for metal analyses (S8)
- Sample-specific serial dilutions, post digestion spikes, and Method of Standard Additions for metal analyses (S9)
- Method detection limit determinations (S10)
- Proficiency test or performance or system evaluation mixture reports (S11)
- Documentation of standards (S12)
- Compound/analyte identification procedures (S13)
- Demonstration of analyst competency (S14)
- Verification/validation documentation for methods (S15)
- Compliance with laboratory standard operating procedures (S16)

These measures are under the control of the laboratory (with the exception of items S7 and S9 in the LRC) and do not depend on the specific nature of the matrix being analyzed and shall be reviewed by the laboratory, including the items in S7 and S9. Any problems identified by the laboratory during that review shall be included in the laboratory data package submitted to the TCEQ as part of the Laboratory Review Checklist and associated ERs. If a laboratory has in place and implements a quality assurance program that meets the requirements of a recognized organization, such as EPA, NELAP, or the International Organization for Standardization (ISO), problems with the data should be random, minimal, appropriately addressed through the laboratory's corrective action procedures, and shall be adequately documented in the Laboratory Review Checklist.

Laboratory supporting data shall be maintained on file and available for inspection. Laboratory supporting data to be used in the data validation process shall be submitted by the laboratory within 30 days from the date of analysis. Any or all of the laboratory supporting data is subject to review by TCEQ at any time within the specified storage duration. A review of the laboratory supporting data by the TCEQ within a 90 day request period from the date of analysis would be warranted when the required reportable data submitted to the TCEQ indicated that problems may exist with the data, and the problems were not identified and resolved by either the laboratory or the person submitting the data, or if the data come under scrutiny for evidentiary reasons. All laboratory supporting data that are outside of QC acceptance criteria shall be identified in the Laboratory Review Checklist contained within the original data package submitted to the TCEQ.

The laboratory can elect to store the laboratory supporting data electronically if the laboratory chooses to do so; however, if requested, the laboratory supporting data shall be made available within a reasonable time period. If any of the QC measures described in the laboratory supporting data do not meet QC limits, an ER shall be included in the Laboratory Review Checklist for the laboratory data package submitted to the TCEQ. The ERs shall include identification of all instances in which quality control measure results failed to meet acceptance criteria, along with a complete description of the QC measure involved, the acceptance limit, and the value for the QC measure that was outside of acceptance limits. Descriptions in the ERs shall include the samples affected by the problem(s)/anomalies and the direction and estimated magnitude of the bias, if possible.

The turn-around time for the project is specified in Section 2 of the FSP.

A.9.4 Data Handling Records

Data handling records shall document protocols used in data reduction, verification, and validation. Data reduction includes data transformation operations, such as converting raw data into reportable quantities and units, use of significant figures, recording of extreme values, blank corrections, etc. Data verification ensures the accuracy of data transcription and calculations, if

necessary, by checking a set of computer calculations manually. Data validation ensures that QC criteria have been met. Procedures for data reduction, verification, and validation are specified in Element D.2.

A.9.5 Data Reporting Package Format and Document Control

The format of all laboratory data reporting packages shall be consistent with the requirements in Element A.9.2 above.

A.9.6 Field Records/Data Reporting Package Archiving and Retrieval

All field records and laboratory data reporting packages shall be archived by the contractor for a period of 10 years from the date the record was created and maintained in hard copy format, unless otherwise specified by the TCEQ. The records shall be made available within a reasonable amount of time upon request by the TCEQ. The contractor shall obtain written consent from the TCEQ before disposing of records at the end of the 10 year period.

B.0 GROUP B: DATA GENERATION AND ACQUISITION

B.1 Sampling Process Design (Experimental Design)

All the relevant components of the experimental design; the key parameters to be estimated; the number and type of samples expected; and description of where, when, and how samples are to be taken are included in Section 4 of the FSP. The level of detail in that section shall be sufficient to allow a person knowledgeable in the area to understand how and why the samples will be collected. This section of the FSP should be reviewed by all data users and suppliers to ensure that the "right" samples will be taken. Strategies such as stratification, compositing, and clustering shall be discussed, and diagrams or maps showing sampling points shall be included. Most of this information is available as outputs from the final steps of the planning (DQO) process.

In addition to describing the design, Section 4 of the FSP discusses the following:

- Schedule for project sampling activities
- Rationale for the design (in terms of meeting DQOs)
- Sampling design assumptions
- Procedures for locating and selecting environmental samples
- Classification of measurements as critical or noncritical
- Type and number of samples required
- Sampling locations and frequency
- Sample matrices
- Identification of critical samples

For nonstandard sampling methods, sample matrices, or other unusual situations, appropriate method validation study information shall be required to confirm the performance of the method for the particular matrix. The purpose of this validation information is to assess the potential impact on the representativeness of the data generated. For example, if qualitative data are needed from a modified method, rigorous validation may not be necessary. However, more rigorous validation studies will be required for quantitative data needs. Such validation studies may include round-robin studies performed by EPA or by other organizations. If previous validation studies are not available, some level of single-user validation study or ruggedness study shall be performed during the project and included as part of the project's final report. Section 8 of the FSP shall specify the requirements for non-standard methods, shall clearly reference any available validation study information, and shall specify and describe studies required during a given project to validate non-standard methods.

B.2 Sampling Methods

The following sampling method requirements are specified in Section 5 of the FSP:

- Sampling methods (collection, preparation, homogenization, decontamination)
- Identification and verification that support facilities for sampling methods can meet project objectives
- Identification of persons responsible for corrective action
- Identification of sampling equipment

B.2.1 Sample Containers

Sample containers shall generally be purchased precleaned and treated according to EPA specifications for the methods. Sampling containers that are reused are decontaminated between uses by the EPA-recommended procedures (i.e., EPA 540/R-93/051). Containers are stored in clean areas to prevent exposure to fuels, solvents, and other contaminants. Amber glass bottles are used routinely where glass containers are specified in the sampling protocol.

B.2.2 Sample Volumes, Container Types, and Preservation Requirements

Sample volumes, container types, and preservation requirements for the analytical methods performed on samples are listed in Table B2-1. The required sample volumes, container types, and preservation requirements for analytical methods proposed for project work not listed in Table B2-1 shall be included in Section 5 of the FSP.

Table B2-1 **Requirements for Containers, Preservation Techniques, Sample Volumes, and Holding Times**

Name	Analytical Methods*	Container[a]	Preservation[b]	Minimum Sample Volume or Weight	Maximum Holding Time
Alkalinity	E310.1	P, G	4°C	50 mL	14 days
Common anions	SW9056A	P, G	4°C	50 mL	28 days for Br^-, F^-, Cl^- and SO_4^{-2}; 48 hours for NO_3^-, NO_2^- and PO_4^{-3}
Perchlorate	E314.0	P,G	4°C	50 mL	28 days
Cyanide, total and amenable to chlorination	SW9010B SW9012A	P, G, T	4°C; NaOH to pH > 12, 0.6 g ascorbic acid	500 mL or 4 ounces	14 days (water and soil)
Filterable residue	E160.1	P, G	4°C	100 mL	7 days
Nonfilterable residue	E160.2	P, G	4°C	100 mL	7 days
Hydrogen ion (pH), water	SW9040B (for water)	P, G	None required	N/A	Analyze immediately[c]
Hydrogen ion (pH), soil	SW9045C (for soil)	P,G	None required	N/A	Analyze immediately[c]
Conductance	SW9050A	P, G	4°C (for water)	N/A	Analyze immediately[c]
Temperature	E170.1	P, G	None required	N/A	Analyze immediately[c]
Dissolved oxygen	E360.1	G (BOD bottles when possible)	None required	500 mL	Analyze immediately[c]
Turbidity	E180.1	P, G	4°C	100 mL	48 hours
Total organic carbon	SW9060	P, G, T	4°C, HCl or H_2SO_4 to pH < 2	500 mL or 4 ounces	28 days (water and soil)
Chromium (VI)	SW7196A SW3060A for soil digestion	P, G, T	4°C	500 mL or 8 ounces	24 hours (water); 30 days until extraction and 4 days after extraction (soil)
Mercury	SW7470A SW7471A	P, G, T	HNO_3 to pH < 2, 4°C	500 mL or 8 ounces	28 days (water and soil)

a. Polyethylene (P); glass (G); brass sleeves in the sample barrel, sometimes called California brass (T).
b. No pH adjustment for soil.
c. Measurement should be performed on site.
d. Preservation with 0.008 percent $Na_2S_2O_3$ is only required when residual chlorine is present.
* E = *Methods for Chemical Analysis of Water and Wastes* (EPA); SW = SW846

Table B2-1 Requirements for Containers, Preservation Techniques, Sample Volumes, and Holding Times - Continued

Name	Analytical Methods*	Container[a]	Preservation[b]	Minimum Sample Volume or Weight	Maximum Holding Time
Metals (except chromium (VI) and mercury)	SW6010B, SW6020A and SW-846 AA methods	P, G, T	HNO_3 to pH < 2, 4°C	500 mL or 8 ounces	180 days (water and soil)
Total petroleum hydrocarbons (TPH) - volatile	TCEQ 1005	G, amber, T(teflon lined septum for water; 40 ml teflon lined	4°C, HCl to pH < 2(pH adjust for water only)	2 x 40 mL vials	14 days from collection to extraction and 14 days after extraction (water and soil)
Volatile aromatics	SW8021B	G, Teflon-lined septum, T	4°C, HCl to pH < 2; 0.008% $Na_2S_2O_3$[d]	2 x 40 mL or 4 ounces	14 days (water and soil); 7 days for water if unpreserved by acid
Halogenated volatiles	SW8021B	G, Teflon-lined septum, T	4°C, HCl to pH < 2, 0.008% $Na_2S_2O_3$[d]	2 x 40 mL or 4 ounces	14 days (water and soil); 7 days for water if unpreserved by acid and nonhalogenated volatiles are analytes of concern
Nitrosamines	SW8070A	G, Teflon-lined cap, T	4°C	1 liter or 8 ounces	7 days until extraction and 40 days after extraction (water); 14 days until extraction and 40 days after extraction (soil)

a. Polyethylene (P); glass (G); brass sleeves in the sample barrel, sometimes called California brass (T).
b. No pH adjustment for soil.
c. Measurement should be performed on site.
d. Preservation with 0.008 percent $Na_2S_2O_3$ is only required when residual chlorine is present.
* E = *Methods for Chemical Analysis of Water and Wastes* (EPA); SW = SW846

Table B2-1 Requirements for Containers, Preservation Techniques, Sample Volumes, and Holding Times - Continued

Name	Analytical Methods*	Container[a]	Preservation[b]	Minimum Sample Volume or Weight	Maximum Holding Time
Chlorinated herbicides	SW8151A	G, Teflon-lined cap, T	4°C	1 liter or 8 ounces	7 days until extraction and 40 days after extraction (water); 14 days until extraction and 40 days after extraction (soil)
Organochlorine pesticides and polychlorinated biphenyls (PCBs)	SW8081A (pesticides), SW8082 (PCBs)	G, Teflon-lined cap, T	4°C	1 liter or 8 ounces	7 days until extraction and 40 days after extraction (water); 14 days until extraction and 40 days after extraction (soil)
Organophosphorus pesticides/ compounds	SW8141A	G, Teflon-lined cap, T	4°C	1 liter or 8 ounces	7 days until extraction and 40 days after extraction (water); 14 days until extraction and 40 days after extraction (soil)
Semivolatile organics	SW8270C	G, Teflon-lined cap, T	4°C, 0.008% $Na_2S_2O_3$[d]	1 liter or 8 ounces	7 days until extraction and 40 days after extraction (water); 14 days until extraction and 40 days after extraction (soil)
Volatile organics	SW8260B	G, amber, T (teflon lined septum for water; 40 ml teflon lined	4°C, HCl to pH < 2 (pH adjust for water only)	2 x 40 mL vials	14 days (7 days if unpreserved by acid) for water; 48 hours for soils (14 days if preserved by lab following TCEQ Method 5035 SOP)

a. Polyethylene (P); glass (G); brass sleeves in the sample barrel, sometimes called California brass (T).
b. No pH adjustment for soil.
c. Measurement should be performed on site.
d. Preservation with 0.008 percent $Na_2S_2O_3$ is only required when residual chlorine is present.
* E = *Methods for Chemical Analysis of Water and Wastes* (EPA); SW = SW846

Table B2-1 Requirements for Containers, Preservation Techniques, Sample Volumes, and Holding Times - Concluded

Name	Analytical Methods	Container[a]	Preservation[b]	Minimum Sample Volume or Weight	Maximum Holding Time
Polynuclear aromatic hydrocarbons (PAHs)	SW8310	G, Teflon-lined cap, T	4°C, store in dark, 0.008% $Na_2S_2O_3$[d]	1 liter or 8 ounces	7 days until extraction and 40 days after extraction (water); 14 days until extraction and 40 days after extraction (soil)
Dioxins and furans	SW8280A, SW8290	G, Teflon-lined cap, T	4°C, 0.008% $Na_2S_2O_3$[d] (kept dark)	1 liter or 8 ounces	30 days until extraction and 45 days after extraction (water and soil)
Ethylene dibromide (EDB)	SW8011	G, Teflon-lined cap, T	4°C, 0.008% $Na_2S_2O_3$[d]	2 x 40 mL	28 days (water)
Explosive residues	SW8330	P, G, T	Cool, 4°C	1 liter or 8 ounces	7 days to extraction (water); 14 days to extraction (soil); analyze-within 40 days after extraction
TCLP	SW1311	G, Teflon-lined cap, T	Cool, 4°C	1 liter or 8 ounces	14 days to TCLP extraction and 14 days after extraction (volatiles); 14 days to TCLP extraction, 7 days to prep extraction and 40 days after prep extraction (semivolatiles); 28 days to TCLP extraction and 28 days after extraction (mercury); 180 days to TCLP extraction and 180 days after extraction (metals)
SPLP	SW1312	G, Teflon-lined cap, T	Cool, 4 °C	1 liter or 8 ounces	14 days to SPLP extraction and 14 days after extraction (volatiles); 14 days to SPLP extraction, 7 days to prep extraction and 40 days after prep extraction (semivolatiles); 28 days to SPLP extraction and 28 days after extraction (mercury); 180 days to SPLP extraction and 180 days after extraction (metals)
Volatile Organics	TO-14A	SUMMA® canister	None	NA	14 days to analysis

a. Polyethylene (P); glass (G); brass sleeves in the sample barrel, sometimes called California brass (T).
b. No pH adjustment for soil.
c. Measurement should be performed on site.
d. Preservation with 0.008 percent $Na_2S_2O_3$ is only required when residual chlorine is present.
* E = *Methods for Chemical Analysis of Water and Wastes* (EPA); SW = SW846

B.3 Sample Handling and Custody

B.3.1 Field Sample Handling and Custody

Sample handling and custody requirements prior to samples being received at the analytical laboratory are contained in Section 5 of the FSP. Sample holding time tracking begins with the collection of samples and continues until the analysis is complete. Holding times are specified in Table B2-1. If the holding time for a sample is specified in hours up to 48 hours, the time (i.e., hours and minutes) and the date shall be included on the sample label and field chain-of-custody document. At TCEQ's discretion, samples not preserved or analyzed in accordance with these requirements shall be recollected and analyzed, at no additional cost to TCEQ.

B.3.2 Laboratory Sample Handling and Custody

The laboratory quality assurance manual and associated laboratory SOPs shall specify the laboratory sample handling and custody requirements to be followed. These requirements shall be generally consistent with NELAC. In addition, the following procedures shall be adhered to:

Once the samples reach the laboratory, they shall be checked for anomalies against information on the C-O-C form contained in each cooler. The condition, temperature, and appropriate preservation of samples shall be checked and documented on the C-O-C form. Appropriate temperature measuring methods include measurement of the temperature of a temperature blank contained in the cooler. Infrared temperature measurement of an aqueous sample is also acceptable. If ice is found to be present in the cooler upon receipt, the laboratory shall also note this on the C-O-C form and may consider this an adequate indication that the cooler temperature is not above the acceptance criterion of 6°C. Checking an aliquot of the sample using pH paper is an acceptable procedure for checking acid/base preservation, except for sample containers to be used for VOC analysis, where an additional sample is required to check preservation. The occurrence of any anomalies in the received samples and the resolution of these anomalies shall be documented in laboratory records and the Exception Reports submitted with the Laboratory Review Checklist. All sample information shall be entered into a tracking system, and unique laboratory analytical sample identifiers shall be assigned. A copy of this information shall be reviewed by the laboratory for accuracy.

Procedures ensuring internal laboratory C-O-C shall also be implemented and documented by the laboratory. Specific instructions concerning the analysis specified for each sample shall be communicated to the analysts. Analytical batches shall be created, and laboratory QC samples shall be introduced into each batch.

While in the laboratory, samples shall be stored in limited-access, temperature-controlled areas. Refrigerators, coolers and freezers shall be monitored for temperature daily. The acceptance criterion for the temperatures of the refrigerators and coolers is 0.1 to 6°C. Acceptance criteria for the temperatures of the freezers shall be less than 0°C. All of the cold storage areas shall be monitored by thermometers or other temperature monitoring devices that have been calibrated

against a NIST-traceable thermometer. As indicated by the findings of the calibration, correction factors shall be applied to each thermometer. Records that include acceptance criteria shall be maintained. All samples shall be stored separately from standards. Samples for volatile organics determination shall be stored separately from other samples, standards, and sample extracts. Samples shall be stored after analysis until disposed of in accordance with applicable local, state, and federal regulations. Prior to disposal the laboratory shall contact the prime contractor. Disposal records shall be maintained by the laboratory.

B.4 Analytical Methods

Analytical methods covered by this QAPP are split into two types of methods: screening methods and definitive methods. The screening methods are generally designed for use in the field, although several laboratory methods are also classified as screening methods based on the generally lower level of required QC analyses. Methods considered routine screening methods and definitive preparation and analysis methods are described in Element B.4 and B.5, respectively. Section 8 of the FSP includes alternative or additional standard analytical methods to be used based on project requirements. The specific analytical methods to be used are listed, including specific options within a method to be used, when such options exist.

Section 8 of the FSP identifies nonstandard sampling methods, sample matrices, or other unusual situations that will be used or encountered during this project and specifies the type of validation study data needed for the project. The appropriate method validation study information shall be provided to confirm the performance of the method for the particular matrix and to assess the potential impact on the representativeness of the data generated. Qualitative data from a modified method will not require rigorous validation unless specified in Section 8 of the FSP. Quantitative data will require more rigorous validation studies, unless otherwise specified in Section 8 of the FSP. Available validation studies for these non-standard methods, including round-robin studies performed by EPA or by other organizations, shall be referenced in Section 8 of the FSP. If previous validation studies are not available, the level of single-user validation study or ruggedness study shall be specified in Section 8 of the FSP and shall be performed during the project and included as part of the project's final report.

B.4.1 Screening Methods

Table B4-1 in the QAPP provides a listing of commonly used screening methods. These methods and QC procedures were taken from *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (U.S. EPA SW-846, Third Edition, and its first, second and third update) noted as "SW", *Methods for Chemical Analysis of Water and Waste* (EPA 600) noted as "E", *American Society of Testing Materials Annual Book of Standards* (1993) noted as "ASTM", and from manufacturers' literature. A brief description of each of the methods included in the table is provided below in this element.

Table B4-1. Screening Analytical Methods

Method	Parameter
SW846 (Section 7.2 of SW3550)	Moisture
SW1020A	Ignitability (for liquids)
SW1030	Ignitability (for solids)
SW1110B	Corrosivity
SW9040B	pH (water)
SW9045C	pH (soil)
SW9050A	Specific Conductance
D6317-98	Total Carbon
D6317-98	Total Inorganic Carbon
SW9060	Total Organic Carbon
E160.1	Filterable Residue
E160.2	Nonfilterable Residue
E170.1	Temperature
E180.1	Turbidity
E310.1	Alkalinity
E360.1	Dissolved oxygen
E413.1	Oil and Grease
ASTM D422	Particle size
ASTM D1498	Oxidation-reduction potential
SW4020	PCBs by Immunoassay
SW4030	TPH by Immunoassay
Field Test Kit Method	Ferrous Iron

B.4.1.1 SW-846 (Described in Method SW3550, Section 7.2)–Percent Moisture

Percent moisture is determined for solid samples undergoing analysis for inorganic and organic analytes. The sample is weighed, dried, and then reweighed. Percent moisture is calculated as:

$$\%\ Moisture = \frac{Initial\ Weight - Dried\ Weight}{Initial\ Weight} \times 100$$

The moisture content is used to calculate results for soil samples on a dry weight basis using the calculation presented below:

$$Results\ of\ analysis\ on\ a\ dry\ weight\ basis = \frac{Result\ of\ analysis\ on\ wet\ weight\ basis}{1 - (\%\ Moisture/100)}$$

All soil or sediment results and SQLs shall be reported on a dry weight basis.

B.4.1.2 EPA Method SW1020A–Ignitability

Method 1020A makes use of the Setaflash Closed Tester to determine the flash point of liquids that have flash points between 0° and 110°C and viscosities lower than 150 stokes at 25°C.

B.4.1.3 EPA Method SW1030–Ignitability of Solids

In a preliminary test, the test material is formed into an unbroken strip or powder train 250 mm in length. An ignition source is applied to one end of the test material to determine whether combustion will propagate along 200 mm of the strip within a specified time period. Materials that propagate burning along a 200 mm strip within the specified time period are then subjected to a burning rate test. Materials that do not ignite or propagate combustion as described above do not require further testing. In the burning rate test, the burning time is measured over a distance of 100 mm and the rate of burning is determined. The test method described here is based on the test procedure adopted by the Department of Transportation from the United Nations regulations for the international transportation of dangerous goods and is contained in Appendix E to Part 173 of 49 CFR.

B.4.1.4 EPA Method SW1110–Corrosivity

This test exposes steel to liquid waste to determine the corrosivity of the waste.

B.4.1.5 EPA Method SW9040B (water)/SW9045C (soil)–pH

Measurements of pH shall be performed for water samples using Method SW9040B. pH measurements of soil samples are performed using Method SW9045C. Measurements are determined electrometrically using either a glass electrode in combination with a reference potential, or a combination electrode.

B.4.1.6 EPA Method SW9050A–Specific Conductance

Standard conductivity meters are used. Temperature is also reported. Results are corrected to 25°C.

B.4.1.7 ASTM Method D6317-98 –Total Carbon and Total Inorganic Carbon

This test method covers the determination of total carbon (TC), inorganic carbon (IC), and total organic carbon (TOC) in water in the range from 10 to 1000 µg/L of carbon. This method is for laboratory or grab sample applications. The test method utilizes persulfate or ultraviolet oxidation of organic carbon, or both coupled with a CO_2 selective membrane to recover the CO_2 into deionized water. The change in conductivity of the deionized water is measured and related to carbon concentration in the oxidized sample. Inorganic carbon is determined in a similar manner without the oxidation step. In both cases, the sample is acidified to facilitate CO_2 recovery through the membrane. The relationship between the conductivity measurement and the carbon concentration is described by a set of chemometric equations for the chemical equilibrium of CO_2, HCO_3^-, and H^+, and the relationship between the ionic concentrations and the conductances resulting in linear response of the method over the stated range of TOC.

B.4.1.8 EPA Method SW9060–Total Organic Carbon

Organic carbon is measured using a carbonaceous analyzer. This instrument converts the organic carbon in a sample to carbon dioxide (CO_2) by either catalytic combustion or wet chemical oxidation. The CO_2 formed is then either measured directly by an infrared detector or converted to methane (CH_4) and measured by a flame ionization detector. The amount of CO_2 or CH_4 in a sample is directly proportional to the concentration of carbonaceous material in the sample.

B.4.1.9 EPA Method 160.1–Filterable Residue

A well-mixed sample is filtered through a standard glass fiber filter. The filtrate is evaporated and dried to constant weight at 180 °C. If non-filterable residue is being determined, the filtrate from that method may be used for the filterable residue determination.

B.4.1.10 EPA Method 160.2–Nonfilterable Residue.

A well-mixed sample is filtered through a glass fiber filter, and the residue retained on the filter is dried to constant weight at 103-105°C. The filtrate from this method may be used to determine the filterable residue.

B.4.1.11 EPA Method 170.1–Temperature

Temperature measurements are made with a mercury-filled or dial type centigrade thermometer, or a thermistor.

B.4.1.12 EPA Method 180.1–Turbidity

This method is based on a comparison of the light scattered by the sample under defined conditions with the light intensity scattered by a standard reference suspension. The higher the intensity, the greater the turbidity. Turbidity measurements are made in a nephelometer and are reported in terms of nephelometric turbidity units (NTUs). The working range for the method is from 0–40 NTU. Higher levels of turbidity can be measured by diluting the sample with turbidity-free deionized water.

B.4.1.13 EPA Method 310.1–Alkalinity

In this method, an unaltered sample is titrated to an end point of pH 4.5 using hydrochloric or sulfuric acid.

B.4.1.14 EPA Method 360.1–Dissolved Oxygen

An instrumental probe, usually dependent upon an electrochemical reaction, is used for determination of dissolved oxygen in water. Under steady-state conditions, the current or potential can be correlated with dissolved oxygen concentrations.

B.4.1.15 ASTM D422–Standard Method for Particle-Size Analysis of Soils

This method covers the quantitative determination of the distribution of particle sizes in soils. The distribution of particle sizes larger than 75 μm (retained on the No. 200 sieve) is determined by sieving, while the distribution of particle sizes smaller than 75 μm is determined by a sedimentation process using a hydrometer.

B.4.1.16 ASTM D1498-93–Oxidation-Reduction Potential

This method is designed to measure the oxidation-reduction potential (ORP) in water, which is defined as the electromotive force between a noble metal electrode and a reference electrode when immersed in a solution.

B.4.1.17 Method SW4020–Screening for Polychlorinated Biphenyls by Immunoassay

Soil samples are screened for total polychlorinated biphenyls (PCBs) using immunoassay test kits. A mini methanol extraction of the soil sample is performed, and the extract and an enzyme conjugate reagent are added to immobilized antibodies. The enzyme conjugate competes with the PCBs in the sample for binding to immobilized anti-PCB antibodies. The test is interpreted by comparing the response produced by the sample to the response produced by a standard.

B.4.1.18 Method SW4030–Screening for Petroleum Hydrocarbons by Immunoassay

Soil samples are screened for levels of total petroleum hydrocarbons (TPH) using TPH test kits. A mini extraction of the soil sample is performed, and the extract and an enzyme conjugate reagent are added to immobilized antibodies. The enzyme conjugate competes with hydrocarbons for binding to immobilized anti-hydrocarbon antibodies. The test is interpreted by comparing the response produced by the sample to the response produced by a standard.

B.4.1.19 Ferrous Iron

Aqueous samples are screened for ferrous iron concentrations using field test kits. The analytical method utilizes a field-portable colorimeter measurement on an unfiltered water sample.

B.4.2 Definitive Preparation Methods

Below in this element is a brief description of some common preparation methods. Element B.4.3 contains brief descriptions for some common analytical procedures, and Element B.5 includes associated quality control criteria and procedures.

The information in these elements was obtained from the *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (U.S. EPA SW-846, Third Edition, and its first, second and third update);

Project-specific extraction and digestion procedures for liquid and solid matrices are included in Section 8 of the FSP. Commonly used extraction and digestion procedures for liquid and solid matrices are presented in Table B4-2 in this element. The preparation methods which are applicable for each analytical method are present in Table B4-3 in this element.

Table B4-2. Extraction and Digestion Procedures

Method*	Parameter
SW1311	Toxicity Characteristic Leaching Procedure
SW1312	Synthetic Precipitation Leaching Procedure
SW3005A	Acid Digestion of Waters for Total Recoverable or Dissolved Metals for Analysis by FLAA or ICP Spectroscopy
SW3010A	Acid Digestion of Aqueous Samples and Extracts for Total Metals for Analysis by FLAA or ICP Spectroscopy
SW3015	Microwave Assisted Acid Digestion of Aqueous Samples and Extracts
SW3020A	Acid Digestion of Aqueous Samples and Extracts for Total Metals for Analysis by GFAA Spectroscopy
SW3050B	Acid Digestion of Sediments, Sludges and Soils
SW3051	Microwave Assisted Acid Digestion of Sediments, Sludges, Soils and Oils
SW3060A	Alkaline Digestion of Soils, Sediments, Sludges and Industrial Wastes for Hexavalent Chromium
SW3510C	Separatory Funnel Liquid-Liquid Extraction
SW3520C	Continuous Liquid-Liquid Extraction
SW3540C/SW3541	Soxhlet Extraction/Automated Soxhlet Extraction
SW3550B	Ultrasonic Extraction
SW5030B	Purge and Trap (aqueous samples)
TCEQ SOP for SW5035	Purge and Trap (sediment, sludge, and soil samples)

* SW denotes a method found in SW-846 (Test Methods for Evaluating Solid Waste, Physical and Chemical Methods, U.S. EPA SW-846, Third Edition, and its first and second update)

B.4.2.1 Method SW1311–Toxicity Characteristic Leaching Procedure

Method SW1311 is used to prepare samples for determining whether a waste or other material which is being classified for land disposal is considered a characteristic hazardous waste due to leachability of organic and inorganic constituents. The TCLP is also used for initial waste determinations to determine if a waste is hazardous for the characteristic of toxicity.

QC is accomplished by preparing a toxicity characteristic leaching procedure (TCLP) blank at a rate of one blank for every 20 extractions conducted in the extraction vessel. Additional extract is prepared so one MS is performed for each waste type (samples of similar waste types shall be batched together). One MS must be analyzed in each project analytical batch. These QA measures are in accordance with the requirements of EPA Method SW1311, Section 8.0.

B.4.2.2 Method SW1312–Synthetic Precipitation Leaching Procedure

This method is used to prepare samples for determining the mobility of organic and inorganic constituents in liquids, soils and wastes which are to be left in place at a site.

QC is accomplished by preparing a synthetic precipitation leaching procedure (SPLP) blank at the rate of one blank for every 20 extractions conducted in the extraction vessel. A matrix spike is performed on an extract from each waste type (samples of similar waste types shall be batched together). One MS must be analyzed in each project analytical batch. The use of internal calibration quantitation methods shall be used for metallic contaminants if: 1) the recovery of the contaminant from the SPLP extract is below 50%, and 2) the concentration of the contaminant is below but within 20% of the regulatory level. These QA measures are in accordance with the requirements of EPA SW1312, Section 8.0.

B.4.2.3 Method SW3005A–Acid Digestion of Waters for Total Recoverable or Dissolved Metals for Analysis by FLAA or ICP Spectroscopy

This method is an acid digestion procedure used to prepare water samples for metals analysis. The digested samples are analyzed for total recoverable and dissolved metals determination by either flame atomic absorption (FLAA) or inductively coupled plasma (ICP).

For analysis of total recoverable metals, the entire sample is acidified at collection time. For dissolved metals, the sample is filtered and filtrate is then acidified. An unfiltered sample analysis shall generally be required for groundwater samples.

B.4.2.4 Method SW3010A–Acid Digestion of Aqueous Samples and Extracts for Total Metals for Analysis by FLAA or ICP Spectroscopy

Method SW3010A prepares aqueous or waste samples for total metals determination by FLAA or ICP. The samples are vigorously digested with acid and then diluted.

B.4.2.5 Method SW3015–Microwave Assisted Acid Digestion of Aqueous Samples and Extracts

This method is used to prepare aqueous or waste samples, that contain suspended solids, for total metals determination by graphite furnace atomic absorption spectroscopy (GFAA), FLAA or ICP. The samples are digested with acid and heated in a microwave.

B.4.2.6 Method SW3020A–Acid Digestion of Aqueous Samples and Extracts for Total Metals for Analysis by GFAA Spectroscopy

Method SW3020A prepares aqueous or waste samples for total metals determination by GFAA or ICP. The samples are vigorously digested with acid and then diluted.

B.4.2.7 Method SW3050B–Acid Digestion of Sediments, Sludges, and Soils

Method SW3050B contains two digestion procedures. One is applicable to the preparation of sediment, sludge, and soil samples for metals analysis by FLAA or ICP. The other is applicable to the preparation of sediment, sludge, and soil samples for metals analysis by GFAA or ICP/MS. A sample is repeatedly treated with nitric acid and hydrogen peroxide. For analyses by FLAA or ICP, the digestate is also treated with hydrochloric acid. A separate aliquot of the sample is dried for a total solids and/or percent moisture determination.

B.4.2.8 Method SW3051–Microwave Assisted Acid Digestion of Sediments, Sludges, Soils, and Oils

Method SW3051 is applicable to the preparation of sediment, sludge, and soil samples for metals analysis by FLAA or GFAA or ICP. The samples are digested with acid and heated in a microwave. A separate aliquot of the sample is dried for a total solids and/or percent moisture determination.

B.4.2.9 Method SW3060A–Alkaline Digestion of Soils, Sediments, Sludges and Industrial Wastes for Hexavalent Chromium.

This method uses an alkaline digestion to solubilize both water-insoluble (with the exception of partial solubility of barium chromate in some soil matrices) and water soluble Cr(VI) compounds in solid waste samples. This is the only acceptable digestion procedure to prepare soil or sediment samples for hexavalent chromium analysis.

B.4.2.10 Method SW3510C–Separatory Funnel Liquid-Liquid Extraction

Method SW3510C is designed to quantitatively extract nonvolatile and semivolatile organic compounds from liquid samples using standard separatory funnel techniques. The sample and the extracting solvent must be immiscible in order to yield recovery of target compounds.

Subsequent cleanup and detection methods are described in the organic analytical method used to analyze the extract.

B.4.2.11 Method SW3520C–Continuous Liquid-Liquid Extraction

Method SW3520C is a procedure for isolating nonvolatile and semivolatile organic compounds from aqueous samples and is designed for extraction solvents with greater density than the sample.

B.4.2.12 Method SW3540C/SW3541–Soxhlet Extraction/Automated Soxhlet Extraction

Method SW3540C is a procedure for extracting nonvolatile and semivolatile organic compounds from solids such as soils and sludges. Method SW3541 is an automated Soxhlet extraction. The Soxhlet extraction process ensures intimate contact of the sample matrix with the extraction solvent.

B.4.2.13 Method SW3550B–Ultrasonic Extraction

Method SW3550B is a procedure for extracting nonvolatile and semivolatile organic compounds from solids such as soils and sludges. The sonication process ensures intimate contact of the sample matrix with the extraction solvent.

B.4.2.14 Method SW5030B–Purge and Trap Method for Aqueous Samples

Method SW5030B describes sample preparation and extraction for the analysis of VOCs. The method is applicable to aqueous and water miscible liquid samples. The success of this method depends on the level of interferences in the sample.

An inert gas is bubbled through the sample solution at ambient temperature to transfer the volatile components to the vapor phase. The vapor is swept through a sorbent column where the volatile components are trapped. After purging is completed, the sorbent column is heated and backflushed with inert gas to desorb the components onto a GC column.

B.4.2.15 Method SW5035–Closed-System Purge and Trap and Extraction for Volatile Organics in Soil and Waste Samples

This method describes a closed-system purge-and-trap process for the analysis of volatile organic compounds (VOCs) in solid materials (e.g., soils, sediments, and solid waste). While the method is designed for use on samples containing low levels of VOCs, procedures are also provided for collecting and preparing solid samples containing high concentrations of VOCs and for oily wastes. For these high concentration and oily materials, sample collection and preparation are performed using the procedures described here, and sample introduction is performed using the aqueous purge-and-trap procedure given in Method SW5030B. These procedures may be used in

conjunction with any appropriate determinative gas chromatographic procedure, including, but not limited to, Methods SW8015, SW8021B, and SW8260B.

B.4.3 Definitive Analysis Methods

Some common analytical procedures are listed in Table B4-3, with associated quality assurance measures and quality control limits that can be used as default criteria during implementation of these methods described in Element B.5 of this QAPP. All soil sample results shall be reported on a dry weight basis.

Use of other analytical methods not included in this element are specified in Section 8 of the FSP. All associated method QC criteria for those methods are presented in Section 8 of the FSP to the same level of detail as presented in this Element B. If the FSP does not specify the project-specific analytes, all analytes included on the analyte list as specified for each method below shall be reported by the laboratory.

Table B4-3. Definitive Analytical Procedures

Analytical Method*	Parameter	Preparatory Methods
SW8011	Ethylene dibromide (EDB) (water)	8011, 5030B, 5035
TCEQ 1005	TPH volatile and extractable (water and soil)	
SW8021B	Halogenated volatile organics (water and soil)	5030B, 5035
SW8070A	Nitrosamines (water and soil)	3510C, 3520C, 3540C, 3541, 3550B
SW8081A	Organochlorine pesticides and PCBs (water and soil)	3510C, 3520C, 3540C, 3541, 3550B
SW8082	Polychlorinated Biphenyls (water and soil)	3510C, 3520C, 3540C, 3541, 3550B
SW8141A	Organophosphorus compounds (water and soil)	3510C, 3520C, 3540C, 3541, 3550B
SW8151A	Chlorinated herbicides (water and soil)	3510C, 3520C, 3540C, 3541, 3550B
SW8260B	Volatile organics (water and soil)	5030B, 5035
SW8270C	Semivolatile organics (water and soil)	3510C, 3520C, 3540C, 3541, 3550B
SW8280A/8290	Dioxins and furans (water and soil)	(see analytical method)
SW8310	Polynuclear aromatic hydrocarbons (PAHs) (water and soil)	3510C, 3520C, 3540C, 3541, 3550B
SW8330	Explosive residues (water and soil)	3510C, 3520C, 3540C, 3541, 3550B
SW6010B	Trace metals by ICP (water and soil)	3005A, 3010A, 3015, 3050B, 3051
SW6020A	Trace metals by ICP-MS (water and soil)	3005A, 3010A, 3015, 3050B, 3051
SW7041	Antimony (water and soil)	(see analytical method)
SW7060A	Arsenic (water and soil)	(see analytical method), 3050B, 3051
SW7131A	Cadmium (water and soil)	3015, 3020A, 3051
SW7191	Chromium (water and soil)	3015, 3020A, 3051
SW7196A	Hexavalent chromium	3060A
SW7421	Lead (water and soil)	3015, 3020A, 3051
SW7470A	Mercury (water)	(see analytical method)
SW7471A	Mercury (soil)	(see analytical method)
SW7740	Selenium (water and soil)	(see analytical method), 3050B
SW7841	Thallium (water and soil)	3015, 3020A, 3051
SW7911	Vanadium (water and soil)	3015, 3020A, 3051
SW9010B/ SW9012A	Cyanide (water)	(see analytical method)
SW9056A	Common anions	N/A
TO-14A	Volatile Organics in Ambient Air	N/A

* SW denotes a method found in SW-846 (Test Methods for Evaluating Solid Waste, Physcial and Chemical Methods, U.S. EPA SW-846, Third Edition, and its first and second update)

B.4.4 Non-standard Method Validation

The specifications for non-standard method validation are described in Element A.9.2.2.11 above and included in Section 8 of the FSP.

B.5 Quality Control

Quality control measures and criteria for some common methods are included in this element below. The QC criteria specified are for laboratory analysis and review and are not intended for use during independent data review and validation. The QC criteria to be used during data review are described in detail in Element D. Element B.5 contains default QC limits to be used by the laboratory for evaluating analyses relative to the contract and method requirements. Any person conducting analyses under this QAPP shall determine, during implementation of the DQO process for each project, whether the default QC limits are sufficient to meet the individual project objectives.

B.5.1 Definitive Analytical Methods

Element B.5.1 contains subelements for some commonly used analytical procedures. A brief description and three tables for each method are included in the following subelements. The first table presents the method quantitation limits (MQLs) for each analyte in the method. The MQLs are presented for both soil and water matrices. The second table presents default acceptance criteria for the accuracy of spiked analyte and surrogate recoveries. If laboratory control limits based on historic data are more stringent than those contained in these tables, the laboratory control limits shall be used. This second table also presents the default acceptance criteria for the precision of matrix, field, and laboratory duplicate recoveries. The third table presents the calibration and QC procedures for each method.

In the third table, the first two columns designate the method number and the class of analytes that may be determined by the method. The third column lists the method-required calibration and QC elements. The fourth column designates the minimum frequency for performing each calibration and QC element. The fifth column designates the acceptance criteria for each calibration and QC element. The sixth column designates the corrective action in the event that a calibration or QC element does not meet the acceptance criteria.

This information was generally obtained from the Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (U.S. EPA SW-846, Third Edition, and its first, second and third update) and HQ Air Force Center for Environmental Excellence Quality Assurance Project Plan, v3.1, August 2001.

B.5.1.1 Method SW8011-Ethylene Dibromide

Ethylene dibromide (EDB) in water is analyzed using Method SW8011. The sample is extracted with hexane. The extract is injected into a GC with a linearized electron capture detector for separation and analysis.

This method provides for the use of a second GC column of dissimilar phase to resolve compounds of interest from interferences that may occur. When second-column analysis is performed, retention times for the analyte must match those established for each column. Otherwise, the chromatographic peaks are considered interferences, and the analyte is not considered to be present in the sample.

Table B5.1.1-1. MQL for Method SW8011

Parameter/Method	Analyte	Water	
		MQL	Unit
SW8011	Ethylene dibromide	0.02	µg/L

Table B5.1.1-2. QC Acceptance Criteria for Method SW8011

Method	Analyte	Accuracy Water (% R)	Precision Water (RPD)
SW8011	Ethylene dibromide	80-120	≤ 20
	Surrogate:		
	1,2-Dibromopropane	70-120	
	or		
	1,2-Dichloropropane	70-120	

Table B5.1.1-3. Summary of Calibration and QC Procedures for Method SW8011

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
SW8011	Ethylene dibromide	Five-point initial calibration for all analytes.	Initial calibration prior to sample analysis.	linear - mean RSD ≤ 20%.	Correct problem then repeat initial calibration.
				linear – least squares regression r > 0.995.	
				non-linear – COD ≥ 0.990 (6 points shall be used for second order, 7 points shall be used for third order).	
		Second-source calibration verification.	Once per five-point initial calibration.	All analytes within ±15% of expected value.	Correct problem then repeat initial calibration.
		Retention time window calculated for each analyte.	Each initial calibration and calibration verifications.	± 3 times standard deviation for each average analyte retention time from 72-hour study.	Correct problem then reanalyze all samples analyzed since the last retention time check.
		Initial calibration verification.	Daily, before sample analysis.	All analytes within ±15% of expected value.	Correct problem then repeat initial calibration.
		Calibration blank.	Once per initial daily multipoint calibration.	No analyte detected ≥ MQL.	Correct problem then reanalyze calibration blank and all samples associated with blank.
		Calibration verification.	After every 10 samples and at the end of the analysis sequence.	All analytes within ±15% of expected value.	Correct problem then repeat initial calibration verification and reanalyze all samples since last successful calibration verification.
		Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample.	Once per analyst.	QC acceptance criteria, Table B5.1.1-2.	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria.

Table B5.1-3. (Concluded)

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
SW8011	Ethylene dibromide	Method blank.	One per analytical batch.	No analytes detected ≥ MQL.	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank.
		LCS for all analytes.	One LCS per analytical batch.	QC acceptance criteria, Table B5.1.1-2.	Correct problem then reprep and analyze the LCS and all samples in the affected analytical batch.
		Surrogate spike.	Every sample, spiked sample, standard, and method blank.	QC acceptance criteria, Table B5.1.1-2.	Method 8000, Section 8.6 Requirements. Describe in Laboratory Review Checklist.
		MS/MSD.	One MS/MSD per every 20 project samples per matrix.	QC acceptance criteria, Table B5.1.1-2.	Describe in Laboratory Review Checklist.
		Second-column confirmation.	100% for all positive results.	Same as for initial or primary column analysis.	Same as for initial or primary column analysis.
		MDL study.	Once per 12 month period.	Detection limits established shall be ≤ ½ the MQLs in Table B5.1-1.	None.

a. All corrective actions associated with TCEQ project work shall be documented, and all records shall be maintained by the laboratory.

B.5.1.2 TCEQ 1005-Volatile and Extractable Total Petroleum Hydrocarbons

Method 1005 has been designed by the Petroleum Storage Tank Program of the TCEQ as a replacement for EPA Method 418.1 to determine the concentration of total petroleum hydrocarbons (TPH) in soil and groundwater. Method 1005 is a gas chromatographic method which uses flame ionization as the method of detection. The method reports the concentration of hydrocarbons in the following boiling point ranges for each sample: $C_6 - C_{12}$, $>C_{12} - C_{28}$, and $C_6 - C_{28}$. When applicable to the project objectives, the $>C_{28} - C_{35}$ and the $C_6 - C_{35}$ ranges shall be reported. These boiling point ranges cover the aromatic hydrocarbons (benzene, toluene, ethylbenzene, and xylenes (BTEX)) and polycyclic aromatic hydrocarbons (PAHs) typically of concern in petroleum fuels.

This method should be used by, or under the supervision of, analysts experienced in the use of solvent extraction and gas chromatography. The analysts should also be skilled in the interpretation of capillary gas chromatography data (specifically petroleum hydrocarbon pattern recognition), quantitation using computerized data acquisition, and use of peak processing software with baseline and peak grouping functions.

Second column confirmation is not required.

Table B5.1.2-1. MQLs for Method TCEQ 1005

Parameter/Method	Analyte	Water		Soil	
		MQL	Unit	MQL	Unit
Petroleum Hydrocarbons TCEQ 1005	TPH	5	mg/L	50	mg/kg

Table B5.1.2-2. QC Acceptance Criteria for Method TCEQ 1005

Method	Analyte	Accuracy Water (% R)	Precision Water (RPD)	Accuracy Soil (%R)	Precision Soil (RPD)
TCEQ 1005	TPH	70-130	≤ 30	70-130	≤ 50

Table B5.1.2-3. Summary of Calibration and QC Procedures for Method TCEQ 1005

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
TCEQ 1005	Total Petroleum Hydrocarbons	Minimum five-point initial calibration.	Initial calibration prior to sample analysis.	Mean RSD for TPH ≤25% or correlation coefficient for linear regression ≥0.995.	Correct problem then repeat initial calibration.
		Calibration verification.	Daily, before sample analysis.	RPD ≤25% of expected value.	Correct problem then repeat initial calibration.
		Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample.	Initially prior to analysis of any samples and in response to changes in staff, instrumentation, or operations.	QC acceptance criteria, Section 8.2 of analytical method.	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria.
		Method blank.	One per analytical batch.	No TPH detected ≥ MQL.	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank.
		LCS for all analytes.	One LCS per analytical batch.	QC acceptance criteria, Table B5.1.2-2.	Correct problem then reprep and analyze the LCS and all samples in the affected analytical batch.
		MS/MSD.	One MS/MSD per every 20 project samples per matrix.	QC acceptance criteria, Table B5.1.2-2.	None.
		Retention time window check.	Once per analytical batch.	Per Section 7.2.2 of the Analytical Method.	Correct problem then reanalyze all samples analyzed since the last retention time check.
		MDL study.	Once per 12 month period.	Detection limits established shall be ≤ ½ the MQLs in Table B5.1.2-1.	None.

a. All corrective actions associated with project work shall be documented, and all records shall be maintained by the laboratory.

B.5.1.3 Method SW8021B- Aromatic and Halogenated Volatile Organics

Aromatic and halogenated volatile organics in water and soil samples are analyzed using Method SW8021B. This method is a purge and trap GC method using preparation Method SW5030B or SW5035. A temperature program is used in the GC to separate the compounds. Detection is achieved by a PID and an electrolytic conductivity detector (HECD) in series.

For analytes detected by both detectors, no further confirmation need be performed. For analytes detected by only one detector, confirmation on another column is required.

Table B5.1.3-1. MQLs for Method SW8021B

Parameter/Method	Analyte	Water		Soil	
		MQL	Unit	MQL	Unit
Aromatic and Halogenated Volatile Organics SW8021B	1,1,1,2-Tetrachloroethane	0.50	µg/L	0.01	mg/kg
	1,1,1-Trichloroethane	1.0	µg/L	0.01	mg/kg
	1,1,2,2-Tetrachloroethane	0.50	µg/L	0.01	mg/kg
	1,1,2-Trichloroethane	0.50	µg/L	0.01	mg/kg
	1,1-Dichloroethane	1.0	µg/L	0.01	mg/kg
	1,1-Dichloroethene	1.0	µg/L	0.01	mg/kg
	1,1-Dichloropropene	1.0	µg/L	0.01	mg/kg
	1,2,3-Trichlorobenzene	1.0	µg/L	0.01	mg/kg
	1,2,3-Trichloropropane	4.0	µg/L	0.01	mg/kg
	1,2,4-Trichlorobenzene	1.0	µg/L	0.01	mg/kg
	1,2,4-Trimethylbenzene	1.0	µg/L	0.01	mg/kg
	1,2-Dibromo-3-chloropropane	30	µg/L	0.03	mg/kg
	1,2-Dibromoethane	8.0	µg/L	0.02	mg/kg
	1,2-Dichloroethane	0.30	µg/L	0.01	mg/kg
	1,2-Dichlorobenzene	1.0	µg/L	0.01	mg/kg
	1,2-Dichloropropane	1.0	µg/L	0.01	mg/kg
	1,3,5-Trimethylbenzene	1.0	µg/L	0.01	mg/kg
	1,3-Dichlorobenzene	1.0	µg/L	0.01	mg/kg
	1,3-Dichloropropane	0.30	µg/L	0.01	mg/kg
	1,4-Dichlorobenzene	0.50	µg/L	0.01	mg/kg
	2,2-Dichloropropane	1.0	µg/L	0.01	mg/kg
	2-Chlorotoluene	1.0	µg/L	0.01	mg/kg
	4-Chlorotoluene	1.0	µg/L	0.01	mg/kg
	Benzene	0.20	µg/L	0.01	mg/kg
	Bromobenzene	1.0	µg/L	0.01	mg/kg
	Bromochloromethane	1.0	µg/L	0.01	mg/kg
	Bromodichloromethane	0.20	µg/L	0.01	mg/kg
	Bromoform	1.0	µg/L	0.01	mg/kg
	Bromomethane	5.0	µg/L	0.01	mg/kg
	Carbon Tetrachloride	0.10	µg/L	0.01	mg/kg
	Chlorobenzene	0.50	µg/L	0.01	mg/kg
	Chloroethane	1.0	µg/L	0.01	mg/kg
	Chloroform	0.20	µg/L	0.01	mg/kg
	Chloromethane	0.50	µg/L	0.01	mg/kg
	Cis-1,2-Dichloroethene	1.0	µg/L	0.01	mg/kg
	Cis-1,3-Dichloropropene	0.50	µg/L	0.01	mg/kg
	Dibromochloromethane	0.50	µg/L	0.01	mg/kg
	Dibromomethane	1.0	µg/L	0.01	mg/kg

Table B5.1.3-1. (Concluded)

Parameter/Method	Analyte	Water		Soil	
		MQL	Unit	MQL	Unit
Aromatic and Halogenated	Dichlorodifluoromethane	1.0	µg/L	0.01	mg/kg
Volatile Organics	Ethylbenzene	1.0	µg/L	0.01	mg/kg
SW8021B	Hexachlorobutadiene	0.60	µg/L	0.01	mg/kg
	Isopropylbenzene	0.50	µg/L	0.01	mg/kg
	m-Xylene	2.0	µg/L	0.01	mg/kg
	Methylene Chloride	1.0	µg/L	0.01	mg/kg
	n-Butylbenzene	1.0	µg/L	0.01	mg/kg
	n-Propylbenzene	1.0	µg/L	0.01	mg/kg
	Naphthalene	1.0	µg/L	0.01	mg/kg
	o-Xylene	1.0	µg/L	0.01	mg/kg
	p-Isopropyltoluene	1.0	µg/L	0.01	mg/kg
	p-Xylene	2.0	µg/L	0.01	mg/kg
	Sec-Butylbenzene	1.0	µg/L	0.01	mg/kg
	Styrene	1.0	µg/L	0.01	mg/kg
	Trichloroethene	0.50	µg/L	0.01	mg/kg
	Tert-Butylbenzene	1.0	µg/L	0.01	mg/kg
	Tetrachloroethylene	0.50	µg/L	0.01	mg/kg
	Toluene	1.0	µg/L	0.01	mg/kg
	Trans-1,2-Dichloroethene	1.0	µg/L	0.01	mg/kg
	Trans-1,3-Dichloropropene	1.0	µg/L	0.01	mg/kg
	Trichlorofluoromethane	1.0	µg/L	0.01	mg/kg
	Vinyl Chloride	0.40	µg/L	0.01	mg/kg
	Xylenes, Total	1.0	µg/L	0.01	mg/kg

Table B5.1.3-2. QC Acceptance Criteria for Method SW8021B

Method	Analyte	Accuracy Water (% R)	Precision Water (RPD)	Accuracy Soil (% R)	Precision Soil (RPD)
SW8021B	1,1,1,2-Tetrachloroethane	75–125	≤ 20	65–125	≤ 30
	1,1,1-Trichloroethane	69–134	≤ 20	59–134	≤ 30
	1,1,2,2-Tetrachloroethane	30–166	≤ 20	25–166	≤ 30
	1,1,2-Trichloroethane	61–130	≤ 20	51–130	≤ 30
	1,1-Dichloroethane	64–127	≤ 20	54–127	≤ 30
	1,1-Dichloroethene	53–147	≤ 20	43–147	≤ 30
	1,1-Dichloropropene	65-135	≤ 20	55-145	≤ 30
	1,2,3-Trichlorobenzene	65-135	≤ 20	55-145	≤ 30
	1,2,3-Trichloropropane	75–125	≤ 20	65–125	≤ 30
	1,2,4-Trichlorobenzene	65-135	≤ 20	55-145	≤ 30
	1,2,4-Trimethylbenzene	65-135	≤ 20	55-145	≤ 30
	1,2-Dibromo-3-chloropropane	65-135	≤ 20	55-145	≤ 30
	1,2-Dibromoethane	65-135	≤ 20	55-145	≤ 30
	1,2-Dichloroethane	68–137	≤ 20	58–137	≤ 30
	1,2-Dichlorobenzene	61–134	≤ 20	51–134	≤ 30
	1,2-Dichloropropane	73–125	≤ 20	63–125	≤ 30
	1,3,5-Trimethylbenzene	65-135	≤ 20	55-145	≤ 30
	1,3-Dichlorobenzene	63–137	≤ 20	53–137	≤ 30
	1,3-Dichloropropane	65-135	≤ 20	55-145	≤ 30
	1,4-Dichlorobenzene	66–135	≤ 20	56–135	≤ 30
	2,2-Dichloropropane	65-135	≤ 20	55-145	≤ 30
	2-Chlorotoluene	65-135	≤ 20	55-145	≤ 30
	4-Chlorotoluene	65-135	≤ 20	55-145	≤ 30
	Benzene	75–125	≤ 20	65–125	≤ 30
	Bromobenzene	75–125	≤ 20	65–125	≤ 30
	Bromochloromethane	65-135	≤ 20	55-145	≤ 30
	Bromodichloromethane	61–135	≤ 20	51–135	≤ 30
	Bromoform	58–129	≤ 20	48–129	≤ 30
	Bromomethane	68–125	≤ 20	58–125	≤ 30
	Carbon Tetrachloride	69–139	≤ 20	59–139	≤ 30
	Chlorobenzene	75–129	≤ 20	65–129	≤ 30
	Chloroethane	75–130	≤ 20	65–130	≤ 30
	Chloroform	49–133	≤ 20	39–133	≤ 30
	Chloromethane	59–154	≤ 20	49–154	≤ 30
	Cis-1,2-Dichloroethene	75–120	≤ 20	65–125	≤ 30
	Cis-1,3-Dichloropropene	75–130	≤ 20	65–130	≤ 30
	Dibromochloromethane	75–131	≤ 20	65–131	≤ 30
	Dibromomethane	65-135	≤ 20	55-145	≤ 30
	Dichlorodifluoromethane	68–125	≤ 20	58–125	≤ 30
	Ethylbenzene	71–129	≤ 20	61–129	≤ 30
	Hexachlorobutadiene	65-135	≤ 20	55-145	≤ 30

Table B5.1.3-2. (Concluded)

Method	Analyte	Accuracy Water (% R)	Precision Water (RPD)	Accuracy Soil (% R)	Precision Soil (RPD)
SW8021B	Isopropylbenzene	65-135	≤ 20	55-145	≤ 30
	m-Xylene	65-135	≤ 20	55-145	≤ 30
	Methylene Chloride	42–176	≤ 20	32–176	≤ 30
	n-Butylbenzene	65-135	≤ 20	55-145	≤ 30
	n-Propylbenzene	65-135	≤ 20	55-145	≤ 30
	Naphthalene	65-135	≤ 20	55-145	≤ 30
	o-Xylene	65-135	≤ 20	55-145	≤ 30
	p-Isopropyltoluene	65-135	≤ 20	55-145	≤ 30
	p-Xylene	65-135	≤ 20	55-145	≤ 30
	Sec-Butylbenzene	65-135	≤ 20	55-145	≤ 30
	Styrene	65-135	≤ 20	55-145	≤ 30
	Trichloroethene	75–141	≤ 20	65–141	≤ 30
	Tert-Butylbenzene	65-135	≤ 20	55-145	≤ 30
	Tetrachloroethene	75–142	≤ 20	65–142	≤ 30
	Toluene	70–125	≤ 20	60–125	≤ 30
	Trans-1,2-Dichloroethene	75–130	≤ 20	68–130	≤ 30
	Trans-1,3-Dichloropropene	42–156	≤ 20	32–156	≤ 30
	Trichlorofluoromethane	75–130	≤ 20	69–130	≤ 30
	Vinyl Chloride	47–142	≤ 20	37–142	≤ 30
	Xylenes, Total	71–133	≤ 20	61–133	≤ 30
	Surrogates:				
	1,4-Dichlorobutane	35–135		35–135	
	Bromochlorobenzene	37–137		37–137	

Table B5.1.3-3. Summary of Calibration and QC Procedures for Method SW8021B

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
SW8021B	Aromatic and Halogenated Volatile Organics	Five-point initial calibration for all analytes.	Initial calibration prior to sample analysis.	linear - mean RSD for all analytes ≤20% with no individual analyte RSD >30%.	Correct problem then repeat initial calibration.
				linear – least squares regression r ≥ 0.995 for each analyte.	
				non-linear – COD ≥ 0.990 (6 points shall be used for second order, 7 points shall be used for third order).	
		Second-source calibration verification.	Once per five-point initial calibration.	All analytes within ±15% of expected value.	Correct problem then repeat initial calibration.
		Retention time window calculated for each analyte.	Each initial calibration and calibration verifications.	± 3 times standard deviation for each average analyte retention time from 72-hour study.	Correct problem then reanalyze all samples analyzed since the last retention time check.
		Initial calibration verification.	Daily, before sample analysis.	All analytes within ±15% of expected value (for low boiling compounds, see footnote b).	Correct problem then repeat initial calibration.
		Calibration verification.	After every 10 samples and at the end of the analysis sequence.	All analytes within ±15% of expected value (for low boiling compounds, see footnote b).	Correct problem then repeat initial calibration verification and reanalyze all samples since last successful calibration verification.
		Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample.	Once per analyst.	QC acceptance criteria, Table B5.3.1-2.	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria.
		Method blank.	One per analytical batch.	No analytes detected ≥ MQL.	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank.
		LCS for all analytes.	One LCS per analytical batch.	QC acceptance criteria, Table B5.1.3-2.	Correct problem then reprep and analyze the LCS and all samples in the affected batch.
		Surrogate spike.	Every sample, spiked sample, standard, and method blank.	QC acceptance criteria, Table B5.1.3-2.	Method 8000, Section 8.6 Requirements. Describe in Laboratory Review Checklist.
		MS/MSD.	One MS/MSD per every 20 project samples per matrix.	QC acceptance criteria, Table B5.1.3-2.	Describe in Laboratory Review Checklist.
		Second-column confirmation.	100% for all positive results.	Same as for initial or primary column analysis.	Same as for initial or primary column analysis.
		MDL study.	Once per 12 month period.	Detection limits established shall be ≤ ½ the MQLs in Table B5.1.3-1.	None.

a. All corrective actions associated with project work shall be documented, and all records shall be maintained by the laboratory.

b. Bromomethane, chloroethane, chloromethane, dichlorodifluoromethane, trichlorofluoromethane and vinyl chloride may be within ±20% of expected value.

B.5.1.4 Method SW8070A-Nitrosamines

Select nitrosamines in water and soil samples are analyzed using Method SW8070A. The sample is extracted and analyzed by gas chromatography.

Table B5.1.4-1. MQLs for Method SW8070A

Parameter/Method	Analyte	Water		Soil	
		MQL	Unit	MQL	Unit
Nitrosamines	N-Nitrosodi-n-propylamine	2.0	µg/L	4.0	mg/kg
SW8070A	N-Nitrosodimethylamine	0.50	µg/L	1.0	mg/kg
	N-Nitrosodiphenylamine	3.0	µg/L	6.0	mg/kg

Table B5.1.4-2. QC Acceptance Criteria for Method SW8070A

Method	Analyte	Accuracy Water (% R)	Precision Water (RPD)	Accuracy Soil (% R)	Precision Soil (RPD)
SW8070A	N-Nitrosodi-n-propylamine	45–146	≤ 30	35–146	≤ 50
	N-Nitrosodimethylamine	25–125	≤ 30	25–135	≤ 50
	N-Nitrosodiphenylamine	25–139	≤ 30	25–149	≤ 50
	Surrogates[a]:				

a. For the surrogate, use an analyte, and its LCS limit, from the method that is not expected to be present in the sample.

Table B5.1.4-3. Summary of Calibration and QC Procedures for Method SW8070A

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
SW8070A	Nitrosamines	Five-point initial calibration for all analytes.	Initial calibration prior to sample analysis.	linear - mean RSD for all analytes ≤20% with no individual analyte RSD >30%.	Correct problem then repeat initial calibration.
				linear – least squares regression r ≥ 0.995 for each analyte.	
				non-linear – COD ≥ 0.990 (6 points shall be used for second order, 7 points shall be used for third order).	
		Second-source calibration verification.	Once per five-point initial calibration.	All analytes within ±15% of expected value.	Correct problem then repeat initial calibration.
		Retention time window calculated for each analyte.	Each initial calibration and calibration verifications.	± 3 times standard deviation for each analyte retention time from 72-hour study.	Correct problem then reanalyze all samples analyzed since the last retention time check.
		Initial calibration verification.	Daily, before sample analysis.	All analytes within ±15% of expected value.	Correct problem then repeat initial calibration.
		Calibration verification.	After every 10 samples and at the end of the analysis sequence.	All analytes within ±15% of expected value.	Correct problem then repeat initial calibration verification and reanalyze all samples since last successful calibration verification.
		Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample.	Once per analyst.	QC acceptance criteria, Table B5.4-2.	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria.
		Method blank.	One per analytical batch.	No analytes detected ≥ MQL.	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank.
		LCS for all analytes.	One LCS per analytical batch.	QC acceptance criteria, Table B5.1.4-2.	Reprep and analyze the LCS and all samples in the affected analytical batch.
		Surrogate spike.	Every sample, spiked sample, standard, and method blank.	QC acceptance criteria, Table B5.1.4-2.	Method 8000, Section 8.6 Requirements. Describe in Laboratory Review Checklist.
		MS/MSD.	One MS/MSD per every 20 project samples per matrix.	QC acceptance criteria, Table B5.1.4-2.	Describe in Laboratory Review Checklist.
		Second-column confirmation.	100% for all positive results.	Same as for initial or primary column analysis.	Same as for initial or primary column analysis.
		MDL study.	Once per 12 month period.	Detection limits established shall be ≤ ½ the MQLs in Table B5.1.4-1.	None

a. All corrective actions associated with project work shall be documented, and all records shall be maintained by the laboratory.

B.5.1.5 Method SW8081A-Organochlorine Pesticides

Organochlorine pesticides in water and soil samples are analyzed using Method SW8081A. This analytical method includes the extraction procedure for the samples. The pesticides are then separated and quantified by GC using electron capture detection.

A second-column confirmation is not required for the analysis of toxaphene or chlordane.

Table B5.1.5-1. MQLs for Method SW8081A

Parameter/Method	Analyte	Water		Soil	
		MQL	Unit	MQL	Unit
Organochlorine	a-BHC	0.1	µg/L	0.004	mg/kg
Pesticides	b-BHC	0.1	µg/L	0.004	mg/kg
SW8081A	d-BHC	0.1	µg/L	0.004	mg/kg
	g-BHC (Lindane)	0.1	µg/L	0.004	mg/kg
	a-Chlordane	0.1	µg/L	0.004	mg/kg
	g-Chlordane	0.1	µg/L	0.004	mg/kg
	4,4'-DDD	0.1	µg/L	0.004	mg/kg
	4,4'-DDE	0.1	µg/L	0.004	mg/kg
	4,4'-DDT	0.1	µg/L	0.004	mg/kg
	Aldrin	0.1	µg/L	0.004	mg/kg
	Dieldrin	0.1	µg/L	0.004	mg/kg
	Endosulfan I	0.1	µg/L	0.004	mg/kg
	Endosulfan II	0.1	µg/L	0.004	mg/kg
	Endosulfan Sulfate	0.1	µg/L	0.004	mg/kg
	Endrin	0.1	µg/L	0.004	mg/kg
	Endrin Aldehyde	0.1	µg/L	0.004	mg/kg
	Heptachlor	0.1	µg/L	0.004	mg/kg
	Heptachlor Epoxide	0.1	µg/L	0.004	mg/kg
	Methoxychlor	0.5	µg/L	0.02	mg/kg
	Toxaphene	1.0	µg/L	0.10	mg/kg

Table B5.1.5-2. QC Acceptance Criteria for Method SW8081A

Method	Analyte	Accuracy Water (% R)	Precision Water (RPD)	Accuracy Soil (% R)	Precision Soil (RPD)
SW8081A	a-BHC	60--128	≤ 30	62–125	≤ 50
	b-BHC	66-126	≤ 30	62–127	≤ 50
	d-BHC	46–136	≤ 30	57–130	≤ 50
	g-BHC (Lindane)	30–146	≤ 30	59–123	≤ 50
	a-Chlordane	63–123	≤ 30	63–121	≤ 50
	g-Chlordane	67–120	≤ 30	48–124	≤ 50
	4,4-DDD	50–139	≤ 30	50–139	≤ 50
	4,4-DDE	48–137	≤ 30	68–126	≤ 50
	4,4-DDT	47-138	≤ 30	46–135	≤ 50
	Aldrin	42–138	≤ 30	47–120	≤ 50
	Dieldrin	62–129	≤ 30	67–125	≤ 50
	Endosulfan I	49–120	≤ 30	41–147	≤ 50
	Endosulfan II	42–130	≤ 30	37–141	≤ 50
	Endosulfan Sulfate	54–137	≤ 30	62–135	≤ 50
	Endrin	56–134	≤ 30	61–133	≤ 50
	Endrin Aldehyde	56–137	≤ 30	37–147	≤ 50
	Heptachlor	51–128	≤ 30	51–140	≤ 50
	Heptachlor Epoxide	62–131	≤ 30	66–130	≤ 50
	Methoxychlor	56–150	≤ 30	57–143	≤ 50
	Toxaphene	41–126	≤ 30	31–136	≤ 50
	Surrogates:				
	DCBP	32–135		56–132	
	TCMX	33–138		69-124	

Table B5.1.5-3. Summary of Calibration and QC Procedures for Method SW8081A

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
SW8081A	Organochlorine pesticides	Five-point initial calibration for all analytes.	Initial calibration prior to sample analysis.	linear - mean RSD for all analytes ≤20% with no individual analyte RSD >30%.	Correct problem then repeat initial calibration.
				linear – least squares regression r ≥ 0.995 for each analyte.	
				non-linear – COD ≥ 0.990 (6 points shall be used for second order, 7 points shall be used for third order).	
		Second-source calibration verification for all analytes.	Once per five-point initial calibration.	All analytes within ±15% of expected value.	Correct problem then repeat initial calibration.
		Retention time window calculated for each analyte.	Each initial calibration and calibration verifications.	± 3 times standard deviation for each analyte retention time from 72-hour study.	Correct problem then reanalyze all samples analyzed since the last retention time check.
		Initial calibration verification.	Daily, before sample analysis.	All analytes within ±15% of expected value.	Correct problem then repeat initial calibration.
		Calibration verification.	After every 10 samples and at the end of the analysis sequence.	All analytes within ±15% of expected value.	Correct problem then repeat initial calibration verification and reanalyze all samples since last successful calibration verification.
		Breakdown check (Endrin and DDT).	Daily prior to analysis of samples.	Degradation ≤15%.	Take corrective action prior to calibration. Repeat breakdown check.
		Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample.	Once per analyst.	QC acceptance criteria, Table B5.1.5-2.	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria.
		Method blank.	One per analytical batch.	No analytes detected ≥ MQL.	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank.

Table B5.1.5-3. (Concluded)

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
SW8081A	Organochlorine pesticides	LCS for all analytes.	One LCS per analytical batch.	QC acceptance criteria, Table B5.1.5-2.	Correct problem then reprep and analyze the LCS and all samples in the affected analytical batch.
		Surrogate spike.	Every sample, spiked sample, standard, and method blank.	QC acceptance criteria, Table B5.1.5-2.	Method 8000, Section 8.6 Requirements. Describe in Laboratory Review Checklist.
		MS/MSD.	One MS/MSD per every 20 project samples per matrix.	QC acceptance criteria, Table B5.1.5-2.	Describe in Laboratory Review Checklist.
		Second-column confirmation (excluding toxaphene and chlordane).	100% for all positive results.	Same as for initial or primary column analysis.	Same as for initial or primary column analysis.
		MDL study.	Once per 12 month period.	Detection limits established shall be ≤ ½ the MQLs in Table B5.1.5-1.	None

a. All corrective actions associated with project work shall be documented, and all records shall be maintained by the laboratory.

B.5.1.6 Method SW8082-Polychlorinated Biphenyls (PCBs)

PCBs in water and soil samples are analyzed using Method SW8082. This analytical method involves the extraction of the samples. The PCBs are then separated and quantified by GC using electron capture detection or electrolytic conductivity detection.

A standard containing a mixture of Aroclor 1016 and Aroclor 1260 will include many of the peaks represented in the other five Aroclor mixtures. For analysis of PCBs, a multi-point initial calibration employing a mixture of Aroclors 1016 and 1260 at five concentrations should be sufficient to demonstrate the linearity of the detector response without the necessity of performing initial calibrations for each of the seven Aroclors. In addition, such a mixture can be used as a standard to demonstrate that a sample does not contain peaks that represent any one of the Aroclors. Retention times shall be verified for all analytes during the initial five point calibration. The daily calibration, initial calibration verification and the calibration verification should be performed in accordance with the provisions of Method SW8082. The LCS and MS/MSD may only be spiked with the 1016/1260 mix. A second-column confirmation is not required.

When PCBs are to be quantitatively determined as individual congeners, the laboratory must submit for approval by the TCEQ QA Specialist a list of the congeners to be determined along with the calibration and QC procedures to be performed.

Table B5.1.6-1. MQLs for Method SW8082

Parameter/Method	Analyte	Water		Soil	
		MQL	Unit	MQL	Unit
Polychlorinated Biphenyls	Aroclor 1016	0.5	µg/L	0.05	mg/kg
SW8082	Aroclor 1221	0.5	µg/L	0.05	mg/kg
	Aroclor 1232	0.5	µg/L	0.05	mg/kg
	Aroclor 1242	0.5	µg/L	0.05	mg/kg
	Aroclor 1248	0.5	µg/L	0.05	mg/kg
	Aroclor 1254	0.5	µg/L	0.05	mg/kg
	Aroclor 1260	0.5	µg/L	0.05	mg/kg
	2-Chlorobiphenyl	0.5	µg/L	0.05	mg/kg
	2,3-Dichlorobiphenyl	0.5	µg/L	0.05	mg/kg
	2,4',5-Trichlorobiphenyl	0.5	µg/L	0.05	mg/kg
	2,2',3,5'-Tetrachlorobiphenyl	0.5	µg/L	0.05	mg/kg
	2,2',5,5'-Tetrachlorobiphenyl	0.5	µg/L	0.05	mg/kg
	2,3',4,4'-Tetrachlorobiphenyl	0.5	µg/L	0.05	mg/kg
	2,2',5-Trichlorobiphenyl	0.5	µg/L	0.05	mg/kg
	2,2',3,4,5'-Pentachlorobiphenyl	0.5	µg/L	0.05	mg/kg
	2,2',4,5,5'-Pentachlorobiphenyl	0.5	µg/L	0.05	mg/kg
	2,3,3',4',6-Pentachlorobiphenyl	0.5	µg/L	0.05	mg/kg
	2,2',3,4,4',5'-Hexachlorobiphenyl	0.5	µg/L	0.05	mg/kg
	2,2',3,4,5,5'-Hexachlorobiphenyl	0.5	µg/L	0.05	mg/kg
	2,2',3,5,5',6-Hexachlorobiphenyl	0.5	µg/L	0.05	mg/kg
	2,2',4,4',5,5'-Hexachlorobiphenyl	0.5	µg/L	0.05	mg/kg
	2,2',3,3',4,4',5-Heptachlorobiphenyl	0.5	µg/L	0.05	mg/kg
	2,2',3,4,4',5,5'-Heptachlorobiphenyl	0.5	µg/L	0.05	mg/kg
	2,2',3,4,4',5',6-Heptachlorobiphenyl	0.5	µg/L	0.05	mg/kg
	2,2',3,4',5,5',6-Heptachlorobiphenyl	0.5	µg/L	0.05	mg/kg
	2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl	0.5	µg/L	0.05	mg/kg

Table B5.1.6-2. QC Acceptance Criteria for Method SW8082

Method	Analyte	Accuracy Water (% R)	Precision Water (RPD)	Accuracy Soil (% R)	Precision Soil (RPD)
SW8082	Aroclor 1016	40–144	≤ 30	41–138	≤ 50
	Aroclor 1221	41–136	≤ 30	45–136	≤ 50
	Aroclor 1232	41–136	≤ 30	45–136	≤ 50
	Aroclor 1242	39–150	≤ 30	43–150	≤ 50
	Aroclor 1248	41–136	≤ 30	44–136	≤ 50
	Aroclor 1254	29–141	≤ 30	41–141	≤ 50
	Aroclor 1260	45–145	≤ 30	61–131	≤ 50
	1016/1260 Mix	50–135	≤ 30	40–130	≤ 50
	Surrogate:				
	DCBP	42–133		58–125	

Table B5.1.6-3. Summary of Calibration and QC Procedures for Method SW8082

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
SW8082	PCBs	Five-point initial calibration.	Initial calibration prior to sample analysis.	linear - mean RSD for all analytes ≤20%.	Correct problem then repeat initial calibration.
				linear – least squares regression r ≥ 0.995 for each analyte.	
		Second-source calibration verification for PCB 1016/1260 mix.	Once per five-point initial calibration.	Mix within ±15% of expected value.	Correct problem then repeat initial calibration.
		Retention time window calculated for PCB 1016/1260 mix.	Each initial calibration and calibration verifications.	± 3 times standard deviation for each analyte retention time from 72-hour study.	Correct problem then reanalyze all samples analyzed since the last retention time check.
		Initial calibration verification for PCB 1016/1260 mix.	Daily, before sample analysis.	All analytes within ±15% of expected value.	Correct problem then repeat initial calibration.
		Calibration verification for PCB 1016/1260 mix.	After every 10 samples and at the end of the analysis sequence.	All analytes within ±15% of expected value.	Correct problem then repeat initial calibration verification and reanalyze all samples since last successful calibration verification.
		Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample.	Once per analyst.	QC acceptance criteria, Table B5.1.6-2.	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria.
		Method blank.	One per analytical batch.	No analytes detected ≥ MQL.	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank.

Table B5.1.6-3. Summary of Calibration and QC Procedures for Method SW8082 (Concluded)

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
SW8082	PCBs	LCS (1016/1260 mix).	One LCS per analytical batch.	QC acceptance criteria, Table B5.1.6-2.	Correct problem then reprep and analyze the LCS and all samples in the affected analytical batch.
		Surrogate spike.	Every sample, spiked sample, standard, and method blank.	QC acceptance criteria, Table B5.1.6-2.	Method 8000, Section 8.6 Requirements. Describe in Laboratory Review Checklist.
		MS/MSD (1016/1260 mix).	One MS/MSD per every 20 project samples per matrix.	QC acceptance criteria, Table B5.1.6-2.	Describe in Laboratory Review Checklist.
		MDL study.	Once per 12 month period.	Detection limits established shall be ≤ ½ the MQLs in Table B5.1.6-1.	None.

a. All corrective actions associated with project work shall be documented, and all records shall be maintained by the laboratory.

B.5.1.7 Method SW8141A-Organophosphorus Pesticides

Method SW8141A is a GC method used to determine the concentrations of various organophosphorus pesticides. This analytical method involves extraction of the samples. An aliquot of the extract is injected into a GC and compounds in the GC effluent are detected with a flame photometric or nitrogen-phosphorus detector. Any compounds identified tentatively in the primary analysis are confirmed on a second GC column.

Table B5.1.7-1. MQLs for Method SW8141A

Parameter/Method	Analyte	Water		Soil	
		MQL	Unit	MQL	Unit
Organophosphorus Pesticides SW8141A	Azinphos Methyl	1.0	µg/L	0.05	mg/kg
	Bolstar	0.7	µg/L	0.04	mg/kg
	Chlorpyrifos	0.7	µg/L	0.05	mg/kg
	Coumaphos	2.0	µg/L	0.10	mg/kg
	Demeton-o	1.2	µg/L	0.06	mg/kg
	Demeton-s	1.2	µg/L	0.06	mg/kg
	Diazinon	2.0	µg/L	0.10	mg/kg
	Dichlorovos	2.0	µg/L	0.04	mg/kg
	Disulfoton	0.7	µg/L	0.04	mg/kg
	Ethoprop	2.0	µg/L	0.10	mg/kg
	Fensulfothion	0.8	µg/L	0.04	mg/kg
	Fenthion	0.8	µg/L	0.05	mg/kg
	Merphos	2.0	µg/L	0.10	mg/kg
	Mevinphos	5.0	µg/L	0.25	mg/kg
	Naled	5.0	µg/L	0.25	mg/kg
	Parathion Methyl	1.2	µg/L	0.06	mg/kg
	Phorate	0.4	µg/L	0.02	mg/kg
	Ronnel	0.7	µg/L	0.04	mg/kg
	Stirophos	8.0	µg/L	0.40	mg/kg
	Tokuthion	0.7	µg/L	0.06	mg/kg
	Trichloronate	8.0	µg/L	0.40	mg/kg

Table B5.1.7-2. QC Acceptance Criteria for Method SW8141A

Method	Analyte	Accuracy Water (% R)	Precision Water (RPD)	Accuracy Soil (% R)	Precision Soil (RPD)
SW8141A	Azinphos Methyl	50–150	≤ 30	40–160	≤ 50
	Bolstar	46–125	≤ 30	36–135	≤ 50
	Chlorpyrifos	75–125	≤ 30	65–135	≤ 50
	Coumaphos	71–147	≤ 30	61–157	≤ 50
	Demeton-o	50–150	≤ 30	40–160	≤ 50
	Demeton-s	50–150	≤ 30	40–160	≤ 50
	Diazinon	47–149	≤ 30	37–159	≤ 50
	Dichlorovos	49–125	≤ 30	39–135	≤ 50
	Disulfoton	50–150	≤ 30	40–160	≤ 50
	Ethoprop	75–125	≤ 30	65–135	≤ 50
	Fensulfothion	43–145	≤ 30	33–155	≤ 50
	Fenthion	25–125	≤ 30	25–135	≤ 50
	Merphos	75–144	≤ 30	65–154	≤ 50
	Mevinphos	33–125	≤ 30	25–135	≤ 50
	Naled	54–125	≤ 30	44–135	≤ 50
	Parathion Methyl	45–130	≤ 30	35–140	≤ 50
	Phorate	50–150	≤ 30	40–160	≤ 50
	Ronnel	75–125	≤ 30	65–135	≤ 50
	Stirophos	48–125	≤ 30	38–135	≤ 50
	Tokuthion	44–125	≤ 30	34–135	≤ 50
	Trichloronate	49–161	≤ 30	39–171	≤ 50
	Surrogates:				
	Tributyl Phosphate	67-136		57-146	
	Triphenyl Phosphate	65-134		55-144	

Table B5.1.7-3. Summary of Calibration and QC Procedures for Method SW8141A

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
SW8141A	Organophos-phorus pesticides	Five-point initial calibration for all analytes.	Initial calibration prior to sample analysis.	linear - mean RSD for all analytes ≤20% with no individual analyte RSD >30%.	Correct problem then repeat initial calibration.
				linear – least squares regression r ≥ 0.995 for each analyte.	
				non-linear – COD ≥ 0.990 (6 points shall be used for second order, 7 points shall be used for third order).	
		Second-source calibration verification.	Once per five-point initial calibration.	All analytes within ±15% of expected value.	Correct problem then repeat initial calibration.
		Retention time window calculated for each analyte.	Each initial calibration and calibration verifications.	± 3 times standard deviation for each analyte retention time from 72-hour study.	Correct problem then reanalyze all samples analyzed since the last retention time check.
		Initial calibration verification.	Daily, before sample analysis.	All analytes within ±15% of expected value.	Correct problem then repeat initial calibration.
		Calibration verification.	After every 10 samples and at the end of the analysis sequence.	All analytes within ±15% of expected value.	Correct problem then repeat initial calibration verification and reanalyze all samples since last successful calibration verification.
		Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample.	Once per analyst.	QC acceptance criteria, Table B5.1.7-2.	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria.
		Method blank.	One per analytical batch.	No analytes detected ≥ MQL.	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank.
		LCS for all analytes.	One LCS per analytical batch.	QC acceptance criteria, Table B5.1.7-2.	Correct problem then reprep and analyze the LCS and all samples in the affected analytical batch.
		Surrogate spike.	Every sample, spiked sample, standard, and method blank.	QC acceptance criteria, Table B5.1.7-2.	Method 8000, Section 8.6 Requirements. Describe in Laboratory Review Checklist.
		MS/MSD.	One MS/MSD per every 20 project samples per matrix.	QC acceptance criteria, Table B5.1.7-2.	Describe in Laboratory Review Checklist.
		Second-column confirmation.	100% for all positive results.	Same as for initial or primary column analysis.	Same as for initial or primary column analysis.
		MDL study.	Once per 12 month period.	Detection limits established shall be ≤ ½ the MQLs in Table B5.1.7-1.	None

a. All corrective actions associated with project work shall be documented, and all records shall be maintained by the laboratory.

B.5.1.8 Method SW8151A-Chlorinated Herbicides

Method SW8151A is a capillary GC method for determining selected chlorinated acid herbicides and related compounds. Samples are extracted then esterified in accordance with the method. The esters are determined by GC employing an electron capture detector. Any compounds identified tentatively in the primary analysis are confirmed on a second GC column.

Table B5.1.8-1. MQLs for Method SW8151A

Parameter/Method	Analyte	Water		Soil	
		MQL	Unit	MQL	Unit
Chlorinated Phenoxy Acid Herbicides SW8151A	2,4-D	10	µg/L	0.2	mg/kg
	2,4-DB	20	µg/L	0.5	mg/kg
	2,4,5-T	20	µg/L	0.5	mg/kg
	2,4,5-TP	10	µg/L	0.2	mg/kg
	Dalapon	30	µg/L	0.8	mg/kg
	Dicamba	20	µg/L	0.5	mg/kg
	Dichloroprop	20	µg/L	0.5	mg/kg
	Dinoseb	3	µg/L	0.1	mg/kg
	MCPA	1	µg/L	10	mg/kg
	MCPP	50	µg/L	15	mg/kg

Table B5.1.8-2. QC Acceptance Criteria for Method SW8151A

Method	Analyte	Accuracy Water (% R)	Precision Water (RPD)	Accuracy Soil (% R)	Precision Soil (RPD)
SW8151A	2,4-D	39–120	≤ 30	32–131	≤ 50
	2,4-DB	44–120	≤ 30	42–145	≤ 50
	2,4,5-T	44–122	≤ 30	43–139	≤ 50
	2,4,5-TP	49–126	≤ 30	46–128	≤ 50
	Dalapon	40–120	≤ 30	22–125	≤ 50
	Dicamba	60–120	≤ 30	56–120	≤ 50
	Dichloroprop	68–122	≤ 30	72–142	≤ 50
	Dinoseb	28–115	≤ 30	20–131	≤ 50
	MCPA	62–144	≤ 30	65–120	≤ 50
	MCPP	60–133	≤ 30	60–118	≤ 50
	Surrogate:				
	2,4-Dichlorophenylacetic acid	50–130		45–140	

Table B5.1.8-3. Summary of Calibration and QC Procedures for Method SW8151A

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
SW8151A	Chlorinated Herbicides	Five-point initial calibration for all analytes.	Initial calibration prior to sample analysis.	linear - mean RSD for all analytes ≤20% with no individual analyte RSD >30%.	Correct problem then repeat initial calibration.
				linear – least squares regression r ≥ 0.995 for each analyte.	
				non-linear – COD ≥ 0.990 (6 points shall be used for second order, 7 points shall be used for third order).	
		Second-source calibration verification.	Once per five-point initial calibration.	All analytes within ±15% of expected value.	Correct problem then repeat initial calibration.
		Retention time window calculated for each analyte.	Each initial calibration and calibration verifications.	± 3 times standard deviation for each analyte retention time from 72-hour study.	Correct problem then reanalyze all samples analyzed since the last retention time check.
		Initial calibration verification.	Daily, before sample analysis.	All analytes within ±15% of expected value.	Correct problem then repeat initial calibration.
		Calibration verification.	After every 10 samples and at the end of the analysis sequence.	All analytes within ±15% of expected value.	Correct problem then repeat initial calibration verification and reanalyze all samples since last successful calibration verification.
		Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample.	Once per analyst.	QC acceptance criteria, Table B5.1.8-2.	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria.
		Method blank.	One per analytical batch.	No analytes detected ≥ MQL.	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank.
		LCS for all analytes.	One LCS per analytical batch.	QC acceptance criteria, Table B5.1.8-2.	Correct problem then reprep and analyze the LCS and all samples in the affected analytical batch.
SW8151A	Chlorinated Herbicides	Surrogate spike.	Every sample, spiked sample, standard, and method blank.	QC acceptance criteria, Table B5.1.8-2.	Method 8000, Section 8.6 Requirements. Describe in Laboratory Review Checklist.
		MS/MSD.	One MS/MSD per every 20 project samples per matrix.	QC acceptance criteria, Table B5.1.8-2.	Describe in Laboratory Review Checklist.
		Second-column confirmation.	100% for all positive results.	Same as for initial or primary column analysis.	Same as for initial or primary column analysis.
		MDL study.	Once per 12 month period.	Detection limits established shall be ≤ ½ the MQLs in Table B5.1.8-1.	None.

a. All corrective actions associated with project work shall be documented, and all records shall be maintained by the laboratory.

B.5.1.9 Method SW8260B-Volatile Organics

Volatile (or purgeable) organics in water and soil samples are analyzed using Method SW8260B. This method uses a capillary column GC/mass spectrometry technique. Volatile compounds are introduced into the GC by purge and trap (SW5030B for water or SW5035 for soil). An inert gas is bubbled through the water samples (or a soil-water slurry for soil samples) to transfer the purgeable organic compounds from the liquid to vapor phase. Soil samples with higher contaminant levels are extracted using methanol before purging. The vapor is then swept through a sorbent trap where the purgeable organics are trapped. The trap is backflushed and heated to desorb the purgeable organics onto a capillary GC column where they are separated and then detected with a mass spectrometer.

The mass spectrometer is tuned daily to give an acceptable spectrum for BFB. The tuning acceptance criteria are given in the following list as an ion abundance for each specified mass:

- mass 50 — 15 percent to 40 percent of mass 95
- mass 75 — 30 percent to 60 percent of mass 95
- mass 95 — base peak, 100 percent relative abundance
- mass 96 — 5 percent to 9 percent of mass 95
- mass 173 — less than 2 percent of mass 174
- mass 174 — greater than 50 percent of mass 95
- mass 175 — 5 percent to 9 percent of mass 174
- mass 176 — greater than 95 percent, but less than 101 percent of mass 174
- mass 177 — 5 percent to 9 percent of mass 176

The IS method is used for quantitation of analytes of interest. For quantitation, RFs are calculated from the base ion peak of a specific IS added to each calibration standard, blank, QC sample, and sample.

In addition to the target analytes listed in Table B5.1.9-1, Method 8260B includes performing library searches for up to ten tentatively identified compounds (TICs).

Table B5.1.9-1. MQLs for Method SW8260B

Parameter/Method	Analyte	Water		Soil	
		MQL	Unit	MQL	Unit
Volatile Organic Compounds SW8260B	1,1,1,2-Tetrachloroethane	0.5	µg/L	0.003	mg/kg
	1,1,1-Trichloroethane	1.0	µg/L	0.005	mg/kg
	1,1,2,2-Tetrachloroethane	0.5	µg/L	0.003	mg/kg
	1,1,2-Trichloroethane	1.0	µg/L	0.005	mg/kg
	1,1-Dichloroethane	1.0	µg/L	0.005	mg/kg
	1,1-Dichloroethene	1.0	µg/L	0.006	mg/kg
	1,1-Dichloropropene	1.0	µg/L	0.005	mg/kg
	1,2,3-Trichlorobenzene	1.0	µg/L	0.005	mg/kg
	1,2,3-Trichloropropane	1.0	µg/L	0.005	mg/kg
	1,2,4-Trichlorobenzene	1.0	µg/L	0.005	mg/kg
	1,2,4-Trimethylbenzene	1.0	µg/L	0.006	mg/kg
	1,2-Dichloroethane	0.5	µg/L	0.003	mg/kg
	1,2-Dichlorobenzene	1.0	µg/L	0.005	mg/kg
	1,2-Dibromo-3-chloropropane	2.0	µg/L	0.01	mg/kg
	1,2-Dichloropropane	1.0	µg/L	0.005	mg/kg
	1,2-Ethylene dibromide	1.0	µg/L	0.005	mg/kg
	1,3,5-Trimethylbenzene	1.0	µg/L	0.005	mg/kg
	1,3-Dichlorobenzene	1.0	µg/L	0.006	mg/kg
	1,3-Dichloropropane	0.4	µg/L	0.002	mg/kg
	1,4-Dichlorobenzene	0.5	µg/L	0.002	mg/kg
	1-Chlorohexane	1.0	µg/L	0.005	mg/kg
	2,2-Dichloropropane	1.0	µg/L	0.005	mg/kg
	2-Chlorotoluene	1.0	µg/L	0.005	mg/kg
	4-Chlorotoluene	1.0	µg/L	0.005	mg/kg
	Acetone	10	µg/L	0.05	mg/kg
	Benzene	0.4	µg/L	0.002	mg/kg
	Bromobenzene	1.0	µg/L	0.005	mg/kg
	Bromochloromethane	1.0	µg/L	0.005	mg/kg
	Bromodichloromethane	0.5	µg/L	0.002	mg/kg
	Bromoform	1.0	µg/L	0.006	mg/kg
	Bromomethane	3.0	µg/L	0.01	mg/kg
	Carbon disulfide	1.0	µg/L	0.01	mg/kg
	Carbon tetrachloride	1.0	µg/L	0.005	mg/kg
	Chlorobenzene	0.5	µg/L	0.002	mg/kg
	Chloroethane	1.0	µg/L	0.005	mg/kg
	Chloroform	0.3	µg/L	0.002	mg/kg
	Chloromethane	1.0	µg/L	0.005	mg/kg
	Cyclohexane	1.0	µg/L	0.01	mg/kg
	Cis-1,2-Dichloroethene	1.0	µg/L	0.005	mg/kg
	Cis-1,3-Dichloropropene	0.5	µg/L	0.003	mg/kg
	Dibromochloromethane	0.5	µg/L	0.003	mg/kg

Table B5.1.9-1. (Concluded)

Parameter/Method	Analyte	Water		Soil	
		MQL	Unit	MQL	Unit
Volatile Organic Compounds SW8260B	Dibromomethane	1.0	µg/L	0.005	mg/kg
	Dichlorodifluoromethane	1.0	µg/L	0.005	mg/kg
	Ethylbenzene	1.0	µg/L	0.005	mg/kg
	Hexachlorobutadiene	0.6	µg/L	0.003	mg/kg
	2-Hexanone	1.0	µg/L	0.01	mg/kg
	Isopropylbenzene	1.0	µg/L	0.005	mg/kg
	m-Xylene	2.0	µg/L	0.005	mg/kg
	Methyl acetate	1.0	µg/L	0.01	mg/kg
	Methylcyclohexane	1.0	µg/L	0.01	mg/kg
	Methyl isobutyl ketone	10	µg/L	0.02	mg/kg
	Methyl ethyl ketone	10	µg/L	0.02	mg/kg
	Methyl tert-butyl ether	5.0	µg/L	0.02	mg/kg
	Methylene chloride	1.0	µg/L	0.005	mg/kg
	n-Butylbenzene	1.0	µg/L	0.005	mg/kg
	n-Propylbenzene	1.0	µg/L	0.005	mg/kg
	Naphthalene	1.0	µg/L	0.005	mg/kg
	o-Xylene	1.0	µg/L	0.005	mg/kg
	p-Isopropyltoluene	1.0	µg/L	0.006	mg/kg
	p-Xylene	2.0	µg/L	0.005	mg/kg
	Sec-Butylbenzene	1.0	µg/L	0.005	mg/kg
	Styrene	1.0	µg/L	0.005	mg/kg
	Trichloroethene	1.0	µg/L	0.005	mg/kg
	Tert-Butylbenzene	1.0	µg/L	0.005	mg/kg
	Tetrachloroethene	1.0	µg/L	0.005	mg/kg
	Toluene	1.0	µg/L	0.005	mg/kg
	Trans-1,2-Dichloroethene	1.0	µg/L	0.005	mg/kg
	Trans-1,3-Dichloropropene	1.0	µg/L	0.005	mg/kg
	Trichlorofluoromethane	1.0	µg/L	0.005	mg/kg
	1,1,2-Trichloro-1,2,2-trifluoroethane	1.0	µg/L	0.01	mg/kg
	Vinyl chloride	1.0	µg/L	0.005	mg/kg

Table B5.1.9-2. QC Acceptance Criteria for Method SW8260B

Method	Analyte	Accuracy Water (% R)	Precision Water (RPD)	Accuracy Soil (% R)	Precision Soil (RPD)
SW8260B	1,1,1,2-Tetrachloroethane	81–129	≤ 20	74–125	≤ 30
	1,1,1-Trichloroethane	67–132	≤ 20	68–130	≤ 30
	1,1,2,2-Tetrachloroethane	63–128	≤ 20	59-140	≤ 30
	1,1,2-Trichloroethane	75–125	≤ 20	62-127	≤ 30
	1,1-Dichloroethane	69–133	≤ 20	73–125	≤ 30
	1,1-Dichloroethene	68–130	≤ 20	65–136	≤ 30
	1,1-Dichloropropene	73–132	≤ 20	70–135	≤ 30
	1,2,3-Trichlorobenzene	67–137	≤ 20	62–133	≤ 30
	1,2,3-Trichloropropane	73–124	≤ 20	63–130	≤ 30
	1,2,4-Trichlorobenzene	66–134	≤ 20	65–131	≤ 30
	1,2,4-Trimethylbenzene	74–132	≤ 20	65–135	≤ 30
	1,2-Dichloroethane	69–132	≤ 20	72–137	≤ 30
	1,2-Dichlorobenzene	71–122	≤ 20	74–120	≤ 30
	1,2-Dibromo-3-chloropropane	50–132	≤ 20	49–135	≤ 30
	1,2-Dichloropropane	75–125	≤ 20	71–120	≤ 30
	1,2-Ethylene dibromide	80–121	≤ 20	70–124	≤ 30
	1,3,5-Trimethylbenzene	74–131	≤ 20	65–133	≤ 30
	1,3-Dichlorobenzene	75–124	≤ 20	72–124	≤ 30
	1,3-Dichloropropane	73–126	≤ 20	76–123	≤ 30
	1,4-Dichlorobenzene	74–123	≤ 20	72–125	≤ 30
	1-Chlorohexane	70–125	≤ 20	60–135	≤ 30
	2,2-Dichloropropane	69–137	≤ 20	67–134	≤ 30
	2-Chlorotoluene	73–126	≤ 20	69–128	≤ 30
	4-Chlorotoluene	74–128	≤ 20	73–126	≤ 30
	Acetone	40–135	≤ 20	40–141	≤ 20
	Benzene	81–122	≤ 20	73–126	≤ 30
	Bromobenzene	76–124	≤ 20	66–121	≤ 30
	Bromochloromethane	65–129	≤ 20	71–127	≤ 30
	Bromodichloromethane	76–121	≤ 20	72–128	≤ 30
	Bromoform	69–128	≤ 20	66–137	≤ 30
	Bromomethane	53–141	≤ 20	45–141	≤ 30
	Carbon disulfide	10–200	≤ 20	10–200	≤ 30
	Carbon tetrachloride	66–138	≤ 20	67–133	≤ 30
	Chlorobenzene	81–122	≤ 20	75–123	≤ 30
	Chloroethane	58–133	≤ 20	41–141	≤ 30
	Chloroform	69–128	≤ 20	72–124	≤ 30
	Chloromethane	56–131	≤ 20	51–129	≤ 30
	Cyclohexane	10–200	≤ 20	10–200	≤ 30
	Cis-1,2-Dichloroethene	72–126	≤ 20	67–125	≤ 30
	Cis-1,3-Dichloropropene	69–131	≤ 20	72–126	≤ 30

Table B5.1.9-2. (Concluded)

Method	Analyte	Accuracy Water (% R)	Precision Water (RPD)	Accuracy Soil (% R)	Precision Soil (RPD)
SW8260B	Dibromochloromethane	66–133	≤ 20	66–130	≤ 30
	Dibromomethane	76–125	≤ 20	73–128	≤ 30
	Dichlorodifluoromethane	53–153	≤ 20	34–136	≤ 30
	Ethylbenzene	73–127	≤ 20	74–127	≤ 30
	Hexachlorobutadiene	67–131	≤ 20	53–142	≤ 30
	2-Hexanone	50–150	≤ 20	50–150	≤ 30
	Isopropylbenzene	75–127	≤ 20	77-129	≤ 30
	m-Xylene	76–128	≤ 20	79–126	≤ 30
	Methyl acetate	50–150	≤ 20	50–150	≤ 30
	Methylcyclohexane	10–200	≤ 20	10–200	≤ 30
	Methyl isobutyl ketone	58–134	≤ 20	47–147	≤ 30
	Methyl ethyl ketone	49–136	≤ 20	40–135	≤ 30
	Methyl tert-butyl ether	65–123	≤ 20	50–135	≤ 30
	Methylene chloride	63–137	≤ 20	63–137	≤ 30
	n-Butylbenzene	69–137	≤ 20	65–138	≤ 30
	n-Propylbenzene	72–129	≤ 20	63–135	≤ 30
	Naphthalene	54–138	≤ 20	51–135	≤ 30
	o-Xylene	80–121	≤ 20	77–125	≤ 30
	p-Isopropyltoluene	73–130	≤ 20	75–133	≤ 30
	p-Xylene	76–128	≤ 20	79–126	≤ 30
	Sec-Butylbenzene	72–127	≤ 20	63–132	≤ 30
	Styrene	65–134	≤ 20	74–128	≤ 30
	Trichloroethene	70–127	≤ 20	77–124	≤ 30
	Tert-butylbenzene	70–129	≤ 20	65–132	≤ 30
	Tetrachloroethene	66–128	≤ 20	67–139	≤ 30
	Toluene	77–122	≤ 20	71–127	≤ 30
	Trans-1,2-Dichloroethene	63–137	≤ 20	66–134	≤ 30
	Trans-1,3-Dichloropropene	59–135	≤ 20	65–127	≤ 30
	Trichlorofluoromethane	57–129	≤ 20	49–139	≤ 30
	Trichloro-1,2,2-trifluoroethane, 1,1,2	67–125	≤ 20	57–135	≤ 30
	Vinyl Chloride	50–134	≤ 20	58–126	≤ 30
	Surrogates:				
	Dibromofluoromethane	85–115		65–135	
	Toluene-d8	81–120		84–116	
	4-Bromofluorobenzene	76–119		84–118	
	1,2-Dichloroethane-d4	72–119		52–149	

Table B5.1.9-3. Summary of Calibration and QC Procedures for Method SW8260B

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
8260B	Volatile Organics	Five-point initial calibration for all analytes.	Initial calibration prior to sample analysis.	SPCCs average RF ≥ 0.30[b] and %RSD for RFs for CCCs ≤ 30% and one option below.	Correct problem then repeat initial calibration.
				option 1 linear - mean RSD for all analytes ≤15% with no individual analyte RSD >30%.	
				option 2 linear – least squares regression r ≥ 0.995 for each analyte.	
				option 3 non-linear – COD ≥ 0.990 (6 points shall be used for second order, 7 points shall be used for third order).	
		Second-source calibration verification.	Once per five-point initial calibration.	All analytes within ±25% of expected value.	Correct problem then repeat initial calibration.
		Calibration verification.	Daily, before sample analysis and every 12 hours of analysis time.	SPCCs average RF ≥ 0.30[b]; and CCCs ≤ 20% difference (when using RFs) or drift (when using least squares regression or non-linear calibration).	Correct problem then repeat initial calibration.
				All calibration analytes within ±30% of expected value.	
		Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample.	Once per analyst.	QC acceptance criteria, Table B5.1.9-2.	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria.
		Internal standards.	Immediately after or during data acquisition of calibration check standard.	Retention time ±30 seconds from retention time of the mid-point std. in the ICAL. EICP area within –50% to +100% of ICAL mid-point std.	Inspect mass spectrometer and GC for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning.
		Method blank.	One per analytical batch.	No analytes detected ≥ MQL.	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank.

Table B5.1.9-3. (Concluded)

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
8260B	Volatile Organics	LCS for all analytes.	One LCS per analytical batch.	QC acceptance criteria, Table B5.1.9-2.	Correct problem then reprep and analyze the LCS and all samples in the affected analytical batch.
		MS/MSD.	One MS/MSD per every 20 project samples per matrix.	QC acceptance criteria, Table B5.1.9-2.	Describe in Laboratory Review Checklist.
		Check of mass spectral ion intensities using BFB.	Prior to initial calibration and calibration verification.	Refer to criteria listed in the method description (Element B5.1.9).	Retune instrument and verify.
		Surrogate spike.	Every sample, spiked sample, standard, and method blank.	QC acceptance criteria, Table B5.1.9-2.	Method 8000, Section 8.6 Requirements. Describe in Laboratory Review Checklist.
		MDL study.	Once per 12 month period.	Detection limits established shall be ≤ ½ the MQLs in Table B5.1.9-1.	None.

a. All corrective actions associated with project work shall be documented, and all records shall be maintained by the laboratory.

b. Except > 0.10 for bromoform, and > 0.10 for chloromethane and 1,1-dichloroethane

B.5.1.10 Method SW8270C-Semivolatile Organics

Semivolatile organics (also known as base/neutral and acid extractables) in water and soil samples are analyzed using Method SW8270C. This technique determines quantitatively the concentration of a number of SVOCs. Samples are extracted and both base/neutral and acid extracts are then concentrated through evaporation. Compounds of interest are separated and quantified using a capillary column GC/mass spectrometer.

The mass spectrometer is tuned every 12 hours to give an acceptable spectrum for decafluorotriphenylphosphine (DFTPP). The tuning acceptance criteria are given in the following list as an ion abundance for each specified mass:

- mass 51 30 percent to 60 percent of mass 198
- mass 68 less than 2 percent of mass 69
- mass 70 less than 2 percent of mass 69
- mass 127 40 percent to 60 percent of mass 198
- mass 197 less than 1 percent of mass 198
- mass 198 base peak, 100 percent relative abundance
- mass 199 5 percent to 9 percent of mass 198
- mass 275 10 percent to 30 percent of mass 198
- mass 365 greater than 1 percent of mass 198
- mass 441 present, but less than mass 443
- mass 442 greater than 40 percent of mass 198
- mass 443 17 percent to 23 percent of mass 442

The IS method is used for quantitation of analytes of interest. For quantitation, RFs are calculated from the base ion peak of a specific IS that is added to each calibration standard, blank, QC sample, and sample.

Table B5.1.10-1 includes the method quantitation limits for full scan GC/MS and the method quantitation limits using select ion monitoring (SIM) analysis. In addition to the target analytes listed in Table B5.1.10-1, full scan Method 8270C includes performing library searches for up to twenty tentatively identified compounds (TICs).

Table B5.1.10-1. MQLs for Method SW8270C

Parameter/Method	Analyte	Water[a]		Soil[a]	
		MQL	Unit	MQL	Unit
Semivolatile organics	2,4-DNT	10.0 (0.3)	µg/L	0.7 (0.02)	mg/kg
Base/Neutral Extractables	2,6-DNT	10.0 (0.3)	µg/L	0.7 (0.02)	mg/kg
SW8270C	2-Chloronaphthalene	10.0 (0.3)	µg/L	0.7 (0.02)	mg/kg
	2-Methylnaphthalene	10.0 (0.3)	µg/L	0.7 (0.02)	mg/kg
	2-Nitroaniline	50.0 (1.3)	µg/L	3.3 (0.08)	mg/kg
	3-Nitroaniline	50.0 (1.3)	µg/L	3.3 (0.08)	mg/kg
	3,3'-Dichlorobenzidine	20.0 (0.5)	µg/L	1.3 (0.03)	mg/kg
	4-Bromophenyl phenyl ether	10.0 (0.3)	µg/L	0.7 (0.02)	mg/kg
	4-Chloroaniline	20.0 (0.5)	µg/L	1.3 (0.03)	mg/kg
	4-Chlorophenyl phenyl ether	10.0 (0.3)	µg/L	0.7 (0.02)	mg/kg
	4-Nitroaniline	50.0 (1.3)	µg/L	3.3 (0.08)	mg/kg
	Acenaphthylene	10.0 (0.3)	µg/L	0.7 (0.02)	mg/kg
	Acenapthene	10.0 (0.3)	µg/L	0.7 (0.02)	mg/kg
	Acetophenone	10.0 (0.3)	µg/L	0.3 (0.008)	mg/kg
	Anthracene	10.0 (0.3)	µg/L	0.7 (0.02)	mg/kg
	Atrazine	10.0 (0.3)	µg/L	0.8 (0.02)	mg/kg
	Benzaldehyde	10.0 (0.3)	µg/L	0.3 (0.008)	mg/kg
	Benz(a)anthracene	10.0 (0.3)	µg/L	0.7 (0.02)	mg/kg
	Benzo (a) pyrene	10.0 (0.3)	µg/L	0.7 (0.02)	mg/kg
	Benzo(b)fluoranthene	10.0 (0.3)	µg/L	0.7 (0.02)	mg/kg
	Benzo(k)fluoranthene	10.0 (0.3)	µg/L	0.7 (0.02)	mg/kg
	Benzo(g,h,i)perylene	10.0 (0.3)	µg/L	0.7 (0.02)	mg/kg
	Benzyl alcohol	20.0 (0.5)	µg/L	1.3 (0.03)	mg/kg
	1,1'-Biphenyl	10.0 (0.3)	µg/L	0.3 (0.008)	mg/kg
	Bis(2-chloroethoxy) methane	10.0 (0.3)	µg/L	0.7 (0.02)	mg/kg
	Bis(2-chloroethyl) ether	10.0 (0.3)	µg/L	0.7 (0.02)	mg/kg
	Bis(2-chloroisopropyl) ether	10.0 (0.3)	µg/L	0.7 (0.02)	mg/kg
	Bis(2-ethylhexyl) phthalate	10.0 (0.3)	µg/L	0.7 (0.02)	mg/kg
	Butyl benzylphthalate	10.0 (0.3)	µg/L	0.7 (0.02)	mg/kg
	Caprolactum	10.0 (0.3)	µg/L	0.3 (0.008)	mg/kg
	Carbazole	10.0 (0.3)	µg/L	0.3 (0.008)	mg/kg
	Chrysene	10.0 (0.3)	µg/L	0.7 (0.02)	mg/kg
	Di-n-butylphthalate	10.0 (0.3)	µg/L	0.7 (0.02)	mg/kg
	Di-n-octylphthalate	10.0 (0.3)	µg/L	0.7 (0.02)	mg/kg
	Dibenz(a,h)anthracene	10.0 (0.3)	µg/L	0.7 (0.02)	mg/kg
	Dibenzofuran	10.0 (0.3)	µg/L	0.7 (0.02)	mg/kg
	Diethyl phthalate	10.0 (0.3)	µg/L	0.7 (0.02)	mg/kg
	Dimethyl phthalate	10.0 (0.3)	µg/L	0.7 (0.02)	mg/kg
	Fluoranthene	10.0 (0.3)	µg/L	0.7 (0.02)	mg/kg
	Fluorene	10.0 (0.3)	µg/L	0.7 (0.02)	mg/kg
	Hexachlorobenzene	10.0 (0.3)	µg/L	0.7 (0.02)	mg/kg

Table B5.1.10-1. (Concluded)

Parameter/Method	Analyte	Water[a]		Soil[a]	
		MQL	Unit	MQL	Unit
Semivolatile organics	Hexachlorobutadiene	10.0 (0.3)	µg/L	0.7 (0.02)	mg/kg
Base/Neutral Extractables	Hexachlorocyclopentadiene	10.0 (0.3)	µg/L	0.3 (0.008)	mg/kg
SW8270C	Hexachloroethane	10.0 (0.3)	µg/L	0.7 (0.02)	mg/kg
(concluded)	Indeno(1,2,3-cd)-pyrene	10.0 (0.3)	µg/L	0.7 (0.02)	mg/kg
	Isophorone	10.0 (0.3)	µg/L	0.7 (0.02)	mg/kg
	n-Nitrosodiphenylamine	10.0 (0.3)	µg/L	0.7 (0.02)	mg/kg
	n-Nitrosodi-n-propylamine	10.0 (0.3)	µg/L	0.7 (0.02)	mg/kg
	Naphthalene	10.0 (0.3)	µg/L	0.7 (0.02)	mg/kg
	Nitrobenzene	10.0 (0.3)	µg/L	0.7 (0.02)	mg/kg
	2,2'-oxybis(1-Chloropropane)	10.0 (0.3)	µg/L	0.3 (0.008)	mg/kg
	Phenanthrene	10.0 (0.3)	µg/L	0.7 (0.02)	mg/kg
	Pyrene	10.0 (0.3)	µg/L	0.7 (0.02)	mg/kg
Semivolatile organics	2,4,5-Trichlorophenol	50.0 (1.3)	µg/L	3.3 (0.08)	mg/kg
Acid Extractables	2,4,6-Trichlorophenol	10.0 (0.3)	µg/L	0.3 (0.008)	mg/kg
SW8270C	2,4-Dichlorophenol	10.0 (0.3)	µg/L	0.3 (0.008)	mg/kg
	2,4-Dimethylphenol	10.0 (0.3)	µg/L	0.3 (0.008)	mg/kg
	2,4-Dinitrophenol	50.0 (1.3)	µg/L	3.3 (0.08)	mg/kg
	2-Chlorophenol	10.0 (0.3)	µg/L	0.3 (0.008)	mg/kg
	2-Methylphenol	10.0 (0.3)	µg/L	0.3 (0.008)	mg/kg
	2-Nitrophenol	10.0 (0.3)	µg/L	0.3 (0.008)	mg/kg
	4,6-Dinitro-2-methylphenol	50.0 (1.3)	µg/L	3.3 (0.08)	mg/kg
	4-Chloro-3-methylphenol	20.0 (0.5)	µg/L	1.3 (0.03)	mg/kg
	4-Methylphenol	50.0 (1.3)	µg/L	2.0 (0.05)	mg/kg
	4-Nitrophenol	50.0 (1.3)	µg/L	1.6 (0.04)	mg/kg
	Benzoic acid	100 (2.5)	µg/L	5.0 (0.13)	mg/kg
	Pentachlorophenol	50.0 (1.3)	µg/L	3.3 (0.08)	mg/kg
	Phenol	10.0 (0.3)	µg/L	0.3 (0.008)	mg/kg

a The parenthetical value is the method quantitation limit for the compound using select ion monitoring (SIM) analysis. All QC checks specified in Table B.5.1.10-3 are applicable to SIM analysis as well.

Table B5.1.10-2. QC Acceptance Criteria for Method SW8270C

Method	Analyte	Accuracy Water (% R)	Precision Water (RPD)	Accuracy Soil (% R)	Precision Soil (RPD)
SW8270C	2,4-DNT	51–120	≤ 20	48–125	≤ 30
	2,6-DNT	49–120	≤ 20	48–125	≤ 30
	2-Chloronaphthalene	49–120	≤ 20	45–125	≤ 30
	2-Methylnaphthalene	46–120	≤ 20	47–125	≤ 30
	2-Nitroaniline	48–120	≤ 20	44–125	≤ 30
	3,3'-Dichlorobenzidine	20–120	≤ 20	25–128	≤ 30
	3-Nitroaniline	20–126	≤ 20	27–125	≤ 30
	4-Bromophenyl phenyl ether	52–120	≤ 20	46–125	≤ 30
	4-Chloroaniline	20–120	≤ 20	25–125	≤ 30
	4-Chlorophenyl phenyl ether	50–120	≤ 20	47–125	≤ 30
	4-Nitroaniline	36–120	≤ 20	34–125	≤ 30
	Acenaphthylene	50–120	≤ 20	44-125	≤ 30
	Acenaphthene	47–120	≤ 20	46–125	≤ 30
	Anthracene	54–120	≤ 20	53–125	≤ 30
	Benz(a)anthracene	56–100	≤ 20	52–125	≤ 30
	Benzo(a)pyrene	53–120	≤ 20	50–125	≤ 30
	Benzo(b)fluoranthene	45–124	≤ 20	45–125	≤ 30
	Benzo(k)fluoranthene	45–124	≤ 20	45–125	≤ 30
	Benzo(g,h,i)perylene	38–123	≤ 20	38–126	≤ 30
	Benzyl alcohol	30–120	≤ 20	25–125	≤ 30
	Bis(2-chloroethoxy) methane	46–120	≤ 20	43–125	≤ 30
	Bis(2-chloroethyl) ether	37–120	≤ 20	38–125	≤ 30
	Bis(2-chloroisopropyl) ether	26–131	≤ 20	25–125	≤ 30
	Bis(2-ethylhexyl) phthalate	42–126	≤ 20	47–127	≤ 30
	Butyl benzyl phthalate	46–120	≤ 20	49–125	≤ 30
	Chrysene	55–120	≤ 20	53–125	≤ 30
	Di-n-butyl phthalate	54–120	≤ 20	56–125	≤ 30
	Di-n-octyl phthalate	37–137	≤ 20	41–132	≤ 30
	Dibenz (a,h) anthracene	42–127	≤ 20	41–125	≤ 30
	Dibenzofuran	54–120	≤ 20	51–125	≤ 30
	Diethyl phthalate	41–120	≤ 20	50–125	≤ 30
	Dimethyl phthalate	25–127	≤ 20	49–125	≤ 30
	Fluoranthene	54–120	≤ 20	54–125	≤ 30
	Fluorene	50–120	≤ 20	49–125	≤ 30

Table B5.1.10-2. (Concluded)

Method	Analyte	Accuracy Water (% R)	Precision Water (RPD)	Accuracy Soil (% R)	Precision Soil (RPD)
SW8270C	Hexachlorobenzene	52–120	≤ 20	47–125	≤ 30
	Hexachlorobutadiene	27–120	≤ 20	40–125	≤ 30
	Hexachlorocyclopentadiene	41–125	≤ 20	31–135	≤ 30
	Hexachloroethane	28–120	≤ 20	34–125	≤ 30
	Indeno(1,2,3-c,d)pyrene	43–125	≤ 20	38–125	≤ 30
	Isophorone	50–120	≤ 20	43–125	≤ 30
	n-Nitrosodi-n-propylamine	34–128	≤ 20	40–125	≤ 30
	n-Nitrosodiphenylamine	48–120	≤ 20	49–125	≤ 30
	Naphthalene	39–120	≤ 20	40–125	≤ 30
	Nitrobenzene	44–120	≤ 20	41–125	≤ 30
	Phenanthrene	51–120	≤ 20	50–125	≤ 30
	Pyrene	49–128	≤ 20	46–125	≤ 30
	2,4,5-Trichlorophenol	49–120	≤ 20	49–125	≤ 30
	2,4,6-Trichlorophenol	49–126	≤ 20	43–125	≤ 30
	2,4-Dichlorophenol	48–120	≤ 20	45–125	≤ 30
	2,4-Dimethylphenol	28–120	≤ 20	32–125	≤ 30
	2,4-Dinitrophenol	25–130	≤ 20	25–132	≤ 30
	2-Chlorophenol	37–120	≤ 20	44–125	≤ 30
	2-Methylphenol	38–120	≤ 20	40–125	≤ 30
	2-Nitrophenol	39–123	≤ 20	42–125	≤ 30
	4,6-Dinitro-2-Methyl Phenol	40–130	≤ 20	29–137	≤ 30
	4-Chloro-3-Methyl Phenol	47–120	≤ 20	46–125	≤ 30
	4-Methylphenol	32–120	≤ 20	41–125	≤ 30
	4-Nitrophenol	20–120	≤ 20	25–138	≤ 30
	Benzoic Acid	20–120	≤ 20	25–125	≤ 30
	Pentachlorophenol	38–120	≤ 20	25–125	≤ 30
	Phenol	20–120	≤ 20	39–125	≤ 30
	Surrogates:				
	2,4,6-Tribromophenol	42–124		36–126	
	2-Fluorobiphenyl	48–120		43–125	
	2-Fluorophenol	20–120		37–125	
	Nitrobenzene-D5	41–120		37–125	
	Phenol-D5	20–120		40–125	
	Terphenyl-D14	51–135		32–125	

Table B5.1.10-3. Summary of Calibration and QC Procedures for Method SW8270C

Method	Applicable Parameters	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
SW8270C	Semivolatile Organics	Five-point initial calibration for all analytes.	Initial calibration prior to sample analysis.	SPCCs average RF ≥ 0.050 and %RSD for RFs for CCCs ≤ 30% and one option below.	Correct problem then repeat initial calibration.
				option 1 linear - mean RSD for all analytes ≤15% with no individual analyte RSD >30%.	
				option 2 linear – least squares regression r ≥ 0.995 for each analyte.	
				option 3 non-linear – COD ≥ 0.990 (6 points shall be used for second order, 7 points shall be used for third order).	
		Second-source calibration verification.	Once per five-point initial calibration.	All analytes within ±25% of expected value.	Correct problem then repeat initial calibration.
		Calibration verification.	Daily, before sample analysis and every 12 hours of analysis time.	SPCCs average RF ≥ 0.05; and CCCs ≤ 20% difference (when using Rfs) or drift (when using least squares regression or non-linear calibration).	Correct problem then repeat initial calibration.
				All calibration analytes within ±30% of expected value.	
		Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample.	Once per analyst.	QC acceptance criteria, Table B5.1.10-2.	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria.
		Internal standards.	Immediately after or during data acquisition for each sample.	Retention time ±30 seconds from retention time of the mid-point std. in the ICAL. EICP area within -50% to +100% of ICAL mid-point std.	Inspect mass spectrometer and GC for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning.

Table B5.1.10-3. (Concluded)

Method	Applicable Parameters	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
8270C	Semivolatile Organics	Method blank.	One per analytical batch.	No analytes detected ≥ MQL.	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank.
		LCS for all analytes.	One LCS per analytical batch.	QC acceptance criteria, Table B5.1.10-2.	Correct problem then reprep and analyze the LCS and all samples in the affected analytical batch.
		MS/MSD.	One MS/MSD per every 20 project samples per matrix.	QC acceptance criteria, Table B5.1.10-2.	Describe in Laboratory Review Checklist.
		Check of mass spectral ion intensities using DFTPP.	Prior to initial calibration and calibration verification.	Refer to criteria listed in the method description (Element B5.1.10).	Retune instrument and verify.
		Surrogate spike.	Every sample, spiked sample, standard, and method blank.	QC acceptance criteria, Table B5.1.10-2.	Method 8000, Section 8.6 Requirements. Describe in Laboratory Review Checklist.
		MDL study.	Once per 12 month period.	Detection limits established shall be ≤ ½ the MQLs in Table B5.1.10-1.	None.

a. All corrective actions associated with project work shall be documented, and all records shall be maintained by the laboratory.

B.5.1.11 Method SW8280A-Polychlorinated Dibenzo-p-Dioxins and Polychlorinated Dibenzofurans

Method SW8280A is used to analyze for polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) in water, sediment, soil, and waste. This GC/MS method uses matrix-specific extraction, analyte-specific cleanup, and high-resolution capillary column GC/low resolution mass spectrometry techniques to separate and identify the analytes of interest. The sensitivity of the method is dependent on the level of matrix interference. Selected cleanup methods may be used to reduce or eliminate interferences. Target analytes may include all congener classes, tetra- through octa-dioxins and furans. Achieved detection limits vary according to matrix and analyte. Because of the extreme toxicity of these compounds, the analyst must take appropriate precautions during preparation and analysis to prevent accidental exposure. Isomer specificity for all congeners cannot be achieved using the recommended GC column and conditions in Method SW8280A. Therefore, if a congener is not resolvable from other congeners during calibration or column performance check analyses and is identified as detectable on the primary column in a given sample analysis, then its presence and concentration shall be determined on another GC column that resolves the given congener.

Method SW8280A provides for sample- and analyte-specific estimated detection limit (EDL) calculations based on measured signal to noise ratios. Therefore, the numeric value associated with a non-detectable result shall be the EDL calculated as specified in the analytical method (depending on the type of response produced during analysis of a given sample), rather than the MDL.

In addition, a detection limit determination for each 2,3,7,8-substituted congener using the following procedure shall be substituted for the MDL determination and comparison to method quantitation limits specified in this QAPP.

Seven method blanks shall be analyzed within a seven consecutive day period during the 12 months preceding the analysis of samples within a given batch. It is acceptable for sample and standard analyses to be interspersed among these method blanks, but no additional method blank analyses shall be interspersed among the seven method blanks to be used for the detection limit evaluation. The maximum reported value (EDL for non-detects) shall be less than or equal to the method quantitation limit specified in Table B5.1.11-1 and the mean of the reported values (EDL for non-detects) shall be less than or equal to one half of the method quantitation limit.

Method SW8280 specifies several quality control samples that are optional. For analyses under this QAPP, the following QC samples will be utilized:

- Performance check solutions will be analyzed in accordance with the method.
- GC column performance check samples will be analyzed in accordance with the method.
- No fortified field blank will be required.
- Matrix spike/duplicate samples will be analyzed at the frequency specified in the method.
- Laboratory duplicate sample analyses will not be required.
- Field duplicate analyses will be conducted at the frequency specified in Section 4 of the FSP.

Table B5.1.11-1. MQLs for Method SW8280A

Parameter/Method	Analyte	Water		Soil	
		MQL	Unit	MQL	Unit
Dioxins and Furans SW8280A	2,3,7,8-PCDDs	4.4	ng/L	1.7	µg/kg
	2,3,7,8-PCDFs	1.0	ng/L	1.1	µg/kg

Table B5.1.11-2. Summary of Calibration and QC Procedures for Method SW8280A

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
SW8280A	Dioxins/ Furans	Mass spectrometer tune	As per Method SW8280A, Section 7.13.	As per Method SW8280A, Section 7.13.	Retune instrument; verify.
		Initial and continuing calibration	As per Method SW8280A, Section 7.13.	As per Method SW8280A, Section 7.13.	Correct problem then repeat calibration.
		Identification/ retention times/ ion ratios/ signal to noise/ interferences	As per Method SW8280A, Section 7.14.	As per Method SW8280A, Section 7.14.	As per Method SW8280A Section 8.5.
		System performance check	As per Method SW8280A, Section 7.12.	As per Method SW8280A, Section 7.12.	Correct problem and rerun.
		Quality control checks except MS/MSD	As per Method SW8280A, Section 8.4, as clarified in Element B5.1.11 of this QAPP.	As per Method SW8280A, Section 8.4.	Correct problem and rerun.
		MS/Duplicate.	One MS/Duplicate per every project samples per matrix.	QC acceptance criteria, Method SW8280A.	None.
		Internal standard.	As per Method SW8280A.	As per Method SW8280A.	Correct problem and rerun.
		MDL study.	As per Element B5.1.11 of this QAPP.	As per Element B5.1.11 of this QAPP.	None.

[a]All corrective actions associated with project work shall be documented, and all records shall be maintained by the laboratory.

[b]In accordance with SW8280A, peaks that fail to meet identification criteria are reported as non-detects at the sample- and analyte-specific estimated detection limit.

B.5.1.12 Method SW8290-Polychlorinated Dibenzo-p-Dioxins and Polychlorinated Dibenzofurans

Method SW8290 is used to analyze for polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) in water, sediment, soil, and waste. This GC/MS method uses matrix-specific extraction, analyte-specific cleanup, and high-resolution capillary column GC/high resolution mass spectrometry techniques to separate and identify the analytes of interest. The sensitivity of the method is dependent on the level of matrix interference. Selected cleanup methods may be used to reduce or eliminate interferences. Target analytes may include all congener classes, tetra- through octa-dioxins and furans. Achieved detection limits vary according to matrix and analyte. Because of the extreme toxicity of these compounds, the analyst must take appropriate precautions during preparation and analysis to prevent accidental exposure.

Isomer specificity for all congeners cannot be achieved using the recommended GC column and conditions in Method SW8290. Therefore, if a congener is not resolvable from other congeners during calibration or column performance check analyses and is identified as detectable on the primary column in a given sample analysis, then its presence and concentration shall be determined on another GC column that resolves the given congener.

Method SW8290 provides for sample- and analyte-specific estimated detection limit (EDL) calculations based on measured signal to noise ratios. Therefore, the numeric value associated with a non-detectable result shall be the EDL calculated as specified in the analytical method (depending on the type of response produced during analysis of a given sample), rather than the MDL.

In addition, a detection limit determination for each 2,3,7,8-substituted congener using the following procedure shall be substituted for the MDL determination and comparison to method quantitation limits specified in this QAPP.

Seven method blanks shall be analyzed within a seven consecutive day period during the 12 months preceding the analysis of samples within a given batch. It is acceptable for sample and standard analyses to be interspersed amongst these method blanks, but no additional method blank analyses shall be interspersed among the seven method blanks to be used for the detection limit evaluation. The maximum reported value (EDL for non-detects) shall be less than or equal to the method quantitation limit specified in Table B5.1.12-1 and the mean of the reported values (EDL for non-detects) shall be less than or equal to one half of the method quantitation limit specified in Table B5.1.12-1.

Method SW8290 specifies several quality control samples that are optional. For analyses under this QAPP, the following QC samples will be utilized:

- Performance check solutions will be analyzed in accordance with the method.
- GC column performance check samples will be analyzed in accordance with the method.
- No fortified field blank will be required.
- Matrix spike/duplicate samples will be analyzed at the frequency specified in the method.
- Laboratory duplicate sample analyses will not be required.
- Field duplicate analyses will be conducted at the frequency specified in Section 4 of the FSP.

Table B5.1.12-1. MQLs for Method SW8290

Parameter/Method	Analyte[a]	Water		Soil	
		MQL	Unit	MQL	Unit
Dioxins and Furans	2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	0.01	ng/L	1.0	ng/kg
SW8290	1,2,3,7,8-Pentachlorodibenzo-p-dioxin (PeCDD)	0.01	ng/L	1.0	ng/kg
	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	0.025	ng/L	2.5	ng/kg
	1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	0.025	ng/L	2.5	ng/kg
	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (HxCDD)	0.025	ng/L	2.5	ng/kg
	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)	0.025	ng/L	2.5	ng/kg
	1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin (OCDD)	0.05	ng/L	5.0	ng/kg
	2,3,7,8-Tetrachlorodibenzofuran (TCDF)	0.01	ng/L	1.0	ng/kg
	1,2,3,7,8-Pentachlorodibenzofuran (PeCDF)	0.01	ng/L	1.0	ng/kg
	2,3,4,7,8-Pentachlorodibenzofuran (PeCDF)	0.05	ng/L	1.0	ng/kg
	1,2,3,6,7,8-Hexachlorodibenzofuran (HxCDF)	0.025	ng/L	2.5	ng/kg
	1,2,3,7,8,9-Hexachlorodibenzofuran (HxCDF)	0.025	ng/L	2.5	ng/kg
	1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF)	0.025	ng/L	2.5	ng/kg
	2,3,4,6,7,8-Hexachlorodibenzofuran (HxCDF)	0.025	ng/L	2.5	ng/kg
	1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)	0.025	ng/L	2.5	ng/kg
	1,2,3,4,7,8,9-Heptachlorodibenzofuran (HpCDF)	0.025	ng/L	2.5	ng/kg
	1,2,3,4,6,7,8,9-Octachlorodibenzofuran (OCDF)	0.05	ng/L	5.0	ng/kg

[a]Total concentrations in a homologous series shall be calculated in accordance with Method SW8290 Section 7.9.4 and shall include concentrations of 2,3,7,8-substituted congeners even though they are separately reported elsewhere on the data reporting form. The method quantitation limit requirement is based on the detection limit attainable on individual congeners within a homologous series.

Table B5.1.12-2. Summary of Calibration and QC Procedures for Method SW8290

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
SW8290	Dioxins/ Furans	Mass spectrometer tune.	As per Method SW8290, Section 7.6.2.	As per Method SW8290, Section 7.6.2.	Retune instrument; verify.
		Initial and continuing calibration.	As per Method SW8290, Section 7.7.	As per Method SW8290, Section 7.7.	Correct problem then repeat calibration.
		Identification/ retention times/ ion ratios/ signal to noise/ interferences.	As per Method SW8290, Section 7.8.4.	As per Method SW8290, Section 7.8.4.	As per Method SW8290 Section 8.5.
		System performance check.	As per Method SW8290, Section 8.2.	As per Method SW8290, Section 8.2.	Correct problem and rerun.
		Quality control checks except MS/MSD.	As per Method SW8290, Section 8.3.	As per Method SW8290, Section 8.3.	Correct problem and rerun.
		MS/MSD.	One MS/MSD per every 20 project samples per matrix.	QC acceptance criteria, Method SW8290, Section 8.3.6.	None.
		Internal standard.	As per Method SW8290, Section 8.4. See variance M3.	As per Method SW8290, Section 8.4.	Correct problem and rerun.

[a]All corrective actions associated with project work shall be documented, and all records shall be maintained by the laboratory.
[b]In accordance with SW8290, peaks that fail to meet identification criteria are reported as non-detects at the sample- and analyte-specific estimated detection limit.

B.5.1.13 Method SW8310–Polynuclear Aromatic Hydrocarbons

Method SW8310 is used to determine the concentration of ppb levels of selected polynuclear aromatic hydrocarbons (PAHs) in groundwater and soils by HPLC. Samples are extracted then analyzed by direct injection. Detection is by ultraviolet and fluorescence detectors.

Table B5.1.13-1. MQLs for Method SW8310

Parameter/Method	Analyte	Water		Soil	
		MQL	Unit	MQL	Unit
Polynuclear Aromatic Hydrocarbons SW8310	Acenaphthene	1.0	µg/L	0.2	mg/kg
	Acenaphthylene	1.0	µg/L	0.1	mg/kg
	Anthracene	1.0	µg/L	0.1	mg/kg
	Benzo(a)anthracene	0.1	µg/L	0.01	mg/kg
	Benzo(a)pyrene	0.2	µg/L	0.015	mg/kg
	Benzo(b)fluoranthene	0.2	µg/L	0.01	mg/kg
	Benzo(g,h,i)perylene	0.5	µg/L	0.05	mg/kg
	Benzo(k)fluoranthene	0.2	µg/L	0.01	mg/kg
	Chrysene	0.5	µg/L	0.1	mg/kg
	Dibenzo(a,h)anthracene	0.2	µg/L	0.01	mg/kg
	Fluoranthrene	1.0	µg/L	0.1	mg/kg
	Fluorene	2.0	µg/L	0.2	mg/kg
	Indeno(1,2,3-c,d)pyrene	0.2	µg/L	0.03	mg/kg
	Naphthalene	1.0	µg/L	0.2	mg/kg
	Phenanthrene	1.0	µg/L	0.1	mg/kg
	Pyrene	1.0	µg/L	0.1	mg/kg

Table B5.1.13-2. QC Acceptance Criteria for Method SW8310

Method	Analyte	Accuracy Water (% R)	Precision Water (RPD)	Accuracy Soil (% R)	Precision Soil (RPD)
SW8310	Acenaphthene	37–128	≤ 30	37–128	≤ 50
	Acenaphthylene	40–121	≤ 30	40–121	≤ 50
	Anthracene	41–120	≤ 30	47–125	≤ 50
	Benzo(a)anthracene	49–120	≤ 30	50–120	≤ 50
	Benzo(a)pyrene	45–120	≤ 30	40–133	≤ 50
	Benzo(b)fluoranthene	51–120	≤ 30	57–121	≤ 50
	Benzo(g,h,i)perylene	34–120	≤ 30	53–120	≤ 50
	Benzo(k)fluoranthene	48–120	≤ 30	48–121	≤ 50
	Chrysene	50–120	≤ 30	55–120	≤ 50
	Dibenzo(a,h)anthracene	33–120	≤ 30	47–120	≤ 50
	Fluoranthene	48–120	≤ 30	43–129	≤ 50
	Fluorene	42–128	≤ 30	46–120	≤ 50
	Indeno(1,2,3-c,d)pyrene	47–120	≤ 30	56–134	≤ 50
	Naphthalene	33–120	≤ 30	48–120	≤ 50
	Phenathrene	40–120	≤ 30	57–126	≤ 50
	Pyrene	52–120	≤ 30	49–120	≤ 50
	Surrogates:				
	Terphenyl-D14	25–157		22–167	
	Decafluorobiphenyl	33–141		37–152	

Table B5.1.13-3. Summary of Calibration and QC Procedures for Method SW8310

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
SW8310	PAHs	Five-point initial calibration for all analytes.	Initial calibration prior to sample analysis.	linear - mean RSD of average CF of all analytes ≤20% and average CF of individual analyte <30% or mean RSD for all analytes ≤20% with no individual analyte RSD > 30%.	Correct problem then repeat initial calibration.
				linear -- least squares regression r ≥ 0.995 for each analyte.	
				non-linear – COD ≥ 0.990 (6 points shall be used for second order, 7 points shall be used for third order).	
		Second-source calibration verification.	Once per five-point initial calibration.	All analytes within ±15% of expected value.	Correct problem then repeat initial calibration.
		Retention time window calculated for each analyte.	Each initial calibration and calibration verifications.	± 3 times standard deviation for each analyte average retention time from 72-hour study.	Correct problem then reanalyze all samples analyzed since the last retention time check.
		Initial calibration verification.	Daily, before sample analysis.	All analytes within ±15% of expected value.	Correct problem then repeat initial calibration.
		Calibration verification.	After every 10 samples and at the end of the analysis sequence.	All analytes within ±15% of expected value.	Correct problem then repeat initial calibration verification and reanalyze all samples since last successful calibration verification.
		Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample.	Once per analyst.	QC acceptance criteria, Table B5.1.13-2.	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria.
		Method blank.	One per analytical batch.	No analytes detected ≥ MQL.	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank.

Table B5.1.13-3. (Concluded)

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
SW8310	PAHs	LCS for all analytes.	One LCS per analytical batch.	QC acceptance criteria, Table B5.1.13-2.	Correct problem then reprep and analyze the LCS and all samples in the affected analytical batch.
		Surrogate spike.	Every sample, spiked sample, standard, and method blank.	QC acceptance criteria, Table B5.1.13-2.	Method 8000 Section 8.6 Requirements. Describe in Laboratory Review Checklist.
		MS/MSD.	One MS/MSD per every 20 project samples per matrix.	QC acceptance criteria, Table B5.1.13-2.	Describe in Laboratory Review Checklist.
		Confirmation[b]	100% for all positive results.	Same as for initial or primary analysis.	Same as for initial or primary analysis.
		MDL study.	Once per 12 month period.	Detection limits established shall be ≤ ½ the MQLs in Table B5.1.13-1.	None

a. All corrective actions associated with project work shall be documented, and all records shall be maintained by the laboratory.
b. Use a second column or different detector.

B.5.1.14 Method SW8330–Explosive Residues

Method SW8330 provides HPLC conditions for the detection of ppb levels of certain explosive residues in a water, soil, and sediment matrix. Prior to using this method, appropriate sample preparation techniques must be used.

In the low-level, salting-out method with no evaporation, aqueous samples of low concentration are extracted by a salting-out extraction procedure. An aliquot of the extract is separated on a C-18 reverse-phase column, determined at 254 nm, and confirmed on a cyanide reverse-phase column.

In the high-level direct injection method, aqueous samples of higher concentration can be diluted, filtered, separated on a C-18 reverse-phase column, determined at 254 nm, and confirmed on a cyanide reverse-phase column.

Soil and sediment samples are extracted in an ultrasonic bath and filtered before chromatography.

Table B5.1.14-1. MQLs for Method SW8330

Parameter/Method	Analyte	Water		Soil	
		MQL	Unit	MQL	Unit
Explosive Residues	1,3,5- TNB	1.0	µg/L	0.25	mg/kg
SW8330	1,3- DNB	1.0	µg/L	0.25	mg/kg
	2,4,6- TNT	1.0	µg/L	0.25	mg/kg
	2,4-DNT	1.0	µg/L	0.25	mg/kg
	2,6-DNT	1.0	µg/L	0.26	mg/kg
	HMX	1.0	µg/L	2.2	mg/kg
	m-Nitrotoluene	1.0	µg/L	0.25	mg/kg
	Methyl-2,4,6-trinitrophenylnitramine	1.0	µg/L	0.65	mg/kg
	Nitrobenzene	1.0	µg/L	0.26	mg/kg
	o-Nitrotoluene	1.0	µg/L	0.25	mg/kg
	p-Nitrotoluene	1.0	µg/L	0.25	mg/kg
	RDX	1.0	µg/L	1.0	mg/kg

Table B5.1.14-2. QC Acceptance Criteria for Method SW8330

Method	Analyte	Accuracy Water (% R)	Precision Water (RPD)	Accuracy Soil (% R)	Precision Soil (RPD)
SW8330	1,3,5-TNB	64–139	≤ 30	54–136	≤ 50
	1,3-DNB	47–158	≤ 30	79–124	≤ 50
	2,4,6-TNT	52–143	≤ 30	55-142	≤ 50
	2,4-DNT	61–135	≤ 30	56–141	≤ 50
	2,6-DNT	60–137	≤ 30	77–122	≤ 50
	HMX	51–161	≤ 30	72–134	≤ 50
	m-Nitrotoluene	48–132	≤ 30	52–133	≤ 50
	Methyl-2,4,6-Trinitrophenylnitramine	22–174	≤ 30	25–142	≤ 50
	Nitrobenzene	49–138	≤ 30	49–154	≤ 50
	o-Nitrotoluene	43–133	≤ 30	59–136	≤ 50
	p-Nitrotoluene	48–132	≤ 30	77–124	≤ 50
	RDX	81–120	≤ 30	74–126	≤ 50
	Surrogates[a]:				

a. For the surrogate, use an analyte from the method that is not expected to be present in the sample and its LCS limit.

Table B5.1.14-3. Summary of Calibration and QC Procedures for Method SW8330

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
SW8330	Explosives	Five-point initial calibration for all analytes.	Initial calibration prior to sample analysis.	mean RSD of average CF of all analytes ≤20% and average CF of individual analyte <30% or mean RSD for all analytes ≤20% with no individual analyte RSD > 30%.	Correct problem then repeat initial calibration.
				linear – least squares regression r ≥ 0.995 for each analyte.	
				non-linear – COD ≥ 0.990 (6 points shall be used for second order, 7 points shall be used for third order).	
		Second-source calibration verification.	Once per five-point initial calibration.	All analytes within ±15% of expected value.	Correct problem then repeat initial calibration.
		Retention time window calculated for each analyte.	Each initial calibration and calibration verifications.	± 3 times standard deviation for each analyte average retention time from 72-hour study.	Correct problem then reanalyze all samples analyzed since the last retention time check.
		Initial calibration verification.	Daily, before sample analysis.	All analytes within ±15% of expected value.	Correct problem then repeat initial calibration.
		Calibration verification.	After every 10 samples and at the end of the analysis sequence.	All analytes within ±15% of expected value.	Correct problem then repeat initial calibration verification and reanalyze all samples since last successful calibration verification.
		Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample.	Once per analyst.	QC acceptance criteria, Table B5.1.14-2.	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria.

Table B5.1.14-3. (Concluded)

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
SW8330	Explosives	Method blank.	One per analytical batch.	No analytes detected ≥ MQL.	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank.
		LCS for all analytes.	One LCS per analytical batch.	QC acceptance criteria, Table B5.1.14-2.	Correct problem then reprep and analyze the LCS and all samples in the affected analytical batch.
		Surrogate spike.	Every sample, spiked sample, standard, and method blank.	QC acceptance criteria, Table B5.1.14-2	Method 8000, Section 8.6 Requirements. Describe in Laboratory Review Checklist.
		MS/MSD.	One MS/MSD per every 20 project samples per matrix.	QC acceptance criteria, Table B5.1.14-2	Describe in Laboratory Review Checklist.
		Confirmation[b]	100% for all positive results.	Same as for initial or primary analysis	Same as for initial or primary analysis.
		MDL study.	Once per 12 month period.	Detection limits established shall be ≤ ½ the MQLs in Table B5.1.14-1	None
		Results reported between MDL and MQL.	None.	None.	None.

a. All corrective actions associated with project work shall be documented, and all records shall be maintained by the laboratory.
b. Use a second column or different detector.

B.5.1.15 Method SW6010B-Trace Elements (Metals) by Inductively Coupled Plasma Atomic Emission Spectroscopy for Water and Soil

Samples are analyzed for trace elements or metals using Method SW6010B for water and soils. Analysis for most metals requires digestion of the sample. Following digestion, the trace elements are determined simultaneously or sequentially using Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP-AES). The elements and corresponding MQLs for this method are listed in Table B5.1.15-1.

Table B5.1.15-1. MQLs for Method SW6010B

Parameter/Method	Analyte	Water		Soil	
		MQL	Unit	MQL	Unit
ICP-AES for Metals	Aluminum	0.2	mg/L	20	mg/kg
SW6010B	Antimony	0.05	mg/L	10.0	mg/kg
	Arsenic	0.03	mg/L	5.0	mg/kg
	Barium	0.05	mg/L	1.0	mg/kg
	Beryllium	0.004	mg/L	1.0	mg/kg
	Cadmium	0.005	mg/L	0.50	mg/kg
	Calcium	1.1	mg/L	100	mg/kg
	Chromium	0.01	mg/L	1.0	mg/kg
	Cobalt	0.06	mg/L	1.0	mg/kg
	Copper	0.01	mg/L	2.0	mg/kg
	Iron	0.2	mg/L	3.0	mg/kg
	Lead	0.025	mg/L	3.0	mg/kg
	Magnesium	1.0	mg/L	100	mg/kg
	Manganese	0.01	mg/L	1.0	mg/kg
	Molybdenum	0.015	mg/L	3.0	mg/kg
	Nickel	0.02	mg/L	2.0	mg/kg
	Potassium	1.0	mg/L	200	mg/kg
	Selenium	0.03	mg/L	3.0	mg/kg
	Silver	0.01	mg/L	1.0	mg/kg
	Sodium	1.0	mg/L	100	mg/kg
	Thallium	0.08	mg/L	6.0	mg/kg
	Vanadium	0.01	mg/L	1.0	mg/kg
	Zinc	0.02	mg/L	2.0	mg/kg

Table B5.1.15-2. QC Acceptance Criteria for Method SW6010B

Method	Analyte	Accuracy Water (% R)	Precision Water (RPD)	Accuracy Soil (% R)	Precision Soil (RPD)
SW6010B	Aluminum	80–120	≤ 20	80–120	≤ 30
	Antimony	80–120	≤ 20	80–120	≤30
	Arsenic	80–120	≤ 20	80–120	≤ 30
	Barium	80–120	≤ 20	80–120	≤ 30
	Beryllium	80–120	≤ 20	80–120	≤ 30
	Cadmium	80–120	≤ 20	80–120	≤ 30
	Calcium	80–120	≤ 20	80–120	≤ 30
	Chromium	80–120	≤ 20	80–120	≤ 30
	Cobalt	80–120	≤ 20	80–120	≤ 30
	Copper	80–120	≤ 20	80–120	≤ 30
	Iron	80–120	≤ 20	80–120	≤ 30
	Lead	80–120	≤ 20	80–120	≤ 30
	Magnesium	80–120	≤ 20	80–120	≤ 30
	Manganese	80–120	≤ 20	80–120	≤ 30
	Molybdenum	80–120	≤ 20	80–120	≤ 30
	Nickel	80–120	≤ 20	80–120	≤ 30
	Potassium	80–120	≤ 20	80–120	≤ 30
	Selenium	80–120	≤ 20	80–120	≤ 30
	Silver	80–120	≤ 20	80–120	≤ 30
	Sodium	80–120	≤ 20	80–120	≤ 30
	Thallium	80–120	≤ 20	80–120	≤ 30
	Vanadium	80–120	≤ 20	80–120	≤ 30
	Zinc	80–120	≤ 20	80–120	≤ 30

Table B5.1.15-3. Summary of Calibration and QC Procedures for Method SW6010B

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
SW6010B	ICP Metals	Initial calibration (minimum 1 standard and a blank).	Daily initial calibration prior to sample analysis.	If more than one standard is used, correlation coefficient must be ≥ 0.995.	If applicable, correct problem and repeat initial calibration.
		Initial calibration verification (second source).	Daily after initial calibration.	All analytes within ±10% of expected value.	Correct problem then repeat initial calibration.
		Calibration blank.	After every calibration verification.	No analytes detected ≥ MQL.	Correct problem then analyze calibration blank and previous 10 samples.
		Calibration verification (Instrument Check Standard).	After every 10 samples and at the end of the analysis sequence.	All analyte(s) within ±10% of expected value and RSD of replicate integrations <5%.	Repeat calibration and reanalyze all samples since last successful calibration.
		Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample.	Once per analyst.	QC acceptance criteria, Table B5.1.15-2.	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria.
		Method blank.	One per analytical batch.	No analytes detected ≥ MQL.	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank.
		Interference check solution (ICS).	At the beginning of an analytical run.	ICS-A All non-spiked analytes < MQL Within ±20% of true value. ICS-AB Within ±20% of true value.	Terminate analysis; correct problem; reanalyze ICS; reanalyze all affected samples.
SW6010B	ICP Metals	LCS for the analyte.	One LCS per analytical batch.	QC acceptance criteria, Table B5.1.15-2.	Correct problem then reprep and analyze the LCS and all samples in the affected analytical batch.
		Dilution test.	Each new sample matrix.	1:5 dilution must agree within ±10% of the original determination for analyte concentration greater than 10x IDL.	Perform post digestion spike addition for failed analytes.
		Post digestion spike addition.	When dilution test fails.	Recovery within 75-125% of expected results.	Correct problem then reanalyze post digestion spike addition.
		MS/MSD.	One MS/MSD per every 20 project samples per matrix.	QC acceptance criteria, Table B5.1.15-2.	Describe in Laboratory Review Checklist.
		MDL study.	Once per 12 month period.	Detection limits established shall be ≤ ½ the MQLs in Table B5.1.15-1.	None.

a. All corrective actions associated with project work shall be documented, and all records shall be maintained by the laboratory.

B.5.1.16 Method SW6020A-Trace Elements (Metals) by Inductively Coupled Plasma Mass Spectroscopy for Water and Soil

Samples are analyzed for trace elements or metals using Method SW6020A for water and soils. Analysis for total (i.e., acid leachable) metals requires digestion of the sample. Following digestion, the trace elements are determined simultaneously or sequentially using Inductively Coupled Plasma Mass Spectroscopy (ICP/MS). The elements and MQLs for this method are listed in Table B5.1.16-1.

Table B5.1.16-1. MQLs for Method SW6020A

Parameter/Method	Analyte	Water		Soil	
		MQL	Unit	MQL	Unit
ICP/MS for Metals	Aluminum	0.02	mg/L	2.0	mg/kg
SW6020A	Antimony	0.001	mg/L	0.10	mg/kg
	Arsenic	0.01	mg/L	1.0	mg/kg
	Barium	0.003	mg/L	0.30	mg/kg
	Beryllium	0.003	mg/L	0.30	mg/kg
	Cadmium	0.002	mg/L	0.20	mg/kg
	Chromium	0.004	mg/L	0.40	mg/kg
	Cobalt	0.008	mg/L	0.80	mg/kg
	Copper	0.006	mg/L	0.60	mg/kg
	Lead	0.002	mg/L	0.20	mg/kg
	Manganese	0.002	mg/L	0.20	mg/kg
	Mercury	0.001	mg/L	0.10	mg/kg
	Nickel	0.002	mg/L	0.20	mg/kg
	Selenium	0.001	mg/L	0.10	mg/kg
	Silver	0.002	mg/L	0.20	mg/kg
	Thallium	0.001	mg/L	0.10	mg/kg
	Zinc	0.025	mg/L	2.5	mg/kg

Table B5.1.16-2. QC Acceptance Criteria for Method SW6020A

Method	Analyte	Accuracy Water (% R)	Precision Water (RPD)	Accuracy Soil (% R)	Precision Soil (RPD)
SW6020A	Aluminum	80–120	≤ 15	80–120	≤ 25
	Antimony	80–120	≤ 15	80–120	≤ 25
	Arsenic	80–120	≤ 15	80–120	≤ 25
	Barium	80–120	≤ 15	80–120	≤ 25
	Beryllium	80–120	≤ 15	80–120	≤ 25
	Cadmium	80–120	≤ 15	80–120	≤ 25
	Chromium	80–120	≤ 15	80–120	≤ 25
	Cobalt	80–120	≤ 15	80–120	≤ 25
	Copper	80–120	≤ 15	80–120	≤ 25
	Lead	80–120	≤ 15	80–120	≤ 25
	Manganese	80–120	≤ 15	80–120	≤ 25
	Mercury	80–120	≤ 15	80–120	≤ 25
	Nickel	80–120	≤ 15	80–120	≤ 25
	Selenium	80–120	≤ 15	80–120	≤ 25
	Silver	80–120	≤ 15	80–120	≤ 25
	Thallium	80–120	≤ 15	80–120	≤ 25
	Zinc	80–120	≤ 15	80–120	≤ 25

Table B5.1.16-3. Summary of Calibration and QC Procedures for Method SW6020A

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
SW6020A	ICP/MS Metals	MS tuning sample.	Prior to initial calibration and calibration verification.	SW6020A paragraph 5.8.	Retune instrument then reanalyze tuning solution.
		Initial calibration (minimum 1 standard and a blank).	Daily initial calibration prior to sample analysis.	If more than one standard is used, correlation coefficient must be ≥ 0.995.	If applicable, correct problem and repeat initial calibration.
		Initial Calibration verification (second source).	Daily after initial calibration,	All analytes within ±10% of expected value.	Correct problem and repeat initial calibration.
		Calibration blank.	Before beginning a sample run, after every 10 samples and at end of the analysis sequence.	No analytes detected ≥ MQL.	Correct problem then analyze calibration blank and previous 10 samples.
		Calibration verification (Instrument Check Standard).	Before beginning a sample run, after every 10 samples and at the end of the analysis sequence.	All analyte(s) within ±10% of expected value.	Correct problem then repeat calibration and reanalyze all samples since last successful calibration.
		Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample.	Once per analyst.	QC acceptance criteria, Table B5.1.16-2.	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria.
		Method blank.	One per analytical batch.	No analytes detected ≥ MQL.	Correct problem reprep and analyze method blank and all samples processed with the contaminated blank.
		Interference check solutions (ICS-A and ICS-AB).	At the beginning of an analytical run or once during a 12-hour period, whichever is more frequent.	ICS-A All non-spiked analytes < MQL unless they are a verified trace impurity from one of the spiked analytes. ICS-AB Within ±20% of true value.	Terminate analysis; locate and correct problem; reanalyze ICS; reanalyze all affected samples.

Table B5.1.16-3. (Concluded)

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
SW6020A	ICP/MS Metals	LCS for the analyte.	One LCS per analytical batch.	QC acceptance criteria, Table B5.1.16-2.	Correct problem reprep and analyze the LCS and all samples in the affected analytical batch.
		Dilution test.	Each preparatory batch.	1:4 dilution must agree within ±10% of the original determination for analytes present at concentrations > 100x concentrations found in reagent blank.	Perform post digestion spike addition for failed analytes.
		Post digestion spike addition.	When dilution test fails.	Recovery within 75-125% of expected results.	Dilute the sample; reanalyze post digestion spike addition.
		MS/MSD.	One MS/MSD per every 20 project samples per matrix.	QC acceptance criteria, Table B5.1.16-2.	Describe in Laboratory Review Checklist.
		Internal standards.	Every sample.	IS intensity within 30-120% of intensity of the IS in the initial calibration standard.	Perform corrective action as described in Method SW6020A, Section 8.3.
		MDL study.	Once per 12 month period.	Detection limits established shall be ≤ ½ the MQLs in Table B5.1.16-1.	None.

a. All corrective actions associated with project work shall be documented, and all records shall be maintained by the laboratory.

B.5.1.17 Method SW7000 Series – Graphite Furnace Atomic Absorption for the Metals Antimony, Arsenic, Cadmium, Chromium, Lead, Selenium, Thallium, and Vanadium

GFAA is used to measure low concentrations of metals in water and soil samples. The samples are extracted then discrete aliquots of sample extract are deposited in a graphite tube furnace in microliter amounts. The graphite tube is heated resistively by an electrical current. The sample solution is dried and charred to remove sample matrix components and then atomized at temperatures sufficient to vaporize the analyte of interest. Matrix modification is used to eliminate interference effects and may also enhance the vaporization efficiency and allow lower detection limits. MQLs for this analysis are listed in Table B5.1.17-1.

Table B5.1.17-1. MQLs for Methods in SW7000 Series for Metals

Method	Analyte	Water		Soil	
		MQL	Unit	MQL	Unit
SW7041	Antimony	0.005	mg/L	0.5	mg/kg
SW7060A	Arsenic	0.005	mg/L	0.5	mg/kg
SW7131A	Cadmium	0.001	mg/L	0.1	mg/kg
SW7191	Chromium	0.005	mg/L	0.5	mg/kg
SW7421	Lead	0.005	mg/L	0.5	mg/kg
SW7740	Selenium	0.005	mg/L	0.5	mg/kg
SW7841	Thallium	0.002	mg/L	0.2	mg/kg
SW7911	Vanadium	0.004	mg/L	0.4	mg/kg

Table B5.1.17-2. QC Acceptance Criteria for Methods in SW7000 Series for Metals

Method	Analyte	Accuracy Water (% R)	Precision Water (RPD)	Accuracy Soil (% R)	Precision Soil (RPD)
SW7041	Antimony	75–125	≤ 15	75–125	≤ 30
SW7060A	Arsenic	75–125	≤ 15	75–125	≤ 30
SW7131A	Cadmium	75–125	≤ 15	75–125	≤ 30
SW7191	Chromium	75–125	≤ 15	75–125	≤ 30
SW7421	Lead	75–125	≤ 15	75–125	≤ 30
SW7740	Selenium	75–125	≤ 15	75–125	≤ 30
SW7841	Thallium	75–125	≤ 15	75–125	≤ 30
SW7911	Vanadium	75–125	≤ 15	75–125	≤ 30

Table B5.1.17-3. Summary of Calibration and QC Procedures for Method 7000 Metals

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
SW7000 series	Antimony Arsenic Cadmium Chromium Lead Selenium Vanadium Thallium	Initial multipoint calibration (minimum 3 standards and a blank).	Daily initial calibration prior to sample analysis.	Correlation coefficient ≥0.995 for linear regression.	Correct problem then repeat initial calibration.
		Second-source calibration check standard.	Once per initial daily multipoint calibration.	Analyte within ±10% of expected value.	Correct problem then repeat initial calibration.
		Calibration blank.	Once per initial daily multipoint calibration.	No analyte detected ≥ MQL.	Correct problem then reanalyze calibration blank and all samples associated with blank.
		Calibration verification.	After every 10 samples and at the end of the analysis sequence.	The analyte within ±20% of expected value.	Correct problem then repeat calibration and reanalyze all samples since last successful calibration.
		Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample.	Once per analyst.	QC acceptance criteria, Table B5.1.17-2.	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria.
		Method blank.	One per analytical batch.	No analytes detected ≥ MQL.	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank.
		LCS for the analyte.	One LCS per analytical batch.	QC acceptance criteria, Table B5.1.17-2.	Correct problem then reprep and analyze the LCS and all samples in the affected analytical batch.
		Dilution test; 1:4 dilution test.	Each preparatory batch.	Five-fold dilution sample result must be ±10% of the undiluted sample result for analytes present at ≥ 10x detection limit.	Perform recovery test.
		Recovery test.	When dilution test fails.	Recovery within 85-115% of expected results.	Run all samples by the method of standard addition.
		MS/MSD.	One MS/MSD per every 20 project samples per matrix.	QC acceptance criteria, Table B5.1.17-2.	Report in Laboratory Review Checklist.
		MDL study.	Once per 12 month period.	Detection limits established shall be ≤ ½ the MQLs in Table B5.1.17-1.	None.

a. All corrective actions associated with project work shall be documented, and all records shall be maintained by the laboratory.

B.5.1.18 Method SW7196A-Hexavalent Chromium (Colorimetric)

Dissolved hexavalent chromium, in the absence of interfering amounts of substances such as molybdenum, vanadium, and mercury, may be determined colorimetrically. MQLs for this method are listed in Table B5.1.18-1. Hexavalent chromium analyses conducted on soil or sediment samples must be extracted using Method SW3060A.

Table B5.1.18-1. MQLs for Method SW7196A

Parameter/Method	Analyte	Water		Soil	
		MQL	Unit	MQL	Unit
SW7196A	Hexavalent Chromium	0.5	mg/L	1.0	mg/kg

Table B5.1.18-2. QC Acceptance Criteria for Method SW7196A

Method	Analyte	Accuracy Water (% R)	Precision Water (RPD)	Accuracy Soil (% R)	Precision Soil (RPD)
SW7196A	Hexavalent Chromium	86–117	≤ 15	86–117	≤ 30

Table B5.1.18-3. Summary of Calibration and QC Procedures for Method SW7196A

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
SW7196A	Hexavalent Chromium	Multipoint calibration curve (minimum three standards and a blank).	Initial calibration prior to sample analysis.	Correlation coefficient ≥ 0.995 for linear regression.	Correct problem then repeat initial calibration.
		Second-source calibration verification.	After each new stock standard preparation.	Analytes within ±10% of expected value.	Correct problem then repeat initial calibration.
		Calibration verification.	After every 15 samples and at the end of the analysis sequence.	Chromium within ±20% of expected value.	Correct problem then repeat initial calibration and reanalyze all samples since last successful calibration.
		Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample.	Once per analyst.	QC acceptance criteria, Table B5.1.18-2.	Recalculate results; locate and fix problem with system and then rerun demonstration.
		Verification check to ensure lack of reducing condition and/or interference.	Once for every sample matrix analyzed.	Spike recovery between 85-115%.	If check indicates interference, dilute and reanalyze sample. Persistent interference indicates the need to use an alternate method.
		Method blank.	One per analytical batch.	No analyte detected ≥ MQL.	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank.
		LCS.	One LCS per analytical batch.	QC acceptance criteria, Table B5.1.18-2.	Correct problem then reprep and analyze the LCS and all samples in the affected analytical batch.
		MS/MSD.	One MS/MSD per every 20 project samples per matrix.	QC acceptance criteria, Table B5.1.18-2.	Describe in Laboratory Review Checklist.
		MDL study.	Once per 12 month period.	Detection limits established shall be ≤ ½ the MQLs in Table B5.1.18-1.	None.

a. All corrective actions associated with project work shall be documented, and all records shall be maintained by the laboratory.

B.5.1.19 Method SW7470A/SW7471A–Mercury Manual Cold-Vapor Technique

Water and soil samples are analyzed for mercury using Methods SW7470A and SW7471A, respectively. This method is a cold-vapor, flameless atomic absorption (AA) technique based on the absorption of radiation by mercury vapor. Mercury is reduced to the elemental state and aerated from solution in a closed system. The mercury vapor passes through a cell positioned in the light path of an AA spectrophotometer. Mercury concentration is measured as a function of absorbance. The MQLs for these methods are listed in Table B5.1.19-1.

Table B5.1.19-1. MQLs for Method SW7470A/SW7471A

Parameter/Method	Analyte	Water		Soil	
		MQL	Unit	MQL	Unit
SW7470A (W) SW7471A (S)	Mercury	0.001	mg/L	0.1	mg/kg

Table B5.1.19-2. QC Acceptance Criteria for Method SW7470A/SW7471A

Method	Analyte	Accuracy Water (% R)	Precision Water (RPD)	Accuracy Soil (% R)	Precision Soil (RPD)
SW7470A/SW7471A	Mercury	85–115	≤ 15	83–118	≤ 30

Table B5.1.19-3. Summary of Calibration and QC Procedures for Method SW7470A/SW7471A

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
SW7470A SW7471A	Mercury	Initial multipoint calibration (minimum 5 standards and a blank).	Daily initial calibration prior to sample analysis.	Correlation coefficient ≥0.995 for linear or non-linear regression.	Correct problem then repeat initial calibration.
		Second-source calibration check standard.	Once per initial daily multipoint calibration.	Analyte within ±10% of expected value.	Correct problem then repeat initial calibration.
		Calibration blank.	Once per initial daily multipoint calibration.	No analyte detected ≥ MQL.	Correct problem then reanalyze calibration blank and all samples associated with blank.
		Calibration verification.	After every 10 samples and at the end of the analysis sequence.	The analyte within ±20% of expected value.	Correct problem then repeat calibration and reanalyze all samples since last successful calibration.
		Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample.	Once per analyst.	QC acceptance criteria, Table B5.1.19-2.	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria.
		Method blank.	One per analytical batch.	No analytes detected ≥ MQL.	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank.
		LCS for the analyte.	One LCS per analytical batch.	QC acceptance criteria, Table B5.1.19-2.	Correct problem then reprep and analyze the LCS and all samples in the affected analytical batch.
		Dilution test; five-fold dilution test.	Each preparatory batch.	Five-fold dilution sample result must be ±10% of the undiluted sample result.	Perform recovery test.
SW7470A SW7471A	Mercury	Recovery test.	When dilution test fails.	Recovery within 85-115% of expected results.	Run all samples by the method of standard addition.
		MS/MSD.	One MS/MSD per every 20 project samples per matrix.	QC acceptance criteria, Table B5.1.19-2.	Describe in Laboratory Review Checklist.
		MDL study.	Once per 12 month period.	Detection limits established shall be ≤ ½ the MQLs in Table B5.1.19-1.	None.
		Results reported between MDL and MQL.	None.	None.	None.

a. All corrective actions associated with project work shall be documented, and all records shall be maintained by the laboratory.

B.5.1.20 Method SW9010B/SW9012A-Total Cyanide and Cyanide Amenable to Chlorination

Water and waste samples are analyzed for total cyanide using Method SW9010B or SW9012A. These methods are equivalent in principle of analysis; SW9010B is a manual procedure, and SW9012A is an automated procedure.

Both methods are used to determine the concentration of inorganic cyanide in aqueous wastes and leachates. The methods detect inorganic cyanides that are present as either sample soluble salts or complex radicals. It is used to determine values for both total cyanide and cyanide amenable to chlorination. The cyanide is released by refluxing the sample with a strong acid and catalyst and distillation. Total cyanide in soils is determined after acidification of the soil and distillation. The cyanide ion in the absorbing solution is then determined by spectrophotometry for Method SW9010B and by automated colorimetry for Method SW9012A. MQLs for cyanide are listed in Table B5.1.20-1.

Table B5.1.20-1. MQLs for Method SW9010B/SW9012A

Parameter/Method	Analyte	Water		Soil	
		MQL	Unit	MQL	Unit
SW9010B/SW9012A	Total cyanide	0.02	mg/L	0.5	mg/kg

Table B5.1.20-2. QC Acceptance Criteria for Method SW9010B/SW9012A

Method	Analyte	Accuracy Water (% R)	Precision Water (RPD)	Accuracy Soil (% R)	Precision Soil (RPD)
SW9010B SW9012A	Total cyanide	79–114	≤ 20	75–125	≤ 30

Table B5.1.20-3. Summary of Calibration and QC Procedures for Method SW9010B/SW9012A

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
SW9010B/ SW9012A	Cyanide	Multipoint calibration curve (six standards and a calibration blank).	Initial daily calibration prior to sample analysis.	Correlation coefficient ≥ 0.995 for linear regression.	Correct problem then repeat initial calibration.
		Distilled standards (one high and one low).	Once per multipoint calibration.	Cyanide within ±10% of true value.	Correct problem then repeat distilled standards.
		Second-source calibration verification.	Once per stock standard preparation.	Cyanide within ±15% of expected value.	Correct problem then repeat initial calibration.
		Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample.	Once per analyst.	QC acceptance criteria, Table B5.1.20-2.	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria.
		Method blank.	One per analytical batch.	No analytes detected ≥ MQL.	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank.
		LCS for all analytes.	One LCS per analytical batch.	QC acceptance criteria, Table B5.1.20-2.	Correct problem then reprep and analyze the LCS and all samples in the affected analytical batch.
		MS/MSD.	One MS/MSD per every 20 project samples per matrix.	QC acceptance criteria, Table B5.1.20-2.	None.
		MDL study.	Once per 12 month period.	Detection limits established shall be ≤ ½ the MQLs in Table B5.1.20-1.	None.

a. All corrective actions associated with project work shall be documented, and all records shall be maintained by the laboratory.

B.5.1.21 Method SW9056A–Common Anions

This method addresses the sequential determination of the anions chloride, fluoride, bromide, nitrate, nitrite, phosphate, and sulfate in the collection solutions from the bomb combustion of solid waste samples, as well as water samples.

A small volume of combustate collection solution or other water sample is injected into an ion chromatograph to flush and fill a constant volume sample loop. The sample is then injected into a stream of eluent.

The sample is pumped through three different ion exchange columns and into a conductivity detector. The first two columns, a precolumn (guard) column and a separator column, are packed with a low-capacity, strongly basic anion exchanger. Ions are separated into discrete bands based on their affinity for the exchange sites of the resin. The last column is a suppressor column that reduces the anions in the sample to their corresponding acids. The separated anions in their acid form are measured using an electrical-conductivity cell. Anions are identified based on their retention times compared to known standards. Quantitation is accomplished by measuring the peak height or area and comparing it to a calibration curve generated from known standards.

MQLs are listed in Table B5.1.21-1.

Table B5.1.21-1. MQLs for Method SW9056A

Parameter/Method	Analyte	Water		Soil	
		MQL	Unit	MQL	Unit
Common Anions	Bromide	0.5	mg/L	5.0	mg/kg
SW9056A	Chloride	1.0	mg/L	10	mg/kg
	Fluoride	1.0	mg/L	10	mg/kg
	Nitrate	1.0	mg/L	10	mg/kg
	Nitrite	1.0	mg/L	10	mg/kg
	Phosphate	1.0	mg/L	10	mg/kg
	Sulfate	1.0	mg/L	10	mg/kg

Table B5.1.21-2. QC Acceptance Criteria for Method SW9056A

Method	Analyte	Accuracy Water (% R)	Precision Water (RPD)	Accuracy Soil (% R)	Precision Soil (RPD)
SW9056A	Bromide	85–115	≤ 20	70–130	≤ 30
	Chloride	85–115	≤ 20	70–130	≤ 30
	Fluoride	85–115	≤ 20	70–130	≤ 30
	Nitrate	85–115	≤ 20	70–130	≤ 30
	Nitrite	85–115	≤ 20	70–130	≤ 30
	Phosphate	85–115	≤ 20	70–130	≤ 30
	Sulfate	85–115	≤ 20	70–130	≤ 30

Table B5.1.21-3. Summary of Calibration and QC Procedures for Method SW9056A

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
SW9056A	Common anions	Multipoint calibration for all analytes (minimum 3 standards and one calibration blank).	Initial calibration prior to sample analysis.	Correlation coefficient ≥0.995 for linear or non-linear regression.	Correct problem then repeat initial calibration.
		Second-source calibration verification.	Once per multipoint calibration	All analytes within ±10% of expected value	Correct problem then repeat initial calibration
		Retention time window calculated for each analyte.	Each initial calibration and calibration verifications	± 3 times standard deviation for each analyte average retention time over 8 hour period	Correct problem then reanalyze all samples analyzed since the last retention time check
		Initial calibration verification.	Daily, before sample analysis or when eluent is changed	All analytes within ±10% of expected value	Correct problem then repeat initial calibration
		Calibration verification.	After every 10 samples and at the end of the analysis sequence	Instrument response within ±10% of expected response	Correct problem then repeat initial calibration verification and reanalyze all samples since last successful calibration verification
		Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample.	Once per analyst.	QC acceptance criteria, Table B5.1.21-2.	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria.
		Method blank.	One per analytical batch.	No analytes detected ≥ MQL.	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank.
		LCS for all analytes.	One LCS per analytical batch.	QC acceptance criteria, Table B5.1.21-2.	Correct problem then reprep and analyze the LCS and all samples in the affected analytical batch.
		Duplicate.	One per every 10 samples.	RPD ≤10% .	None.
		MS/MSD.	One MS/MSD per every 20 project samples per matrix.	QC acceptance criteria, Table B5.1.21-2.	None.
		MDL study.	Once per 12 month period.	Detection limits established shall be ≤ ½ the MQLs in Table B5.1.21-1.	None.

a. All corrective actions associated with project work shall be documented, and all records shall be maintained by the laboratory.

B.5.1.22 Method TO-14A - Volatile Organics in Ambient Air

Volatile organics in air are sampled using a Summa Cannister and analyzed using Method TO-14A. This method uses a high resolution GC coupled to one or more appropriate detectors. The QC criteria specified herein are pertinent to using a mass spectrometer in scan mode as the detector. The analytes detected and MQLs for this method are listed in Table B5.1.22-1.

Calibration—The mass spectrometer is tuned daily to give an acceptable spectrum for BFB. The tuning acceptance criteria are given in the following list as an ion abundance for each specified mass:

- mass 50 — 15 percent to 40 percent of mass 95
- mass 75 — 30 percent to 60 percent of mass 95
- mass 95 — base peak, 100 percent relative abundance
- mass 96 — 5 percent to 9 percent of mass 95
- mass 173 — less than 2 percent of mass 174
- mass 174 — greater than 50 percent of mass 95
- mass 175 — 5 percent to 9 percent of mass 174
- mass 176 — greater than 95 percent, but less than 101 percent of mass 174
- mass 177 — 5 percent to 9 percent of mass 176

The internal standard method is used for quantitation of analytes of interest. For quantitation, response factors are calculated from the base ion peak of a specific internal standard added to each calibration standard, blank, QC sample, and sample.

Table B5.1.22-1. MQLs for Method TO-14A

Parameter/Method	Analyte[a]	Air	
		MQL	Unit
VOCs	1,1,1-Trichloroethane	0.8	ppbv
TO-14A	1,2-Dichloroethane	0.6	ppbv
	1,2-Dibromoethane	0.6	ppbv
	Benzene	0.4	ppbv
	Carbon tetrachloride	2.1	ppbv
	Chloroform	0.3	ppbv
	m-Xylene	0.5	ppbv
	o-Xylene	1.1	ppbv
	p-Xylene	1.3	ppbv
	Styrene	0.4	ppbv
	Trichloroethene	1.0	ppbv

[a] Other compounds may be analyzed using TO-14A if specified in a Site-Specific QAPP Addendum. The Addendum should also specify holding times pertinent to additional analytes.

Table B5.1.22-2. QC Acceptance Criteria for Method TO-14A

Method	Analyte	Accuracy Air (% R)	Precision Air (RPD)
TO-14A	1,1,1-Trichloroethane	72–125	≤ 20
	1,2-Dichloroethane	75–125	≤ 20
	1,2-Dibromoethane	74–125	≤ 20
	Benzene	75–127	≤ 20
	Carbon tetrachloride	72–125	≤ 20
	Chloroform	75–125	≤ 20
	m-Xylene	75–125	≤ 20
	o-Xylene	75–137	≤ 20
	p-Xylene	75–125	≤ 20
	Styrene	75–135	≤ 20
	Trichloroethene	75-125	≤ 20

Table B5.1.22-3. Summary of Calibration and QC Procedures for Method TO-14A

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
TO-14A	Volatile Organics	Initial multipoint calibration (minimum 3 standards and humid zero air).	Initial calibration prior to sample analysis.	%RSD for all calibration analytes ≤ 30%.	Correct problem then repeat initial calibration.
		Second-source calibration verification.	Once per three-point initial calibration.	All analytes within ± 25% of expected value.	Correct problem then repeat initial calibration.
		Calibration verification (one point).	Daily, before sample analysis and every 12 hours of analysis time.	All calibration analytes within ±25% of expected value.	Correct problem then repeat initial calibration.
		Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample.	Once per analyst.	QC acceptance criteria, Table B5.1.22-2.	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria.
		Check of mass spectral ion intensities using BFB.	Prior to initial calibration and calibration verification.	Refer to criteria in Element B.5.1.22 text.	Retune instrument and verify.
		Internal standards.	Immediately after or during data acquisition for the calibration verification standard.	Retention time ±30 seconds from retention time of the mid-point std. in the ICAL. EICP area within -50% to +100% of ICAL mid-point std.	Inspect mass spectrometer and GC for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning.
		Method blank.	One per analytical batch.	No analytes detected ≥ MQL.	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank.
		LCS for all analytes.	One LCS per analytical batch.	QC acceptance criteria, Table B5.1.22-2.	Correct problem then reprep and analyze the LCS and all samples in the affected analytical batch.
		MDL study.	Once per 12 month period.	Detection limits established shall be ≤ ½ the MQLs in Table B5.1.22-1.	None.

a. All corrective actions associated with project work shall be documented, and all records shall be maintained by the laboratory.

B.5.2 Screening Methods

Table B5.2-1 presents the calibration, QC, and corrective action procedures for each screening method. In this table, the first two columns designate the method number and the class of analytes that may be determined by the method. The third column lists the method-required calibration and QC elements. The fourth column designates the minimum frequency for performing each calibration and QC element. The fifth column designates the acceptance criteria for each calibration and QC element. The sixth column designates the corrective action in the event that a calibration or QC element does not meet the acceptance criteria.

Table B5.2-1 Summary of Calibration and QC Procedures for Screening Methods

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
described in Method SW3550	Moisture.	Laboratory Duplicate sample.	1 per 20 samples.	% solid RPD ≤ 15%.	Correct problem, repeat measurement. If still out, flag data.
SW9045C	pH (soil).	2-point calibration with pH buffers.	1 per 10 samples analyzed	± 0.05 pH unit	Check with new buffers; if still out, repair meter; repeat calibration check.
		pH 7 buffer.	At each sample location.	± 0.1 pH unit.	Recalibrate.
		Duplicate sample.	10% of field samples.	± 0.1 pH unit.	Correct problem, repeat measurement. If still out, repeat calibration and reanalyze samples.
SW9050A	Conductance.	Calibration with KCl standard.	Once per day at beginning of testing.	± 5%.	If calibration is not achieved, check meter, standards, and probe; recalibrate.
		Field duplicate.	10% of field samples.	± 5%.	Correct problem, repeat measurement.
SW9040B	pH (water).	2-point calibration with pH buffers.	Once per day.	± 0.05 pH units for every buffer.	If calibration is not achieved, check meter, buffer solutions, and probe; replace if necessary; repeat calibration.
		pH 7 buffer.	At each sample location.	± 0.1 pH units.	Correct problem, recalibrate.
		Field duplicate.	10% of field samples.	± 0.1 pH units.	Correct problem, repeat measurement.
E170.1	Temperature.	Field duplicate.	10% of field samples.	± 1.0°C.	Correct problem, repeat measurement.
E180.1	Turbidity.	Calibration with one formazin standard per instrument range used.	Once per day at beginning of testing.	± 5 units,0–100 range ± 0.5 units,0–0.2 range ± 0.2 units,0–1 range	If calibration is not achieved, check meter; replace if necessary, recalibrate.
		Field duplicate.	10% of field samples.	RPD ≤ 20%	Correct problem, repeat measurement.
SW9060	Total organic carbon.	Method blank.	Daily or one per batch, whichever is more frequent.	< MQL	Clean system; reanalyze blank. Repeat until analyte < MQL.
		Field duplicate.	10% of field samples.	RPD < 20%	Repeat measurement.
		Laboratory duplicate.	10% of field samples.	RPD < 20%	Correct problem, repeat measurement.

Table B5.2-1 Summary of Calibration and QC Procedures for Screening Methods - Cont.

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
E160.1	Filterable residue.	Field duplicate.	10% of field samples.	RPD < 20%	Correct problem, repeat measurement.
		Laboratory duplicate.	10% of field samples.	RPD <20%	Correct problem, repeat measurement.
E160.2	Nonfilterable residue.	Field duplicate.	10% of field samples.	RPD < 20%.	Correct problem, repeat measurement.
		Laboratory duplicate.	10% of field samples.	RPD <20%.	Correct problem, repeat measurement.
ASTM D1498	Oxidation-reduction potential (ORP).	Sensitivity verification.	Daily.	ORP should decrease when pH is increased.	If ORP increases, correct the polarity of electrodes. If ORP still does not decrease, clean electrodes and repeat procedure.
		Calibration with one standard.	Once per day.	Two successive readings ± 10 millivolts.	Correct problem, recalibrate.
		Field duplicate.	10% of field samples.	± 10 millivolts.	Correct problem, repeat measurement.
SW1110	Corrosivity.	Laboratory Duplicate.	10% of field samples.	RPD < 20%.	Correct problem, repeat measurement.
E310.1	Alkalinity.	Field duplicate.	10% of field samples.	RPD < 20%.	Correct problem, repeat measurement.
		Field duplicate.	10% of field samples.	RPD < 20%.	Correct problem, repeat measurement.
E360.1	Dissolved oxygen.	Field duplicate.	10% of field samples.	RPD < 20%.	Correct problem, repeat measurement.
SW4020	PCBS by immunoassay.	Field duplicate.	10% of field samples.	RPD < 20%.	Correct problem, repeat measurement.
SW4030	Petroleum hydrocarbons by immunoassay.	Field duplicate.	10% of field samples.	RPD < 20%.	Correct problem, repeat measurement.

a. All corrective actions shall be documented, and the records shall be maintained by the prime contractor.

B.5.3 Quality Control Measure Descriptions

B.5.3.1 Precision, Accuracy, Representativeness, Completeness, and Comparability

The basis for assessing each of these elements of data quality is discussed in the following subelements. Precision and accuracy QC limits for each method and matrix are identified in Elements B.5.1 and B.5.2 of this QAPP.

Precision

Precision measures the reproducibility of measurements. It is strictly defined as the degree of mutual agreement among independent measurements as the result of repeated application of the same process under similar conditions. (EPA QA/G-5 definition) *Analytical* precision is the measurement of the variability associated with duplicate (two) or replicate (more than two) analyses. TCEQ uses the laboratory control sample (LCS) to determine the precision of the analytical method. If the recoveries of analytes in the LCS are within established control limits, then precision is within limits. In this case, the comparison is not between a sample and a duplicate sample analyzed in the same batch, rather the comparison is between the sample and the control charted samples analyzed in previous batches. *Total* precision is the measurement of the variability associated with the entire sampling and analysis process. It is determined by analysis of duplicate or replicate field samples and measures variability introduced by both the laboratory and field operations. Field duplicate samples and matrix duplicate spiked samples shall be analyzed to assess field and analytical precision, and the precision measurement is determined using the relative percent difference (RPD) between the duplicate sample results. The formula for the calculation of precision is provided in Table B5.3-1. For replicate analyses, the relative standard deviation (RSD) is determined. The formula for the calculation of the RSD is in Table B5.3-1.

Accuracy

Accuracy is a statistical measurement of correctness and includes components of random error (precision) and systematic error (bias). (EPA QA/G-5 definition) It therefore reflects the total error associated with a measurement. A measurement is accurate when the value reported does not differ from the true value or known concentration of the spike or standard. Analytical accuracy is measured by comparing the percent recovery of analytes spiked into an LCS or matrix spike sample to a control limit. For volatile and semivolatile organic compounds, surrogate compound recoveries are also used to assess accuracy and method performance for each sample analyzed. Analysis of performance evaluation (PE) samples may also be used to provide additional information for assessing the accuracy of the analytical data being produced.

Both accuracy and precision are calculated for each analytical batch, and the associated sample results are interpreted by considering these specific measurements. The formula for calculation of accuracy is included in Table B5.3-1 as percent recovery (%R) from reagent grade pure matrices and sample matrices.

Representativeness

Representativeness is defined as a measure of the extent to which data accurately and precisely represent a characteristic of a population, a parameter variation at a sampling point, a process condition, or an environmental condition. (EPA QA/G-5 definition) Objectives for representativeness are defined for each sampling and analysis task and are a function of the investigative objectives. Representativeness shall be achieved through use of the standard field, sampling, and analytical procedures. Representativeness is also determined by appropriate program design, with consideration of elements such as proper well locations, drilling and installation procedures, and sampling locations. Decisions regarding sample/well/ boring locations and numbers and the statistical sampling design are documented in the Section 4 of the FSP.

Completeness

Completeness is calculated for the aggregation of data for each analyte measured for any particular sampling event or other defined set of samples. Completeness is calculated and reported for each method, matrix and analyte combination. Completeness shall be calculated in two ways: 1) the number of valid individual analyte results divided by the number of possible individual analyte results, expressed as a percentage, determines the completeness of the data set for risk assessment; and 2) the number of valid sample points divided by the number of planned sample points, expressed as a percentage, determines the completeness of the data set for remedial investigation/feasibility studies. For completeness requirements, valid results are all results not qualified with an "R" flag. The completeness requirements for the project are specified in Element A.7 of this QAPP. The formula for the calculation of analytical completeness for risk assessment is presented below:

$$\%\ Completeness = \frac{number\ of\ valid\ (i.e.,\ non\text{ - }R\ flagged)\ results}{number\ of\ possible\ individual\ analyte\ results}$$

The formula for the calculation of completeness of a data set for remedial investigation/feasibility studies is presented below:

$$\%\ Completeness = \frac{number\ of\ valid\ sample\ points}{number\ of\ planned\ sample\ points}$$

Comparability

Comparability is the confidence with which one data set can be compared to another data set. (EPA QA/G-5 definition) The objective of this QA/QC program is to produce data with the greatest possible degree of comparability. The number of matrices that are sampled and the range of field conditions encountered are considered in determining comparability. Comparability is achieved by using standard methods for sampling and analysis, reporting data in standard units, normalizing results to standard conditions and using standard and comprehensive reporting formats. Complete field documentation using standardized data collection forms shall support the assessment of comparability. Analysis of performance evaluation (PE) samples and reports from audits shall also be used to provide additional information for assessing the comparability of analytical data produced among subcontracting laboratories. Historical comparability shall be achieved through consistent use of methods and documentation procedures throughout the project.

Table B5.3-1 Statistical Calculations

Statistic	Symbol	Formula	Definition	Uses
Mean	$\bar{x}$	$\frac{\left(\sum_{i=1}^{n} x_i\right)}{n}$	Measure of central tendency	Used to determine average value of measurements
Standard Deviation	S	$\left(\frac{\Sigma(x_i-\bar{x})^2}{(n-1)}\right)^{1/2}$	Measure of relative scatter of the data	Used in calculating variation of measurements
Relative Standard Deviation	RSD	$S / \bar{X} \ x \ 100$	Relative standard deviation, adjusts for magnitude of observations	Used to assess precision for replicate results
Relative Percent Difference	RPD	$\text{abs} \left(\frac{(x_1-x_2)}{(x_1+x_2)/2}\right) \ x \ 100$	Measure of variability that adjusts for the magnitude of observations	Used to assess total and analytical precision of duplicate measurements
Percent Difference	%D	$\frac{x_1-x_2}{x_2} \ x \ 100$	Measure of the difference of 2 observations	Used to assess accuracy
Percent Recovery	%R	$\frac{x_{meas}}{x_{true}} \ x \ 100$	Recovery of spiked compound in laboratory matrix	Used to assess accuracy
Percent Recovery	%R	$\frac{\left(\text{value of spiked sample} - \text{value of unspiked sample}\right)}{\text{value of added spike}} \ x \ 100$	Recovery of spiked compound in sample matrix	Used to assess matrix effects and total precision

x = Observation (concentration)
n = Number of observations

B.5.4 Elements of Quality Control

This element presents QC requirements relevant to analysis of environmental samples that shall be followed during all analytical activities for fixed-base, mobile, and field laboratories producing definitive data. The purpose of this QC program is to produce data of known quality that satisfy the project objectives and that meet or exceed the requirements of the standard methods of analysis. This program provides a mechanism for ongoing control and evaluation of data quality measurements through the use of QC materials.

Laboratory QC samples (e.g., blanks and laboratory control samples) shall be included in the preparation batch with the field samples. An analytical batch is a number of samples (not to exceed 20 environmental samples) that are similar in composition (matrix) and that are extracted or digested at the same time and with the same lot of reagents. Matrix spikes and matrix spike duplicates count as environmental samples. The term "analytical batch" also extends to cover samples that do not need separate extraction or digestion (e.g., volatile analyses by purge and trap) and is the number of samples (not to exceed 20 environmental samples) that are similar in composition (matrix) and analyzed sequentially. The identity of each analytical batch shall be unambiguously cross-referenced and reported with the associated sample analyses so that a reviewer can identify the QC samples and the associated environmental samples. All references to the analytical batch in the following elements and tables in this QAPP refer to the analytical batch as defined here.

The type of QC samples and the frequency of use of these samples are discussed below and in the method-specific subelements of Element B.5.1.

B.5.4.1 Laboratory Control Sample

The laboratory control sample (LCS) is analyte-free water (for aqueous analyses), Ottawa sand or other solid matrix demonstrated to be analyte-free (for soil analyses) which, at a minimum, is spiked with all chemicals of concern identified in Section 4 of the FSP. When the chemicals of concern are not identified for the project, the LCS shall be spiked with all analytes for which data are reported. The LCS shall be spiked at a level less than or equal to the midpoint of the calibration curve for each analyte. The LCS shall be carried through the complete sample preparation and analysis procedure. The LCS is used to evaluate each analytical batch and to determine if the method is in control. If the recovery of any analyte in the LCS is outside control limits, the laboratory shall reextract and reanalyze all samples associated with the given LCS. Reanalysis is only required for the analytes outside of control limits. The LCS cannot be used as the continuing calibration verification.

Section 4 of the FSP identifies a Level of Required Performance (LORP) for all analytes of concern. When specified in Section 8 of the FSP, the laboratory shall successfully analyze an LCS at a concentration below or near the LORP prior to analyzing project samples and once every 3 months during the life of the project for all analytes of concern for the project. Acceptance criteria for this QC spike sample are those contained in the QC acceptance criteria tables in QAPP Element B.5.1.

B.5.4.2 Matrix Spike/Matrix Spike Duplicate

A matrix spike (MS) (and matrix spike duplicate (MSD)) is an aliquot of sample spiked with known concentrations of all chemicals of concern identified in Section 4 of the FSP. When the chemicals of concern are not identified in the FSP, the MS/MSD shall be spiked with a subset of the analytes included in the laboratory's initial calibration standard mixture(s) that are representative of the range and characteristics of the calibrated analytes. The spiking occurs prior to sample preparation and analysis. The MS and MSD shall be spiked at a level less than or equal to the midpoint of the calibration curve for each analyte. Spike levels are only considered appropriate for assessing accuracy if they are less than four times the native sample concentration. Only TCEQ project samples shall be used for the MS/MSD analysis. The sample to be used for the MS/MSD shall be designated on the chain-of-custody. The MS/MSD is used to document the bias of a method due to sample matrix. TCEQ does not use MSs and MSDs to control the analytical process.

Section 4 of the FSP identifies a Level of Required Performance (LORP) for all analytes of concern. When specified in Section 8 of the FSP, the laboratory shall successfully analyze a MS/MSD spike sample at a concentration below or near the LORP prior to analyzing project samples and once every 3 months during the life of the project for all analytes of concern for a given project. Acceptance criteria for this QC spike sample are those contained in the QC acceptance criteria tables in QAPP Element B.5.1.

B.5.4.3 Surrogates

Surrogates are organic compounds that are similar to the target analyte(s) in chemical composition and behavior in the analytical process but that are not normally found in environmental samples. Surrogates are used to evaluate accuracy, method performance, and extraction efficiency. Surrogates shall be added to environmental samples, controls, and blanks, in accordance with the method requirements. The laboratory should follow method requirements should surrogate recovery be outside control limits. Surrogate recoveries outside of control limits should be clearly identified in the laboratory data package. Critical samples are identified in the Section 4 of the FSP. The procedures to be followed if surrogate recoveries are outside the acceptance criteria of these critical samples are specified in Section 8 of the FSP.

B.5.4.4 Internal Standards

Internal standards (ISs) are measured amounts of certain compounds added after preparation or extraction of a sample. They are used in an IS calibration method to correct sample results affected by extraction losses, column injection losses, purging losses, or viscosity effects.

ISs shall be added to environmental samples, controls, and blanks, in accordance with the method requirements.

B.5.4.5 Retention Time Windows

Retention time windows are used in GC and high performance liquid chromatography (HPLC) analysis for qualitative identification of analytes. They are calculated from replicate analyses of a standard on multiple days. The procedure and calculation method are given in SW-846 Method 8000B.

B.5.4.6 Interference Check Sample

The interference check sample (ICS), used in inductively coupled plasma (ICP) analyses only, contains both interfering and analyte elements of known concentrations. The ICS is used to verify background and interelement correction factors.

B.5.4.7 Method Blank

A method blank is an analyte-free matrix to which all reagents are added in the same volumes or proportions as used in sample processing. The method blank shall be carried through the complete sample preparation and analytical procedure. The method blank is used to document contamination resulting from the analytical process.

The presence of analytes in a method blank at concentrations equal to or greater than the MQL indicates a need for corrective action for samples in which the reported concentration is less than or equal to 5 times the associated blank concentration. Corrective action shall be performed to eliminate the source of contamination prior to proceeding with analysis of these samples. After the source of contamination has been eliminated, all such samples in the analytical batch shall be reextracted/redigested and reanalyzed. No analytical data shall be corrected for the presence of analytes in blanks. When an analyte is detected in the method blank and in the associated samples, the data validator will evaluate the effect of the potential laboratory contamination on the quality of the data.

B.5.4.8 Field Blank

The field blank consists of ASTM Type II reagent grade water poured into a volatile organic compound (VOC) sample vial at the sampling site (in the same vicinity as the associated samples). It is handled like an environmental sample and transported to the laboratory for analysis. Field blanks are prepared only when VOC samples are taken and are analyzed only for VOC analytes. Field blanks are used to assess the potential introduction of contaminants from field sources (e.g., gasoline motors in operation, etc.) to the samples during sample collection.

Field blanks shall be collected at a frequency of one blank per 20 samples for a given matrix. Field blanks shall be collected downwind of possible VOC sources.

B.5.4.9 Equipment Blank

An equipment blank (also known as a rinsate blank) is a sample of ASTM Type II reagent grade water poured into or over or pumped through the sampling device, collected in a sample container, and

transported to the laboratory for analysis. If the equipment is dedicated, no equipment blank shall be collected. Equipment blanks are used to assess the effectiveness of equipment decontamination procedures.

Equipment blanks shall be collected at a frequency of one blank per equipment type per medium per day. Equipment blanks shall be collected immediately after the equipment has been decontaminated. The equipment blank should be analyzed for all laboratory analyses requested for the environmental samples collected at the site.

B.5.4.10 Trip Blank

The trip blank consists of a VOC sample vial filled in the laboratory with ASTM Type II reagent grade water, transported to the sampling site, handled like an environmental sample and returned to the laboratory for analysis. Trip blanks are not opened in the field. Trip blanks are prepared only when VOC samples are taken and are analyzed only for VOC analytes. Trip blanks are used to assess the potential introduction of contaminants from sample containers or during the transportation and storage procedures.

One trip blank shall accompany each cooler of samples sent to the laboratory for analysis of VOCs.

B.5.4.11 Field Duplicates

A field duplicate sample is a second, collocated sample collected at the same location as the original sample. Duplicate samples are collected simultaneously or in immediate succession, using identical recovery techniques, and treated in an identical manner during storage, transportation, and analysis. The sample containers are assigned an identification number in the field, such that they cannot be identified as duplicate samples (blind duplicate) by laboratory personnel performing the analysis. Specific locations are designated for collection of field duplicate samples prior to the beginning of sample collection.

Duplicate sample results are used to assess the precision of the sample collection process and for evaluating the homogeneity of composite samples. The frequency of collection for field duplicates is specified in Section 4 of the FSP.

B.5.4.12 Field Replicates

A field replicate sample (also called a field split sample) is a single sample that is homogenized and divided into two equal parts for analysis. The sample containers are assigned an identification number in the field, such that they cannot be identified as replicate samples by laboratory personnel performing the analysis. Specific locations are designated for collection of field replicate samples prior to the beginning of sample collection.

Replicate sample results are used to assess sampling precision, the laboratory analysis precision, and/or the performance between two or more laboratories. Precision of soil samples to be analyzed for VOCs is assessed from field duplicates (i.e.collocated samples) rather than field replicates because the

process required to obtain uniform field replicate samples could result in significant loss of the compounds of interest.

Ten percent of all field samples shall be split into field replicates to be analyzed by a second laboratory. The frequency of collection for field replicates is specified in Section 4 of the FSP.

B.5.5 Method Detection Limit, Method Quantitation Limit, and Sample Quantitation Limit

The method detection limit (MDL) shall be the concentration at which the false rejection decision error is $\leq 1\%$. The method detection limit (MDL), as defined in this TCEQ QAPP, is the minimum concentration as determined by the procedures given in 40 CFR Part 136, Appendix B. The laboratory can either run an MDL determination on each instrument to be used for the project or run an MDL determination only on the least sensitive instrument and demonstrate that the qualitative identification criteria can be met on other instruments for all target analytes spiked into a QC check sample at a concentration equal to the MDL.

The Method Quantitation Limit (MQL) is equal to the lowest non-zero standard concentration in the laboratory's initial calibration curve based on the final volume or weight used by the laboratory. The MQL should be 5 to 10 times the MDL for the majority of target analytes but no lower than 3 times the MDL.

The laboratory shall report all non-detected results as less than the numeric value of the sample quantitation limit (SQL). The SQL is defined as the method detection limit adjusted to reflect sample-specific actions, such as dilution or use of smaller aliquot for analysis due to matrix effects or the high concentration of some analytes. The SQL may be defined by the laboratory in such a manner as to allow rounding of MDLs upward to the next integer value higher than the MDL for the laboratory instrument with the least sensitivity but should be based on the MDL as defined in this subelement B.5.5.

B.6 Instrument/Equipment Testing, Inspection, and Maintenance

A preventive maintenance program shall be in place to promote the timely and effective completion of a measurement effort. The preventive maintenance program is designed to minimize the downtime of crucial sampling and/or analytical equipment due to unexpected component failure. In implementing this program, efforts are focused in three primary areas: (1) establishment of maintenance responsibilities, (2) establishment of maintenance schedules for major and/or critical instrumentation and apparatus, and (3) establishment of an adequate inventory of critical spare parts and equipment.

Specific requirements for field instrumentation for a given project shall be specified in Section 5 of the FSP.

B.6.1 Maintenance Responsibilities

Maintenance responsibilities for equipment and instruments are assumed by the respective facility managers. The managers then establish maintenance procedures and schedules for each major equipment item. This responsibility may be delegated to laboratory personnel, although the managers retain responsibility for ensuring adherence to the prescribed protocols.

B.6.2 Maintenance Schedules

The effectiveness of any maintenance program depends to a large extent on adherence to specific maintenance schedules for each major equipment item. Other maintenance activities are conducted as needed. Manufacturers' recommendations provide the primary basis for the established maintenance schedules, and manufacturers' service contracts provide primary maintenance for many major instruments (e.g., GC/mass spectrometry instruments, AA spectrometers, and analytical balances).

B.6.3 Spare Parts

Along with a schedule for maintenance activities, an adequate inventory of spare parts is required to minimize equipment downtime. The inventory includes those parts (and supplies) that are subject to frequent failure, have limited useful lifetimes, or cannot be obtained in a timely manner should failure occur.

Field sampling task leaders and the respective laboratory managers are responsible for maintaining an adequate inventory of spare parts. In addition to spare parts and supply inventories, the contractor shall maintain an in-house source of backup equipment and instrumentation.

B.6.4 Maintenance Records

Maintenance and repair of major field and laboratory equipment shall be recorded in field or laboratory logbooks. These records shall document the serial numbers of the equipment, the person performing the maintenance or repairs, the date of the repair, the procedures used during the repair, and proof of successful repair prior to the use of the equipment.

B.7 Instrument/Equipment Calibration and Frequency

Instruments and equipment used to generate or measure environmental data will be maintained and calibrated according to the manufacturers' specifications, the requirements of the analytical method, and the QC requirements specified in Element B5. Element B.5 includes a discussion of required quality, calibration and tuning criteria, control checks, frequencies, acceptance criteria, and corrective actions associated with routine analytical methods. Calibration and tuning of laboratory instruments is the responsibility of the laboratory.

Field instrument calibration and frequency requirements for water level, pH, temperature, conductivity, dissolved oxygen, redox potential, and turbidity measurements are contained in Section 5 of the FSP. Specific requirements for other field instrumentation for the project are specified in the FSP.

B.8 Inspection/Acceptance of Supplies and Consumables

Any laboratory consumables or supplies that come into contact with samples must be documented to be free of contamination ("clean"). Examples of laboratory consumables and supplies include: gloves, glassware, soaps, sample bottles, reagent-grade water, reagents, and pipettes.

Documentation that laboratory consumables and supplies are clean may be achieved through several methods as follows:

- Collection of QC Samples, such as bottle blank, water blank, or reagent blank samples. Bottle blanks may be used to demonstrate that bottles are free of contamination. Water blanks may be used to demonstrate that deionized or distilled water does not contain contamination. Reagent blank samples may be used to demonstrate that reagents are free from contamination.

- Certifications from manufacturers or laboratories may be used to show that bottles, consumable equipment and other supplies are free of contamination.

- Purchasing through reliable and frequently used sources. A restricted list of common items may be assumed to be "clean", until proven otherwise, if purchased from reliable commercial sources. This restricted list includes gloves and other personal protective equipment, paper towels, plastic bags, aluminum foil, or other similar items. If the "clean" certification provided by the vendor has been compromised (e.g., tears in the packaging), decontamination should be performed prior to use or the item should be discarded if it cannot be adequately decontaminated. Items which are purchased through commercial sources, and which are not documented to be "clean", should not be used in direct contact with samples.

The laboratory must have documentation on file showing the procedure or process by which laboratory consumables and supplies are documented "clean". This documentation must be available to the TCEQ upon request.

The laboratory Quality Assurance Manual should clearly identify other critical supplies, such as calibration gases or standards, the inspection or acceptance testing requirements and the acceptance criteria. Critical field supplies, the inspection or acceptance testing requirements, and the acceptance criteria are included in Section 5 of the FSP.

B.9 Non-direct Measurements

All types of data needed for project implementation or decision making that are obtained from non-direct measurement sources (e.g., computer databases, programs, literature files, and historical

databases), the acceptance criteria for use of these data, and the limitations on the use of the data will be clearly identified and specified in Section 2 of the FSP.

B.10 Data Management

The following subelements specify the data storage/retrieval requirements for the project records.

B.10.1 Logbooks and Forms

Laboratory and field records shall be kept by appropriate personnel and shall be sufficiently detailed to allow for the reconstruction of the collection, handling, preparation, and analysis procedures performed on the sample without having to rely upon recollection by members of the sampling and/or analysis team. All aspects of sample collection, handling, preparation, and analysis shall be documented in logbooks or forms. If SOPs are being followed, those SOPs shall be maintained. It is sufficient to identify the SOPs being followed and record any deviations from the procedures in the SOP. All logbook pages should be initialed and dated by the person making the entries. All entries should be legible. If errors are made when making entries, the error must be crossed out with a single line and initialed and dated by the person correcting the entry. All maintenance and calibration records for equipment must be traceable through records to the person using the instrument and to the specific piece of instrumentation itself.

B.10.2 Data Storage/Retrieval

Data storage/retrieval requirements are specified in Element A.9.6 of this QAPP.

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C.0 GROUP C: ASSESSMENT AND OVERSIGHT

C.1 Assessments and Response Actions

Internal audits and assessments will be performed by the organization primarily responsible for conducting the task being audited. For example, the contractor responsible for the field activities shall perform audits and/or assessments of those field activities. Laboratories shall perform audits and/or assessments of laboratory activities. External assessments, inspections, and/or audits shall be performed by parties independent of the organization, such as NELAC or A2LA pertaining to the laboratory, and by the TCEQ Quality Assurance Section.

A technical systems audit of field activities is an on-site, qualitative review of the sampling system to ensure that the activity is being performed in compliance with the site QAPP specifications. Field and sampling procedures shall be audited by the contractor at the beginning of the fieldwork.

Generalized items for a technical systems audit of field activities will include (as pertinent to the project):

- On-site presence and use of required documents (SOPs, site QAPP, FSP, relevant laboratory specifications, etc.)
- Appropriate collection of planned sample types and quantities at specified sites, locations, and environmental media according to the site QAPP and FSP
- Use of SOPs and FSP specifications for the collection, tracking, labeling, and custody of samples and for the decontamination of equipment
- Field form preparation of location and sampling information and logbook documentation of field events and measurements
- Fulfillment of project quality assurance objectives including precision, accuracy, completeness, comparability, and representativeness as these relate to field measurements, sample collection, data traceability, and sampling rationale
- Field instrument calibration and documentation
- General field crew organization and knowledge of the field sampling plan and technical issues relevant to the tasks being conducted
- Deviations from the project plans and SOPs that are clearly documented, with indications

as to how and why the deviations were made, and any approvals needed to proceed with the deviations

- Handling and documentation of investigation-derived waste and coordination of disposal of the various types of waste

Specific items related to the collection of samples for laboratory analysis will include (as pertinent):

- Sample location and adherence to the plan
- Field instrumentation and calibration
- Sample collection protocol
- Sample volume
- Sample preservation
- Blanks collected and submitted with each respective sample set
- Duplicates collected and submitted with each respective sample set
- Sample documentation protocols
- Chain-of-custody protocols
- Sample shipment

After each on-site audit, a debriefing session will be held for all participants to discuss the preliminary audit results. The auditor will then complete the audit evaluation and submit an audit report including observations of the deficiencies and the necessary recommendations for corrective actions. Compliance with the specifications presented in the QAPP will be noted and noncompliance or deviations shall be addressed in writing by the contractor to the TCEQ with the corrective actions and a time frame for implementation of the corrective actions. Follow-up audits will be performed prior to completion of the project to ensure corrective actions have been taken. Deviations from the site QAPP, SOPs, FSP and their effect on the quality of the associated data will be included in the Data Usability Summary, as described under Section D.2.3.2 "Corrective Actions and Workplan Deviations" of this QAPP.

The project data will undergo an audit by the TCEQ project manager and QA specialist as described in Elements D.3.1 and D.3.2, respectively.

The types of assessment activities may include, but are not limited to, one or more of the following:

- Management Systems Review (MSR)
- Readiness Review
- Surveillance
- Technical Systems Audit (TSA)

- Performance Evaluation (PE)
- Audit of Data Quality (ADQ)
- Peer Review
- Data Quality Assessment (DQA)

The number, frequency, and type of assessments, the responsible staff, and the procedures to be performed during the life of the project are specified in Section 2 of the FSP.

C.2 Reports to Management

QA reports shall be submitted to the TCEQ project manager during the course of the project to ensure that problems arising during the sampling and analysis phases of the project are investigated and corrected. A QA summary report shall be submitted monthly (at a minimum) and can be part of the monthly progress report to TCEQ management and the EPA. The report shall include the project QA Specialist's evaluation of the accuracy, precision, and completeness of the data, and will contain at a minimum:

- Data validation and assessment results since the last report
- Field and laboratory audit/assessment results since the last report
- Results of technical systems and performance evaluation audits
- Significant QA/QC problems, recommended solutions, and results of corrective actions
- Assessment of data generated since last report, including consideration as to whether originally targeted objectives are being met through the implemented plan(s)
- Minor deviations from work plan or QAPP (Note: Major changes to procedures and/or responsibilities require approval from the TCEQ.)

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D.O GROUP D: DATA VALIDATION AND USABILITY

D.1 Data Review, Verification, and Validation

D.1.1 Criteria for Accepting, Rejecting, or Qualifying Data

Data review performed by the laboratory shall be conducted in accordance with the criteria specified below in Element D.2.1.1. The process used by the independent data reviewer (i.e., the person independent of the laboratory who is reviewing and qualifying the data) are specified in Element D.2.1.2 below. The data review results shall be summarized in a Data Usability Summary (DUS) described in Element D.2.3.1 below.

Qualification of data by the independent data reviewer shall be directly related to potential bias and imprecision in the results and should not be confused with qualification based on laboratory performance. Review qualifiers used in preparing the DUS shall be assigned to data by the independent data reviewer to warn data users of potential uncertainty in the data, regardless of whether the laboratory was expected to provide better results. Therefore, only one set of accuracy and precision criteria for organic results and one set for inorganic results shall be used in determining whether or not a given sample result needs to be flagged as estimated. For example, if an organic result is not flagged as estimated or rejected, the end user shall know that the results are considered likely to be accurate to within ± 40% and precise within about 40%. Conversely, any organic result flagged as estimated is likely to differ from the reported value by 40% or more. These limits are provided in Table D-1.

TABLE D-1: ACCEPTANCE CRITERIA FOR ACCURACY AND PRECISION

	ACCURACY [1] (% RECOVERY)	PRECISION [2] (RELATIVE PERCENT DIFFERENCE)
ORGANICS	60% to 140%	40%
INORGANICS	70% to 130%	30%
PCDDs/PCDFs	60% to 140%	40%

Notes: [1] Accuracy acceptance criteria are pertinent to the matrix spike, the laboratory control sample, the post digestion spike, and surrogate recoveries.
[2] Precision acceptance criteria are pertinent to laboratory duplicates, matrix spike duplicates, and duplicate laboratory control samples.

During the data review process, the person reviewing the data shall annotate qualified data on the analytical data sheets with appropriate data review qualifiers ("U", "J", "UJ", "N", "NJ" and "R") as listed in Table D-2 and associated qualifier codes and bias codes as listed in Table D-3. The purpose of the qualifier codes is to provide information with respect to the data quality condition(s) that resulted in the assigned qualification. A hyphen and then the applicable bias

code shall follow the data qualifier codes. The bias code provides an indication of the potential direction of the bias. For example, "LCS–L" would mean the result was qualified for laboratory control sample spike recoveries, which were outside of the acceptance criteria, resulting in a potential low bias in the reported value or sample quantitation limit. In the case of multiple data quality conditions resulting in qualification, each qualifier code is listed and separated by a comma. For example, a result qualified as estimated due to low LCS spike recovery (%R = 30%) and poor field duplicate precision (RPD = 50%) would have the following codes annotated on the data sheet, "MS, FD–L".

TABLE D-2: DATA REVIEW QUALIFIER DEFINITIONS[1]

QUALIFIER	DEFINITIONS
U	Not detected: The analyte was analyzed for but was not detected above the level of the associated value. The associate value is the sample quantitation limit (SQL).
J	Estimated: The analyte was detected and positively identified. The associated numerical value is the approximate concentration of the analyte in the sample.
UJ	Not detected, SQL is estimated: The analyte was analyzed for but was not detected above the reported sample quantitation limit. However, the reported SQL is an estimate and may be inaccurate or imprecise.
N	Tentatively identified: The analysis indicates the presence of an analyte for which there is presumptive evidence to make a tentative identification.
NJ	Tentatively identified, reported concentration is estimated: The analysis indicates the presence of an analyte for which there is presumptive evidence to make a tentative identification and the associated numerical value represents the analyte's approximate concentration.
R	Rejected: The data are unusable. (Note: The presence or absence of the analyte cannot be confirmed.)

[1]Definitions cited were modified after the USEPA National Functional Guidelines for Organic Data Review, October 1999.

TABLE D-3: DATA REVIEW QUALIFIER CODES

Qualifier Code	Data Quality Condition Resulting In Assigned Qualification
General Use	
FB	Field blank contamination
FD	Field duplicate evaluation criteria not met
HT	Holding time requirement was not met
LCS	Laboratory control sample evaluation criteria not met
MB	Method blank or preparation blank contamination
RB	Rinsate blank contamination
TB	Trip blank contamination
SQL	Sample quantitation limit exceeds decision criteria (for nondetected results)
Inorganic Methods	
CCB	Continuing calibration blank contamination
CCV	Continuing calibration verification evaluation criteria not met
D	Laboratory duplicate precision evaluation criteria not met
DL	Serial dilution results did not met evaluation criteria
ICS	Interference check sample evaluation criteria not met
ICV	Initial calibration verification evaluation criteria not met
MS	Matrix spike recovery outside acceptance range
PDS	Post-digestion spike recovery outside acceptance range
MSA	Method of standard additions correlation coefficient <0.995
PB	Preparation Blank
Organic Methods	
CCAL	Continuing calibration evaluation criteria not met
ICAL	Initial calibration evaluation criteria not met
ID	Target compound identification criteria not met
IS	Internal standard evaluation criteria not met
MS/SD	Matrix spike/matrix spike duplicate accuracy and/or precision criteria not met
SUR	Surrogate recovery outside acceptance range
TUNE	Instrument performance (tuning) criteria not met
P	Detected concentration difference between the primary and secondary column is greater than 25%
Bias Codes	
H	Bias in sample result likely to be high
I	Bias in sample result is indeterminate
L	Bias in sample result likely to be low

D.1.2 Project Specific Calculations or Algorithms

The project specific calculations are specified in Element B.5.3 and in Section 3 of the FSP.

D.2 Verification and Validation Methods

D.2.1 Process for Data Verification and Validation

The review performed on the data at every level shall be documented, beginning with the laboratory's review of the analytical results onward through the independent data review performed for, or by, the data user, and finally the review by the TCEQ. The intent is to capture the review effort of each party to minimize duplicative activities, to ensure that critical elements of the review process are not overlooked, and to set in place a system that can be audited or inspected. If a laboratory has in place and implements a quality assurance program that meets the requirements of a recognized organization, such as EPA, NELAP, or the International Organization for Standardization (ISO), problems with the data should be random, minimal, appropriately addressed through the laboratory's corrective action procedures, and adequately documented in the Laboratory Review Checklists. Therefore, it is not necessary to routinely duplicate the laboratory review during independent data review. Instead, the independent data reviewer shall review the sample performance criteria and rely on review of the laboratory's report of problems associated with the laboratory performance criteria to evaluate the quality and usability of the associated analytical results.

Element D.2.1.1 describes the first level of review performed by the laboratory. The second level of review of the analytical data shall be performed as specified in Element D.2.1.2 by data review personnel independent of the laboratory generating the data. The purpose of this second level of review is to provide an independent review of the laboratory data package, including the Laboratory Review Checklist(s), and to evaluate the effect(s) of any QC measures not meeting the QC acceptance criteria on the usability of the analytical data. Element D.2.1.3 describes the level of review performed during data validation by the independent data reviewer. The final review performed by the TCEQ is specified in Elements D.3.1 and D.3.2.

D.2.1.1 Data Review by the Laboratory

The laboratory shall review the data for technical acceptance based on the project requirements as specified in Sections 3 and 4 of the FSP and Element B.5. The results of the laboratory's review shall be documented in the Laboratory Review Checklist described in A.9.2.1. If no project-specific acceptance criteria have been specified, then the review shall be based on the method requirements. The laboratory will review the data reduction and verification procedures used in the laboratory to assure the overall analysis results and reporting protocols meet method and project specifications. The procedures for data reduction, reporting, and review, as described

in this element, shall be included in the laboratory's QAP and SOPs to assure: (1) complete documentation is maintained; (2) transcription and data reduction errors are minimized; (3) the data are reviewed and the review documented; and (4) the reported results are qualified to reflect potential limitations of the data, when necessary. The laboratory should have a QA program in place that identifies and corrects problems associated with the generation of analytical data. The specific data reduction, verification, and reporting procedures may vary from laboratory to laboratory but shall be completed in accordance with the laboratory's Quality Assurance Plan (QAP) and the laboratory's Standard Operating Procedures (SOPs).

The laboratory analyst responsible for the reduction of raw data generated at the laboratory bench shall document the outcome of his/her activities and clearly identify any problems or anomalies that might affect the quality of the data being reported. The analyst shall verify that data reduction performed by an instrument or Laboratory Information Management System (LIMS) is correct. In each laboratory analytical section, the analyst performing the tests shall review 100 percent of the data, and the verification by laboratory personnel shall, at a minimum, include the following:

- Verification of the calibrations and calibration checks for compliance with laboratory criteria and criteria specified in Element B.5 of this QAPP.
- Verification that batch QC samples were analyzed at the frequency specified in the method and in Element B.5 of this QAPP.
- Verification that QC sample results were within the specifications in the method and in Element B.5 of this QAPP.
- Comparison of the raw data (chromatograms, mass spectra, etc.) with the reported identifications and concentrations for accuracy and consistency.
- Verification that holding times for extractions and analyses were met.
- Verification that sample quantitation limits and method detection limits are current and correct.
- Verification that corrective actions were performed and control was adequately reestablished and documented prior to reanalysis of QC or project samples.
- Verification that all project and QC sample results were properly reported and flagged.
- Preparation of Laboratory Review Checklists (LRCs) as specified in Element A.9.2.1.

After the analyst's review has been completed, at least 10% of the following data (as applicable to the analytical method) shall be reviewed independently by a senior analyst or by the supervisor of the respective analytical section using the criteria specified above and/or in Element B.5 of this QAPP:

- Calibrations and calibration verifications
- Instrument and system performance checks (e.g., tuning, performance evaluation mixture analysis, etc.)
- Blanks
- LCS recoveries and precision
- MS/MSD recoveries and precision
- Duplicate sample precision
- Compound quantitation and identification
- Surrogate recoveries
- Internal standard areas
- Serial dilutions
- Post-digestion spike recoveries
- Method of Standard Addition quantitation
- Interference check sample results
- Tentatively Identified Compound identifications

The Laboratory QA section shall 1) review the completed data packages, 2) perform a reasonableness check review on all the completed data packages, and 3) ensure that all deliverables are present, that qualifiers have been applied to the data, that the chain-of-custody has been maintained and is documented, and that all nonconformance and other issues have been addressed in the LRC to be included in the data report packages. The content and format of laboratory electronic data deliverables, if applicable, shall be specified in Section 8 of the FSP. The laboratory QA section shall perform a QA check on 100% of data key-punched into electronic data deliverables and shall perform a 5% spot-check of data electronically transferred into an electronic data deliverable for consistency with hard copy deliverables.

D.2.1.2 Data Review by the Independent Data Reviewer

The independent data reviewer (i.e. the person independent of the laboratory who is reviewing the data) shall review all of the reportable data and the Laboratory Review Checklist(s). The results of the review shall be conveyed to the data user(s) in the Data Usability Summary as described in Element D.2.3.1 below.

D.2.1.2.1 Review of the Laboratory Review Checklist

The independent data reviewer shall evaluate the sample-specific criteria and the laboratory

performance criteria based on the review of the Laboratory Review Checklist(s). If an ER describes a laboratory performance criterion not covered by the subsections below, if appropriate, the person reviewing the data shall evaluate and qualify the associated data using guidance from USEPA's National Functional Guidelines for Organic/Inorganic Data Review as applicable to the analytical method. If the Functional Guidelines are not considered appropriate, the person reviewing the data shall utilize professional judgement to evaluate the effect of the reported item or condition on the associated analytical data. All uses of professional judgement shall be described in the narrative describing the data review. In some cases, it may be appropriate for the data reviewer to assign the final accuracy and precision qualifications from Table D-1 based on the overall performance of the applicable QC parameters (e.g., LCS, MS/MSD, blank results) rather than relying solely on the QC results associated with an individual analytical batch.

D.2.1.2.1.1 Initial Calibration

Element B.5.1 contains the QC acceptance criteria for initial calibration for analytical methods required for a specific project. If no site-specific QAPP is available, the acceptance criteria specified in the analytical method shall be used. If the Laboratory Review Checklist indicates that the initial calibration for any analyte did not meet the acceptance criteria, then all results for that given analyte associated with the initial calibration shall be qualified as estimated ("J/UJ") with a qualifier code of "ICAL" and a bias code of "I" for indeterminate direction of bias.

D.2.1.2.1.2 Initial and/or Continuing Calibration Verification

Element B.5.1 contains the QC acceptance criteria for initial calibration or continuing calibration verification for analytical methods required for a specific project. If no site-specific QAPP is available, the acceptance criteria specified in the analytical method shall be used. If the Laboratory Review Checklist indicates that the initial or continuing calibration verification for any analyte did not meet the acceptance criteria, then all results for that given analyte associated with the initial or continuing calibration verification shall be qualified as estimated ("J/UJ") with a qualifier code of "ICV" or "CCV" for inorganics and "CCAL" for organics. If the data reviewer can discern a probable magnitude and/or direction of bias to the associated sample results, based on the information provided in the ER, then appropriate qualifier bias codes shall be assigned.

D.2.1.2.1.3 Internal Standard Data

Element B.5.1 contains the QC acceptance criteria for internal standard area counts for GC/MS organic analysis and internal standard quantitation methods required for the project. If no site-specific QAPP is available, the acceptance criteria specified in the analytical method shall be used. Internal standard area counts are not a direct measure of the accuracy of the analysis. Low internal standard area counts for sample analysis relative to those observed in the associated

continuing calibration analysis may be indicative of low extraction or purging efficiency, which decreases the analysis sensitivity (raises the detection limit). High internal standard area counts may be indicative of coeluting interferences at the retention time of the internal standard in the sample, may be caused by a drift in detector sensitivity, or may be caused by injection of a different amount of sample extract. Coeluting interferences to the internal standard may result in a low bias in reported results quantified by the given internal standard. Injection of a larger volume of extract would result in increased sensitivity of the analysis (lowered detection limit).

- If the ER indicates that internal standard area counts are below the lower acceptance limit, then results reported as not-detected shall be qualified as estimated ("UJ") and results reported as detected shall not require qualification since the calculation performed by the instrument corrects for reduced extraction efficiency.

- If the ER indicates that internal standard area counts are above the upper acceptance limit, then results reported as detected or as not-detected shall be qualified as estimated ("J/UJ").

A qualifier code of "IS" shall be assigned to all results qualified on the basis of internal standard area counts.

D.2.1.2.1.4 Dual Column Confirmation Results

A second, dissimilar column confirmation is required by some of the gas chromatographic analysis methods. If the ER specifies the relative percent difference between primary and secondary column results for organic analysis by GC is greater than 25%, the following qualification shall be considered:

- If the ER indicates that the RPD is greater than 40%, and that the difference is likely due to coeluting interference, the person reviewing the data shall qualify the reported sample results as presumptive evidence of presence at an estimated quantity ("NJ"). If the result reported by the laboratory was the higher of the two results, then the person reviewing the data may cross out the reported result and replace it with the lower of the two results, if there is evidence that the higher value is caused by coeluting interference.

- If the samples analyzed would not be considered as previously well-characterized as to constituents present and second column confirmation was not performed for a GC analysis, the reported sample results may be qualified as presumptive evidence of presence at an estimated quantity ("NJ").

D.2.1.2.1.5 Interference Check Sample

ICS analysis is applicable to ICP/MS and ICP-AES analysis. Element B.5.1 contains the QC acceptance criteria for ICS results for analytical methods required for a specific project.

- If the ER indicates that the %R for analytes present in the ICS sample was above the upper acceptance criterion, then results reported as detected for that analyte in associated samples for which the potentially interfering elements were present at concentrations equivalent to or greater than those present in the ICS sample shall be qualified as estimated ("J") with a potential high bias; non-detected results do not require qualification.

- If the ER indicates that the %R for analytes present in the ICS sample was less than the lower acceptance criterion, then both detected and non-detected results for that analyte in associated samples for which the potentially interfering elements were present at concentrations equivalent to or greater than those present in the ICS sample shall be qualified as estimated ("J/UJ") with a potential low bias.

- If the ER indicates that analytes not actually present in the ICS sample are reported at concentrations for which the absolute value of the concentration is greater than the sample quantitation limit for the analyte, then the potential effect and magnitude of the bias shall be evaluated for all associated samples for which the potentially interfering elements were present at concentrations equivalent to or greater than those present in the ICS sample.

- If the concentration is reported as a positive value and the magnitude of the ICS sample result represents more than 25% of an associated sample result reported as detected, then the associated sample result shall be qualified as estimated ("J") with a potential high bias. Non-detected results shall not require qualification.

- If the concentration is reported as a negative value and the absolute value of the magnitude of the ICS sample result represents more than 25% of an associated sample result (or sample quantitation limit for non-detects), then the associated sample result shall be qualified as estimated ("J/UJ") with a potential low bias.

A qualifier code of "ICS"shall be assigned to all results qualified on the basis of ICS results.

D.2.1.2.1.6 Serial Dilution Analysis Data

Serial dilution analysis may be pertinent to metals analysis by ICP-AES, ICP/MS and GFAA. The ICP serial dilutions are run to help evaluate whether or not significant physical or chemical

interferences exist due to the sample matrix. When analyte concentrations are sufficiently high (the concentration in the original sample is minimally a factor of 50 above the IDL), the results obtained from a five fold-dilution of the original sample are compared to the original results by means of a percent difference (%D). The %D is compared to a precision acceptance limit of ±10%. If the absolute value of the percent difference between the diluted and original result is greater than 10%, all results for that analyte in that sample batch are qualified as estimated ("J/UJ"). Generally, the diluted result can be considered to be the more accurate result, as long as the diluted concentration is well above the detection limit. Therefore, the person reviewing the data can generally discern a potential bias direction from a comparison of the diluted and undiluted results.

A qualifier code of "DL" shall be assigned to all results qualified on the basis of serial dilution results.

D.2.1.2.1.7 Post Digestion Spike Data

Post digestion spike analysis may be pertinent to metals analysis by ICP-AES, ICP/MS and GFAA. The analyte recoveries obtained for post-digestion spike analyses shall be compared to the acceptance range for accuracy contained in Table D-1 (70-130%). Under some circumstances, laboratories will quantify results by the Method of Standard Additions (MSA) to compensate for low post-digestion spike recovery. The low spike recovery will not compromise the accuracy of the results, as the standards used in the MSA analysis are spiked directly into the sample. However, if the result for the sample on which the post-digestion spike analysis was performed was not obtained by the Method of Standard Additions and the post-digestion spike recovery is outside of the acceptance limits, qualify the result for the sample on which the post-digestion spike was run based on the following guidance:

- If the recovery is above 130%, qualify detectable results as estimated ("J"). No action needs to be taken for non-detects.

- If the recovery is below 70% but greater than or equal to 30%, qualify detectable and non-detected results as estimated ("J/UJ").

- If the recovery is less than 30%, qualify detectable results as estimate ("J") and reject non-detected results.

The person reviewing the data shall use professional judgement in conjunction with other QC sample results, such as matrix spike recoveries, to determine the need for qualification of results for other samples (if any) associated with the post-digestion spike analysis.

A qualifier code of "PDS"shall be assigned to all results qualified or rejected on the basis of post-digestion recoveries.

D.2.1.2.1.8 Method of Standard Additions Data

Method of Standard Additions (MSA) quantitation of results may be pertinent to inorganic analyses. MSA may either be by the single-addition technique or using a series of standard additions. The single-addition technique is only considered valid if the apparent concentrations from the original calibration curve are linear over the concentration range of concern. If the single-addition technique is used, the laboratory shall document the slope of the MSA curve, the slope of the calibration curve, and the percent difference between the slopes of the MSA and the calibration curve. If a multiple addition MSA technique is used, the laboratory shall document the correlation coefficient for the MSA plot and the control limits utilized for the correlation coefficient.

D.2.1.2.2 Review of Reportable Data

The independent data reviewer shall review the reportable data for all of the laboratory data packages from each laboratory for each analysis type. Data review shall be conducted from the results reported on the summary forms and/or test reports using the provisions below and guidance from USEPA's National Functional Guidelines for Organic/Inorganic Data Review (the Functional Guidelines), as applicable to the analytical method. No recalculation of results from the raw data or transcription error checking shall be performed during the review of the reportable data.

D.2.1.2.2.1 Metals and Inorganic (General Chemistry) Analyses

Metals data from ICP/MS, ICP, CVAA, or GFAA analyses and other inorganic (i.e., general chemistry) data shall undergo evaluation from the reported results for the following sample-specific criteria using the specifications given below and the criteria from Table D-1:

- Holding times
- Blank results
- Laboratory control sample results
- Matrix spike sample analysis
- Matrix spike duplicate or analytical duplicate precision
- Field duplicate result agreement
- Anion/cation balance
- Balance of total to partial analyses

The person reviewing the data shall use guidance from EPA's Functional Guidelines to address issues not covered by this Element D.

D.2.1.2.2.1.1 Holding Times

The holding times shall be compared to the holding time requirements specified in Element B.2.2, Table B2-1. If no holding time requirements are specified in the QAPP, the holding time requirements specified in the method shall be used. Results for analyses not performed within holding time limits shall be qualified as estimated ("J/UJ"). If the holding time is grossly exceeded for mercury or chromium +6 (more than two times the holding time limit), the person reviewing the data shall use professional judgement to evaluate the need to reject non-detected results.

A qualifier code of "HT" shall be assigned to all results qualified or rejected on the basis of holding times.

D.2.1.2.2.1.2 Blank Results

The results for method blanks, rinsate blanks and other blanks reported in the data package shall be reviewed. If the associated sample matrix is a solid, positive associated aqueous blank results shall be converted to equivalent concentrations in the solid samples by assuming that all contamination found in the aqueous blank aliquot analyzed is potentially present at up to five times that amount in the solid sample aliquot analyzed. Sample results for analytes detected in an associated blank at concentrations less than five times the equivalent blank concentration shall be qualified as nondetect ("U") at the reported concentration. Negative blank concentrations shall be evaluated for potential effects (low bias) on sample data when the absolute value of the negative concentration is greater than the method quantitation limit (MQL). If the negative concentration in a blank may potentially have produced more than a 25% effect on a reported sample result or sample quantitation limit, the associated sample result shall be qualified as estimated ("J/UJ"). For example, if the blank result is –2 mg/L, the MQL is 1 mg/L and the associated sample result is 5 mg/L, the sample result shall be qualified since a potential low bias of 2 mg/L represents 40% of the reported concentration and the absolute value of the blank concentration is greater than the MQL.

Preparation blanks are associated with all samples prepared in the preparation batch to which the preparation blank is associated. Continuing calibration blank samples are considered to be associated with all samples back to the previously analyzed continuing calibration blank sample and up to the next continuing calibration blank sample in the analytical run.

The appropriate qualifier code, e.g. "MB" or "RB", shall be assigned to all results qualified on the basis of blank data.

D.2.1.2.2.1.3 Laboratory Control Sample (LCS) Analysis

The analyte recoveries obtained for LCS analyses shall be compared to the acceptance range

contained in Table D-1 (i.e., 70-130%). All chemicals of concern shall be spiked into the LCS. Data associated with LCS recoveries outside the acceptance range shall be qualified as follows:

- If the LCS recovery for an analyte is greater than 130%, suggesting a potential high bias in reported results, all positive results for that analyte in all associated samples shall be qualified as estimated ("J"), whereas nondetect results shall be considered to be acceptable for use without qualification.

- If the LCS recovery for an analyte is less than 70% but greater than or equal to 30%, suggesting a potential low bias in reported results, positive and nondetect results for that analyte in all associated samples shall be qualified as estimated ("J" or "UJ").

- If the LCS recovery for an analyte is <30%, positive sample results shall be qualified as estimated ("J") whereas nondetect results shall be qualified as unusable ("R") for all associated sample results.

A qualifier code of "LCS" shall be assigned to all results qualified as estimated or rejected on the basis of LCS recoveries.

D.2.1.2.2.1.4 Duplicate Sample Analysis

Results for the duplicate sample (analytical duplicate or matrix spike duplicate) analyses shall be compared to the acceptance criteria contained in Table D-1. The relative percent difference (RPD) criterion of 30% shall be applied for cases in which both the sample and duplicate results are greater than 5 times the method quantitation limit. Otherwise, the absolute difference between the samples shall be compared to 1 times the greater sample quantitation limit (SQL) for aqueous samples (2 times the SQL for soil samples). If the duplicate results for an analyte do not satisfy the applicable evaluation criterion, results for that analyte in all associated samples shall be qualified as estimated ("J/UJ").

A qualifier code of "D" shall be assigned to all results qualified on the basis of laboratory duplicate results.

D.2.1.2.2.1.5 Matrix Spike Sample Analysis

The analyte recoveries obtained for matrix spike (or matrix duplicate) analyses shall be compared to the acceptance range contained in Table D-1 (70-130%) for cases in which the native sample concentration is less than four times the spike concentration, as specified in the Functional Guidelines. When sample concentrations of an analyte are greater than four times the spiking concentration, the results are considered to be inappropriate for assessing accuracy. The reviewer shall be aware that a matrix spike (MS) recovery may be outside acceptance limits when the parent sample was quantified by the Method of Standard Additions but the MS was not. In such a case, the %R for the MS may not

be an appropriate measure of accuracy. Data associated with matrix spike recoveries outside the acceptance range shall be qualified as follows:

- If the matrix spike recovery for an analyte is greater than 130%, suggesting a potential high bias in reported results, all positive results for that analyte in all associated samples shall be qualified as estimated ("J"), whereas nondetect results shall be considered acceptable for use without qualification.

- If the matrix spike recovery for an analyte is less than 70% but greater than or equal to 30%, suggesting a potential low bias in reported results, positive and nondetect results for that analyte in all associated samples shall be qualified as estimated ("J" or "UJ").

- If the matrix spike recovery for an analyte is <30%, positive sample results shall be qualified as estimated ("J"), whereas nondetect results shall be qualified as unusable ("R") for all associated samples.

A qualifier code of "MS" shall be assigned to all results qualified as estimated or rejected on the basis of matrix spike recoveries.

D.2.1.2.2.1.6 Field Duplicate Agreement

Criteria for evaluating field duplicate results are not provided in the Functional Guidelines. Therefore, the following criteria shall be used for reviewing homogenized or collocated field duplicate results for all analyses. Where both the sample and duplicate values are greater than 5 times the method quantitation limit (MQL), acceptable sampling and analytical precision is indicated by a relative percent difference (RPD) for the two field duplicate results of less than or equal to 50 percent (30 percent for aqueous samples). Where the results for analytes in one or both of the field duplicate pair are less than 5 times the MQL, satisfactory precision is indicated if the field duplicate results agree within 3.5 times the greater SQL (2 times for aqueous samples). If the above criteria are not met for an analyte, all associated sample data for that analyte shall be qualified as estimated ("J/UJ").

D.2.1.2.2.1.7 Anion/Cation Balance

Since water is generally electrically neutral, the sum of the dissolved cation concentrations (expressed in milliequivalents per liter) shall equal the sum of the dissolved anion concentrations. For projects in which the major cations and anions are being analyzed, the person reviewing the data shall evaluate whether there is an acceptable balance between anion concentrations and cation concentrations. In accordance with Standard Methods #1030F, the equation used to calculate anion-cation balances is:

$$\textit{percent difference} = 100 \times (S\ cations - S\ anions) / (S\ cations + S\ anions)$$

Laboratory accuracy control limits for most analytes are ±30%. This level of accuracy is considered

to be fully acceptable in meeting the end use objectives of groundwater monitoring. A 30% bias in the metals analysis corresponds to an anion-cation balance percent difference of approximately 13%. Therefore, since a 30% bias is considered not to adversely affect the usability of the data, an evaluation criterion of a percent difference less than ± 13% shall be utilized for anion-cation balance evaluation. If the anion/cation balance is greater than ±13%, the person reviewing the data shall use professional judgement to discern likely causes of the imbalance and need for qualification of data.

D.2.1.2.2.1.8 Balance of Total to Partial Analyses

Results for the total analysis of a particular analyte shall be greater than the results for a partial analysis of that analyte. For example, the results for total metals shall be greater than, or equal to, the results for dissolved metals, and ammonia concentrations shall not be greater than Total Kjeldahl Nitrogen concentrations. Because all results are limited by the accuracy of the analysis, the criteria for accuracy of the analysis shall be used as the basis for criteria to evaluate the agreement between the results for the partial analysis and the total portion. Where both of the results are greater than 5 times the higher MQL, the criterion utilized shall be that the two values shall agree within ±30%. For example, the partial analysis result shall not be more than 30% higher than the total analysis result. Where either of the results is less than 5 times the MQL, an evaluation criterion of plus or minus two times the higher SQL is compared against the difference between the partial and total results. If the results for the partial versus total analyses do not satisfy the appropriate evaluation criterion, results for the partial and total analyses are qualified as estimated ("J/UJ").

D.2.1.2.2.2 Organic Analyses

For organics by GC or GC/MS, the data shall be evaluated from the reported results for the following sample-specific criteria using the specifications given below and the criteria from Table D-1:

- Holding times
- Blank results
- Laboratory control sample analyses
- Surrogate recovery results
- Matrix spike/matrix spike duplicate analyses
- Internal standard recoveries for isotope dilution GC/MS analyses
- Tentatively identified compounds
- Field duplicate result agreement

The person reviewing the data shall use guidance from EPA's Functional Guidelines to address issues not covered by Element D of the QAPP.

D.2.1.2.2.2.1 Holding Times

The holding times shall be compared to the holding time requirements specified in Element B.2.2,

Table B2-1. If no holding time requirements are specified in the QAPP, the holding time requirements specified in the method should be used to evaluate the data. Results for analyses not performed within holding time limits shall be qualified as estimated ("J/UJ"). If the holding time is grossly exceeded (more than two times the holding time limit), the person reviewing the data shall use professional judgement to evaluate the need to reject non-detected results.

A qualifier code of "HT" shall be assigned to all results qualified or rejected on the basis of holding times.

D.2.1.2.2.2.2 Blank Results

The results for method blanks, field and trip blanks, rinsate blanks and other blanks reported in the data package shall be reviewed. If the associated sample matrix is a solid, positive rinsate, calibration, and other associated aqueous blank results shall be converted to equivalent concentrations in the solid samples by assuming that all contamination found in the aqueous blank aliquot analyzed is potentially present at up to five times that amount in the solid sample aliquot analyzed. Sample results for analytes detected in an associated blank at concentrations less than five times (ten times for the common laboratory contaminants: methylene chloride, acetone, 2-butanone, cyclohexane, and phthalates) the equivalent blank concentration shall be qualified as non-detect ("U") at the reported concentration. A method blank is associated with all samples prepared with that blank.

A qualifier code of "MB", "FB", "RB" or "TB" shall be assigned to all results qualified on the basis of method blank, field blank, rinsate blank or trip blank results, respectively.

D.2.1.2.2.2.3 Laboratory Control Sample (LCS) Analysis

The analyte recoveries obtained for LCS analyses shall be compared to the acceptance range contained in Table D-1 (60-140%). All target analytes shall be spiked into the LCS. Data associated with LCS recoveries outside the acceptance range shall be qualified as follows:

- If the LCS recovery for an analyte is greater than 140%, suggesting a potential high bias in reported results, all positive results for that analyte in all associated samples shall be qualified as estimated ("J"), whereas nondetect results shall be considered to be acceptable for use without qualification.

- If the LCS recovery for an analyte is less than 60% but greater than or equal to 10%, suggesting a potential low bias in reported results, positive and nondetect results for that analyte in all associated samples shall be qualified as estimated ("J" or "UJ").

- If the LCS recovery for an analyte is <10%, positive sample results shall be qualified as estimated ("J") whereas nondetect results shall be qualified as unusable ("R") for all associated sample results.

A qualifier code of "LCS" shall be assigned to all results qualified or rejected on the basis of LCS recoveries.

D.2.1.2.2.2.4 Surrogate Recovery Results

The surrogate recoveries obtained for each sample analysis for which surrogates were analyzed shall be compared to the acceptance range contained in Table D-1 (60-140%). Results for analytes in the sample associated with surrogate recoveries outside the acceptance range shall be qualified as follows:

- If the surrogate recovery is greater than 140% for any surrogate (for semivolatile organics by GC/MS, two or more surrogates in either fraction shall be high), suggesting a potential high bias in reported results, all positive results for that associated analytes in that sample shall be qualified as estimated ("J"), whereas non-detect results shall be considered to be acceptable for use without qualification.

- If the surrogate recovery is less than 60% but greater than or equal to 10% (for semivolatile organics by GC/MS, two or more surrogates in either fraction are out with at least one of them being less than the lower limit but >10%), suggesting a potential low bias in reported results, positive and nondetect results for associated analytes in that sample shall be qualified as estimated ("J" or "UJ").

- If any surrogate recovery is <10%, positive results for associated analytes in that sample shall be qualified as estimated ("J"), whereas associated non-detect results shall be qualified as unusable ("R").

A qualifier code of "SUR" shall be assigned to all results qualified or rejected on the basis of surrogate recoveries.

D.2.1.2.2.2.5 Matrix Spike/Matrix Spike Duplicate Sample Analysis

The analyte recoveries obtained for matrix spike and matrix spike duplicate analyses shall be compared to the acceptance range contained in Table D-1 (60-140%) for cases in which the native sample concentration is less than four times the spike concentration. When sample concentrations of an analyte are greater than four times the spiking concentration, the results are considered to be inappropriate for assessing accuracy. Data associated with matrix spike or matrix spike duplicate recoveries outside the acceptance range shall be qualified as follows:

- If the matrix spike recovery for an analyte is greater than 140%, suggesting a potential high bias in reported results, all positive results for that analyte in the sample used for the matrix spike analysis shall be qualified as estimated ("J"), whereas nondetect results shall be considered to be acceptable for use without qualification.

- If the matrix spike recovery for an analyte is less than 60% but greater than or equal to 10%, suggesting a potential low bias in reported results, positive and nondetect results for that analyte in the sample used for the matrix spike analysis shall be qualified as estimated ("J" or "UJ").

- If the matrix spike recovery for an analyte is <10%, positive sample results in the sample used for the matrix spike analysis shall be qualified as estimated ("J"), whereas nondetect results shall be qualified as unusable ("R") for all associated samples.

- No qualification of associated samples in the batch or data package shall be performed on the basis of matrix spike recoveries alone. The person reviewing the data shall use professional judgement and consider the results of other QC measures, such as surrogate recoveries in conjunction with MS/MSD results, to determine the need for qualification of associated samples.

- Relative percent differences (RPDs) between the matrix spike and the matrix spike duplicate shall be compared to the acceptance criteria contained in Table D-1 of 40%. If the MS/MSD RPD for an analyte does not satisfy the evaluation criterion, results for that analyte in the sample used for the matrix spike analysis shall be qualified as estimated ("J/UJ"). The person reviewing the data shall use professional judgement and consider the results of other QC measures in conjunction with MS/MSD results to determine the need for qualification of associated samples.

A qualifier code of "MS/SD" shall be assigned to all results qualified on the basis of MS/MSD precision.

D.2.1.2.2.2.6 Tentatively Identified Compound Identification

Tentatively Identified Compound (TIC) identification may be required for volatile or semivolatile organic compound analysis by GC/MS. Qualification of TIC results shall be performed based on the following:

- All TIC results shall be qualified "NJ", tentatively identified with approximated concentrations.

- If it is determined that a tentative identification of a non-target compound is not acceptable, the tentative identification shall be changed to "unknown" or to an appropriate identification.

- If TIC concentrations are attributable to laboratory contamination, based on the criteria specified above for evaluating blank results, line-out the identification of the TIC (the compound shall not be considered a TIC).

D.2.1.2.2.2.7 Field Duplicate Agreement

Criteria for evaluating field duplicate results are not provided in the Functional Guidelines. Therefore, the following criteria shall be used for reviewing homogenized or collocated field duplicate results for all analyses. Where both the sample and duplicate values are greater than 5 times the method quantitation limit (MQL), acceptable sampling and analytical precision is indicated by a relative percent difference (RPD) for the two field duplicate results of less than or equal to 50% (30% for aqueous samples). Where results for analytes in one or both of the field duplicate pair are less than 5 times the MQL, satisfactory precision is indicated if the field duplicate results agree within 3.5 times the higher SQL (2 times for aqueous samples). If the above criteria are not met for an analyte, all associated sample data for that analyte shall be qualified as estimated ("J").

D.2.1.2.2.2.8 Other Analyses

For other analyses, data review shall consist of the applicable portions of the following as defined by the QA provisions contained in Section 8 of the FSP. If no QA provisions are included in Section 8 of the FSP, then the following method criteria should be used:

- Evaluation of compliance to holding time limits, with data outside of the holding time limits qualified as estimated (or rejected if in the professional judgment of the reviewer the data are unusable).

- Evaluation of spike recoveries (matrix spikes) and duplicate analysis precision (field duplicates, matrix spike duplicates, or laboratory duplicates) with data outside of the accuracy and precision limits qualified as estimated, "J/UJ" (or rejected, "R," if in the professional judgment of the reviewer the data are unusable). If the given QC result indicates that associated sample results have a potential high bias, associated results reported as not detected do not require qualification.

- Evaluation of field blank contamination with qualification of data from samples associated with contaminated blanks using the following guidance adapted from the Functional Guidelines.

  Action in the case of unsuitable blank results depends on the circumstances and origin of the blank. No positive sample results shall be reported unless the concentration of the analyte in the sample exceeds five times the amount in any blank. In instances where more than one blank is associated with a given sample, qualification shall be based upon a comparison with the associated blank having the highest concentration of a contaminant. The results shall not be corrected by subtracting any blank value. Specific actions are as follows:

  1. If a compound is found in a blank, but not found in the sample, no action is taken.

2. If a blank has a positive result for an analyte, qualify associated sample data as follows:

   If the sample result is greater than the laboratory method quantitation limit but less than 5 times the blank concentration, flag the sample result as a non-detect ('U'). If the sample result is reported as detected at a concentration less than the sample quantitation limit and less than 5 times the blank concentration, qualify the sample result as not-detected at the sample quantitation limit. If the sample result is greater than or equal to 5 times the blank concentration, no action is taken. For aqueous blanks applied to soil/sediment samples, qualification is assigned based on comparison of the sample result to the equivalent concentration of the blank. The equivalent concentration is determined by assuming that all of the analyte present in the blank aliquot analyzed is present in the sample aliquot analyzed.

The reviewer shall note that the blank analyses may not involve the same weights, volumes, or dilution factors as the associated samples. These factors shall be taken into consideration when applying the 5 times criteria, such that a comparison of the total contamination is actually made.

D.2.1.2.3 Review of Field Data

All field data should be verified at the time of collection by following the QC checks outlined in the site-specific FSP and work plan. The data reviewer shall review the field data documentation to identify discrepancies or unclear entries. Field data documentation should be validated against the following criteria, as appropriate:

- Sample location and adherence to the plan
- Field instrumentation and calibration
- Sample collection protocol
- QC measures employed
- Quality assurance objectives achievement

D.2.1.3 Process for Data Validation

Validation of project data is performed on a minimum ten percent of the project analytical batches (or at least one analytical batch per sampling event if there are fewer than 10 batches). Data validation is implemented to provide a quality check on the laboratory system generating the data. All of the QC results which were reported on the laboratory test reports (or summary forms) as being outside of the

acceptance criteria shall be checked against the Laboratory Review Checklist to evaluate whether problems were identified and reported. Ten percent of the data in the data packages being validated shall be checked for transcription errors and calculation errors. If systematic or frequent errors are encountered, 100 percent of the data packages shall be reviewed for errors analogous to those identified in the initial review.

In addition to the data review described in Element D.2.1.2, the independent data reviewer shall perform a validation on a minimum ten percent of the project analytical batches, including analytical batches containing split sample analyses from a second laboratory. The criteria specified in Elements D.2.1.2.1.1 through D.2.1.2.1.8 shall be used to evaluate the laboratory performance criteria data and those sample specific data included in the supporting data listed in the Laboratory Review Checklist. If a criterion is not covered in these elements (e.g., relative response factors, correlation coefficients, tuning criteria), the data reviewer shall use professional judgement in evaluating and qualifying the associated data using guidance from the National Functional Guidelines, as applicable to the analytical method.

If Tentatively Identified Compounds were reported, the tentative identification shall be checked against the mass spectra and the chromatograms.

Prior to selecting the data for validation, the project objectives should be reviewed to ensure that any samples critical to the decision process can be identified and given priority, if necessary. The results of the data validation shall be conveyed to the data user(s) in the Data Usability Summary as described in Element D.2.3.1 below.

D.2.2 Resolution Procedures and Responsible Individuals

During the data review process, situations may be encountered that warrant corrective action. Corrective actions may involve an increased level of data review, reanalysis or resampling.

D.2.2.1 Additional Data Review

Additional data review may include a review of some or all of the laboratory performance criteria for 100% of the data packages for a given phase of the project, or at the discretion of the TCEQ, if a review of the required reportable data indicates the need for more in-depth data review. The data review performed by the analytical laboratory includes a thorough review of laboratory performance criteria (which are independent of the field samples being analyzed). Any laboratory performance criteria results not meeting QC acceptance criteria are documented by the laboratory in the Laboratory Review Checklist and associated ERs. Examples of problems identified during review that could trigger additional review of the laboratory performance criteria include:

- Items identified as being outside QC acceptance criteria by the person reviewing the data during independent review of the data that were not identified by the laboratory in the Laboratory Review Checklist and associated ERs. Such a situation would suggest that the Laboratory Review Checklist may not be a reliable indicator of difficulties encountered during analysis that could potentially adversely affect data quality.
- Failure to meet acceptance criteria on performance evaluation samples or laboratory control samples. This would suggest that the given analyses may not be fully in the laboratory's control.
- Zero percent surrogate recoveries or matrix spike recoveries on organics analyses. This could be an indication that the peaks for the standards fell outside retention time windows, which might be discernable through evaluation of chromatograms. It could also be an indication of coeluting interferences (unresolved hump) obscuring proper identification of the peaks due to the standards.
- Failure to meet QC acceptance criteria on samples known to be relatively "clean", such as rinsate or field blanks.
- Inconsistent results, such as homogenized field duplicate sample results differing greatly, identification of contaminants at a site that do not make sense from site history and processes, or concentrations of analytes or identification of contaminants inconsistent with historic data from the same location/medium.
- Poor anion/cation balance calculation results for aqueous samples or situations where dissolved metal results exceed total metals results by more than what would be expected from normal analytical variability.

The data reviewer is responsible for communicating with the laboratory(s). The laboratory(s) will be contacted with regard to any missing or incorrect deliverables in the data packages noted during the review process. The data reviewer will document all subsequent submittals and resubmittals from the laboratory, recalculations, and data reviewer corrections. The data reviewer shall summarize the results of the data review and the impact on the quality and usability of the data in the Data Usability Summary as described in Element D.2.3.1.

D.2.2.2 Reanalysis

During the data review and usability evaluation, individual sample analysis results may have been rejected or identified as unusable. If such data include results considered crucial to meeting project objectives, it is likely that resampling or reanalyses shall be required. For example, if the Data Usability Summary identifies a data point as having too high a level of uncertainty to demonstrate compliance with an action level or LORP, and the data point is critical to making a decision, then an evaluation shall be conducted to determine whether reanalysis or resampling/ reanalysis is likely to improve the situation.

D.2.2.3 Procedures for Corrective Actions and Documenting Corrective Actions Taken

All corrective actions based on review and/or validation of the data shall be documented in the project files and shall include the resolution of each corrective action.

D.2.3 Method of Conveying Results of the Independent Review

D.2.3.1 Data Usability Summary (DUS)

The person reviewing and validating the data shall prepare a DUS that describes the results of the data review/validation effort and summarizes the usability of the data in meeting specific project objectives. The DUS shall discuss what QC measures were reviewed and validated, how these measures were reviewed or validated, the evaluation criteria used in the review/validation, all items identified as falling outside the evaluation criteria, the specific data potentially affected, and the potential effect on the quality of the associated data. Attachment 2 contains an example of a completed DUS. Figure 4-1 below provides a suggested Table of Contents for a DUS. A brief summary of the contents required for each section of the DUS is provided Element D.2.3.2 below.

D.2.3.2 Contents/Scope/Description of the DUS

- INTRODUCTION

This section of the Data Usability Summary provides a description of the data that were reviewed and, if applicable to the project, the data that were validated and identifies the project for which the review was performed and the contents of the DUS. This section shall include a table cross-referencing the laboratory identification number to field identification numbers and shall identify all field QC samples submitted blind to the laboratory. The QC sample descriptions shall include specification of samples associated with the given QC sample. For example, for a field duplicate the description shall indicate the sample for which the QC sample is a duplicate and the samples for which the duplicate agreement results are considered applicable. Another example would be that for a rinsate sample, the text shall describe the sample location at which the rinsate was taken, the sampling equipment over which the blank was collected, and the samples associated with the rinsate blank that were collected with the same type of sampling equipment.

- LABORATORY REVIEW CHECKLIST REVIEW CRITERIA

This section of the Data Usability Summary provides a concise summary of the criteria used to review the Laboratory Review Checklist. This section provides a description of the QC measures reviewed, how these measures were reviewed, and the evaluation criteria used to review items identified in the Laboratory Review Checklist that are not part of the reportable data. The portions of this section that are not project-specific may be taken directly from the text of Element D.2.1.2.1.

- FIELD DATA AND LABORATORY DATA PACKAGE REVIEW CRITERIA

This section contains a concise summary of the criteria used to review the field analytical results and the laboratory data package and a summary of criteria used to review the data. This section provides a description of the QC measures reviewed, how these measures were reviewed, and the evaluation criteria used to review the data reported in the laboratory data package. The portions of this section that are not project-specific may be taken directly from the text of Element D.2.1.2.1.

- DATA VALIDATION CRITERIA

This section of the Data Usability Summary provides a concise summary of the criteria used to validate the data. This section provides a description of the QC measures validated, how these measures were validated, and the evaluation criteria used in the data validation. These criteria may be specific to the project.

- DATA REVIEW/VALIDATION RESULTS

This section provides the results of the review conducted on both the laboratory data package and the Laboratory Review Checklist. This section shall also include the results of the data validation. This section shall indicate all items identified as falling outside the evaluation criteria described in the previous three sections, the specific data potentially affected, and the potential effect on the quality of these associated data. All professional judgement used in making decisions concerning qualification of data associated with QC measures outside acceptance criteria shall be included. It is acceptable for this section to contain descriptions only of those QC measures failing to meet acceptance criteria, as long as the text specifically indicates that all other QC measures specified for review in Element D.2.1 met acceptance criteria for data review.

This section of the DUS shall contain a description of the reason for qualification and the direction of potential bias or imprecision (if known). Data review procedures shall involve assignment of qualifier codes to each result qualified or rejected during data review. These qualifier codes shall reflect the reason for qualification as well as the potential direction of bias. For example, "MS–L" would mean the result was qualified for matrix spike recoveries outside of evaluation criteria resulting in a potential low bias in the reported value or sample quantitation limit. Qualifiers and qualifier codes to be used are described in more detail in Element D.1.1 above and listed in Tables D-2 and D-3, respectively. If additional user-defined codes are used, they shall be defined specifically in this section of the DUS.

- OVERALL ASSESSMENT OF THE DATA

An overall assessment of the data relative to the quantitative and qualitative data quality assurance parameters is provided in this section.

- DATA USABILITY RELATIVE TO PROJECT OBJECTIVES

A systematic planning process, such as USEPA's Data Quality Objectives Process, shall be used in designing the sampling and analysis plan for a given project. Specific project objectives, decisions that are anticipated to be required to meet the project objectives, and the criteria by which these decisions are anticipated to be made are defined in Section 3 of the FSP. This section of the DUS shall describe the effect of the uncertainty associated with results qualified as estimated which may affect the usability of the data in making a meaningful comparison to the project objectives, such as comparing results to an action level or LORP. For example, if a given result was 30% below an action level to which it is to be compared, but the data review indicated that the result had a potential low bias with an estimated magnitude of 60% (e.g. surrogate spike recovery = 40%), then the data point would not be sufficient to conclude confidently that the result was below the action level. If on the other hand the action level is 2 orders of magnitude higher than the reported result, the same data point would be considered sufficient to conclude confidently that the result was below the action level.

This section of the DUS shall also include requirements for comparison of sample quantitation limits to action levels or LORPs to evaluate whether or not results reported as non-detected have sufficient sensitivity to demonstrate absence of the analyte above the action level or LORP. Potential biases and imprecisions in sample quantitation limits for non-detected results qualified as estimated also shall be considered in comparisons to the action levels or LORPs.

The text shall include an evaluation of how representative the analytical results are of the medium being evaluated based on measures such as sampling design, replicate analyses, etc. It shall also include discussion on the sufficiency of the valid data set in meeting project objectives.

- POTENTIAL ADDITIONAL DATA USES AND LIMITATIONS

This is an optional section that shall describe the usability of the analytical data for additional end uses and in particular shall summarize the major limitations of the data. The example DUS provided in Attachment 2 contains text for risk assessment as a potential additional end use of the data for a circumstance in which the data were being collected to make decisions using criteria other than risk assessment, but it was reasonably foreseeable that the data might ultimately be used in a risk assessment.

- CORRECTIVE ACTIONS AND WORKPLAN DEVIATIONS

This section of the DUS shall describe deviations from the site-specific QAPP or project plan and Standard Operating Procedures and the potential effects of these deviations on the quality of the associated data and its usability in meeting the end use objectives. This section shall also describe all corrective actions that were implemented in response to a failure to meet QC criteria or deviations from this QAPP or project plan.

In particular, this section shall include a complete description of problems encountered during field sample collection; failures in following prescribed sampling, field analysis, and custody procedures; and an evaluation of the potential effect on the quality of the data or on how representative the samples collected are of the medium being characterized.

- REJECTED DATA AND PROJECT CONSEQUENCES

This section of the DUS shall contain a listing of all data that have been considered to be unusable in meeting the specific project objectives. It shall also provide a detailed discussion of whether any of the rejected or unusable data are considered critical to meeting project objectives and what the specific project consequences are of having these rejected or unusable data.

- CONCLUSIONS

This section of the DUS shall summarize the conclusions reached during review and evaluation of data usability.

- APPENDICES

The laboratory data packages, including the Laboratory Review Checklists and associated Exception Reports, shall be included as an appendix to the DUS. The test reports annotated with the final data review qualifiers and associated qualifier codes and bias codes shall also be included. Each reviewed test report shall be initialed and dated by the person who performed the review. The appendices shall also contain copies of the chain-of-custody forms, if these are not included as part of the laboratory data package.

At the discretion of TCEQ, the data packages may be provided as a separate submittal, but the appendices to the DUS shall at a minimum contain the annotated test reports, the Laboratory Review Checklists, the Exception Reports, the required reportable data, and the chain-of-custody forms.

FIGURE 4-1 - SUGGESTED TABLE OF CONTENTS FOR DUS

INTRODUCTION

LABORATORY REVIEW CHECKLIST REVIEW CRITERIA

FIELD DATA AND LABORATORY DATA PACKAGE REVIEW CRITERIA

DATA VALIDATION REVIEW CRITERIA

DATA REVIEW/VALIDATION RESULTS

Data package 1234

Data package 1235

Data package etc.

OVERALL ASSESSMENT OF THE DATA

DATA USABILITY RELATIVE TO PROJECT OBJECTIVES

Sample quantitation limits and Decision Criteria Comparison

Effects of Potential Biases and Imprecision on Usability of the Data

Representativeness Evaluation

POTENTIAL ADDITIONAL DATA USES AND LIMITATIONS

CORRECTIVE ACTIONS AND WORKPLAN DEVIATIONS

Corrective Actions

Deviations from the Site-Specific QAPP or Project Plan

REJECTED DATA AND PROJECT CONSEQUENCES

CONCLUSIONS

APPENDIX A - CERTIFICATES OF ANALYSIS AND SUMMARY FORMS

A.1 Data Reports for Data Package 1234

A.2 Data Reports for Data Package 1235

A.3 Data Reports for Data Package etc.

APPENDIX B – CHAIN-OF-CUSTODY FORMS

APPENDIX C - LABORATORY REVIEW CHECKLISTS AND EXCEPTION REPORTS

D.3 Reconciliation with User Requirements

A systematic planning process, such as USEPA's Data Quality Objectives Process, shall be used in designing the sampling and analysis plan for a given project. Specific project objectives, decisions that are anticipated to be required to meet those project objectives, and the criteria by which those decisions are anticipated to be made are specified in Section 3 of the FSP. The DUS shall describe the effect of the uncertainty associated with results qualified as estimated which may affect the usability of the data in making a meaningful comparison to the project objectives, such as comparing results to an action level or LORP. The DUS shall also include requirements for comparison of sample quantitation limits to action levels or LORPs to evaluate whether or not results reported as non-detected have sufficient sensitivity to demonstrate absence of the analyte above the action level or LORP. Potential biases and imprecisions in sample quantitation limits for non-detected results qualified as estimated also shall be considered in comparisons to the action levels or LORPs. The text shall include an evaluation of how representative the analytical results are of the medium being evaluated based on measures such as sampling design, replicate analyses, etc. It shall also include discussion on the sufficiency of the valid data set in meeting project objectives.

The DUS shall describe deviations from the site-specific FSP or QAPP and Standard Operating Procedures, and the potential effects of these deviations on the quality of the associated data and its usability in meeting the end use objectives. The DUS shall also describe all corrective actions that were implemented in response to a failure to meet QC criteria or deviations from the site-specific QAPP or project plan and Standard Operating Procedures.

In particular, the DUS shall also include a complete description of problems encountered during field sample collection; failures in following prescribed sampling, field analysis, and custody procedures; and an evaluation of the potential effect on the quality of the data or on how representative the samples collected are of the medium being characterized.

The DUS shall also contain a listing of all data that have been rejected during data review or that have been considered to be unusable in meeting specific project objectives. It shall also provide a detailed discussion of whether any of the rejected or unusable data are considered critical to meeting project objectives and what the specific project consequences are of having these rejected or unusable data.

D.3.1 TCEQ Project Manager's Responsibilities

The TCEQ Project Manager's responsibilities, with respect to laboratory data review and usability evaluation, are described below. A checklist listing these responsibilities is provided in Attachment 3.

D.3.1.1 Review and Interpretation of the Laboratory Review Checklist (LRC)

Review and interpretation of the LRC is performed by the person reviewing the data and reported in the DUS. The TCEQ Project Manager or designee shall perform a spot check of selected Laboratory Review Checklists to provide assurance that the items contained therein are in agreement with the reportable data included in the laboratory data package and adequately addressed in the DUS.

D.3.1.2 Review and Interpretation of the DUS

The TCEQ Project Manager or designee shall perform a spot check of the DUS. At a minimum, this spot check shall include the following items:

- The TCEQ Project Manager or designee shall review the completeness of the DUS against the criteria contained in the TCEQ Project Manager's Review Checklist in Attachment 3.

- The TCEQ Project Manager or designee shall spot check the performance of the person reviewing the data by reviewing some of the required reportable data to assure that the data were appropriately treated in the DUS.

- The TCEQ Project Manager or designee shall spot check the data usability evaluation performed by the person reviewing the data to assure that the usability evaluation relative to action levels or LORPs has been performed appropriately. Particular care shall be taken to evaluate the appropriateness of the data usability evaluation relative to project end use objectives to assure that the end use objectives (action levels, LORPs, etc.) are appropriate to the project, that the evaluation of the magnitude of uncertainty is consistent with the QC measure results, and that items identified in the Laboratory Review Checklist are appropriately addressed in the DUS.

- The TCEQ Project Manager or designee shall assure him/herself that the person has completed all aspects of the data review/data usability evaluation required by this Element D.

- The TCEQ Project Manager or designee shall assure him/herself that all data that were either rejected or considered unusable for meeting project objectives are either: 1) not crucial to meeting project objectives, or 2) the need for resampling or reanalysis has been identified and provisions proposed to fill the data gaps in a manner that will meet project objectives.

D.3.2 TCEQ QA Specialist Responsibilities

The TCEQ QA Specialist shall serve primarily as a consultant/interface among the various involved parties, such as the TCEQ Project Manager, the Potentially Responsible Parties (PRPs) and/or their representatives, TCEQ or PRP consultants, or laboratories. The QA specialist responsibilities are generally limited to complex, technical QA issues, and the QA Specialist is not anticipated to be involved in routine matters. At the request of the TCEQ Project Manager, the QA Specialist will also provide a second level of review for the DUS and, if warranted, could provide additional data review services. If a given laboratory is being used on multiple projects through differing consultants, the QA Specialist may also evaluate whether the laboratory appears to be experiencing systematic difficulties in meeting some QC acceptance criteria for laboratory performance criteria that might warrant review of laboratory performance criteria from other projects using the same laboratory.

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Attachment 1

Laboratory Review Checklist

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LABORATORY DATA PACKAGE SIGNATURE PAGE

This data package consists of:

- ☐ This signature page, the laboratory review checklist, and the following reportable data:
- ☐ R1 Field chain-of-custody documentation;
- ☐ R2 Sample identification cross-reference;
- ☐ R3 Test Reports (analytical data sheets) for each environmental sample that include:
  a) items consistent with NELAC 5.13 or ISO/IEC 17025 Section 5.10,
  b) dilution factors,
  c) preparation methods,
  d) cleanup methods, and
  e) if required for the project, tentatively identified compounds (TICs).
- ☐ R4 Surrogate recovery data including:
  a) calculated percent recovery (%R), and
  b) the laboratory's surrogate QC limits.
- ☐ R5 Test reports/summary forms for blank samples;
- ☐ R6 Test reports/summary forms for laboratory control sample (LCSs) including:
  a) LCS spiking amounts,
  b) calculated %R for each analyte, and
  c) the laboratory's LCS QC limits.
- ☐ R7 Test reports for matrix spike/matrix spike duplicates (MS/MSDs) including:
  a) samples associated with the MS/MSD clearly identified,
  b) MS/MSD spiking amounts,
  c) concentration of each MS/MSD analyte measured in the parent and spiked samples,
  d) calculated %Rs and relative percent differences (RPDs), and
  e) the laboratory's MS/MSD QC limits.
- ☐ R8 Laboratory analytical duplicate (if applicable) recovery and precision including:
  a) the amount of analyte measured in the duplicate,
  b) the calculated RPD, and
  c) the laboratory's QC limits for analytical duplicates.
- ☐ R9 List of method quantitation limits (MQLs) for each analyte for each method and matrix;
- ☐ R10 Other problems or anomalies.
- ☐ An exception report for every "No" or "Not Reviewed (NR)" item in the laboratory review checklist.

Release Statement: I am responsible for the release of this laboratory data package. This data package has been reviewed by the laboratory and is complete and technically compliant with the requirements of the methods used, except where noted by the laboratory in the attached exception reports. By my signature below, I affirm to the best of my knowledge that all problems/anomalies observed by the laboratory as having the potential to affect the quality of the data have been identified by the laboratory in the Laboratory Review Checklist, and no information or data have been knowingly withheld that would affect the quality of the data.

Name (printed)	Signature	Official Title (printed)	Date

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LABORATORY REVIEW CHECKLIST: REPORTABLE DATA

Laboratory Name:	Report Date:
Project Name:	Laboratory Job Number:
Reviewer Name:	Batch Number(s):

#[1]	Analysis[2]	Description	Yes	No	NA[3]	NR[4]	ER#[5]
R1	OI	**CHAIN-OF-CUSTODY (C-O-C)**					
		1) Did samples meet the laboratory's standard conditions of sample acceptability upon receipt?					
		2) Were all departures from standard conditions described in an Exception Report?					
R2	OI	**SAMPLE AND QUALITY CONTROL (QC) IDENTIFICATION**					
		1) Are all field sample ID numbers cross-referenced to the laboratory ID numbers?					
		2) Are all laboratory ID numbers cross-referenced to the corresponding QC data?					
R3	OI	**TEST REPORTS**					
		1) Were all samples prepared and analyzed within holding times?					
		2) Other than those results < MQL, were all other results bracketed by calibration standards?					
		3) Were calculations checked by a peer or supervisor?					
		4) Were all analyte identifications checked by a peer or supervisor?					
		5) Were sample quantitation limits reported for all analytes not detected?					
		6) Were all results for soil and sediment samples reported on a dry weight basis?					
		7) Were % moisture (or solids) reported for all soil and sediment samples?					
		8) If required for the project, were tentatively identified compounds (TICs) reported?					
R4	O	**SURROGATE RECOVERY DATA**					
		1) Were surrogates added prior to extraction?					
		2) Were surrogate percent recoveries in all samples within the laboratory QC limits?					
R5	OI	**TEST REPORTS/SUMMARY FORMS FOR FOR BLANK SAMPLES**					
		1) Were appropriate type(s) of blanks analyzed?					
		2) Were blanks analyzed at the appropriate frequency?					
		3) Were method blanks taken through the entire analytical process, including preparation and, if applicable, cleanup procedures?					
		4) Were blank concentrations < MQL?					
R6	OI	**LABORATORY CONTROL SAMPLES (LCSs)**					
		1) Were all COCs included in the LCS?					
		2) Was each LCS taken through the entire analytical procedure, including prep and cleanup steps?					
		3) Were LCSs analyzed at the required frequency?					
		4) Were LCS (and LCSD, if applicable) %Rs within the laboratory QC limits?					
		5) Does the detectability data document the laboratory's capability to detect the COCs at the MDL used to calculate the SQLs?					
		6) Was the LCSD RPD within QC limits?					
R7	OI	**MATRIX SPIKE (MS) and MATRIX SPIKE DUPLICATE (MSD) DATA**					
		1) Were the project/method specified analytes included in the MS and MSD?					
		2) Were MS/MSD analyzed at the appropriate frequency?					
		3) Were MS (and MSD, if applicable) %Rs within the laboratory QC limits?					
		4) Were MS/MSD RPDs within laboratory QC limits?					
R8	OI	**ANALYTICAL DUPLICATE DATA**					
		1) Were appropriate analytical duplicates analyzed for each matrix?					
		2) Were analytical duplicates analyzed at the appropriate frequency?					
		3) Were RPDs or relative standard deviations within the laboratory QC limits?					
R9	OI	**METHOD QUANTITATION LIMITS (MQLs)**					
		1) Are the MQLs for each method analyte included in the laboratory data package?					
		2) Do the MQLs correspond to the concentration of the lowest non-zero calibration standard?					
		3) Are unadjusted MQLs included in the laboratory data package?					
R10	OI	**OTHER PROBLEMS/ANOMALIES**					
		1) Are all known problems/anomalies/special conditions noted in this LRC and ER?					
		2) Were all necessary corrective actions performed for the reported data?					
		3) Was applicable and available technology used to lower the SQL to minimize the matrix interference effects on the sample results?					

LABORATORY REVIEW CHECKLIST (continued): SUPPORTING DATA

Laboratory Name:	Report Date:
Project Name:	Laboratory Job Number:
Reviewer Name:	Batch Number(s):

#[1]	Analysis[2]	Description	Yes	No	NA[3]	NR[4]	ER #[5]
S1	OI	**INITIAL CALIBRATION (ICAL)** 1) Were response factors (RFs) and/or relative response factors (RRFs) for each analyte within the QC limits? 2) Were percent RSDs or correlation coefficient criteria met? 3) Were the number of standards recommended in the method used for all analytes? 4) Were all points generated between the lowest and highest standard used to calculate the curve? 5) Are ICAL data available for all instruments used? 6) Has the calibration curve been verified using an appropriate second source standard?					
S2	OI	**INITIAL AND CONTINUING CALIBRATION VERIFICATION (ICV AND CCV)** 1) Was the CCV analyzed at the method-required frequency? 2) Were percent differences for each analyte within the method-required QC limits? 3) Was the ICAL curve verified for each analyte? 4) Was the absolute value of the analyte concentration in the inorganic CCB < MDL?					
S3	O	**MASS SPECTRAL TUNING** 1) Was the appropriate compound for the method used for tuning? 2) Were ion abundance data within the method-required QC limits?					
S4	O	**INTERNAL STANDARDS (IS)** Were IS area counts and retention times within the method-required QC limits?					
S5	OI	**RAW DATA** (NELAC Section 1 Appendix A Glossary, and Section 5.12) 1) Were the raw data (for example, chromatograms, spectral data) reviewed by an analyst? 2) Were data associated with manual integrations flagged on the raw data?					
S6	O	**DUAL COLUMN CONFIRMATION** Did dual column confirmation results meet the method-required QC?					
S7	O	**TENTATIVELY IDENTIFIED COMPOUNDS (TICs)** If TICs were requested, were the mass spectra and TIC data subject to appropriate checks?					
S8	I	**INTERFERENCE CHECK SAMPLE (ICS) RESULTS** Were percent recoveries within method QC limits?					
S9	I	**SERIAL DILUTIONS, POST DIGESTION SPIKES, AND METHOD OF STANDARD ADDITIONS** Were percent differences, recoveries, and the linearity within the QC limits specified in the method?					
S10	OI	**METHOD DETECTION LIMIT (MDL) STUDIES** 1) Was a MDL study performed for each reported analyte? 2) Is the MDL either adjusted or supported by the analysis of detectability check standards?					
S11	OI	**PROFICIENCY TEST REPORTS** Was the laboratory's performance acceptable on the applicable proficiency tests or performance evaluation studies?					
S12	OI	**STANDARDS DOCUMENTATION** Are all standards used in the analyses NIST-traceable or obtained from other appropriate sources?					
S13	OI	**COMPOUND/ANALYTE IDENTIFICATION PROCEDURES** Are the procedures for compound/analyte identification documented?					
S14	OI	**DEMONSTRATION OF ANALYST COMPETENCY (DOC)** 1) Was DOC conducted consistent with NELAC 5C or ISO/IEC 4? 2) Is documentation of the analyst's competency up-to-date and on file?					
S15	OI	**VERIFICATION/VALIDATION DOCUMENTATION FOR METHODS** Are all methods used to generate the data documented, verified and validated, where applicable? (NELAC Chap 5 or ISO/IEC 17025 Section 5)					
S16	OI	**LABORATORY STANDARD OPERATING PROCEDURES (SOPs)** Are laboratory SOPs current and on file for each method performed?					

1 Items identified by the letter "R" should be included in the laboratory data package submitted to the TCEQ. Items identified by the letter "S" should be retained and made available to the TCEQ upon request.
2 O = organic analyses; I = inorganic analyses (and general chemistry, when applicable).
3 NA = Not applicable.
4 NR = Not reviewed.
5 ER# = Exception Report identification number (an Exception Report should be completed for an item if "NR" or "No" is checked).

LAB REVIEW CHECKLIST (continued): EXCEPTION REPORTS	
Laboratory Name:	Report Date:
Project Name:	Laboratory Job Number:
Reviewer Name:	Batch Number(s):

ER #[1]	DESCRIPTION

1 ER# = Exception Report identification number (an Exception Report should be completed for an item if "NR" or "No" is checked on the LRC)

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Attachment 2

Example of a Data Usability Summary

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APPENDIX A - DATA REPORTING FORMS
A.1 Data Reporting Forms SDG 0024

APPENDIX B - CHAIN-OF-CUSTODY FORMS
APPENDIX C - LABORATORY REVIEW CHECKLISTS

1. INTRODUCTION

This report contains the results of the data validation conducted for the confirmation samples collected and analyzed as part of the site investigation at the ZYX foundry site. Six soil samples and one rinsate blank sample were analyzed by High Quality Lab, Inc. (the site) in accordance with the approved Superfund Program QAPP and the analytical methods specified for the analytes requested on the chain-of-custody (C-O-C) documentation. The analytes requested for soil samples and one water sample include the following 11 metals: arsenic, barium, cadmium, cobalt, copper, lead, manganese, selenium, silver, zinc, and molybdenum.

Table 1-1: Sample Field and Laboratory ID numbers

Field ID	Lab ID	Medium	Sample Type	Sample Station	Purpose
0353	S173615	Soil	Composite	11	Composite sample collected from approximately the same locations as the original sample 0053.
0354	S173616	Soil	Composite	11	Field Duplicate of 0353.
0355	S173617	Soil	Composite	11	Composite sample collected from six new randomly selected subsample locations.
0356	W173621	Water	Grab	11	Rinse Blank
0357	S173618	Soil	Composite	11	Composite sample collected from six new randomly selected subsample locations.
0358	S173619	Soil	Composite	11	Field Duplicate of 0357.
0359 0359D	S173620 S174069	Soil	Composite	37	Archived sample from initial Investigation sample collection, split of 0093. Analyzed in duplicate.

The data were generated and reviewed in accordance with the Superfund Program QAPP. The analytical results were reported in laboratory data package 0024. The data were evaluated against the quantitative acceptance limits given in the Superfund Program QAPP for the data quality assurance parameters of sensitivity, accuracy, precision, and completeness. The data were also evaluated for fulfillment of the qualitative data quality assurance parameters of representativeness and comparability as defined in the Superfund Program QAPP.

In accordance with the Superfund Program QAPP, a review of all data was conducted independent of the laboratory. The review consisted of an evaluation of laboratory performance criteria from the Laboratory Review Checklist (LRC), an evaluation of sample-specific criteria included in the laboratory data package in accordance with the Superfund Program QAPP, and validation of calculations and data transcription using guidance from the February 1994 USEPA National Functional Guidelines for Inorganic Data Review (Functional Guidelines). If the Functional Guidelines were not considered appropriate, professional judgement was used to evaluate the effect of the reported item or condition on the associated analytical data. All uses of projessional judgement are described in this summary. The independent data review included three levels of data review conducted on laboratory data package 0024. These three levels of review are summarized below.

The first level of review consisted of an evaluation of the laboratory performance criteria based on review of the Laboratory Review Checklist (LRC) and associated Exception Reports. The laboratory performance parameters evaluated include: initial calibration procedures and results, continuing calibration procedures and results, interference check sample (ICS) analysis, post digestion spike recoveries, ICP serial dilution, and other items identified as "Supporting Data" in the LRC.

The second level of review consisted of an evaluation of the sample-specific criteria included in the laboratory data package and an evaluation of the field data being used to make project decisions, such as ferrous iron concentrations in determinations/demonstrations of natural attenuation. For these samples, no field measurements were taken to be used for comparison to project decision criteria. The sample specific evaluation parameters include: holding times, blank contamination, laboratory control sample analysis, laboratory duplicate sample analysis, matrix spike sample analysis, and field duplicate result agreement. No field data were collected for use in decision making for this project.

The third level of review consisted of validation back to the raw data for evaluation of laboratory performance related to calculations, data transcription, chromatographic and spectrometric performance. The results were reported as one batch of data; therefore, 100% of the data were validated.

These three types of review procedures are described further in Sections 2.0, 3.0, and 4.0 of this Data Useability Summary report, respectively. The results of the data review and validation are presented in Sections 5.0 and 6.0, respectively.. An overall assessment of the data relative to the quantitative and qualitative data quality assurance parameters is provided in Section 7.0. Section 8.0 presents an evaluation of the quality and usability of the data with respect to making project decisions and is the written record of the reconciliation of the analytical data with the end use of the data and project objectives specified in the Superfund Program QAPP. Section 8.0 also contains specific discussions on the quality and usability of the analytical data for making specific project decisions.

Following the specifications in the Superfund Program QAPP related to the data validation process, the data reviewer annotated validation qualifiers ("U", "J", "UJ" and "R") and associated qualifier and bias codes on the analytical data sheets. Table 1-2 provides definitions of the data qualifiers issued, and Table 1-3 lists and defines the data qualifier and bias codes. The purpose of the qualifier codes is to provide information with regard to the data quality condition(s) that resulted in the assigned qualification. The bias code provides an indication of the direction of the bias in the results qualified as estimated, based on the data quality condition(s) that resulted in the data qualification and the results of the other associated quality control analyses. A hyphen and then the applicable bias code follow the data qualifier codes. For example, a result qualified as estimated due to a holding time exceedance, which resulted in a potential low bias in the result, has the following code annotated on the data sheet, "J-HT-L". In the case of multiple data quality conditions resulting in qualification, each qualifier code is listed and separated by a comma. For example, a result qualified as estimated due to low matrix

spike recovery and poor field duplicate precision would have the following codes annotated on the data sheet, "J-MS,FD-L". Where discernible from the data, an estimate of the magnitude of the potential bias is included prior to the bias code. For example, an inorganic result qualified as estimated based on a matrix spike recovery of 20% would be annotated on the data sheet as "J-MS-80%L".

Table 1-2 Data Validation Qualifier Definitions

QUALIFIER	DEFINITIONS
U	The analyte was analyzed for, but was not detected above the level of the associated value. The associate value is either the sample quantitation limit or the sample detection limit.
J	The associated value is an estimated quantity.
UJ	The material was analyzed for, but was not detected. The associated value is an estimate and may be inaccurate or imprecise.
R	The data are unusable. (Note: Analyte may or may not be present.)

[1] Definitions cited from the USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review, February 1994.

Table 1-3 Data Validation Qualifier Codes

QUALIFIER CODE	DATA QUALITY CONDITION RESULTING IN ASSIGNED QUALIFICATION
general use	
HT	Holding time requirement was not met
MB	Method blank or preparation blank contamination
LCS	Laboratory control sample evaluation criteria not met
FB	Field blank contamination
RB	Rinsate blank contamination
FD	Field duplicate evaluation criteria not met
SQL	Sample quantitation limit exceeds decision criteria (for nondetects)
P	Preservation requirements not met
inorganic methods	
ICV	Initial calibration verification evaluation criteria not met
CCV	Continuing calibration verification evaluation criteria not met
PB	Preparation blank contamination
CCB	Continuing calibration blank contamination
ICS	Interference check sample evaluation criteria not met
D	Laboratory duplicate precision evaluation criteria not met
MS	Matrix spike recovery outside acceptance range
PDS	Post-digestion spike recovery outside acceptance range
MSA	Method of standard additions correlation coefficient < 0.995
DL	Serial dilution results did not met evaluation criteria
organic methods	
TUNE	Instrument performance (tuning) criteria not met
P	The detected concentration difference between the primary and secondary column is greater than 25%.
ICAL	Initial calibration evaluation criteria not met
CCAL	Continuing calibration evaluation criteria not met
SUR	Surrogate recovery outside acceptance range
MS/MSD	Matrix spike/matrix spike duplicate accuracy and/or precision criteria not met
IS	Internal standard evaluation criteria not met
ID	Target compound identification criteria not met
BIAS CODES	**BIAS DIRECTION**
H	Bias in sample result likely to be high
L	Bias in sample result likely to be low
I	Bias in sample result is indeterminate

2. LABORATORY REVIEW CHECKLIST REVIEW CRITERIA

The data review by the analytical laboratory included a thorough review of the laboratory and sample-specific performance criteria. Any results not meeting the QC acceptance criteria were documented by the laboratory in the Laboratory Review Checklist and associated Exception Reports. The laboratory performance criteria evaluated from the LRC include: initial calibration procedures and results, continuing calibration procedures and results, ICP interference check sample, and other items identified in the LRC as potentially affecting the data. The sample-specific criteria reviewed from the LRC include: ICP serial dilution and post digestion spike recoveries. The subsections below discuss how each of the parameters was evaluated, as specified in the Superfund Program QAPP. If an Exception Report described a criterion not covered by the subsections below, the data were evaluated and qualified using guidance from the Functional Guidelines as applicable to the analytical method.

2.1 Initial Calibration

The Superfund Program QAPP contains the QC acceptance criteria for initial calibration for analytical methods required for the project. If the LRC indicated that the initial calibration for any analyte did not meet the acceptance criteria, then the Exception Report was evaluated and all results for that given analyte associated with the initial calibration were qualified as estimated ("J/UJ") with a qualifier code of "ICAL" and a bias code of "I" for indeterminate direction of bias.

2.2 Initial and/or Continuing Calibration Verification

The Superfund Program QAPP contains the QC acceptance criteria for initial and continuing calibration verification for analytical methods used in the project. If the LRC indicates that the initial or continuing calibration verification for any analyte did not meet the acceptance criteria, then all results for that given analyte associated with the initial or continuing calibration verification were qualified as estimated ("J/UJ") with a qualifier code of "ICV" or "CCV" for inorganics and "CCAL" for organics. If the data reviewer could discern a probable magnitude and/or direction of bias to the associated sample results, based on the information provided in the Exception Report, then appropriate qualifier bias codes were assigned.

2.3 ICP Interference Check Sample (ICS)

For analytes present in the ICS sample, the percent recoveries were compared to the acceptance range of 80-120%. For analytes not present in the ICS sample, the absolute value of the result was compared to the acceptance criterion of less than the method quantitation limit for the analyte.

The sample results were reviewed in order to determine if any samples contained interferent concentrations on the order of the concentrations in the ICS samples (A and AB). For samples containing one or more interferent elements at a concentration greater than or equal to the

concentration in the ICS, potential effects on the data were evaluated in accordance with the Functional Guidelines as follows:

- If the ICS recovery of an element was >120% and the sample results were non-detectable, the data were considered to be acceptable for use without qualification.
- If the ICS recovery of an element was >120% and the sample results were detectable, associated data were qualified as estimated ("J").
- If the ICS recovery for an element was between 50% and 79% and the sample results were detectable, associated data were qualified as estimated ("J").
- If the ICS recovery for an element was between 50% and 79% and the sample results were non-detectable, associated data were qualified as estimated ("UJ").
- If the ICS recovery for an element was <50%, the associated sample data were considered to be unusable ("R").
- If a negative concentration of an element not present in the ICS A or ICS AB was reported at a concentration where the absolute value was greater than the MQL, associated analytical results were qualified as estimated ("J" or "UJ") if the potential low bias was more than 25% of the reported result and the interferent concentrations were comparable to or greater than those in the ICS.

2.4 ICP Serial Dilution

An ICP serial dilution was run on one sample in the data package to evaluate whether or not significant physical or chemical interferences existed due to sample matrix. When analyte concentrations were sufficiently high (the concentration in the original sample was minimally a factor of 50 above the IDL), the results obtained for a five fold-dilution of the original sample were compared to the original results by means of a percent difference. The percent difference was compared to the precision acceptance limit of ±10% in the Superfund Program QAPP. If the percent difference between the diluted and original result was greater than 10%, all associated results for that analyte in the laboratory data package were qualified as estimated ("J/UJ") in accordance with Functional Guidelines guidance.

2.5 Post Digestion Spike Analysis

The analyte recoveries obtained for post-digestion spike analyses were compared to the acceptance range for accuracy contained in the Superfund Program QAPP (i.e., 70-130%). If the result for the sample on which the post-digestion spike analysis was performed was not obtained by the Method of Standard Additions and the post-digestion spike recovery is outside of the acceptance limits, the results were qualified for the sample on which the post-digestion spike was run based on the following guidance:

- If the recovery is >130%, detectable results were qualified as estimated ("J"). No action needs to be taken for non-detects.

- If the recovery is <70% but greater than or equal to 30%, detectable and non-detected results were qualified as estimated ("J/UJ").

- If the recovery is <30%, detectable results were qualified as estimated ("J") and non-detected results were rejected.

2.6 Other Items Identified in the LRC Narrative

Other items for which the laboratory may provide an Exception Report related to data not contained in the laboratory data package may include: tuning, system performance evaluation mixture analysis, internal standard area counts, Method of Standard Additions, and method or SOP deviations. If an Exception Report describes a laboratory performance criterion not covered by the Superfund Program QAPP, the data should be evaluated and qualified using guidance from the Functional Guidelines as applicable to the analytical method or professional judgement should be used.

3. FIELD DATA AND LABORATORY DATA PACKAGE REVIEW CRITERIA

The sample specific criteria evaluated for the data package summary forms include: holding times, blank contamination, LCS analysis, matrix spike sample analysis, duplicate sample analysis, and field duplicate result agreement. The subsections below discuss how each of these sample specific parameters was evaluated. No field analytical data were collected during this phase of the project; all analytical data were generated by an off-site or fixed laboratory. Therefore, no field data review criteria are specified in this data useability summary.

3.1 Holding Times

Holding times were calculated by computing the difference between the sample collection date found on the chain-of-custody form and the sample analysis date found on sample test reports (i.e., sample analytical data sheets). The holding times were compared to the holding time requirements contained in the Superfund Program QAPP. Results for analyses not performed within holding time limits were qualified as estimated ("J/UJ").

3.2 Blanks

The results for rinsate blanks, preparation blanks, and calibration blanks were reviewed. Positive rinsate and calibration blank results were converted to equivalent concentrations in the soil samples and then compared to the results obtained for the soil samples. Sample results for analytes detected in an associated blank at concentrations less than five times the blank concentration were qualified as nondetect ("U"). Negative blank concentrations were evaluated for potential effects (low bias) on sample data when the absolute value of the negative concentration was greater than the analyte method quantitation limit. If the negative

concentration in a blank may have produced more than a 25% effect on a reported sample result, the associated sample result was qualified as estimated ("J/UJ"). Preparation blanks are associated with all samples prepared with that sample. If contamination was noted in a continuing calibration blank, the samples preceding and following that blank were evaluated for potential effects.

3.3 Laboratory Control Sample (LCS) Results

Aqueous LCS results were compared to the acceptance limits of 70-130% contained in QAPP Element D.1.1. Positive sample results associated with LCS recoveries outside the applicable acceptance limits, but >30%, were qualified as estimated ("J"); nondetect sample results associated with LCS recoveries lower than the lower limit, but >30%, were qualified as estimated ("UJ"); and nondetect sample results associated with LCS recoveries greater than the upper limit did not require qualification. Aqueous sample results associated with a LCS percent recovery <30% were considered to be unusable ("R") per Functional Guidelines guidance.

3.4 Matrix Spike Sample Analysis

The analyte recoveries obtained for matrix spike analyses were compared to the acceptance range of 70-130% specified in the Superfund Program QAPP for cases in which the native sample concentration was less than four times the spike concentration (as specified in the Functional Guidelines, when sample concentrations of an analyte are greater than four times the spiking concentration, the results are considered to be inappropriate for assessing accuracy).

Data associated with matrix spike recoveries outside the acceptance range were qualified as follows in accordance with Functional Guidelines. If the matrix spike recovery for an analyte was >130%, suggesting a potential high bias in reported results, all positive results for that analyte in the data package were qualified as estimated ("J") whereas nondetect results were considered to be acceptable for use without qualification. If the matrix spike recovery for an analyte was <70% but >30%, suggesting a potential low bias in reported results, positive and nondetect results for that analyte in all samples were qualified as estimated ("J" or "UJ"). If the matrix spike recovery for an analyte was <30%, positive sample results were qualified as estimated ("J") whereas nondetect results were qualified as unusable ("R").

3.5 Duplicate Sample Analysis

Results for the laboratory duplicate sample analyses were compared to the acceptance criteria in QAPP Element D.1.1. The Relative Percent Difference (RPD) criterion (≤30% for inorganics and ≤40% for organics) was applied for cases in which both the sample and duplicate results were greater than 5 times the method quantitation limit. Otherwise, the absolute difference between the samples was compared to 1 times the greater sample quantitation limit for aqueous samples and 2 times the greater sample quantitation limit for solid samples. If the duplicate results for an analyte did not satisfy the applicable evaluation criterion, results for that analyte in all associated samples were qualified as estimated ("J/UJ").

3.6 Field Duplicate Results

Results for field duplicate sample analyses were compared to the following concentration-dependent acceptance criteria. The Relative Percent Difference (RPD) criterion, ≤30% for aqueous samples and ≤50% for soil samples, was applied for cases in which both the sample and duplicate results were greater than 5 times the method quantitation limit. Otherwise, the absolute difference between the sample results was compared to 3.5 times the greater sample quantitation limit for soil samples (2 times for aqueous samples). If the field duplicate results for an analyte did not satisfy the applicable evaluation criterion, results for that analyte in all associated samples were qualified as estimated ("J/UJ").

4. VALIDATION REVIEW CRITERIA

As specified in the QAPP, validation of project data is performed on ten percent of the project data packages. Since the project consisted of only one batch of data, 100 percent of the data were validated in accordance with the QAPP. Data validation is implemented to provide a quality check on the laboratory system generating the data. The laboratory has a QA program in place that generally identifies and corrects problems associated with the generation of analytical data. All of the QC results which were reported on the laboratory test reports (or summary forms) as being outside of the acceptance criteria were checked against the laboratory review checklist to ensure problems were identified and reported. Ten percent of the data were checked for transcription errors and calculation errors. No data used for decision making on the project were generated in the field.

The following laboratory performance criteria (supporting data) were evaluated as part of the data validation:

- Initial calibrations
- Initial and continuing calibration verifications
- ICP interference check sample results
- Post digestion spike recoveries
- ICP serial dilution results

5. DATA REVIEW RESULTS

5.1 Laboratory Data Package Review

The samples reported in the data package 0024 and the QC designations are listed in the table below. All samples underwent analysis for metals by inductively coupled plasma emission (ICP) and graphite furnace atomic absorption (GFAA) spectroscopy.

Table 5-1: Sample and Associated QC Designations

Field ID	Lab ID	QC Designation
0353	S173615	Matrix Spike/Laboratory Duplicate
0354	S173616	Field Duplicate of 0353.
0355	S173617	
0356	W173621	Rinse Blank
0357	S173618	
0358	S173619	Field Duplicate of 0357.
0359 0359D	S173620 S174069	Analyzed in duplicate

5.1.1 Review of the Laboratory Review Checklist

Items identified in the Laboratory Review Checklist as outside of control limits for laboratory performance criteria were evaluated for data package 0024. The evaluation of the sample-specific QC items (reportable data) was conducted as summarized in Section 3.0 above.

With one exception, the samples were received in good condition. The sample bottle for 0359 was cracked upon receipt, but the sample was still contained and acceptable for use. A copy of the original C-O-C document and airbill receipt were present in data packages. Custody seals were not used. The data package included results for all analyses requested on the C-O-C.

5.1.2 Holding Times

With the exception of sample 0359 and its duplicate 0359D, all samples were prepared and analyzed within the aqueous holding time limits (180 days for metals by ICP and GFAA). Sample 0359 was the archived split sample of 0093 which was collected on 06/03/97. Since the samples were received at the laboratory on 06/27/98, the analyses were not conducted within the aqueous holding time limit. However, the Functional Guidelines states that it is left to the discretion of the data reviewer whether or not to apply water holding time criteria to soil samples due to the limited information concerning holding times for soil samples. The analytical results for samples 0359 and 0359D were not considered to necessitate qualification based on holding times, due to the stability and lack of volatility of the metals analyzed.

The rinsate blank sample, 0356 was acid preserved at the laboratory nine days after sample collection (the laboratory received the rinsate blank sample eight days after collection). As a conservative measure, all results for the rinsate blank sample have been qualified as estimated since the delay in preservation may have potentially affected sample results.

5.1.3 Blanks

Target analytes were reported as present in various preparation and calibration blanks for both aqueous and soil analytical runs. The discussion of blank results is divided by data blank type and sample matrix.

Aqueous Preparation Blank (PB) - No target analytes were reported as present in the aqueous preparation blank.

Soil Preparation Blank (PB) - Zinc was reported as present in the soil preparation blank at a concentration of 0.645 mg/kg. All sample concentrations of zinc were greater than five times the concentration present in the preparation blank. As such, data qualification on the basis of the preparation blank was not necessary.

ICP Initial and Continuing Calibration Blanks (ICBs and CCBs) - The aqueous and soil samples were analyzed in the same ICP analytical run. Zinc was reported as present in CCB1 at a concentration of 2.8 ug/L (equivalent to a soil concentration of 0.56 mg/kg). Zinc concentrations in the associated samples were greater than five times the concentration in CCB1 and data qualification of zinc results was not necessary. Cobalt was reported as detected in CCB2 at the negative concentration of -10.3 ug/L (equivalent to a soil concentration of -2.06 mg/kg) suggesting a potential low bias in cobalt results. Cobalt concentrations for samples 0355, 0357, and 0358 were relatively low such that the amount of potential low bias in cobalt results suggested by the CCB2 result may have accounted for more than 25% of the reported sample results. Thus, the cobalt results for these three samples were qualified as estimated.

GFAA Calibration Blanks (ICBs and CCBs) - The aqueous and soil samples were analyzed in the same analytical runs. Lead was the only GFAA analyte reported as present in calibration blanks (arsenic, lead, selenium, and thallium were analyzed by GFAA). There were two analytical runs for the lead analyses. In the first run, lead was reported as present in CCB5 at a concentrations of –1.0 ug/L (equivalent to -0.2 mg/kg). The concentrations of lead reported for the two associated samples, 0359 and 0359D, were sufficiently greater than the amount of potential low bias in lead results suggested by the CCB5 result, which accounted for less than 25% of the reported sample results. In the second run, lead was reported as present in CCB2 at a concentrations of –1.1 ug/L (equivalent to -0.22 mg/kg). The concentration of lead reported for the associated sample 0354 was sufficiently great that the amount of potential low bias in the lead result suggested by the CCB2 would account for less than 25% of the reported sample result. Thus, data qualification of lead results on the basis of the calibration blanks was not necessary.

Rinsate Blank (RB) - Sample 0356 is the rinsate blank sample associated with the soil samples reported in data package 0024. It was collected by pouring deionized water (from Wal-Mart) over a decontaminated sampling trowel and collecting the water in a decontaminated stainless steel bowl used for homogenization. The water was then poured from the bowl into the sampling containers. Barium, lead, manganese, and zinc were detected in the rinsate blank at the respective concentrations of 12.4, 2.7, 10.9, and 20.7 ug/L. The soil sample results were evaluated for potential cross contamination effects. The reviewer calculated the barium, lead, manganese, and zinc concentrations for soil samples that could have resulted from potential cross

contamination if all of an analyte present in the rinsate sample aliquot analyzed were present in the soil sample aliquot analyzed. These calculations resulted in 1.24 mg/kg barium, 0.27 mg/kg of lead, 1.09 mg/kg of manganese, and 2.07 mg/kg of zinc. Concentrations of these analytes in all soil samples were greater than five times the estimated maximum possible contribution due to potential cross contamination. Therefore, qualification of soil data on the basis of the rinsate blank was not considered necessary.

5.1.4 Laboratory Control Sample (LCS)

Percent recoveries for all analytes for all LCS analyses were within the acceptance range of 70% to 130% indicating that satisfactory levels of accuracy for analyses on a clean matrix were achieved.

5.1.5 Matrix Spike Sample Analysis

An additional aliquot 0353 was used for the matrix spike sample analyses. The analyte percent recoveries were compared to the acceptance range of 70-130%. The recoveries for two analytes were outside the acceptance range resulting in data qualification. The recoveries of arsenic and selenium were 19.1% and 59.6%, respectively. Although a spike recovery of <30% would result in rejection of data, such a severe measure was not considered appropriate for the soil samples in this package. The arsenic post-digestion spike analysis for every soil sample indicated that the samples required analysis by the method of standard additions (MSA) which essentially generates an independent calibration for each sample to overcome matrix effects. However, the arsenic concentration in the matrix spike sample was not determined using MSA and therefore can not provide an adequate measure of the accuracy of the arsenic analysis on the sample matrix by MSA. For this reason, rejection of the arsenic data was not considered to be necessary; however, the arsenic data were qualified as estimated as a conservative measure. Selenium results for all samples were qualified as estimated ("J/UJ") to reflect the potential low bias in results suggested by the matrix spike recovery.

The sample concentrations of copper, lead, and manganese were greater than four times the spiking levels of these analytes such that the matrix spike results are considered to be an inappropriate measure of the accuracy of the sample analysis for these analytes on this particular sample matrix. Data qualification for these three analytes was not considered necessary based on a lack of matrix spike data.

5.1.6 Duplicate Sample Analysis

Additional aliquots of soil samples 0353 and 0359 were used for duplicate sample analyses.

With regard to the duplicate sample analysis on 0353, the duplicate results obtained for all analytes satisfied the applicable concentration-dependent evaluation criteria contained in QAPP Element D.2 and data qualification was not necessary.

With regard to sample 0359, the duplicate evaluation criteria were satisfied for all analytes except lead and selenium. The RPDs between the lead and selenium results were 40% and 50%,

respectively, exceeding the ≤35% criterion. Because the lead and selenium results for the duplicate analysis on sample 0353 were within acceptance limits, only the lead and selenium results for samples 0359 and 0359D were qualified as estimated based on the duplicate results for 0359/0359D.

5.2 Field Duplicate Result Agreement

Two field duplicate sample pairs were reported in this data package. Sample 0354 is the field duplicate of sample 0353 and sample 0358 is the field duplicate of sample 0357. The field duplicate results were evaluated using the criteria described in Section 3.6. Results for all analytes satisfied the applicable concentration-dependent evaluation criterion and data qualification was not necessary.

6. DATA VALIDATION RESULTS

The laboratory appears to have an adequate QA system in place that is designed to ensure the accurate reporting of analytical results generated by the laboratory. No transcription or calculation errors were found. All instances in which the analytical QC results fell outside the acceptance criteria were fully and correctly reported in the Laboratory Review Checklist.

The results for the initial calibration and initial and continuing calibration verification met the minimum QC acceptance criteria given in Tables B5.1.15-3 and B5.1.17-3 of the QAPP for metals analyses by ICP and GFAA, respectively. In addition, the laboratory performance criteria (supporting data) below were evaluated using the criteria as summarized in Section 2.0 above.

6.1 ICP Interference Check Sample (ICS)

The percent recoveries of all analytes present in the ICS AB were within the acceptance range of 80-120%. The percent recoveries for aluminum, calcium, iron and magnesium were within the acceptance range of 80-120% in both ICSA and ICSAB. However, results for a few analytes not present in the ICS A were reported with absolute values greater than the Instrument Detection Limit (IDL). These are shown in Table 5-2 below.

Table 5-2: Summary Results of Interference Check Sample

Analyte	IDL (ug/L)	ICS $A_{initial}$	ICS A_{final}
Barium	1.8	2	4
Cadmium	3.2		
Cobalt	9.9		
Copper	4.2	-14	-12
Manganese	2.9	3	
Silver	5.4	7	7
Zinc	2.7	5	4

Concentrations of interferent analytes were checked for all samples. None of the samples contained concentrations of the interferent analytes that approached the concentrations present in the ICS samples. Data qualification was therefore not considered to be necessary.

6.2 Post Digestion Spike Recoveries

Post-digestion spike (PDS) recoveries for some GFAA elements for some samples were outside the acceptance range of 70-130%. Some samples required quantitation by the method of standard additions (MSA).

Arsenic - MSA was used to determine arsenic concentrations for all soil samples. The correlation coefficients obtained were all >0.995 and data qualification was not necessary. The arsenic PDS for the rinsate sample was within the acceptance range.

Lead - MSA was used to determine the lead concentration for one soil sample and the correlation coefficient obtained was >0.995 such that data qualification was not necessary. PDS recoveries for the other six soil samples and the rinsate blank were within the acceptance range.

Selenium - MSA was required to quantitate selenium in all samples except the rinsate blank. In all cases, the correlation coefficient obtained was >0.995. The PDS recovery for the rinsate blank sample was within acceptance limits.

6.3 ICP Serial Dilution

A serial dilution analysis was performed on sample 0353. Only the concentrations of barium, copper, manganese, and zinc were sufficiently high such that the serial dilution evaluation criterion could be applied. For these four analytes, the %D between the original results and the serial dilution results were all within ± 10%, satisfying the evaluation criterion.

7. OVERALL ASSESSMENT

The data reported in 0024 are considered to be acceptable for use in meeting project objectives as qualified. An overall assessment of each of the data quality assurance objectives is provided below.

7.1 Accuracy

Accuracy is defined as the degree of agreement of a measurement to an accepted reference or true value. Accuracy was measured as the percent recovery (%R) of an analyte in a reference standard or spiked sample.

Percent recoveries for all calibration check samples and laboratory control samples were within their respective acceptance criteria. The results for 9 of the 11 matrix spikes results were within the acceptance range of 70-130%. The matrix spike recoveries for arsenic and selenium were low. These instances are detailed above.

Since all of the spike recoveries associated with laboratory performance criteria were within acceptance limits and most of the spike recoveries associated with spikes on field samples were within acceptance limits, the overall level of accuracy demonstrated by the analyses is considered to be acceptable.

7.2 Precision

Precision is defined as the agreement between a set of replicate measurements without assumption or knowledge of the true value. Precision of laboratory measurements was evaluated by the comparison of sample/sample duplicate results.

Twenty of 22 laboratory duplicate results satisfied the applicable evaluation criteria. Additionally, all of 22 field duplicate results satisfied the applicable evaluation criteria. As such, the overall level of precision demonstrated by the analyses is considered to be acceptable.

7.3 Completeness

No data were considered to be unusable for reconciliation with project objectives. As such, the analytical completeness, defined as the ratio of the number of valid analytical results (valid analytical results include values qualified as estimated) to the total number of analytical results requested on samples submitted for analysis, for the project is 100% which satisfies the Superfund Program QAPP goal of 90% for soils.

7.4 Representativeness

Representativeness is the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Representativeness was evaluated by comparing the results obtained for the field duplicate sample pairs. Representativeness was maintained during the sampling event by conducting sampling in accordance with the workplan (QAPP) and relevant SOPs. Results for all analytes satisfied the field duplicate evaluation criteria.

7.5 Comparability

Comparability expresses the confidence with which one data set can be compared to another. Comparability can be related to accuracy and precision because these quantities are measures of data reliability. Data are comparable if collection techniques, measurement procedures, method and reporting are equivalent for the samples within a sample set. As the samples in this set and the other soil samples collected under the Superfund Program QAPP were analyzed in accordance with the quality assurance and quality control measures prescribed in the Superfund Program QAPP; and acceptable levels of overall accuracy and precision were attained, the data within this set are considered to be comparable to each other and to the other soil samples collected under the Superfund Program QAPP.

7.6 Sensitivity

Sensitivity is evaluated in Section 8.1 below.

8. DATA USABILITY RELATIVE TO PROJECT OBJECTIVES

The usability of the sample data relative to the intended end uses is discussed in this section. To facilitate the discussion, the project objectives and associated decisions for which confirmation sampling data are to be used as a data source are discussed.

The confirmation sampling program was conducted following the Initial Site Investigation in order to evaluate whether the manganese concentrations measured for sampling station 11 and the lead concentration measured for sampling station 37 are representative of the soil concentrations at those two locations. The confirmation sampling event, conducted in May 1998, included collecting five soil samples and one rinsate blank sample in accordance with the sample collection procedures contained in the Superfund Program QAPP. Additionally, in order to evaluate the lead concentration measured for sampling station 37, an archived split sample of the original analysis was submitted to the laboratory for analysis in duplicate. The manganese confirmation soil samples were collected to meet the objective stated in the Superfund Program QAPP:

Objective A: The purpose of the potential manganese outlier resampling is to provide data to evaluate whether the manganese result (11,200 mg/kg) for the original soil sample at station 11 (sample number 0053) is an outlier.

The decision associated with this objectives can be stated as:

Decision 1: Based on the five additional sample results (three samples and two field duplicates) obtained from station 11, is the manganese result for the original sample (11,200 mg/kg) representative of the soil concentration at the property?

The criteria to be utilized in making this specific decision are:

Criteria:

1. The analytical results for the original sample and the three new samples will be evaluated to determine whether there is a significant difference between the original manganese result versus the three new manganese results.

2. In addition, the analytical results for the other investigation constituents will be evaluated to determine whether there are significant differences between the original sample results and those for the three new samples.

The archived split sample of 0093, sample 0359, was submitted to the laboratory for analysis in duplicate in order to satisfy the following objective.

Objective B: The purpose of the potential lead outlier resampling is to provide data to evaluate whether the lead result (1,270 mg/kg) for the original soil sample at station 37 (sample number 0093) is an outlier.

Decision 2: Based on the duplicate additional sample results obtained from station 37, is the lead result for the original sample (1,270 mg/kg) representative of the soil concentration at the locations sampled?

The criteria to be utilized in making this specific decision are:

Criteria:

1. The analytical results for the original sample and two new samples will be evaluated to determine whether there is a difference between the original lead results and the two new lead results.

2. In addition, the analytical results for the other investigation constituents will be evaluated to determine whether there is a difference between the original sample and the two new samples.

In order to evaluate the usability of the data for making project decisions, the data must be reconciled with the project objectives and decision criteria. Only data considered to be valid (i.e., the quality of the data is known) as determined through data validation, may be considered for reconciliation with the project objectives.

The reconciliation process begins with a comparison of the maximum sample quantitation limits obtained to the decision criteria. In general, for the data to be considered usable for making the project decisions, the sample quantitation limits obtained for each analyte must be less than or equal to the decision criteria. Nondetect results at sample quantitation limits which exceed decision criteria are not sufficient for making project decisions based on those criteria. Below in Section 8.1, the sample quantitation limits obtained are compared to the project decision criteria.

After evaluating the usability of the data with respect to sample quantitation limits obtained and project decision criteria, any potential biases and imprecision in results suggested by QC results must be assessed in order to evaluate the ultimate usability of the data for making decisions. Potential biases and imprecision in analytical results and data usability are discussed in Section 8.2.

Since multiple samples and two field duplicates samples were collected at location 11 and the archived sample from location 37 was analyzed in duplicate, there exist data which can be used to evaluate the representativeness of the samples to the medium sampled. The results of this evaluation are discussed on Section 8.3.

8.1 Sample Quantitation Limits and Decision Criteria Comparison

Sample quantitation limits (SQLs) represent the method detection limit for an analyte adjusted for sample size and dilutions. Table 8-1 below compares the maximum SQL reported for each analyte to the decision criteria specified in the QAPP.

Table 8-1: Sample Quantitation Limits and QAPP Decision Criteria Comparison

Analyte	Sample Quantitation Limit (mg/kg)	$^{Tot}Soil_{Comb}$ [1] (mg/kg)	$^{GW}Soil$ [2] (mg/kg)
Arsenic	0.14	24	25
Barium	0.36	2800	440
Cadmium	0.64	43	1.5
Cobalt	1.98	3400	1300
Copper	0.84	550	1000
Lead	0.16	500	3.0
Manganese	0.58	3700	1200
Molybdenum	3.0	160	49
Selenium	0.12	310	2.3
Silver	0.40	96	0.48
Zinc	0.54	9900	2400

1 Total-soil-combined Residential Tier 1 PCLs for a 0.5 acre source area - from Table 1 in the Texas Risk Reduction Program Rule, Tier 1 PCL Tables

2 Tier 1 Residential Soil-to-groundwater Tier 1 PCLs for a 0.5 acre source area - from Table 1 in the Texas Risk Reduction Program Rule, Tier 1 PCL Tables

All soil data are considered usable for meeting project objectives from the point of view of sample quantitation limits because the maximum sample quantitation limit reported for each analyte is below the QAPP specified decision criteria.

No data were reported as not detected at elevated sample quantitation limits based on qualification due to blank contamination or due to dilutions.

8.2 Effects of Potential Biases and Imprecision on Usability of the Data

After evaluating the usability of the data with respect to sample quantitation limits obtained and project decision criteria, any potential biases and imprecision in results suggested by QC results must be assessed in order to evaluate the ultimate usability of the data for making decisions. Potential biases and imprecision in analytical results are inferred from the results obtained for various types of quality control sample analyses. Potential bias and imprecisions can result from the analytical system or the specific sample matrix analyzed.

Quality control analyses that provide an indication of the potential bias and imprecision in the analytical system relative to the specific sample matrix include matrix spike analyses, post digestion spike analyses, laboratory duplicate analyses of field samples, and field duplicate analyses. Matrix spike samples are site-specific samples into which target analytes are spiked. As such, the percent recoveries obtained from the matrix spike analyses provide an indication of the potential biases of the analytical method on site-specific samples. Additionally, laboratory

duplicate results provide an indication of the precision of the analyses on site-specific samples.

Matrix spike and laboratory duplicate analyses were conducted on one of the new field samples (0353). The archived Sample 0359 was also analyzed in duplicate. Furthermore, two field duplicate samples were collected and analyzed to provide an indication of the overall sampling and analytical precision. Results obtained for other QC parameters, such as laboratory control sample recoveries, provide indications of biases existing in the analytical system.

While the results obtained for the vast majority of quality control analyses met the acceptance limits in Element D indicating that overall, acceptable levels of accuracy and precision were attained, results for a few quality control results were outside the acceptance limits. Quality control results that suggest a potential bias in the analytical results are discussed below along with their effect on the usability of the associated data.

Delay in Preservation For Rinsate Blank - The rinsate blank sample, 0356, was acid-preserved at the laboratory eight days after sample collection. As a conservative measure, all results for the rinsate blank sample were qualified as estimated. The delay in preservation may have resulted in analytical results that are potentially biased low. Any bias associated with the late preservation, is likely to be minimal for the analytes of concern. As such, the usability of the soil data was not considered to be affected because the concentrations of target analytes detected in the soil samples were significantly greater than the maximum amount of potential cross contamination inferred from the rinsate blank results.

Cobalt Accuracy - The cobalt results for samples 0355, 0357, and 0358 were qualified as estimated because the negative concentration of cobalt reported for an associated continuing calibration blank accounted for more that 25% of the reported sample results. The cobalt concentration reported for the calibration blank was -10.3 μg/L which is equivalent to a soil concentration of -2.06 mg/kg. The cobalt concentrations for these three samples are 7.8, 7.0, and 6.5 mg/kg, respectively. The pertinent cobalt decision criteria specified in the QAPP are 3,400 mg/kg for total-soil-combined and 1,300 mg/kg for soil-to-groundwater migration. If each sample was affected by the maximum potential low bias such that each value was greater by 2.06 mg/kg, the values would still be below the decision criteria. The question of usability of the cobalt results due the potential low bias for these three samples must be considered if the data user selects a soil-to-groundwater migration decision criterion less than approximately 8.7 mg/kg based on site specific considerations. Otherwise, the cobalt data are considered to be acceptable for use in comparing to decision criteria list in Table 8.1 above and making project decisions.

Lead Imprecision Relative to 0359 and 0359D - Samples 0359 and 0359D are laboratory duplicates. The parent sample was homogenized at the time of collection. The relative percent difference between the lead results was 40%, exceeding the evaluation criterion of ≤35%. The lead results for both samples were qualified as estimated to reflect the potential imprecision in the lead results suggested by the laboratory duplicate analysis.

The lead results for samples 0359 and 0359D were 129 mg/kg and 193 mg/kg, respectively. The pertinent decision criteria specified in the QAPP for lead are 500 mg/kg for total-soil-combined and 3.0 mg/kg for the soil-to-groundwater migration. Although the duplicate lead results suggest

that the lead results may be affected by a small degree of imprecision, both measured concentrations are less than half of the decision criterion of 400 mg/kg. As such, the potential imprecision in the lead results (40%) is not considered to affect the usability of the data for making project decisions based on the total-soil-combined pathway.

The lead results exceed the soil-to-groundwater migration pathway criterion of 3.0 mg/kg. However both measured concentrations exceed the decision criterion by greater than a factor of 2. Therefore, the potential imprecision in the lead results (40%) is not considered to affect the useability of the data for making project decisions.

Selenium Imprecision Relative to 0359 and 0359D - Samples 0359 and 0359D are laboratory duplicates. The parent samples was homogenized at the time of collection. The relative percent difference between the selenium results was 50%, exceeding the evaluation criterion of ≤35%. The selenium results for both samples were qualified as estimated to reflect the potential imprecision in the selenium results suggested by the laboratory duplicate analysis.

The selenium results for samples 0359 and 0359D were 2.0 mg/kg and 1.2 mg/kg, respectively. The pertinent decision criteria specified in the QAPP for selenium are 310 mg/kg for the total-soil-combined pathway and 2.3 mg/kg for the soil-to-groundwater migration pathway. Although the duplicate selenium results suggest some imprecision, both measured concentrations are less than the decision criterion for the total-soil-combined pathway by greater than a factor of 2. As such, the potential 50% imprecision in the selenium results is not considered to affect the usability of the data for making project decisions based on the total-soil-combined criterion.

Both measured concentrations are within a factor of 2 from the soil-to-groundwater pathway criterion indicating the likely real concentration could exceed the decision criteria. Therefore, the potential imprecision in the selenium results of 50% is great enough that the reported selenium results for samples 0359 and 0359D are not considered useable for making the decision that selenium concentrations are less than the soil-to-groundwater pathway criterion of 2.3 mg/kg.

Arsenic Accuracy - The arsenic matrix spike recovery associated with the confirmation samples was 19%, outside the evaluation range of 70-130%. Although a spike recovery of <30% would result in rejection of data, such a severe measure was not considered appropriate for the soil samples in this package. The arsenic post-digestion spike (PDS) analysis for every soil sample indicated that the samples required analysis by the method of standard additions (MSA) which essentially generates an independent calibration for each sample to overcome matrix effects. However, the arsenic concentration in the matrix spike sample was not determined using MSA and therefore can not provide an adequate measure of the accuracy of the arsenic analysis on the sample matrix by MSA. For this reason, rejection of the arsenic data was not considered to be necessary; however, the arsenic data were qualified as estimated as a conservative measure.

The arsenic results for the soil samples ranged from 3.0 mg/kg to 4.0 mg/kg. Although the arsenic matrix spike recovery suggests that arsenic sample results may potentially be biased low with the magnitude of that bias being up to 81%, it is extremely important to note that all arsenic

concentrations for soil samples were measured by MSA and are not likely to be affected by the potential low bias suggested by the matrix spike recovery. For this reason, the usability of the arsenic data for making project decision is not considered to be affected by potential inaccuracy in the arsenic results. Furthermore, due to the range of the reported concentrations being less than 20% of the decision criteria of 24 mg/kg and 25 mg/kg, an incorrect decision about whether the reported concentrations exceed decision criteria would not likely be made using any of the decision criteria even if the results were affected by a low bias of 81%.

Selenium Accuracy - The matrix spike recovery of selenium associated with the confirmation samples was 55%, outside the evaluation range of 70-130% suggesting a potential low bias in selenium results. The matrix spike results indicate that the maximum amount of the potential low bias may be up to 45% (a factor of 2.2). Selenium results for all samples were qualified as estimated ("J/UJ") to reflect the potential bias in results suggested by the various quality control sample analyses.

Selenium results for the soil samples ranged from 0.27 mg/kg to 2.0 mg/kg. The pertinent decision criteria specified in the QAPP for selenium are 310 mg/kg for the total-soil-combined pathway and 2.3 mg/kg for the soil-to-groundwater pathway. Although the results of various quality control analyses suggest a low bias in selenium results, all measured concentrations are more than a factor of 2.2 lower than the total-soil-combined pathway decision criterion of 310 mg/kg. As such, the potential low bias of 45% in the selenium results is not considered to affect the usability of the data for making project decisions regarding the total-soil-combined pathway.

Samples 0358 and 0359 had reported concentrations of 2.0 and 2.1 mg/kg respectively. These measured concentrations are below but within a factor of 2.2 of the soil-to-groundwater pathway decision criterion. Taking into account the potential low bias of up to 45%, the actual concentrations of selenium in soil may be higher than the decision criterion of 2.3 mg/kg. Therefore, even though the reported sample results are less than the decision criterion, they cannot be used to conclude that the soil concentrations are less than the soil-to-groundwater pathway decision criterion. All other sample results were more than a factor of 2.2 below the decision criterion. Therefore, the potential low bias of 45% in the selenium results is not considered to affect the usability of these data for making project decisions regarding the soil-to-groundwater pathway.

Molybdenum, Copper, Lead, and Manganese Accuracy - The concentrations of copper, lead, and manganese in the sample used for the matrix spike sample analysis were greater than four times the respective spiking levels such that the matrix spike results are considered to be an inappropriate measure of the accuracy of the analysis for these analytes in this particular sample matrix. As such, the effect of the site sample matrix on the accuracy of the copper, lead, and manganese analyses can not be assessed. However, the laboratory control sample results indicated that the accuracy of the copper, lead, and manganese analyses relative to a "clean" soil matrix was satisfactory. The absence of a matrix spike analysis for these analytes was not considered to require qualification of the associated sample data.

8.3 Representativeness Evaluation

Representativeness is the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Conducting sampling and analysis in compliance with the QAPP and relevant standard operating procedures (SOPs) is one way to maintain representativeness. Results obtained for field duplicate samples can also be used to assess representativeness.

8.3.1 Representativeness of Manganese Confirmation Samples

In order to determine whether the manganese result for sample 0053 is representative of the soil at sampling station 11, five composite surface soil samples were collected from location 11. One of the samples, 0353, was collected from approximately the same six subsampling locations as the original sample, 0053. Two additional samples were collected from six randomly selected subsample locations at station 11. Samples 0354 and 0358 were collected as field duplicates of samples 0353 and 0357, respectively. Since the samples were collected and analyzed in accordance with the QAPP and acceptable levels of accuracy and precision were attained, the samples are considered to be comparable to the other investigation data. Additionally, results for all analytes for both field duplicates satisfied the field duplicate evaluation criteria contained in the QAPP suggesting that the samples collected were adequately representative of the medium sampled.

Table 7-2 presents the results obtained for the new samples and compares them with the results for the original sample. With the exception of the manganese result for the original sample, the analytical results for all analytes show very little variation across all samples. The manganese results for the five new samples range in concentration from 2,290 mg/kg to 4,320 mg/kg with an average concentration of 3,118 mg/kg and a median concentration of 2,770 mg/kg. The median concentration for the five new samples, 2,770 mg/kg, is four times lower than the manganese result of 11,200 mg/kg obtained for the original sample.

Using the decision criteria specified in Section 7 for Objective A, it is concluded that the original manganese result is an outlier and, therefore, is not representative of the manganese concentration in the soil at sampling station 11 because there is a large difference between the manganese results for the original sample and the new samples, but not for the other analytes. Therefore, the manganese results for the supplemental samples were averaged and this average manganese concentration was used to represent conditions at sampling station 11.

8.3.2 Representativeness of Lead Split Sample

In order to determine whether the lead result for sample 0093 is representative of the soil at sampling station 37, the archived split sample, 0359, was submitted for analysis in duplicate. The analytical data for the archived sample and its laboratory duplicate are considered to be comparable to the other data because the split sample was collected and analyzed in accordance with the QAPP and acceptable levels of accuracy and precision were attained.

Table 8-3 presents the results obtained for the duplicate analysis of the archived split sample and compares them with the results for the original sample. With the exception of the lead result for the original sample, the analytical results for all analytes show very little variation across all samples. The lead results for the two new analyses are 129 mg/kg and 193 mg/kg. These values are an order of magnitude below the lead result of 1,270 mg/kg obtained for the original sample.

Using the decision criteria in Section 8 for Objective B, it is concluded that the original lead result is an outlier and, therefore, is not representative of the lead concentration in the soil at sampling station 37 because there is a large difference between the lead results for the original sample and the new analyses, but not for the other analytes. As such, the results for lead for the archived sample analysis are considered likely to be more representative of average lead concentrations in sample 0359. Therefore, the lead value and the values for all investigation constituents from the archived sample analysis were used to represent the soil concentration at Station 37.

Table 8-2: Comparison of Results for Manganese Confirmation Sample Analyses

SDG	0002	0024	0024	0024	0024	0024
Field ID	0053 **Original**	0353	0354 **FD**	0355	0357	0358 **FD**
Arsenic	4.4 J	3.9 J	4.2 J	3.7 J	3.3 J	3.0 J
Barium	208	222	194	196	193	197
Cadmium	2.0	2.5	2.9	2.5	2.9	3.4
Cobalt	11.2	9.8	8.4	7.8	7.0	6.5
Copper	3020	3150	2700	2240	2510	3040
Lead	119 J	116	132	125	325	272
Manganese	11200	2550	2290	4320	3660	2770
Selenium	0.40 J	0.27 J	0.33 J	0.40 J	0.45 J	0.42 J
Silver	1.1 U	1.4	1.1	2.1	1.1 U	1.1 U
Zinc	339 J	332	302	353	571	583
Molybdenum	20.2	17.3	13.5	15.8	14.2	11

SDG = Sample Delivery Group
FD = Field Duplicate
J = Estimated Value
U = Analyte not detected at the associated sample quantitation limit

Table 8-3: Comparison of Results for Lead Confirmation Sample Analyses

SDG	0002	0024	0024
Field ID	0093 Original	0359	0359D LD
Arsenic	4.5 J	4.1 J	4.0 J
Barium	220	196	189
Cadmium	4.0	4.5	4.6
Cobalt	11.0	9.6	10.1
Copper	5120	5100	4470
Lead	1270 J	129 J	193 J
Manganese	425	405	418
Selenium	1.5 J	2.0 J	1.2 J
Silver	1.1 U	1.3	1.1
Zinc	240 J	255	236
Molybdenum	18.4	14.2	14.5

SDG = Sample Delivery Group
LD = Laboratory Duplicate
J = Estimated Value
U = Analyte not detected at the associated sample quantitation limit

9. POTENTIAL ADDITIONAL DATA USES AND LIMITATIONS

In addition to being used in making the decisions specified in the QAPP, the supplemental sample data generated may potentially have other end uses including risk assessment. The analytical data quality is generally considered sufficient for this additional potential end use, however, the magnitude of potential biases and imprecisions discussed above must be considered. Prior to use in risk assessment, end users of the data should perform a data quality assessment relative to their specific risk assessment objectives and should perform an evaluation of whether the analytical data are sufficiently representative of the medium under evaluation.

All data were validated in accordance with the provisions of the QAPP using guidance from the USEPA National Functional Guidelines for Inorganic Data Review (February 1994). The data validation is considered to meet the minimum requirements specified in USEPA's Risk Assessment Guidance for Superfund (September, 1989) (RAGS) and those specified in USEPA's Guidance for Data Usability in Risk Assessment (April, 1992) (DURA). Data qualified as estimated in this report have been assigned a "J" qualifier, and any data rejected during validation were assigned an "R" qualifier. In addition, all data which were qualified as estimated were assigned a qualifier code indicating the reason for qualification and a suffix to the qualifier code indicating the potential bias direction based on the QC indicators and the magnitude of the potential bias when known. The qualifier codes have been annotated on the analytical result reporting forms and also entered into the project database management system. A code suffix of

"L" for a given result indicates a potential low bias exists, "H" a potential high bias, and "I" indicates imprecision in the result without a bias direction being discernible from the QC indicators.

As specified in DURA, data qualified as "U" (non-detectable) or "J" (estimated) should be used for risk assessment purposes. DURA (page 5-15) further indicates that:

> "the guidance here is to use J-qualified concentrations the same way as positive data that do not have this qualifier. If possible, note potential uncertainties associated with the qualifier, so that if data qualified with a J contribute significantly to the risk, then appropriate caveats can be attached."

Section 8.2 above provides a detailed description of the magnitude and direction of potential biases associated with J-qualified data and should be useful to the risk assessor in evaluating the uncertainty associated with qualified results.

When using the data for other end uses, care must be taken to ensure that the data are adequately representative of the media under evaluation. In general, the confirmation analytical data were generated to evaluate outliers and designed to meet the objectives specified in Section 8.0. Each end user of the data should perform a data quality assessment relative to their specific end use objectives for the data and should perform an evaluation of whether the analytical data are sufficiently representative of the medium under evaluation for their specific data use. The discussion on sensitivity (sample quantitation limits), bias (accuracy), and representativeness provided in Section 8.1, 8.2, and 8.3, respectively should be useful in performing a data quality assessment relative to other end uses of the data and in evaluating whether the data are sufficiently representative of the medium under evaluation for a specific end use.

10. CORRECTIVE ACTIONS AND WORKPLAN DEVIATIONS

This section describes any corrective actions implemented and workplan (QAPP) deviations that occurred during the sampling and analysis of confirmation samples and the effect on the usability of the data.

10.1 QAPP and Sampling Plan Corrective Action

No field or laboratory corrective actions were required during the course of the field investigation.

10.2 QAPP/Sampling Plan Modifications

No QAPP modifications were implemented during the course of the analytical program.

However, during the course of the planning and execution, one modification to the sampling plan was implemented.

Number of Field Duplicate Samples - The QAPP stated that one soil field duplicate sample would be collected. However, an additional field duplicate sample was collected and submitted for analysis. As the frequency of field duplicate sample collection for the soil samples satisfies the TCEQ Superfund QAPP-required frequency, this modification to the sampling plan is not considered to affect the usability of the data generated.

11. REJECTED DATA AND PROJECT CONSEQUENCES

None of the analytical results were rejected during data validation. As a result, all data were considered to be usable for reconciliation with project objectives.

As discussed in Sections 5 and 7, some results were qualified as estimated based on a variety of minor QC problems. Section 8.2 discussed the direction and magnitude of bias associated with all results qualified as estimated.

After reconciliation of the data with project objectives (by means of evaluating the data set relative to sample quantitation limits, the magnitude and direction of any potential biases, and representativeness), all results for the confirmation samples are considered to be suitable for making the decision of whether individual analyte concentrations exceed the decision criteria specified in the QAPP.

12. CONCLUSIONS

With the exception of limitations noted in Section 8.0, the data are considered to be usable for making project decisions. As described in Section 8.0, these data are also considered to be of sufficient analytical quality for a variety of other end uses including baseline risk assessment. For end uses of the data other than those for which decision criteria are specified in Section 8.0, the end user of the data should perform a data quality assessment relative to their specific end use objectives and should perform an evaluation of whether the analytical data are sufficiently representative of the medium under evaluation for their specific data use.

APPENDIX A to the DUS

DATA REPORTING FORMS

Appendix A.1 to the DUS

DATA REPORTING FORMS

SDG 0024

APPENDIX B to the DUS
CHAIN-OF-CUSTODY FORMS

APPENDIX C to the DUS
LABORATORY REVIEW CHECKLISTS

Attachment 1

Laboratory Review Checklist

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LABORATORY DATA PACKAGE SIGNATURE PAGE

This data package consists of:

- ☐ This signature page, the laboratory review checklist, and the following reportable data:
  - ☐ R1 Field chain-of-custody documentation;
  - ☐ R2 Sample identification cross-reference;
  - ☐ R3 Test Reports (analytical data sheets) for each environmental sample that include:
    a) items consistent with NELAC 5.13 or ISO/IEC 17025 Section 5.10,
    b) dilution factors,
    c) preparation methods,
    d) cleanup methods, and
    e) if required for the project, tentatively identified compounds (TICs).
  - ☐ R4 Surrogate recovery data including:
    a) calculated percent recovery (%R), and
    b) the laboratory's surrogate QC limits.
  - ☐ R5 Test reports/summary forms for blank samples;
  - ☐ R6 Test reports/summary forms for laboratory control sample (LCSs) including:
    a) LCS spiking amounts,
    b) calculated %R for each analyte, and
    c) the laboratory's LCS QC limits.
  - ☐ R7 Test reports for matrix spike/matrix spike duplicates (MS/MSDs) including:
    a) samples associated with the MS/MSD clearly identified,
    b) MS/MSD spiking amounts,
    c) concentration of each MS/MSD analyte measured in the parent and spiked samples,
    d) calculated %Rs and relative percent differences (RPDs), and
    e) the laboratory's MS/MSD QC limits.
  - ☐ R8 Laboratory analytical duplicate (if applicable) recovery and precision including:
    a) the amount of analyte measured in the duplicate,
    b) the calculated RPD, and
    c) the laboratory's QC limits for analytical duplicates.
  - ☐ R9 List of method quantitation limits (MQLs) for each analyte for each method and matrix;
  - ☐ R10 Other problems or anomalies.
  - ☐ An exception report for every "No" or "Not Reviewed (NR)" item in the laboratory review checklist.

Release Statement: I am responsible for the release of this laboratory data package. This data package has been reviewed by the laboratory and is complete and technically compliant with the requirements of the methods used, except where noted by the laboratory in the attached exception reports. By my signature below, I affirm to the best of my knowledge that all problems/anomalies observed by the laboratory as having the potential to affect the quality of the data have been identified by the laboratory in the Laboratory Review Checklist, and no information or data have been knowingly withheld that would affect the quality of the data.

Name (printed)	Signature	Official Title (printed)	Date

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LABORATORY REVIEW CHECKLIST: REPORTABLE DATA

Laboratory Name: High Quality Lab, Inc.	Report Date: 07/30/98
Project Name: ZYX Foundry Site	Laboratory Job Number: 0024
Reviewer Name: Al Kemmest	Batch Number(s): 1736

#[1]	Analysis[2]	Description	Yes	No	NA[3]	NR[4]	ER#[5]
R1	OI	**CHAIN-OF-CUSTODY (C-O-C)**					
		1) Did samples meet the laboratory's standard conditions of sample acceptability upon receipt?		X			1-1,1-2
		2) Were all departures from standard conditions described in an Exception Report?	X				
R2	OI	**SAMPLE AND QUALITY CONTROL (QC) IDENTIFICATION**					
		1) Are all field sample ID numbers cross-referenced to the laboratory ID numbers?	X				
		2) Are all laboratory ID numbers cross-referenced to the corresponding QC data?	X				
R3	OI	**TEST REPORTS**					
		1) Were all samples prepared and analyzed within holding times?		X			1-3
		2) Other than those results < MQL, were all other results bracketed by calibration standards?	X				
		3) Were calculations checked by a peer or supervisor?	X				
		4) Were all analyte identifications checked by a peer or supervisor?	X				
		5) Were sample quantitation limits reported for all analytes not detected?	X				
		6) Were all results for soil and sediment samples reported on a dry weight basis?	X				
		7) Were % moisture (or solids) reported for all soil and sediment samples?	X				
		8) If required for the project, were tentatively identified compounds (TICs) reported?			X		
R4	O	**SURROGATE RECOVERY DATA**					
		1) Were surrogates added prior to extraction?			X		
		2) Were surrogate percent recoveries in all samples within laboratory QC limits?			X		
R5	OI	**TEST REPORTS/SUMMARY FORMS FOR FOR BLANK SAMPLES**					
		1) Were appropriate type(s) of blanks analyzed?	X				
		2) Were blanks analyzed at the appropriate frequency?	X				
		3) Were method blanks taken through the entire analytical process, including preparation and, if applicable, cleanup procedures?	X				
		4) Were blank concentrations < MQL?		X			1-4
R6	OI	**LABORATORY CONTROL SAMPLES (LCSs)**					
		1) Were all COCs included in the LCS?	X				
		2) Was each LCS taken through the entire analytical procedure, including prep and cleanup steps?	X				
		3) Were LCSs analyzed at the required frequency?	X				
		4) Were LCS (and LCSD, if applicable) %Rs within the laboratory QC limits?	X				
		5) Does the detectability data document the laboratory's capability to detect the COCs at the MDL used to calculate the SQLs?	X				
		6) Was the LCSD RPD within QC limits?	X				
R7	OI	**MATRIX SPIKE (MS) and MATRIX SPIKE DUPLICATE (MSD) DATA**					
		1) Were the project/method specified analytes included in the MS and MSD?	X				
		2) Were MS/MSD analyzed at the appropriate frequency?	X				
		3) Were MS (and MSD, if applicable) %Rs within the laboratory QC limits?		X			1-5
		4) Were MS/MSD RPDs within laboratory QC limits?			X		
R8	OI	**ANALYTICAL DUPLICATE DATA**					
		1) Were appropriate analytical duplicates analyzed for each matrix?	X				
		2) Were analytical duplicates analyzed at the appropriate frequency?	X				
		3) Were RPDs or relative standard deviations within the laboratory QC limits?		X			1-6
R9	OI	**METHOD QUANTITATION LIMITS (MQLs)**					
		1) Are the MQLs for each method analyte included in the laboratory data package?	X				
		2) Do the MQLs correspond to the concentration of the lowest non-zero calibration standard?	X				
		3) Are unadjusted MQLs included in the laboratory data package?	X				
R10	OI	**OTHER PROBLEMS/ANOMALIES**					
		1) Are all known problems/anomalies/special conditions noted in this LRC and ER?	X				
		2) Were all necessary corrective actions performed for the reported data?	X				
		3) Was applicable and available technology used to lower the SQL to minimize the matrix interference effects on the sample results?			X		

LABORATORY REVIEW CHECKLIST (continued): SUPPORTING DATA

Laboratory Name: High Quality Lab, Inc.	Report Date: 07/30/98
Project Name: ZYX Foundry Site	Laboratory Job Number: 0024
Reviewer Name: Al Kemmest	Batch Number(s): 1736

#[1]	Analysis[2]	Description	Yes	No	NA[3]	NR[4]	ER #[5]
S1	OI	**INITIAL CALIBRATION (ICAL)**					
		1) Were response factors (RFs) and/or relative response factors (RRFs) for each analyte within the QC limits?			X		
		2) Were percent RSDs or correlation coefficient criteria met?	X				
		3) Were the number of standards recommended in the method used for all analytes?	X				
		4) Were all points generated between the lowest and highest standard used to calculate the curve?	X				
		5) Are ICAL data available for all instruments used?	X				
		6) Has the calibration curve been verified using an appropriate second source standard?	X				
S2	OI	**INITIAL AND CONTINUING CALIBRATION VERIFICATION (ICV AND CCV)**					
		1) Was the CCV analyzed at the method-required frequency?	X				
		2) Were percent differences for each analyte within the method-required QC limits?	X				
		3) Was the ICAL curve verified for each analyte?	X				
		4) Was the absolute value of the analyte concentration in the inorganic CCB < MDL?	X				
S3	O	**MASS SPECTRAL TUNING**					
		1) Was the appropriate compound for the method used for tuning?			X		
		2) Were ion abundance data within the method-required QC limits?			X		
S4	O	**INTERNAL STANDARDS (IS)**					
		Were IS area counts and retention times within the method-required QC limits?			X		
S5	OI	**RAW DATA** (NELAC Section 1 Appendix A Glossary, and Section 5.12)					
		1) Were the raw data (for example, chromatograms, spectral data) reviewed by an analyst?	X				
		2) Were data associated with manual integrations flagged on the raw data?			X		
S6	O	**DUAL COLUMN CONFIRMATION**					
		Did dual column confirmation results meet the method-required QC?			X		
S7	O	**TENTATIVELY IDENTIFIED COMPOUNDS (TICs)**					
		If TICs were requested, were the mass spectra and TIC data subject to appropriate checks?			X		
S8	I	**INTERFERENCE CHECK SAMPLE (ICS) RESULTS**					
		Were percent recoveries within method QC limits?	X				
S9	I	**SERIAL DILUTIONS, POST DIGESTION SPIKES, AND METHOD OF STANDARD ADDITIONS**					
		Were percent differences, recoveries, and the linearity within the QC limits specified in the method?		X			1-7
S10	OI	**METHOD DETECTION LIMIT (MDL) STUDIES**					
		1) Was a MDL study performed for each reported analyte?	X				
		2) Is the MDL either adjusted or supported by the analysis of detectability check standards?	X				
S11	OI	**PROFICIENCY TEST REPORTS**					
		Was the laboratory's performance acceptable on the applicable proficiency tests or performance evaluation studies?	X				
S12	OI	**STANDARDS DOCUMENTATION**					
		Are all standards used in the analyses NIST-traceable or obtained from other appropriate sources?	X				
S13	OI	**COMPOUND/ANALYTE IDENTIFICATION PROCEDURES**					
		Are the procedures for compound/analyte identification documented?	X				
S14	OI	**DEMONSTRATION OF ANALYST COMPETENCY (DOC)**					
		1) Was DOC conducted consistent with NELAC 5C or ISO/IEC 4?	X				
		2) Is documentation of the analyst's competency up-to-date and on file?	X				
S15	OI	**VERIFICATION/VALIDATION DOCUMENTATION FOR METHODS**					
		Are all methods used to generate the data documented, verified and validated, where applicable? (NELAC Chap 5 or ISO/IEC 17025 Section 5)	X				
S16	OI	**LABORATORY STANDARD OPERATING PROCEDURES (SOPs)**					
		Are laboratory SOPs current and on file for each method performed?	X				

1 Items identified by the letter "R" should be included in the laboratory data package submitted to the TCEQ. Items identified by the letter "S" should be retained and made available to the TCEQ upon request.
2 O = organic analyses; I = inorganic analyses (and general chemistry, when applicable).
3 NA = Not applicable.
4 NR = Not reviewed.
5 ER# = Exception Report identification number (an Exception Report should be completed for an item if "NR" or "No" is checked).

LAB REVIEW CHECKLIST (continued): EXCEPTION REPORTS	
Laboratory Name:	Report Date:
Project Name:	Laboratory Job Number:
Reviewer Name:	Batch Number(s):

ER 1-1: Laboratory sample ID# W173621 was received by the laboratory at a pH of 7.3. Sufficient volume of nitric acid was added to the sample on 7/6/98 to lower the pH to <2.

ER 1-2: The sample container for laboratory sample ID# S173620 was received by the laboratory in a cracked condition. The sample was still contained in the container. The ZYX project manager was contacted on 6/27/98 from whom direction was received by the laboratory to continue with the analysis of the sample.

ER 1-3: Laboratory sample ID#s S173620 and S174069 were duplicate samples from an archived sample (laboratory sample ID# S146370). The archived sample was associated with the chain-of-custody tag # 1463, which indicates the sample was collected on 6/3/97. The ZYX project manager requested the sample be analyzed, even though the holding time had expired for the archived sample.

ER 1-4: The soil method blank contained zinc at 0.645 mg/kg, the ICP initial and/or continuing calibration blanks contained zinc and cobalt at concentrations of 2.8 µg/L and -10.3 µg/L respectively, and the GFAA calibration blank contained lead at -1 µg/L in CCB5 and -1.1 µg/L in CCB2. Blanks collected in the field, such as a field blank and rinsate blank, were not identified on the chain-of-custody.

ER 1-5: Laboratory Sample ID# S173615 was used for the matrix spike sample analysis. The recoveries for arsenic and selenium were outside control limits at 19.1% and 59.6%, respectively. The reported concentrations of arsenic and selenium were determined by the Method of Standard Additions (MSA).

ER 1-6: The relative percent differences between the laboratory duplicate results for laboratory sample ID# S173620 were outside control limits at 40% and 50% for lead and selenium, respectively.

ER 1-7: The results of the GFAA post-digestion spike were outside of the method acceptance criteria for arsenic, lead, and selenium. As a result, each of these analytes was quantified by the Method of Standard Additions (MSA) with acceptable correlation coefficients.

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Attachment 3

TCEQ Project Manager's Review Checklist

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TCEQ PROJECT MANAGER'S REVIEW CHECKLIST

Project Name:	
DUS Report:	
Report Date:	
TCEQ Project Manager:	Laboratory:
Signature:	Laboratory Job Number:

If an item is not applicable, check N/A. If an item was not reviewed, check N/R. All items checked with NO or N/R must be explained in an attached EXCEPTION REPORT (ER).

	ITEM	YES	NO	N/A	N/R	ER #
1	Completeness					
1.a	Laboratory review checklist (LRC) present?					
1.b	Data usability summary present?					
1.c	Annotated analytical data sheets present?					
1.c.i	Each page initialed and dated?					
1.c.ii	Bias codes and qualifier codes assigned?					
1.d	Lab QC analysis summary forms present?					
1.e	Chain-of-custody information present?					
1.f	Field QA problems addressed?					
2	Spot-check of data validation performed?					
3	Spot-check of data usability performed?					
4	Items in LRC exception reports addressed?					
5	Are there any rejected/unusable data?					
5.a	Are these data critical?					
5.b	Are these data gaps addressed?					
6	Is additional validation of data required?					

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Attachment 4

Contract Laboratory Program Guidance for Field Samplers

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OSWER 9240.0-35
EPA540-R-00-003

Contract Laboratory Program Guidance for Field Samplers

Draft Final
January 2004

Foreword

The intent of the *Contract Laboratory Program Guidance for Field Samplers* is to replace the *CLP Samplers Guide*. This guidance document is designed to provide users with general information regarding environmental sample collection for the United States Environmental Protection Agency's (USEPA's) CLP. This document provides minimum CLP requirements, an explanation of the general sampling process sequence of events, and any related information. The appendices contain useful reference information and checklists to aid in planning and documenting sampling activities.

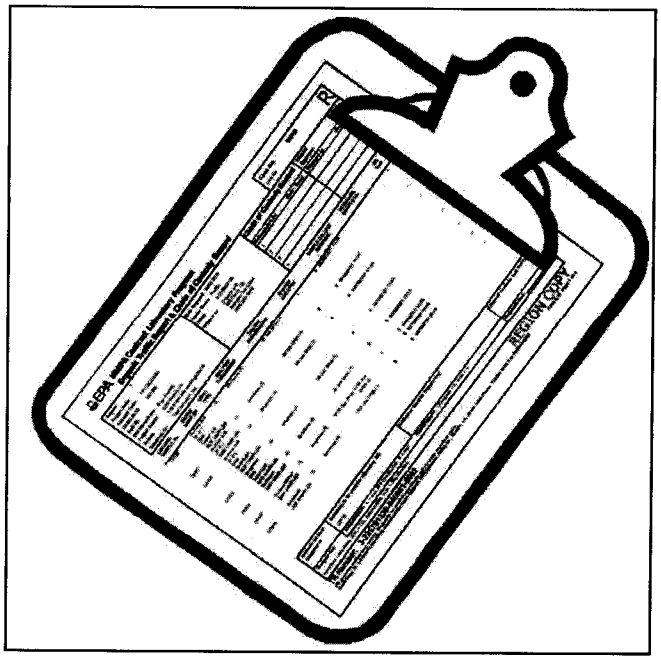
CLP users also are encouraged to review the *Introduction to the Contract Laboratory Program* document that contains a general overview of the CLP, how it works, and how to access the program. The CLP requires samplers to use the functionality provided by the Field Operations Records Management System (FORMS) II Lite™ software, which is the preferred means of creating CLP sample documentation. For guidance in using the software to record and submit sampling data, users should reference the *FORMS II Lite User's Guide*.

Both the *Introduction to the Contract Laboratory Program* and the *Contract Laboratory Program Guidance for Field Samplers* can be downloaded from the CLP Web site at the following address:

http://www.epa.gov/superfund/programs/clp/guidance.htm

The *FORMS II Lite User's Guide* can be downloaded from the CLP Web site at the following address:

http://dyncsdao1.dyncorp.com/itg/forms2lite/documents/51docs/UserGuide51.pdf



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ASB	Analytical Services Branch
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLP	Contract Laboratory Program
CLP PO	Regional CLP Project Officer
CVAA	Cold Vapor Atomic Absorption
DOT	Department of Transportation
DQO	Data Quality Objective
FORMS II Lite™	Field Operations Records Management System II Lite
FSP	Field Sampling Plan
GFAA	Graphite Furnace Atomic Absorption
IATA	International Air Transport Association
ICP-AES	Inductively Coupled Plasma - Atomic Emission Spectroscopy
ICP-MS	Inductively Coupled Plasma - Mass Spectrometry
MS	Matrix Spike
MSD	Matrix Spike Duplicate
OSC	On-Scene or On-Site Coordinator
OSRTI	Office of Superfund Remediation and Technical Innovation
OSWER	Office of Solid Waste and Emergency Response
PCBs	Polychlorinated Biphenyls
PE	Performance Evaluation
PM	Program Manager
ppb	Parts-Per-Billion
ppt	Parts-Per-Trillion
PRP	Potentially Responsible Party
PTFE	Polytetrafluoroethylene
PVC	Polyvinyl Chloride
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QASPER	Quality Assurance Sampling Plan for Environmental Response
QATS	Quality Assurance Technical Support
QC	Quality Control
RAS	Routine Analytical Services
RPM	Remedial Project Manager
RSCC	Regional Sample Control Center
RSM	Regional Site Manager
SAM	Site Assessment Manager
SAP	Sampling Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
SDG	Sample Delivery Group
SMC	System Monitoring Compound
SMO	Sample Management Office
SOP	Standard Operating Procedure
SOW	Statement of Work
SVOA	Semivolatile Organic Analyte
TR/COC	Traffic Report/Chain of Custody Record
USEPA	United States Environmental Protection Agency
VOA	Volatile Organic Analyte

1.0 INTRODUCTION

1.1 About this Guide

This document is intended to guide those who plan and conduct environmental sample collection projects for analysis through the Superfund's Contract Laboratory Program (CLP). This chapter describes the structure and purpose of this document. Chapter 2, *Pre-field Activities*, addresses pre-field planning activities that the sampling team could complete prior to the actual sampling event. Chapter 3, *In-field Activities*, addresses those activities that need to be completed during the sampling event.

Appendix E contains checklists to help the sampler ensure that all necessary steps are completed.

Note: A project and site-specific Quality Assurance Project Plan (QAPP) providing any Regional guidance will override guidance given within this document.

1.2 Overview of the CLP

The CLP is a national program of commercial Laboratories under contract to support the United States Environmental Protection Agency's (USEPA's) nationwide effort to clean up designated hazardous waste sites by supporting the USEPA's Superfund program. The Superfund program was originally established under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 and presently exists under the Superfund Amendments and Reauthorization Act (SARA) of 1986.

The CLP uses state-of-the-art technology to provide users with analytical services. The program provides data of known and documented quality to support USEPA enforcement activities or other user needs. To achieve this goal, the CLP has established strict Quality Control (QC) procedures and detailed documentation requirements. Current CLP users include the USEPA Regions, States and tribal governments, and other Federal agencies. CLP users also are encouraged to review the *Introduction to the Contract Laboratory Program* document that contains a general overview of the CLP, how it works, and how to access the program.

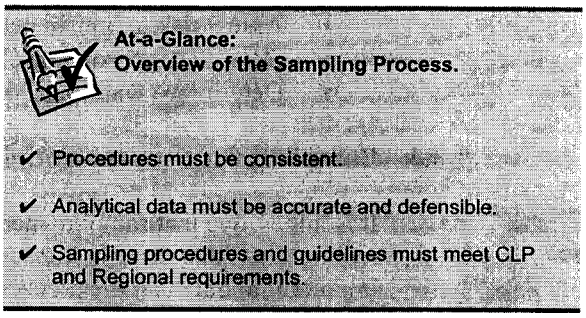
1.2.1 Key Players Within the CLP

In coordinating Superfund sampling efforts, the Analytical Services Branch (ASB) is supported by the Sample Management Office (SMO) contractor, the Regional CLP Project Officers (CLP POs), the Regional Sample Control Center (RSCC) Coordinators, and the Regional Site Managers (RSMs), including Site Assessment Managers (SAMs), On-Scene/On-Site Coordinators (OSCs), and Remedial Project Managers (RPMs). Samplers may work directly with the RSCC Coordinator and/or RSM (or equivalent), and/or an OSC from the field support section during a sampling event. See Table 1-1 for a brief description of the functions performed by key participants (functions may vary by Region).

Table 1-1. Participants in the CLP

Participants in the CLP Program	Responsibilities
Analytical Services Branch (ASB)	USEPA ASB directs the CLP from within the Office of Superfund Remediation and Technical Innovation (OSRTI) in the Office of Solid Waste and Emergency Response (OSWER). ASB responsibilities include: • Development of the Statements of Work (SOWs) that define required analytical methods (including QC, detection/quantitation limits, and holding times) for the analytical services procured under the CLP; • Development and implementation of policies and budgets for Superfund analytical operations; • Development of information management policies and products for analytical data; • Management of CLP SMO and Quality Assurance Technical Support (QATS) contracts; • National administration, evaluation, and management of the CLP; and • Direction of CLP Quality Assurance (QA) activities in coordination with overall OSWER QA activities. To obtain the most current ASB contact list, refer to the following Web site: http://www.epa.gov/superfund/programs/clp/contacts.htm#ASB
CLP Sample Management Office (SMO)	Provides necessary management, operations, and administrative support to the CLP. The SMO contractor receives Regional analytical requests, coordinates and schedules sample analyses, and tracks sample shipments and analyses. The SMO contractor also receives and checks data for completeness and compliance, processes laboratory invoices, and maintains a repository of sampling records and program data.
Regional CLP Project Officer (CLP PO)	Monitors the technical performance of the contract Laboratories in each Region. The CLP PO works closely with ASB Program Managers (PMs) to identify and resolve laboratory technical issues, and leads laboratory on-site evaluations. The CLP PO (or their designee) is the sole Regional official who contacts the CLP laboratories. To obtain the most current CLP PO contact list, refer to the following Web site: http://www.epa.gov/superfund/programs/clp/polist.htm
Regional Sample Control Center (RSCC) Coordinator	In most Regions, the RSCC Coordinator coordinates sampling efforts and serves as the central point-of-contact for sampling questions and problems. The RSCC Coordinator works with SMO to schedule sample shipments to Laboratories. In addition, the RSCC Coordinator's activities may include: providing monthly projections; and informing SMO of sample shipment, cancellations, special instructions, and sampling issues. To obtain the most current RSCC Coordinator contact list, refer to the following Web site: http://www.epa.gov/superfund/programs/clp/rsceclist.htm
Regional Site Manager (RSM)	Coordinates the development of acceptance or performance criteria and oversees project-specific contractors, state officials, or private parties conducting site sampling efforts. The RSM could be the Site Assessment Manager (SAM), the On-Scene/On-Site Coordinator (OSC), or the Remedial Project Manager (RPM).
Field Support Section	The Field Support Section consists of personnel such as the OSC, SAM, and RPM. In most Regions, the Field Support Section develops Standard Operating Procedures (SOPs) for field sampling and related procedures, and assists sampling teams in following those SOPs. The sampling team determines what type(s) of CLP services will be required or a particular sampling event. The Field Support Section reviews Sampling Analysis Plans (SAPs) prepared by sampling teams and oversees sampling teams in the field. They also prepare their own SAP, perform sampling activities in the field, and analyze and report the results of their sampling events to the RSM.

1.3 Overview of the Sampling Process



Once USEPA has determined that physical, chemical, and biological testing of a site is necessary, samples of material from the investigated area must be collected. The type of material that must be collected and the analytical method to be used depends upon the physical location of the site, detection level(s), site history (previous sampling), and known vs. unknown conditions and contaminants. The sampling process includes carefully planned and consistently applied procedures that produce accurate and legally defensible data. The sampling team should consider the procedures and plans presented in this guide as minimum sampling process guidelines to maintain sample integrity and identity. Samples should be collected according to the approved project and site-specific QAPP and SAP. This document does not define specific sampling procedures for sampling because specific sampling protocols depend on individual site conditions, Regional requirements, and acceptance and performance criteria. Since Regions may have their own specific requirements for individual sampling programs, they are responsible for generating Region-specific sampling SOPs.

1.3.1 Procedures Must be Consistent

The purpose of sampling is to collect representative portions from a suspected contaminated site. Sample collection is critical to determining the presence, type, concentration, and extent of environmental contamination by hazardous substances, thus it is a crucial part of every sampling and environmental testing effort. Sampling procedures must be consistently written and followed to mitigate risk of error and the expense of resampling.

Failure to follow proper sampling and shipping procedures could result in samples that are contaminated, broken, mislabeled, lost during shipping, or unusable because of a missed holding time. If procedures are inconsistently or improperly followed, any resultant analytical data may be inaccurate and may not be defensible in a court of law.

Note: If resampling is needed due to improper sampling, the sampling team may incur the cost.

1.3.2 Site Data Must be Accurate and Defensible

The data gathered during sampling activities helps to accurately characterize contaminated waste sites so that the impact on human health and the environment can be properly evaluated. Acquiring accurate and defensible data that will be accepted in a court of law is the CLP's primary objective; therefore, the sampler must collect samples according to strict sampling procedures, plans, and guidelines. USEPA and many other Federal agencies use data resulting from analytical testing of soil/sediment/aqueous samples to:

- Determine if a site is contaminated with organic and/or inorganic compounds;
- Identify pollution sources and Potentially Responsible Parties (PRPs);

- Validate remedial design methodologies;
- Assess response and remedial priorities;
- Assess risk to human health and the environment;
- Determine appropriate clean-up actions; and
- Determine clean-up achievements.

1.3.3 Sampling Procedures and Guidelines Must Meet Minimum Requirements

It is imperative that sampling personnel be aware of the minimum CLP and Regional requirements that directly impact and define how a sampling event will take place. It is important to note that the procedures and guidelines set forth in this document are considered minimum CLP requirements. Samplers should reference the following sections within this document that specifically address important requirements that must be met for a successful sampling event:

- Section 1.4.1 CLP Documentation Requirements;
- Section 2.4.1 Request Scheduling of Analysis, Case and CLP Sample Numbers, and Laboratory Contact Information;
- Section 2.7 Comply with Transportation and Shipping Requirements;
- Section 2.8 Provide Shipment Notification;
- Section 3.1 Collecting Samples; and
- Section 3.2 Complete Required Documentation.

1.4 Overview of Sampling Documentation Requirements

The sampler must properly document samples collected for analysis to uniquely identify each sample and ensure adequate chain-of-custody procedures. Samplers may also be required by a Region to use a sample label, sample tag, or field operations records documenting information such as daily activities, equipment and materials used, personnel involved, site security, etc. These types of documentation help ensure proper sample identification and provide additional chain-of-custody records.

The documentation required by a Region for a sampling event is outlined in project plans such as the QAPP, SAP, and Field Sampling Plan (FSP). CLP Sample Numbers are provided to samplers by their RSCC Coordinator.

Note: Under no circumstances should the site name appear on any documentation being sent to the laboratory.

At-a-Glance: Overview of Sampling Document Requirements.

✔ Must use FORMS II Lite to create sample documentation.

✔ CLP documentation requirements:
- CLP Sample Number
- SMO-assigned Case Number
- Traffic Report/Chain of Custody (TR/COC) Record
- Sample Labels
- Sample Tags
- Custody Seals
- Field Operation Records

1.4.1 CLP Documentation Requirements

Sampling personnel must:

1) Record the CLP Sample Number on each sample bottle;
2) Record the SMO-assigned Case Number on each sample bottle and the all associated sample documentation;
3) Complete the Traffic Report/Chain of Custody (TR/COC) Record using the Field Operations Records Management System Lite (FORMS II Lite) software, making sure to indicate on the form if you used a Method Flexibility Clause;
4) Complete and attach sample labels;
5) Complete and attach sample tags;
6) Complete and attach custody seals to meet Regional requirements; and
7) Complete field operations records, as necessary.

Please contact your RSCC Coordinator (see Table 1-1) for information regarding CLP Sample Numbers, SMO-assigned Case Numbers, TR/COC Records, and chain-of-custody seals for sampling events.

For information regarding using FORMS II Lite to create and complete a TR/COC Record, refer to the following Web site:

http://www.epa.gov/superfund/programs/clp/f2lite.htm

1.4.1.1 CLP Sample Number

A CLP Sample Number is a number that is unique per sample, per Statement of Work (SOW), that is used to identify and track a sample. CLP Sample Numbers are used to track samples throughout the sampling and analytical processes and are recorded on many types of sampling documentation (e.g., TR/COC Records, sample labels, and sample tags).

Samplers must contact their RSCC Coordinator (or their designee) to obtain CLP Sample Numbers for their sampling event. Sampling personnel must correctly assign the CLP Sample Numbers to the appropriate sample bottle or container. Please refer to Section 3.2.1 for more detailed information regarding use of CLP Sample Numbers.

Note: If the sampler has any questions regarding the assignment of CLP Sample Numbers, they should contact their RSCC Coordinator.

1.4.1.2 SMO-Assigned Case Number

SMO-assigned Case Numbers are used to track groups of samples throughout the sampling and analytical processes and are recorded on many types of sampling documentation (e.g., TR/COC Records, sample labels, and sample tags). Sampling personnel must correctly assign the SMO-assigned Case Number to the appropriate sample bottle or container. Samplers must contact their RSCC Coordinator (or their designee) to obtain a SMO-assigned Case Number.

1.4.1.3 Laboratory Assignment

Samplers are responsible for shipping samples to the appropriate SMO-assigned laboratory for analysis. Samplers must contact their RSCC Coordinator (or their designee) to obtain their laboratory assignment.

1.4.1.4 Traffic Report/Chain of Custody (TR/COC) Record

The TR/COC Record is used as physical evidence of sample custody and functions as a permanent record of each sample collected. **Per CLP documentation requirements, a separate TR/COC Record must accompany every cooler that is shipped by sampling personnel.**

In an effort to automate sample documentation in the field, ASB has developed a stand-alone, Windows-based software application that samplers can use to automatically create and generate sample documentation. The FORMS II Lite software allows users to enter information prior to and during sampling events. It allows users to multi-task and electronically create, edit, then print documentation associated with sampling activities. Users can customize data entry screens to view data throughout the entire documentation process. Users can also customize the format and content of sample labels based on specific requirements.

The program simplifies and accelerates the tedious manual sample documentation process by reducing the generation of handwritten documents by almost 70%. The FORMS II Lite software enables sampling personnel to:

- Generate CLP Sample Numbers or manually assign their own unique, project-specific CLP Sample Numbers;
- Input the SMO-assigned Case Number into the appropriate field;
- Create sample labels, sample tags, TR/COC Records, and Field Weight forms;
- Track samples from the field to the laboratory;
- Electronically capture sample information into databases; and
- Export electronic data as a Data Base File (.dbf) , Text (.txt), or eXtensible Markup Language (.xml) file.

USEPA requires samplers to use the FORMS II Lite software for all CLP sampling efforts. For assistance with obtaining or using the FORMS II Lite software, please contact the FORMS II Lite Help Desk at 703-818-4200 from 9:00 AM - 5:00 PM Eastern Time (ET). For additional information regarding FORMS II Lite use and training, please refer to the following Web site:

http://www.epa.gov/superfund/programs/clp/f2lite.htm

1.4.1.5 Chain-of-Custody Seals

A chain-of-custody seal is any adhesive label or tape that can be used to seal a sample bottle, container, plastic bag, or shipping cooler such that if it is opened or tampered with, the seal will be broken. Custody seals must be placed on each sample bottle, container, or bag (as appropriate) and each shipping cooler or container.

1.4.1.6 Sample Labels

A sample label is an identification label attached to a sample bottle or container that contains a sample. Sample labels are affixed to each sample container as samples are collected in the field. A sample label must contain, at a minimum, a CLP Sample Number and a SMO-assigned Case Number so that they can be associated with, and listed on, the associated TR/COC Record and chain-of-custody paperwork. The sample label must also include the required analysis/fraction and preservative used (to eliminate confusion at the laboratory). Sampling personnel should refer to their project plans for Region-specific sample label requirements.

1.4.1.7 Sample Tags

A sample tag identifies a sample bottle or container that contains a sample. The tag also provides specific analytical direction and proof that a sample existed. To support the use of sample data in potential enforcement actions, samples with other than *in situ* measurements (e.g., pH, temperature, conductivity) can be identified with a sample tag. A CLP Sample Number and SMO-assigned Case Number must be recorded on a sample tag to indicate that the sample container comprises the whole sample in the case where there is just one container of sample, or part of the indicated sample in the case of multiple containers of sample. Sampling personnel should refer to their project plans for Region-specific sample tag requirements.

1.4.1.8 Field Operation Records

Sampling personnel should maintain complete, accurate, and legible field operations records as they perform a sampling activity. The following records are included: Field Logbooks; Corrective Action Reports; Sampling Trip Reports; supplemental standardized forms; logs; and records such as maps or photographs that document each step of the work performed in the field. Sampling personnel should refer to their project plans for Region-specific field operations record requirements. These records are very important tools because they are considered part of the official project file when legal issues arise.

2.0 PRE-FIELD ACTIVITIES

This chapter provides instructions for completing the suggested pre-field activities that samplers could complete prior to performing sampling activities. These important pre-field activities will save time and help the sampler to better prepare for the sampling event. Samplers should be aware of issues faced during the sampling process on a regular basis so that they can strive to avoid making the same mistakes or having the same problems that could adversely affect their sampling event. Samplers are also expected to review all pertinent project plans and meet both Contract Laboratory Program (CLP) and Regional requirements that directly impact the structure and purpose of a sampling event.

At-a-Glance: Pre-field Activities.

- ✔ Understand why preparation for a sampling event is so important!
- ✔ Review project plans containing Regional requirements.
- ✔ Plan to meet documentation requirements.
- ✔ Obtain any necessary permits, licenses, and clearances.
- ✔ Identify and obtain sampling materials.
- ✔ Comply with transportation and shipping requirements.
- ✔ Provide shipment notification.
- ✔ Perform readiness review/dry-run.

The project plans provide information such as the type and numbers of samples to be collected, the analytical methods to be used based on the desired level of quantitation, and the necessary equipment and supplies. The plans also describe the sampling method which may require different specific sample volumes/masses, containers, preservation, shipping, and handling to maintain the integrity of the samples without degradation or contamination.
In addition to reviewing project plans, sampling personnel should obtain the necessary permission to access the sampling site. Sampling personnel must also prepare to identify and obtain sampling materials, prepare to meet documentation requirements by obtaining and learning to use the software used for such purposes, comply with transportation and shipping requirements, and perform a readiness review/dry-run of the sampling process.

2.1 Why Preparation for a Sampling Event Is Important

Personnel must prepare to meet CLP requirements for a sampling event, appropriately use the CLP Sample Number and Sample Management Office (SMO)-assigned Case Number, complete the Traffic Report/Chain of Custody (TR/COC) Record using the Field Operations Records Management System Lite (FORMS II Lite) software, and complete and attach the custody seal(s). It is very important that the sampler include the correct CLP Sample Number and SMO-assigned Case Number on each sample. It is also imperative that the TR/COC Record be accurately completed and submitted with the sample(s). Finally, the sampler must accurately and legibly complete and attach a custody seal to each sample bottle, container, or plastic sample bag (as appropriate), and each shipping cooler or container. The custody seal is an excellent means of maintaining a record of chain-of-custody, as well as guarding against possible sample contamination or tampering during shipping.

However, meeting the sampling requirements requires more than just the proper application of a CLP Sample Number on each sample, completion of the TR/COC Record, and use of a custody seal. The actual collection of samples, packaging, and shipping of those samples are equally important to a successful sampling event.
For example, if a sampler collects an insufficient volume of a sample, the laboratory will not be able to perform the requested analysis. Insufficient sample volumes will also result in a laboratory

being unable to analyze a Matrix Spike/Matrix Spike Duplicate (MS/MSD). Finally, if the laboratory receives a sample that is either unpreserved or the sample pH is outside of the required range, the sample cannot be properly analyzed.

Unfortunately, improper shipping and labeling processes and procedures often result in:

- Samples being shipped to the wrong laboratory;
- Broken or empty samples being received at the laboratory; and
- Custody seals or sealant tape that is missing or broken on sample bottles, containers, plastic bags, or shipping coolers shipped to the laboratories.

The importance of completing the paperwork associated with a sampling event cannot be overemphasized. Sampling personnel must make a conscientious effort to accurately complete the TR/COC Record since this is the main document used to derive vital information about a particular sample. The person completing a TR/COC Record must make sure they are careful to avoid errors such as the appropriate sample(s) not being listed, or the wrong samples being listed. In an effort to eliminate such errors and the confusion that can be associated with handwritten TR/COC Records, samplers must use the Field Operations Records Management System (FORMS) II Lite software to complete the TR/COC Record and other associated sampling documentation.

It is extremely important that Quality Control (QC) samples, including Performance Evaluation (PE) samples, be designated and labeled per Regional guidance by samplers in the field. Mislabeling of QC samples can result in improper and/or inaccurate analysis of a sample at the laboratory.

2.2 Why Communication During a Sampling Event Is Important

Communication is a key element in the planning, administrating, and conducting of a sampling event. It is extremely important that all parties involved in a sampling event be in contact throughout the sampling process. The procedures and recommendations outlined in this guide are based on over 20 years of experience that have demonstrated that approximately 50% of all sampling efforts have been negatively affected by incorrect sampling procedures and poor communication among participants.

The key elements of communication for a sampling event include the relationship between the Regional Sample Control Center (RSCC) Coordinator, CLP SMO, the samplers in the field, and the laboratories who will be accepting the samples. For instance, the samplers must contact the RSCC Coordinator to start the process for setting up a sampling event. The RSCC Coordinator will in turn contact CLP SMO who will schedule the sampling event, establish laboratory availability, and arrange for the laboratory to accept projected samples.

It is imperative that the sampler contact the RSCC Coordinator (per Regional guidelines) and allow enough time for the RSCC Coordinator to contact CLP SMO by 12:00 PM Regional Time on the Wednesday prior to the week of the sampling event.

This will enable CLP SMO to provide SMO-assigned Case and CLP Sample Numbers in time for the sampling event. It will also enable CLP SMO to schedule a laboratory and to make sure the laboratory will not have any capacity problems. Communication is also important because if there is a change in the sampling event due to a cancellation or an increase or decrease in the number of samples that will be sent to the laboratory, the sampler can contact

the RSCC Coordinator who can work with CLP SMO to remedy potential capacity, availability, or overbooking problems.

2.3 Review Project Plans Containing Regional Requirements

In addition to meeting CLP requirements, the sample collection process must fulfill numerous Regional requirements. These requirements are determined by a variety of factors that affect how samples should be collected for an individual sampling event. These factors include:

- The type of samples being collected (organic/inorganic, water, or soil/sediment);
- How the samples will be analyzed;
- Acceptance or performance criteria (i.e., Data Quality Objectives [DQOs]); and
- The type of data needed.

The Quality Assurance Project Plan (QAPP) for each sampling project is written to meet requirements outlined in the documents *EPA Requirements for Quality Assurance Project Plans* (QA/R-5), *EPA Guidance on Quality Assurance Project Plans* (G-5), and Regional QAPP preparation documents. The QAPP is prepared in advance of field activities and is used by sampling personnel to develop any subsequent plans such as the Sampling and Analysis Plan (SAP) or the Field Sampling Plan (FSP). Samplers should review the QAPP and any subsequent project plans for information outlining the basic components of a sampling activity. QAPP and project plans should be finalized and approved by appropriate Regional QA personnel, the On-Scene/On-Site Coordinator (OSC), the Site Area Manager (SAM), or the Remedial Project Manager (RPM) before providing them to the sampling team. This should be done prior to the start of field activities. Appendix A explains the functions within a sampling project (as they relate to a sampling event) and the elements of that function as described in a typical QAPP. Copies of all project plans and relevant Standard Operating Procedures (SOPs) should be maintained in the field for the duration of the sampling project.

2.4 Plan to Meet Documentation Requirements

At-a-Glance:
Plan to meet documentation requirements.

- ✔ Request SMO-assigned Case and CLP Sample Numbers.
- ✔ Sample cooler return documentation.
- ✔ Prepare to use the FORMS II Lite software.

Sampling events require a variety of accurate and complete documentation. Sampling personnel should review their project plans to determine the types of documentation they will need to complete for a sampling project and to ensure that they will have the appropriate documentation on-hand in the field. The CLP documentation requirements includes the CLP Sample Number, the SMO-assigned Case Number, the TR/COC Record, sample labels, sample tags, custody seals, and field operations records (as necessary). Sampling personnel will need to request SMO-assigned Case and CLP Sample Numbers for each sampling event prior to starting field activities. They will also need to make sure that they are using the correct TR/COC Records (Organic TR/COC Record for organic analysis or Inorganic TR/COC Record for inorganic analysis) in the FORMS II Lite software. Finally, sampling personnel should be prepared to complete the appropriate shipping cooler return documentation.

Since sampling personnel are required to use the FORMS II Lite software to prepare and submit sampling project documentation and maintain sample chain-of-custody, they must be apprised of all

emergency back up procedures that should be followed in the event of a system failure. Samplers must have access to FORMS II Lite-generated TR/COC Records at sampling events. In the event that the system crashes, samplers must have backup hardcopies of FORMS II Lite TR/COC Records. For information regarding emergency backup procedures, please refer to the following Web site:

http: //www.epa.gov/superfund/programs/clp/trcoc.htm

2.4.1 Request Scheduling of Analysis, SMO-assigned Case Numbers, CLP Sample Numbers, and Laboratory Contact Information

SMO-assigned Case Numbers are assigned based on a request for CLP Routine Analytical Services (RAS), which is processed though the RSCC Coordinator (or their designee). The sampler must request the RSCC Coordinator to schedule CLP RAS analysis. The sampler must make the request such that the RSCC Coordinator can contact CLP SMO by 12:00 PM Regional Time on the Wednesday prior to the week of the sampling event. The sampler should receive SMO-assigned Case and CLP Sample Numbers from the RSCC Coordinator (or their designee) particular to the sampling event by Friday afternoon before the start of sampling activities. The CLP does have the capacity to schedule sampling on an emergency basis, however the sampler must contact the RSCC Coordinator (or their designee) to obtain details regarding how to handle such a situation. When scheduling a sampling event that will last for more than one week, it is recommended that the sampler contact the RSCC Coordinator (or their designee) on a weekly basis to provide updates. This contact between the sampler, RSCC Coordinator (or their designee), and CLP SMO is very important because it will ensure better availability of laboratory capacity.

In addition to SMO-assigned Case and CLP Sample Numbers, samplers should make sure they have accurate laboratory contact information to include:

- Laboratory name;
- Laboratory address;
- Contact name; and
- Laboratory phone number.

This information is used for both TR/COC Records and chain-of-custody documentation and shipping paperwork such as address labels and airbills.

The RSCC Coordinator (or their designee) provides the CLP Sample Numbers for each sampling event to sampling personnel. Once the CLP Sample Numbers have been provided to the sampler, the sampler can use FORMS II Lite to print them onto sample labels. The following characters are not to be used in generating CLP Sample Numbers and should never appear on any paperwork submitted to the laboratory: I; O; U; and V.

A CLP *Sample Number* is defined as a number that is unique per sample and per Statement of Work (SOW), and identifies each CLP sample (see Section 1.4.1.1). Since samples must be identified per SOW, there are two types of TR/COC Records and two letter codes to denote organic vs. inorganic analysis.

A CLP *sample* is defined as one sample matrix, at one concentration level, from one station location for each individual or set of analytical fractions -- provided the fractions are all requested for the same CLP analytical service (i.e., organic or inorganic).

Note: When samples are collected from several station locations to form a composite sample, the composite sample should be assigned either a number from one of the station locations used during collection, or a unique number that represents the composite sample for tracking purposes. The numbering scheme used internally at a sampling event for identifying composite samples should also be documented appropriately (e.g., in the field logs).

Organic CLP Sample Numbers begin with the Regional letter code, followed by letters and numbers. Inorganic CLP Sample Numbers begin with "M", followed by the Regional letter code and then letters and numbers. See Table 2-1 for Region and letter codes for each sample type (i.e., organic or inorganic).

Table 2-1. CLP Sample Number Letter Codes

Region	Letter Code	
	Organic	Inorganic
I	A	MA
II	B	MB
III	C	MC
IV	D	MD
V	E	ME
VI	F	MF
VII	G	MG
VIII	H	MH
IX	Y	MY
X	J	MJ

According to CLP guidelines, each individual inorganic water sample may be analyzed for total metals or dissolved metals, but not both. Therefore, water samples collected for total metal and dissolved metal analyses must receive separate (unique) CLP Sample Numbers. A sampler can use one CLP Sample Number for an inorganic soil or water sample collected for both total metals and cyanide analyses.

Organic soil and water samples may be collected for analysis under the OLM04.3 SOW to detect:

- Semivolatile Organic Analytes (SVOAs); and/or
- Pesticides and Polychlorinated Biphenyls (PCBs); and/or
- Volatile Organic Analytes (VOAs).

Organic water only samples may be collected for analysis under the OLC03.2 SOW to detect:

- SVOAs; and/or
- Pesticides and PCBs; and/or
- VOAs.

Inorganic soil and water samples may be collected for analysis for Cyanide, and for metals using Inductively Coupled Plasma-Atomic Emissions Spectroscopy (ICP-AES) and Cold Vapor Atomic Absorption (CVAA), under the ILM05.2 and ILM05.3 SOWs.

Inorganic water only samples may be collected for analysis for Cyanide, and for metals using Inductively Coupled Plasma-Mass Spectrometry (ICP-MS) and CVAA, under the ILM05.2 and ILM05.3 SOWs.

Samplers should check with their RSCC Coordinator to verify what samples are scheduled to be collected for analysis.

2.4.2 Prepare Sample Cooler Return Documentation

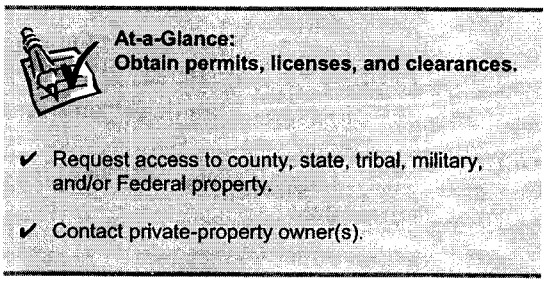
CLP Laboratories must routinely return sample shipping coolers to the appropriate sampling office within 14 calendar days following receipt of shipment from the sampler. In order for sample coolers to be returned, the sampler must complete the appropriate cooler documentation and work with Regions and government agencies to provide a cost-effective mechanism for laboratories to return the empty coolers to the appropriate sampling office. The sampling cooler return documentation can be prepared in advance and provided to sampling personnel before field activities begin. **The sampler (<u>not</u> the CLP laboratory) is responsible for paying for return of the cooler and should also include shipping airbills bearing the sampler's account number, as well as a return address to allow for cooler return.**

To maintain consistency among cooler transportation programs, samplers should:

- Minimize the use of multiple transportation carriers to avoid confusion;
- Use multiple-copy labels so the laboratory and the sampling team can each retain a copy for their records;
- Prepare labels in advance so that the laboratory can simply affix a completed shipping label on the cooler;
- Include third-party billing information (i.e., their shipping account number) on labels so the laboratory will not be billed by the transportation carrier;
- Confirm that the laboratory knows which transportation carrier to use; and
- Include the SMO-assigned Case Number on return information.

2.5 Obtain Municipal Permits, Licenses, and Clearances

Before starting a sampling event, samplers must make sure they have obtained the proper municipal permits, accesses to the property, and any government clearances, if required. The sampler must also contact any appropriate utility companies to ascertain where any underground pipes, cables, etc., may be located.



2.5.1 Request Access to County, State, Tribal, Military, and/or Federal Property

Proper access to perform sampling activities is important not only for legal reasons, but also to eliminate delays in work and possible refusal to allow sampling to take place. It is crucial that the appropriate permits, licenses, and clearances be secured to obtain access for sampling activities that will be performed on county, state, tribal, military and/or Federal property. The sampler must contact the appropriate government offices or personnel well in advance to determine what kinds of approval are required. Pre-approval may be required for specific types of sample collection such as drilling or excavation. For example, drilling on a military base requires pre-approval. Base security may require clearances for all members of the sampling team, including subcontractors. This process may take two or more days.

If arrangements are not made in advance, the team may not be allowed to the enter the site until their clearances are processed and they have been approved to drill. As a result, the sampling schedule is delayed, costing extra time and money.

2.5.2 Contact Private Property Owners

The sampler must obtain written permission from the private property owners before sampling on their property, even if verbal permission has been granted. It is recommended that samplers obtain written permission prior to their arrival at the sampling location, but written permission can be obtained on the day of sampling. If a property owner refuses to grant access to their property, it may be necessary for sampling participants to contact the appropriate authorities for assistance.

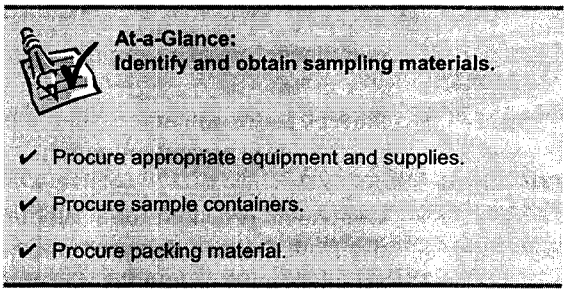
2.5.3 Contact Utility Companies

The sampler should contact local utility companies (e.g., power, phone, gas, cable, sanitation, etc.) at least one week prior to the sampling event to have underground cables, lines, and pipes flagged and marked. This will eliminate potential safety hazards and service disruption. For example, soil sampling in a residential area may require digging below the soil's surface. It is very important to know where utility lines and pipes are located so that sampling personnel do not hit live electrical wires or rupture gas lines. Samplers should follow Regional or other appropriate program procedures for the procurement of such services. The utility service(s) disruption dates should be confirmed at least two days prior to sampling activities.

Note: Pre-payment of survey fees to local utility companies may be required.

2.6 Identify and Obtain Sampling Materials

Samplers must make sure that they are prepared for a sampling project with the appropriate sampling materials to include equipment, supplies, sample containers, packing materials, and shipping materials. The equipment and supplies must be properly cleaned, calibrated, and tested as necessary to meet the needs of the sampling project.



2.6.1 Procure Appropriate Equipment and Supplies

Each sampling event requires the procurement of equipment and materials to collect, document, identify, pack, and ship samples. The proper field sampling equipment is vital to a successful sample collection. Regional or other sampling personnel should obtain, and arrange in advance, all of the equipment and supplies required for each sampling event. Sampling personnel should review the project plans to verify that they are using the proper equipment for sample collection.

At a minimum, the following materials are generally required during a sampling event:

- Sample storage containers;
- Packing material;
- Sample containers;
- Shipping containers;
- Access to the FORMS II Lite software for creating sample labels, tags, and TR/COC Records;
- Custody seals; and
- Sampling equipment such as bowls, augers, pumps, etc.

Sampling events may also require specific items such as:

- Cooler temperature blanks;
- Trip blanks for VOA analysis;
- Preservation supplies (e.g., ice or acid); and
- Specially prepared sample vials (e.g., for SW-846 Method 5035A).

2.6.2 Procure Sample Containers

The analytical protocol(s) to be used for sample analysis often requires the use of a particular type of sample container. The type of container also may depend on the sample matrix and analysis. For example, samples collected for low-level soil VOA analysis using SW-846 Method 5035A may require the sampler to use pre-prepared, tared closed-system purge-and-trap vials with a preservative (refer to Appendix B).

Using the wrong container may result in breakage, gathering of an insufficient volume needed to perform sample analysis, or the container material may interfere with the analysis. Therefore, sampling personnel should identify and use the correct sample containers for each sampling event.

Using the wrong container may result in breakage, gathering of an insufficient volume needed to perform sample analysis, or the container material may interfere with the analysis. Therefore, sampling personnel should identify and use the correct sample containers for each sampling event.

Note: Extra containers should be provided for each sampling event in case of breakage, loss, or contamination.

Containers procured for a sampling event are usually pre-cleaned and shipped ready-for-use from the manufacturer to the sampling site. Regardless of the type of container used, samplers must ensure that the containers have been analyzed/certified clean to levels below concern for the project. These containers must meet the USEPA container type specifications listed in Table 2-2. The information contained in this table is also cross-referenced in the sample collection parameters discussed in Chapter 3. The container Reference Numbers are used in Tables 3-2 and 3-3 under the Containers column.

It is recommended that samplers use borosilicate glass containers (e.g., Kimax or Pyrex), which are inert to most materials, when sampling for pesticides and/or other organics. Conventional polyethelene is recommended when sampling for metals because of the lower cost and absorption rate of metal ions.

Table 2-2. Container Type Specifications

Reference Number	Container Type	Specifications	
		Closure	Septum
1	40 mL amber glass vial, 24 mm neck finish.	Polypropylene or phenolic, open-top screw-cap, 15 cm opening, 24-400 size.	24 mm disc of 0.005 in Polytetrafluoroethylene (PTFE) bonded to 0.120 in silicone for total a thickness of 0.125 in.
2	1 L high density polyethylene, cylinder-round bottle, 28 mm neck finish.	Polyethylene cap, ribbed, 28-410 size; F217 polyethylene liner.	N/A
3	8 oz short, wide mouth, straight-sided, glass jar, 70 mm neck finish.	Polypropylene or phenolic cap, 70-400 size; 0.015 in PTFE liner.	N/A
4	4 oz (120 mL) tall, wide mouth, straight-sided, glass jar, 48 mm neck finish.	Polypropylene or phenolic cap, 48-400 size; 0.015 in PTFE liner.	N/A
5	1 L amber, Boston round glass bottle, 33 mm pour-out neck finish.	Polypropylene or phenolic cap, 33-430 size; 0.015 in PTFE liner.	N/A
6	500 mL high density polyethylene, cylinder-round bottle, 28 mm neck finish.	Polypropylene cap, ribbed, 28-410 size; F217 polyethylene liner.	N/A

Table 2-2. Container Type Specifications (Con't)			
Reference Number	Container Type	Specifications	
		Closure	Septum
7	Coring tool used as a transport device (e.g., EnCore™ 5 g Sampler).	Has built-in closing mechanism.	N/A
8	250 mL high density polyethylene, cylinder-round bottle, 28 mm neck finish.		N/A

2.6.3 Procure Packing Materials

Samples should be correctly packaged for shipment to the laboratory to eliminate the risk of breakage or spillage and to properly contain certain types of samples. The sampler should refer to their project plans to determine the types of samples to be taken during the sampling project to ensure that they are properly prepared to package the sample containers with the appropriate packaging materials. For example, samplers must package certain samples in sample coolers, while others containing hazardous materials must be shipped in metal cans.

2.6.4 Procure Shipping Supplies

Samples should be correctly packaged into the appropriate shipping containers to reduce the risk of breakage or leakage, and the shipping containers should be appropriately prepared for shipment. Before heading into the field, samplers should refer to their project plans to determine the types of samples they will take during the sampling project so that they will have the proper packaging materials at the site for all pertinent samples container types and sample matrices. Samplers should also make sure they have obtained the appropriate shipping paperwork (e.g., FedEx or UPS shipping forms).

2.7 Comply with Transportation and Shipping Requirements

Sampling personnel are expected to review the applicable project plans to be aware of all State, Federal, Department of Transportation (DOT), and International Air Transport Association (IATA) regulations governing environmental and hazardous sample packaging. The person who ships the samples is responsible for being in compliance with applicable packaging, labeling, and shipping requirements.

Additional information can be obtained on Hazardous Materials Safety Program regulations from the DOT's Research and Special Programs Administration. Federal transportation regulations can be found in 49-CFR Parts 100-185, are available on the Internet at:

http://www.myregs.com/dotrspa/

2.8 Provide Shipment Notification

Some Regions may require that sampling personnel notify their RSCC Coordinator (or their designee) when they ship samples. Some Regions allow samplers to contact CLP SMO directly to provide shipment notification. It is recommended that sampling personnel contact the RSCC of sample origin to verify if such notification is necessary.

Regardless of Regional notification requirements, sampling personnel **must immediately** report all CLP sample shipments to the RSCC Coordinator (or their designee) or to CLP SMO. If sampling personnel are shipping samples after 5:00 PM Eastern Time (ET), they must notify the RSCC Coordinator (or their designee) or CLP SMO by 8:00 AM ET on the following business day.

Important Note: For Saturday delivery at the laboratory, samplers MUST contact the RSCC Coordinator (or their designee) or CLP SMO such that CLP SMO will receive the delivery information by 3:00 PM ET on the Friday prior to delivery.

2.9 Perform Readiness Review/Dry-run

A readiness review/dry-run is a test run of the proposed sampling event. This is a recommended practice since it gives sampling personnel a chance to check all plans, documentation software (i.e., FORMS II Lite), and equipment lists for accuracy and completeness prior to sampling activities. It also provides an opportunity to consult with sampling team members to make sure all the elements are in place and everyone understands their tasking before actually going out to the field. Sampling project managers should provide samplers the test or dry-run dates and schedules so they can prepare accordingly.

If problems are experienced with using the FORMS II Lite software during the readiness review/dry-run, please contact the FORMS II Lite Help Desk at 703-818-4200 from 9:00 AM - 5:00 PM ET.

3.0 IN-FIELD ACTIVITIES

This chapter addresses the in-field activities a sampler will focus on during a sampling event such as: determining the type of samples to be collected; collecting the samples; meeting volume, preservation, and holding time requirements; completing documentation; and packing and shipping samples.

At-a-Glance: In-field Activities.

✔ Collecting samples:
- Determine types of samples to be collected.
- Meet volume, preservation, and holding time requirements.

✔ Completing documentation:
- Identify a sample with a Contract Laboratory Program (CLP) Sample Number
- Identify a sample with a CLP Sample Management Office (SMO)-assigned Case Number
- Complete Traffic Report/Chain of Custody (TR/COC) Records.
- Complete and attach sample labels.
- Complete and attach sample tags.
- Complete and attach custody seals.

✔ Sampling considerations:
- General sampling techniques.
- Special sampling considerations.
- Contaminant sampling.
- Sample compositing and mixing.

✔ Packing and shipping samples:
- Sample containers.

When performing a sampling event, the sampler is expected to follow prescribed sampling techniques. The sampler should also be aware of any special sampling considerations, contamination issues, and sample compositing and mixing methods that could affect their sampling efforts. Please refer to Appendix D for more detailed information.

Note: Appropriate Regional guidance and procedures should be consulted for detailed sample collection, preservation, handling and storing, equipment decontamination, and Quality Assurance/Quality Control (QA/QC) procedures.

3.1 Collecting Samples

A CLP sample consists of all sample aliquots (portions):
- for each individual or set of analytical fractions;
- from one station location;
- for one sample matrix;
- at one concentration level;
- for one laboratory; and
- for one analytical program,

provided that the fractions are all requested from the same CLP analytical service.

CLP Routine Analytical Services (RAS) are generally used to analyze samples from Superfund sites. The matrices can be water, soil, or sediment. In some instances, a mixed-matrix sample may be collected which contains either a supernate (for a sediment/soil sample) or a precipitate (for a water sample). In this event, samplers should consult their management plans and/or discuss the required procedures with the Regional Site Manager (RSM) or their designee. In general, it is recommended that two individual samples be collected by separating the aqueous layer from the solid/precipitate layer at the point of collection.

3.1.1 Determine Types of Samples to be Collected

Sampling personnel may be required to take several types of samples or sample aliquots during a sampling event. Samplers should refer to their project plans to determine the types of samples or aliquots to be taken, the volumes needed of each sample or aliquot, and the preservation needed for each sample. For an explanation of the various sample types and the requirements for collecting and submitting each particular type, refer to Table 3-1.

Table 3-1. Quality Control Sample Types and CLP Submission Requirements

Sample Type	Purpose	Collection [1]	CLP Sample Number
Field Duplicate	To check reproducibility of laboratory and field procedures. To indicate non-homogeneity.	Collect from areas that are known or suspected to be contaminated. Collect one sample per week or 10% (Regions may vary) of all field samples per matrix, whichever is greater.	Assign two separate (unique) CLP Sample Numbers (i.e., one number to the field sample and one to the duplicate). Submit blind to the laboratory.
Field Blanks	To check cross-contamination during sample collection, preservation, and shipment, as well as in the laboratory. Also to check sample containers and preservatives.	Collect for each group of samples of similar matrix per day of sampling. Organics - Use water (demonstrated to be free of the contaminants of concern). Inorganics - Use metal-free (deionized or distilled) water.	Assign separate CLP Sample Numbers to the field blanks.
Trip Blank (Volatile Organic Analysis Only)	To check contamination of Volatile Organic Analyte (VOA) samples during handling, storage, and shipment from field to laboratory.	Prior to going into the field, prepare and seal one sample per shipment per matrix using water demonstrated to be free of the contaminants of concern (deionized water is appropriate). Place this sample in the cooler used to ship VOA samples.	Assign separate CLP Sample Numbers to the trip blanks.
Equipment Blank or Rinsate Blank	To check field decontamination procedures.	Collect when sampling equipment is decontaminated and reused in the field or when a sample collection vessel (bailer or beaker) will be used. Use blank water (water decontamination to be organic-free, deionized or distilled for inorganics) to rinse water into the sample containers.	Assign separate CLP Sample Numbers to the equipment blanks.
Matrix Spike and Matrix Spike Duplicate (MS/MSD)[2] (Organic Analysis Only)	To check accuracy and precision of organic analyses in specific sample matrices.	Collect from areas that are known or suspected to be contaminated. For smaller sampling events (i.e., 20 samples or less), MS/MSD additional volume should be collected in the first round of sampling and included in the first shipment of samples to the laboratory. Collect double or triple volume[3] for aqueous samples and soil VOA samples designated for MS/MSD analyses. Additional sample volume is not required for soil samples requiring Semivolatile Organic Analyte (SVOA) and/or Pesticide/Polychlorinated Biphenyl (PCB) analysis. See Appendix B for VOA collection volumes.	Assign the same CLP Sample Number to the field sample and the extra volume for MS/MSD. Identify the sample designated for MS/MSD on the Traffic Report/Chain of Custody (TR/COC) Record.

Table 3-1. Quality Control Sample Types and CLP Submission Rquirements (Con't)

Sample Type	Purpose	Collection [1]	CLP Sample Number
Matrix Spike and Laboratory Duplicate (Inorganic Analysis Only)	To check accuracy and precision of inorganic analyses in specific sample matrices.	Collect from areas that are known or suspected to be contaminated. For smaller sampling events (i.e., 20 samples or less), Matrix Spike and laboratory duplicates should be collected in the first round of sampling and included in the first shipment of samples to the laboratory. Additional sample volume may be required for inorganic analysis.[4]	Assign the same CLP Sample Number to the field sample and extra volume (if collected). Identify the sample(s) designated for Matrix Spike and laboratory duplicates on the TR/COC Record.
Performance Evaluation (PE) Samples	Specially-prepared QC samples used to evaluate a laboratory's analytical proficiency.	The PE samples contain analytes with concentrations unknown to the laboratory. Designated Regional or authorized personnel (depending on Regional policy) arrange for Case-specific CLP PE samples to be prepared and shipped by the Quality Assurance Technical Support (QATS) contractor. The PE samples can be shipped to the site, or shipped per Regional directon. QATS provides the appropriate preparation instructions and chain-of-custody materials.	Samplers have no direct interaction with the PE sampling process, but should be aware that such samples do exist within the CLP sampling process. Samplers must, however, order PE samples and ship them to the laboratory if required by the Region.

[1] Consult Regional or Project Manager guidance for field QC sample frequencies; laboratory QC sample frequencies are generally fixed in the laboratory subcontracts or specified in analytical methods. Current frequency for MS/MSD (organic) and MS/duplicate (inorganic) for the CLP is one sample per twenty field samples of similar matrix.

[2] Samples sent under the Low Concentration Organic SOW (OLC03.2) do not require an MS or MSD, but the Region may opt to send them at their discretion.

[3] Example of double volume: An aqueous sample for SVOA analysis would require the field sampler to collect at least 2 L of field sample and at least 1 L each for the MS and MSD samples for a total volume of 4 L. If Pesticide/PCB MS/MSD analyses is required for the same sample, an additional 4 L must be collected. Double volume is the MINIMUM allowable volume for samples designated for MS/MSD analysis. Triple volume may be sent for MS/MSD samples to allow for sufficient volume for these analysis in the event sample volume is lost as a result of samples breaking, leaking, or laboratory accidents.

[4] Double volume may be sent for inorganic aqueous MS and laboratory duplicate samples to allow for sufficient volume for these analysis in the event sample volume is lost as a result of samples leaking or laboratory accidents.

3.1.1.1 Collect Field Quality Control (QC) Samples

Samplers can collect Field Quality Control (QC) samples and laboratory QC samples to verify that sample quality is maintained during a sampling project.

Field QC samples are designed to assess variability of the media being sampled and to detect contamination and sampling error in the field. The types of Field QC samples that are generally collected include field duplicates and field blanks (such as equipment, trip, or rinse blanks).

Generally, field duplicate samples should remain "blind" to the laboratory (i.e., they should have separate CLP Sample Numbers). The sampler should also prepare them to look identical to field samples (i.e., label, package, and shipment method).

3.1.1.2 Collect Laboratory Quality Control (QC) Samples

A Laboratory QC sample is an additional analysis of a field sample, as required by the laboratory's contract. There are three types of laboratory QC samples:

- Matrix Spikes (MSs) [for organic and inorganic samples];
- Matrix Spike Duplicates (MSDs) [for organic samples only]; and
- Laboratory duplicates (for inorganic samples only).

Note: Samplers should obtain Regional guidance for MS/MSDs.

Samplers should select one sample per matrix per 20 samples as a "laboratory QC" sample. Designated organic laboratory QC samples should be noted on the Organic TR/COC Record. Designated inorganic laboratory QC samples should be noted on the Inorganic TR/COC Record. The laboratory QC sample must not be designated in the "Field QC Qualifier" column on either the Organic or Inorganic TR/COC Records.

The sampler should select a field sample as the laboratory QC sample. If the sampler does not select a field sample as the laboratory QC sample, then it is possible that the laboratory could select the field blank (e.g., an equipment or rinse blank) sample to meet contractual QC requirements. The use of field blanks for laboratory MS/MSD/duplicate QC analysis reduces the usability of the data to assess data quality.

Extra volumes should be shipped with each group of samples (i.e., with each Sample Delivery Group [SDG]). For organic analyses, extra volumes will be collected in separate containers for MS and MSD samples. Mark these extra volume containers with the CLP Sample Number and "MS/MSD".

Note: In the event of multiple sample shipments during a sampling event, it is recommended that the sampler submit laboratory QC samples in the first sample shipment.

3.1.2 Meeting Volume, Preservation, and Holding Time Requirements

Sampling personnel should refer to their project plans to obtain the specific sample volumes to be collected, the preservation needed for those samples, and the technical holding times under which they must submit samples to the scheduled CLP laboratory. Currently available sample collection parameters (to include sample volumes, preservatives, and technical holding times) for organic collection and analysis are listed in Table 3-2. Sample collection parameters for inorganic analysis and collection are listed in Table 3-3. To determine availability of sampling services, please visit the USEPA Web site at:

http://www.epa.gov/superfund/programs/clp/index.htm

3.1.2.1 Collecting Sample Volume

Collecting sufficient sample volume is critical. There must be sufficient physical sample volume for the analysis of all required parameters and completion of all QC determinations. The type of analytical procedure(s) to be performed will often dictate the sample volume to collect. For example, each water sample collected for VOA analysis by CLP SOW OLM04.3 requires a minimum of two vials, each filled completely to a 40 mL capacity. See Appendix C for information regarding the collection of VOAs in water. It is extremely important that sampling personnel refer to their specific project plans to identify and collect the correct sample volume during each sampling event.

When sampling for VOAs in soils, samplers must use SW-846 Method 5035A guidelines included in Appendix B.

3.1.2.2 Preserving Samples

Degradation of some contaminants may occur naturally (e.g., VOAs). The sampler must chemically preserve some water samples for certain analytes before shipping them to the laboratory. The sampler should preserve and immediately cool all samples to 4°C (±2°C) upon collection to time of analysis (do not freeze water samples). Preservation techniques vary among Regions so the sampler should obtain Region-specific instructions and review the appropriate project plans and Standard Operating Procedures (SOPs). See Appendix C for information regarding the collection of VOAs in water.

3.1.2.3 Shipping Within Holding Times

Sampling personnel should ship samples to scheduled CLP laboratories as soon as possible after collection. Daily shipment of samples to CLP laboratories is preferred whenever possible. If samples cannot be shipped on a daily basis, they must be properly preserved and maintained to meet CLP-specified temperatures, holding times, and custody requirements.

The technical holding times are the maximum lengths of time allowed between when a sample is collected and when the extraction and/or analysis is completed. In contrast, contractual holding times are the maximum lengths of time that the CLP laboratory can hold the sample prior to extraction and/or analysis. These contractual holding times are described in the appropriate CLP SOW. Contractual holding times are shorter than the technical holding times to allow for sample packing and shipping.

If sampling personnel are shipping samples after 5:00 PM Eastern Time (ET), they must notify the RSCC Coordinator (or their designee) or CLP SMO by 8:00 AM ET on the following business day. When making a Saturday delivery, samplers **must** contact the RSCC Coordinator (or their designee) or CLP SMO by 3:00 PM ET on the Friday prior to delivery. Samplers should contact their RSCC Coordinator to obtain a CLP SMO contact name and phone number.

Table 3-2. Low Medium and Low Concentration Organic Collection Parameters (SOW OLM04.3 and OLC03.2)

Analysis	Matrix	Containers	Volume/ Mass	Special Notes	Preservative	Technical Holding Time[1]
Volatile Organic Analytes (VOAs)	Water	At least two 40 mL glass containers with Polytetrafluoroethylene (PTFE)-lined septa and open top screw-caps (see Table 2-2, Reference Number 1). If Selected Ion Monitoring (SIM) analysis is requested, at least two additional 40 mL glass containers with Polytetrafluoroethylene (PTFE)-lined septa and open top screw-caps that are filled to capacity with no air bubbles, preserved to a pH of 2 with HCL, and cooled to 4°C (±2°C) immediately after collection (see Table 2-2, Reference Number 1).	Fill to capacity	Vials must be filled to capacity with no headspace or air bubbles. Refer to Appendix C for samples requiring QC analyses.	Preserve to a pH of 2 with HCL and cool to 4°C (±2°C) immediately after collection.[2] DO NOT FREEZE water samples.	14 days
	Soil/Sediment	Option 1: At least three 40 mL glass containers with PTFE-lined septa and open tip screw-caps, pre-weighed and containing magnetic stir bars (see Table 2-2, Reference Number 1). AND One container of sample filled with no headspace for determination of moisture content.	5 g	Place samples on side prior to being frozen. Refer to Appendix B for samples requiring QC analyses.	Frozen (-7°C and -15°C)	14 days
			5g	Refer to Appendix B for samples requiring QC analysis.	Iced to 4° (±2°C).	48 hours
		Option 2: At least three 40 mL glass containers with PTFE-lined septa and open tip screw-caps, pre-weighed and containing magnetic stir bars (see Table 2-2, Reference Number 1). Two of the containers will also contain 5 mL of water. AND One container of sample filled with no headspace for determination of moisture content.	5 g	Place samples on side prior to being frozen. Refer to Appendix B for samples requiring QC analysis.	Frozen (-7°C and -15°C).	14 days
			5 g	Refer to Appendix B for samples requiring QC analysis.	Iced to 4° (±2°C)	48 hours

Table 3-2. Low Medium and Low Concentration Organic Collection Parameters (SOW OLM04.3 and OLC03.2) (Con't)

Analysis	Matrix	Containers	Volume/ Mass	Special Notes	Preservative	Technical Holding Time[1]
Volatile Organic Analytes (VOAs) (Con't)	Soil/Sediment	Option 3: At least three coring tools used as transport devices (e.g., Encore™ 5 g Samplers) (see Table 2-2, Reference Number 7). AND One container of sample filled with no headspace for determination of moisture content.	5 g	Refer to Appendix B for samples requiring QC analysis.	Frozen (-7°C and -15°C) or iced to 4° (±2°C).	48 hours
Semivolatile Analytes	Water	At least two 1 L amber glass bottles, fitted with screw-caps lined with PTFE (see Table 2-2, Reference Number 5).	2 L	If amber containers are not available, the samples should be protected from light.	Cool all samples to 4°C (±2°C) immediately after collection. DO NOT FREEZE water samples.	7 days
	Soil/Sediment	Use one 8 oz wide-mouth glass jar or two 4 oz wide-mouth glass jars (see Table 2-2, Reference Numbers 3 and 4).	Fill to capacity		Cool all samples to 4°C (±2°C) immediately after collection.	14 days
Pesticides/ Aroclors	Water	At least two 1 L amber glass bottles, fitted with screw-caps lined with PTFE (see Table 2-2, Reference Number 5).	2 L	If amber containers are not available, the samples should be protected from the light.	Cool all samples to 4°C (±2°C) immediately after collection. DO NOT FREEZE water samples.	7 days
	Soil/Sediment	Use one 8 oz wide-mouth glass jar or two 4 oz wide-mouth glass jars (see Table 2-2, Reference Numbers 3 and 4).	Fill to capacity		Cool all samples to 4°C (±2°C) immediately after collection.	14 days

[1]This technical holding time is calculated from the time of sample collection to sample extraction. Sample extracts are to be analyzed within 40 days of extraction. It is recommended that samplers ship samples to the laboratory on the same day that they are collected, or as soon as possible thereafter.

[2]Check Regional guidance regarding use of acid preservatives when testing for carbonates, residual chlorine, and other oxidants.

[3]When sampling for VOAs in soil using the CLP options of SW-846 Method 5035A, samplers should use the requirements that are provided in Appendix B.

Table 3-3. Inorganic Sample Collection Parameters (SOW ILM05.2 and ILM05.3)

Target Analyte/Method	Matrix	Containers	Volume/ Mass	Special Notes	Preservative	Technical Holding Time[1]
Metals/ICP-AES and/or Mercury by CVAA	Water	Use one 1 L high density polyethylene glass bottle (see Table 2-2, Reference Number 2).	1 L	If collecting for both ICP-AES **AND** ICP-MS methods, a separate 1 L volume of sample must be collected for each method per sample location.	Acidify to pH <2 with HNO_3 and cool to 4°C (±2°C) immediately after collection.[2] DO NOT FREEZE water samples.	6 months for all metals except Mercury (28 days)
	Soil/ Sediment	Use one 8 oz wide-mouth glass jar (see Table 2-2, Reference Number 3).	Fill to capacity		Cool to 4°C (±2°C) immediately after collection.	6 months
Metals/ICP-MS and/or Mercury by CVAA	Water	Use one 1 L high density polyethylene glass bottle (see Table 2-2, Reference Number 2).	1 L	If collecting for both ICP-AES **AND** ICP-MS methods, a separate1 L volume of sample must be collected for each method per sample location.	Acidify to pH <2 with HNO_3 and cool to 4°C (±2°C) immediately after collection.[2] DO NOT FREEZE water samples.	6 months for all metals except Mercury (28 days)
Cyanide/Spectro-photometric Determination[3]	Water	Use one 1 L high density polyethylene glass bottle (see Table 2-2, Reference Number 2).	1 L		To neutralize residual chlorine, immediately upon collection, add 0.6 g ascorbic acid for each liter of sample collected. Add NaOH until pH >12 and cool to 4°C (±2°C) immediately after collection. DO NOT FREEZE water samples.	14 days
	Soil/ Sediment	Use one 8 oz wide-mouth glass jar (see Table 2-2, Reference Number 3).	Fill to capacity		Cool to 4°C (±2°C) immediately after collection.	14 days

[1]The technical holding time is calculated from the time of sample collection. It is recommended that samplers ship samples to the laboratory the same day that they are collected, or as soon as possible thereafter.

[2]For the analysis of dissolved metals, the sampler is required to filter the sample through a membrane filter (such as a 0.45 micron pore diameter membrane filter) at the time of collection or as soon as possible thereafter. Use a portion of the sample to rinse the filter flask, discard this portion, and collect the required volume of filtrate. Then preserve as described above.

[3]Samplers must test for sulfide and oxidizing agents (e.g., chlorine) in aqueous samples in the field upon collection. Please refer to the SAP and Appendix C for guidance. Sulfides adversely affect the analytical procedure. The following can be done to test for and neutralize sulfides. Place a drop of the sample on lead acetate test paper to detect the presence of sulfides. If sulfides are present, treat 25 mL more of the sample than that required for the cyanide determination with powdered cadmium carbonate or lead carbonate. Yellow cadmium sulfide or black lead sulfide precipitates if the sample contains sulfide. Repeat this operation until a drop of the treated sample solution does not darken the lead acetate test paper. Filter the solution through a dry filter paper into a dry beaker, and from the filtrate measure the sample to be used for analysis. Avoid a large excess of cadmium carbonate and a long contact time in order to minimize a loss by complexation or occlusion of cyanide on the precipitated material. Sulfide removal should be performed in the field, if practical, prior to pH adjustment with NaOH.

3.2 Complete Required Documentation

The documentation that sampling personnel must complete is the recording of the CLP Sample Number and the SMO-assigned Case Number on the sample container or bottle, the use of sample tags, labels, and chain-of-custody seals (as appropriate), the completion of the Traffic Report/Chain of Custody (TR/COC) Record, and the completion of field operations records (as necessary).

Sampling personnel are expected to review their project plans to determine what documentation they are expected to include during a sampling event. It is highly recommended that sampling personnel use this documentation, even if the Region does not require it.

Note: Under no circumstances should the site name appear on any documentation being sent to the laboratory.

An example of a packaged sample is shown in Figure 3-1. A description of each type of documentation and instructions for accurately completing them are included in the following sections.

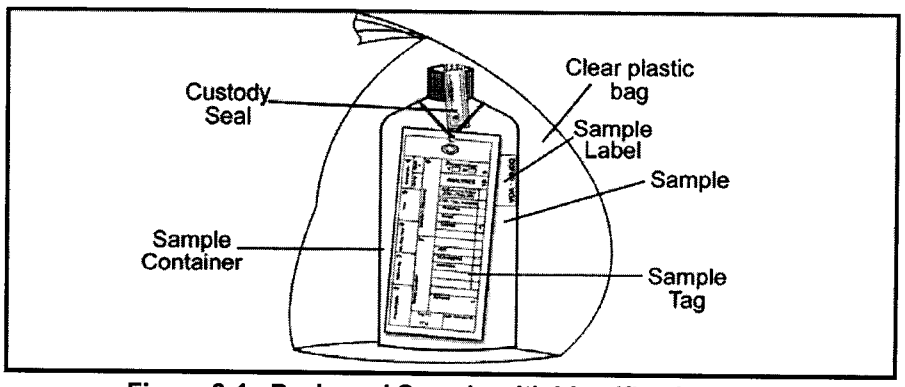


Figure 3-1. Packaged Sample with Identification and Chain-of-Custody Documentation (Excluding TR/COC Record) Attached

3.2.1 Identify a Sample with a CLP Sample Number and SMO-Assigned Case Number

The CLP Sample Number and SMO-assigned Case Number **must** be recorded on each sample taken during a sampling event (see Section 1.4.1.1). Sampling personnel can record these numbers on the sample bottle or container using permanent ink. The numbers must also be recorded on the sample tag.

Note: Dissolved metal samples and total metal samples taken from the same sampling location cannot have the same CLP Sample Number because two different sets of data will be generated for evaluation purposes.

3.2.2 Complete Traffic Report/Chain of Custody (TR/COC) Records

A TR/COC Record is used as physical evidence of sample custody and as a permanent record for each sample collected. A chain-of-custody record documents the exchange and transportation of samples from the field to the laboratory.

The Analytical Services Branch (ASB) requires samplers to use the FORMS II Lite software to create documentation for all CLP sampling efforts. For assistance with obtaining or using the FORMS II Lite software, please contact the FORMS II Lite Help Desk at 703-818-4200 from 9:00 AM - 5:00 PM ET.

To meet CLP sample documentation and chain-of-custody requirements, the sampler must attach a separate TR/COC Record to each cooler they ship. The TR/COC Record must document each sample within the cooler. Samples shipped in other coolers should not be documented. This practice maintains the chain-of-custody for all samples in case of incorrect shipment.

It is critical that each CLP sample have a unique CLP Sample Number and SMO-assigned Case Number, therefore samplers must avoid errors such as:

- Failure to use CLP Sample Numbers or SMO-assigned Case Numbers;
- Incorrect use of CLP Sample Numbers or SMO-assigned Case Numbers (e.g., duplication); and
- Water and soil samples sent under the same CLP Sample Number.

If more than one TR/COC Record is used for the samples within one cooler, all of the records must have complete header information and original signatures. Sampling personnel are responsible for the care and custody of samples from the time of collection to the time of shipment to the laboratories for analysis. A sample is considered under custody if:

- It is in possession or in view after being in possession;
- It was in possession and then locked up or sealed to prevent tampering; or
- It was in possession when placed in a secured area.

Each time the custody of samples is turned over to another person, the TR/COC Record must be signed off by the former custodian and accepted by the new custodian. Sampling personnel are, therefore, responsible for properly completing any forms or other Region-required documentation used to establish the chain-of-custody for each sample during a sampling event.

3.2.2.1 Completing a Traffic Report/Chain of Custody (TR/COC) Record Using the FORMS II Lite Software

A sampler will input sample collection information into FORMS II Lite and a TR/COC Record will be generated electronically. The software will automatically allocate space on the form only to the fields used by the sampler. This feature of the software re-allocates on an as-needed basis, displaying only the information input by the sampler when the TR/COC Record is printed. The FORMS II Lite software will generate a laboratory and a Regional copy of the TR/COC Record (see Figures 3-2 through 3-5). The sampler can print out multiple copies of the TR/COC Record as necessary. The sampler must sign and submit original copies of the TR/COC Record as appropriate.

An electronic TR/COC Record created using the FORMS II Lite software contains basic header information; however, the sampler can

also include some additional detailed information. For example, not only is the sample matrix listed on the electronic TR/COC Record, but the name of the sampler taking the sample can also be entered. The appearance of more space on the electronic TR/COC Record is a result of the space re-allocation on an as-needed basis. Samplers should note that certain guidance information will not appear on the electronic TR/COC Record (e.g., matrix and preservative descriptions).

3.2.2.2 Indicating Method Flexibility on FORMS II Lite TR/COC Records

When completing a TR/COC Record using FORMS II Lite, the sampler should identify any samples that will be analyzed using a CLP-modified analysis (i.e., Method Flexibility Clause). Samplers should indicate use of a modified analysis by inputting the name of the analysis and its associated abbreviation code. To do this, a new analysis must be created within the FORMS II Lite Wizard or through the FORMS II Lite Reference Tables. This newly-created analysis should contain the Modification Reference Number within the name assigned to the flexibility clause. For example, if a Region submits a modified analysis for an additional analyte, and CLP SMO assigns the Modification Reference Number as "R9092203", the FORMS II Lite analysis could be named as "VOA by M.A. R9092203". The associated abbreviation for this analysis would be "VOA M.A.". If you have any questions regarding identification of method flexibility using FORMS II Lite, please contact the FORMS II Lite Help Desk at 703-818-4200 from 9:00 AM - 5:00 PM ET.

3.2.2.3 Making Manual Edits to Printed FORMS II Lite TR/COC Records

If FORMS II Lite TR/COC Record has been printed and deletions or edits need to be made by the sampler, the following procedures must be followed:

- **If a making a deletion,** cross out the information to be deleted from the TR/COC Record and initial and date the deletion.
- **If making an addition,** enter the new information and sign and date the newly added information.

Note: All modifications made on a printed TR/COC Record must be initialed and dated.

Figure 3-2. An Organic TR/COC Record Created Using the FORMS II Lite Software (Laboratory Copy)

EPA **USEPA Contract Laboratory Program**
Organic Traffic Report & Chain of Custody Record

Case No: 99999
DAS No:
SDG No:
L

Date Shipped: 04/09/2001
Carrier Name: FedEx
Airbill: 4133427744
Shipped to: Organic Lab
999 Route 120
Arlington, VA 22044
(999) 555-5555

Chain of Custody Record

Relinquished By	(Date / Time)	Received By	(Date / Time)
1			
2			
3			
4			

Sampler Signature:

For Lab Use Only
Lab Contract No:
Unit Price:
Transfer To:
Lab Contract No:
Unit Price:

ORGANIC SAMPLE No.	MATRIX/ SAMPLER	CONC TYPE	ANALYSES/ TURNAROUND	TAG No/ PRESERVATIVE	STATION LOCATION		SAMPLE COLLECT DATE/TIME	INORGANIC SAMPLE No.	FOR LAB USE ONLY Sample Condition On Receipt
C0100	Surface Soil (0"-6") DAN SAMPLER, BOB SAMPLER	XG	Aroclors (7)	31 (Ice Only) (1)	1	S	04/09/2001 11:05		
C0101	Surface Soil (0"-6") DAN SAMPLER	XG	Aroclors (7)	32 (Ice Only) (1)	2	S	04/09/2001 11:20		
C0102	Surface Soil (0"-6") DAN SAMPLER, BOB SAMPLER	XG	Aroclors (7)	33 (Ice Only) (1)	3	S	04/09/2001 11:30		
C0103	Sediment DAN SAMPLER, BOB SAMPLER	XG	Aroclors (7)	34 (Ice Only) (1)	4	S	04/09/2001 11:45		
C0104	Sediment DAN SAMPLER	XG	Aroclors (7)	35 (Ice Only) (1)	5	S	04/09/2001 11:55		
C0107	Surface Water DAN SAMPLER	XG	Aroclors (7)	3133 (Ice Only), 3134 (Ice Only) (2)	1	S E	04/09/2001 10:52 04/09/2001 10:54		
C0108	Sediment JOE SAMPLER	XG	Aroclors (7)	3135 (Ice Only) (1)	3	S	04/09/2001 10:5[illegible]		

Shipment for Case Complete?(Y)	Sample(s) to be used for laboratory QC: C0100	Additional Sampler Signature(s):	Cooler Temperature Upon Receipt:	Chain of Custody Seal Number:
Analysis Key:	Concentration: L = Low, M = Low/Medium, H = High	Type/Designate: Composite = C, Grab = G	Custody Seal Intact?___	Shipment Iced?___

Aroclors = Aroclors, BNA = TCL Semivolatiles, VOA = TCL Volatiles

TR Number: 3-235781339-040901-0002

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Figure 3-3. An Inorganic TR/COC Record Created Using the FORMS II Lite Software (Laboratory Copy)

EPA **USEPA Contract Laboratory Program**
Inorganic Traffic Report & Chain of Custody Record

Case No: 99999
CAS No:
SDG No:
L

Date Shipped: 04/09/2001
Carrier Name: FedEx
Airbill: #103427133
Shipped to: norganic Lab
555 Clp Street
CLP VA 22044
(703) 555-5555

Chain of Custody Record

Relinquished By	(Date / Time)	Received By	(Date / Time)
1			
2			
3			
4			

Sampler Signature:

For Lab Use Only
Lab Contract No:
Unit Price:
Transfer To:
Lab Contract No:
Unit Price:

INORGANIC SAMPLE No.	MATRIX SAMPLER	CONC/ TYPE	ANALYSIS/ TURNAROUND	TAG No./ PRESERVATIVE	STATION LOCATION	SAMPLE COLLECT DATE/TIME	ORGANIC SAMPLE No.	FOR LAB USE ONLY Sample Condition On Receipt
MC3103	Sediment/ DAN SAMPLER, BOB SAMPLER	/G	TM (7)	35 (Ice Only) (1)	4	S: 04/09/2001 11:45		
MC3104	Sediment/ DAN SAMPLER	/G	TM (7)	37 (Ice Only) (1)	5	S: 04/09/2001 11:55		
MC3106	Sediment/ DAN SAMPLER	/G	TM (7)	311 (Ice Only) (1)	3	S: 04/09/2001 9:52		
MC3107	Surface Water/ DAN SAMPLER	/G	TM (7)	312 (HNO3, Ice) (1)	1	S: 04/09/2001 10:52 E: 04/09/2001 10:54		
MC3108	Sediment/ JOE SAMPLER	/G	TM (7)	313 (Ice Only) (1)	3	S: 04/09/2001 10:51		
MC3109	Surface Water/ JOHN SAMPLER	/G	TM (7)	329 (HNO3, Ice), 330 (HNO3, Ice), 331 (~NCS, Ice) (3)	14	S: 04/09/2001 13:00		
MC3110	Surface Sol KY-GTV BOBBY SAMPLER	/G	TM (7)	335 (Ice Only) (1)	16	S: 04/09/2001 13:00		
MC3111	Surface Water/ JOE SAMPLER	/G	TM (7)	342 (HNO3, Ice) (1)	15	S: 04/09/2001 14:00		
MC3112	Sediment/ JOHN SAMPLER	/G	TM (7)	343 (Ice Only) (1)	17	S: 04/09/2001 14:00		

Shipment for Case Complete?N	Sample(s) to be used for laboratory QC:	Additional Sampler Signature(s):	Cooler Temperature Upon Receipt:	Chain of Custody Seal Number:
Analysis Key: TM = TAL Total Metals	Concentration: L = Low, M = Low/Medium, H = High	Type/Designate: Composite = C, Grab = G	Custody Seal Intact?___	Shipment Iced?___

TR Number: 3-235781339-040901-0001

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Figure 3-4. An Organic TR/COC Record Created Using the FORMS II Lite Software (Regional Copy)

USEPA Contract Laboratory Program
Organic Traffic Report & Chain of Custody Record

Case No: 99999
DAS No:
R

Region:	3
Project Code:	
Account Code:	111122223333
CERCLIS ID:	MD-900
Spill ID:	
Site Name/State:	Real Site/VD
Project Leader:	DAN SAMPLER
Action:	Expanded Site Investigation/RI
Sampling Co:	Test Samplers, Inc.

Date Shipped:	04/09/2001
Carrier Name:	FedEx
Airbill:	41033427144
Shipped to:	Organic Lab 999 Route 128 Arlington VA 22044 (999) 555-5555

Chain of Custody Record

Relinquished By	(Date / Time)	Received By	(Date / Time)
1			
2			
3			
4			

Sampler Signature:

ORGANIC SAMPLE No.	MATRIX/ SAMPLER	CONC/ TYPE	ANALYSIS/ TURNAROUND	TAG No./ PRESERVATIVE	STATION LOCATION	SAMPLE COLLECT DATE/TIME	INORGANIC SAMPLE No.	QC Type
O0100	Surface Soil (0"-6") DAN SAMPLER, BOB SAMPLER	/G	Arochlors (7)	31 (Ice Only) (1)	1	S: 04/09/2001 11:05		–
O0101	Surface Soil (0"-6") DAN SAMPLER	/G	Arochlors (7)	32 (Ice Only) (1)	2	S: 04/09/2001 11:20		–
O0102	Surface Soil (0"-6") DAN SAMPLER, BOB SAMPLER	/G	Arochlors (7)	33 (Ice Only) (1)	3	S: 04/09/2001 11:30		–
O0103	Sediment/ DAN SAMPLER, BOB SAMPLER	/G	Arochlors (7)	34 (Ice Only) (1)	4	S: 04/09/2001 11:45		–
O0104	Sediment/ DAN SAMPLER	/G	Arochlors (7)	35 (Ice Only) (1)	5	S: 04/09/2001 11:55		–
O0107	Surface Water/ DAN SAMPLER	/G	Arochlors (7)	3133 (Ice Only), 3134 (Ice Only) (2)	1	S: 04/09/2001 10:52 E: 04/09/2001 10:54		–
O0108	Sediment/ JOE SAMPLER	/G	Arochlors (7)	3135 (Ice Only) (1)	3	S: 04/09/2001 10:51		–

Shipment for Case Complete? N	Sample(s) to be used for laboratory QC: O0109	Additional Sampler Signature(s):	Chain of Custody Seal Number:
Analysis Key:	Concentration: L = Low, M = Low/Medium, H = High	Type/Designate: Composite = C, Grab = G	Shipment Iced?_____

Arochlors = Arochlors, BNA = TCL Semivolatiles, VOA = TCL Volatiles

TR Number: 3-235781339-040901-0002

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Figure 3-5. An Inorganic TR/COC Record Created Using the FORMS II Lite Software (Regional Copy)

EPA **USEPA Contract Laboratory Program**
Inorganic Traffic Report & Chain of Custody Record

Case No: 99999
DAS No:
R

Region: 3
Project Code:
Account Code: 111122223333
CERCLIS ID: MD-999
Spill ID:
Site Name/State: Real Site/MD
Project Leader: DAN SAMPLER
Action: Expanded Site Investigation/RI
Sampling Co: Test Samplers Inc.

Date Shipped: 04/09/2001
Carrier Name: FedEx
Airbill: 4133827133
Shipped to: Inorganic Lab
555 Clp Street
CLP VA 22044
(703) 555-5555

Chain of Custody Record

Relinquished By	(Date / Time)	Received By	(Date / Time)
1			
2			
3			
4			

Sampler Signature:

INORGANIC SAMPLE No.	MATRIX/ SAMPLER	CONC/ TYPE	ANALYSIS/ TURNAROUND	TAG No./ PRESERVATIVE	STATION LOCATION	SAMPLE COLLECT DATE/TIME	ORGANIC SAMPLE No.	QC Type
MD3103	Sediment/ DAN SAMPLER, BOB SAMPLER	/G	TM (7)	35 (Ice Only) (1)	4	S: 04/09/2001 11:45		–
MD3104	Sediment/ DAN SAMPLER	/G	TM (7)	37 (Ice Only) (1)	5	S: 04/09/2001 11:55		–
MD3108	Sediment/ DAN SAMPLER	/G	TM (7)	311 (Ice Only) (1)	3	S: 04/09/2001 9:52		–
MD3107	Surface Water/ DAN SAMPLER	/G	TM (7)	312 (HNO3, Ice) (1)	1	S: 04/09/2001 10:52 E: 04/09/2001 10:54		–
MD3106	Sediment/ JOE SAMPLER	/G	TM (7)	315 (Ice Only) (1)	3	S: 04/09/2001 10:5[illegible]		–
MD3109	Surface Water/ JOHN SAMPLER	/G	TM (7)	329 (HNO3, ice), 330 (HNO3, Ice), 331 (HNO3, Ice) (3)	14	S: 04/09/2001 13:00		MS/MC
MD3113	Surface Soil (0"-6")/ BOBBY SAMPLER	/G	TM (7)	335 (Ice Only) (1)	16	S: 04/09/2001 13:00		–
MD3111	Surface Water/ JOE SAMPLER	/G	TM (7)	342 (HNO3, Ice) (1)	15	S: 04/09/2001 14:00		–
MD3112	Sediment/ JOHN SAMPLER	/G	TM (7)	346 (Ice Only) (1)	17	S: 04/09/2001 14:00		–

Shipment for Case Complete? N	Samples(s) to be used for laboratory QC:	Additional Sampler Signature(s):	Chain of Custody Seal Number:
Analysis Key: TM = "AL Total Metals	Concentration: L = Low, M = Low/Medium, H = High	Type/Designate: Composite = C, Grab = G	Shipment Iced?_____

TR Number: 3-235781339-040901-0001

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F2V5.0.66 Page 1 of 2

3.2.3 Complete and Attach Custody Seals

Custody seals are usually pre-printed stickers that are signed (or initialed) and dated by the sampler after collection and placed on sample bottles or containers and/or shipping coolers or containers. These seals document who sealed the sample container and that the sample has not been tampered with. The seals must be placed such that they will break if the sample bottle or container or the shipping cooler or container is tampered with or opened after leaving custody of sampling personnel (see Figure 3-6). Custody seals can also be used to maintain custody of other items such as envelopes containing videotapes of the sample collection process.

Note: Custody seals should never be placed directly onto an EnCore™ container or tared, 40 mL closed-system vials. They must be placed on the EnCore™ bag or on the bag used to enclose the vials. Refer to Appendix B for details.

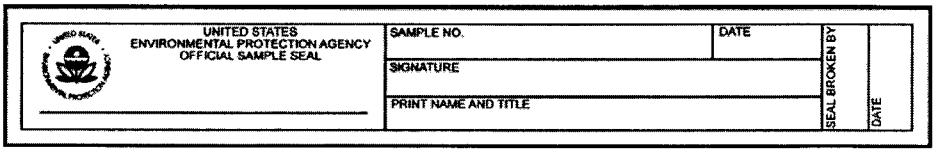

Figure 3-6. Custody Seal

Instructions for completing and attaching a custody seal are included in Table 3-4.

Table 3-4. Completing and Attaching a Custody Seal

Step	Action	Special Notes
1	Record the CLP Sample Number.	The space for the CLP Sample Number does not need to be completed on custody seals being placed on the opening of a cooler, only on those being placed on the opening of sample bottles or containers.
2	Record the SMO-assigned Case Number.	
3	Record the month, day, and year of sample collection.	
3	Sign the seal in the Signature area.	
4	Print your name and title in the Print Name and Title area.	
5	Place the custody seal over the edge of the sample bottle or container such that it will break if tampered with.	Custody seals can be placed directly on any sample container except for EnCore™ and tared VOA bottles. If packing EnCore™ or tared VOA bottles, place them in a clear plastic bag and place the custody seal on the outside of the bag.
6	If possible, cover the custody seal with clear plastic tape to protect it.	Take special care to not place the protective tape over the seal in such a way that it can be removed and then re-attached without signs of tampering.

The use and type of custody seals can vary by Region or collecting organization. Sampling personnel should obtain the appropriate custody seals and specific instructions for correctly attaching them from the RSCC Coordinator.

3.2.4 Complete and Attach Sample Labels

It is recommended that samplers affix sample labels to each sample container. A sample label must contain the associated CLP Sample Number (either written or pre-printed), SMO-assigned Case Number, and the preservative used. It must also denote the analysis/fraction. Samplers may also include additional information such as the station location or the date/time of collection. Per CLP documentation requirements, the CLP Sample Number and SMO-assigned Case Number must appear on a sample label or be legibly printed on the sample. Samplers should complete the label information if necessary using waterproof ink, place the label on the outside of the sample bottle or container, then cover the label with clear packaging tape to protect the label and maintain legibility (see Figure 3-1).

Note: Do not attach labels to tared VOA sample vials. A label should already be pre-attached to the tared vial and the sampler should complete the pre-attached label using waterproof ink.

3.2.5 Complete and Attach Sample Tags

To support use of sample data in potential enforcement actions, sample characteristics other than *in situ* measurements (e.g., pH, temperature, conductivity) can be identified with a sample tag. Typically, site-specific information is written on the tags using waterproof ink. The use and type of sample tags may vary by Region. For each sampling event, sampling personnel should receive the required sample tags and type of information to include from the Region/RSCC Coordinator. Per CLP documentation requirements, the sampler must record the CLP Sample Number and SMO-assigned Case Number on a sample tag. A detailed set of instructions for completing and attaching a sample tag are included in Table 3-5.

Note: Styles of sample tags may vary among Regions.

Table 3-5. Completing and Attaching a Sample Tag

Step	Action	Special Notes
1	Under the "Remarks" heading, record the CLP Sample Number and SMO-assigned Case Number.	Make sure to record the correct CLP Sample Number and SMO-assigned Case Number in a legible manner.
2	Record the project code (e.g., Contract Number, Work Assignment Number, Interagency Agreement Number, etc.) assigned by USEPA.	
3	Enter the station number assigned by the sampling team coordinator.	
4	Record the month, day, and year of sample collection.	

Table 3-5. Completing and Attaching a Sample Tag (Con't)

Step	Action	Special Notes
5	Enter the military time of sample collection (e.g., 13:01 for 1:01 PM).	
6	Place an "X" in the box next to Yes or No to indicate if a preservative was added to the sample.	
7	Under "Analyses", place an "X" in the box next to the parameters for which the sample is to be analyzed.	
8	Leave the box for "Laboratory Sample Number" blank.	
9	It is recommended that the sample tag be attached to the neck of the sample bottle or container using regular string, stretch string, or wire (see Figure 3-1).	Do **NOT** use wire to attach a sample tag to a metals sample.

An example of a completed sample tag is included in Figure 3-7 below:

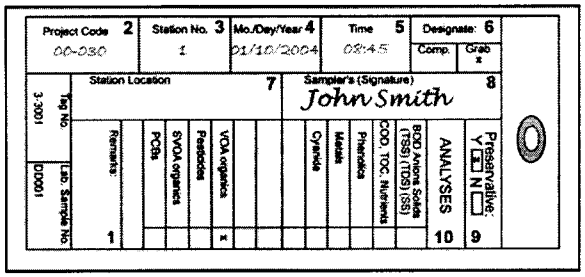

Figure 3-7. Completed Sample Tag

3.3 Pack and Ship Samples

Once the samples have been taken, it is very important that the sampler properly package the samples for shipment and ensure that the samples are sent to the appropriate laboratory as quickly as possible. Prompt and proper packaging of samples will:

- Meet acceptance or performance criteria (i.e., acceptance or performance criteria such as detection limits) by collecting sufficient sample volumes for each method;
- Protect the integrity of samples from changes in composition or concentration caused by bacterial growth or degradation from increased temperatures;
- Reduce the chance of leaking or breaking of sample containers that would result in loss of sample volume, loss of sample integrity, and exposure of personnel to toxic substances; and
- Help ensure compliance with shipping regulations.

3.3.1 Sample Containers

Once samples are collected, they must be stored in conditions that maintain sample integrity. All samples should be placed in shipping containers or other suitable containers with ice to reduce the temperature as soon as possible after collection. Ideally, all samples

should be shipped the day of collection for overnight delivery to the laboratory. If samples cannot be shipped on the day of collection, the sample temperature should be maintained at 4°C (±2°C) until they are shipped to the laboratory.

One CLP RAS sample may be contained in several bottles and vials. For example, under the CLP SOW OLC04.3, one water sample might consist of all containers needed for the three analytical fractions available under this service (i.e., VOA fraction, SVOA fraction, and Pesticide/Aroclor fraction), even though the fractions will be collected in separate containers. Therefore, the analysis to be performed and the matrix type will determine the type of container that will be used, as well as the volume that must be collected for that particular sample fraction.

3.3.2 Inventory of Samples and Documentation

Prior to shipment, sampling personnel should conduct an inventory of the contents of the shipping cooler or container against the corresponding TR/COC Record when packing for shipment to laboratories. An inventory will ensure that the proper number of containers have been collected for each analysis of the samples, that the required PE and QC samples and cooler temperature blanks are included, and the correct Sample Numbers and fractions have been assigned to each sample.

3.3.3 Follow Shipping Regulations

Sample shipping personnel are legally responsible for ensuring that the sample shipment will comply with all applicable shipping regulations. For example, hazardous material samples must be packaged, labeled, and shipped in compliance with all International Air Transport Association (IATA) Dangerous Goods regulations or DOT regulations and USEPA guidelines.

Refer to Appendix B for detailed shipping guidelines when using SW-846 Method 5035A to preserve and ship samples.

3.3.4 Package Samples for Shipment

Sampling personnel are responsible for the proper packaging of samples for shipment. To ensure that samples are appropriately packaged (e.g., to avoid breakage and/or contamination) the sampler should consult their respective project plans to determine the proper packing and shipping procedures. The sampler must determine the sample type, pack the shipping containers correctly, include necessary paperwork, label and seal shipping containers or coolers, and ship the samples.

3.3.4.1 Determine the Sample Type and Container

Sampling personnel should know what kinds of samples they are handling to ensure proper packaging. Samplers should refer to their appropriate project plans to determine which type of sample container should be used for each type of sample being taken during the sampling event.

Note: Please follow Regional guidance with reference to samples containing dioxin or radioactive waste. The CLP cannot accept any radioactive waste samples for analysis.

3.3.4.2 Pack Shipping Containers

It is imperative that samples are correctly and carefully packed in shipping containers to prevent the sample containers from breaking or leaking. Samplers must prepare and pack a shipping cooler or container according to the instructions outlined in Table 3-6.

Table 3-6. Packing Samples for Shipment

Step	Action	Special Notes
1	Seal all drain holes, both inside and out, to prevent leakage in the event of sample breakage.	
2	Check all lids/caps to make sure they are tightly sealed and will not leak.	
3	Seal samples within a clear plastic bag.	Custody seals can be placed directly on any sample container except for EnCore™ and tared VOA bottles. If packing EnCore™ or tared VOA bottles, place them in a clear plastic bag and place the custody seal on the outside of the bag.
4	Fully chill samples to 4°C (±2°C) prior to placement within suitable packing materials.	
5	Prior to placing samples within the shipping cooler, it is recommended that samplers line shipping containers with non-combustible, absorbent packing material such as rock wool, ground corn cobs, perlite, or clay-based absorbents (e.g., kitty litter or 'oil dry').	
6	Place samples in CLEAN, sealed, watertight shipping containers (metal or hard plastic cooler).	
7	Conduct an inventory of the contents of the shipping cooler/container against the corresponding TR/COC Record.	
8	Cover samples in double-bagged ice to prevent water damage to packing materials.	Do NOT pour loose ice directly into the sample cooler. The ice will maintain the temperature of the samples within the shipping cooler.
9	**It is recommended that samplers include a temperature blank within each cooler being shipped.**	**The temperature blank is generally a 40 mL vial filled with water and labeled "temperature blank".**
10	**Ensure that the site name or other site-identifying information does not appear on any documentation being sent to the laboratory.**	**The laboratory cannot receive any site-identifying information.**

3.3.4.3 Include Necessary Paperwork

Sampling personnel must properly place the necessary paperwork in the shipping cooler. All paperwork must be placed in a plastic bag or pouch and then secured to the underside of the shipping cooler lids (see Figure 3-8).

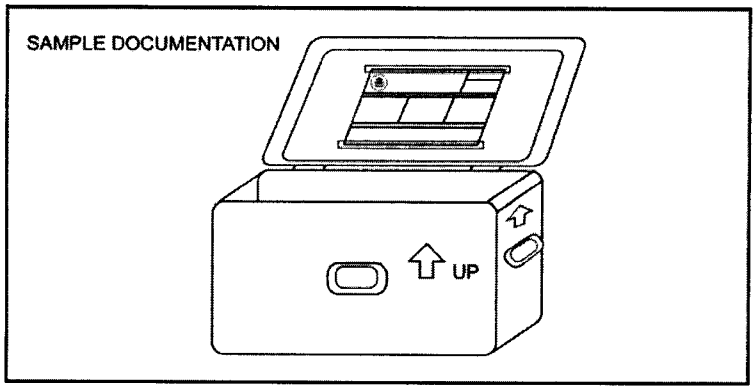

Figure 3-8. Sample Cooler with Attached TR/COC Record and Cooler Return Documentation

Necessary paperwork includes TR/COC Records and sample weight logs (see Figure 3-9), if required (for VOA samples). Sampling personnel should contact their RSCC or their designee for specific paperwork requirements.

USEPA Contract Laboratory Program
Sample Weight Log

Shipped to: AAA Testing Laboratory
1700 Mill Avenue
Houston TX 77099
(281) 983-1234

Case No. 39563
DAS No. DAS34
Date Shipped: 9/29/2003

Sample No.	Matrix	Analysis	Preservative	Bottle/ Tag Number	Tared Weight (g)	Final Weight (g)	Sample Weight (g)	Laboratory Weight	Traffic Report No.
C0036	Subsurface Soil (>12")	CLP TCL Volatiles	Ice Only	199548	32.80	37.20	4.40		3-103018225-092903-0001
C0036	Subsurface Soil (>12")	CLP TCL Volatiles	Ice Only	199547	32.10	38.30	6.20		3-103018225-092903-0001
C0036	Subsurface Soil (>12")	CLP TCL Volatiles	Ice Only	199549	31.20	38.60	7.40		3-103018225-092903-0001
C0037	Surface Soil (0"-12")	CLP TCL Volatiles	Ice Only	199552	32.00	36.90	4.90		3-103018225-092903-0001
C0037	Surface Soil (0"-12")	CLP TCL Volatiles	Ice Only	199551	32.40	37.10	4.70		3-103018225-092903-0001
C0037	Surface Soil (0"-12")	CLP TCL Volatiles	Ice Only	199550	31.90	35.90	4.00		3-103018225-092903-0001

Completed By:	Date:

All weights are measured in grams

Figure 3-9. Sample Weight Log

3.3.4.4 Return Sample Shipping Coolers

CLP Laboratories must routinely return sample shipping coolers within 14 calendar days following shipment receipt. Therefore, the sampler should also include cooler return instructions with each shipment. The sampler (not the CLP laboratory) is responsible for paying for return of the cooler and should also include shipping airbills bearing the sampler's account number, as well as a return address to allow for cooler return.

3.3.4.5 Label and Seal Sample Shipping Coolers

After samples are packaged within shipping coolers, sampling personnel must carefully secure the top and bottom of the coolers with tape, place return address labels clearly on the outside of the cooler, and attach the required chain-of-custody seals (see Figure 3-10).

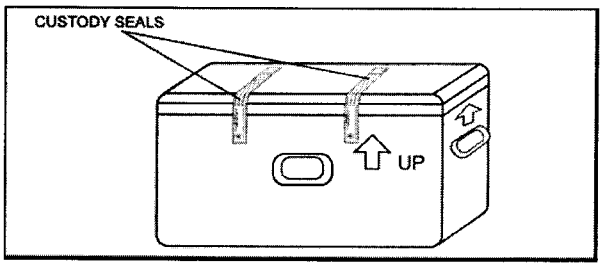

Figure 3-10. Shipping Cooler with Custody Seals

If more than one cooler is being delivered to a laboratory, samplers should mark each cooler as "1 of 2", "2 of 2", etc. In addition, sampling personnel must accurately complete and attach shipping airbill paperwork for shipment of the samples to the laboratory. An airbill, addressed to the Sample Custodian of the receiving laboratory, should be completed for each cooler shipped. Sampling personnel should receive the correct name, address, and telephone number of the Laboratory to which they must ship samples from the Region/RSCC Coordinator. To avoid delays in analytical testing, sampling personnel should make sure they are sending the correct types of samples to the correct laboratory when collecting samples for multiple types of analysis. For example, inorganic samples may be shipped to one laboratory for analysis, while organic samples may need to be shipped to another laboratory.

3.3.4.6 Ship Samples

The sampling contractor should ensure that sampling personnel know the shipping company's name, address, and telephone number. In addition, they should be aware of the shipping company's hours of operation, shipping schedule, and pick-up/drop-off requirements.

Overnight Delivery

It is imperative that samples be sent via overnight delivery. Delays caused by longer shipment times may cause technical holding times to expire, which in turn may destroy sample integrity or require the recollection of samples for analysis.

Saturday Delivery

If shipping samples for Saturday delivery, the sampler **MUST** contact the RSCC Coordinator (or their designee) or CLP SMO by 3:00 PM ET on the Friday prior to delivery.

3.3.5 Provide Shipment Notification

When samples are shipped to CLP Laboratories, sampling personnel **must immediately** report all sample shipments to the RSCC Coordinator (or their designee) or to CLP SMO. **Under no circumstances should the sampler contact the laboratory directly.** If sampling personnel are shipping samples after 5:00 PM ET, they must notify the RSCC Coordinator (or their designee) or CLP SMO by 8:00 AM ET on the following business day. Sampling personnel should receive the name and phone number of the appropriate CLP SMO coordinator to contact from the Region/RSCC Coordinator.

Samplers must provide the following information to the RSCC Coordinator (or their designee) or to CLP SMO :

- Name and phone number at which they can easily be reached (preferably closest on-site phone number if still in the field);
- SMO-assigned Case Number (see Section 2.4.1);
- Number, concentration, matrix and analysis of samples being shipped;
- Name of laboratory (or laboratories) to which the samples were shipped;
- Airbill number(s);
- Date of shipment;
- Case status (i.e., whether or not the Case is complete);
- Problems encountered, special comments, or any unanticipated issues;
- When to expect the next anticipated shipment; and
- An electronic export of the TR/COC Record (must be sent within five days of sample shipment). For information regarding electronic export of TR/COC Records, refer to the following Web site:

  http://www.epa.gov/superfund/programs/clp/f2lsubmit.htm

Note: For Saturday delivery, samplers MUST contact the RSCC Coordinator (or their designee) or CLP SMO by 3:00 PM ET on the Friday prior to delivery.

Samplers should be aware if their Region requires them to notify the RSCC Coordinator (or their designee) and/or CLP SMO of sample shipment.

Attachment 5

Low Concentration and Multi-Media, Multi-Concentration Organic Analytical Service for Superfund

Quick Reference Fact Sheets

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United States Environmental Protection Agency

Office of Solid Waste and Emergency Response

EPA 540-F-01-013
Publication 9240.0-37FS
June 2001

EPA

Low Concentration Organic Analytical Service for Superfund (Water Matrix) (OLC03.2)

Office of Emergency and Remedial Response
Analytical Operations/Data Quality Center (5204G)

Quick Reference Fact Sheet

Under the legislative authority granted to the U.S. Environmental Protection Agency (EPA) under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and the Superfund Amendments and Reauthorization Act of 1986 (SARA), EPA develops standardized analytical methods for the measurement of various pollutants in environmental samples from known or suspected hazardous waste sites. Among the pollutants that are of concern to the EPA at such sites are a series of volatile, semivolatile, and pesticide/Aroclor (pesticide/PCB) compounds that are analyzed using Gas Chromatography coupled with Mass Spectrometry (GC/MS) and Gas Chromatography with an Electron Capture Detector (GC/ECD). The Analytical Operations/Data Quality Center (AOC) of the Office of Emergency and Remedial Response (OERR) offers an analytical service that provides data from the analysis of water samples for low concentration organic compounds for use in the Superfund decision-making process. Through a series of standardized procedures and a strict chain-of-custody, the low concentration organic analytical service produces data of known and documented quality. This service is available through the Superfund Contract Laboratory Program (CLP).

DESCRIPTION OF SERVICES

The low concentration organic analytical service provides a contractual framework for laboratories to apply EPA/CLP analytical methods for the isolation, detection, and quantitative measurement of 50 volatile, 65 semivolatile, and 28 pesticide/Aroclor (pesticide/PCB) target compounds in water samples. The analytical service provides the methods to be used and the specific contractual requirements, by which EPA evaluates the data. The options for data turnaround time for this contract are 7, 14, or 21 days after laboratory receipt of the last sample in the Sample Delivery Group (SDG). This service uses Gas Chromatography/Mass Spectrometry (GC/MS) and Gas Chromatography with Electron Capture Detector (GC/ECD) techniques to analyze the target compounds.

DATA USES

This analytical service provides data that EPA uses for a variety of purposes such as: determining the nature and extent of contamination at a hazardous waste site; assessing priorities for response based on risks to human health and the environment; determining appropriate cleanup actions; and determining when remedial actions are complete. The data may be used at all stages in the investigation of hazardous waste sites including: site inspections; Hazard Ranking System (HRS) scoring; remedial investigation/ feasibility studies; remedial design; treatability studies; and removal actions. In addition, this service provides data that are available for use in Superfund enforcement/litigation activities.

TARGET COMPOUNDS

The compounds and quantitation limits for which this service is applicable are listed in **Table 1**. The lowest reportable quantitation limits are 0.50 µg/L for the volatile compounds, 5.0 µg/L for the semivolatile compounds, and 0.01 µg/L for the pesticide/Aroclor compounds. The list of target compounds for this service was originally derived from the EPA Priority Pollutant List of 129 compounds. In the years since the inception of the CLP, compounds have been added to and deleted from the Target Compound List (TCL), based on advances in analytical methods, evaluation of method performance data, and the needs of the Superfund program.

METHODS AND INSTRUMENTATION

For volatiles, 25 mL of sample is added to a purge-and-trap device. A solution of 14 Deuterated Monitoring Compounds (DMCs) and a solution of internal standards are added to the sample which is then purged with an inert gas at room temperature.

Table 1. Target Compound List and Contract Required Quantitation Limits (CRQLs) in µg/L (OLC03.2)

VOLATILES	Quantitation Limits µg/L
1. Dichlorodifluoromethane	0.5
2. Chloromethane	0.5
3. Vinyl Chloride	0.5
4. Bromomethane	0.5
5. Chloroethane	0.5
6. Trichlorofluoromethane	0.5
7. 1,1-Dichloroethene	0.5
8. 1,1,2-Trichloro-1,2,2-trifluoroethane	0.5
9. Acetone	5
10. Carbon Disulfide	0.5
11. Methyl Acetate	0.5
12. Methylene Chloride	0.5
13. trans-1,2-Dichloroethene	0.5
14. Methyl tert-Butyl Ether	0.5
15. 1,1-Dichloroethane	0.5
16. cis-1,2-Dichloroethene	0.5
17. 2-Butanone	5
18. Bromochloromethane	0.5
19. Chloroform	0.5
20. 1,1,1-Trichloroethane	0.5
21. Cyclohexane	0.5
22. Carbon Tetrachloride	0.5
23. Benzene	0.5
24. 1,2-Dichloroethane	0.5
25. Trichloroethene	0.5
26. Methylcyclohexane	0.5
27. 1,2-Dichloropropane	0.5
28. Bromodichloromethane	0.5
29. cis-1,3-Dichloropropene	0.5
30. 4-Methyl-2-pentanone	5
31. Toluene	0.5
32. trans-1,3-Dichloropropene	0.5
33. 1,1,2-Trichloroethane	0.5
34. Tetrachloroethene	0.5
35. 2-Hexanone	5
36. Dibromochloromethane	0.5
37. 1,2-Dibromoethane	0.5
38. Chlorobenzene	0.5
39. Ethylbenzene	0.5
40. Xylenes (total)	0.5
41. Styrene	0.5
42. Bromoform	0.5
43. Isopropylbenzene	0.5
44. 1,1,2,2-Tetrachloroethane	0.5
45. 1,3-Dichlorobenzene	0.5
46. 1,4-Dichlorobenzene	0.5
47. 1,2-Dichlorobenzene	0.5
48. 1,2-Dibromo-3-chloropropane	0.5
49. 1,2,4-Trichlorobenzene	0.5
50. 1,2,3-Trichlorobenzene	0.5

SEMIVOLATILES	Quantitation Limits µg/L
51. Benzaldehyde	5
52. Phenol	5
53. bis-(2-Chloroethyl) ether	5
54. 2-Chlorophenol	5
55. 2-Methylphenol	5
56. 2,2'-oxybis (1-Chloropropane)[1]	5
57. Acetophenone	5
58. 4-Methylphenol	5
59. N-Nitroso-di-n-propylamine	5
60. Hexachloroethane	5
61. Nitrobenzene	5
62. Isophorone	5
63. 2-Nitrophenol	5
64. 2,4-Dimethylphenol	5
65. bis (2-Chloroethoxy) methane	5
66. 2,4-Dichlorophenol	5
67. Naphthalene	5
68. 4-Chloroaniline	5
69. Hexachlorobutadiene	5
70. Caprolactam	5
71. 4-Chloro-3-methylphenol	5
72. 2-Methylnaphthalene	5
73. Hexachlorocyclopentadiene	5
74. 2,4,6-Trichlorophenol	5
75. 2,4,5-Trichlorophenol	20
76. 1,1'-Biphenyl	5
77. 2-Chloronaphthalene	5
78. 2-Nitroaniline	20
79. Dimethylphthalate	5
80. 2,6-Dinitrotoluene	5
81. Acenaphthylene	5
82. 3-Nitroaniline	20
83. Acenaphthene	5
84. 2,4-Dinitrophenol	20
85. 4-Nitrophenol	20
86. Dibenzofuran	5
87. 2,4-Dinitrotoluene	5
88. Diethylphthalate	5
89. Fluorene	5
90. 4-Chlorophenyl-phenylether	5
91. 4-Nitroaniline	20
92. 4,6-Dinitro-2-methylphenol	20
93. N-Nitrosodiphenylamine	5
94. 1,2,4,5 Tetrachlorobenzene	5
95. 4-Bromophenyl-phenylether	5
96. Hexachlorobenzene	5
97. Atrazine	5
98. Pentachlorophenol	5
99. Phenanthrene	5
100. Anthracene	5

	Quantitation Limits µg/L
101. Di-n-butylphthalate	5
102. Fluoranthene	5
103. Pyrene	5
104. Butylbenzylphthalate	5
105. 3,3'-Dichlorobenzidine	5
106. Benzo(a)anthracene	5
107. Chrysene	5
108. bis-(2-Ethylhexyl) phthalate	5
109. Di-n-octylphthalate	5
110. Benzo(b)fluoranthene	5
111. Benzo(k)fluoranthene	5
112. Benzo(a)pyrene	5
113. Indeno(1,2,3-cd)pyrene	5
114. Dibenzo(a,h)anthracene	5
115. Benzo(g,h,i)perylene	5
PESTICIDES/AROCLORS (PESTICIDES/PCBs)	
116. alpha-BHC	0.01
117. beta-BHC	0.01
118. delta-BHC	0.01
119. gamma-BHC (Lindane)	0.01
120. Heptachlor	0.01
121. Aldrin	0.01
122. Heptachlor epoxide[2]	0.01
123. Endosulfan I	0.01
124. Dieldrin	0.02
125. 4,4'-DDE	0.02
126. Endrin	0.02
127. Endosulfan II	0.02
128. 4,4'-DDD	0.02
129. Endosulfan sulfate	0.02
130. 4,4'-DDT	0.02
131. Methoxychlor	0.10
132. Endrin ketone	0.02
133. Endrin aldehyde	0.02
134. alpha-Chlordane	0.01
135. gamma-Chlordane	0.01
136. Toxaphene	1.0
137. Aroclor-1016	0.20
138. Aroclor-1221	0.40
139. Aroclor-1232	0.20
140. Aroclor-1242	0.20
141. Aroclor-1248	0.20
142. Aroclor-1254	0.20
143. Aroclor-1260	0.20

[1]Previously known by the name bis (2-chloroisopropyl) ether.
[2]Only the exo-epoxy isomer (isomer B) of heptachlor epoxide is reported on the data reporting forms.

The volatiles purged from the sample are trapped on a solid sorbent. They are subsequently desorbed into a GC/MS system.

For semivolatile and pesticide/Aroclor water samples, a 1-L aliquot is extracted with methylene chloride using continuous liquid-liquid extraction or a separatory funnel (for pesticides/Aroclors only). For pesticide/Aroclors, the aliquot is spiked with a solution of two surrogate compounds before extraction. The extract is dried, concentrated, and subjected to cleanup prior to GC/ECD analysis. For semivolatiles, the aliquot is acidified to a pH of 2.0 and a solution of 16 DMCs is added before extraction. The extract is dried and concentrated, internal standards are added, and then it is analyzed by GC/MS. **Table 2** summarizes the preparation methods and instruments used in this analytical service.

DATA DELIVERABLES

Data deliverables for this service include hardcopy data reporting forms, supporting raw data, and electronic data on diskette or other means specified by EPA. The laboratory must submit data to EPA within 7, 14, or 21 days after laboratory receipt of the last sample in the SDG. EPA then checks the data for compliance with contract requirements. A report of instances of noncompliance is distributed to the laboratory and the Region within 7 days from the receipt of the data. The laboratory has 7 days from receipt of the report to reconcile defective data and resubmit the data to EPA. EPA then screens the data and sends a final data assessment report to the laboratory and the Region.

QUALITY ASSURANCE

The Quality Assurance (QA) process consists of management review and oversight at the planning, implementation, and completion stages of the environmental data collection activity. This process ensures that the data provided are of the quality required.

During the implementation of the data collection effort, QA activities ensure that the Quality Control (QC) system is functioning effectively and that the deficiencies uncovered by the QC system are corrected. After environmental data are collected, QA activities focus on assessing the quality of data to determine its suitability to support enforcement or remedial decisions. Each contract laboratory prepares a Quality Assurance Plan (QAP) with the objective of providing sound analytical chemical measurements. The QAP must specify the policies, organization, objectives, and functional guidelines, as well as the QA/QC activities designed to achieve the data quality requirements for this analytical service.

QUALITY CONTROL

The QC process includes those activities required during analytical data collection to produce data of known and documented quality. The analytical data acquired from QC procedures are used to estimate and evaluate the analytical results and to determine the necessity for, or the effect of, corrective action procedures. The QC requirements for this analytical service are shown in **Table 3**.

PERFORMANCE MONITORING ACTIVITIES

Laboratory performance monitoring activities are provided primarily by AOC and the Regions to ensure that contract laboratories are producing data of the appropriate quality. EPA performs on-site laboratory audits, data package audits, and GC/MS tape audits, and evaluates laboratory performance through the use of blind PE samples.

Table 2. Methods and Instruments

Fraction	Preparation Method	Analytical Instrument
Volatiles	Purge-and-trap	GC/MS analysis
Semivolatiles	Continuous liquid-liquid extraction	GC/MS analysis
Pesticides/Aroclors (Pesticides/PCBs)	Continuous liquid-liquid or separatory funnel extraction	GC/ECD analysis

Table 3. Quality Control

QC Operation	Frequency
Deuterated Monitoring Compounds (DMCs) (volatiles and semivolatiles)	Added to each sample, standard, and blank.
Method Blanks (volatiles)	Analyzed at least every 12 hours.
Method Blanks [semivolatiles and pesticides/Aroclors (pesticides/PCBs)]	Prepared with each group of 20 field samples or less, or each time samples are extracted.
Instrument Blank (volatiles)	Analyzed after a sample that contains compounds at concentrations greater than the calibration range.
Instrument Blank [pesticides/Aroclors (pesticides/PCBs)]	Every 12 hours and preceding all groups of acceptable sample analysis.
Surrogates [pesticides/Aroclors (pesticides/PCBs)]	Added to each sample, standard, and blank.

Table 3. Quality Control (Continued)

QC Operation	Frequency
Storage Blank (volatiles)	Prepared and stored with each group of samples. Analyzed after all samples in the SDG have been analyzed.
Instrument Performance Check (volatiles and semivolatiles)	Prior to any analysis and every 12 hours.
GC Resolution Check [pesticides/Aroclors (pesticides/PCBs)]	Prior to initial calibration on each GC column used for analysis.
Initial Calibration	Upon initial set up of each instrument, after major instrument maintenance or modification, and each time continuing calibration fails to meet the acceptance criteria.
Continuing Calibration (volatiles and semivolatiles)	Every 12 hours for each instrument used for analysis.
Calibration Verification [pesiticides/Aroclor (pesticides/PCBs)]	Beginning and end of each 12-hour data collection period.
Internal Standards (volatiles and semivolatiles)	Added to each sample, standard, and blank.
Laboratory Control Sample (LCS) [pesticides/Aroclor (pesticides/PCBs)]	Prepared and analyzed once per SDG.
Performance Evaluation (PE) Sample	Prepared and analyzed (if provided) with every 20 field samples in an SDG or for each SDG, whichever is most frequent.
Matrix Spike/Matrix Spike Duplicate (MS/MSD)	Performed only when requested by Region. Performed with every 20 field samples in an SDG or for each SDG, whichever is most frequent.
Method Detection Limit (MDL)	Run before any samples analyzed under contract (annually thereafter) and after major instrument maintenance.
Sulfur Cleanup Blank [pesticides/Aroclor (pesticides/PCBs)]	Only when part of a set of samples extracted together requires sulfur removal.
Sample Cleanup by Florisil Cartridge	Performed on all sample extracts and method blank extracts.
Florisil Cartridge Performance Check [pesticides/Aroclor (pesticides/PCBs)]	Performed at least once on each lot of cartridges used for sample cleanup or every 6 months, whichever is most frequent.

For more information, or for suggestions to improve this analytical service, please contact:

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United States Environmental Protection Agency

Office of Solid Waste and Emergency Response

OSWER Document 9240.1-42-FSD
EPA Publication 540-F-03-005
August 2003

EPA

Multi-Media, Multi-Concentration, Organic Analytical Service for Superfund (OLM04.3)

Office of Superfund Remediation and Technology Innovations
Analytical Operations/Data Quality Center (5204G)

Quick Reference Fact Sheet

Under the legislative authority granted to the U.S. Environmental Protection Agency (EPA) under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and the Superfund Amendments and Reauthorization Act of 1986 (SARA), EPA develops standardized analytical methods for the measurement of various pollutants in environmental samples from known or suspected hazardous waste sites. Among the pollutants that are of concern to the EPA at such sites, are a series of volatile, semivolatile, and pesticide/Aroclor (pesticide/PCB) compounds that are analyzed using Gas Chromatography coupled with Mass Spectrometry (GC/MS) and Gas Chromatography with Electron Capture (GC/EC). The Analytical Operations/Data Quality Center (AOC) of the Office of Superfund Remediation and Technology Innovations (OSRTI) offers an analytical service that provides data from the analysis of water and soil/sediment samples for organic compounds for use in the Superfund decision-making process. Through a series of standardized procedures and a strict chain-of-custody, the organic analytical service produces data of known and documented quality. This service is available through the Superfund Contract Laboratory Program (CLP).

DESCRIPTION OF SERVICES

The new organic analytical service is available as of March 2003. It provides a technical and contractual frame work for laboratories to apply EPA/CLP analytical methods for the isolation, detection, and quantitative measurement of 48 volatile, 65 semivolatile, and 28 pesticide/Aroclor target compounds in water and soil/sediment environmental samples. The CLP provides the methods to be used and the specific technical, reporting, and contractual requirements, including Quality Assurance (QA), Quality Control (QC), and Standard Operating Procedures (SOPs), by which EPA evaluates the data. This service uses GC/MS and GC/EC methods to analyze the target compounds. Three data delivery turnarounds are available to CLP customers: 7, 14, and 21-day turnaround after laboratory receipt of the last sample in the set. In addition, there are 48 (for volatiles) and 72-hour (or semivolatiles and pesticides/Aroclors) preliminary data submission options available. The data associated with these Preliminary Results is due within the specified time after receipt of each sample at the laboratory. Options under this service include a closed system purge-and-trap method for low-level volatile soil analysis and methanol preservation for medium-level volatile soil analysis. In addition, data users may request modifications to the SOW that may include, but are not limited to, additional compounds, modified quantitation limits (e.g., lower volatile limits), additional cleanup options, and other requirements to enhance method performance.

DATA USES

This analytical service provides data which EPA uses for a variety of purposes, such as determining the nature and extent of contamination at a hazardous waste site, assessing priorities for response based on risks to human health and the environment, determining appropriate cleanup actions, and determining when remedial actions are complete. The data may be used in all stages in the investigation of a hazardous waste site including site inspections, Hazard Ranking System scoring, remedial investigations/feasibility studies, remedial design, treatability studies, and removal actions. In addition, this service provides data that will be available for use in Superfund enforcement/litigation activities.

TARGET COMPOUNDS

The compounds for which this service is applicable and the corresponding quantitation limits are listed in **Table 1**. For water samples, the lowest reportable quantitation limits are 10 ppb for the volatile compounds, 10 ppb for the semivolatile compounds, and 0.05 ppb for the pesticide/Aroclor compounds. For soil samples, the lowest reportable quantitation limits are 10 ppb for the volatile compounds, 330 ppb for the semivolatile compounds, and 1.7 ppb for the pesticide/Aroclor compounds. Specific sample quantitation limits will be highly matrix-dependent. Compounds identified with concentrations below the quantitation limit will be reported as estimated concentration values.

Table 1. Target Compound List and Contract Required Quantitation Limits (CRQLs) For OLM04.3*

Quantitation Limits	Water (µg/L)	Low Soil (µg/Kg)	Modified Cal.[1] Levels (µg/L)
VOLATILES			
1. Dichlorodifluoromethane	10	10	0.50
2. Chloromethane	10	10	0.50
3. Vinyl Chloride	10	10	0.50
4. Bromomethane	10	10	0.50
5. Chloroethane	10	10	0.50
6. Trichlorofluoromethane	10	10	0.50
7. 1,1-Dichloroethene	10	10	0.50
8. 1,1,2-Trichloro-1,2,2-trifluoroethane	10	10	0.50
9. Acetone	10	10	10
10. Carbon Disulfide	10	10	0.50
11. Methyl Acetate	10	10	0.50
12. Methylene Chloride	10	10	0.50
13. trans-1,2-Dichloroethene	10	10	0.50
14. Methyl tert-Butyl Ether	10	10	0.50
15. 1,1-Dichloroethane	10	10	0.50
16. cis-1,2-Dichloroethene	10	10	0.50
17. 2-Butanone	10	10	10
18. Chloroform	10	10	0.50
19. 1,1,1-Trichloroethane	10	10	0.50
20. Cyclohexane	10	10	0.50
21. Carbon Tetrachloride	10	10	0.50
22. Benzene	10	10	0.50
23. 1,2-Dichloroethane	10	10	0.50
24. Trichloroethene	10	10	0.50
25. Methylcyclohexane	10	10	0.50
26. 1,2-Dichloropropane	10	10	0.50
27. Bromodichloromethane	10	10	0.50
28. cis-1,3-Dichloropropene	10	10	0.50
29. 4-Methyl-2-pentanone	10	10	10
30. Toluene	10	10	0.50
31. trans-1,3-Dichloropropene	10	10	0.50
32. 1,1,2-Trichloroethane	10	10	0.50
33. Tetrachloroethene	10	10	0.50
34. 2-Hexanone	10	10	0.50
35. Dibromochloromethane	10	10	10
36. 1,2-Dibromoethane	10	10	0.50
37. Chlorobenzene	10	10	0.50
38. Ethylbenzene	10	10	0.50
39. Xylenes (Total)	10	10	0.50
40. Styrene	10	10	0.50
41. Bromoform	10	10	0.50
42. Isopropylbenzene	10	10	0.50
43. 1,1,2,2-Tetrachloroethane	10	10	0.50
44. 1,3-Dichlorobenzene	10	10	0.50
45. 1,4-Dichlorobenzene	10	10	0.50
46. 1,2-Dichlorobenzene	10	10	0.50
47. 1,2-Dibromo-3-chloropropane	10	10	0.50
48. 1,2,4-Triclorobenzene	10	10	0.50

Quantitation Limits	Water (µg/L)	Low Soil (µg/Kg)
SEMIVOLATILES		
49. Benzaldehyde	10	330
50. Phenol	10	330
51. bis-(2-Chloroethyl)ether	10	330
52. 2-Chlorophenol	10	330
53. 2-Methylphenol	10	330
54. 2,2'-oxybis (1-Chloropropane)	10	330
55. Acetophenone	10	330
56. 4-Methylphenol	10	330
57. N-Nitroso-di-n-propylamine	10	330
58. Hexachloroethane	10	330
59. Nitrobenzene	10	330
60. Isophorone	10	330
61. 2-Nitrophenol	10	330
62. 2,4-Dimethylphenol	10	330
63. bis-(2-Chloroethoxy) methane	10	330
64. 2,4-Dichlorophenol	10	330
65. Naphthalene	10	330
66. 4-Chloroaniline	10	330
67. Hexachlorobutadiene	10	330
68. Caprolactam	10	330
69. 4-Chloro-3-methylphenol	10	330
70. 2-Methylnaphthalene	10	330
71. Hexachlorocyclo-pentadiene	10	330
72. 2,4,6-Trichlorophenol	10	330
73. 2,4,5-Trichlorophenol	25	830
74. 1,1'-Biphenyl	10	330
75. 2-Chloronaphthalene	10	330
76. 2-Nitroaniline	25	830
77. Dimethylphthalate	10	330
78. 2,6-Dinitrotoluene	10	330
79. Acenaphthylene	10	330
80. 3-Nitroaniline	25	830
81. Acenaphthene	10	330
82. 2,4-Dinitrophenol	25	830
83. 4-Nitrophenol	25	830
84. Dibenzofuran	10	330
85. 2,4-Dinitrotoluene	10	330
86. Diethylphthalate	10	330
87. Fluorene	10	330
88. 4-Chlorophenyl-phenyl ether	10	830
89. 4-Nitroaniline	25	830
90. 4,6-Dinitro-2-methylphenol	25	830
91. N-Nitrosodiphenylamine	10	330
92. 4-Bromophenyl-phenylether	10	330
93. Hexachlorobenzene	10	330
94. Atrazine	10	330
95. Pentachlorophenol	25	830
96. Phenanthrene	10	330
97. Anthracene	10	330

Quantitation Limits	Water (µg/L)	Low Soil (µg/Kg)
98. Carbazole	10	330
99. Di-n-butylphthalate	10	330
100. Fluoranthene	10	330
101. Pyrene	10	330
102. Butylbenzylphthalate	10	330
103. 3,3'-Dichlorobenzidine	10	330
104. Benzo(a)anthracene	10	330
105. Chrysene	10	330
106. bis-(2-Ethylhexyl)phthalate	10	330
107. Di-n-octylphthalate	10	330
108. Benzo(b)fluoranthene	10	330
109. Benzo(k)fluoranthene	10	330
110. Benzo(a)pyrene	10	330
111. Indeno(1,2,3-cd)pyrene	10	330
112. Dibenz(a,h)anthracene	10	330
113. Benzo(g,h,i)perylene	10	330
PESTICIDES/AROCLORS (PESTICIDES/PCBs)	**Water (µg/L)**	**Soil (µg/Kg)**
114. alpha-BHC	0.05	1.7
115. beta-BHC	0.05	1.7
116. delta-BHC	0.05	1.7
117. gamma-BHC (Lindane)	0.05	1.7
118. Heptachlor	0.05	1.7
119. Aldrin	0.05	1.7
120. Heptachlor epoxide	0.05	1.7
121. Endosulfan I	0.05	1.7
122. Dieldrin	0.10	3.3
123. 4,4'-DDE	0.10	3.3
124. Endrin	0.10	3.3
125. Endosulfan II	0.10	3.3
126. 4,4'-DDD	0.10	3.3
127. Endosulfan sulfate	0.10	3.3
128. 4,4'-DDT	0.10	3.3
129. Methoxychlor	0.50	17
130. Endrin ketone	0.10	3.3
131. Endrin aldehyde	0.10	3.3
132. alpha-Chlordane	0.05	1.7
133. gamma-Chlordane	0.05	1.7
134. Toxaphene	5.0	170
135. Aroclor-1016	1.0	33
136. Aroclor-1221	2.0	67
137. Aroclor-1232	1.0	33
138. Aroclor-1242	1.0	33
139. Aroclor-1248	1.0	33
140. Aroclor-1254	1.0	33
141. Aroclor-1260	1.0	33

*For volatiles, quantitation limits for medium soils are approximately 130 times the quantitation limits for low soils. For semivolatile medium soils, quantitation limits are approximately 30 times the quantitation limits for low soils.

[1]Modified quantitation limits are available under the Flexibility Clause.

The list of target compounds for this service was originally derived from the EPA Priority Pollutant List of 129 compounds. In the years since inception of the CLP, compounds have been added to and removed from the Target Compound List (TCL), based on advances in analytical methods, evaluation of method performance data, and the needs of the Superfund program.

For drinking water and groundwater type samples, use of the low concentration organic analytical service is recommended.

METHODS AND INSTRUMENTATION

For volatile water samples, 5 mL of water sample is added to a purge and trap device and purged with an inert gas at room temperature. For volatile low-level soil samples, a 5 g aliquot of soil is added to a purge and trap device with 5 mL of reagent water then purged with an inert gas at 40°C; or a 5 g aliquot (pre-weighed in the field) is purged from a closed-system purge and trap device at 40°C. For volatile medium-level soil samples, a measured amount is collected/extracted with methanol and an aliquot of the methanol extract is added to reagent water and purged at room temperature. For both water and soil samples, the volatiles purged from the sample are trapped on a solid sorbent. They are subsequently desorbed by rapidly heating the sorbent and then introduced into a GC/MS system.

For semivolatile and pesticide/Aroclor water samples, a 1 L aliquot is extracted with methylene chloride using a continuous liquid-liquid extractor or separatory funnel [for pesticides/Aroclors only]. For low-level semivolatile soil and pesticide/Aroclor soil samples, a 30 g soil/sediment sample is extracted with methylene chloride/acetone using sonication, automated soxhlet, or pressurized fluid extraction techniques. For medium-level semivolatile soil samples, a 1 g aliquot is extracted with methylene chloride using the techniques mentioned above for low-level soil samples. For both water and soil samples, the extract is concentrated, subjected to fraction-specific cleanup procedures, and analyzed by GC/MS for semivolatiles or GC/EC for pesticides/Aroclors. **Table 2** summarizes the methods and instruments used in this analytical service.

PRESERVATION OF VOLATILE SOIL SAMPLES

All soil sample containers that are not chemically preserved should be frozen upon receipt at the laboratory. This includes closed-system vials received from the sampler; closed-system vials generated by the laboratory; low headspace vials containing sample for moisture determination (or for analysis by the old Method 5030 protocol); and all QC samples.

DATA DELIVERABLES

Data deliverables for this service include hardcopy data reporting forms and supporting raw data. In addition to the hardcopy deliverable, contract laboratories must also submit the same data electronically. The laboratory must submit data to EPA within 7, 14, or 21 days after laboratory receipt of the last sample in the set. Preliminary data must be submitted within 48 hours (for volatiles) or 72 hours (for semivolatiles and pesticides/Aroclors) after receipt of each sample at the laboratory. EPA then processes the data through an automated Data Assessment Tool (DAT). DAT is a complete CLP data assessment package. DAT incorporates Contract Compliance Screening (CCS) and Computer-Aided Data Review and Evaluation (CADRE) to provide EPA Regions with PC-compatible reports, spreadsheets, and electronic files within 24 to 48 hours from the receipt of the data. This automated tool facilitates the transfer of analytical data into Regional databases. In addition to the Regional electronic reports, the CLP laboratories are provided with a data assessment report that documents the instances of noncompliance. The laboratory has 6 days to reconcile defective data and resubmit the data to EPA. EPA then reviews the data for noncompliance and sends a final data assessment report to the CLP laboratory and the Region.

QUALITY ASSURANCE

The QA process consists of management review and oversight at the planning, implementation, and completion stages of the environmental data collection activity. This process ensures that the data provided are of the quality required.

During the implementation of the data collection effort, QA activities ensure that the QC system is functioning effectively and that the deficiencies uncovered by the QC system are corrected. After environmental data are collected, QA activities focus on assessing the quality of data to determine its suitability to support enforcement or remedial decisions.

Each contract laboratory prepares a Quality Assurance Plan (QAP) with the objective of providing sound analytical chemical measurements. The QAP must specify the policies, organization, objectives, and functional guidelines, as well as the QA and QC activities designed to achieve the data quality requirements for this analytical service.

QUALITY CONTROL

The QC process includes those activities required during analytical data collection to produce data of known and documented quality. The analytical data acquired from QC procedures are used to estimate and evaluate the analytical results and to determine the necessity for, or the effect of, corrective action procedures. The QC procedures required for this analytical service are shown in **Table 3.**

Table 2. Methods and Instruments

Fraction	Water	Soil
Volatiles	Purge-and-trap followed by GC/MS analysis.	Purge-and-trap or closed-system purge-and-trap followed by GC/MS analysis.
Semivolatiles	Continuous liquid-liquid extraction followed by GC/MS analysis.	Sonication, automated soxhlet, or pressurized fluid extraction followed by GC/MS analysis.
Pesticides/Aroclors	Continuous liquid-liquid or separatory funnel extraction followed by dual column GC/EC analysis.	Sonication, automated soxhlet, or pressurized fluid extraction followed by dual column GC/EC analysis.

Table 3. Quality Control

QC Operation	Frequency
System Monitoring Compounds (volatiles)	Added to each sample, standard, and blank.
Surrogates (for semivolatiles and pesticides/Aroclors)	Added to each sample, standard, and blank.
Method Blanks (volatiles)	Analyzed at least every 12 hours for each matrix and level.
Method Blanks (semivolatiles and pesticides/Aroclors)	Prepared with each group of 20 samples or less of same matrix and level, or each time samples are extracted by the same procedure.
Instrument Blank (volatiles)	Analyzed after a sample that contains compounds at concentrations greater than the calibration range.
Instrument Blank (pesticides/Aroclors)	Every 12 hours on each GC column used for analysis.
Storage Blanks (volatiles)	Prepared and stored with each set of samples.
GC/MS Mass Calibration and Ion Abundance Patterns (volatiles and semivolatiles)	Every 12 hours for each instrument used for analysis.
GC Resolution Check (pesticides/Aroclors)	Prior to initial calibration, on each instrument used for analysis.
Initial Calibration	Upon initial set up of each instrument, whenever instrument maintenance/modification has been performed, and each time continuing calibration fails to meet the acceptance criteria.
Continuing Calibration	Every 12 hours for each instrument used for analysis.
Internal Standards (volatiles and semivolatiles)	Added to each sample, standard, and blank.
Matrix Spike and Matrix Spike Duplicate	Once every 20 or fewer samples of same fraction, matrix, and level in an SDG.

PERFORMANCE MONITORING ACTIVITIES

Laboratory performance monitoring activities are provided primarily by AOC and the Regions to ensure that contract laboratories are producing data of the appropriate quality. EPA performs on-site laboratory audits, data package audits, GC/MS and/or GC/EC tape audits, and evaluates laboratory performance through the use of blind performance evaluation samples.

For more information, or for suggestions to improve this analytical service, please contact:

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Attachment 6

Multi-Media, Multi-Concentration, Inorganic Analytical Service for Superfund

Quick Reference Fact Sheet

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United States Environmental Protection Agency | Office of Solid Waste and Emergency Response | OSWER Document 9240.1-43FS
EPA Publication 540-F-04-001
February 2004

EPA

Multi-Media, Multi-Concentration, Inorganic Analytical Service for Superfund (ILM05.3)

Office of Superfund Remediation and Technology Innovation
Analytical Services Branch (5204G)

Quick Reference Fact Sheet

Under the legislative authority granted to the U.S. Environmental Protection Agency (EPA) under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and the Superfund Amendments and Reauthorization Act of 1986 (SARA), EPA develops standardized analytical methods for the measurement of various pollutants in environmental samples from known or suspected hazardous waste sites. Among the pollutants that are of concern to EPA at such sites is a series of inorganic analytes and cyanide that are analyzed using Inductively Coupled Plasma-Atomic Emission Spectroscopy (ICP-AES), Inductively Coupled Plasma-Mass Spectrometry (ICP-MS), Cold Vapor Atomic Absorption (CVAA), and colorimetric techniques. The Analytical Services Branch (ASB) of the Office of Superfund Remediation and Technology Innovation (OSRTI) offers an analytical service that provides data from the analysis of water/aqueous and soil/sediment samples for inorganic analytes for use in the Superfund and other decision making processes. Through a series of standardized procedures and a strict chain-of-custody, the inorganic analytical service produces data of known and documented quality. This service is available through the Superfund Contract Laboratory Program (CLP).

DESCRIPTION OF SERVICES

The inorganic analytical service provides a technical and contractual framework for laboratories to utilize EPA/CLP analytical methods. These methods are used in the isolation, detection and quantitative measurement of 23 target analyte metals (including mercury) and cyanide in both water and soil/sediment environmental samples. The CLP provides the methods to be used and the specific technical, reporting, and contractual requirements, including Quality Assurance (QA), Quality Control (QC), and Standard Operating Procedures (SOPs), by which EPA evaluates the data.

Three data delivery turnaround times are available to CLP customers: 7, 14, and 21-day turnaround after receipt of the last sample in the set. A 72-hour preliminary data submission option also is available for all turnaround times. The data associated with these Preliminary Results is due within 72 hours after receipt of each sample at the laboratory. In addition, data users may request modifications to the SOW that may include, but are not limited to, additional analytes and modified quantitation limits.

DATA USES

This analytical service provides data that EPA uses for a variety of purposes. Examples include determining the nature and extent of contamination at a hazardous waste site, assessing priorities for response based on risks to human health and the environment, determining appropriate cleanup actions, and determining when remedial actions are complete. The data may be used in all stages in the investigation of a hazardous waste site including: site inspections, Hazard Ranking System scoring, remedial investigations/feasibility studies, remedial design, treatability studies, and removal actions. In addition, this service provides data that are available for use in Superfund enforcement/litigation activities.

TARGET ANALYTES

The inorganic analytes and quantitation limits for which this service is applicable are listed in **Table 1**. Specific detection limits are method and matrix dependent.

The list of target analytes for this service was originally derived from the EPA Priority Pollutant List of 129 compounds. In the years since the inception of the CLP, analytes have been added to and deleted from the Target Analyte List (TAL), based on advances in analytical methods, evaluation of method performance data, and the needs of the Superfund program.

METHODS AND INSTRUMENTATION

The Contractor laboratories will demonstrate the ability to meet certain program data quality objectives prior to analyzing field samples. The laboratories must document methods used to generate analytical results and determine Method Detection Limits (MDLs).

Table 1. Inorganic Target Analyte List and Contract Required Quantitation Limits (CRQLs)

Analyte	ICP-AES CRQL for Water (µg/L)	ICP-AES CRQL for Soil (mg/kg)	ICP-MS CRQL for Water (µg/L)
1. Aluminum	200	20	--
2. Antimony	60	6	2
3. Arsenic	10	1	1
4. Barium	200	20	10
5. Beryllium	5	0.5	1
6. Cadmium	5	0.5	1
7. Calcium	5000	500	--
8. Chromium	10	1	2
9. Cobalt	50	5	1
10. Copper	25	2.5	2
11. Iron	100	10	--
12. Lead	10	1	1
13. Magnesium	5000	500	--
14. Manganese	15	1.5	1
15. Mercury	0.2	0.1	--
16. Nickel	40	4	1
17. Potassium	5000	500	--
18. Selenium	35	3.5	5
19. Silver	10	1	1
20. Sodium	5000	500	--
21. Thallium	25	2.5	1
22. Vanadium	50	5	1
23. Zinc	60	6	2
24. Cyanide	10	2.5	--

ICP-Atomic Emission Spectroscopy (ICP-AES) is used to analyze water, sediment, sludge, and soil samples. Water and soil samples are treated with acids and heated. The digestates are then analyzed for trace metals by an atomic emission optical spectroscopic technique. The samples are nebulized and the aerosol is transported to a plasma torch. The atomic-line emission spectra are dispersed and a photosensitive device monitors line intensities.

ICP-Mass Spectrometry (ICP-MS) is used to determine the concentration of dissolved and total recoverable elements in water/aqueous samples. The sample material is introduced, by nebulization, into radio frequency plasma where desolvation, atomization, and ionization take place. The ions are extracted from the plasma through a differentially pumped vacuum interface and separated based on their mass-to-charge ratio.

Cold Vapor Atomic Absorption (CVAA) is used to analyze water, sediment, sludge, and soil samples for total mercury. Organo-mercury compounds may also be present and will need to be broken down and converted to mercuric ions to respond to the CVAA techniques. For water samples, organic compounds are oxidized and then reacted with a strong reducing agent. The volatile free mercury is then driven from the reaction flask by bubbling air through the solution. The air stream carries the mercury atoms to an absorption cell, which is then placed in the light path of the AA spectrophotometer. For soil/sediment, the samples undergo acid digestion/oxidation followed by reduction and measurement by conventional cold vapor technique.

Various water types, sediment, sludge, and soil samples are also analyzed for total cyanide. Hydrocyanic acid (HCN) is released through a reflux-distillation and absorbed in a scrubber containing sodium hydroxide solution. The cyanide ion is determined colorimetrically by converting it to cyanogen chloride (CNCl).

Table 2 summarizes the methods and instruments used in this analytical service.

DATA DELIVERABLES

Data deliverables for this service include both hardcopy/electronic data reporting forms and supporting raw data. The laboratory must submit data to EPA within 7-, 14- or 21-days, or preliminary data must be submitted within 72 hours after laboratory receipt of each sample in the set, if requested. EPA then processes the data through an automated Data Assessment Tool (DAT). DAT is a complete CLP data assessment package. DAT incorporates Contract Compliance Screening (CCS) and Computer-Aided Data Review and Evaluation (CADRE) review to provide EPA Regions and other data users with electronic reports (PC-compatible reports, spreadsheets, and electronic files) within 24 to 48 hours from the receipt of the data. This automated tool facilitates the

Table 2. Methods and Instruments

Analyte	Instrument	Method
Al, Sb, As, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Ni, K, Se, Ag, Na, Tl, V, Zn	Inductively Coupled Plasma - Atomic Emission Spectroscopy (ICP-AES)	ICP analysis of atomic-line emission spectra.
Sb, As, Ba, Be, Cd, Cr, Co, Cu, Pb, Mn, Ni, Se, Ag, Tl, V, Zn	ICP - Mass Spectrometry (ICP-MS)	ICP analysis of ions separated on basis of mass-to-charge ratio.
Mercury (Hg)	Cold Vapor Atomic Absorption (CVAA)	Acid digestion/oxidation followed by reduction and CVAA analysis.
Cyanide (CN)	Colorimeter or Spectrophotometer	Distillation followed by colorimetric analysis.

Table 3. Quality Control

QC Operation	Frequency
Instrument Calibration	Daily or each time instrument is set up.
Initial Calibration Verification	Following each instrument calibration for each wavelength or mass used.
Initial Calibration Blank	Following each instrument calibration, immediately after the Initial Calibration Verification (ICV).
Continuing Calibration Verification	For each wavelength or mass used, at a frequency of 10% or every two hours of a run, whichever is more frequent, and at the beginning and end of each run.
Continuing Calibration Blank	10% or every two hours of a run, whichever is more frequent, and at the beginning and end of each run. Performed immediately after the last Continuing Calibration Verification (CCV).
CRQL Check Standard (CRI)	Every 20 analytical samples and at the beginning and end of each run, but not before the ICV. Performed before the Interference Check Sample.
Interference Check Sample	For ICP-AES, every 20 analytical samples and at the beginning and end of each run, immediately after the CRI. For ICP-MS, at the beginning of the run.
Serial Dilution for ICP	For each matrix type or for each SDG, whichever is more frequent.
Preparation Blank	For each SDG or each sample preparation and analysis procedure per batch of prepared samples.
Laboratory Control Sample	For each SDG or each sample preparation and analysis procedure per batch of prepared samples, except aqueous mercury and cyanide.
Spike Sample	For each matrix type or for each SDG, whichever is more frequent.
Post Digestion/Distillation Spike	Each time Spike Sample Recovery is outside QC limits.
Duplicate Sample Analysis	For each matrix type or for each SDG, whichever is more frequent.
ICP-MS Tune	Prior to calibration.
Method Detection Limit Determination	Prior to contract, annually thereafter, and after major instrument maintenance.
Interelement Corrections	Prior to contract, quarterly thereafter, and after major instrument adjustment.
Linear Range Analysis	Prior to contract, and quarterly thereafter.

transfer of analytical data into Regional databases. DAT can also be used to assist in the data validation process at the Region. In addition to the Regional electronic reports, the CLP laboratories are provided with a data assessment report that documents the instances of noncompliance. The laboratory has four business days to reconcile defective data and resubmit the data to EPA. EPA then reviews the data for noncompliance and sends a final data assessment report to the CLP laboratory and the Region.

QUALITY ASSURANCE

The Quality Assurance (QA) process consists of management review and oversight at the planning, implementation, and completion stages of the environmental data collection activity and ensures that the data provided are of the quality required. During the data collection effort, QA activities ensure that the Quality Control (QC) system is functioning effectively and that the deficiencies uncovered by the QC system are corrected. After environmental data are collected, QA activities focus on assessing the quality of data obtained to determine its suitability to support enforcement or remedial decisions. Each contract laboratory will establish a Quality Assurance Plan (QAP) with the objective of providing sound analytical chemical measurements. The QAP must specify the policies, organization, objectives, functional guidelines, and specific QA/QC activities designed to achieve the data quality requirements for this analytical service.

QUALITY CONTROL

The QC process includes those activities required during analytical data collection to produce data of known and documented quality.

The analytical data acquired from QC procedures are used to estimate and evaluate the analytical results and to determine the necessity for, or the effect of, corrective action procedures. The QC procedures required for this analytical service are shown in **Table 3**.

PERFORMANCE MONITORING ACTIVITIES

Laboratory performance monitoring activities are provided primarily by ASB and the Regions to ensure that contract laboratories are producing data of the appropriate quality. EPA performs on-site laboratory audits, data package audits, and evaluates laboratory performance with blind performance evaluation samples.

For more information, or for suggestions to improve this analytical service, please contact:

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TCEQ
SUPERFUND PROGRAM
STANDARD OPERATING PROCEDURES

TCEQ SUPERFUND PROGRAM SOP INDEX

Date: 07/26/04

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1.3	0	SITE RESTORATION
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STANDARD OPERATING PROCEDURE NO. 1.1
INITIAL SITE RECONNAISSANCE

1.0 METHOD SUMMARY

This standard operating procedure (SOP) provides guidance for conducting an initial site reconnaissance. The purpose of conducting a site reconnaissance is to familiarize personnel with the site and to identify hazards which may affect field activities.

2.0 EQUIPMENT/APPARATUS/REAGENTS

2.1 Equipment List

- Appropriate personal protective equipment (PPE) (if conditions are unknown, initial site entry should be conducted in Level B PPE)
- Air monitoring equipment (e.g., OVA)

3.0 PROCEDURES

1. Obtain site access (access agreements).
2. Identify site boundaries.
3. Identify any special requirements for the preparation of the site (e.g., heavy equipment required to clear trees).
4. Identify areas on the site which may require control (i.e., fencing).
5. Identify vehicle access routes.
6. An organic vapor analyzer (OVA) is typically used during this survey. These gross measurements may be used on a preliminary basis to (1) determine levels of personal protection, (2) establish site work zones, and (3) map candidate areas for more thorough qualitative and quantitative studies involving air sampling.
7. Identify locations for central decontamination area and exits for it, field office/laboratory, and emergency equipment (e.g., fire extinguishers and PPE).

4.0 CAUTIONS AND INTERFERENCES

Two people should perform the initial site reconnaissance staying together at all times. Also, all instrumentation should be intrinsically safe or explosion-proof.

STANDARD OPERATING PROCEDURE NO. 1.2
PREPARATION AND CONTROL

1.0 METHOD SUMMARY

This standard operating procedure (SOP) provides guidance for site preparation and control. It is intended to assist field personnel in preparing the site before conducting any work activities.

2.0 EQUIPMENT/APPARATUS/REAGENTS

2.1 Equipment List

- Appropriate personal protective equipment (PPE)
- Caution tape, orange cones and/or other visible means of delineating boundaries
- Heavy gauge plastic sheeting
- Collection systems for decontamination areas (e.g., sump pump)
- 55-gallon drums or other appropriate containers
- Sheets of plywood
- Hay bales
- 2 x 4 lumber
- Landscape timbers
- Tables or sawhorse benches
- Site Plan

3.0 PROCEDURES

1. Don appropriate PPE.
2. Identify and mark utility locations in accordance with SOP 2.4
3. Designate and mark the decontamination zone with caution tape, orange cones and/or other visible means. To control access of personnel and equipment to possible contaminants, the site will be divided into work zones. There is only one entrance and exit to the zones. Three categories of zones and one command post are utilized. For all operations except Level D, work zones will be designated as follows:
    1. Support Zone or Clean Zone -- Along with the command post, this is the outermost boundary of the site. Contamination of personnel and equipment in this area is unlikely.
    2. Contamination Reduction Zone -- This area serves as a corridor between the exclusion zone and the support zone and is the area where decontamination activities occur. All personnel and equipment passing through this corridor from the exclusion zone to the support zone must undergo appropriate decontamination.
    3. Exclusion Zone -- This is the area where actual operations are being conducted. Access to this area is limited to personnel and equipment being utilized at that particular time for the specific operation in progress. The risk of contamination in this area is high.
    4. Create a central decontamination area for drilling rigs and other large equipment (see SOP 1.5). The decontamination area should be large enough to allow storage of cleaned equipment and materials prior to use, as well as drums of decontamination waste. The decontamination area shall be lined with heavy gauge plastic sheeting, and designed with a collection system to capture decontamination waters. Solid wastes shall be accumulated in 55-gallon drums or other

appropriate containers and stored in a designated investigative derived waste (IDW) storage area (see SOP 1.4).

A large equipment decontamination pad can be constructed by placing sheets of plywood on the ground and covering them with plastic sheeting. Walls for controlling over spray can be created from hay bales or by constructing 2 x 4 frames covered with plastic sheeting. Landscape timbers can be used to create berms around the floor of the decontamination pad. A sump pump should be used to collect decontamination water and transfer the water to 55-gallon drums.

A small equipment decontamination line can be created by placing plastic sheeting on the ground and using tables or sawhorse benches to hold wash basins.

Decontamination lines are site specific since they are dependent upon the types of contamination and the type of work activity onsite. It is usually a location in a shaded area in which the wind can help to cool personnel.

5. Identify the locations of utilities, the field office/laboratory, IDW storage areas, exclusion zone, contamination reduction zone (including decontamination facilities), and the clean zone on a site plan.

4.0 CAUTIONS AND INTERFERENCES

This section is not applicable to this SOP.

STANDARD OPERATING PROCEDURE NO. 1.3
SITE RESTORATION

1.0 METHOD SUMMARY

This standard operation procedure (SOP) describes the steps necessary for site restoration. Upon completion of field activities, the site should be repaired to its original condition when possible. All drums or waste containers should be staged in a designated staging area and all other waste should be removed. All borings should be backfilled.

2.0 EQUIPMENT/APPARATUS/REAGENTS

Varies depending on which of the following tasks are completed.

3.0 PROCEDURES

1. Minimize impacts to work sites and sampling locations, particularly those in or near sensitive environments, such as wetlands with the use of soil erosion fences or by diverting streams/brooks during work operations.
2. Fill boreholes and pits, re-vegetate or erect erosion fences as necessary, re-establish streams, brooks, etc, as applicable.
3. Remove all sampling, decontamination equipment, and other items introduced to the site upon completion of work.
4. Remove all drums, trash, and other waste upon completion of work at the site.
5. Transport decontamination and/or purge water and soil cuttings to the designated locations.

4.0 CAUTIONS AND INTERFERENCES

This section is not applicable to this SOP.

STANDARD OPERATING PROCEDURE NO. 1.4
MANAGEMENT OF
INVESTIGATIVE DERIVED WASTE

1.0 METHOD SUMMARY

This standard operating procedure (SOP) provides standard operating procedures for managing investigative derived waste (IDW) generated during field activities. Materials which may become IDW include:

- Personnel protective equipment (PPE) including disposable coveralls, gloves, booties, respirator canisters, splash suits, etc.
- Disposable equipment including plastic ground and equipment covers, aluminum foil, conduit pipe, composite liquid waste samplers (COLIWASAs), disposable bailers, rope or twine, Teflon® tubing, broken or unused sample containers, sample container boxes, tape, etc.
- Soil cuttings from drilling or hand augering.
- Excess soil sample material.
- Drilling mud or water used for water rotary drilling.
- Ground water obtained through well development or well purging.
- Cleaning fluids such as spent solvents and washwater.
- Packing and shipping materials.

2.0 EQUIPMENT/APPARATUS/REAGENTS

2.1 Equipment List

- 55-gallon drums
- Labels for drums
- Wrenches for securing drum lids
- Marking pens (for marking on labels and on drums)
- Lumber (for creating storage area)
- Plastic sheeting (for storage area)
- Plywood (for storage area flooring)
- 5-gallon buckets
- Manifests
- Drum log

3.0 PROCEDURES

Be sure to keep all hazardous waste separate from non-hazardous waste. Label each container properly and keep a log (Appendix A) of all the drums or containers, stating their identification number and contents. Drill cuttings from different holes can be put in the same drums provided they originate from similar areas of the site (e.g., upgradient, background borings, etc.).

3.1 Management of Non-Hazardous IDW

1. If necessary, compact the waste into a reusable container, such as a 55-gallon drum to reduce the volume of non-hazardous waste.
2. If the waste is generated from an active facility, seek permission from the operator of the facility to place the *non-hazardous* PPE, disposable equipment, and/or paper/cardboard wastes into the facility dumpsters. These materials may also be taken to a nearby permitted landfill. On larger studies, waste hauling services may be obtained and a dumpster located at the study site.

3. Dispose of *non-hazardous* IDW such as drill cuttings, purge or development water, decontamination washwater, drilling muds, etc. in a unit with an environmental permit such as a landfill or sanitary sewer. These materials must not be placed into dumpsters.

4. Seek permission to place these types of IDW into the facility treatment system if the facility is active.

3.2 Management of Hazardous IDW

1. Properly contain and label all suspected or identified hazardous wastes. Wastes should be stored in labeled 55-gallon drums at a segregated staging facility with a secondary containment structure.

2. Take care to keep non-hazardous materials segregated from hazardous waste contaminated materials.

3. Review appropriate sample results to determine waste characterization and perform any specific analysis required by the permitted disposal facility.

4. Hazardous wastes may be stored on site for a maximum of 90 days before they must be manifested and shipped to a permitted treatment or disposal facility.

5. Dispose of hazardous IDW as specified in the USEPA and TNRCC regulations. If appropriate, place these wastes in an active facility waste treatment system.

6. Anticipate generation of hazardous IDW, if possible, to permit arrangements for proper containerization, labeling, transportation, and disposal/treatment in accordance with USEPA and TNRCC regulations.

4.0 CAUTIONS AND INTERFERENCES

1. All liquid and soil/sediment IDW *must* be containerized and analyzed before disposal.

2. The collection handling, and proposed disposal method must be specified in the site work plan.

APPENDIX A

DRUMMED MATERIAL WORKSHEET

Project Name: _____ **Project No.:** _____

Site Address: _____ **Project Manager:** _____

Drum No.	Boring No.	Date	Contents	Sample ID	Lab Results	Disposition

STANDARD OPERATING PROCEDURE NO. 1.5
DECONTAMINATION

1.0 METHOD SUMMARY

This standard operating procedure (SOP) provides a description of the methods used for preventing, minimizing, or limiting cross-contamination of samples due to inappropriate or inadequate equipment decontamination and to provide general guidelines for developing decontamination procedures for sampling equipment to be used during hazardous waste operations. This SOP does not address personnel decontamination.

Removing or neutralizing contaminants from equipment minimizes the likelihood of sample cross contamination, reduces or eliminates transfer of contaminants to clean areas, and prevents the mixing of incompatible substances. Gross contamination can be removed by physical decontamination procedures. These abrasive and non-abrasive methods include the use of brushes, air and wet blasting, and high and low pressure water cleaning.

2.0 EQUIPMENT/APPARATUS/REAGENTS

- Non-phosphate detergent
- Tap water
- Distilled or deionized water
- Long and short handled brushes
- Bottle brushes
- Drop cloth/plastic sheeting
- Paper towels
- Plastic or galvanized tubs or buckets
- Pressurized sprayers
- Aluminum foil
- Ziploc® bags
- Trash bags
- Appropriate personal protective equipment (PPE)
- Face shield (for hard hat)
- High pressure washer (if necessary)
- Fuel for high pressure washer
- 55-gallon drums
- Plywood
- Sump pump
- Landscape timbers, 4 x 4's, or 2 x 4's

3.0 PROCEDURES

3.1 Decontamination

The prime contractor shall describe all decontamination of drilling equipment, well construction materials, sampling equipment, tools, etc in the project work plan. All samples and equipment leaving the contaminated area of a site must be decontaminated to remove any contamination that may have adhered to equipment. This includes casing, drill bits, auger flights, the portions of drill rigs that stand above boreholes, sampling devices, and instruments, such as slugs and sounders. In addition, the contractor shall take care to prevent the sample from coming into contact with potentially contaminating substances, such as tape, oil, engine exhaust, corroded surfaces, and dirt.

The following procedures shall be used to decontaminate large pieces of equipment, such as casings, auger flights, pipe and rods, and those portions of the drill rig that may stand directly over a boring or well location or that come into contact with casing, auger flights, pipe, or rods.

1. Prepare the decontamination zone in accordance with SOP 1.2.
2. Don appropriate PPE.
3. Deposit the contaminated equipment on the plastic drop cloth/sheet or in a container inside the CRZ.
4. Place large pieces of equipment (e.g., auger flights) on sawhorses.
5. Use a high-pressure washer and a low-phosphate soap (e.g, Alconox) to remove encrusted material from grossly contaminated equipment. If necessary, use a brush to scrub the equipment until all visible dirt, grime, grease, oil, loose paint, rust flakes, etc., have been removed.
6. Rinse all equipment with potable water.
7. Store the equipment on sawhorses or wrapped in clean plastic sheeting.
8. Decontamination water should be collected and transferred to a 55-gallon drum at the end of the day or whenever significant quantities of water have accumulated. Drums of investigative derived waste (IDW) should be managed in accordance with SOP 1.4.

The following procedures shall be used to decontaminate small pieces of sampling equipment such as split spoons, bailers, trowels/spoons and bowls.

1. Prepare the decontamination zone in accordance with SOP 1.2.
2. Don appropriate PPE.
3. Scrub the equipment with a solution of potable water and low-phosphate soap (e.g., Alconox).
4. If organic constituents are contaminants of concern, rinse the equipment with a pesticide-grade solvent, typically acetone. If acetone is a constituent of concern, substitute methanol as the rinse agent.
5. Rinse the equipment with copious quantities of distilled or deionized water.
6. Allow the equipment to air dry on a clean surface or rack elevated at least two feet above ground.
7. Wrap the sampling device in aluminum foil or place in Ziploc® bags prior to reuse.

At the completion of the decontamination activities, all fluids and solid waste should be containerized and managed in accordance with SOP 1.4.

If a particular contaminant fraction is not present at the site, the ten (10) step decontamination procedure specified above may be modified for site specificity. For example, the solvent rinse may be eliminated if organics are not of concern at a site. Modifications to the standard procedure should be documented in the site specific work plan or subsequent report.

4.0 CAUTIONS AND INTERFERENCES

- The use of distilled/deionized water commonly available from commercial vendors is typically acceptable for decontamination of sampling equipment.

- The use of an untreated potable water supply is not an acceptable substitute for tap water. Tap water may be used from any municipal or industrial water treatment system.
- If solvents are utilized in decontamination they raise health and safety, and waste disposal concerns.
- Damage can be incurred by solvent washing of complex and sophisticated sampling equipment.

STANDARD OPERATING PROCEDURE NO. 2.1
LAND SURVEY

1.0 METHOD SUMMARY

The objective of a standard operating procedure (SOP) is to provide guidance for conducting routine or repetitive land surveys.

Field measurements of topographic features, samples and sample points, monitoring wells, sample traverses or water levels are frequently required at any environmental investigation site. All work should be done in accordance with the procedures provided in this SOP. All locations whether subsurface, surface, ecological, or any other area sampled during field investigations should be depicted on an accurate drawing, topographic or other standard map, or be referenced in such a manner that the location(s) can be firmly established. Each field measurement made should be traceable to the person(s) making the measurement.

2.0 EQUIPMENT/APPARATUS/REAGENTS

The following equipment is typically used for conducting field surveys:

- Electric Measuring Device
- Theodolites and prisms
- Total Stations
- Tripod
- Survey logbook
- Stakes, flagging, etc.
- Global positioning satellite (GPS) equipment
- Hand held scale
- Notebook

3.0 PROCEDURES

All property surveys should be performed in accordance with good land surveying practices and should conform to all pertinent federal and state laws and regulations governing land surveying in the area where the work is being accomplished. The surveyor shall be licensed and registered in the state of Texas. A GPS can be used for surveying. The following guidelines shall apply when conducting property surveys:

1. All surveying shall be conducted by a registered professional land surveyor.
2. All surveys shall be based on a measuring point that is tied to the state plane system.
3. All surveys shall be third order (Texas Board of Land Surveyors, 1962).
4. An XY-coordinate system shall be used to identify locations. The X-coordinate shall be the east-west axis; the Y-coordinate shall be the north-south axis. The reference point shall be the origin.
5. The surveyed control information for all data collection points shall be recorded and displayed in a table. The table shall give the X and Y coordinates in state plane coordinate values, the ground elevation and the measuring point elevation if the location is a ground water monitoring well. The elevation of all newly installed wells and piezometers shall be surveyed at the water level measuring point (notch) on the riser pipe.
6. Include the elevation of the ground surface in the survey.

All surveying locations of field activities shall be measured by the licensed land surveyor as the distance in feet from a reference location that is tied to the State Plane system. The surveys shall be in third order. An XY-coordinate system shall be used to identify locations. The X-coordinate shall be the east-west axis; the Y-coordinate shall be the north-south axis with the reference location as the origin. All surveyed locations shall be reported using the state plane coordinate system. The surveyed control information for all data collection points shall be recorded and displayed in a table. The table shall give the X and Y coordinates in state plane coordinate values, the ground elevation, and the measuring point elevation if the location is a groundwater monitoring well. Newly installed wells and piezometers shall be surveyed at the water level measuring point (notch) on the riser pipe.

Upon completion of the project, all original field note books, computations, and pertinent reference materials should be delivered to the site manager for retention in the site file. The surveyor may keep photostatic copies of the material. All field note reductions should be checked and marked in such a way that a visual inspection of the field notes will confirm that checks have been made. All office entries in field notebooks should be made in colored pencil. The office worker who reduces or checks field notes should initial each page in the color used on that page.

All plats, maps, figures, and etc. should be prepared using AutoCad™ and shall be presented at a scale appropriate to the needs of the TNRCC. AutoCad™ files shall sensibly separate different types of points and layers; AutoCad™ files shall be submitted along with the drawings. All drawings shall have a place where the associated AutoCad™ file name is displayed along with the list of layers plotted and the program version number of AutoCad™ used to generate the file.

4.0 CAUTIONS AND INTERFERENCES

When exact locations of sampling points or other physical features at a site are needed, surveying methods must be used based on existing control data. If unavailable at the time of the investigation, and if necessary, the site property boundary survey, legal description, and any physical property corners or monuments must be established by a professional Register Professional Land Surveyor (RPLS). At a minimum, the registered surveyor will be required to establish at least two control points upon which the elevation and the State Plane coordinates are set. Data on control points shall be of at least third-order accuracy. A network of horizontally (and vertically) located control points has been established and is continually maintained by the National Oceanic and Atmospheric Administration (NOAA) through its National Ocean Survey. The old horizontal datum, called the North American Datum of 1927 (NAD27), has been replaced with the newer datum of 1983 (NAD83).

STANDARD OPERATING PROCEDURE NO. 2.2
WATER USE SURVEY

1.0 METHOD SUMMARY

The objective of a standard operating procedure (SOP) is to provide guidance for routine or repetitive water use surveys.

2.0 EQUIPMENT/APPARATUS/REAGENTS

The following equipment is typically used for conducting field surveys:

- Notebook

3.0 PROCEDURES

Water use surveys are used to assess groundwater contamination in public or private water wells. Information may be obtained through a literature search from various agencies, a house-to-house well survey, and subsequent sampling of selected off-site wells.

The literature search is conducted by collecting file data for all water wells within a 3-mile radius of the site and should include locations, completion depths, well installation details, static water levels, and generalized lithologic logs.

A house-to-house well survey should include all houses, industries, and farmland within a 1-mile radius of the site. The occupants/workers at each location should be interviewed in order to identify the source (municipal, groundwater wells, or surface water) and quantity of water use. The type of use (irrigation, industrial or domestic) will identify the potential for human health exposure from any groundwater or surface water use. The owner, location and depth of each well, along with well construction and lithologic details must be tabulated.

Selected water sources including groundwater and surface water should be sampled to determine the quality of groundwater near the site both in the upgradient and in the downgradient direction. The possibility of contamination migrating from the site towards or from these sources should be assessed. Offsite samples should be analyzed for the same contaminants as any onsite samples. Depending on the analytical results obtained from the sampling, more wells can be installed or sampled in subsequent rounds of sampling. Groundwater samples should be obtained from selected wells in accordance with SOP 7.6, 7.7, or 7.8.

4.0 CAUTIONS AND INTERFERENCES

There are none for this SOP.

STANDARD OPERATING PROCEDURE NO. 2.3
RECEPTOR SURVEY

1.0 METHOD SUMMARY

This standard operating procedure (SOP) provides general guidance on receptor surveys in accordance with the Tier1: Exclusion Criteria Checklist from 30 TAC §350.77(b) .

2.0 EQUIPMENT/APPARATUS/REAGENTS

The following equipment is typically used for conducting field surveys:

- Electric Measuring Device
- Theodolites and prisms
- Total Stations
- Tripod
- Survey logbook
- Stakes, flagging, etc.
- Global positioning satellite (GPS) equipment
- Stainless steel buckets
- Dip net
- Electroshocker
- Fish measuring board
- Hand held scale
- Decontamination supplies
- Aluminum foil
- Notebook
- Wet Lands Maps

3.0 PROCEDURES

Receptor surveys assess the ecological conservation value of the subject site as a habitat and a movement corridor for various organisms. The surveys usually consist of dividing the subject site into subareas and conducting walks for recording observations regarding various habitats, their size, food requirements, general species composition and structural features. There are various types of habitats such as wetlands, forests, grasslands, etc. Note any potential wetlands, especially. The habitats generally include and are not limited to vegetation, birds, terrestrial vertebrate and invertebrate species, mammals, amphibians, reptiles, aquatic, and exotic species. The Texas Parks and Wildlife Department should be contacted to obtain an endangered species list for the area.

Vegetation

A qualitative vegetation survey consists of identifying the different species of vegetation present, canopy height, vegetation structure, principal species present in the area and its surroundings, evidence of stress, stunted growth, leaf burns, and/or deformities and comparing it with the composition of species off-site. The species composition suggests trends whereby species such as those found onsite reflect a response to a perturbation, physical or chemical.

Terrestrial Species

Sampling of terrestrial species consists of trapping species from a variety of micro and macro habitats, and sampling tissue for contaminant analyses. The species selected depend on abundance or presence, whether herbivorous, and whether they live close to the ground with constant exposure to contamination. Physical and weight characteristics are measured for each of the species and their physiological abnormalities observed.

Aquatic Species

Aquatic species sampling is conducted to identify site constituents of concern which may be present in the sediments or surface waters at the site and have been ingested by the aquatic species. Samples of the species may be collected with:

- Trawls
- Electrofishing (not applicable in marine waters)
- Seining
- Hook and line
- Other fish collection approaches
- In-situ bioassays

The samples are then analyzed for contaminants of concern and physiological differences between upstream and downstream samples. Upstream and downstream samples are compared to measure the impact of contamination. Fish are common test organisms in acute and bio-concentration tests.

Follow and complete the Tier1: Exclusion Criteria Checklist from 30 TAC §350.77(b) (see Appendix A).

4.0 CAUTIONS AND INTERFERENCES

There are none for this SOP.

APPENDIX A

Tier 1: Exclusion Criteria Checklist

This exclusion criteria checklist is intended to aid the person and the TNRCC in determining whether or not further ecological evaluation is necessary at an affected property where a response action is being pursued under the Texas Risk Reduction Program (TRRP). Exclusion criteria refer to those conditions at an affected property which preclude the need for a formal ecological risk assessment (ERA) because there are **incomplete or insignificant ecological exposure pathways** due to the nature of the affected property setting and/or the condition of the affected property media. This checklist (and/or a Tier 2 or 3 ERA or the equivalent) must be completed by the person for all affected property subject to the TRRP. The person should be familiar with the affected property but need not be a professional scientist in order to respond, although some questions will likely require contacting a wildlife management agency (i.e., Texas Parks and Wildlife Department or U.S. Fish and Wildlife Service). The checklist is designed for general applicability to all affected property; however, there may be unusual circumstances which require professional judgement in order to determine the need for further ecological evaluation (e.g., cave-dwelling receptors). In these cases, the person is strongly encouraged to contact TNRCC before proceeding.

Besides some preliminary information, the checklist consists of three major parts, **each of which must be completed unless otherwise instructed.** PART I requests affected property identification and background information. PART II contains the actual exclusion criteria and supportive information. PART III is a qualitative summary statement and a certification of the information provided by the person. **Answers should reflect existing conditions and should not consider future remedial actions at the affected property.** Completion of the checklist should lead to a logical conclusion as to whether further evaluation is warranted. Definitions of terms used in the checklist have been provided and users are strongly encouraged to familiarize themselves with these definitions before beginning the checklist.

Name of Facility:

Affected Property Location:

Mailing Address:

TNRCC Case Tracking #s:

Solid Waste Registration #s:

Voluntary Cleanup Program #:

EPA I.D. #s:

Definitions[1]

Affected property - The entire area (i.e., on-site and off-site; including all environmental media) which contains releases of chemicals of concern at concentrations equal to or greater than the assessment level applicable for the land use (i.e., residential or commercial/industrial) and groundwater classification.

Assessment level - A critical protective concentration level for a chemical of concern used for affected property assessments where the human health protective concentration level is established under a Tier 1 evaluation as described in §350.75(b) of this title (relating to Tiered Human Health PCL Evaluation), except for the protective concentration level for the soil-to-groundwater exposure pathway which may be established under Tier 1, 2, or 3 as described in §350.75(i)(7) of this title, and ecological protective concentration levels are developed, when necessary, under Tier 2 and/or 3 in accordance with §350.77(c) and/or (d), respectively of this title (relating to Ecological Risk Assessment and Development of Ecological PCLs).

Bedrock - The solid rock (i.e., consolidated, coherent, and relatively hard naturally formed material that cannot normally be excavated by manual methods alone) that underlies gravel, soil or other surficial material.

Chemicals of concern - Any chemical that has the potential to adversely affect ecological or human receptors due to its concentration, distribution, and mode of toxicity. Depending on the program area, chemicals of concern may include the following: solid waste, industrial solid waste, municipal solid waste, and hazardous waste as defined in Texas Health and Safety Code, §361.003, as amended; hazardous constituents as listed in 40 Code of Federal Regulations Part 261, Appendix VIII, as amended; constituents on the groundwater monitoring list in 40 Code of Federal Regulations Part 264, Appendix IX, as amended; constituents as listed in 40 CFR Part 258 Appendices I and II, as amended; pollutant as defined in Texas Water Code, §26.001, as amended; hazardous substance as defined in Texas Health and Safety Code, §361.003, as amended, and the Texas Water Code §26.263, as amended; regulated substance as defined in Texas Water Code §26.342, as amended and §334.2 of this title (relating to Definitions), as amended; petroleum product as defined in Texas Water Code §26.342, as amended and §334.122(b)(12) of this title (relating to Definitions for ASTs), as amended; other substances as defined in Texas Water Code §26.039(a), as amended; and daughter products of the aforementioned constituents.

Community - An assemblage of plant and animal populations occupying the same habitat in which the various species interact via spatial and trophic relationships (e.g., a desert community or a pond community).

Complete exposure pathway - An exposure pathway where a human or ecological receptor is exposed to a chemical of concern via an exposure route (e.g., incidental soil ingestion, inhalation of volatiles and particulates, consumption of prey, etc).

[1] These definitions were taken from 30 TAC §350.4 and may have both ecological and human health applications. For the purposes of this checklist, it is understood that only the ecological applications are of concern.

Deminimus - The description of an area of affected property comprised of one acre or less where the ecological risk is considered to be insignificant because of the small extent of contamination, the absence of protected species, the availability of similar unimpacted habitat nearby, and the lack of adjacent sensitive environmental areas.

Ecological protective concentration level - The concentration of a chemical of concern at the point of exposure within an exposure medium (e.g., soil, sediment, , groundwater, or surface water) which is determined in accordance with §350.77(c) or (d) of this title (relating to Ecological Risk Assessment and Development of Ecological Protective Concentration Levels) to be protective for ecological receptors. These concentration levels are primarily intended to be protective for more mobile or wide-ranging ecological receptors and, where appropriate, benthic invertebrate communities within the waters in the state. These concentration levels are not intended to be directly protective of receptors with limited mobility or range (e.g., plants, soil invertebrates, and small rodents), particularly those residing within active areas of a facility, unless these receptors are threatened/endangered species or unless impacts to these receptors result in disruption of the ecosystem or other unacceptable consequences for the more mobile or wide-ranging receptors (e.g., impacts to an off-site grassland habitat eliminate rodents which causes a desirable owl population to leave the area).

Ecological risk assessment - The process that evaluates the likelihood that adverse ecological effects may occur or are occurring as a result of exposure to one or more stressors; however, as used in this context, only chemical stressors (i.e., COCs) are evaluated.

Environmental medium - A material found in the natural environment such as soil (including non-waste fill materials), groundwater, air, surface water, and sediments, or a mixture of such materials with liquids, sludges, gases, or solids, including hazardous waste which is inseparable by simple mechanical removal processes, and is made up primarily of natural environmental material.

Exclusion criteria - Those conditions at an affected property which preclude the need to establish a protective concentration level for an ecological exposure pathway because the exposure pathway between the chemical of concern and the ecological receptors is not complete or is insignificant.

Exposure medium - The environmental medium or biologic tissue in which or by which exposure to chemicals of concern by ecological or human receptors occurs.

Facility - The installation associated with the affected property where the release of chemicals of concern occurred.

Functioning cap - A low permeability layer or other approved cover meeting its design specifications to minimize water infiltration and chemical of concern migration, and prevent ecological or human receptor exposure to chemicals of concern, and whose design requirements are routinely maintained.

Landscaped area - An area of ornamental, or introduced, or commercially installed, or manicured vegetation which is routinely maintained.

Off-site property (off-site) - All environmental media which is outside of the legal boundaries of the on-site property.

On-site property (on-site) - All environmental media within the legal boundaries of a property owned or leased by a person who has filed a self-implementation notice or a response action plan for that property or who has become subject to such action through one of the agency's program areas for that property.

Physical barrier - Any structure or system, natural or manmade, that prevents exposure or prevents migration of chemicals of concern to the points of exposure.

Point of exposure - The location within an environmental medium where a receptor will be assumed to have a reasonable potential to come into contact with chemicals of concern. The point of exposure may be a discrete point, plane, or an area within or beyond some location.

Protective concentration level - The concentration of a chemical of concern which can remain within the source medium and not result in levels which exceed the applicable human health risk-based exposure limit considering cumulative risk and hazard index for both carcinogenic and non-carcinogenic effects respectively, or ecological protective concentration level at the point of exposure for that exposure pathway.

Release - Any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment, with the exception of:

(A) A release that results in an exposure to a person solely within a workplace, concerning a claim that the person may assert against the person's employer;

(B) An emission from the engine exhaust of a motor vehicle, rolling stock, aircraft, vessel, or pipeline pumping station engine;

(C) A release of source, by-product, or special nuclear material from a nuclear incident, as those terms are defined by the Atomic Energy Act of 1954, as amended (42 U.S.C. §2011 et seq.), if the release is subject to requirements concerning financial protection established by the Nuclear Regulatory Commission under §170 of that Act;

(D) For the purposes of the environmental response law §104, as amended, or other response action, a release of source, by-product, or special nuclear material from a processing site designated under §102(a)(1) or §302(a) of the Uranium Mill Tailings Radiation Control Act of 1978 (42 U.S.C. §7912 and §7942), as amended; and

(E) The normal application of fertilizer.

Sediment - Non-suspended particulate material lying below surface waters such as bays, the ocean, rivers, streams, lakes, ponds, or other similar surface water body (including intermittent streams). Dredged sediments which have been removed from surface water bodies and placed on land shall be considered soils.

Sensitive environmental areas - Areas that provide unique and often protected habitat for wildlife species. These areas are typically used during critical life stages such as breeding, hatching, rearing of young, and overwintering. Examples include critical habitat for threatened and endangered species, wilderness areas, parks, and wildlife refuges.

Source medium - An environmental medium containing chemicals of concern which must be removed, decontaminated and/or controlled in order to protect human health and the environment. The source medium may be the exposure medium for some exposure pathways.

Stressor - Any physical, chemical, or biological entity that can induce an adverse response; however, as used in this context, only chemical entities apply.

Subsurface soil - For human health exposure pathways, the portion of the soil zone between the base of surface soil and the top of the groundwater-bearing unit(s). For ecological exposure pathways, the portion of the soil zone between 0.5 feet and 5 feet in depth.

Surface cover - A layer of artificially placed utility material (e.g., shell, gravel).

Surface soil - For human health exposure pathways, the soil zone extending from ground surface to 15 feet in depth for residential land use and from ground surface to 5 feet in depth for commercial/industrial land use; or to the top of the uppermost groundwater-bearing unit or bedrock, whichever is less in depth. For ecological exposure pathways, the soil zone extending from ground surface to 0.5 feet in depth.

Surface water - Any water meeting the definition of surface water in the state as defined in §307.3 of this title (relating to Abbreviations and Definitions), as amended.

PART I. Affected Property Identification and Background Information

1) Provide a description of the specific area of the response action and the nature of the release. Include estimated acreage of the affected property and the facility property, and a description of the type of facility and/or operation associated with the affected property. Also describe the location of the affected property with respect to the facility property boundaries and public roadways.

Attach available USGS topographic maps and/or aerial or other affected property photographs to this form to depict the affected property and surrounding area. Indicate attachments:

__Topographic map __Aerial photo __Other_____

2) Identify environmental media known or suspected to contain chemicals of concern (COCs) at the present time. Check all that apply:

Known/Suspected COC Location	Based on sampling data?	
__Soil ≤ 5 ft below ground surface	__Yes	__No
__Soil >5 ft below ground surface	__Yes	__No
__Groundwater	__Yes	__No
__Surface Water/Sediments	__Yes	__No

Explain (previously submitted information may be referenced):

3) Provide the information below for the nearest surface water body which has become or has the potential to become impacted from migrating COCs via surface water runoff, air deposition, groundwater seepage, etc. Exclude wastewater treatment facilities and storm water conveyances/impoundments authorized by permit. Also exclude conveyances, decorative ponds, and those portions of process facilities which are:

a. Not in contact with surface waters in the State or other surface waters which are ultimately in contact with surface waters in the State; and

b. Not consistently or routinely utilized as valuable habitat for natural communities including birds, mammals, reptiles, etc.

The nearest surface water body is _____feet/miles from the affected property and is named _____. The water body is best described as a:

__freshwater stream: __perennial (has water all year)

__intermittent (dries up completely for at least 1 week a year)

__intermittent with perennial pools

__freshwater swamp/marsh/wetland

__saltwater or brackish marsh/swamp/wetland

__reservoir, lake, or pond; approximate surface acres: _____

__drainage ditch

__tidal stream __bay __estuary

__other; specify_____

Is the water body listed as a State classified segment in Appendix C of the current Texas Surface Water Quality Standards; §§307.1 - 307.10?

__Yes Segment # _____ Use Classification: _____

__No

If the water body is not a State classified segment, identify the first downstream classified segment.

Name:

Segment #:

Use Classification:

As necessary, provide further description of surface waters in the vicinity of the affected property:

PART II. Exclusion Criteria and Supportive Information

Subpart A. Surface Water/Sediment Exposure

1) Regarding the affected property where a response action is being pursued under the TRRP, have COCs migrated and resulted in a release or imminent threat of release to either surface waters or to their associated sediments via surface water runoff, air deposition, groundwater seepage, etc.? Exclude wastewater treatment

facilities and storm water conveyances/impoundments authorized by permit. Also exclude conveyances, decorative ponds, and those portions of process facilities which are:

a. Not in contact with surface waters in the State or other surface waters which are ultimately in contact with surface waters in the State; and

b. Not consistently or routinely utilized as valuable habitat for natural communities including birds, mammals, reptiles, etc.

__Yes __No

Explain:

If the answer is Yes to Subpart A above, the affected property does not meet the exclusion criteria. However, complete the remainder of Part II to determine if there is a complete and/or significant soil exposure pathway, then complete PART III - Qualitative Summary and Certification . If the answer is No, go to Subpart B.

Subpart B. Affected Property Setting

In answering "Yes" to the following question, it is understood that the affected property is not attractive to wildlife or livestock, including threatened or endangered species (i.e., the affected property does not serve as valuable habitat, foraging area, or refuge for ecological communities). (May require consultation with wildlife management agencies.)

1) Is the affected property wholly contained within contiguous land characterized by: pavement, buildings, landscaped area, functioning cap, roadways, equipment storage area, manufacturing or process area, other surface cover or structure, or otherwise disturbed ground?

__Yes __No

Explain:

If the answer to Subpart B above is Yes, the affected property meets the exclusion criteria, assuming the answer to Subpart A was No. Skip Subparts C and D and complete PART III - Qualitative Summary and Certification. If the answer to Subpart B above is No, go to Subpart C.

Subpart C. Soil Exposure

1) Are COCs which are in the soil of the affected property solely below the first 5 feet beneath ground surface **or** does the affected property have a physical barrier present to prevent exposure of receptors to COCs in surface soil?

__Yes __No

Explain:

If the answer to Subpart C above is Yes, the affected property meets the exclusion criteria, assuming the answer to Subpart A was No. Skip Subpart D and complete PART III - Qualitative Summary and Certification. If the answer to Subpart C above is No, proceed to Subpart D.

Subpart D. *Deminimus* Land Area

In answering "Yes" to the question below, it is understood that all of the following conditions apply:

- The affected property is not known to serve as habitat, foraging area, or refuge to threatened/endangered or otherwise protected species. (Will likely require consultation with wildlife management agencies.)
- Similar but unimpacted habitat exists within a half-mile radius.
- The affected property is not known to be located within one-quarter mile of sensitive environmental areas (e.g., rookeries, wildlife management areas, preserves). (Will likely require consultation with wildlife management agencies.)
- There is no reason to suspect that the COCs associated with the affected property will migrate such that the affected property will become larger than one acre.

1) Using human health protective concentration levels as a basis to determine the extent of the COCs, does the affected property consist of one acre or less and does it meet all of the conditions above?

__Yes __No

Explain how conditions are met/not met:

If the answer to Subpart D above is Yes, then no further ecological evaluation is needed at this affected property, assuming the answer to Subpart A was No. Complete PART III - Qualitative Summary and Certification. If the answer to Subpart D above is No, proceed to Tier 2 or 3 or comparable ERA.

PART III. Qualitative Summary and Certification (Complete in all cases.)

Attach a brief statement (not to exceed 1 page) summarizing the information you have provided in this form. This summary should include sufficient information to verify that the affected property meets or does not meet the exclusion criteria. The person should make the initial decision regarding the need for further ecological evaluation (i.e., Tier 2 or 3) based upon the results of this checklist. After review, TNRCC will make a final determination on the need for further assessment. **Note that the person has the continuing obligation to re-enter the ERA process if changing circumstances result in the affected property not meeting the Tier 1 exclusion criteria.**

Completed by: _____*(Typed/Printed Name)*

_____*(Title)*

_____*(Date)*

I believe that the information submitted is true, accurate, and complete, to the best of my knowledge.

_____*(Typed/Printed Name of Person)*

_____*(Title of Person)*

_____*(Signature of Person)*

_____*(Date Signed)*

STANDARD OPERATING PROCEDURE NO. 2.4
BELOW GROUND UTILITY SURVEY

1.0 METHOD SUMMARY

The objective of this standard operating procedure (SOP) is to provide guidance for a utility survey.

2.0 EQUIPMENT/APPARATUS/REAGENTS

The following equipment is typically used for conducting field utility surveys:

- Notebook
- Camera
- Metal detector or magnetometer, for detecting underground utilities/pipes/drums (1 per sampling team).
- Tile probe

3.0 PROCEDURE

1. Obtain and review copies of facility drawings to identify utility lines that may be located on the property.
2. Call "One Call". Schedule a utility locating session with participating utility companies.
3. Obtain and review copies of map surveys to identify utility easements.
4. Call city or county utilities to identify locations of under ground utility lines.
5. Inspect the site for pipeline marker posts.
6. Screen each sample location with a metal detector or magnetometer to verify that no underground pipes or drums exist.
7. Probe boring locations with a tile probe to verify that no non-metallic obstructions exist.

4.0 CAUTIONS AND INTERFERENCES

Utility locating services (e.g., One Call) typically do not mark utility lines on private property. The contractor should review all utilities identified at the sit boundaries to verify their point of entry onto the site. Utility locating services require a minimum of 48 hours notice.

STANDARD OPERATING PROCEDURE NO. 3.0
GEOLOGICAL OBSERVATIONS

1.0 METHOD SUMMARY

This SOP provides guidance for conducting borehole logging and soil classification to adequately record lithologic information at any given boring location. All drilling activities shall be logged daily in a bound field notebook in accordance with SOP 6.1.

2.0 EQUIPMENT/APPARATUS/REAGENTS

No specialized equipment is required for performing work in accordance with this SOP. The only materials needed are:

- Logbook
- Tape measure
- Compass (in the absence of a survey)
- Camera and Film
- Munsell soil color charts
- Clipboard
- Boring log forms
- Pens

3.0 PROCEDURES

3.1 Borehole Logging

Unconsolidated samples for lithologic description shall be obtained at each change in lithology or every five (5) foot interval, whichever is less, or as specifically stated in the Statement of Work. Lithologic descriptions of unconsolidated materials encountered in the boreholes shall generally be described in accordance with American Society for Testing and Materials (ASTM) D-2488-90 Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) (ASTM, 1990). Lithologic descriptions shall use the name of the predominant particle size (e.g., silt, fine sand, etc.). Consolidated materials (igneous, metamorphic, and sedimentary rocks) shall be described as per the standard professional nomenclature (cf. Tenissen, A.C., 1983, Nature of Earth Materials, 2nd Edition, pp. 204-348), with specific attention given to describing fractures, vugs, solution cavities, and their fillings or coatings, and any other characteristics affecting permeability.

A standard boring log form shall be used for recording the logged information. The information on the boring log shall include borehole location; drilling information; sampling information such as lithology, sample intervals, recovery, and blow counts; sample description information; and monitoring equipment. If a monitoring well is installed in the boring, a graphical depiction of the well construction may be included. Additional information to be recorded includes the depth to the water table, caving or sloughing of the borehole, performance of the drill rig, drilling fluid pump rate, changes in drilling rate, depths of laboratory samples, presence of organic materials, disposal method for investigation derived waste, decontamination procedures, and other noteworthy observations or conditions, such as the locations of geologic boundaries.

All samples shall be monitored with an organic vapor monitor (e.g., photo ionization detector (PID), Organic Vapor Analyzer (OVA)). Samples handling procedures shall be mentioned on the logs. Cuttings shall be examined for loss of volatiles and other hazardous characteristics. Abnormal color, odor or organic vapor readings shall be noted.

Borehole abandonment procedures shall be discussed. All abandoned boreholes shall be checked 24 to 48 hours after mud/solid bentonite emplacement to determine whether curing is occurring properly. If settling has occurred, a sufficient amount of mud/solid bentonite shall be added to fill the hole to the ground surface. These curing checks shall be recorded in the field log.

3.2 Soil Classification

Identification of the soils shall be accomplished by the United Soil Classification System (USCS). Descriptive information to be recorded in the field shall include: (1) identification of the predominant and secondary particle sizes and range of particles size, (2) percent of gravel, sand, fines or all three, (3) description of grading and sorting of all coarse particles, (4) particle angularity and shape, and (5) maximum particle size or dimension. The dimensions of the predominant and secondary sizes shall be recorded. The grain size and name of the deposit shall be accompanied by the predominant mineral content, accessory minerals, color, particle angularity, and any other characteristics.

Plasticity of fines description shall include: (1) color using Munsell Color System, (2) moisture (dry, moist or wet), (3) consistency of fine grained soils, (4) structure of consolidated materials, and (5) maximum particle size or dimension.

4.0 CAUTIONS AND INTERFERENCES

No cautions or interferences are presented in this SOP.

STANDARD OPERATING PROCEDURE NO. 4.0
GEOTECHNICAL INVESTIGATION

1.0 METHOD SUMMARY

A geotechnical investigation can be conducted using a variety of methods and equipment depending on the objective (sampling vs. real-time data), the depth of the desired sample, site conditions, type of sample required (disturbed vs. undisturbed), formation type (consolidated vs. unconsolidated), and soil type (fine grained vs. coarse grained). Sample analyses are used to determine the shear strength, compressive strength, moisture content, plasticity, and the permeability of the soil for construction purposes.

2.0 EQUIPMENT/APPARATUS/REAGENTS

Equipment needed for collection of soil samples may include:

- Maps/plot plan
- Safety equipment
- Tape measure
- Survey stakes, flags, or buoys and anchors
- Camera and film
- Spatula
- Scoop
- Trowel
- Logbook
- Chain of custody records
- Field data sheets
- Decontamination supplies/equipment
- Spade or shovel
- Plastic bucket w/lids

3.0 PROCEDURES

3.1 Preparation

- Determine the extent of the investigation effort, the methods to be employed, and the types and amounts of equipment and supplies required.
- Obtain necessary sampling and monitoring equipment.
- Decontaminate or pre-clean equipment, and ensure that it is in working order.
- Prepare schedules, and coordinate with staff, client, and regulatory agencies, if appropriate.
- Perform a general site survey prior to site entry in accordance with the site specific Health and Safety Plan.
- Use stakes, flagging, or buoys to identify factors. The extent and nature of contaminant should be considered when selecting sample location. If required, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions. All staked locations will be utility-cleared by the property owner prior to soil sampling per SOP 2.4.
- Prior to mobilization, the drill rig and all associated equipment should be thoroughly decontaminated in

accordance with SOP 1.5 (Decontamination).

3.2 Sampling

1. Clear the area of any surface debris (e.g., twigs, rocks, litter).
2. Attach the continuos flight auger to the drill rig.
3. Begin augering, periodically removing and depositing accumulated soils onto a plastic sheet spread near the hole.
4. After reaching the desired depth, carefully remove the auger from the borehole to minimize any cuttings falling into borehole.
5. Sample collection for geotechnical analysis in granular soil shall be done in accordance SOP 10.2 (Soil Sampling Using a Split Spoon).
6. Upon retrieval of sample from borehole, the sample will be wrapped in aluminum foil and labeled appropriately for shipment to the lab.
7. Visually inspect and record the lithology of the core and also record the depth, color using a Munsell Color Chart, and any odors detected in the logbook or on the field data sheet.
8. If another sample is to be collected in the same hole, but at a greater depth, reattach the auger to the drill and assembly, and follow steps 3 through 7.
9. Upon completion of boring the augers are extracted without being rotated from the borehole, and the hole is abandoned according to applicable State regulations.
10. Dispose of IDW in accordance with SOP 1.4 (IDW Disposal).

4.0 CAUTIONS AND INTERFERENCES

No cautions or interferences are presented in this SOP.

STANDARD OPERATING PROCEDURE NO. 5.1
HOLLOW STEM BOREHOLE ADVANCEMENT

1.0 METHOD SUMMARY

Hollow-stem augers allow for a variety of soil core sampling methods. This method does not require the use of drilling fluids or lubricants and allows for the installation of well screens prior to removal of the auger. Formation waters can be sampled during drilling by using a screened lead auger or advancing a well point ahead of the auger.

Hollow-stem auger methods are commonly used in cohesive soils or in granular soils above the groundwater level. The hollow-stem auger column rotates as it drills into the ground and is designed to push soil up and out of the borehole along the outside of the auger. The hollow-stem augers are designed to be advanced with a center bit or plug to prevent soil from rising through the hollow portion of the auger.

2.0 EQUIPMENT/APPARATUS/REAGENTS

Equipment needed for borehole advancement using hollow stem augers may include:

- Maps/plot plan
- Safety equipment
- Tape measure
- Survey stakes or flags
- Camera and film
- Trowel
- Logbook
- Field data sheets
- Decontamination supplies/equipment
- Spade or shovel
- Drill rig and associated drilling equipment
- Plastic sheeting
- Potable water for mixing
- Drums

3.0 PROCEDURES

The following procedure will be used for borehole advancement using hollow stem augers:

1. Prior to drilling perform a utility survey in accordance with SOP 2.4 in the vicinity of the drilling site can be marked and identified.
2. Prior to mobilization, the drill rig and all associated equipment should be thoroughly decontaminated in accordance with SOP 1.5 (Decontamination).
3. Clear the area of any surface debris (e.g., twigs, rocks, litter).
4. Advance the hollow stem auger at a slow rate during the first five to seven feet of drilling as an extra precaution so that any possible contact with underground utilities will be less damaging.
5. Hollow-stem auger flights are five feet in length, therefore drilling is temporarily halted at five foot intervals so that additional flights can be attached. Auger flights are attached to one another by

threaded ends and bolts.

6. Attach the center bit to center rod and place inside the hollow stem auger or if soil samples are not to be taken. Alternatively, a wooden center plug can be placed at the bottom of the auger to stop soil from entering the hollow potion of the auger.

7. Begin augering, periodically removing and depositing accumulated soils onto a plastic sheet spread near the hole or in an appropriately labeled drum.

8. If sampling or geotechnical evaluation is to take place during drilling, advancement of the hollow-stem auger can be temporarily stopped and the center bit can be removed. A device such as a split barrel sampler or a thin wall sampler can be attached to the center rod and lowered to the bottom of the bore hole (see SOP 10.2 Soil Sampling Using a Split Spoonl). Sampling or testing occurs in the undisturbed region of the soil immediately beneath the deepest auger flight.

9. When the bore hole has been advanced to the desired depth, the center rods or wooden plug can be removed , thereby allowing well casing to be installed (see SOP 5.5 Monitor Well Installation/Completion).

10. If the borehole is not to be closed through procedures as outlined in other SOPs, then it shall be abandoned according to applicable State regulations.

11. Excavated material, PPE, and the plastic sheeting should be placed in 30- or 55-gallon drums according to the procedures outlined in SOP 1.4 (IDW).

12. Upon removal of the auger flights and other down-hole drilling equipment, all of the equipment should be decontaminated according to the procedures outlined in SOP 1.5 (Decontamination).

4.0 CAUTIONS AND INTERFERENCES

Drilling rigs and equipment present a variety of safety hazards. A site health and safety plan should be developed prior to any drilling activities, and should be followed during all drilling activities. All personnel conducting drilling activities should be qualified in proper drilling and safety procedures. Before any drilling activity is initiated, the area should be surveyed with the necessary detection equipment to locate, flag, or mark all under ground utilities such as electrical lines, natural gas lines, fuel tanks and lines, water lines, etc. In addition, overhead obstructions (e.g., process piping, structures, or power lines) should be noted. Before operating the drill rig, a pilot hole should be dug (with hand equipment) to a depth of two to three feet to check for undetected utilities or buried objects. Proceed with caution until a safe depth is reached where utilities normally would not be buried. The following safety requirements should be adhered to while performing drilling activities:

13. All drilling personnel should wear safety hats, safety glasses, ear plugs, and steel toed boots.
14. All personnel directly involved with the drilling rig(s) should know where the kill switch(s) is located in case of emergencies.

15. All personnel should stay clear of the drill rods or augers while in motion, and should not grab or attempt to attach a tool to the drill rods or augers until they have completely stopped rotating.
16. Do not hold drill rods or any part of the safety hammer assembly while taking standard penetration tests or while the hammer is being operated.
17. Do not lean against the drill rig or place hands on or near moving parts at the rear of the rig while it is operating.
18. Keep the drilling area clear of any excess debris, tools, or drilling equipment.
19. Do not climb on the drilling rig while it is being operated or attempt to repair the rig while it is being operated.
20. Do not move or pick up any drilling equipment unless directed by the driller and/or the project leader.
21. The drill rig should have a first-aid kit and a fire extinguisher located on the rig quickly accessible for emergencies.
22. Work clothes will be form fitting, but comfortable and free of straps, loose ends, strings etc., that might catch on some moving part of the drill rig.
23. Rings or other jewelry should not be worn while working around the drill rig.
24. The drill rig should not be operated within a minimum distance of 20 feet of overhead electrical power lines and/or buried utilities that might cause a safety hazard. In addition, the drill rig should not be operated while there is lightning in the area of the drilling site. If an electrical storm moves in during drilling activities, vacate the area until it is safe to return.

As the boring is advanced to greater depths, a considerable delay may occur before the soil cuttings appear at the ground surface, limiting the ability of the driller and the field representative to detect changes in soil conditions.

STANDARD OPERATING PROCEDURE NO. 5.2
SOLID STEM BOREHOLE ADVANCEMENT

1.0 METHOD SUMMARY

The solid stem or continuous flight auger consists of a solid stem or shaft with a continuous spiraled steel flight, welded on the outer side of the stem. This auger method is used in cohesive and semi-cohesive soils that do not have a tendency to collapse when disturbed. Boreholes can be augered to depths of 200 feet or more (depending on the auger size), but generally boreholes are augered to depths less than 150 feet and rarely into the saturated zone.

2.0 EQUIPMENT/APPARATUS/REAGENTS

Equipment needed for borehole advancement using solid stem augers may include:

- Maps/plot plan
- Safety equipment
- Tape measure
- Survey stakes and flags
- Camera and film
- Trowel
- Logbook
- Field data sheets
- Decontamination supplies/equipment
- Spade or shovel
- Plastic sheeting
- Drill rig and associated drilling equipment
- Drums

3.0 PROCEDURES

The following procedure will be used for borehole advancement using solid-stem augers:

1. Prior to drilling perform a utility survey in accordance with SOP 2.4.
2. Prior to mobilization, the drill rig and all associated equipment should be thoroughly decontaminated in accordance with SOP 1.5 (Decontamination).
3. Clear the boring location of any surface debris (e.g., twigs, rocks, litter).
4. Advance the solid-stem auger at a slow rate during the first five to seven feet of drilling as an extra precaution so that any possible contract with underground utilities will be less damaging.
5. Solid-stem auger flights are five feet in length. Drilling is temporarily halted at 5 foot intervals so that the auger can be rotated and raised to the surface which removes auger cuttings from the hole.
6. Attach the continuos flight auger to the drill rig.
7. Begin augering, periodically removing and depositing accumulated soils onto a plastic sheet spread near the hole or in an appropriately labeled drum.

8. If sampling or geotechnical evaluation is to take place during drilling, the solid-stem auger can be temporarily stopped and removed. A device such as a split-barrel sampler or thin wall tube sampler can be attached to drilling rods and lowered to the bottom of the bore hole (see SOP 10.2 Soil Sampling Using a Split Barrel).

9. After reaching the desired depth, the solid-stem augers can be removed, thereby allowing casing to be installed (see SOP 5.5 Monitor Well Installation/Completion). This method is not recommended for monitoring well installation.

10. Visually inspect and record the lithology of the cutting and also record the depth, color, and any odors detected in the logbook or on the field data sheet.

11. If the borehole is not to be closed through procedures as outlined in other SOPs, then it shall be abandoned according to applicable State regulations.

12. Excavated material, PPE, and the plastic sheeting should be placed in 30- or 55-gallon drums according to the procedures outlined in SOP 1.4 (IDW).

13. Upon removal of the auger flights and other down-hole drilling equipment, all of the equipment should be decontaminated according to the procedures outlined in SOP 1.5 (Decontamination).

4.0 CAUTIONS AND INTERFERENCES

Drilling rigs and equipment present a variety of safety hazards. A site health and safety plan should be developed prior to any drilling activities, and should be followed during all drilling activities. All personnel conducting drilling activities should be qualified in proper drilling and safety procedures. Before any drilling activity is initiated, the area should be surveyed with the necessary detection equipment to locate, flag, or mark all under ground utilities such as electrical lines, natural gas lines, fuel tanks and lines, water lines, etc. In addition, overhead obstructions (e.g., process piping, structures, or power lines) should be noted. Before operating the drill rig, a pilot hole should be dug (with hand equipment) to a depth of two to three feet to check for undetected utilities or buried objects. Proceed with caution until a safe depth is reached where utilities normally would not be buried. The following safety requirements should be adhered to while performing drilling activities:

14. All drilling personnel should wear safety hats, safety glasses, ear plugs, and steel toed boots.
15. All personnel directly involved with the drilling rig(s) should know where the kill switch(s) is located in case of emergencies.
16. All personnel should stay clear of the drill rods or augers while in motion, and should not grab or attempt to attach a tool to the drill rods or augers until they have completely stopped rotating.
17. Do not hold drill rods or any part of the safety hammer assembly while taking standard penetration tests or while the hammer is being operated.
18. Do not lean against the drill rig or place hands on or near moving parts at the rear of the rig while it is operating.

19. Keep the drilling area clear of any excess debris, tools, or drilling equipment.
20. Do not climb on the drilling rig while it is being operated or attempt to repair the rig while it is being operated.
21. Do not move or pick up any drilling equipment unless directed by the driller and/or the project leader.
22. The drill rig should have a first-aid kit and a fire extinguisher located on the rig quickly accessible for emergencies.
23. Work clothes will be form fitting, but comfortable and free of straps, loose ends, strings etc., that might catch on some moving part of the drill rig.
24. Rings or other jewelry should not be worn while working around the drill rig.
25. The drill rig should not be operated within a minimum distance of 20 feet of overhead electrical power lines and/or buried utilities that might cause a safety hazard. In addition, the drill rig should not be operated while there is lightning in the area of the drilling site. If an electrical storm moves in during drilling activities, vacate the area until it is safe to return.

As the boring is advanced to greater depths, a considerable delay may occur before the soil cuttings appear at the ground surface, limiting the ability of the driller and the field representative to detect changes in soil conditions. Soil samples using continuous flight augers are unreliable unless a split spoon or thin-wall samples are taken and the drilling speed is slowed. Recovery of samples from the saturated zone is difficult.

STANDARD OPERATING PROCEDURE NO. 5.3
MUD ROTARY BOREHOLE ADVANCEMENT

1.0 METHOD SUMMARY

Mud rotary or wash boring methods are commonly used in soil formations below the groundwater level where the boring walls are unstable. A rotating drill pipe with a hard-tooled drill bit attached at the bottom is used for drilling. Drilling fluid is forced down through the drill bit and back up the borehole. The drilling fluid is used to stabilize the boring walls and to remove drill cuttings, cool and lubricate the drill bit, and prevent the inflow of formation fluids. As the drilling fluid with the cuttings discharge at the surface, it flows into a mud pit. As the cuttings settle, the drilling fluid overflows into the suction pit and gets recirculated through a pump back into the drill rods. Casing is not required during drilling. Soil samples are then obtained through a split spoon or thin wall sampler.

2.0 EQUIPMENT/APPARATUS/REAGENTS

Equipment needed for borehole advancement using mud rotary may include:

- Maps/plot plan
- Safety equipment
- Tape measure
- Survey stakes and flags
- Camera and film
- Trowel
- Logbook
- Bentonite (for drilling mud)
- Decontamination supplies/equipment
- Spade or shovel
- Mud rotary drill rig and associated equipment
- Potable water for mixing
- Drums
- Plastic sheeting

3.0 PROCEDURES

The following procedure will be used for borehole advancement using hollow stem augers:

1. 48 hours prior to drilling, inform the Utilities Locating Service so that any underground utilities in Prior to drilling perform a utility survey in accordance with SOP 2.4 in the vicinity of the drilling site can be marked and identified.
2. Prior to mobilization, the drill rig and all associated equipment should be thoroughly decontaminated in accordance with SOP 1.5 (Decontamination).
3. Clear the boring of any surface debris (e.g., twigs, rocks, litter).
4. When using mud rotary, the potable water and bentonite drilling muds must be analyzed for the contaminants of concern.
5. Clear the area of any surface debris (e.g., twigs, rocks, litter).

6. Position the mud pit in a suitable work location so it does not interfere with the drilling operation.

7. Mix the bentonite drilling mud to the manufacturer's specifications.

8. Attach the drill rods to the mud rotary drilling rig.

9. Attach the bit to the drill rods.

10. When drilling is begun, the mud forced down the drill pipe, escapes through small ports at the bottom of the drill bit, thereby lifting cuttings and cooling the bit. The cuttings are pushed to the surface, where they are collected in a mud pit. As these cuttings collect, periodically remove them from the pit and place them in a labeled drum.

11. Initially, advance the borehole at a slow rate as an extra precaution, so that any possible contract with underground utilities will be less damaging.

12. If sampling or geotechnical evaluation is to take place during drilling, advancement of the borehole can be temporarily stopped and the drill bit can be removed. A device such as a split-barrel sampler or thin wall tube sampler can be attached to the drill rod and lowered to the bottom of the bore hole (see SOP 10.2 Soil Sampling Using a Split Barrel). Sampling or testing occurs in the undisturbed region of soil immediately beneath the depth of drilling.

13. Visually inspect and record the lithology of the cutting and also record the depth, color, and any odors detected in the logbook or on the field data sheet.

14. After reaching the desired depth, the drill pipe can be removed, thereby allowing casing to be installed (see SOP 5.5 Monitor Well Installation/Completion).

15. If the borehole is not to be closed through procedures as outlined in other SOPs, then it shall be abandoned according to applicable State regulations.

16. Excavated material, PPE, and the plastic sheeting should be placed in 30- or 55-gallon drums according to the procedures outlined in SOP 1.4 (IDW).

17. Upon removal of the drill pipe and other down-hole drilling equipment, all of the equipment should be decontaminated according to the procedures outlined in SOP 1.5 (Decontamination).

4.0 CAUTIONS AND INTERFERENCES

Drilling rigs and equipment present a variety of safety hazards. A site health and safety plan should be developed prior to any drilling activities, and should be followed during all drilling activities. All personnel conducting drilling activities should be qualified in proper drilling and safety procedures. Before any drilling activity is initiated, the area should be surveyed with the necessary detection equipment to locate, flag, or mark all under ground utilities such as electrical lines, natural gas lines, fuel tanks and lines, water lines, etc. In addition, overhead obstructions (e.g., process piping, structures, or power lines) showed be noted. Before operating the drill rig, a pilot hole should be dug (with hand equipment) to a depth of two to three feet to check for undetected utilities or buried objects. Proceed with caution until a safe depth is reached where utilities

normally would not be buried. The following safety requirements should be adhered to while performing drilling activities:

- All drilling personnel should wear safety hats, safety glasses, ear plugs, and steel toed boots.
- All personnel directly involved with the drilling rig(s) should know where the kill switch(s) is located in case of emergencies.
- All personnel should stay clear of the drill rods or augers while in motion, and should not grab or attempt to attach a tool to the drill rods or augers until they have completely stopped rotating.
- Do not hold drill rods or any part of the safety hammer assembly while taking standard penetration tests or while the hammer is being operated.
- Do not lean against the drill rig or place hands on or near moving parts at the rear of the rig while it is operating.
- Keep the drilling area clear of any excess debris, tools, or drilling equipment.
- Do not climb on the drilling rig while it is being operated or attempt to repair the rig while it is being operated.
- Do not move or pick up any drilling equipment unless directed by the driller and/or the project leader.
- The drill rig should have a first-aid kit and a fire extinguisher located on the rig quickly accessible for emergencies.
- Work clothes will be form fitting, but comfortable and free of straps, loose ends, strings etc., that might catch on some moving part of the drill rig.
- Rings or other jewelry should not be worn while working around the drill rig.

Mud rotary can cause contaminants to be introduced into the borehole from the constituents in the drilling mud, and it is very difficult to remove the drilling mud from the borehole after drilling and during well development. The drilling mud can also carry contaminants from a contaminated zone to an uncontaminated zone thereby cross-contaminating the borehole. Only potable water and pure (no additives) bentonite drilling muds should be used. All materials used should have adequate documentation as to manufacturer's recommendations and product constituents. The proper field QA/QC procedures should be initiated before and during drilling to minimize the potential for contamination. These QA/QC procedures include, but are not limited to, sampling and analyzing of all drilling materials such as drilling muds, bentonite pellets, grouts, sand, etc., and the potable water to be used during drilling.

STANDARD OPERATING PROCEDURE NO. 5.4
AIR ROTARY BOREHOLE ADVANCEMENT

1.0 METHOD SUMMARY

Air rotary boring methods are commonly used in soil formations that are very hard where the boring walls are stable. A rotating drill pipe with a hard-tooled drill bit attached at the bottom is used for drilling. Air is forced down through the drill bit and back up the borehole. The air is used to remove drill cuttings and cool the drill bit, and prevent the inflow of formation fluids. As the air with the cuttings discharges at the surface, the cuttings settle around the bore hole. Casing is not required during drilling.

2.0 EQUIPMENT/APPARATUS/REAGENTS

Equipment needed for borehole advancement using air rotary may include:

- Maps/plot plan
- Safety equipment
- Tape measure
- Survey stakes and flags
- Camera and film
- Trowel
- Logbook
- Decontamination supplies/equipment
- Spade or shovel
- Drill rig and associated equipment
- Air compressor
- Drums
- Plastic Sheeting

3.0 PROCEDURES

The following procedure will be used for borehole advancement using hollow stem augers:

1. Prior to drilling perform a utility survey in accordance with SOP 2.4 in the vicinity of the drilling site can be marked and identified.
2. Prior to mobilization, the drill rig and all associated equipment should be thoroughly decontaminated in accordance with SOP 1.5 (Decontamination).
3. Clear the boring location of any surface debris (e.g., twigs, rocks, litter).
4. When using air rotary, the air compressor must have an in-line organic filter system to filter the air coming from the compressor.
5. Position air compressor in a suitable work location so the air line and/or exhaust does not interfere with the drilling operation.
6. Attach the drill rods to the air rotary rig.
7. Position deflector shield around drill rod, so drill rod will move freely through deflector shield.

8. Attach the bit to the drill rods.

9. When drilling is begun, the air is forced down the drill pipe, escapes through small ports at the bottom of the drill bit, thereby lifting cuttings and cooling the bit. The cuttings are blown to the surface, where they collect around the bore hole. As these cuttings collect, periodically remove them from around the bore hole and place in a marked drum.

10. Begin augering, periodically removing and depositing accumulated soils near the hole in an appropriately labeled drum.

11. Initially, advance the borehole at a slow rate as an extra precaution, so that any possible contract with underground utilities will be less damaging.

12. If sampling or geotechnical evaluation is to take place during drilling, advancement of the borehole can be temporarily stopped and the drill bit can be removed. A device such as a split-barrel sampler or thin wall tube sampler can be attached to the drill rod and lowered to the bottom of the bore hole (see SOP 10.2 Soil Sampling Using a Split Barrel). Sampling or testing occurs in the undisturbed region of soil immediately beneath the depth of drilling.

13. Visually inspect and record the lithology of the cutting and also record the depth, color, and any odors detected in the logbook or on the field data sheet.

14. After reaching the desired depth, the drill pipe can be removed, thereby allowing casing to be installed (see SOP 5.5 Monitor Well Installation/Completion).

15. If the borehole is not to be closed through procedures as outlined in other SOPs, then it shall be abandoned according to applicable State regulations.

16. Excavated material, PPE, and the plastic sheeting should be placed in 30- or 55-gallon drums according to the procedures outlined in SOP 1.4 (IDW).

17. Upon removal of the drill pipe and other down-hole drilling equipment, all of the equipment should be decontaminated according to the procedures outlined in SOP 1.5 (Decontamination).

4.0 CAUTIONS AND INTERFERENCES

Drilling rigs and equipment present a variety of safety hazards. A site health and safety plan should be developed prior to any drilling activities, and should be followed during all drilling activities. All personnel conducting drilling activities should be qualified in proper drilling and safety procedures. Before any drilling activity is initiated, the area should be surveyed with the necessary detection equipment to locate, flag, or mark all under ground utilities such as electrical lines, natural gas lines, fuel tanks and lines, water lines, etc. In addition, overhead obstructions (e.g., process piping, structures, or power lines) should be noted. Before operating the drill rig, a pilot hole should be dug (with hand equipment) to a depth of two to three feet to check for undetected utilities or buried objects. Proceed with caution until a safe depth is reached where utilities normally would not be buried. The following safety requirements should be adhered to while performing drilling

activities:

- All drilling personnel should wear safety hats, safety glasses, ear plugs, and steel toed boots.
- All personnel directly involved with the drilling rig(s) should know where the kill switch(s) is located in case of emergencies.
- All personnel should stay clear of the drill rods or augers while in motion, and should not grab or attempt to attach a tool to the drill rods or augers until they have completely stopped rotating.
- Do not hold drill rods or any part of the safety hammer assembly while taking standard penetration tests or while the hammer is being operated.
- Do not lean against the drill rig or place hands on or near moving parts at the rear of the rig while it is operating.
- Keep the drilling area clear of any excess debris, tools, or drilling equipment.
- Do not climb on the drilling rig while it is being operated or attempt to repair the rig while it is being operated.
- Do not move or pick up any drilling equipment unless directed by the driller and/or the project leader.
- The drill rig should have a first-aid kit and a fire extinguisher located on the rig quickly accessible for emergencies.
- Work clothes will be form fitting, but comfortable and free of straps, loose ends, strings etc., that might catch on some moving part of the drill rig.
- Rings or other jewelry should not be worn while working around the drill rig.
- The drill rig should not be operated within a minimum distance of 20 feet of overhead electrical power lines and/or buried utilities that might cause a safety hazard. In addition, the drill rig should not be operated while there is lightening in the area of the drilling site. If an electrical storm moves in during drilling activities, vacate the area until it is safe to return.

Air rotary can cause contaminates to be introduced into the borehole from the compressor air. Volatile organic soil samples are difficult to collect with this method of drilling.

STANDARD OPERATING PROCEDURE NO. 5.5
MONITORING WELL INSTALLATION AND COMPLETION

1.0 METHOD SUMMARY

The design and installation of permanent monitoring wells involves drilling into various types of geologic formations that exhibit varying subsurface conditions. Designing and installing permanent monitoring wells in these geologic environments may require several different drilling methods and installation procedures.

Double cased wells may be required when there is reason to believe that interconnection of two aquifers by well construction may cause cross contamination, and/or when flowing sands make it impossible to install a monitoring well using conventional methods. An outer casing (sometimes called a surface or pilot casing) should be placed into the borehole and sealed with grout.

Each permanent monitoring well should be designed and installed to function properly throughout the duration of the monitoring program. When designing monitoring wells, the following should be considered:

- short-and long-term objectives;
- purpose(s) of the well(s);
- probable duration of the monitoring program;
- contaminants likely to be monitored;
- migration characteristics of the release;
- types of well construction materials to be used;
- surface and subsurface geologic conditions;
- properties of the aquifer(s) to be monitored;
- well screen placement;
- general site conditions; and
- potential site health and safety hazards.
-

2.0 EQUIPMENT/APPARATUS/REAGENTS

Equipment needed during well installation activities:

- Maps/plot plan
- Appropriate personal protective equipment (PPE)
- Tape measure
- Logbook
- Bentonite powder/pellets
- Filter pack material
- Portland cement
- Steel protective casing and locking cap
- Threaded end-cap (sump)
- Well casing (e.g., PVC or stainless steel)
- Well screen (e.g., PVC or stainless steel)
- Tremie Apparatus
- Decontamination supplies/equipment
- All required health and safety equipment
- Clipboard

3.0 PROCEDURES

3.1 Monitoring Well/Piezometer Installation

When selecting the materials for well construction, the prime concern should be to select materials that will not contribute foreign constituents, or remove contaminants of concern from the ground water. All materials selected for monitoring well installation should be evaluated and approved by an experienced geologist.

Well screen and casing materials generally used in monitoring well construction on Superfund sites are listed in order of preference:

- Rigid PVC meeting NSF Standard 14
- Stainless Steel (304 or 316)
- Other (e.g., black iron, carbon steel, galvanized steel, and fiberglass). These materials are not recommended for use in long term monitoring programs at hazardous waste sites, because of their low resistance to chemical attack and potential constituent contribution to the ground water.

The length of well screens in permanent monitoring wells should be long enough to effectively monitor the interval or zone of interest. However, well screens designed for long term monitoring purposes should normally not be less than 5 feet in length. Well screens less that 5 feet long should be used only in temporary monitoring wells where ground water samples are collected for screening purposes. Slot openings for wells screens should be selected to retain 90 per cent or more of the filter pack material.
The following procedures should be followed when installing a monitoring well:

- Advance a bore hole to the required depth using the procedures outline in one of the following SOPs; SOP 5.1 (Hollow Stem Borehole Advancement), SOP 5.2 (Solid Stem Borehole Advancement), SOP 5.3 (Mud Rotary Borehole Advancement), or SOP 5.4 (Air Rotary Borehole Advancement).

- The diameter of the well to be installed will depend on the intended use for the well and possible engineering considerations and needs. A minimum two-inch annular space is required between the borehole and the casing.

- All well screen and well casing material should be new and of adequate structural integrity, and should be made of material that will be compatible with the contaminants present (or anticipated). Screen size should be determined based on sieve analysis results. Screen length should be adequate to monitor the zone of interest, and in general should not be less than five feet long nor greater than 20 feet.

- If required, place a threaded sump on the bottom most section of well screen and lower the section into the open bore hole. The decision for placing sumps on wells will be made on a site specific basis.

- Thread additional lengths of well screen together, as needed, until the appropriate total well screen length is achieved. Do not use cement or glue.

- Thread solid well casing (in 10-foot lengths) on to the well screen sections to complete the well to a height approximately two to three feet above ground surface. Do not use cement or glue.
- Centralizers should be placed on wells greater than 50 feet.

- Plumb the well string by the use of centralizers and/or a plumb bob and level. Another method of placing the well screen and casings into the borehole and plumbing it at the same time is to suspend the string of well screen and casings in the borehole by means of the wire line on the drill rig. The string of well screen and casings can be placed into the borehole and plumbed in one easy operation. This wire line method is especially useful if the borehole is deep and a long string of well screen and casings have to be set and plumbed. Centralizers can be used to plumb a well, but centralizers should be placed so that the placement of the filter pack, bentonite pellet seal, and annular grout will not be hindered. Centralizers placed in the wrong locations can cause bridging during material placement. Monitoring wells less than 50 feet deep generally do not need centralizers. If centralizers are used they should be placed below the well screen and above the bentonite pellet seal.

- Install a locking well cap onto the well head. The well cap should have a small hole drilled to allow for pressure equalization.

- Place a minimum of 6-inches of filter pack material under the bottom of the well screen or sump to provide a firm footing and an unrestricted flow under the screened area. Filter pack should extend a minimum of two feet above the top of the well screen, and should be placed by a tremie pipe where possible. If drilling with hollow-stem augers, the augers should be lifted as the sand is tremied into the bore hole.

  If it is impracticable to tremie the filter pack, pouring the sand is acceptable in shallow bore holes (less than 50 feet), where the annular space is large enough to prevent bridging. The level of the filter pack materials must be measured at appropriate intervals to ensure no bridging has occurred.

- Once the filter pack material has been placed, place a seal above the filter pack in the annulus of the bore hole to provide a watertight seal. The seal should be a minimum of two feet thick and should consist of a minimum of 20 percent solids bentonite. This type of bentonite is available in either powder or pellet form.

  The preferred method of placing either bentonite pellets or a bentonite powder/water mixture is by tremie pipe. If this method is not practicable (pellets only), pouring the pellets is acceptable in shallow bore holes (less than 50 feet), where the annular space is large enough to prevent bridging. The pellets must be tamped, and measured at appropriate intervals to ensure they have not bridged.
  The bentonite seal must be allowed to hydrate for eight hours or the manufacture's recommended hydration time, whichever is greater. Measure the seal after hydration time to ensure that the required two feet of seal is present.

- After the bentonite seal has hydrated, grout the remainder of the borehole to prevent surface water infiltration.
- Prepare the grout mixture for use. The preferred grout to use should be a 30% solids bentonite grout with a minimum density of 10 lb/gal. All grouts should be prepared in accordance with the manufacturers specifications. Cement grouts should be mixed using 6.5 to 7 gallons of water per 94-lb bag of Type 1 Portland cement. The addition of bentonite (5 to 10 percent) to the cement grout is generally used to delay the "setting" time and may not be needed in all applications. The specific mixtures and other types of cement and/or grout proposed should be evaluated by an experienced geologist on a case by case basis. Drilling muds are not acceptable for grouting.

- Place the grout mixture into the borehole, by the tremie method, from the top of the bentonite seal to within 2-feet of the ground surface or below the frost line, whichever is greater. The tremie tube should have an option of a side discharge port or a bottom discharge port, to minimize damage to the filter pack and/or the bentonite pellet seal, during grout placement.

- Continue the grouting operation until the grout flowing out of the borehole has achieved a significant density.

- Place the steel protective casing over the top of the well using with a spacer to keep the protective casing from resting directly on top of the well casing. Ensure that the lower end of the protective casing extends into the grout seal.

- The outer protective casing should be installed into the bore hole a minimum of 24 hours after the grout has been poured.

- Allow the grout to cure for a minimum of 24 hours before installing the concrete surface pad or conducting well development activities.

- Clean and decontaminate all of the equipment used following the procedures outlined in SOP 1.5 (Decontamination).

- Document the installation of the well screen and riser, height of the filter pack, installation and thickness of the annular seal, types and quantities of grout material used in the field logbook, recording the type of materials used, the lengths of screen and riser sections, the bottom depth of the boring, the screen slot size, and any sumps or caps placed on the bottom of the well.

3.1.1 Surface Completions

1. Outer Protective Casings

The outer protective casings used over 2-inch well casings should be 4 inches square by 5 feet long. Similarly, protective casings used over 4-inch well casings should be 6 inches square and 5 feet long. Round protective casings are also acceptable. All protective casings should have sufficient clearance around the inner well casings, so that the outer protective casings will not come into contact with the inner well casings after installation. The protective casings should have a minimum of two weep holes for drainage. These weep holes should be a minimum 1/4-inch in diameter and drilled into the protective casings just above the top of the concrete surface pads to prevent water from standing inside of the protective casings. Protective casings made of aluminum or other soft metals are normally not acceptable because they are not strong enough to resist tampering. Aluminum protective casing may be used in very corrosive environments such as coastal areas. After the wells have been installed, the outer protective casing should be painted with a highly visible enamel paint. The wells should be permanently marked with the well number, date installed, site name, and elevation on a brass plate to be permanently affixed to the cover or an appropriate place that will not be easily damaged and/or vandalized.

A case-hardened steel lock should be installed on the locking casing cap to provide well security. This lock should be covered by some protective measure (i.e., a plastic covering). to prevent corrosion. Lubricants should not be used on the lock as they may contribute to chemical sample alteration. At each site, all locks on the outer protective casings should be keyed alike. There should be at least 1 to2 inches of clearance between the top of the in-place inner well casing cap and the bottom of the protective casing locking cap when in the locked position. The protective casing should be anchored into the cement surface seal and extend at least 18 inches above the surface of the ground.

Upright completions are the preferred completion method, but if the monitoring wells are installed in a high traffic area such as a parking lot, in a residential yard, or along the side of a road it may be desirable to finish the wells to the ground surface and install water-tight flush mounted traffic and/or man-hole covers. Flush mounted traffic and man-hole covers are designed to extend from the ground surface down into the concrete plug around the well casing. Although flush mounted covers may vary in design, they should have seals that make the unit water-tight when closed and secured. The flush mounted covers should be installed as far above grade as practical to minimize standing water and promote runoff.

2. Concrete Surface Pad

A concrete surface pad should be installed around each well at the same time as the outer protective casing is being installed. The concrete used should be a reinforced concrete. The surface pad should be formed around the well casing. Concrete should be placed into the formed pad and into the borehole (on top of the grout) in one operation making a contiguous unit. The size of the concrete surface pad should be 4 feet x 4 feet x 6 inches with #3 Rebar at 18" on center each way (O.C.E.W).
The finished pad should be sloped 1/4 inch at 4', so that drainage will flow away from the protective casing and off of the pad. In addition, a minimum of four inches of the finished pad should be below grade or ground elevation to prevent washing and undermining by soil erosion.

3. Surface Protection-Bumper Guards

If the monitoring wells are located in a high traffic area, a minimum of four bumper guards consisting of steel pipes 6 inches in diameter and a minimum 6-foot length should be installed. These bumper guards should be installed to a minimum depth of 3 feet below the ground surface in a concrete footing and extend a minimum of 3 feet above ground surface. Concrete should also be placed into the steel pipe to provide additional strength. As shown in the figure bellow. Steel rails and/or other steel materials can be used in place of steel pipe but should be approved by an experienced engineer prior to installation.

3.2 Temporary Piezometers

A temporary piezometer is a small diameter cased borehole placed in a direct push borehole. The size of the borehole usually does not allow for filter pack to be placed in the piezometer annulus. The intent of a temporary borehole is to obtain water level data to determine the proper location of monitoring wells. Temporary piezometers differ from permanent piezometers in the following ways:

1. Casing is gernerally one-inch in diameter or less.
2. Filter pack is not necessary for temporary piezometers.
3. Screen lengths are generally less than five feet.
4. A smaller pad is used to stabilize the top of the piezometer.

Specifications of temporary piezometers will be approved by the TNRCC on a site specific basis.

3.3 Surface Casing

When determined necessary by the TNRCC PM, surface casing consists of a watertight pipe which is installed in an excavated or drilled hole, temporarily or permanently, to maintain the hole sidewalls against caving, advance the borehole, and in conjunction with cementing and/or bentonite grouting, to confine the ground waters to their respective zones of origin, and to prevent surface contaminant filtration.

The drilled hole shall be of sufficient diameter to allow for a minimum two inch annular space between the borehole and the casing. The borehole shall be advanced by hollow stem auger or other approved method a minimum two feet into the confining zone or other desired depth. The casing shall be assembled and placed into the center of the boring. The casing shall be grouted with cement bentonite grout in such a manner that the desired zone is sealed and no voids remain in the annular space. The cement bentonite grout shall be allowed to cure 24 hours before advancing the boring.

3.4 Well Identification

This provides guidance to use standard nomenclature for numbering or identifying Monitoring Wells in reports and on identification plates, installed on the Monitoring Wells.

1. All the Monitoring Wells shall be surveyed by a licenced surveyor.
2. Permanent identification marking should be placed on the well or on the brass monument installed in the protective concrete pad.
3. The identification marking should contain Well Number, Depth of the Well, Installation Dated, Site Name, MSL Elevation.
4. A small key of abbreviations shall be added on the bottom of every table and map.
5. The wells shall be identified as follows:

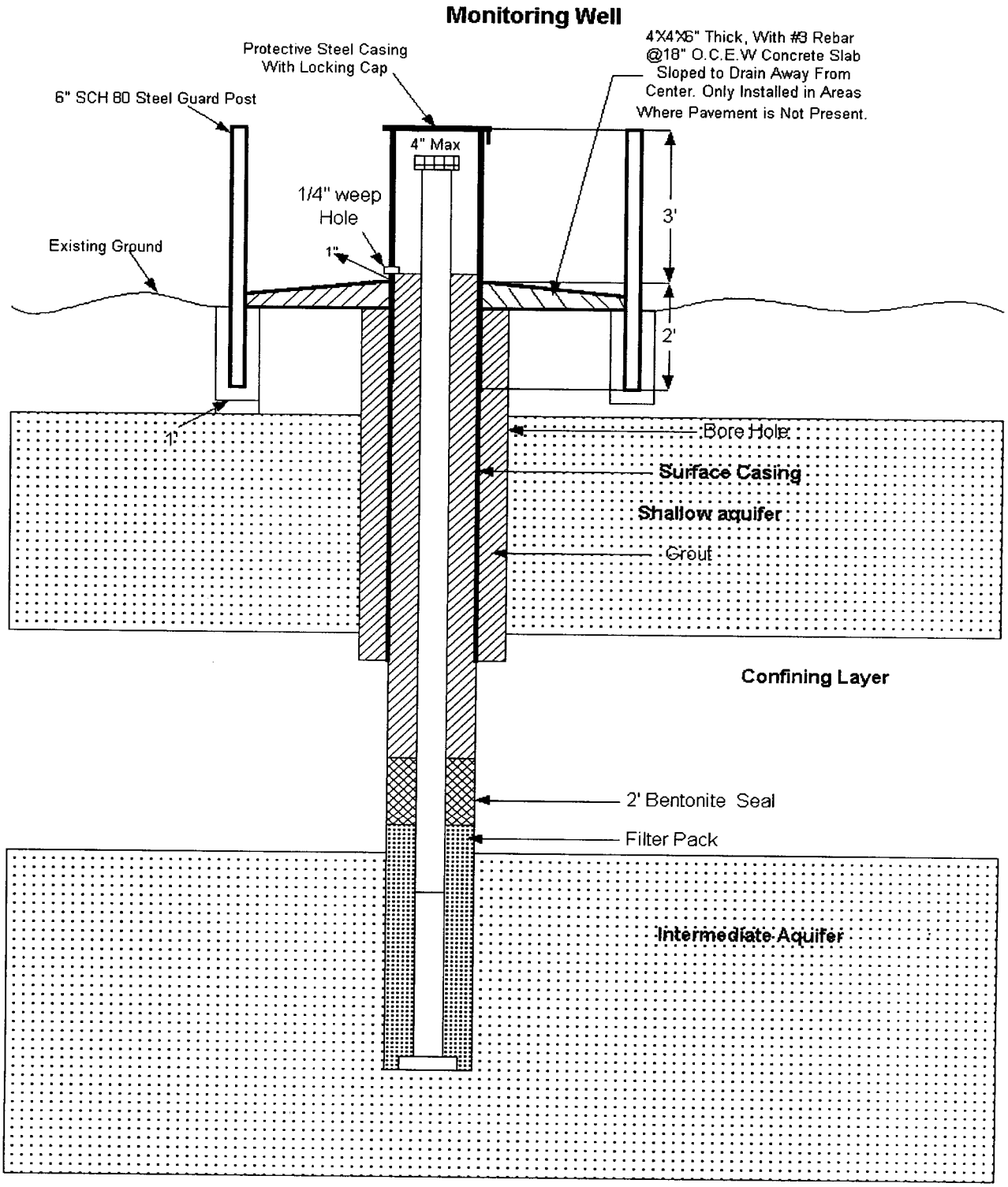
MW- X	Monitor well completed in the uppermost saturated zone/aquifer or shallow aquifer, where the "X" represents the well number, in consecutive order of installation. At no time will any two wells have the same well number, this is, there will not be a well number MW-3 and RW-3 at the same site.
RW-X	Monitor well used as a recovery well in shallow aquifer.
IW- X	Monitor well used as an injection well. This includes both wells used for nutrient injection during bio-remediation activities and for re-injection of treated groundwater.
PW-X	Piezometer.

4.0 CAUTIONS AND INTERFERENCES

When installing doubled cased wells, the surface casing should be allowed to set for 24 hours after installation, before completing the installation of monitoring well.

Care should be taken to avoid bridging of filter pack material.

Wells should be allowed to set for 24 hours after installation, before well completions or well development activities are performed.


Monitoring Well
Protective Steel Casing
With Locking Cap
4'X4'X6" Thick, With #3 Rebar
@18" O.C.E.W Concrete Slab
Sloped to Drain Away From
Center. Only Installed in Areas
Where Pavement is Not Present.
6" SCH 80 Steel Guard Post
4" Max
1/4" weep
Hole
1"
3'
Existing Ground
2'
1'
Bore Hole
Surface Casing
Shallow aquifer
Grout
Confining Layer
2' Bentonite Seal
Filter Pack
Intermediate Aquifer

STANDARD OPERATING PROCEDURE NO. 5.6
MONITORING WELL DEVELOPMENT/ABANDONMENT

1.0 METHOD SUMMARY

The purpose of developing new monitoring wells is to remove residual materials remaining in the wells after installation has been completed, and to establish a good hydraulic communication between the formations in the immediate vicinity of each well and the well which may have been disturbed by well construction.

The following development methods are generally used to develop monitoring wells:

- Pumping
- Compressed air (with the appropriate organic filter system)
- Bailing
- Surging
- Backwashing ("rawhiding")
- Jetting

2.0 EQUIPMENT/APPARATUS/REAGENTS

Equipment needed during well development activities:

- Maps/plot plan
- As-built diagrams of monitoring wells
- Logbook
- Field data sheets
- Appropriate personal protective equipment (PPE)
- Water level indicator
- Camera and film
- Bailer or pump
- Nylon rope
- Pump controller (if required)
- Generator, if pump is used
- Air compressor, if bladder pump is used
- Gas for generator/air compressor
- Surge block
- Appropriate pump fittings (e.g., hose clamps, barbed fittings, etc.)
- Discharge tubing for pump
- Field parameter instruments (pH meter, thermometer, conductivity meter, turbidimeter, DO meter)
- Drums
- Marking pen for labeling drums
- Wrench for opening/sealing drums
- Decontamination supplies/equipment

3.0 PROCEDURES

3.1 Well Development

Development of all monitoring wells shall be conducted in accordance with the following procedures:

1. All monitoring well development equipment shall be decontaminated in accordance with SOP 1.5 (Decontamination) before any development activities are initiated.
2. Well development shall occur a minimum of 24 hours after the installation of the monitoring well.

3. Collect water level measurements in accordance SOP 7.1 (Water Level Measurements).
4. Calculate the well volume in accordance with SOP 7.2 (Monitoring Well Purging with a Bailer) or 7.3 (Monitoring Well Purging with a Pump).
5. Assemble well development equipment in accordance with SOP 7.2 (Monitoring Well Purging with a Bailer) or 7.3 (Monitoring Well Purging with a Pump), depending upon the development method.
6. Begin developing the well using the development method selected.
7. Collect field parameters after each well volume in accordance with SOP 7.5 (Measurement of Monitoring Well Field Parameters) and record in logbook or on the field data sheet.
8. As purge water clears, place a surge block (or weighted bailer) in the well and lower the surge block until it is near the top of the screen or water surface. Alternately raise and lower the surge block through the vertical distance of one to two feet. The velocity of the surge block motion will depend on the tightness of the formation in which it is installed.
9. After surging the well a few times at a given depth, move the surge block deeper by one or two feet and repeat step 8.
10. Repeat steps 8 and 9 until the surge block has been lowered to the bottom of the screened section of the well.
11. Slowly raise the surge block out of the well.
12. Purge the well of sediment that may have accumulated due to the mechanical surging.
13. Repeat steps 7 through 12 until the purge water remains clear and field parameters have stabilized.
14. If the well is pumped to dryness or near dryness, the water level should be allowed to sufficiently recover (to the static water level) before the next development period is initiated. Continuous purging over a period of several days may be necessary to complete the well development.
15. All field decisions should be documented in the field log book.

3.2 Well Abandonment

Well abandonment reports should be submitted to the TNRCC by the subcontractor. Abandonment of all monitoring wells shall be conducted in accordance with the following procedures:

1. Remove all surface casing and well casing materials from the well borehole. This may be achieved either through pulling the casing or over-drilling the casing. Exceptions may be made for steel surface casings. In the event the entire length of steel surface casing cannot be pulled free, the steel casing should be cut at a depth of at least three feet below surface and this section is to be pulled free.
2. Re-drill the borehole with a bit diameter at least equal to the diameter of original to remove the sand pack, bentonite plug, and grout seal. In the event the steel surface casing cannot be removed, the bit diameter for re-drilling of the borehole shall be at least equal to the internal steel casing diameter minus one inch.
3. Pressure grout the borehole using a tremie pipe, grouting from the bottom of the borehole to the top using a cement-bentonite slurry (i.e., one 94-pound sack of Portland type II cement, 7.5 to 8 gallons of water, and 3 to 5 percent bentonite powder).
4. Remove the well pad, protective steel casing, bumper posts, and any other ancillary well features/materials.

5. Restore the ground level at the well location to the original grade.

Any deviations from these procedures will require the approval of the TNRCC project manager.

4.0 CAUTIONS AND INTERFERENCES

A newly completed monitoring well should not be developed for at least 24 hours after installation. This will allow sufficient time for the well materials to cure before development procedures are initiated. When surging the well with a surge block, care should be taken to not damage the screen of the well while surging. Caution should be taken when using high rate pumps and/or large volume air compressors during well development because excessive high rate pumping and high air pressures can damage or destroy the well screen and filter pack.

1.0 METHOD SUMMARY

This SOP provides requirements for documenting and reporting site activities. The objective of the documentation program is to accurately and completely describe all field activities, thereby demonstrating that all field activities are conducted in accordance with the project specific Field Sampling Plan or Field Work Plan and applicable Superfund Program Standard Operating Procedures (SOPs).

2.0 EQUIPMENT/APPARATUS/REAGENTS

Equipment typically required for documenting the progress of the project includes:

- Field logbook (all weather or water resistant)
- Field forms
- Camera
- Video recorder (if necessary)
- Permanent marking pens
- Ink pens (with waterproof, black ink)

The field logbook shall contain the following information at a minimum:

- Location, date and time of each activity
- Weather conditions (changes)
- Activity being performed
- Identity of the person(s) performing the activity
- The numerical value and units of any field measurements
- The identity of, and the calibration results for, each field instrument being used
- All information required to demonstrate that the work is conducted in accordance with applicable Sampling Plans, Work Plans and SOPs
- visitors to the site

Specific information which shall be included for each sample includes:

- Sample type and sampling method
- The identity of each sample and depth(s) from which it was collected
- The amount of each sample
- Sample description (e.g., color, odor, clarity)
- Identification of sampling devices
- Identification of conditions that might affect the representativeness of a sample (e.g., refueling operations, damaged well casings)
- All information required to demonstrate that the work is conducted in accordance with applicable Sampling Plans, Work Plans and SOPs

All information relating to installation and development of monitor wells, installation of temporary groundwater sampling points, well development, well purging, groundwater sample collection and all other sampling activities or field work shall be recorded in a field logbook or field form(s). When field forms are used the field logbook shall reference the data noted on field forms and the field forms shall be dated and signed by the author. The field logbook will be bound with consecutively numbered pages and will be suitable for submission as evidence in legal proceedings. Each entry in the field logbooks will be signed and dated by the author. All original data recorded in the field logbook and other field forms will be written using permanent, waterproof ink. Errors

made in the field logbook will be corrected by the individual making the entry by crossing a line through the error, entering the correct information, and dating and initialing the correction. The field logbooks and field forms will become part of the project file, and should be kept in the project file at all times when not in the possession of the field team.

3.0 PHOTOGRAPHS

General guidelines (all types of photos):

- If possible, use a camera that has a time and/or date stamp. Record the date and time each photo was taken on the photo or with the photo file (as applicable) and in the field logbook.
- Do not use special lenses (i.e., wide-angle lenses) as they can distort the image
- A brief, accurate description of what the photograph shows, including the name of the site and location shall be recorded in the field logbook.
- Include the name of the photographer, and witness, as applicable.

When photographs are taken the record of each frame exposed/recorded is kept in the bound field logbook along with the information above required for each photograph. The field investigator shall then enter the required information on the prints, slides or CD (if digital photos) using the photographic record from the bound field logbook, to identify each photograph.

Conventional 35 mm Cameras

- Obtain negatives in one continuous, uncut sheet and include with the pictures.
- Arrange photos in album format and include the above information for each photo and submit with the field logbook.

Digital Cameras

- Submit a CD-R of the downloaded picture files in JPEG format (include the above information for each photo) and submit with the field logbook.
- Digital camera recording mode (dependent on camera's pixel resolution quality and picture quality mode) shall be set to achieve a minimum pixel resolution of 1600 x 1200 or higher.

4.0 OTHER FIELD FORMS

Other types of records which may be used in the field include:

- Drum inventory forms
- Well development/purging records
- Boring logs

- Well construction diagrams (as-builts)

5.0 CAUTIONS AND INTERFERENCES

This section is not applicable to this SOP.

STANDARD OPERATING PROCEDURE NO. 6.2
HOMOGENIZATION OF SOIL SAMPLES

1.0 METHOD SUMMARY

This standard operating procedure (SOP) provides guidance for homogenization of soil samples.

2.0 EQUIPMENT/APPARATUS/REAGENTS

Typical equipment required for surface and subsurface sampling includes:

- Stainless steel trowel
- Stainless steel bowl
- Stainless steel hand auger
- Knife
- Field logbook
- Waterproof and permanent marking pens
- Duct tape
- Latex gloves
- Decontamination supplies
- Paper towels
- Appropriate personal protective equipment (PPE)
- Sample jars with labels
- Cooler with ice
- Zip-lock bags
- Organic Vapor Meter

3.0 PROCEDURES

1. Select and label the proper sample containers for collecting the soil samples.
2. Complete the sample labels with the appropriate information.
3. Collect sample material using a trowel (SOP 10.1), split spoon (SOP 10.2), hand auger (SOP 10.3), or by the direct push method (SOP10.4). Collect equal volumes of soil from each location.
4. Place the soil sample material into a stainless steel bowl and homogenize the sample with a stainless steel spoon by thoroughly mixing and breaking up the sample material. Do not homogenize samples for VOC analysis as the homogenization will cause a release of VOC constituents.
5. Quarter the sample bowl and set aside two of the sample quarters.
6. Homogenize the sample again.
7. Fill the appropriate sample jars using the material from the bowl, placing equal portions of sample into the sample bottles.
8. Securely tighten the caps on the sample bottles and place them in Zip-lock bags.
9. Place the bottles in a cooler with ice.
10. Fill out a chain of custody.
11. Ship the sample and chain of custody to the laboratory.

The sampling equipment shall be decontaminated between each sample, and new gloves should be worn each time.

4.0 CAUTIONS AND INTERFERENCES

There are no cautions or interferences for this SOP.

STANDARD OPERATING PROCEDURE NO. 6.3
COLLECTION OF VOC SAMPLES

1.0 METHOD SUMMARY

The objective of this standard operating procedure (SOP) is to provide guidance for the sampling of volatile organic compounds.

2.0 EQUIPMENT/APPARATUS/REAGENTS

Typical equipment required for groundwater, surface and subsurface soil sampling includes:

- Sample bottles with labels
- Hermetically sealed 40-ml VOA vials or hermetically sealed intermediate sample containers
- Coring device
- Stir bar
- Bailer (stainless steel or disposable)
- Scoop or spatula
- 2-oz. sample jars

Sample bottles for the collection of VOCs in groundwater will be preserved with hydrochloric acid.

3.0 PROCEDURES

3.1 Groundwater Sample Collection

The following procedures shall be followed in the collection of groundwater VOC samples:

1. Wells shall be purged in accordance with one of the following SOPs: SOP 7.2 (Monitor Well Purging with a Bailer), SOP 7.3 (Monitor Well Purging with a Pump), or SOP 7.3 (Monitor Well Micro Purging).
2. Label sample bottles in accordance with SOP 6.5 (Sample Handling and Control).
3. Care must be taken when filling a VOC bottle to direct a slow, steady stream of water down the side of the bottle to minimize aeration of the sample.
4. Fill the sample container to the top of the container so that a meniscus is formed. Allow any air bubbles to rise to the surface. Carefully and quickly screw the cap onto the container and finger tighten.
5. Invert the sample and tap it gently, looking for any air bubbles. If the sample contains air bubbles, discard the sample and repeat the sampling process with a new sampling container.
6. All samples must be properly packaged (SOP 6.5) and chilled to 4±2°C immediately upon collection.
7. During sample shipment, all conditions relating to the isolation/segregation of the samples from potential contaminants (gasoline/diesel engines or generators, highly contaminated samples, etc.) must be observed.
8. Decontaminate all non-disposable sampling equipment prior to moving to new sampling point and/or at the end of the day.

3.2 Soil Sample Collection

This section is based on the TNRCC Guidance on SW846-5035 and provides guidance for the implementation of Method 5035. The intent of Method 5035 is to collect the sample causing the least amount of disturbance to the soil structure and to transfer and hermetically seal the sample in a sample container as quickly as possible.

The recommended method of sample collection for both low and high concentration soils is the closed-system field collection using hermetically sealed 40-ml VOA vials or hermetically sealed intermediate sample containers. Three vials are needed for a regular sample, and 6 vials are need for a matrix spike/matrix spike duplicate sample (MS/MSD). Bulk sampling can be used for sample points where the contamination is expected to be high or where the procedure requires a sample volume that exceeds the recommended 5 grams, such as TCLP determination, or where a sample using Method 5035 procedures cannot be collected. Method 5035 includes a procedure for preparing low concentration samples, i.e., soil samples that can reasonably be expected to contain concentrations of VOCs between 5 µg/kg and 200 µg/kg, and a second procedure for high concentration samples, i.e., soil samples that are expected to contain greater than 200 µg/kg of VOCs.

It is recommended that screening of samples, both in the field using an appropriate field instrument, and in the laboratory using a gas chromatography screening method, be conducted prior to selecting the Method 5035 option. The selection of the appropriate analytical methodology depends upon the data quality objectives (DQOs) for the project. These DQOs include the analytical sensitivity requirements for the project and identification of the VOCs present, or suspected to be present, at the site.

3.2.1 Field procedures

This recommended sample collection technique does not require preservative.

9. All containers and sampling devices must be pre-cleaned and/or be certified free of VOCs.

10. The sample vial should be a standard supply 40-ml VOA vial with a PTFE (Teflon®)-lined septum that can be hermetically sealed.

11. Sample vials should be prepared in a fixed laboratory or other controlled environment. The tare weight of the sample vial including cap, septum, and label must be determined and recorded on the label prior to shipping the vials to the field for sample collection. Clean gloves should be worn when handling tared vials.

12. Exposure to air must be minimized by obtaining the sample directly from the sample source using a coring device or a commercially designed sampling device and by transferring the sample as quickly as possible to a 40-ml VOA vial (or sealing the sample borer/hermetically sealed sample container immediately). The 40-ml vial must be hermetically sealed immediately after placing the sample in the vial. The vial should be quickly wiped free of any particulate matter that would compromise the integrity of the vial seal. Fingers should be used to minimize exposure to air by forming a temporary seal between the vial and the sampling device. The coring/sampling device must be designed to fit tightly against the mouth of a tared 40-ml vial or be small enough to be inserted into the vial. The coring

device can be used to collect multiple aliquots from the same sample point provided the integrity of the coring device is not compromised. If the coring device is designed and approved to be used as a temporary storage device for transport to the laboratory, the manufacturer's instructions should be followed. If a bulk sample is being collected because the concentrations in the soil are considered high, the 2 ounce sample jar should be filled to capacity to minimize the head space in the sample container.

13. The sample size collected should be approximately 5 grams (10 grams for TPH analysis by TNRCC 1005 and 1006). The coring device should be calibrated and designed to minimize the disturbance of the sample during collection. Several calibrated coring devices are available commercially. If the sampling team is not using a coring/sampling device that is calibrated to 5 grams, the TNRCC strongly recommends that, prior to collecting any samples, the sampling team practice collecting 5± grams using the chosen sampling device and a balance as described in Section 6.2.1.4 of Method 5035. For non-cohesive soils and waste (e.g., dry sand, fly ash, etc.), for highly cohesive materials (e.g., concrete, rock, etc), and for soils that have high compressive and shear strength, the sample should be quickly transferred into a 2 ounce jar using a scoop or spatula. Enough sample should be collected such that the head space in the jar is minimized.

6. A bulk sample with no preservative should be collected to use for screening purposes in the laboratory, but not for quantitative analysis. After the sample is screened in the laboratory, the sample can be used to determine the percent moisture, to run the MS/MSD, to check reactivity with sodium bisulfate and/or to determine the appropriate extraction solvent, as necessary.

7. The entire sample is consumed during the analysis for low concentrations of VOCs. It is recommended that a total of three samples be collected at each sample point for a regular sample; allowing one sample for the analysis, one sample in case a dilution is required, and one sample for re-analysis, if necessary.

8. For the samples with high concentrations of volatiles, the sample is extracted with methanol and the extract is used for dilutions and/or re-analysis. Therefore, only two samples are recommended, one sample for analysis and one replicate for re-analysis, if necessary. If the VOC concentration is unknown, collect three samples as stated in number 7.

9. Six samples should be collected at each sample point for matrix spike/matrix spike duplicated (MS/MSD) sampling.

10. Sample containers remain unopened from the time of collection until analysis.

11. The use of a balance in the field is required to check the tare weight when field preservation with methanol is being conducted. For other sample collection procedures, balances are used to verify that an adequate volume (weight) of soil is collected, because the initial soil sample size will affect the quantitation limit that can be achieved on the sample.

12. All samples must be properly packaged (SOP 6.4) and chilled to 4±2°C immediately upon collection.

13. During sample shipment, all conditions relating to the isolation/segregation of the samples from potential contaminants (gasoline/diesel engines or generators, highly contaminated samples, etc.) must be observed.

14. Decontaminate all non-disposable sampling equipment prior to moving to another well and/or at the end of the day.

3.2.2 Quality Control

The laboratory quality control measures specified throughout Method 5035 must be followed. Field quality control measures should include a trip blank in every sample shuttle that contains samples for volatile analysis regardless of the sample collection technique.

4.0 CAUTIONS AND INTERFERENCES

4.1 Groundwater Sample Collection

Make sure that there are no air bubbles in the sample bottle. Be careful not to agitate the sample. The sample bottle should be quickly sealed and chilled, held at 4±2°C, and shipped to the laboratory

4.2 Soil Sample Collection

The recommended method of sample collection for both low and high concentration soils is to collect the sample using a coring device and to quickly extrude the sample core into a tared 40-ml vial that does not contain preservative but does contain the stir bar, if applicable. The threads of the vial are inspected and wiped clean, and the vial is quickly sealed and chilled, held at 4±2°C, and shipped to the laboratory. The laboratory should analyze the sample within 48 hours from the time of collection. Alternatively, the laboratory can preserve the sample within the 48 hour time frame to extend the holding time to 14 days. The manual addition of any water, surrogates, and/or internal standards, and all additions of preservatives should be made using a 22-gauge or thinner needle through the septum seal. This collection procedure does not require the use of preservatives in the field or balances in the field. An alternative method is the collection of the sample using an approved coring device that serves as an intermediate hermetically sealed sample container. This type of sampling device should be used according to the manufacturer's instructions.

STANDARD OPERATING PROCEDURE NO. 6.4
SAMPLE HANDLING AND CONTROL

1.0 METHOD SUMMARY

This SOP presents procedures for maintaining control of environmental samples following collection through shipment to the analytical laboratory. In addition, this SOP describes standard chain-of-custody protocols which should be followed to document the possession of samples from the time of collection until the laboratory report is submitted.

2.0 EQUIPMENT/APPARATUS/REAGENTS

Equipment needed for use in this SOP includes:

- Precleaned sample containers
- Preservatives (if not in containers)
- Sturdy cooler, in good repair
- Fiberglass strapping tape
- Duct tape
- Clear tape
- Bubble wrap or other packing material Ziploc-type bags
- Trash bags
- Ice
- Shipping labels
- Pens, markers, etc.

3.0 PROCEDURES

3.1 Sample Identification

The contractor should identify procedures for unique sample identification and the relation to field identification (i.e., how sample numbers are assigned). Samples shall be uniquely identified, labeled, and documented in the field at the time of collection. Samples collected for laboratory analysis are identified by using standard sample labels which are affixed to the sample containers. Most analytical laboratories will supply the necessary labels. The following information shall be included on the sample label at the time of collection using waterproof, non-erasable ink:

- Project number
- Field identification or sample station number
- Date and time of sample collection
- Designation of the sample as a grab or composite
- Whether the sample is preserved or unpreserved
- The types of analyses to be performed
- Any relevant comments (such as readily detectable or identifiable odor, color, or known hazardous properties)
- Signature or initials of the sampler(s)

3.2 Sample Packaging

Environmental samples should be packed prior to shipment using the following procedures:

1. Allow sufficient headspace (approximately 10 percent of the volume of the container) in all bottles (except volatile organic analysis (VOA) vials with a septum seal) to compensate for any pressure and temperature changes which may occur during shipment.

2. Ensure that the lids on all bottles are tight.

3. Select a sturdy cooler in good repair. Secure and tape the drain plug with fiberglass strapping tape or duct tape. Line the cooler with a heavy duty plastic garbage bag.

4. Place glass sample bottles into bubble wrap bags or wrap a layer of bubble wrap around glass containers. Many laboratories provide bubble wrap bags for sample shipment. Place two to three VOA vials in a single bag.

5. Place the bottles in the cooler with larger bottles on the bottom inside the garbage bag. Insert polyethylene bottles between glass bottles for cushion. Put VOA vials (in bubble wrap bags) on their side on top of the larger sample containers.

6. Ensure that a trip blank has been included as appropriate for VOA samples and that a temperature blank (if supplied) is included as outlined in SOP No. 6.3, and SOP No. 6.5.

7. Place ice that has been "double bagged" on top of and/or between the samples. Fill remaining void space in the cooler with bubble wrap. Ensure that a sufficient quantity of ice has been placed into the cooler to maintain VOC samples at 4°C. In summer months, it may be necessary to fill as much as 50 percent of the cooler volume with ice to properly cool warm samples.

8. Securely fasten the top of the garbage bag with tape.

9. Place the Chain-of-Custody record into a Ziploc-type bag and tape the bag to the inside of the cooler lid.

10. Close the cooler and securely tape (preferably with fiberglass strapping tape) the top of the cooler shut. Chain-of-custody seals (preferably two) should be affixed to the cooler with clear tape so that the cooler can not be opened without breaking the seals.

11. Place the shipping label in a sealed pouch on the lid of the cooler for shipment. A label containing the name and address of the shipper and the destination should be placed on the outside of each additional cooler included in the shipment.

3.3 Sample Shipping

Samples collected in the field shall be transported to the laboratory or field testing site as expeditiously as possible (within 24 hours of sampling) to avoid hold time exceedances and to ensure that samples remain properly preserved. Samples for VOC analysis must be maintained at a temperature of 4°C.

In general environmental samples include drinking water, most ground water and ambient surface water, soil, sediment, treated municipal and industrial wastewater effluent, biological specimens, or any samples not expected to be contaminated with high levels of hazardous materials. Samples collected from process wastewater streams, drums, bulk storage tanks, soil, sediment, or water samples from areas suspected of being highly contaminated may require shipment as dangerous goods. Regulations for packing marking, labeling, and shipping of dangerous goods by air transport are promulgated by the International Air Transport Authority

(IATA), which is equivalent to United Nations International Civil Aviation Organization (UN/ICAO). It is the responsibility of the shipper to ensure that shipments are made in accordance with all applicable laws, including contents and labeling.

3.4 Sample Chain-of-Custody

Procedures to ensure the custody and integrity of the samples should begin at the time of sampling and continue through transport, sample receipt, preparation, analysis and storage, data generation and reporting, and sample disposal. Records concerning the custody and condition of the samples are maintained in field laboratory records.

The contractor shall maintain chain-of-custody records for all field and field QC samples. A sample is defined as being within a person's custody if any of the following conditions exist:

- It is in their possession,
- It is in their view,
- It was in their possession and they secured it in a locked area, or
- It is in a designated secured area.

All sample containers shall be sealed in a manner that shall prevent or provide detection of tampering if it occurs. In no case shall tape be used to seal sample containers. Samples shall not be packaged with activated carbon unless prior approval is obtained from TNRCC.

The following minimum information concerning the sample shall be documented on the TNRCC chain-of-custody form (Attachment 1):

- Unique sample identification
- Date and time of sample collection
- Source of sample (including name, location, and sample type)
- Designation of matrix spike/matrix spike duplicate (MS/MSD)
- Preservative used
- Analyses required
- Number of sample containers
- Pertinent field data (pH, temperature, elevated headspace results or contaminant concentrations)
- Serial numbers of custody seals and transportation cases (if used)
- Name(s) of person(s) collecting the samples
- Custody transfer signatures and dates and times of sample transfer from the field to transporters and to the laboratory or laboratories
- Transporter tracking number (if applicable) or courier receipts

4.0 CAUTIONS AND INTERFERENCES

This section is not applicable to this SOP.

CHAIN OF CUSTODY RECORD

Project Name	Project No.	Analytical Parameters
Project Location	Project Manager	
Sampler(s)		

Sample		Type				Containers												
Date	Time	Comp.	Grab	Sample Identification	Matrix	No.	Type											Remarks

Signatures	Date	Time	Shipping Details	Special Instructions
Relinquished by:			Method of Shipment	
Received by:			Airbill No.	
Relinquished by:			Lab Address	
Received for Laboratory by:				

STANDARD OPERATING PROCEDURE NO. 6.5
COLLECTION OF QA/QC SAMPLES

1.0 METHOD SUMMARY

Quality assurance/quality control samples are collected to attempt to determine if sample bottle preparation, sample shipment, handling, and storage procedures had an impact on the sample integrity. Data validation is an integral part of the sampling program and consists of reviewing and assessing the quality of data and determining the usability of the data based on previously defined objectives.

2.0 EQUIPMENT/APPARATUS/REAGENTS

The following equipment is used for collection of QA/QC samples:

- Pre-cleaned sample containers (with preservatives, if required)
- Analyte-free water (distilled or deionized)
- Stainless steel sampling bowl
- Stainless steel sampling spoon
- Other equipment as prescribed for collecting soil or water samples

3.0 PROCEDURES

3.1 Collection Field QA/QC Samples

3.1.1 Equipment Blanks

Equipment blanks should be collected using the following procedures:

1. Properly decontaminate the sampling device. Equipment blanks are not collected on disposable equipment (e.g., disposable bailers).
2. Select the proper sample containers and an appropriate quantity of analyte-free water (deionized or distilled).
3. Complete the sample labels with the appropriate information.
4. Slowly pour the analyte-free water through or over the sampling device until the sample bottle is filled to the appropriate level.
5. Securely tighten the cap on the bottle.
6. Prepare the bottle for shipment in accordance with SOP 6.5 (Sampling Handling and Control).

3.1.2 Field Blanks

Field blanks should be collected downwind of possible VOC sources. The procedures for collecting field blanks are:

1. Select the proper sample containers (VOC vials) for collecting the sample and an appropriate quantity of analyte-free water.

2. Complete the sample labels with the appropriate information.

3. Pour the water into the vial just to overflowing so that there is a meniscus at the top of the vials.

4. Securely tighten the lid on the sample vials.

5. Prepare the sample for shipment in accordance with SOP 6.5 (Sampling Handling and Control).

3.1.3 Field Duplicate Samples

Duplicate samples should be collected simultaneously or in immediate succession, using identical recovery techniques, and treated in an identical manner during storage, transportation, and analysis. If possible, collect duplicate samples in areas known to be contaminated to assess the laboratory's ability to measure contamination.

1. Select the proper sample containers for collecting a sample and a duplicate sample.

2. Complete the sample labels with the appropriate information.

3. Collect the sample as required.

   a. Groundwater Samples

      i. Collect the sample in accordance with the appropriate sampling SOP.

      ii. Fill the sample bottle half full with the pump or bailer then fill the duplicate sample bottle half full. Fill the remainder of the sample bottle then the remainder of the duplicate sample bottle. If a bailer is used, attempt to fill equal quantities from each bailer load into the sample and duplicate bottles.

   b. Soil Samples

      i. Collect the sample in accordance with the appropriate sampling SOP but collect double the required sample volume.

      ii. Place the sample material into a stainless steel bowl and homogenize the sample with a stainless steel spoon. Do not homogenize samples for VOC analysis as the homogenization will cause a release of VOC constituents.

      iii. Quarter the sample bowl and set aside two of the sample quarters.

      iv. Homogenize the sample again.

      v. Fill the appropriate sample jars using the material from the bowl, placing equal portions of sample into the sample bottles.

4. Securely tighten the caps on the sample bottles.

5. Prepare the sample for shipment in accordance with SOP 6.5 (Sampling Handling and Control).

3.1.4 Field Replicate (Split) Samples

If possible, collect field replicate samples from areas known to be contaminated to assess the laboratory's ability to measure contamination.

1. Select the proper sample containers for collecting a sample and a replicate sample.
2. Complete the sample labels with the appropriate information.
3. Prepare the sample using the same methods described in Section 3.1.3.
4. Place the field replicate samples in a separate cooler for shipment to the second laboratory.

3.1.5 Matrix Spike/Matrix Spike Duplicate (MS/MSD)

Many laboratories can prepare the MS/MSD samples from the submitted sample volume. The sampler is only required to identify the sample for MS/MSD analysis on the chain of custody. If the sampler is required to collect MS/MSD samples, they should be collected as replicate samples but with three sets of samples (one original sample, one matrix spike sample, and one matrix spike duplicate).

3.1.6 Temperature Blank

Temperature blanks are typically prepared by the analytical laboratory and included in the shipment of sample coolers and containers. One temperature blank should be returned to the laboratory in each sample cooler.

3.1.7 Trip Blank

Trip blanks are usually prepared by the analytical laboratory using analyte-free water and included in the shipment of sample coolers and containers. Trip blanks should only be submitted with samples requiring VOC analysis. One trip blank should be included in each sample cooler containing samples for VOC analysis. The procedures for submitting a trip blank are:

- Prepare the coolers for shipment to the laboratory. If possible, pack all samples for VOC analysis in one cooler so that only one trip blank is required.
- Identify the trip blank on the chain-of-custody record. If the project will continue for several days, be sure to number trip blanks sequentially so that multiple trip blanks with the same identification number are not submitted to the laboratory.
- Ensure that VOC analysis (or benzene, toluene, ethylbenzene, and xylenes (BTEX) at Leaking Petroleum Storage Tank (LPST) sites) is the selected analysis for the trip blank.

4.0 CAUTIONS AND INTERFERENCES

The types of QA/QC samples and frequency for collection are typically outlined in the project Quality Assurance Project Plan (QAPP). It is important to identify the sample frequency prior to beginning the field

effort. QA/QC samples should be selected to match the sampling program (i.e., it is not necessary to collect trip blanks for sites where only samples for metals analysis are being collected).

1.0 METHOD SUMMARY

An accurate water level measurement is necessary to calculate purge volumes and to create water level surface maps. This SOP describes the steps necessary to collect a water level/sediment level from a monitoring well.

2.0 EQUIPMENT/APPARATUS/REAGENTS

The following is a typical equipment list used for water level/sediment measurement of groundwater monitoring wells.

2.1 Equipment List

- Water level indicator
- Well keys
- PID or FID
- Logbook
- As-built diagrams of monitoring wells
- Calculator
- Plastic sheeting
- Bolt cutters
- Cotton string
- Clear bailers
- Nylon rope
- Weights
- Appropriate personal protective equipment (PPE)

3.0 PROCEDURES

3.1 Water level/Sediment Measurement

1. Start at the least contaminated well, if known.
2. Inspect the well for signs of tampering or other damage. If tampering is suspected, (i.e., casing is damaged, lock or cap is missing) this shall be recorded in the field log book and on the well sampling form and reported to the Field Operations Leader. Wells that are suspected to have been tampered with shall not be sampled until the Field Operations Leader has discussed the matter with the project manager.
3. Lay plastic sheeting around the well to minimize likelihood of contamination of equipment from soil adjacent to the well.
4. Remove locking well cap, note location, time of day, and date in field notebook or appropriate log form.
5. Remove well casing cap.
6. For confined aquifers, wait for water level to equilibrate before measuring water level.

7. Turn on the water level meter.

8. Press the battery check button (if so equipped). A solid tone will be heard if the battery is good.

9. Lower water level measuring device or equivalent (i.e., permanently installed transducers or airline) into well, unreeling the measuring tape from the spool of the meter as you go.

10. Continue lowering the probe until a continuous tone is heard. This tone indicates that the probe has come in contact with the water.

11. Holding the measuring tape near the measuring reference point, alternately raise and lower the probe across the depth at which the tone sounds. This will ensure that you have an accurate measurement of the depth to water. Record the distance from water surface to the referenced measuring point on well casing in site logbook. Alternatively, if there is no reference point, note that water level measurement is from top of steel casing, top of PVC riser pipe, from ground surface, or some other position on the wellhead, typically on the north edge. Water level measurement should be recorded to the nearest 0.01 foot.

12. Measure total depth of well (at least twice to confirm measurement) and record in the site logbook or field data sheet. Total depth measurements should be recorded to the nearest 0.01 foot..

13. If the field investigator suspects that excessive sediment buildup may be occurring at the bottom of the well, the measured total depth should be compared with the total depth at the time of drilling (from boring log). If the sediment thickness exceeds one foot, or is excessively impeding the flow of groundwater through the well screen, the well shall be redeveloped in accordance with SOP 5.6 (Monitor Well Development/Abandonment).

14. Decontaminate water level probe in accordance with SOP 1.5 (Decontamination).

3.2 Measurement of Separate Phase Liquids (DNAPL or LNAPL)

Separate phase organics frequently occur at hazardous waste sites as light non-aqueous phase liquids (LNAPL) or dense non-aqueous phase liquids (DNAPL). The presence of these constituents should be documented if possible. The presence of LNAPL can be confirmed using a clear bailer by lowering the bailer to just below the top of the water surface, removing the bailer, and observing the contents. The volume of LNAPL recovered can be enhanced through the use of a product cup. The presence of DNAPL can be confirmed by one of two ways.

1. Lower a weighted bailer to the bottom of the well, remove the bailer and observe the contents for any free product.

2. Lower a length of weighted cotton string to the bottom of the well, remove the string and observe the string for the DNAPL staining.

3. Measure and record the thickness of any free product identified to the nearest 0.01 ft.

4.0 CAUTIONS AND INTERFERENCES

Water levels in wells should measured from the least contaminated to the most contaminated or from upgradient to downgradient if chemistry is unknown.

STANDARD OPERATING PROCEDURE NO. 7.2
PURGING A MONITORING WELL WITH A BAILER

1.0 METHOD SUMMARY

Purging is the process of removing stagnant water from a monitoring well, immediately prior to sampling, causing its replacement by groundwater from the adjacent formation, which is representative of actual aquifer conditions. .

2.0 EQUIPMENT/APPARATUS/REAGENTS

The following is a typical equipment list used for purging groundwater monitoring wells with a bailer.

2.1 Equipment List

- Logbook
- As-built diagrams of monitoring wells
- Calculator
- Field data sheets
- 5-gallon buckets
- Plastic sheeting
- Nylon rope
- Bailers
- Drums
- Marking pen for labeling drums
- Wrench for opening/sealing drums
- Appropriate PPE

3.0 PROCEDURES

The procedures for purging the well with a bailer are as follows:

1. Collect water level measurements as described in SOP 7.1 (Water Level Measurements).
2. Calculate the purge volume according to the following equation.

   Volume = [π (radius of borehole)^2 x7.48 (gal/ft^3) x 0.3] - [π (radius of well casing)^2 x 7.48 (gal/ft^3)]

   where:

   π = pi (3.14, dimensionless)

   7.48 gal/ft^3 = volume of water in an open borehole

   0.3 = typical estimate of filter pack porosity (30%)

   Knowing the diameter of the borehole, there are a number of standard conversion factors which can be used to simplify the equation above. The volume, in gallons per linear foot, for various standard monitor well diameters can be calculated as follows:

   Well volume (gal/ft) = h x cf

where:

h = height of water column (feet), calculated by subtracting the depth to water (WL) from the total depth of the well (TD).
cf = the conversion factor.

Remember that you must use the *radius* in feet to be able to use the equation.

3. All non-dedicated equipment shall be decontaminated in accordance with SOP 1.5 (Decontamination) prior to sampling activities.
4. Attach a new piece of nylon rope to the bailer and slowly lower until the bailer is completely submerged, being careful not to drop the bailer to the water, causing turbulence and the possible loss of volatile organic contaminants. The well should be purged at a rate low enough to prevent water from cascading down the sides of the well, if at all possible.
5. Pull bailer out ensuring that the rope either falls onto a clean area of plastic sheeting or never touches the ground.
6. Empty the bailer into a pail until full to determine the number of bails necessary to achieve the required purge volume.
7. When no sediments are visible in the purge water, begin measuring field parameters in accordance with Section 7.5 (Measurements of Monitor Well Field Parameters).
8. Continue purging the well and repeat measurement of field parameter after each purged well volume .
9. Thereafter, pour the water into a container and dispose of purge waters as specified in the site specific sampling plan.
10. Purge the well until the purge volume has been achieved, and the well parameters have stabilized. As a general rule, all monitoring wells should be purged prior to sampling. Purge water should be containerized on site on site or handled as specified in the specific project plan. Evacuation of a minimum of one borehole volume of water, and preferably three to five volumes, is recommended for a representative sample.

4.0 CAUTIONS AND INTERFERENCES

In a non-pumping well, there will be little or no vertical mixing of the water, and stratification will occur. The well water in the screened section will mix with the groundwater due to normal flow patterns, but the well water above the screened section will remain isolated, become stagnant, and may lack the contaminants representative of the groundwater. Persons sampling should realize that stagnant water may contain foreign material inadvertently or deliberately introduced from the surface resulting in an unrepresentative sample. To safeguard against collecting nonrepresentative stagnant water, the following guidelines and techniques should be adhered to during sampling:

- Water level and sediment thickness measurements should be taken prior to beginning the purging activities.
- As a general rule, all monitoring wells should be pumped (preferred) or bailed prior to sampling.

- Purge water should be containerized on site or handled as specified in the site specific project plan.

Materials of construction for samplers and evacuation equipment (bladders, pump, bailers, tubing, etc.) should be limited to stainless steel, Teflon, and glass in areas where concentrations are expected to be at or near the detection limit. The tendency of organics to leach into and out of many materials make the selection of materials critical for trace analyses. The use of plastics, such as PVC or polyethylene, should be avoided when analyzing for organics. However, PVC may be used for evacuation equipment as it will not come in contact with the sample, and in highly contaminated wells, disposable equipment (i.e., polypropylene bailers) may be appropriate to avoid cross-contamination.

STANDARD OPERATING PROCEDURE NO. 7.3
PURGING A MONITORING WELL WITH A PUMP

1.0 METHOD SUMMARY

Purging is the process of removing stagnant water from a monitoring well, immediately prior to sampling, causing its replacement by groundwater from the adjacent formation, which is representative of actual aquifer conditions.

2.0 EQUIPMENT/APPARATUS/REAGENTS

The following is a typical equipment list used for purging groundwater monitoring wells a pump.

2.1 Equipment List

- Logbook
- As-built diagrams of monitoring wells
- Calculator
- Field data sheets
- 5-gallon buckets
- Plastic sheeting
- Generator, if using pump
- Air compressor for bladder pumps
- Pump
- Gasoline for generator/air compressor
- Discharge tubing for pump
- Control box (if necessary)
- Appropriate pump fittings (e.g., hose clamps, barbed fittings, etc.)
- Drums
- Marking pen for labeling drums
- Wrench for opening/sealing drums
- Appropriate PPE

3.0 PROCEDURES

1. Collect water level measurements as described in SOP 7.1 (Water Level Measurements).
2. Calculate the purge volume according to the following equation.

   Volume = [π (radius of borehole)^2 x7.48 (gal/ft^3) x 0.3] - [π (radius of well casing)^2 x 7.48 (gal/ft^3)]

   where:

   π = pi (3.14, dimensionless)

   7.48 gal/ft^3 = volume of water in an open borehole

   0.3 = typical estimate of filter pack porosity (30%)

Knowing the diameter of the borehole, there are a number of standard conversion factors which can be used to simplify the equation above. The volume, in gallons per linear foot, for various standard monitor well diameters can be calculated as follows:

Well volume (gal/ft) = h x cf

where:

h = height of water column (feet), calculated by subtracting the depth to water (WL) from the total depth of the well (TD).
cf = the conversion factor shown on the table below.

Remember that you must use the *radius* in feet to be able to use the equation.

3. All non-dedicated equipment shall be decontaminated in accordance with SOP 1.5 (Decontamination) prior to sampling activities.
4. Assemble pump, hoses and safety rope, and lower the pump into the well. Make sure the pump is deep enough so all the water is not evacuated. (Running the pump without water may cause damage).
5. Make connections between the pump and control box if using an air-lift or bladder pump (i.e., Well Wizard).
6. Attach flow meter to the outlet hose to measure the volume of water purged.
7. Use a ground fault circuit interrupter (GFCI) or ground the generator to avoid possible electric shock.
8. Attach power supply, and begin purging the well. The well should be purged at a rate low enough to prevent water from cascading down the sides of the well, if at all possible. Do not allow the pump to run dry.
9. If the pumping rate exceeds the well recharge rate, lower the pump further into the well, reduce the pumping rate to decrease well drawdown, and continue pumping.
10. If using an air-lift or bladder type pump, be sure to adjust flow rate to prevent violent jolting of the hose as sample is drawn in.
11. Purge water shall be pumped into a container and dispose of as specified in the site specific sampling plan.
12. When no sediments are visible in the purge water, begin measuring field parameters in accordance with SOP 7.5 (Measurements of Monitor Well Field Parameters).
13. Purge the well until the purge volume has been achieved, and the well parameters have stabilized. As a general rule, all monitoring wells should be pumper or bailed prior to sampling. Purge water should be containerized on site or handled as specified in the site specific project plan. Evacuation of a minimum of one borehole volume, and preferably three to five volumes, is recommended for a representative sample

4.0 CAUTIONS AND INTERFERENCES

The primary goal in performing groundwater sampling is to obtain a representative sample of the groundwater body. Analysis can be compromised by field personnel in two primary ways: (1) taking an unrepresentative sample, or (2) by incorrect handling of the sample. There are numerous ways of introducing foreign

contaminants into a sample, and these must be avoided by following strict sampling procedures and utilizing trained field personnel. While laboratory methods have become extremely sensitive, well controlled and quality assured, they cannot compensate for a poorly collected sample. The collection of a sample should be as sensitive, highly developed and quality assured as the analytical procedures.

In a non-pumping well, there will be little or no vertical mixing of the water, and stratification will occur. The well water in the screened section will mix with the groundwater due to normal flow patterns, but the well water above the screened section will remain isolated, become stagnant, and may lack the contaminants representative of the groundwater. Persons sampling should realize that stagnant water may contain foreign material inadvertently or deliberately introduced from the surface resulting in an unrepresentative sample. To safeguard against collecting nonrepresentative stagnant water, the following guidelines and techniques should be adhered to during sampling:

1. Water level and sediment thickness measurements should be taken prior to beginning the purging activities.
2. As a general rule, all monitoring wells should be pumped (preferred) or bailed prior to sampling. Purge water should be containerized on site or handled as specified in the site specific project plan.
3. A non-representative sample can result from excessive pre-pumping of the monitoring well. Stratification of the leachate concentration in the groundwater formation may occur, or heavier-than-water compounds may sink to the lower portions of the aquifer. Excessive pumping can dilute or increase the contaminant concentrations from what is representative of the sampling point of interest.

Materials of construction for samplers and evacuation equipment (bladders, pump, bailers, tubing, etc.) should be limited to stainless steel, Teflon, and glass in areas where concentrations are expected to be at or near the detection limit. The tendency of organics to leach into and out of many materials make the selection of materials critical for trace analyses. The use of plastics, such as PVC or polyethylene, should be avoided when analyzing for organics. However, PVC may be used for evacuation equipment as it will not come in contact with the sample, and in highly contaminated wells, disposable equipment (i.e., polypropylene bailers) may be appropriate to avoid cross-contamination.

STANDARD OPERATING PROCEDURE NO. 7.4
MICRO PURGING A MONITORING WELL

1.0 METHOD SUMMARY

Micro purging is an approach to purging based on the observation that groundwater flows through the well screen in most formations with sufficient velocity to maintain an exchange with formation water surrounding the well screen. By placing a pump within the screen interval and pumping at a low-flow rate which does not induce drawdown of the water column, a representative sample of formation groundwater can be collected with minimal withdrawal of stagnant water. Ideally micro purging should be conducted in wells in which dedicated pumps have been installed. It is possible to use non-dedicated pumps if a sufficient amount of time is allowed for the water level to equilibrate following insertion of the pump. Whenever possible, micro purging and low-flow sampling methods are preferred for use at Superfund sites.

2.0 EQUIPMENT/APPARATUS/REAGENTS

The following is a typical equipment list used for micro purging groundwater monitoring wells.

Equipment List

- Logbook
- As-built diagrams of monitoring wells
- Field data sheets
- Plastic sheeting
- Generator, if using pump
- Air compressor for bladder pumps
- Pump
- Gasoline for generator or an electrical source
- Discharge tubing for pump
- Control box (if necessary)
- Appropriate pump fittings (e.g., hose clamps, barbed fittings, etc.)
- Drums
- Marking pen for labeling drums
- Wrench for opening/sealing drums
- Appropriate PPE

3.0 PROCEDURES

The procedures for micro purging are as follows:

1. All non-dedicated equipment shall be decontaminated in accordance with SOP 1.5 (Decontamination) prior to sampling activities.
2. Assemble pump, hoses and safety cable, and, if using a non-dedicated pump, lower the pump into the well. The pump should be set at or just above the screened interval if the aquifer is under confined conditions (depth to water is above the screen), or just below the air/water interface if the aquifer is under unconfined conditions (water table straddles screen).

3. If using a non-dedicated pump, allow sufficient time for the water level to equilibrate to obtain a representative sample.

4. Make connections between the pump and control box if using an air-lift or bladder pump (i.e., Well Wizard).

5. Use a ground fault interrupter (GFCI) or ground the generator to avoid possible electric shock.

6. Attach power supply and begin micro purging the well. A well should be purged at or below its recovery rate, ideally less than 0.2 to 0.3 L/min.

7. Monitor the drawdown in the well. If the drawdown exceeds 0.3 ft, then reduce the pumping rate to ensure that drawdown does not exceed 0.3 ft.

8. Connect the water quality meters to the discharge hose and measure field parameters in accordance with Section 7.5 (Measurements of Monitor Well Field Parameters).

9. Repeat the measurements at a regular interval (i.e., every minute). Record the values in the field log book. Continue purging until the measured parameters stabilize for 3 successive readings.

10. If field parameters have not stabilized after 3 successive readings, continue taking measurements at 3 minute intervals up to a maximum of 5 successive readings. If, after 5 successive readings, the parameters have not stabilized, an entry shall be made in the field logbook indicating that sampling will be conducted without stabilized parameters.

11. Purge water should be containerized on site or handled as specified in the site specific project plan.

4.0 CAUTIONS AND INTERFERENCES

The primary goal in performing groundwater sampling is to obtain a representative sample of the groundwater body. Analysis can be compromised by field personnel in two primary ways: (1) taking an unrepresentative sample, or (2) by incorrect handling of the sample. There are numerous ways of introducing foreign contaminants into a sample, and these must be avoided by following strict sampling procedures and utilizing trained field personnel. While laboratory methods have become extremely sensitive, well controlled and quality assured, they cannot compensate for a poorly collected sample. The collection of a sample should be as sensitive, highly developed and quality assured as the analytical procedures.

In a nonpumping well, there will be little or no vertical mixing of the water, and stratification will occur. The well water in the screened section will mix with the groundwater due to normal flow patterns, but the well water above the screened section will remain isolated, become stagnant, and may lack the contaminants representative of the groundwater. Persons sampling should realize that stagnant water may contain foreign material inadvertently or deliberately introduced from the surface resulting in an unrepresentative sample. To

safeguard against collecting nonrepresentative stagnant water, the following guidelines and techniques should be adhered to during sampling:

12. Water level and sediment thickness measurements should be taken prior to beginning the purging activities.

13. As a general rule, all monitoring wells should be pumped (preferred) or bailed prior to sampling. Purge water should be containerized on site or handled as specified in the site specific project plan.

14. For wells that can be easily pumped or bailed to dryness, micro purging and low-flow sampling methods shall be used.

Materials of construction for samplers and evacuation equipment (bladders, pump, bailers, tubing, etc.) should be limited to stainless steel, Teflon, and glass in areas where concentrations are expected to be at or near the detection limit. The tendency of organics to leach into and out of many materials make the selection of materials critical for trace analyses. The use of plastics, such as PVC or polyethylene, should be avoided when analyzing for organics. However, PVC may be used for evacuation equipment as it will not come in contact with the sample, and in highly contaminated wells, disposable equipment (i.e., polypropylene bailers) may be appropriate to avoid cross-contamination.

STANDARD OPERATING PROCEDURE NO. 7.5
MEASUREMENT OF FIELD PARAMETERS

1.0 METHOD SUMMARY

Field parameters are collected during surface water or groundwater sampling events to identify physical/chemical characteristics of the sample that are representative of field conditions as they exist at the time of sample collection. They are also used to indicate when stagnant water has been removed from the well so that sampling may begin. Numerous instruments are commercially available for measuring field parameters. The setup and use of all instruments should follow a basic format to imply consistency of use. Regardless of the brand of meter used, all meters should be properly maintained and operated in accordance with the manufacturer's instructions and calibrations should be checked prior to use.

2.0 EQUIPMENT/APPARATUS/REAGENTS

The following is a typical equipment list used for measuring field parameters:

2.1 Equipment List

- Logbook
- Field data sheets
- Decontamination solutions
- Tap water
- Field parameter instruments (pH meter, thermometer, conductivity meter, turbidimeter, DO meter)
- Calibration standards
- Tap water
- Non-phosphate soap (Note: Alconox is not considered a non-phosphate soap; rather a low-phosphate soap)
- Glass bulb thermometer

3.0 PROCEDURES

3.1 Temperature

Temperature is a measure of hotness or coldness on a defined scale as measured using a thermometer. Typical types of thermometers include**:**

- Digital (thermo-couple) thermistor
- Glass bulb mercury filled
- Bi-metal strip/dial indicator

No matter which type of thermometer is used, it should be calibrated prior to use, if possible. Digital thermometers should be calibrated prior to use by comparison with a mercury bulb thermometer and should agree within ± 0.5 ^{o}C.

The procedures for measuring temperature are as follows:

1. Clean the probe end with analyte-free water and immerse into sample.
2. Swirl the thermometer in the sample.

3. Allow the thermometer to equilibrate with the sample.

4. Suspend the thermometer away from the sides and bottom to observe the reading.

5. Record the reading in the field log book or on the appropriate sampling log sheet. Units of temperature are degrees Celsius (^oC) and should be recorded to the nearest tenth (0.1).

Conversion Formulas:

$^oF = (1.8\ ^oC) + 32^o$ or $^oC = 0.56\ (^oF - 32^o)$

3.2 pH

Hydrogen ion concentration (pH) is used to express both acidity and alkalinity on a scale which ranges from 0 to 14 with 7 representing neutrality.

The procedures for measuring pH in the field are as follows:

1. Calibrate the instrument in accordance with the manufacturer's specifications.

2. Collect a sample. Measure the temperature prior to measuring the pH.

3. Immerse the probe in the sample, keeping it away from the sides and bottom of the sample container. Allow ample time for the probe to equilibrate with the sample.

4. While suspending the probe away from the sides and bottom of the sample container, record the pH. Units of pH are standard units and should be recorded in tenths (0.1).

5. Rinse the probe with analyte-free water and store it in a analyte-free water filled container until the next sample is ready.

6. Perform a post calibration at the end of the day and record all findings.

3.3 Conductivity

Conductivity is defined as the quality or power of conducting or transmitting. The procedures for measuring conductivity in the field are as follows:

1. Calibrate the instrument in accordance with the manufacturer's specifications.

2. Collect the sample and check and record its temperature.

3. Correct the conductivity instruments temperature adjustment to the temperature of the sample (if required).

4. Immerse the probe in the sample keeping it away from the sides and bottom of the container. It is important that the entire portion of the probe be wetted by the sample. This will be evident when some of the sample water is seen coming out of the small weep hole.

5. Record the result in the field log book or field sampling sheet. Units of conductivity are micro ohms per centimeter (µohms/cm) at 25ºC. Results should be reported to the nearest 10 units for readings below 1,000 µohms/cm and to the nearest 100 units for readings above 1,000 µohms/cm.

6. Rinse probe.

3.4 Dissolved Oxygen

Dissolved oxygen (DO) should be measured in-situ or "down hole" whenever possible. If in-situ measurements are not possible, precautions should be taken to minimize the time the sample is exposed to ambient air. Dissolved oxygen readings should not exceed the saturation limit of oxygen in water (8 to 10 mg/l). If readings greater than 10mg/l are observed, the meter is probably not functioning correctly. The procedures for collecting a DO sample are as follows:

1. Inspect the membrane of the DO meter for air bubbles and/or holes. If air bubbles or holes exist, replace the membrane.

2. Calibrate the DO meter in accordance with the manufacturer's specifications.

3. Measure the temperature of the sample and adjust the temperature setting of the DO meter, if so equipped.

4. Record the reading in the field log book or field sampling sheet. Dissolved oxygen is measured in units of mg/l. Results should be reported to the nearest tenth of a unit (0.1).

3.5 Turbidity

Turbidity is measured using a nephelometer/turbidimeter. The procedures for measuring turbidity are as follows:

1. Rinse the sample cell with analyte-free water.

2. Follow the manufacturer's specifications for collecting a turbidity measurement.

3. Record the reading in the field log book or field sampling sheet. The units of turbidity are nephelometric turbidity units or NTUs. Units should be recorded to the nearest whole unit.

4.0 CAUTIONS AND INTERFERENCES

Refer to owner's manual for instructions on proper calibration methods of all field parameter measuring equipment.

1.0 METHOD SUMMARY

Most hazardous waste site investigations utilize some form of a groundwater sampling or monitoring program to fully characterize the nature and extent of groundwater contamination. In order to obtain a representative groundwater sample for chemical analysis it is important to remove stagnant water in the borehole or pump tubing before collection of the sample. This may be achieved using a variety of instruments including pumps and bailers. Once purging is completed and the correct laboratory-cleaned sample containers have been prepared, sampling may proceed. Sampling may be conducted with any of the above instruments, and need not be the same as the device used for purging. During sampling, a field data sheet should be completed, a chain of custody form prepared, and all pertinent data recorded in the site logbook. This SOP describes the methods used to sample monitoring wells with a bailer.

2.0 EQUIPMENT/APPARATUS/REAGENTS

The following is a typical equipment list used for sampling groundwater monitoring wells using a bailer.

5.1 Equipment List

- Field data sheets and sample jar labels
- Chain-of-custody forms/Custody seals
- Sample containers
- Knife or scissors
- 5-gallon buckets
- Plastic sheeting
- Shipping containers
- Packing materials
- Ziploc-type plastic bags
- Field parameter instruments (pH meter, thermometer, conductivity meter, turbidimeter, DO meter)
- Calibration standards
- Non-phosphate soap (Note: Alconox is not considered a non-phosphate soap; rather a low-phosphate soap)
- Nylon rope
- Bailers
- Appropriate PPE

3.0 .PROCEDURES

This section outlines the procedures for collecting representative groundwater samples using the following steps. Each step in the procedure is covered in a separate SOP. The reference SOP is in parenthesis.

1. Prepare for sampling using: SOP 6.1 (Documentation), 6.3 (Collection of VOCs), 6.4 (Sample Handling and Control), and 6.5 (Collection of QC Samples).
2. Water level/sediment measurement will be taken in accordance with SOP 7.1 (Water Level Measurement)

3. Measurement of field parameters will be done in accordance with SOP 7.5 (Measurements of Monitoring Well Field Parameters).

4. Purge the well in accordance with SOP 7.2 (Monitoring Well Purging with a Bailer) or SOP 7.3 (Monitoring Well Purging with a Pump).

5. Assemble and label appropriate sample containers.

6. Attach a new piece of nylon rope to a dedicated bailer, a disposable bailer, or a clean, decontaminated non-dedicated bailer.

7. Lower the bailer slowly and gently into the well, taking care not to shake the casing sides or to splash the bailer into the water. Stop lowering at a point adjacent to the screen.

8. Allow bailer to fill and then slowly and gently retrieve the bailer from the well avoiding contact with the casing, so as not to knock flakes of rust or other foreign material into the bailer.

9. Remove the cap from the sample container and place it on the plastic sheet or in a location where it won't become contaminated or disturbed.

10. Begin pouring slowly from the bailer into the appropriate container. Samples should be collected in the following order:

    - Volatile organic compounds (VOCs)
    - Semi-volatile organic compounds (SVOCs); including polyaromatic hydrocarbons (PAHs)
    - Inorganic constituents (metals)
    - Mercury
    - Cyanide
    - Total organic carbon (TOC)
    - Total organic halogen (TOX)
    - Samples requiring field filtration
    - Samples for field parameter measurement
    - Samples for nutrient anion determinations

11. Filter and preserve samples as required by the sampling plan.

12. Cap the sample container tightly and place pre-labeled sample container in a pre-chilled cooler.

13. Replace the well cap.

14. Log all samples in the site logbook and on the chain-of-custody form and label all samples in accordance with SOP 6.1 (Documentation).

15. Package samples and complete necessary paperwork in accordance with SOP 6.4 (Sampling Handling and Control).

16. Transport samples to decontamination zone for preparation for transport to analytical laboratory.

4.0 CAUTIONS AND INTERFERENCES

Before sampling, monitoring wells shall be allowed to stabilize for a minimum period of 24 hours after development.

The primary goal in performing groundwater sampling is to obtain a representative sample of the groundwater body. Analysis can be compromised by field personnel in two primary ways: (1) taking an unrepresentative sample, or (2) by incorrect handling of the sample. There are numerous ways of introducing foreign contaminants into a sample, and these must be avoided by following strict sampling procedures and utilizing trained field personnel. While laboratory methods have become extremely sensitive, well controlled and quality assured, they cannot compensate for a poorly collected sample. The collection of a sample should be as sensitive, highly developed and quality assured as the analytical procedures.

Sample withdrawal methods require the use of pumps, compressed air, bailers, and samplers. Ideally, sample withdrawal equipment should be completely inert, economical to manufacture, easily cleaned, sterilized, reusable, able to operate at remote sites in the absence of power sources, and capable of delivering variable rates for sample collection. Wells should be sampled as soon as possible after purging (certainly no more than 24 hours) and should be sampled in order from least contaminated to most contaminated or from upgradient to downgradient if chemistry is unknown. Water levels shall be allowed to recover to 90% of the static water level before sampling. All non-dedicated equipment shall be decontaminated in accordance with SOP 1.5 (Decontamination) prior to use or upon completion of the sampling activities.

1.0 METHOD SUMMARY

Most hazardous waste site investigations utilize some form of a groundwater sampling or monitoring program to fully characterize the nature and extent of groundwater contamination. In order to obtain a representative groundwater sample for chemical analysis it is important to remove stagnant water in the borehole or pump tubing before collection of the sample. This may be achieved using a variety of instruments including pumps and bailers. Once purging is completed and the correct laboratory-cleaned sample containers have been prepared, sampling may proceed. Sampling may be conducted with any of the above instruments, and need not be the same as the device used for purging. During sampling, a field data sheet should be completed, a chain of custody form prepared, and all pertinent data recorded in the site logbook. This SOP describes the procedures used for sampling a monitoring well with a pump.

2.0 EQUIPMENT/APPARATUS/REAGENTS

The following is a typical equipment list used for sampling groundwater monitoring wells using a pump.

2.1 Equipment List

- Field data sheets and sample jar labels
- Chain-of-custody forms/Custody seals
- Sample containers
- Knife or scissors
- 5-gallon buckets
- Plastic sheeting
- Shipping containers
- Packing materials
- Ziploc-type plastic bags
- Field parameter instruments (pH meter, thermometer, conductivity meter, turbidimeter, DO meter)
- Calibration standards
- Non-phosphate soap (Note: Alconox is not considered a non-phosphate soap; rather a low-phosphate soap)
- Generator, if using pump
- Air compressor for bladder pumps
- Pump
- Gasoline for generator
- Discharge tubing for pump
- Control box (if necessary)
- Appropriate pump fittings (e.g., hose clamps, barbed fittings, etc.)
- Appropriate PPE

3.0 PROCEDURES

This section outlines the procedures for collecting representative groundwater samples using the following steps: Each step in the procedure is covered in a separate SOP. The reference SOP is in parenthesis.

1. Refer to SOP 6.1 (Documentation), 6.3 (Collection of VOCs), 6.4 (Sample Handling and Control), and 6.5 (Collection of QC Samples).
2. Water level/sediment measurement will be taken in accordance with SOP 7.1 (Water Level Measurement)
3. Measurement of field parameters will be done in accordance with SOP 7.5 (Measurements of Monitor Well Field Parameters).
4. Purging will be done in accordance with SOP 7.2 (Purging a Monitoring Well with a Bailer) or SOP 7.3 (Purging a Monitoring Well with a Pump).
5. Allow well to recharge after purging to 90% of the static water level.
6. Assemble and label the appropriate bottles.
7. Set the pump height so that the intake is near the center of the screened interval.
8. Adjust the flow rate of the pump to minimize aeration and bubble formation. A flow rate of <0.5 L/min is typically appropriate. The pump discharge should produce a thin, continuous stream of water when filling the sample container.
9. Begin using the pump to fill the appropriate container. Samples should be collected in the following order:
   - Volatile organic compounds (VOCs)
   - Semi-volatile organic compounds (SVOCs); including polyaromatic hydrocarbons (PAHs)
   - Inorganic constituents (metals)
   - Mercury
   - Cyanide
   - Total organic carbon (TOC)
   - Total organic halogen (TOX)
   - Samples requiring field filtration
   - Samples for field parameter measurement
   - Samples for nutrient anion determinations
10. Filter and preserve samples as required by sampling plan.
11. Cap the sample container tightly and place pre-labeled sample container in a pre-chilled cooler.
12. Replace the well cap.

13. Log all samples in the site logbook and on the chain-of-custody form and label all samples in accordance with SOP 6.1 (Documentation).

14. Package samples and complete necessary paperwork in accordance with 6.4 (Sample Handling and Control).

15. Transport sample to decontamination zone for preparation for transport to analytical laboratory.

4.0 CAUTIONS AND INTERFERENCES

Before sampling, monitoring wells shall be allowed to stabilize for a minimum period of 24 hours after development.

The primary goal in performing groundwater sampling is to obtain a representative sample of the groundwater body. Analysis can be compromised by field personnel in two primary ways: (1) taking an unrepresentative sample, or (2) by incorrect handling of the sample. There are numerous ways of introducing foreign contaminants into a sample, and these must be avoided by following strict sampling procedures and utilizing trained field personnel. While laboratory methods have become extremely sensitive, well controlled and quality assured, they cannot compensate for a poorly collected sample. The collection of a sample should be as sensitive, highly developed and quality assured as the analytical procedures.

Sample withdrawal methods require the use of pumps, compressed air, bailers, and samplers. Ideally, sample withdrawal equipment should be completely inert, economical to manufacture, easily cleaned, sterilized, reusable, able to operate at remote sites in the absence of power sources, and capable of delivering variable rates for sample collection. Wells should be sampled as soon as possible after purging (certainly no more than 24 hours) and should be sampled in order from least contaminated to most contaminated or from upgradient to downgradient if chemistry is unknown. Water levels shall be allowed to recover to 90% of the static water level before sampling. All non-dedicated equipment shall be decontaminated in accordance with SOP 1.5 (Decontamination) prior to use or upon completion of the sampling activities.

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STANDARD OPERATING PROCEDURE NO. 7.8 GROUNDWATER SAMPLING USING A LOW-FLOW TECHNIQUES

1.0 METHOD SUMMARY

Most hazardous waste site investigations utilize some form of a groundwater sampling or monitoring program to fully characterize the nature and extent of groundwater contamination. In order to obtain a representative groundwater sample for chemical analysis it is important to remove stagnant water in the borehole or pump tubing before collection of the sample. This may be achieved using a variety of instruments including pumps and bailers. Once purging is completed and the correct laboratory-cleaned sample containers have been prepared, sampling may proceed. Sampling may be conducted with any of the above instruments, and need not be the same as the device used for purging. During sampling, a field data sheet should be completed, a chain of custody form prepared, and all pertinent data recorded in the site logbook. This SOP describes the procedures for sampling a monitoring well using low-flow techniques. Low-flow methods are typically used in conjunction with micropurging (See SOP 7.4).

2.0 EQUIPMENT/APPARATUS/REAGENTS

The following is a typical equipment list used for sampling groundwater monitoring wells using a pump.

2.1 Equipment List

- Field data sheets and sample jar labels
- Chain-of-custody forms/Custody seals
- Sample containers
- Knife or scissors
- 5-gallon buckets
- Plastic sheeting
- Shipping containers
- Packing materials
- Ziploc-type plastic bags
- Field parameter instruments (pH meter, thermometer, conductivity meter, turbidimeter, DO meter)
- Calibration standards
- Non-phosphate soap (Note: Alconox is not considered a non-phosphate soap; rather a low-phosphate soap)
- Generator, if using pump
- Air compressor for bladder pumps
- Pump
- Gasoline for generator
- Discharge tubing for pump
- Control box (if necessary)
- Appropriate pump fittings (e.g., hose clamps, barbed fittings, etc.)
- Appropriate PPE

3.0 PROCEDURES

This section outlines the procedures for collecting representative groundwater samples using the following steps: Each step in the procedure is covered in a separate SOP. The reference SOP is in parenthesis.

STANDARD OPERATING PROCEDURE NO. 7.8 GROUNDWATER SAMPLING USING A LOW-FLOW TECHNIQUES

Low-flow sampling procedures should be used whenever pumps are used for groundwater sampling. These procedures should be used in conjunction with micropurging techniques.

1. Prepare for sampling using: SOP 6.1 (Documentation), 6.3 (Collection of VOCs), 6.4 (Sample Handling and Control), and 6.5 (Collection of QC Samples).
2. Water level/sediment measurements will be taken in accordance with SOP 7.1 (Water Level Measurement)
3. Measurement of field parameters will be done in accordance with SOP 7.5 (Measurements of Monitoring Well Field Parameters).
4. Purging will be done in accordance with SOP 7.4 (Micro Purging).
5. Allow well to recharge after purging to 90% of the static water level.
6. Disconnect flow-through cells.
7. Assemble and label the appropriate bottles.
8. Set the pump height so that the intake is near the center of the screened interval.
9. Adjust the flow rate of the pump to minimize aeration and bubble formation. A flow rate of <0.5 L/min is typically appropriate. The pump discharge should produce a thin, continuous stream of water when filling the sample container.
10. Begin using the pump to fill the appropriate container. Samples should be collected in the following order:
    - Volatile organic compounds (VOCs)
    - Semi-volatile organic compounds (SVOCs); including polyaromatic hydrocarbons (PAHs)
    - Inorganic constituents (metals)
    - Mercury
    - Cyanide
    - Total organic carbon (TOC)
    - Total organic halogen (TOX)
    - Samples requiring field filtration
    - Samples for field parameter measurement
    - Samples for nutrient anion determinations
11. Filter and preserve samples as required by sampling plan.

12. Cap the sample container tightly and place pre-labeled sample container in a pre-chilled cooler.

13. Replace the well cap.

14. Log all samples in the site logbook and on the chain-of-custody form and label all samples in accordance with SOP 6.1 (Documentation).

15. Package samples and complete necessary paperwork in accordance with SOP 6.4 (Sample Handling and Control).

16. Transport sample to decontamination zone for preparation for transport to analytical laboratory.

4.0 CAUTIONS AND INTERFERENCES

Before sampling, monitoring wells shall be allowed to stabilize for a minimum period of 24 hours after development.

The primary goal in performing groundwater sampling is to obtain a representative sample of the groundwater body. Analysis can be compromised by field personnel in two primary ways: (1) taking an unrepresentative sample, or (2) by incorrect handling of the sample. There are numerous ways of introducing foreign contaminants into a sample, and these must be avoided by following strict sampling procedures and utilizing trained field personnel. While laboratory methods have become extremely sensitive, well controlled and quality assured, they cannot compensate for a poorly collected sample. The collection of a sample should be as sensitive, highly developed and quality assured as the analytical procedures.

Sample withdrawal methods require the use of pumps, compressed air, bailers, and samplers. Ideally, sample withdrawal equipment should be completely inert, economical to manufacture, easily cleaned, sterilized, reusable, able to operate at remote sites in the absence of power sources, and capable of delivering variable rates for sample collection. Wells should be sampled as soon as possible after purging (certainly no more than 24 hours) and should be sampled in order from least contaminated to most contaminated or from upgradient to downgradient if chemistry is unknown. Water levels shall be allowed to recover to 90% of the static water level before sampling. All non-dedicated equipment shall be decontaminated in accordance with SOP 1.5 (Decontamination) prior to use or upon completion of the sampling activities.

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STANDARD OPERATING PROCEDURE NO. 8.1 SURFACE WATER SAMPLING USING THE DIRECT METHOD

1.0 METHOD SUMMARY

This SOP is applicable to the collection of representative liquid samples, both aqueous and non-aqueous, from streams, rivers, lakes, ponds, lagoons, and surface impoundments. It includes samples collected from depth, as well as samples collected from the surface. For streams, rivers, lakes, and other surface waters, the direct method may be utilized to collect water samples from the surface directly into the sample bottle.

2.0 EQUIPMENT/APPARATUS/REAGENTS

Equipment needed for collection of surface water samples using the direct method:

- Line and messengers
- Sample bottles (volumes and preservatives based on analysis)
- Ziploc® bags
- Ice
- Coolers
- Chain of Custody records, custody seals
- Field data sheets
- Decontamination equipment
- Maps/plot plan
- Safety equipment
- Compass
- Tape measure
- Survey stakes, flags, or buoys and anchors
- Camera and film
- Logbook/waterproof pen
- Scoops
- Non-preserved sample containers
- Peristaltic pumps
- Teflon bailers
- Buckets

Reagents will be utilized for preservation of samples and for decontamination of sampling equipment. The preservatives required are specified by the analysis to be performed. These sampling techniques will allow for the collection of representative samples from the majority of surface waters and impoundments encountered.

3.0 PROCEDURES

3.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed.
2. Obtain the necessary sampling and monitoring equipment.
3. Decontaminate or pre-clean equipment, and ensure that it is in working order.
4. Prepare scheduling and coordinate with staff, clients, and regulatory agency, if appropriate.

5. Perform a general site survey prior to site entry, in accordance with the site specific Health and Safety Plan.

6. Use stakes, flagging, or buoys to identify and mark all sampling locations. If required the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions. If collecting sediment samples, this procedure may disturb the bottom.

Water quality data should be collected in impoundments and other locations required by the sampling plan, and to determine if stratification is present. Measurements of dissolved oxygen, pH, and temperature can indicate if strata exist which would affect analytical results. Measurements should be collected at one-meter intervals from the substrate to the surface using the appropriate instrument (i.e., a Hydrolab or equivalent).

3.2 Representative Sampling Considerations

In order to collect a representative sample, the hydrology and morphometrics of a stream or impoundment should be determined prior to sampling. This will aid in determining the presence of phases or layers in lagoons, or impoundments, flow patterns in streams, and appropriate sample locations and depths.
Generally, the deciding factors in the selection of a sampling device for sampling liquids in streams, rivers, lakes, ponds, lagoons, and surface impoundments are:

1. Will the sample be collected from shore or from a boat?
2. What is the desired depth at which you wish to collect the sample?
3. What is the overall depth and flow direction of river or stream?
4. What type of sample will be collected (i.e., water or lagoon liquids)?

3.2.1 Sampler Composition

The appropriate sampling device must be of a proper composition. Selection of samplers constructed of glass, stainless steel, PVC or PFTE (Teflon) should be based upon the analyses to be performed.

3.3 Sample Collection

This method is not to be used when contact with high concentrations of contaminants is a concern. Using adequate protective clothing, access the sampling station by appropriate means. When using the direct method, do not use pre-preserved sample bottles as the collection method may dilute the concentration of preservative necessary for proper sample preservation.

1. Collect water quality parameters in accordance with SOP 7.5 (Measurement of Monitoring Well Field Parameters).
2. For shallow stream stations, collect the sample under the water surface while pointing the sample container upstream; the container must be upstream of the collector. Avoid disturbing the substrate. For lakes and other impoundments, collect the sample under the water surface avoiding surface debris and the boat wake.
3. Transfer the sample(s) into suitable, labeled sample containers.

5. Preserve the sample if appropriate, or use pre-preserved sample bottles. Do not overfill bottles if they are pre-preserved.
6. Cap the container, place in a Ziploc® plastic bag and cool to 4ºC.
7. Record all pertinent data in the site logbook and on field data sheets in accordance with SOP 6.1 (Documentation).
8. Complete the Chain of Custody record in accordance with SOP 6.5 (Sampling Handling and Control).
9. Attach custody seals to cooler prior to shipment in accordance with SOP 6.4 (Sampling Handling and Control).
10. Decontaminate all sampling equipment prior to the collection of additional samples with that sampling device in accordance with SOP 1.5 (Decontamination).

4.0 CAUTIONS AND INTERFERENCES

There are two primary interferences or potential problems with surface water sampling. These include cross contamination of samples and improper sample collection.

1. Cross contamination problems can be eliminated or minimized through the use of dedicated sampling equipment. If this is not possible or practical, then decontamination of sampling equipment is necessary. Refer to the Sampling Equipment Decontamination SOP 1.5.
2. Improper sample collection can involve using contaminated equipment, disturbance of the stream or impoundment substrate, and sampling in an obviously disturbed area. Following proper decontamination procedures and minimizing disturbance of the sample site will eliminate these problems.

Bottles can also be used for sample collection. For sample below water surface place hand over the opening and drop the bottle below the surface to the desired depth then remove hand from the opening.

STANDARD OPERATING PROCEDURE NO. 8.2
SURFACE WATER SAMPLING USING A KEMMERER BOTTLE

1.0 METHOD SUMMARY

This SOP is applicable to the collection of representative liquid samples, both aqueous and non-aqueous, from streams, rivers, lakes, ponds, lagoons, and surface impoundments using a Kemmerer bottle. A Kemmerer bottle is a water sampling device used to sample discrete depths. It includes samples collected from depth, as well as samples collected from the surface.

2.0 EQUIPMENT/APPARATUS/REAGENTS

Equipment needed for collection of surface water samples using the direct method:

- Line and messengers
- Sample bottles/preservatives
- Ziploc-type bags
- Ice
- Coolers
- Chain of Custody records, custody seals
- Field data sheets
- Decontamination equipment
- Maps/plot plan
- Safety equipment
- Tape measure
- Survey stakes, flags, or buoys and anchors
- Camera and film
- Logbook/waterproof pen
- Kemmerer bottle

Reagents will be utilized for preservation of samples and for decontamination of sampling equipment. The preservatives required are specified by the analysis to be performed.

3.0 PROCEDURES

These sampling techniques will allow for the collection of representative samples from the majority of surface waters and impoundments encountered.

3.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed.
2. Obtain the necessary sampling and monitoring equipment.
3. Prepare scheduling and coordinate with staff, clients, and regulatory agency, if appropriate.
4. Perform a general site survey prior to site entry, in accordance with the site specific Health and Safety Plan.

5. Use stakes, flagging, or buoys to identify and mark all sampling locations. If required the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions. If collecting sediment samples, this procedure may disturb the bottom.

Water quality data should be collected in impoundments and other location required by the sampling plan, and to determine if stratification is present. Measurements of dissolved oxygen, pH, and temperature can indicate if strata exist which would effect analytical results. Measurements should be collected at one-meter intervals from the substrate to the surface using the appropriate instrument (i.e., a Hydrolab or equivalent) in accordance with SOP 7.5 (Measurement of Monitor Well Field Parameters).

3.2 Representative Sampling Considerations

In order to collect a representative sample, the hydrology and morphometrics of a stream or impoundment should be determined prior to sampling. This will aid in determining the presence of phases or layers in lagoons, or impoundments, flow patterns in streams, and appropriate sample locations and depths.

Generally, the deciding factors in the selection of a sampling device for sampling liquids in streams, rivers, lakes, ponds, lagoons, and surface impoundments are:

1. Will the sample be collected from shore or from a boat?
2. What is the desired depth at which you wish to collect the sample?
3. What is the overall depth and flow direction of river or stream?
4. What type of sample will be collected (i.e., water or lagoon liquids)?

3.2.1 Sampler Composition

The appropriate sampling device must be of a proper composition. Selection of samplers constructed of glass, stainless steel, PVC or PFTE (Teflon) should be based upon the analyses to be performed.

3.3 Sample Collection

A Kemmerer bottle (Appendix A) may be used in most situations where site access is from a boat or structure such as a bridge or pier, and where samples at depth are required. the direct method may be utilized to collect water samples from the surface directly into the sample bottle.

1. Collect water quality parameters in accordance with SOP 7.5 (Measurement of Monitoring Well Field Parameters).
2. Use a properly decontaminated Kemmerer bottle. Set the sampling device so that the sampling end pieces (upper and lower stoppers) are pulled away from the sampling tube (body), allowing the substance to be sampled to pass through this tube.
3. Lower the pre-set sampling device to the predetermined depth. Avoid bottom disturbance.

4. When the Kemmerer bottle is at the required depth, send down the messenger, closing the sampling device.

5. Retrieve the sampler and discharge from the bottom drain the first 10-20 ml to clear any potential contamination of the valve. Transfer the sample(s) into suitable, labeled sample containers.

6. Preserve the sample if appropriate, or use pre-preserved sample bottles. Do not overfill bottles if they are pre-preserved.

7. Cap the container, place in a Ziploc-type plastic bag and cool to 4ºC in accordance with SOP 6.4 (Sampling Handling and Control).

8. Record all pertinent data in the site logbook and on field data sheets in accordance with SOP 6.1 (Documentation).

9. Complete the Chain of Custody record in accordance with SOP 6.4 (Sampling Handling and Control).

10. Attach custody seals to cooler prior to shipment in accordance with SOP 6.4 (Sampling Handling and Control).

11. Decontaminate all sampling equipment prior to the collection of additional samples with that sampling device in accordance with SOP 1.5 (Decontamination).

4.0 CAUTIONS AND INTERFERENCES

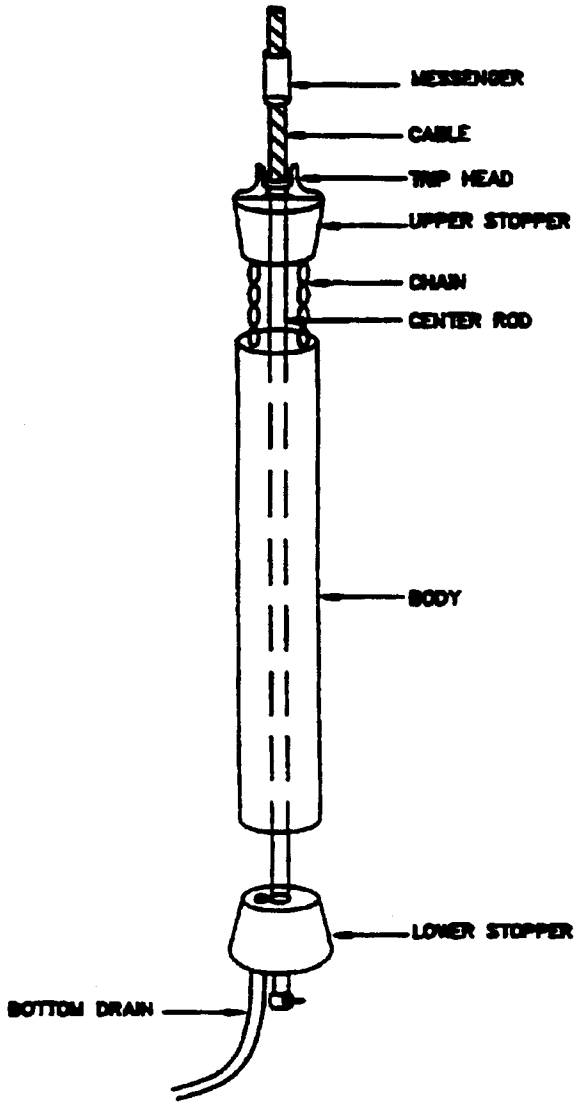
There are two primary interferences or potential problems with surface water sampling. These include cross contamination of samples and improper sample collection.

1. Cross contamination problems can be eliminated or minimized through the use of dedicated sampling equipment. If this is not possible or practical, then decontamination of sampling equipment is necessary. Refer to the SOP 1.5 (Decontamination).

2. Improper sample collection can involve using contaminated equipment, disturbance of the stream or impoundment substrate, and sampling in an obviously disturbed area. Following proper decontamination procedures and minimizing disturbance of the sample site will eliminate these problems.

APPENDIX A

Kemmerer Sampler



STANDARD OPERATING PROCEDURE NO. 8.3
SURFACE WATER SAMPLING USING A DIP SAMPLER

1.0 METHOD SUMMARY

This SOP describes the procedures for collecting surface water samples using a dip sampler. A dip sampler (Appendix A) is useful in situations where a sample is to be recovered from an outfall pipe or along a lagoon bank where direct access is limited. The long handle on such a device allows access from a discrete location.

2.0 EQUIPMENT/APPARATUS/REAGENTS

Equipment needed for collection of surface water samples using the direct method:

- Sample bottles (volumes and preservatives based on analysis)
- Ziploc-type bags
- Ice
- Coolers
- Chain of Custody records, custody seals
- Field data sheets
- Decontamination equipment
- Maps/plot plan
- Safety equipment
- Tape measure
- Survey stakes, flags, or buoys and anchors
- Camera and film
- Logbook/waterproof pen
- Dip sampler

Reagents will be utilized for preservation of samples and for decontamination of sampling equipment. The preservatives required are specified by the analysis to be performed.

3.0 PROCEDURES

These sampling techniques will allow for the collection of representative samples from the majority of surface waters and impoundments encountered.

3.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed.
2. Obtain the necessary sampling and monitoring equipment.
3. Prepare scheduling and coordinate with staff, clients, and regulatory agency, if appropriate.
4. Perform a general site survey prior to site entry, in accordance with the site specific Health and Safety Plan.
5. Use stakes, flagging, or buoys to identify and mark all sampling locations. If required the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions. If collecting sediment samples, this procedure may disturb the bottom.

Water quality data should be collected in impoundments and other location required by the sampling plan, and to determine if stratification is present. Measurements of dissolved oxygen, pH, and temperature can indicate if strata exist which would effect analytical results. Measurements should be collected at one-meter intervals from the substrate to the surface using the appropriate instrument (i.e., a Hydrolab or equivalent).

3.2 Representative Sampling Considerations

In order to collect a representative sample, the hydrology and morphometrics ( ) of a stream or impoundment should be determined prior to sampling. This will aid in determining the presence of phases or layers in lagoons, or impoundments, flow patterns in streams, and appropriate sample locations and depths.

Generally, the deciding factors in the selection of a sampling device for sampling liquids in streams, rivers, lakes, ponds, lagoons, and surface impoundments are:

1. Will the sample be collected from shore or from a boat?
2. What is the desired depth at which you wish to collect the sample?
3. What is the overall depth and flow direction of river or stream?
4. What type of sample will be collected (i.e., water or lagoon liquids)?

3.2.1 Sampler Composition

The appropriate sampling device must be of a proper composition. Selection of samplers constructed of glass, stainless steel, PVC or PFTE (Teflon) should be based upon the analyses to be performed.

3.3 Sample Collection

Sampling procedures are as follows:

1. Collect water quality parameters in accordance with SOP 7.5 (Measurement of Monitoring Well Field Parameters).
2. Assemble the device in accordance with the manufacturer's instructions. Sampler may be a beaker of suitable material attached to an extension pole.
3. Properly decontaminate the sampler in accordance with SOP 1.5 (Decontamination) before the start of sampling activities.
4. Extend the device to the sample location and collect the sample by dipping the sampler into the substance.
5. Retrieve the sampler and transfer the sample to the appropriate sample container.
6. Cap the container, place in a Ziploc® plastic bag and cool to 4ºC in accordance with SOP 6.4 (Sampling Handling and Control).

7. Record all pertinent data in the site logbook and on field data sheets in accordance with SOP 6.1 (Documentation).

8. Complete the Chain of Custody record in accordance with SOP 6.4 (Sampling Handling and Control).

9. Attach custody seals to cooler prior to shipment in accordance with SOP 6.4 (Sampling Handling and Control).

10. Decontaminate all sampling equipment prior to the collection of additional samples with that sampling device in accordance with SOP 1.5 (Decontamination).

4.0 CAUTIONS AND INTERFERENCES

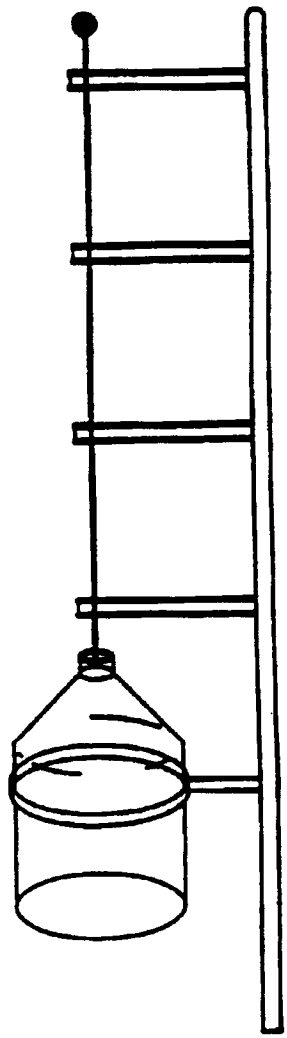
There are two primary interferences or potential problems with surface water sampling. These include cross contamination of samples and improper sample collection.

1. Cross contamination problems can be eliminated or minimized through the use of dedicated sampling equipment. If this is not possible or practical, then decontamination of sampling equipment is necessary. Refer to the SOP 1.5 (Decontamination).

2. Improper sample collection can involve using contaminated equipment, disturbance of the stream or impoundment substrate, and sampling in an obviously disturbed area. Following proper decontamination procedures and minimizing disturbance of the sample site will eliminate these problems.

APPENDIX A

Dip Sampler



STANDARD OPERATING PROCEDURE NO. 8.4
SURFACE WATER SAMPLING USING A PUMP

1.0 METHOD SUMMARY

This SOP is applicable to the collection of representative liquid samples, both aqueous and non-aqueous, from streams, rivers, lakes, ponds, lagoons, and surface impoundments using a peristaltic pump. It includes samples collected from depth, as well as samples collected from the surface.

2.0 EQUIPMENT/APPARATUS/REAGENTS

Equipment needed for collection of surface water samples using the direct method:

- Sample bottles/preservatives
- Ziploc-type bags
- Ice
- Coolers
- Chain of Custody records, custody seals
- Field data sheets
- Decontamination equipment
- Maps/plot plan
- Safety equipment
- Tape measure
- Survey stakes, flags, or buoys and anchors
- Camera and film
- Logbook/waterproof pen
- Peristaltic pump
- Pump tubing and fittings

Reagents will be utilized for preservation of samples and for decontamination of sampling equipment. The preservatives required are specified by the analysis to be performed.

3.0 PROCEDURES

These sampling techniques will allow for the collection of representative samples from the majority of surface waters and impoundments encountered.

3.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed.
2. Obtain the necessary sampling and monitoring equipment.
3. Prepare scheduling and coordinate with staff, clients, and regulatory agency, if appropriate.
4. Perform a general site survey prior to site entry, in accordance with the site specific Health and Safety Plan.
5. Use stakes, flagging, or buoys to identify and mark all sampling locations. If required the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions. If collecting sediment samples, this procedure may disturb the bottom.

Water quality data should be collected in impoundments and other location required by the sampling plan, and to determine if stratification is present. Measurements of dissolved oxygen, pH, and temperature can indicate if strata exist which would effect analytical results. Measurements should be collected at one-meter intervals from the substrate to the surface using the appropriate instrument (i.e., a Hydrolab or equivalent).

3.2 Representative Sampling Considerations

In order to collect a representative sample, the hydrology and morphometrics of a stream or impoundment should be determined prior to sampling. This will aid in determining the presence of phases or layers in lagoons, or impoundments, flow patterns in streams, and appropriate sample locations and depths.

Generally, the deciding factors in the selection of a sampling device for sampling liquids in streams, rivers, lakes, ponds, lagoons, and surface impoundments are:

1. Will the sample be collected from shore or from a boat?
2. What is the desired depth at which you wish to collect the sample?
3. What is the overall depth and flow direction of river or stream?
4. What type of sample will be collected (i.e., water or lagoon liquids)?

3.2.1 Sampler Composition

The appropriate sampling device must be of a proper composition. Selection of samplers constructed of glass, stainless steel, PVC or PFTE (Teflon) should be based upon the analyses to be performed.

3.3 Sample Collection

A peristaltic pump may be used in most situations where site access is from a boat, samples from a certain depth, or a sweep of the width of narrow streams is required.

1. Collect water quality parameters in accordance with SOP 7.5 (Measurement of Monitoring Well Field Parameters).
2. Install clean medical-grade silicone tubing in the pump head, as per the manufacturing instructions. Allow sufficient tubing on the discharge side of the pump for filling sample containers but only enough on the suction side for attachment to the intake line.
3. Select the length of suction intake tubing necessary to reach the required depth and attach the tubing to intake side of the pump.
4. Position the suction intake tube to the required depth and begin pumping at a slow flow rate to minimize material agitation.
5. Fill the appropriate sample bottles by allowing pump discharge to flow gently down the side of the bottle with minimal entry turbulence.

6. Preserve the sample if appropriate, or use pre-preserved sample bottles. Do not overfill bottles if they are pre-preserved.

7. Cap the container, place in a Ziploc® plastic bag and cool to 4°C in accordance with SOP 6.4 (Sampling Handling and Control).

8. Record all pertinent data in the site logbook and on field data sheets in accordance with SOP 6.1 (Documentation).

9. Complete the Chain of Custody record in accordance with SOP 6.4 (Sampling Handling and Control).

10. Attach custody seals to cooler prior to shipment in accordance with SOP 6.4 (Sampling Handling and Control).

11. Change both the pump tubing and the suction intake tubing prior to the collection of additional samples.

4.0 CAUTIONS AND INTERFERENCES

There are two primary interferences or potential problems with surface water sampling. These include cross contamination of samples and improper sample collection

1. Cross contamination problems can be eliminated or minimized through the use of dedicated sampling equipment. If this is not possible or practical, then decontamination of sampling equipment is necessary. Refer to the SOP 1.5 (Decontamination).

2. Improper sample collection can involve using contaminated equipment, disturbance of the stream or impoundment substrate, and sampling in an obviously disturbed area. Following proper decontamination procedures and minimizing disturbance of the sample site will eliminate these problems.

STANDARD OPERATING PROCEDURE NO. 8.5
SURFACE WATER SAMPLING USING A BOMB SAMPLER

1.0 METHOD SUMMARY

This SOP is applicable to the collection of representative liquid samples, aqueous and non-aqueous, from streams, rivers, lakes, ponds, lagoons, and surface impoundments using a bomb sampler. It includes samples collected from depth, as well as samples collected from the surface. A Bomb sampler is a water sampling device used to sample discrete depths. The sampler (Appendix A) may be used in most situations where site access is from a boat or structure such as a bridge or pier, and where samples at depth are required.

2.0 EQUIPMENT/APPARATUS/REAGENTS

Equipment needed for collection of surface water samples using the direct method:

- Sample bottles/preservatives
- Ziploc-type bags
- Ice
- Coolers
- Chain of Custody records, custody seals
- Field data sheets
- Decontamination equipment
- Maps/plot plan
- Safety equipment
- Tape measure
- Survey flags, or buoys and anchors
- Camera and film
- Logbook/waterproof pen
- Bomb Sampler

Reagents will be utilized for preservation of samples and for decontamination of sampling equipment. The preservatives required are specified by the analysis to be performed.

3.0 PROCEDURES

These sampling techniques will allow for the collection of representative samples from the majority of surface waters and impoundments encountered.

3.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed.
2. Obtain the necessary sampling and monitoring equipment.
3. Prepare scheduling and coordinate with staff, clients, and regulatory agency, if appropriate.
4. Perform a general site survey prior to site entry, in accordance with the site specific Health and Safety Plan.

5. Use stakes, flagging, or buoys to identify and mark all sampling locations. If required the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions. If collecting sediment samples, this procedure may disturb the bottom.

Water quality data should be collected in impoundments and other location required by the sampling plan, and to determine if stratification is present. Measurements of dissolved oxygen, pH, and temperature can indicate if strata exist which would effect analytical results. Measurements should be collected at one-meter intervals from the substrate to the surface using the appropriate instrument (i.e., a Hydrolab or equivalent).

3.2 Representative Sampling Considerations

In order to collect a representative sample, the hydrology and morphometrics ( ) of a stream or impoundment should be determined prior to sampling. This will aid in determining the presence of phases or layers in lagoons, or impoundments, flow patterns in streams, and appropriate sample locations and depths.

Generally, the deciding factors in the selection of a sampling device for sampling liquids in streams, rivers, lakes, ponds, lagoons, and surface impoundments are:

1. Will the sample be collected from shore or from a boat?
2. What is the desired depth at which you wish to collect the sample?
3. What is the overall depth and flow direction of river or stream?
4. What type of sample will be collected (i.e., water or lagoon liquids)?

3.2.1 Sampler Composition

The appropriate sampling device must be of a proper composition. Selection of samplers constructed of glass, stainless steel, PVC or PFTE (Teflon) should be based upon the analyses to be performed.

3.3 Sample Collection

A bomb sampler (Appendix A) may be used in most situations where site access is from a boat or structure such as a bridge or pier, and where samples at depth are required.

1. Collect water quality parameters in accordance with SOP 7.5 (Measurement of Monitoring Well Field Parameters).
2. Properly decontaminate the bomb sampler in accordance with SOP 1.5 (Decontamination) before the start of sampling activities.
3. Lower the bomb sampler carefully to the desired depth, allowing the line for the trigger to remain slack at all times. Avoid bottom disturbance. When the desired depth is reached, pull the trigger line until taut. This will allow the sampler to fill.

4. Retrieve the sampler and discharge from the bottom drain the first 10-20 ml to clear any potential contamination of the valve. Transfer the sample(s) into suitable, labeled sample containers.

5. Preserve the sample if appropriate, or use pre-preserved sample bottles. Do not overfill bottles if they are pre-preserved.

6. Cap the container, place in a Ziploc-type plastic bag and cool to 4ºC in accordance with SOP 6.4 (Sampling Handling and Control).

7. Record all pertinent data in the site logbook and on field data sheets in accordance with SOP 6.1 (Documentation).

8. Complete the Chain of Custody record in accordance with SOP 6.4 (Sampling Handling and Control).

9. Attach custody seals to cooler prior to shipment in accordance with SOP 6.4 (Sampling Handling and Control).

10. Decontaminate all sampling equipment prior to the collection of additional samples with that sampling device in accordance with SOP 1.5 (Decontamination).

4.0 CAUTIONS AND INTERFERENCES

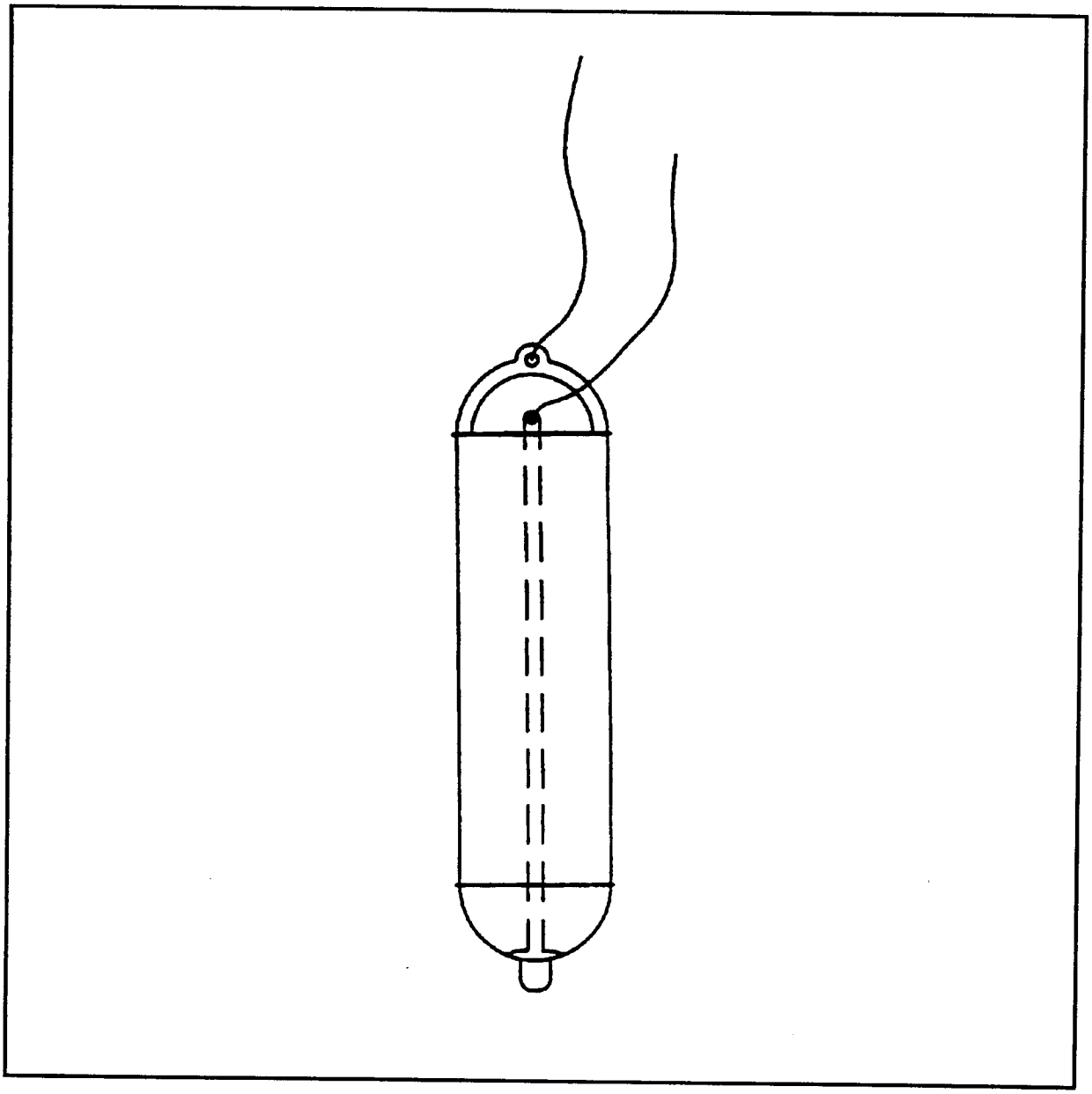
There are two primary interferences or potential problems with surface water sampling. These include cross contamination of samples and improper sample collection.

1. Cross contamination problems can be eliminated or minimized through the use of dedicated sampling equipment. If this is not possible or practical, then decontamination of sampling equipment is necessary. Refer to the SOP 1.5 (Decontamination).

2. Improper sample collection can involve using contaminated equipment, disturbance of the stream or impoundment substrate, and sampling in an obviously disturbed area. Following proper decontamination procedures and minimizing disturbance of the sample site will eliminate these problems.

APPENDIX A

Bomb Sampler



STANDARD OPERATING PROCEDURE NO. 9.1
SEDIMENT SAMPLING
[*Incorporates former SOPs 9.2, 9.3 and 9.4*]

1.0 METHOD SUMMARY

The objective of this standard operating procedure (SOP) is to provide guidance for sampling sediment using various gear types including; scoops or trowels, dredges and corers. The methodologies discussed in this SOP are applicable to the sampling of sediment in both flowing and standing water. Analysis of sediment may be biological, chemical, or physical in nature and may be used to determine the following:

- toxicity;
- biological availability and effects of contaminants;
- benthic biota;
- extent and magnitude of contamination;
- contaminant migration pathways and source;
- fate of contaminants;
- grain size distribution, and
- pore water concentrations.

Sediment samples may be collected using a variety of methods and equipment, depending on the depth of the aqueous layer, the portion of the sediment profile required (surface vs. subsurface), the type of sample required (disturbed vs. undisturbed), contaminants present, and sediment type. Sampling techniques and equipment are designed to minimize effects on the chemical and physical integrity of the sample.

Chemical preservation of solids is not to be used unless specifically detailed in the Sampling Plan. Cooling to 4ºC is usually the best approach, supplemented by the appropriate holding time for the analyses requested.

Sampling devices should be cleaned in the field using the decontamination procedure described in SOP 1.5 (Sampling Equipment Decontamination).

2.0 EQUIPMENT/APPARATUS/REAGENTS

In addition to the specific sediment sampling gear employed (see Sections 3.2.1 through 3.2.5), the following is a typical equipment list for sediment sampling:

- Maps/plot plan
- Safety equipment
- Compass
- Tape measure
- Survey stakes, flags, or buoys and anchors
- Camera and film
- Stainless steel or plastic bucket
- 4-oz.(120 ml), 8-oz.(240 ml), and one-quart wide mouth jars w/Teflon lined lids
- Ziploc-type plastic bags
- Logbook
- Sample jar labels
- Chain of Custody records, field data sheets
- Cooler(s)
- Ice
- Decontamination supplies/equipment
- Spade or shovel
- Spatula

3.0 PROCEDURES

3.1 Preparation

1. Determine the objective(s) and extent of the sampling effort. The sampling methods to be employed, and the types and amounts of equipment and supplies required will be a function of site characteristics and objectives of the study (see Section 3.2 below). Each physicochemical and biological test requires a specific amount of sediment which, for chemical analyses, depends on the detection limits attainable and extraction efficiency by the procedure and, for biological testing, depends on the test organisms and test method.

2. Obtain the necessary sampling and monitoring equipment.

3. Prepare schedules and coordinate with staff, client, and regulatory agencies, as appropriate.

4. Decontaminate or pre-clean equipment, and ensure that it is in working order.

5. Perform a general site survey prior to site entry in accordance with the site specific Health and Safety Plan.

Recommended Sediment Volumes

Analysis	Volume
Inorganics	90 mL
Non-petroleum Organics	230 mL
Particle Size	300 mL
Petroleum Organics	250 -1000 mL
Toxicity Tests	1- 2 L
Bioaccumulation Tests	15 L
Benthic Macroinvertebrates	8 - 16 L
Pore Water	2 L
TOC, Moisture, etc.	300 mL

6. Use stakes, flagging, or buoys to identify and mark all sampling locations. Specific site factors including flow regime, basin morphometry, sediment characteristics, depth of overlying aqueous layer, contaminant source, and extent and nature of contamination should be considered when selecting sample locations and equipment.

7. Location of sediment depositional zones can be important in defining sub-areas for sampling or for stratifying sampling at some locations (see Section 4.0 below).

3.2 Sample Strategy

Selection of a sampling device is most often contingent upon: (1) the depth of water at the sampling location, (2) the physical characteristics of the sediment to be sampled, and (3) the volume of sediment required for proposed testing.

3.2.1 Trowel (and similar devices)

Collection of surface sediment from beneath a shallow aqueous layer can be accomplished with tools such as spades, shovels, trowels, and scoops. Although this method can be used to collect both consolidated or unconsolidated sediment, it is limited somewhat by the depth and movement of the water layer. Deep and rapidly flowing water render this method less accurate than other methods. However, representative samples can be collected with this procedure in shallow sluggish water provided care is demonstrated by the sampling team. A stainless steel or plastic sampling implement will suffice in most applications. Care should be exercised

to avoid the use of devices plated with chrome or other materials; plating is particularly common with garden trowels. The following procedure shall be used to collect sediment with a scoop, shovel, or trowel:

1. Using a decontaminated sampling implement, remove the desired thickness and volume of sediment from the sampling area.
2. Sediment is transferred directly from the sampling device to a labeled sample or homogenization container(s) (see SOP 6.2). of appropriate size and construction for the analyses requested. Ensure that non-dedicated containers have been properly decontaminated (see SOP 1.5). Transfer is accomplished with a stainless steel or plastic lab spoon or equivalent.
3. Surface water should be decanted from the sample or homogenization container prior to sealing or transfer; care should be taken to retain the fine sediment fraction during this procedure.
4. Place the sample in the sampling container. Be sure to fill the container to the top.
5. Label the container with the sample identification number, site name, sample point number, date and time sampled, and the samplers initials. Complete and sign the chain of custody form(s).
6. Place the sample in a cooler with ice at 4°C.
7. Ship the samples in the cooler along with the chain of custody form to the laboratory.
8. Decontaminate all equipment prior to moving to the next location (see SOP 1.5).

General Considerations for Selecting Sampling Gear

Use

Trowel if:
- **shallow water**
- **non-flowing**
- **small volume required**

Auger if:
- **consolidated material**
- **shallow water**
- **required depth sought**

Dredge if:
- **deep water**
- **large grain size**
- **large volumes needed**
- **large surface area needed**
- **benthic macroinvertebrates**

Corer if:
- **sediment profile needed**
- **soft, fine grained**
- **reduce O_2 exposure**

3.2.2 Auger

Collection of surface sediment from beneath a shallow aqueous layer can be accomplished with a system consisting of bucket or tube auger, a series of extensions, and a "T" handle (Figure 1, Appendix A). The use of additional extensions in conjunction with a bucket auger can increase the depth of water from which sediment can be collected [e.g., 24 inches to 10 feet or more], however, water clarity must be sufficient to permit the sampler to directly observe the sampling operation. Sample handling and manipulation increases in difficulty with increasing depth of water and plasticity of sediment . For deep samples, the bucket auger is used to bore a hole to the upper range of the desired sampling depth and then withdrawn. The tube auger is then lowered down the borehole, and driven into the sediment to

the lower range of the desired sampling depth. Alternatively the tube auger may be used alone and the desired interval may be extracted from the tube.

The following procedure shall be used to collect shallow sediment samples with a bucket auger or tube auger:

1. An acetate liner may be inserted into the bucket auger or tube auger prior to sampling if characteristics of the sediments or water body warrant. By using this technique, an intact core can be extracted.
2. Attach the auger head to the required length of extensions, then attach the "T" handle to the upper extension.
3. Clear the area to be sampled of any surface debris.
4. Insert the bucket auger or tube auger into the sediment at a 0˚ to 20˚ angle from vertical. This orientation minimizes spillage of the sample from the sampler upon extraction from the sediment and water.
5. Rotate the auger to cut a core of sediment.
6. Slowly withdraw the auger; if using a tube auger, make sure that the slot is facing upward.
7. Sediment is transferred directly from the sampling device to a labeled sample or homogenization container (see SOP 6.2) of appropriate size and construction for the analyses requested. Ensure that non-dedicated containers have been properly decontaminated (see SOP 1.5). Transfer is accomplished with a stainless steel or plastic lab spoon or equivalent.
8. Label the container with the sample identification number, site name, sample point number, date and time sampled, and the samplers initials. Fill out the chain of custody forms.
9. Place the sample in a cooler with ice at 4°C.
10. Ship the samples in the cooler along with the chain of custody forms to the laboratory.

The following procedure shall be used to collect deep sediment samples with a system consisting of a bucket auger and a tube auger:

1. Attach the bucket auger bit to the required lengths of extensions, then attach the "T" handle to the upper extension.
2. Clear the area to be sampled of any surface debris.
3. Begin augering, periodically removing any accumulated sediment (i.e., cuttings) from the auger bucket. Cuttings should be disposed of far enough from the sampling area to minimize cross contamination of various depths.
4. After reaching the upper range of the desired depth, slowly and carefully remove bucket auger from the boring.

5. Attach the tube auger bit to the required lengths of extensions, then attach the "T" handle to the upper extension.

6. Carefully lower tube auger down borehole using care to avoid making contact with the borehole sides and, thus, cross contaminating the sample. Gradually force tube auger into sediment to the lower range of the desired sampling depth. Hammering of the tube auger to facilitate coring should be avoided as the vibrations may cause the boring walls to collapse.

7. Remove tube auger from the borehole, again taking care to avoid making contact with the borehole sides and, thus, cross contaminating the sample.

8. Discard the top of core (approximately 1 inch [2.54 cm]); as this represents material collected by the tube auger before penetration to the layer of concern.

9. Transfer sample into an appropriate sample or homogenization container. Ensure that non-dedicated containers have been adequately decontaminated.

10. Label the container with the sample identification number, site name, sample point number, date and time sampled, and the samplers initials. Fill out the chain of custody forms.

11. Place the sample in a cooler with ice at 4°C.

12. Ship the samples in the cooler along with the chain of custody forms to the laboratory.

13. Decontaminate all equipment prior to moving to the next location (see SOP 1.5).

3.2.3 Ekman Dredge

Collection of the top layer of sediment can be accomplished with a system consisting of a remotely activated device (dredge) and a deployment system. This technique consists of lowering a sampling device (dredge) to the surface of the sediment by use of a rope, cable, or extended handle. The mechanism is activated, and the device entraps sediment in spring loaded or lever operated jaws. An Ekman dredge is a lightweight sediment sampling device with spring activated jaws. It is used to collect moderately consolidated, fine textured sediment. The following procedure shall be used for collecting sediment with an Ekman dredge (Figure 2, Appendix A):

1. Attach a sturdy nylon rope or stainless steel cable through the hole on the top of the bracket, or secure the extension handle to the bracket with machine bolts.

2. Attach springs to both sides of the jaws. Fix the jaws so that they are in open position by placing trip cables over the release studs. Ensure that the hinged doors on the dredge top are free to open.

3. Lower the sampler to a point 4 to 6 inches [10-15 cm] above the sediment surface.

4. Drop the sampler to the sediment.

5. Trigger the jaw release mechanism by lowering a messenger down the line, or by depressing the button on the upper end of the extension handle.

6. Raise the sampler and slowly decant any free liquid through the top of the sampler. Care should be taken to retain the fine sediment fraction during this procedure.

7. Open the dredge jaws and transfer the sample into a stainless steel, plastic or other appropriate composition (e.g., Teflon) containers. Ensure that non-dedicated containers have been adequately decontaminated (SOP 1.5). If necessary, continue to collect additional sediment grabs until sufficient material has been secured to fulfill analytical requirements. Thoroughly homogenize and then transfer sediment to sample containers appropriate for the analyses requested. Samples for volatile organic analysis must be collected directly from the bucket before homogenization to minimize volatilization of contaminants.

8. Label the container with the sample identification number, site name, sample point number, date and time sampled, and the samplers initials. Fill out the chain of custody forms.

9. Place the sample in a cooler with ice at 4°C.

10. Ship the samples in the cooler along with the chain of custody forms to the laboratory.

3.2.4 Ponar Dredge

A Ponar dredge is a heavyweight sediment sampling device with weighted jaws that are lever or spring activated. It is used to collect consolidated fine to coarse textured sediment. The following procedure shall be used for collecting sediment with a Ponar dredge (Figure 3, Appendix A):

1. Attach a sturdy nylon rope or steel cable to the ring provided on top of the dredge.

2. Arrange the Ponar dredge with the jaws in the open position, setting the trip bar so the sampler remains open when lifted from the top. If the dredge is so equipped, place the spring loaded pin into the aligned holes in the trip bar.

3. Slowly lower the sampler to a point approximately two inches [5 cm] above the sediment.

4. Drop the sampler to the sediment. Slack on the line will release the trip bar or spring loaded pin; pull up sharply on the line closing the dredge.

5. Raise the dredge to the surface and slowly decant any free liquid through the screens on top of the dredge. Care should be taken to retain the fine sediment fraction during this operation.

6. Open the dredge and transfer the sediment to a stainless steel, plastic or other appropriate composition (e.g., Teflon) container. Ensure that non-dedicated containers have been adequately decontaminated. If necessary, continue to collect additional sediment until sufficient material has been secured to fulfill analytical requirements. Thoroughly homogenize and then transfer sediment to sample containers appropriate for the analyses requested. Samples for volatile organic analysis must be collected directly from the bucket before homogenization to minimize volatilization of contaminants.

7. Label the container with the sample identification number, site name, sample point number, date and time sampled, and the samplers initials. Fill out the chain of custody forms.

8. Place the sample in a cooler with ice at 4°C.

9. Ship the samples in the cooler along with the chain of custody forms to the laboratory.

10. Decontaminate all equipment prior to moving to the next location (see SOP 1.5).

3.2.5 Push Core

Collection of subsurface sediment from beneath a shallow aqueous layer can be accomplished with a system consisting of a tube sampler, acetate liner, eggshell check valve, nosecone, extensions, and "T" handle, or drive head. The use of additional extensions can increase the depth of water from which sediment can be collected from 24 inches to 10 feet or more. This sampler may be used with either a drive hammer for firm sediment, or a "T" handle for soft sediment. However, sample handling and manipulation increases in difficulty with increasing depth of water. A disadvantage of coring devices is that a relatively small surface area and sample size is obtained often necessitating repetitive sampling in order to obtain the required amount of sample. This method is advantageous in sampling sediments for trace organic compounds or metals. The following procedure describes the use of a sample coring device (Figure 4, Appendix A) used to collect subsurface sediments.

1. Assemble the coring device by inserting the acetate liner into the sampling tube.

2. Insert the "egg shell" check valve into the lower end of the sampling tube with the convex surface positioned inside the acetate liner.

3. Screw the nosecone onto the lower end of the sampling tube, securing the acetate liner and eggshell check valve.

4. Screw the handle onto the upper end of the sampling tube and add extension rods as needed.

5. Place the sampler in a perpendicular position on the sediment to be sampled.

6. If the "T" handle is used, place downward pressure on the device until the desired depth is reached. After the desired depth is reached, rotate the sampler to shear off the core at the bottom. Slowly withdraw the sampler from the sediment and proceed to Step 15.

7. If the drive hammer is selected, insert the tapered handle (drive head) of the drive hammer through the drive head.

8. Drive the sampler into the sediment to the desired depth.

9. Record the length of the tube that penetrated the sample material, and the number of blows required to obtain this depth.

10. Remove the drive hammer and fit the keyhole-like opening on the flat side of the hammer onto the drive head. In this position, the hammer serves as a handle for the sampler.

11. Rotate the sampler to shear off the core at the bottom.

12. Lower the sampler handle (hammer) until it just clears the two ear-like protrusions on the drive head, and rotate about 90°.

13. Slowly withdraw the sampler from the sediment. If the drive head was used, pull the hammer upwards and dislodge the sampler from the sediment.

14. Carefully remove the coring device from the water.

15. Unscrew the nosecone and remove the eggshell check valve.

16. Slide the acetate liner out of the sampler tube. Decant surface water, using care to retain the fine sediment fraction. If head space is present in the upper end, a hacksaw may be used to shear the acetate liner off at the sediment surface. The liner may then be capped at both ends. Indicate on the acetate liner the appropriate orientation of the sediment core using a waterproof marker. The sample may be used in this fashion, or the contents transferred to a sample or homogenization container.

17. Open the acetate liner and transfer the sediment to a stainless steel, plastic or other appropriate composition (e.g., Teflon) container. Ensure that non-dedicated containers have been adequately decontaminated. If necessary, continue to collect additional sediment until sufficient material has been secured to fulfill analytical requirements. Thoroughly homogenize and then transfer sediment to sample containers appropriate for the analyses requested. Samples for volatile organic analysis must be collected directly from the bucket before homogenization to minimize volatilization of contaminants.

18. Label the container with the sample identification number, site name, sample point number, date and time sampled, and the samplers initials. Fill out the chain of custody forms.

19. Place the sample in a cooler with ice at 4°C.

20. Ship the samples in the cooler along with the chain of custody forms to the laboratory.

21. Decontaminate all equipment prior to moving to the next location (see SOP 1.5).

4.0 ASSESSING ZONES of DEPOSITION FOR SAMPLING

For sediment assessment studies directed at determining contaminant distributions, there is a need to understand the spatial gradient and extent of the suspected contaminants. A standard assumption in sediment quality studies is that the fine-grained sediments (<63µ; i.e., silt and clay fraction) act as repositories for both inorganic and organic contaminants due to contaminant fate and transport characteristics. Typically, the affinity of metals (inorganics) to fine-grained sediments is a result of adhesive properties, with organic contaminants typically found in fine-grained sediment due to the association of organic carbon (i.e., TOC). With this understanding, it would not be practical to conduct a random, grid- or transect-based sampling approach in areas with variable substrates because in many cases a large percentage of the sample locations may be located in sandy (coarse) substrates, and thus the value of the chemical data produced would be minimal, and not an effective use of the budget. To focus the sampling effort toward those areas which would have a reasonable probability of exhibiting contamination, it is important to have a prior understanding of the distribution of sediment types which occur within the water body.

4.1 Assessing Site Sediments

Developing a study directed at determining the sediment characteristics of a site involves a systematic approach along established transects, or within grids to:

1. Determine those areas which may be depositional in nature; and
2. Qualitatively assess sediment characteristics in these identified deposition zones.

First, areas of deposition are determined through a bathymetric survey of the site (pond or slow flowing stream) or through an understanding of the hydraulic energy within a system (i.e., fast flowing river or stream). For ponds and slower flowing streams, a determination of the bathymetry along set transects (or within grids) is conducted using either electronic depth measuring instruments or through physical sounding. The information produced from this exercise is a spatial understanding of the depth contours within the water body, and thus a prediction of the physical characteristics of the sediment found in deeper areas where deposition is suspected. For assessing the depositional characteristics of fast flowing streams, it can be assumed that depositional areas will occur along the inside of bends or in backwater areas where eddies form.

NOTE: Location of sediment depositional zones can be important in defining subareas for sampling or for stratifying sampling in some programs.

The second part of the study involves visual characterization of the sediments using the ASTM-derived Unified Soil Classification System (USCS). Parameters such as grain-size, relative density, grading, color, odor, plasticity, stratification and other attributes can be determined qualitatively. To accomplish this, sample points are located along established transects (or qualitatively within grids) at positions that have been identified as being depositional (e.g., depression areas) based on the first phase of the assessment. Within shallow waters, sample locations can be marked with PVC poles or similar devices. In deeper waters it is suggested that locations be geo-referenced using a Global Positioning System (GPS) approach.

This approach can also be used for identifying and characterizing sediments in non-impacted areas that may potentially be used to denote background or reference conditions. It is important to note that standard protocols (USEPA, 2001) designate that reference stations have similar physical properties as the sediment being sampled within the impacted area. Adhering to this principle will provide more confidence when assessing the potential effects of contamination on biota, and will also provide for determination of natural metal concentrations in local sediments. Also, the use of normalization tools such as aluminum-to-metal ratios can be used to differentiate natural metals from those derived from anthropogenic sources, and concentrations for non-polar organic contaminants may be more easily evaluated when normalized to organic carbon than as considered from a dry weight perspective.

The overall goal of the study will be to focus future analytical sampling efforts within those portions of the water body that have the greatest potential for containing contamination.

5.0 CAUTIONS AND INTERFERENCES

In streams, caution should be taken when sampling sediments in concert with surface water samples. Disturbance of sediment prior to surface water collection can result in elevated contaminant concentrations as a result of suspended sediments within the water column. To avoid this situation, start by sampling all surface water samples prior to collecting sediments. In flowing streams, collect downstream sediment (and surface water) samples first, moving upstream in a systematic fashion. Avoid sampling in locations where footprints may have disturbed the surficial substrate.

The homogenization procedure should not be used for volatile organics; in this case, sediment, or multiple grabs of sediment, should be transferred directly from the sample collection device or homogenization container to the sample container.

6.0 REFERENCES

USEPA, 2001, *Methods for Collection, Storage and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manual*, EPA-823-B-01-002, Office of Science & Technology, Office of Water, U.S. Environmental Protection Agency, Washington, DC,

STANDARD OPERATING PROCEDURE NO. 10.1
SOIL SAMPLING USING A TROWEL

1.0 METHOD SUMMARY

Surface soil sampling involves the removal of a representative portion of the topsoil (0-6 in.) to be analyzed in a lab. This sampling method attempts only to ascertain the extent of contamination on the upper most layer of soil. Above ground plant debris is excluded from the sample.

2.0 EQUIPMENT/APPARATUS/REAGENTS

The contractor shall describe the equipment to be used to collect the sample, field screening equipment including calibration and quality control (QC) requirements for the samples to be taken. Each instrument will be calibrated according to the manufacturer's operating manual prior to each day's use. Instrument calibrations will be documented in the field book. During this calibration, an appropriate maintenance check will be performed on each piece of equipment. If damaged or failed parts are identified during the daily maintenance check and it is determined that the damage can impact the instrument's performance, the instrument will be removed from service until the part or parts are replaced or repaired. An equivalent piece of equipment will be substituted for the malfunctioning instrument to maintain schedule, if possible. Typical equipment required for surface sampling includes:

- Stainless steel trowel
- Stainless steel bowl
- Stainless steel spoon
- Field logbook
- Waterproof and permanent marking pens
- Duct tape
- Decontamination supplies
- Paper towels
- Appropriate personal protective equipment (PPE)
- Sample jars with labels (volume based on analysis)
- Cooler with ice
- Zip-lock bags
- Organic Vapor Meter

3.0 .PROCEDURES

Surface soil samples shall be collected from the land surface not to exceed six inches below the surface. The sample shall be homogenized and quartered in accordance with the following procedures:

1. Select the proper sample containers for collecting the sample.
2. Complete the sample labels with the appropriate information.
3. Place the sample material into a stainless steel bowl and homogenize the sample in accordance with SOP 6.2 (Homogenization of Soil Samples) with a stainless steel spoon. Do not homogenize samples for VOC analysis as the homogenization will cause a release of VOC constituents.
4. Collect VOC samples in accordance with SOP 6.3 (Collection of VOCs).
5. Fill the appropriate sample jars using the material from the bowl, placing equal portions of sample into the sample jar.
6. Collection of QC samples will done in accordance with SOP 6.5 (Collection of QC Samples).

7. Tighten the caps securely on the sample jars.

8. Place samples in a cooler with ice and fill out the chain of custody in accordance with SOP 6.4 (Sampling Handling and Control).

9. Sample location, time, and sample type shall be documented in the logbook in accordance with SOP 6.1(Documentation).

Grab samples shall be collected by obtaining a representative volume of soil from the area to be sampled and placing it directly into the appropriate sample jar.

The sampling equipment shall be decontaminated in accordance with SOP 1.5 (Decontamination) between each sample, and new gloves should be worn each time.

4.0 CAUTIONS AND INTERFERENCES

Interferences and potential problems for surface sampling include rocky or extremely hard surface soil, fill material over natural surface, and dense vegetation. The soil could be impenetrable, so sampling may be impossible at that particular location. Also, if backfill has been recently applied, it will not show accurate results for that area. Digging through the fill down to the native soil or moving to another location may be necessary.

STANDARD OPERATING PROCEDURE NO. 10.2
SOIL SAMPLING USING A SPLIT BARREL SAMPLER

1.0 METHOD SUMMARY

Subsurface sampling attempts to remove soil below the ground surface in a relatively undisturbed state in order to quantify the extent of contamination at specific depths. Soil samples shall be collected based on odors, discoloration, organic vapor meter readings, predetermined depth, and any other appropriate field screening method.

2.0 EQUIPMENT/APPARATUS/REAGENTS

The contractor shall describe the equipment to be used to collect the sample, field screening equipment including calibration and quality control (QC) requirements for the samples to be taken. Each instrument will be calibrated according to the manufacturer's operating manual prior to each day's use. Instrument calibrations will be documented in the field book. During this calibration, an appropriate maintenance check will be performed on each piece of equipment. If damaged or failed parts are identified during the daily maintenance check and it is determined that the damage can impact the instrument's performance, the instrument will be removed from service until the part or parts are replaced or repaired. An equivalent piece of equipment will be substituted for the malfunctioning instrument to maintain schedule, if possible. Typical equipment required for subsurface sampling includes:

- Tape measure (in tenths of feet)
- Split-barrel samplers
- Knife
- Field logbook
- Waterproof and permanent marking pens
- Duct tape
- Decontamination supplies
- Paper towels
- Appropriate personal protective equipment (PPE)
- Sample jars with labels
- Cooler with ice
- Zip-lock bags
- Drum for drill cuttings, if necessary
- Organic Vapor Meter
- Table for examining drilled cores

3.0 PROCEDURES

When soil samples are to be submitted for laboratory analysis, they shall be collected using stainless steel, continuous drive, California modified split-barrel sampler, or equivalent. These samplers are 24 inches in length and have an outside diameter (OD) of 2 inches to accommodate four 2-inch diameter brass/stainless steel rings, each of which is 6 inches in length. The brass/stainless steel rings are optional and are used only when collecting geotech samples.

Each time a split-barrel sample is taken, a standard penetration test shall be performed in accordance with ASTM C-1586 "Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils."

1. Decontaminate the split barrel sampler to be used for soil sampling.

2. Soil sampling using a split barrel soil sampling is performed in conjunction with SOP 5.1 (Hollow Stem Borehole Advancement) or 5.3 (Mud Rotary Borehole Advancement).
3. Attach the split barrel sampler to the center rods and lower the sampler to the bottom of the bore hole.
4. Attach the drill rig drive hammer to the center rods.
5. Drive the sampler a depth of 1 foot into undisturbed soil with a 140-pound hammer free falling a distance of 30 inches.
6. Drive 6 inches to seat it in undisturbed soil; then perform test.
7. For each 6 inches of penetration, record the number of hammer blows for seating the spoon and making the test (i.e., 5/7/8).
8. Obtain the standard penetration test result (N) by adding the last two figures (i.e., 7+8=15 blows per foot).
9. Drive the sampler an additional 6 inches to fill the remainder of the split-spoon prior to retrieval, if necessary.
10. Detach the hammer and attach the center rods to the hanger assembly.
11. Pull the split-barrel sampler out of the bore hole and detach the sampler from the center rods.
12. Disassemble the sampler.
13. As soon as the split-spoon is opened, monitor the open ends of the brass/stainless steel rings for organic vapors using the PID or FID.
14. Record the results on the boring log and in the field log book.

Samples for VOC analysis will be collected following the sample collection procedures discussed in TCEQ Superfund Program SOP No. 6.3.

If initial screening results indicate the presence of organic vapors, a headspace analysis shall be conducted on remaining portions of the sample.

Grab samples shall be collected by obtaining a representative volume of soil from the area to be sampled and placing it directly into the sample bottle.

Collection of QC samples shall be done in accordance with SOP 6.5 (Collection of QC Samples).

The sampling equipment shall be decontaminated in accordance with SOP 1.5 (Decontamination) between each sample, and new gloves should be worn each time.

4.0 CAUTIONS AND INTERFERENCES

Rock or impenetrable soil may be encountered during split spoon sampling. If this is the case, a different method may be used (drill rig, etc), or it may be necessary to move to another location. If access is a problem, different drilling methods or locations may solve this problem as well.

STANDARD OPERATING PROCEDURE NO. 10.3
SOIL SAMPLING USING A HAND AUGER

1.0 METHOD SUMMARY

Subsurface soil sampling attempts to remove soil below the ground surface in a relatively undisturbed state in order to quantify the extent of contamination at specific depths. Soil samples shall be collected based on odors, discoloration, organic vapor meter readings, predetermined depth, and any other appropriate field screening method.

2.0 EQUIPMENT/APPARATUS/REAGENTS

The contractor shall describe the equipment to be used to collect the sample, field screening equipment including calibration and quality control (QC) requirements for the samples to be taken. Each instrument will be calibrated according to the manufacturer's operating manual prior to each day's use. Instrument calibrations will be documented in the field book. During this calibration, an appropriate maintenance check will be performed on each piece of equipment. If damaged or failed parts are identified during the daily maintenance check and it is determined that the damage can impact the instrument's performance, the instrument will be removed from service until the part or parts are replaced or repaired. An equivalent piece of equipment will be substituted for the malfunctioning instrument to maintain schedule, if possible. Typical equipment required for subsurface sampling includes:

- Tape measure (in tenths of feet)
- Stainless steel hand auger
- Field logbook
- Waterproof and permanent marking pens
- Duct tape
- Latex gloves
- Plastic sheeting
- Stainless Steel Auger Bucket
- Extension Shafts
- Cross Handle
- Decontamination supplies
- Paper towels
- Appropriate personal protective equipment (PPE)
- Sample jars with labels (volume based on analysis)
- Cooler with ice
- Zip-lock bags
- Drum for drill cuttings, if necessary
- Organic Vapor Meter
- Table for examining drilled cores

3.0 PROCEDURES

Hand augering is used to collect soil samples from depths as great as 10 ft below ground surface (bgs), although the technique can sometimes be used to a depth as great as 30 ft bgs. This method is not appropriate for collecting samples for volatile organic analysis, because volatile compounds may be lost. Samples for VOC analysis will be collected following the sample collection procedures discussed in TCEQ Superfund Program SOP No. 6.3 (Collection of VOC Samples). Each hand auger is equipped with 3-inch diameter cylindrical stainless steel with cutting teeth. For each hand auger boring:

1. Select the proper sample containers for collecting the sample.

2. Complete the sample labels with the appropriate information.

3. Depending on the type of soil material present, attach either a regular auger bucket or a mud auger bucket to an extension shaft. Attach a cross handle to the other end of the extension shaft.
4. Decontaminate the auger bucket in accordance with SOP 1.5 (Decontamination) prior to the initial use.
5. Turning the handle clockwise, auger down until the bucket is full of soil.
6. Lift the auger out of the bore hole and deposit the excavated soil on an impermeable plastic liner to prevent any leaching of possible contaminates.
7. Attach additional extension shafts as needed.
8. Place the auger back in the bore hole and advance it to the required sampling depth.
9. Remove the auger from the bore hole and decontaminate the auger bucket in preparation for sample collection.
10. Place the auger back in the bore hole and advance it through the required sampling depth interval.
11. Describe the sample lithology in the boring log.
12. Place the material from the auger into a stainless steel bowl.
13. Fill the appropriate sample jars using the material from the bowl.
14. Homogenization of soil samples from different sample intervals will be performed in accordance with SOP 6.2 (Homogenization of Soil Samples).
15. Collection of QC samples will done in accordance with SOP 6.5 (Collection of QC Samples).
16. Tighten the caps securely on the sample jars.
17. Place samples in a cooler with ice and fill out the chain of custody in accordance SOP 6.4 (Sample Handling and Control).
18. Record the appropriate information in the field logbook in accordance with SOP 6.1 (Documentation).

The sampling equipment shall be decontaminated in accordance with SOP 1.5 (Decontamination) between each sample, and new gloves should be worn each time.

4.0 CAUTIONS AND INTERFERENCES

Interferences and potential problems for subsurface soil sampling include rocky or extremely hard subsurface soil, fill material over natural surface, utilities, and dense vegetation. Digging through the fill down to the native soil or moving to another location may be necessary. Rock or impenetrable soil may be encountered during hand augering.. If this is the case, it may be necessary to move to another location.

STANDARD OPERATING PROCEDURE NO. 10.4
SOIL SAMPLING USING DIRECT PUSH

1.0 METHOD SUMMARY

Subsurface sampling attempts to remove soil below the ground surface in a relatively undisturbed state in order to quantify the extent of contamination at specific depths. Soil samples shall be collected based on odors, discoloration, organic vapor meter readings, predetermined depth, and any other appropriate field screening method. This SOP does not describe the procedures for operating a Geoprobe™ or similar direct push unit.

2.0 EQUIPMENT/APPARATUS/REAGENTS

The contractor shall describe the equipment to be used to collect the sample, field screening equipment including calibration and quality control (QC) requirements for the samples to be taken. Each instrument will be calibrated according to the manufacturer's operating manual prior to each day's use. Instrument calibrations will be documented in the field book. During this calibration, an appropriate maintenance check will be performed on each piece of equipment. If damaged or failed parts are identified during the daily maintenance check and it is determined that the damage can impact the instrument's performance, the instrument will be removed from service until the part or parts are replaced or repaired. An equivalent piece of equipment will be substituted for the malfunctioning instrument to maintain schedule, if possible. Typical equipment required for subsurface sampling includes:

- Tape measure (in tenths of feet)
- Utility Knife
- Field logbook
- Waterproof and permanent marking pens
- Duct tape
- Latex gloves
- Decontamination supplies
- Paper towels
- Appropriate personal protective equipment (PPE)
- Sample jars with labels
- Cooler with ice
- Zip-lock bags
- Table for examining drilled cores
- Field screening equipment

3.0 PROCEDURES

Direct push sampling involves advancing a sampling probe by applying direct hydraulic pressure by using a slide or rotary hammer. Samples may be collected continuously or at specific depths. Typically a subcontractor is used to perform the actual probing operation. To collect samples using push methods:

1. Once the sampler is removed from the hole, the soil sample is recovered by unscrewing the cutting shoe and pulling the liner out. When the shoe is loosened, pull the liner from the sample tube.

2. Carefully cut the liner open, using a utility knife with a hooked blade (linoleum blade). By cutting the sample liner along two sides the sample can be exposed.

3. Describe the sample lithology and record on the boring log.

4. Monitor head space readings (if necessary).

5. Fill the appropriate sample jars using the material from the open sample liner.

6. Collect VOC samples in accordance with SOP 6.3 (Collection of VOCs).
7. Collect QC samples in accordance with SOP 6.5 (Collection of QC Samples).
8. Tighten the caps securely on the sample jars.
9. Place samples in a cooler with ice and fill out the chain of custody in accordance SOP 6.4 (Sample Handling and Control).
10. Record the appropriate information in the field logbook in accordance with SOP 6.1 (Documentation).
11. Decontaminate all non-disposable sampling equipment in accordance with SOP 1.5 (Decontamination).

4.0 CAUTIONS AND INTERFERENCES

Rock or impenetrable soil may be encountered during the direct push method. If this is the case, it may be necessary to move to another location

STANDARD OPERATING PROCEDURE NO. 10.5
SOIL SAMPLING USING A SHELBY TUBE SAMPLER

1.0 METHOD SUMMARY

Subsurface sampling attempts to remove soil below the ground surface in a relatively undisturbed state in order to quantify the extent of contamination at specific depths. Soil samples shall be collected based on odors, discoloration, organic vapor meter readings, predetermined depth, and any other appropriate field screening method.

2.0 EQUIPMENT/APPARATUS/REAGENTS

The contractor shall describe the equipment to be used to collect the sample, field screening equipment including calibration and quality control (QC) requirements for the samples to be taken. Each instrument will be calibrated according to the manufacturer's operating manual prior to each day's use. Instrument calibrations will be documented in the field book. During this calibration, an appropriate maintenance check will be performed on each piece of equipment. If damaged or failed parts are identified during the daily maintenance check and it is determined that the damage can impact the instrument's performance, the instrument will be removed from service until the part or parts are replaced or repaired. An equivalent piece of equipment will be substituted for the malfunctioning instrument to maintain schedule, if possible. Typical equipment required for subsurface sampling includes:

- Tape measure (in tenths of feet)
- Shelby tube samplers
- Rig-mounted extruder
- Knife
- Field logbook
- Waterproof and permanent marking pens
- Duct tape
- Decontamination supplies
- Paper towels
- Appropriate personal protective equipment (PPE)
- Sample jars with labels
- Cooler with ice
- Zip-lock bags
- Drum for drill cuttings, if necessary
- Organic Vapor Meter
- Table for examining drilled cores

3.0 PROCEDURES

When soil samples are to be submitted for laboratory analysis, they shall be collected using stainless steel, continuous drive, Shelby tube samplers. These samplers are 24 inches in length and have an outside diameter (OD) of 2 inches. Shelby tube samplers are not appropriate for use on sandy, unconsolidated materials.

- Decontaminate the Shelby tube sampler to be used for soil sampling.
- Soil sampling using a Shelby tube sampler is performed in conjunction with SOP 5.1 (Hollow Stem Borehole Advancement) or 5.3 (Mud Rotary Borehole Advancement).
- Attach the Shelby tube sampler to the center rods and lower the sampler to the bottom of the bore hole.

- Drive the sampler a depth of 2 feet into undisturbed soil.
- Pull the Shelby tube sampler out of the bore hole and detach the sampler from the center rods.
- Place the Shelby tube with the "bottom" (the end of the tube with the shallowest sample) of the tube against the extruder head. Extrude the sample into a decontaminated trough.
- As soon as the Shelby tube sample is extruded, monitor the sample for organic vapors using the PID or FID.
- Record the results on the boring log and in the field log book.

Carefully split the sample core using a decontaminated stainless steel knife. Immediately cut center sections for VOC samples and place into appropriate sample containers, filling the container as full as possible. Immediately place the sample in an iced cooler held at a temperature below 4 degrees C.

Samples collected to be tested for other analytical parameters concurrently with VOCs shall be then collected. Soil chemistry samples not being analyzed for VOCs shall be placed in 8 or 16-ounce, laboratory cleaned, EPA-approved glass containers with Teflon-lined lids. This shall be done using clean stainless steel sampling tools and rubber gloves. If initial screening results indicate the presence of organic vapors, a headspace analysis shall be conducted on remaining portions of the sample.

Grab samples shall be collected by obtaining a representative volume of soil from the area to be sampled and placing it directly into the sample bottle.

If soil samples are being collected for VOC analysis, the sample collection procedures discussed in TCEQ Superfund Program SOP No. 6.3 (Collection of VOC Samples) must be followed.

Collection of QC samples shall be done in accordance with SOP 6.5 (Collection of QC Samples).

The sampling equipment shall be decontaminated in accordance with SOP 1.5 (Decontamination) between each sample, and new gloves should be worn each time.

4.0 CAUTIONS AND INTERFERENCES

Rock or impenetrable soil may be encountered during Shelby tube sampling. If this is the case, a different method may be used (drill rig, etc), or it may be necessary to move to another location. If access is a problem, different drilling methods or locations may solve this problem as well. Additionally, if loose, unconsolidated materials are encountered, a different sampling method, such as the use of split spoon sampling devises, will be necessary, therefore contractor shall be prepared for all scenarios and uncertainties.

STANDARD OPERATING PROCEDURE NO. 11.1
SOURCE SAMPLING OF A HOMOGENOUS LIQUID

1.0 METHOD SUMMARY

Source sampling of homogenous liquids involves the collection of multiple aliquots from one source and then mixing the aliquots together, to create one representative sample of the source material for laboratory analysis.

2.0 EQUIPMENT/APPARATUS/REAGENTS

Equipment needed for collection of homogenous liquid samples:

- Line and messengers
- Sample bottles/preservatives
- Ziploc® bags
- Ice
- Coolers
- Chain of Custody records, custody seals
- Field data sheets
- Decontamination equipment
- Maps/plot plan
- Safety equipment
- Compass
- Tape measure
- Survey stakes, flags, or buoys and anchors
- Camera and film
- Logbook/waterproof pen
- Homogenization container
- Scoops
- Non-preserved sample containers

3.0 PROCEDURES

3.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed.
2. Obtain the necessary sampling and monitoring equipment.
3. Decontaminate or pre-clean equipment, and ensure that it is in working order.
4. Assemble and label appropriate sample bottles.
5. Prepare scheduling and coordinate with staff, clients, and regulatory agency, if appropriate.
6. Perform a general survey of the source prior to sampling, in accordance with the site specific Health and Safety Plan.
7. Use stakes, flagging, or buoys to identify and mark all sampling locations. If required the proposed locations may be adjusted based on access, boundaries, and obstructions.

3.2.1 Sampler Composition

The appropriate sampling device must be of a proper composition. Selection of samplers constructed of glass, stainless steel, PVC or PFTE (Teflon) should be based upon the analyses to be performed.

3.3 Sample Collection

1. Collect an equal quantity of sample aliquot from each sample location with the appropriate sampling device and transfer the liquid to a collection container.
2. Throughly homogenize the liquid in the collection container.
3. Transfer the sample(s) into suitable, labeled sample containers.
4. Preserve the sample if appropriate, or use pre-preserved sample bottles. Do not overfill bottles if they are pre-preserved.
5. Cap the container, place in a Ziploc® plastic bag and cool to 4ºC.
6. Record all pertinent data in the site logbook in accordance with SOP 6.1 (Documentation).
7. Complete the Chain of Custody record in accordance with SOP 6.4 (Sampling Handling and Control).
8. Attach custody seals to cooler prior to shipment in accordance with SOP 6.4 (Sampling Handling and Control).
9. Decontaminate all sampling equipment prior to the collection of additional samples with that sampling device in accordance with SOP 1.5 (Decontamination).
10. Dispose of all derived waste in accordance with SOP 1.6 (IDW).

4.0 CAUTIONS AND INTERFERENCES

Volatile organic samples should not be taken using this method. The mixing will cause volatile compounds to be released from the liquids.

STANDARD OPERATING PROCEDURE NO. 11.2
SOURCE SAMPLING OF A HETEROGENEOUS OR STRATIFIED LIQUID

1.0 METHOD SUMMARY

Source sampling of liquids from stratified liquids involves the collection of sample aliquots from different depths of the source. This method is applicable for sampling of tanks, drums, and impoundments.

2.0 EQUIPMENT/APPARATUS/REAGENTS

Equipment needed for collection of heterogeneous or stratified liquid samples:

- Sample bottles/preservatives
- Ziploc® bags
- Ice
- Coolers
- Chain of Custody records, custody seals
- Field data sheets
- Decontamination equipment
- Maps/plot plan
- Safety equipment
- Tape measure
- Camera and film
- Logbook/waterproof pen
- Appropriate sampling device (e.g., bailer, drum thief)

3.0 PROCEDURES

3.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed.
2. Obtain the necessary sampling and monitoring equipment.
3. Decontaminate or pre-clean equipment, and ensure that it is in working order.
4. Assemble and label appropriate sample bottles.
5. Prepare scheduling and coordinate with staff, clients, and regulatory agency, if appropriate.
6. Perform a general survey of the source prior to sampling, in accordance with the site specific Health and Safety Plan.

3.2 Sampler Composition

The appropriate sampling device must be of a proper composition. Selection of samplers constructed of glass, stainless steel, PVC or PFTE (Teflon) should be based upon the analyses to be performed.

3.3 Sample Collection

1. Lower the appropriate sampling device to the predetermined depth and allow to fill.
2. Retrieve the sampler and transfer the sample(s) into suitable, labeled sample containers.
3. Preserve the sample if appropriate, or use pre-preserved sample bottles. Do not overfill bottles if they are pre-preserved.
4. Cap the container, place in a Ziploc® plastic bag and cool to 4ºC in accordance with SOP 6.4 (Sampling Handling and Control).
5. Record all pertinent data in the site logbook in accordance with SOP 6.1 (Documentation).
6. Complete the Chain of Custody record in accordance with SOP 6.4 (Sampling Handling and Control).
7. Attach custody seals to cooler prior to shipment in accordance with SOP 6.4 (Sampling Handling and Control).
8. Decontaminate all sampling equipment prior to the collection of additional samples with that sampling device in accordance with SOP 1.5 (Decontamination).

4.0 CAUTIONS AND INTERFERENCES

The source strata interface and different strata maybe difficult to identify. Samples maybe collected from the strata interface and not from the strata of concern.

STANDARD OPERATING PROCEDURE NO. 11.3
SOURCE SAMPLING OF A HOMOGENOUS SOLID

1.0 METHOD SUMMARY

This standard operating procedure (SOP) provides guidance for collecting samples from a homogenous solid.

2.0 EQUIPMENT/APPARATUS/REAGENTS

Typical equipment required for surface and subsurface sampling includes:

- Tape measure (in tenths of feet)
- Stainless steel trowel
- Stainless steel bowl
- Stainless steel hand auger
- Stainless steel corers
- Watch
- Knife
- Field logbook
- Waterproof and permanent marking pens
- Duct tape
- Latex gloves
- Decontamination supplies
- Paper towels
- Appropriate personal protective equipment (PPE)
- Sample jars with labels
- Cooler with ice
- Zip-lock bags
- Drum for drill cuttings, if necessary
- Organic Vapor Meter
- Table for examining drilled cores

3.0 PROCEDURES

1. Select and label the proper sample containers for collecting the sample.
2. Complete the sample labels with the appropriate information.
3. Collect sample material using a trowel (SOP 10.1), split spoon (SOP 10.2), hand auger (SOP 10.3), or by the direct push method (SOP 10.4).
4. Place the sample material into a stainless steel bowl and homogenize the sample with a stainless steel spoon by thoroughly mixing and breaking up the sampling material. Do not homogenize samples for VOC analysis as the homogenization will cause a release of VOC constituents.
5. Quarter the contents of the sample bowl and set aside two of the sample quarters.
6. Homogenize the sample again.
7. Fill the appropriate sample jars using the material from the bowl, placing equal portions of sample into the sample bottles.
8. Securely tighten the caps on the sample bottles.
9. Place the bottles in a cooler with ice.
10. Fill out a chain of custody.
11. Ship the sample and chain of custody to the laboratory.

Grab samples shall be collected by obtaining a representative volume of soil from the area to be sampled and placing it directly into the sample bottle.

The sampling equipment shall be decontaminated between each sample, and new gloves should be worn each time.

4.0 CAUTIONS AND INTERFERENCES

Interferences and potential problems for surface sampling include rocky or extremely hard surface soil, fill material over natural surface, utilities, and dense vegetation. The soil could be impenetrable, so sampling may be impossible at that particular location. Also, if backfill has been applied recently, it will not show accurate results for that area. Digging through the fill down to the native soil or moving to another location may be necessary. Also, during subsurface boring, rock or impenetrable soil may be encountered. If this is the case, a different method may be used (drill rig, etc), or it may be necessary to move to another location. If access is a problem, different drilling methods or locations may solve this problem as well.

STANDARD OPERATING PROCEDURE NO. 11.4
SOURCE SAMPLING OF A HETEROGENEOUS OR STRATIFIED SOLID

1.0 METHOD SUMMARY

This standard operating procedure (SOP) provides guidance regarding source sampling of a heterogeneous or stratified solid.

Source sampling of a heterogeneous or stratified solid can be conducted using a variety of methods and equipment depending on the objective, the depth of the desired sample, site conditions, type of sample required (disturbed vs. undisturbed), formation type (consolidated vs. unconsolidated), and soil type (fine grained vs. coarse grained). Near surface soils can be sampled utilizing a spade, trowel, and scoop. Sampling at greater depths may be performed using a hand auger, drilling methods, Cone Penetrometer Test (CPT), and Direct Push Methods. Investigation techniques and equipment are designed to minimize the effects on the chemical and physical integrity of the sample.

2.0 EQUIPMENT/APPARATUS/REAGENTS

Equipment needed for collection of sediment samples may include:

- Maps/plot plan
- Safety equipment
- Compass
- Tape measure
- Survey stakes or flags
- Camera and film
- 4-oz., 8-oz., and one-quart wide mouth jars w/ teflon lined lids
- Ziploc plastic bags
- Spatula
- Scoop
- Trowel
- Logbook
- Sample jar labels
- Chain of custody records
- Field data sheets
- Cooler(s)
- Ice
- Decontamination supplies/equipment

3.0 PROCEDURES

19. Clear the boring location of any surface debris (e.g., twigs, rocks, litter).

20. Begin drilling. Use the appropriate coring method, such as hollow stem augers(SOP 5.1) or direct push (SOP 10.4), to obtain a core of the solid.

21. Periodically remove and deposit accumulated soils onto a plastic sheet spread near the hole or in an appropriately labeled drum.

22. After reaching the desired depth, remove the sampler, and remove the core.

23. Discard the top of the core (approximately 1 inch), as this possibly represents material collected before penetration of the layer of concern.

24. Visually inspect the core, describe the lithology, the depth, color, and any odors detected and record in the logbook or on the field data sheet.

25. Select and label the proper sample containers for collecting the sample. Complete the sample labels with the appropriate information.

26. Fill the appropriate sample jar. When sampling stratified solids, one sample should be collected from each discrete layer identified. Care should be taken to avoid commingling soils/sludges from different strata.

27. Securely tighten the caps on the sample bottles.

28. Fill out the chain of custody form.

29. Place the sample in cooler in ice and ship cooler to the lab with the chain of custody.

4.0 CAUTIONS AND INTERFERENCES

There are potentially four primary interferences including:

1. a potential for cross-contamination
2. sample disturbance making it difficult to decipher the exact depth of sample
3. the presence of drilling fluid (to stabilize sidewalls of the boring) making the water bearing zone difficult to detect.

These problems could be minimized through the use of dedicated sampling equipment, geotechnical tools appropriate for the geologic conditions that exist at the subject site, and an appropriate Sampling and Analysis Plan (SAP).

1.0 METHOD SUMMARY

The objective of a standard operating procedure (SOP) is to provide general reference information for conducting routine or repetitive activities to facilitate consistency in the quality and integrity of the product. This (SOP) provides procedures for asbestos air sampling by drawing a known volume of air through a mixed cellulose ester (MCE) filter which is then sent to a laboratory for analysis. . One of the following four analytical methods is commonly used for determining asbestos in the air:

1. U.S. EPA's Environmental Asbestos Assessment Manual, Superfund Method for the Determination of Asbestos in Ambient Air for Transmission Electron Microscopy (TEM)[1]
2. U.S. EPA's Modified Yamate Method for TEM[2]
3. National Institute for Occupational Safety and Health (NIOSH) Method 7402 (direct method only) for TEM
4. NIOSH Method 7400 for Phase Contrast Microscopy (PCM)[3]

Each method has specific sampling and analytical requirements (i.e., sample volume and flow rate) for determining asbestos in air. Much information can be derived from each analytical method previously mentioned. Each analytical method has specific sampling requirements and produce results which may or may not be applicable to a specific sampling effort. The site sampling objectives should be carefully identified so as to select the most appropriate analytical method. Additionally, some preparation (i.e., lot blanks results) prior to site sampling may be required, these requirements are specified in the sections discussing the analytical methods.

During a site investigation, sampling stations should be arranged to distinguish spatial trends in airborne asbestos concentrations. Sampling schedules should be fashioned to establish temporal trends. The sampling strategy typically requires that the concentration of asbestos at the source (worst case) or area of concern (downwind), crosswind, as well as background (upwind) contributions be quantified. It is important to establish background levels of contaminants in order to develop a reference point from which to evaluate the source data. Field blanks and lot blanks can be utilized to determine other sources.

2.0 EQUIPMENT/MATERIALS/REAGENTS

2.1 Sampling Pump

The constant flow or critical orifice controlled sampling pump should be capable of a flow-rate and pumping time sufficient to achieve the desired volume of air sampled.

The lower flow personal sampling pumps generally provide a flow rate of 20 cubic centimeters/minute (cc/min) to 4 L/min. These pumps are usually battery powered. High flow pumps are utilized when flow rates between 2 L/min to 20 L/min are required. High flow pumps are used for short sampling periods so as to obtain the desired sample volume. High flow pumps usually run on AC power and can be plugged into a nearby outlet. If

an outlet is not available then a generator should be obtained. The generator should be positioned downwind from the sampling pump. Additional voltage may be required if more than one pump is plugged into the same generator. Several electrical extension cords may be required if sampling locations are remote.

The recommended volume for the Superfund method (Phase I) requires approximately 20 hours to collect. Such pumps typically draw 6 amps at full power so that 2 lead/acid batteries should provide sufficient power to collect a full sample. The use of line voltage, where available, eliminates the difficulties associated with transporting stored electrical energy.

A stand should be used to hold the filter cassette at the desired height for sampling and the filter cassette shall be isolated from the vibrations of the pump.

2.2 Filter Cassette

The cassettes are purchased with the required filters in position, or can be assembled in a laminar flow hood or clean area. When the filters are in position, a shrink cellulose band or adhesive tape should be applied to cassette joints to prevent air leakage.

2.2.1 TEM Cassette Requirements

Commercially available field monitors, comprising 25 mm diameter three-piece cassettes, with conductive extension cowls shall be used for sample collection. The cassette must be new and not previously used. The cassette shall be loaded with an MCE filter of pore size 0.45 µm, and supplied from a lot number which has been qualified as low background for asbestos determination. The cowls should be constructed of electrically conducting material to minimize electrostatic effects. The filter shall be backed by a 5 µm pore size MCE filter (Figure 1, Appendix A).

2.2.2 PCM Cassette Requirements

NIOSH Method 7400, PCM involves using a 0.8 to 1.2 µm mixed cellulose ester membrane, 25 mmdiameter, 50 mm conductive cowl on cassette (Figure 2, Appendix A). Some labs are able to perform PCM and TEM analysis on the same filter; however, this should be discussed with the laboratory prior to sampling.

2.3 Other Equipment

Additional equipment which may be required includes the following:

- Inert tubing with glass cyclone and hose barb
- Whirlbags (plastic bags) for cassettes
- Tools - small screw drivers
- Container - to keep samples upright
- Generator or electrical outlet (may not be required)
- Extension cords (may not be required)
- Multiple plug outlet

- Sample labels
- Air data sheets
- Chain of Custody records

Reagents are not required for the preservation of asbestos samples.

3.0 PROCEDURES

3.1 Sample Handling, Container, and Storage Procedures

Procedures for handling and storage of asbestos samples are as follows:

15. Place a sample label on the cassette indicating a unique sampling number. Do not put sampling cassettes in shirt or coat pockets as the filter can be contaminated by fibers. The original cassette box is used to hold the samples.
16. Wrap the cassette individually in a plastic sample bag. Each bag should be marked with a waterproof marker indicating the sample identification number, total volume, and date.
17. The wrapped sampling cassettes should be placed upright in a rigid container so that the cassette cap is on top and cassette base is on bottom. Use enough packing material to prevent jostling or damage. Do not use vermiculite as packing material for samples. If possible, hand carry to lab.
18. Provide appropriate documentation with samples (i.e., chain of custody and requested analytical methodology).

No preservation is required for asbestos samples.

3.2 Air Volumes and Flow Rates

Sampling volumes are determined on the basis of how many fibers need to be collected for reliable measurements. Therefore, one must estimate how many airborne fibers may be in the sampling location. Since the concentration of airborne aerosol contaminants will have some effect on the sample, the following is a suggested criteria to assist in selecting a flow rate based on real-time aerosol monitor (RAM) readings in milligrams/cubic meter (mg/m^3).

Rate	Concentration	Flow (L/min)
Low RAM readings:	<6.0 mg/m^3	11-15
Medium RAM readings:	>6.0 mg/m^3	7.5
High RAM readings:	>10 mg/m^3	2.5

In practice, pumps that are available for environmental sampling at remote locations operate under a maximum load of approximately 12 L/min.

3.2.1 U.S. EPA's Superfund Method

The Superfund Method incorporates an indirect preparation procedure to provide flexibility in the amount of deposit that can be tolerated on the sample filter and to allow for the selective concentration of asbestos prior to analysis. To minimize contributions to background contamination from asbestos present in the plastic matrices of membrane filters while allowing for sufficient quantities of asbestos to be collected, this method also requires the collection of a larger volume of air per unit area of filter than has traditionally been collected for asbestos analysis. Due to the need to collect large volumes of air, higher sampling flow rates are recommended in this method than have generally been employed for asbestos sampling in the past. As an alternative, samples may be collected over longer time intervals. However, this restricts the flexibility required to allow samples to be collected while uniform meteorological conditions prevail.

The sampling rate and the period of sampling should be selected to yield as high a sampled volume as possible, which will minimize the influence of filter contamination. Wherever possible, a volume of 15 cubic meters (15,000 L) shall be sampled for those samples intended for analysis only by the indirect TEM preparation method (Phase 1 samples). For those samples to be prepared by both the indirect and the direct specimen preparation methods (Phase 2 samples), the volumes must be adjusted so as to provide a suitably-loaded filter for the direct TEM preparation method. One option is to collect filters at several loadings to bracket the estimated optimum loading for a particular site. Such filters can be screened in the laboratory so that only those filters closest to optimal loading are analyzed. It has been found that the volume cannot normally exceed 5 cubic meters (5,000 L) in an urban or agricultural area, and 10 cubic meters (10,000 L) in a rural area for samples collected on a 25 mm filter and prepared by a direct-transfer technique.

An upper limit to the range of acceptable flow rates for this method is 15 L/min. At many locations, wind patterns exhibit strong diurnal variations. Therefore, intermittent sampling (sampling over a fixed time interval repeated over several days) may be necessary to accumulate 20 hours of sampling time over constant wind conditions. Other sampling objectives also may necessitate intermittent sampling. The objective is to design a sampling schedule so that samples are collected under uniform conditions throughout the sampling interval. This method provides for such options. Air volumes collected on Phase I samples are maximized (<16 L/min). Air volumes collected on Phase 2 samples are limited to provide optimum loading for filters to be prepared by a direct-transfer procedure.

3.2.2 U.S. EPA's Modified Yamate Method for TEM

U.S. EPA's TEM method requires a minimum volume of 560 L and a maximum volume of 3,800 L in order to obtain an analytical sensitivity of 0.005 structures/cc. The optimal volume for TEM is 1,200 L to 1,800 L. These volumes are determined using a 200 mesh EM grid opening with a 25-mm filter cassette. Changes in volume would be necessary if a 37-mm filter cassette is used since the effective area post-of a 25 mm (385 sq mm) and 37 mm (855 sq m) differ.

3.2.3 NIOSH Method for TEM and PCM

The minimum recommended volume for TEM and PCM is 400 L at 0.1 fiber/cc. Sampling time is adjusted to obtain optimum fiber loading on the filter. A sampling rate of 1 to 4 L/min for eight hours (700 to 2,800 L) is appropriate in non-dusty atmospheres containing 0.1 fiber/cc. Dusty atmospheres (i.e., areas with high levels of asbestos) require smaller sample volumes (<400 L) to obtain countable samples.

In such cases, take short, consecutive samples and average the results over the total collection time. For documenting episodic exposures, use high flow rates (7 to 16 L/min) over shorter sampling times. In relatively clean atmospheres where targeted fiber concentrations are much less than 0.1 fiber/cc, use larger sample volumes (3,000 to 10,000 L) to achieve quantifiable loadings. Take care, however, not to overload the filter with background dust. If greater than 50% of the filter surface is covered with particles, the filter may be too overloaded to count and will bias the measured fiber concentration. Do not exceed 0.5 mg total dust loading on the filter.

3.3 Calibration Procedures

In order to determine if a sampling pump is measuring the flow rate or volume of air correctly, it is necessary to calibrate the instrument. Sampling pumps should be calibrated immediately before and after each use. Preliminary calibration should be conducted using a primary calibrator such as a soap bubble type calibrator, (e.g., a Buck Calibrator, Gilibrator, or equivalent primary calibrator) with a representative filter cassette installed between the pump and the calibrator. The representative sampling cassette can be reused for calibrating other pumps that will be used for asbestos sampling. The same cassette lot used for sampling should also be used for the calibration. A sticker should be affixed to the outside of the extension cowl marked "Calibration Cassette."

A rotameter can be used provided it has been recently precalibrated with a primary calibrator. Three separate constant flow calibration readings should be obtained both before sampling and after sampling. Should the flow rate change by more than 5% during the sampling period, the average of the pre- and post-calibration rates will be used to calculate the total sample volume. The sampling pump used shall provide a non-fluctuating air-flow through the filter, and shall maintain the initial volume flow-rate to within ± 10% throughout the sampling period. The mean value of these flow-rate measurements shall be used to calculate the total air volume sampled. A constant flow or critical orifice controlled pump meets these requirements. If at any time the measurement indicates that the flow-rate has decreased by more than 30%, the sampling shall be terminated. Flexible tubing is used to connect the filter cassette to the sampling pump. Sampling pumps can be calibrated prior to coming on-site so that time is saved when performing on-site calibration.

3.3.1 Calibrating a Personal Sampling Pump with an Electronic Calibrator

19. See Manufacturer's manual for operational instructions.

20. Set up the calibration train as shown in (Figure 3, Appendix A) using a sampling pump, electronic calibrator, and a representative filter cassette. The same lot sampling cassette used for sampling should also be used for calibrating.

21. To set up the calibration train, attach one end of the PVC tubing (approximately 2 foot) to the cassette base; attach the other end of the tubing to the inlet plug on the pump. Another piece of tubing is attached from the cassette cap to the electronic calibrator.

22. Turn the electronic calibrator and sampling pump on. Create a bubble at the bottom of the flow chamber by pressing the bubble initiate button. The bubble should rise to the top of the flow chamber. After the bubble runs its course, the flow rate is shown on the LED display.

23. Turn the flow adjust screw or knob on the pump until the desired flow rate is attained.

24. Perform the calibration three times until the desired flow rate of ± 5% is attained.

3.3.2 Calibrating a Rotameter with an Electronic Calibrator

1. See manufacturer's manual for operational instructions.

2. Set up the calibration train as shown in (Figure 4, Appendix A) using a sampling pump, rotameter, and electronic calibrator.

3. Assemble the base of the flow meter with the screw provided and tighten in place. The flow meter should be mounted within 6° of vertical.

4. Turn the electronic calibrator and sampling pump on.

5. Create a bubble at the bottom of the flow chamber by pressing the bubble initiate button. The bubble should rise to the top of the flow chamber. After the bubble runs its course, the flow rate is shown on the LED display.

6. Turn the flow adjust screw or knob on the pump until the desired flow rate is attained.

7. Record the electronic calibrator flow rate reading and the corresponding rotameter reading. Indicate these values on the rotameter (sticker). The rotameter should be able to work within the desired flow range. Readings can also be calibrated for 10 cm^3 increments for low flow rotameters, 500 cm^3 increments for medium flow rotameters, and 1 liter increments for high flow rotameters.

8. Perform the calibration three times until the desired flow rate of ± 5% is attained. Once on site, a secondary calibrator (i.e., rotameter) may be used to calibrate sampling pumps.

3.3.3 Calibrating a Personal Sampling Pump with a Rotameter

1. See manufacturer's manual for rotameter's operational instructions.
2. Set up the calibration train as shown in (Figure 5, Appendix A) using a rotameter, sampling pump, and a representative sampling cassette.
3. To set up the calibration train, attach one end of the PVC tubing (approximately 2 ft) to the cassette base; attach the other end of the tubing to the inlet plug on the pump. Another piece of tubing is attached from the cassette cap to the rotameter.
4. Assemble the base of the flow meter with the screw provided and tighten in place. The flow meter should be mounted within 6° of vertical.
5. Turn the sampling pump on.
6. Turn the flow adjust screw (or knob) on the personal sampling pump until the float ball on the rotameter is lined up with the precalibrated flow rate value. A sticker on the rotameter should indicate this value.
7. A verification of calibration is generally performed on-site in the clean zone immediately prior to the sampling.

3.4 Meteorology

It is recommended that a meteorological station be established. If possible, sample after two to three days of dry weather and when the wind conditions are at 10 mph or greater. Record wind speed, wind direction, temperature, and pressure in a field logbook. Wind direction is particularly important when monitoring for asbestos downwind from a fixed source.

3.5 Ambient Sampling Procedures

3.5.1 Pre-site Sampling Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed.
2. Obtain necessary sampling equipment and ensure it is in working order and fully charged (if necessary).
3. Perform a general site survey prior to site entry in accordance with the site specific Health and Safety plan.
4. Once on-site the calibration is performed in the clean zone. The calibration procedures are listed in Section 3.2.
5. After calibrating the sampling pump, mobilize to the sampling location.

3.5.2 Site Sampling

6. To set up the sampling train, attach the air intake hose to the cassette base. Remove the cassette cap (Figure 6 and 7, Appendix B). The cassette should be positioned downward, perpendicular to the wind.

7. If AC or DC electricity is required, then turn it on. If used, the generator should be placed approximately 10 ft downwind from the sampling pump.

8. Record the following in a field logbook: date, time, location, sample identification number, pump number, flow rate, and cumulative time.

9. Turn the pump on. Should intermittent sampling be required, sampling filters must be covered between active periods of sampling. To cover the sample filter: turn the cassette to face upward, place the cassette cap on the cassette, remove the inlet plug from the cassette cap, attach a rotameter to the inlet opening of the cassette cap to measure the flow rate, turn off the sampling pump, place the inlet plug into the inlet opening on the cassette cap. To resume sampling: remove the inlet plug, turn on the sampling pump, attach a rotameter to measure the flow rate, remove the cassette cap, replace the inlet plug in the cassette cap and invert the cassette, face downward and perpendicular to the wind.

10. Check the pump at sampling midpoint if sampling is longer than 4 hours. The generators may need to be refueled depending on tank size. If a filter darkens in appearance or if loose dust is seen in the filter, a second sample should be started.

11. At the end of the sampling period, orient the cassette up, turn the pump off.

12. Check the flow rate as shown in Section 6.2. When sampling open-faced, the sampling cap should be replaced before post calibrating. Use the same cassette used for sampling for post calibration (increased dust/fiber loading may have altered the flow rate).

13. Record the post flow rate.

14. Record the cumulative time or run.

15. Remove the tubing from the sampling cassette. Still holding the cassette upright, replace the inlet plug on the cassette cap and the outlet plug on the cassette base.

3.5.3 Post Site Sampling

1. Follow handling procedures in Section 3.1, steps 1-4.

2. Obtain an electronic or hard copy of meteorological data which occurred during the sampling event. Record weather: wind speed, ambient temperature, wind direction, and precipitation. Obtaining weather data several days prior to the sampling event can also be useful.

3.6 Indoor Sampling Procedures

PCM analysis is used for indoor air samples. When analysis shows total fiber count above the OSHA action level 0.1 fibers/cubic centimeter (f/cc) then TEM (U.S. EPA's Modified Yamate Method) is used to identify asbestos from non-asbestos fibers. Sampling pumps should be placed four to five feet above ground level away from obstructions that may influence air flow. The pump can be placed on a table or counter. Refer to Table 2 (Appendix A) for a summary of indoor sampling locations and rationale for selection. Indoor sampling utilizes high flow rates to increased sample volumes (2,000 L for PCM and 2,800 to 4,200 L for TEM) in order to obtain lower detection limits below the standard, (i.e., 0.01 f/cc or lower [PCM] and 0.005 structures/cc or lower [TEM]).

3.6.1 Aggressive Sampling Procedures

Sampling equipment at fixed locations may fail to detect the presence of asbestos fibers. Due to limited air movement, many fibers may settle out of the air onto the floor and other surfaces and may not be captured on the filter. In the past, an 8-hour sampling period was recommended to cover various air circulation conditions. A quicker and more effective way to capture asbestos fibers is to circulate the air artificially so that the fibers remain airborne during sampling. The results from this sampling option typifies worst case condition. This is referred to as aggressive air sampling for asbestos. Refer to Table 2 for sample station locations.

1. Before starting the sampling pumps, direct forced air (such as a 1-horsepower leaf blower or large fan) against walls, ceilings, floors, ledges, and other surfaces in the room to initially dislodge fibers from surfaces. This should take at least 5 minutes per 1,000 sq. ft. of floor.
2. Place a 20-inch fan in the center of the room. (Use one fan per 10,000 cubic feet of room space.) Place the fan on slow speed and point it toward the ceiling.
3. Follow procedures in Section 3.5.1 and 3.5.2 (Turn off the pump and then the fan(s) when sampling is complete.).
4. Follow handling procedures in Section 3.1, steps 1-4.

4.0 CAUTIONS AND INTERFERENCES

Flow rates exceeding 16 liters/minute (L/min) which could result in filter destruction due to (a) failure of its physical support under force from the increased pressure drop; (b) leakage of air around the filter mount so that the filter is bypassed, or (c) damage to the asbestos structures due to increased impact velocities.

4.1 U.S. EPA's Superfund Method

4.1.1 Direct-transfer TEM Specimen Preparation Methods

Direct-Transfer TEM specimen preparation methods have the following significant interferences:

- The achievable detection limit is restricted by the particulate density on the filter, which in turn is controlled by the sampled air volume and the total suspended particulate concentration in the atmosphere being sampled.
- The precision of the result is dependent on the uniformity of the deposit of asbestos structures on the sample collection filter.
- Air samples must be collected so that they have particulate and fiber loadings within narrow ranges. If too high a particulate loading occurs on the filter, it is not possible to prepare satisfactory TEM specimens by a direct-transfer method. If too high a fiber loading occurs on the filter, even if satisfactory TEM specimens can be prepared, accurate fiber counting will not be possible.

4.1.2 Indirect TEM Specimen Preparation Methods

Indirect TEM specimen preparation methods have the following interferences:

- The size distribution of asbestos structures is modified.
- There is increased opportunity for fiber loss or introduction of extraneous contamination.
- When sample collection filters are ashed, any fiber contamination in the filter medium is concentrated on the TEM specimen grid.

It can be argued that direct methods yield an under-estimate of the asbestos structure concentration because many of the asbestos fibers present are concealed by other particulate material with which they are associated. Conversely, indirect methods can be considered to yield an over-estimate because some types of complex asbestos structures disintegrate during the preparation, resulting in an increase in the numbers of structures counted.

4.2 U.S. EPA's Modified Yamate Method for TEM

High concentrations of background dust interfere with fiber identification.

4.3 NIOSH Method for TEM

Other amphibole particles that have aspect ratios greater than 3:1 and elemental compositions similar to the asbestos minerals may interfere in the TEM analysis. Some non-amphibole minerals may give electron diffraction patterns similar to amphiboles. High concentrations of background dust interfere with fiber identification.

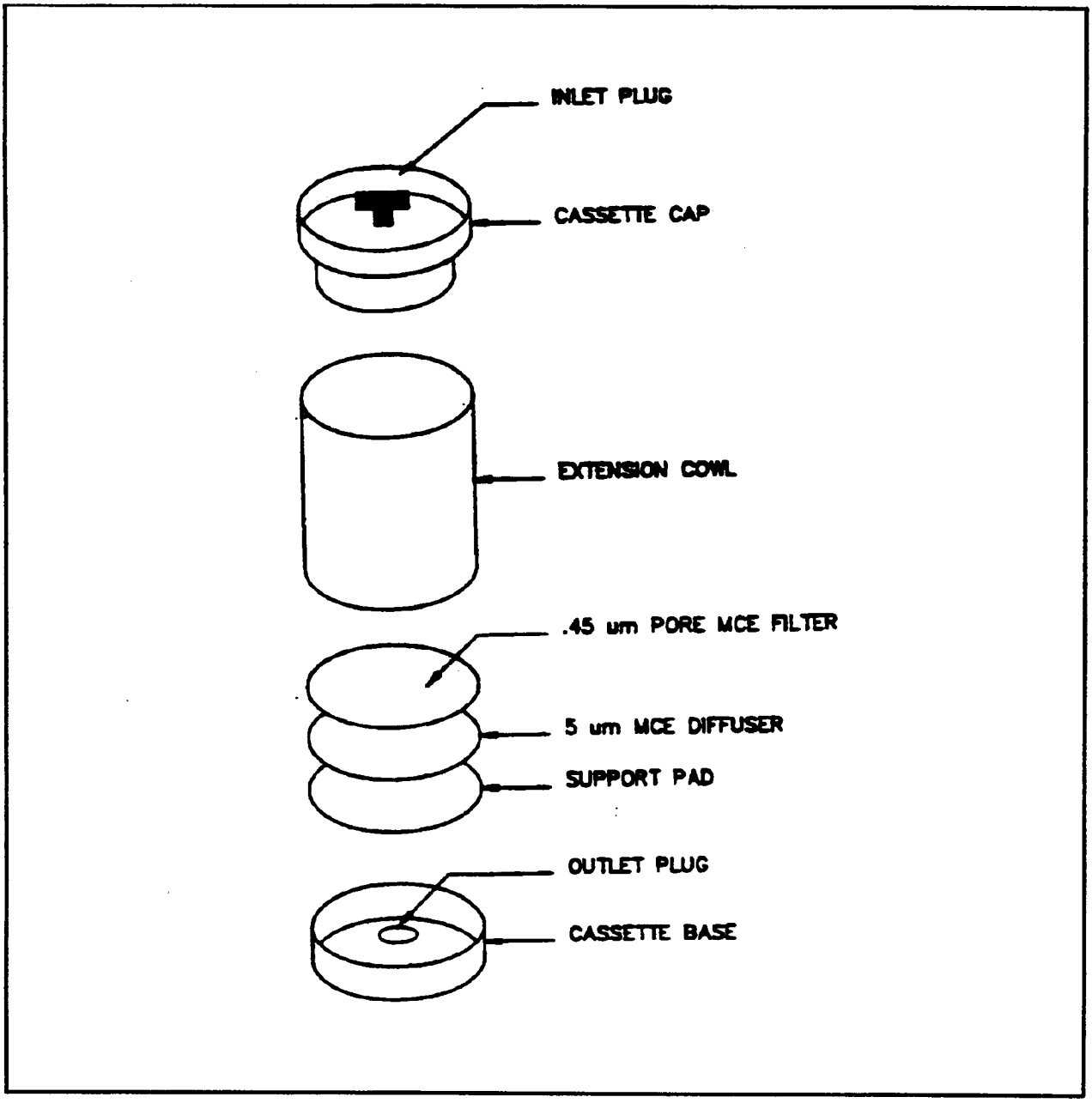
4.4 NIOSH Method for PCM

PCM cannot distinguish asbestos from non-asbestos fibers; therefore, all particles meeting the counting criteria are counted as total asbestos fibers. Fiber less than 0.25 um in length will not be detected by this method. High levels of non-fibrous dust particles may obscure fibers in the field of view and increase the detection limit.

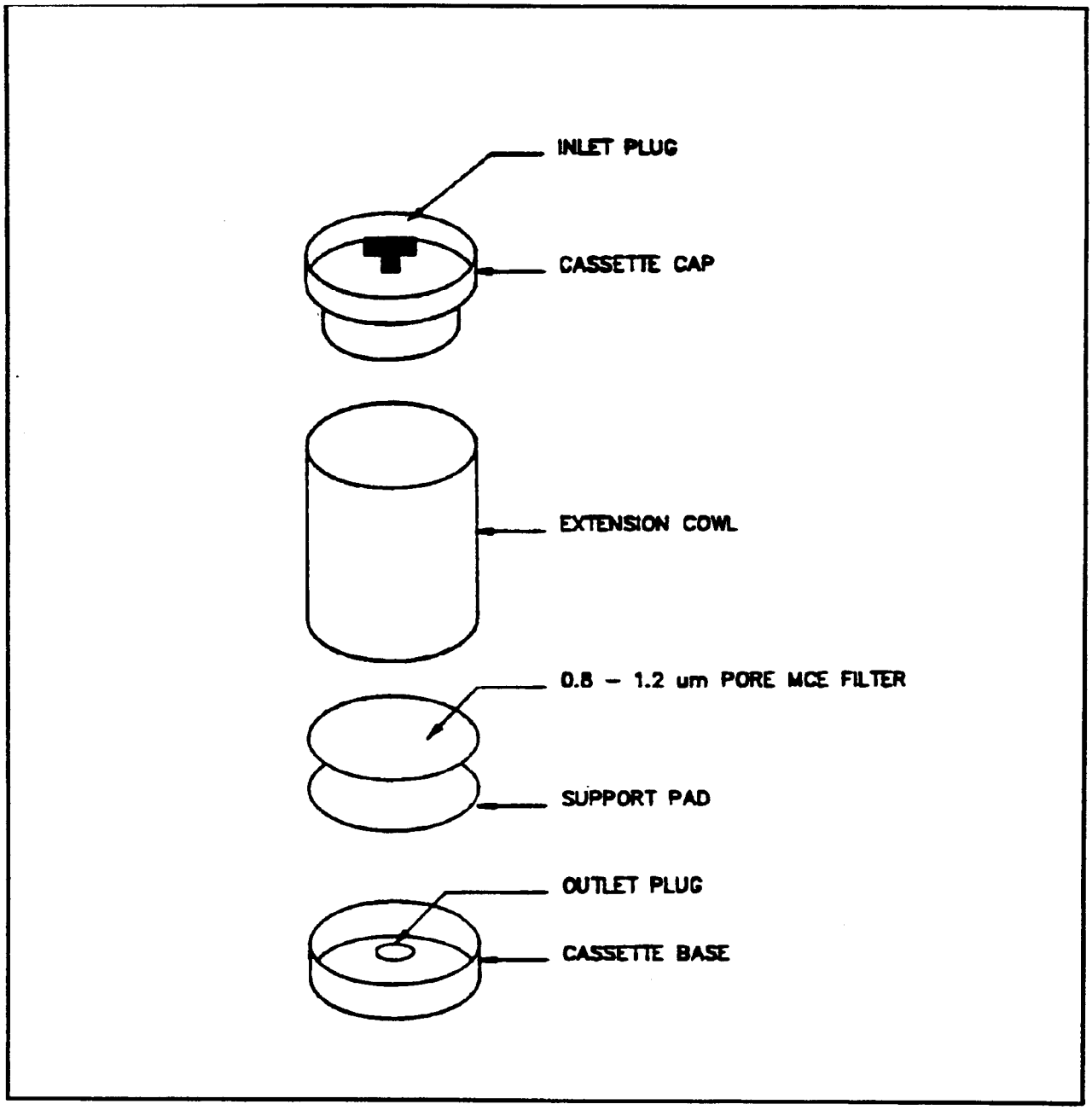
4.4 NIOSH Method for PCM

PCM cannot distinguish asbestos from non-asbestos fibers; therefore, all particles meeting the counting criteria are counted as total asbestos fibers. Fiber less than 0.25 um in length will not be detected by this method. High levels of non-fibrous dust particles may obscure fibers in the field of view and increase the detection limit.

APPENDIX A
FIGURE 1: Transmission Electron Microscopy Filter Cassette

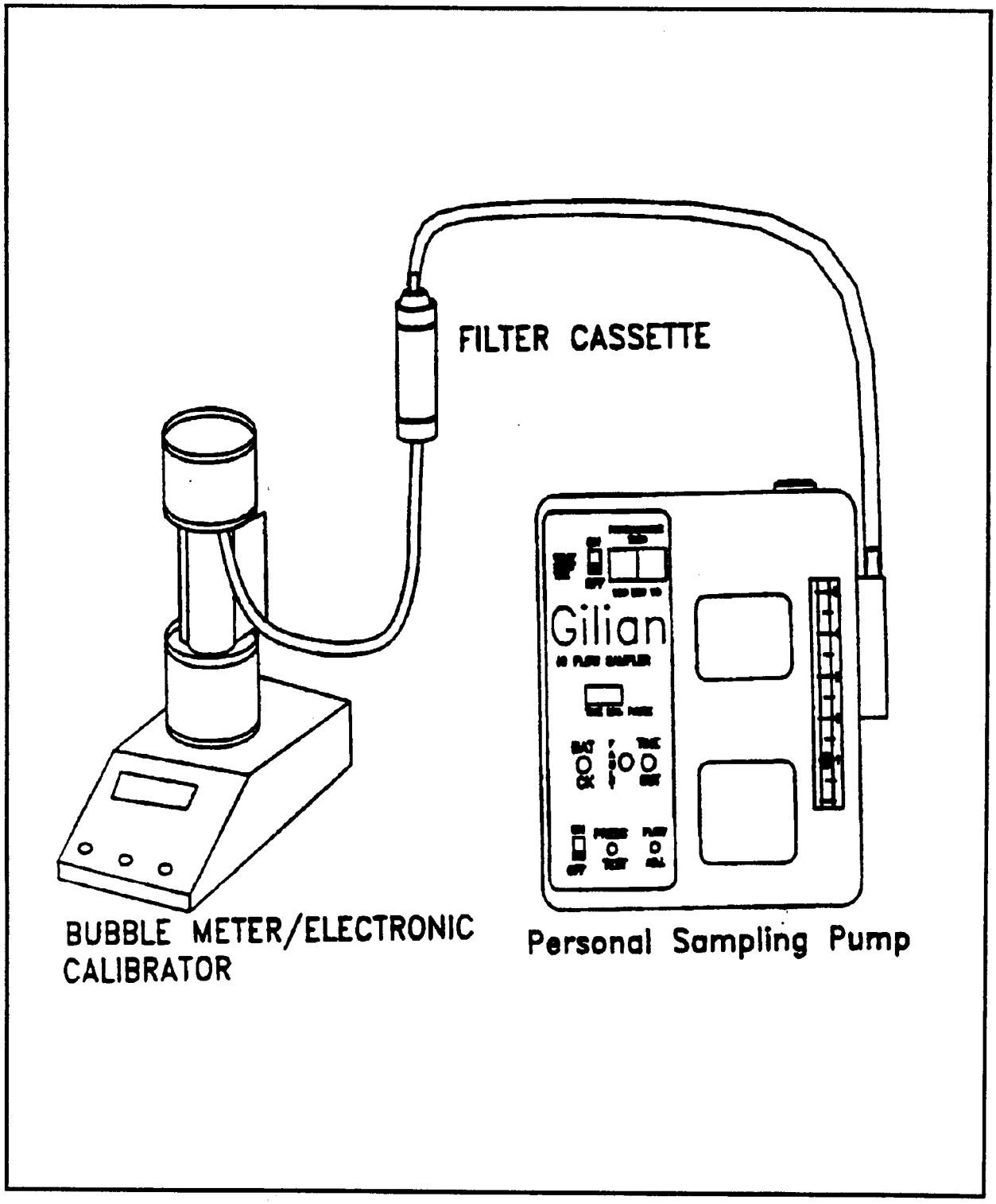


APPENDIX A
FIGURE 2: Phase Contrast Microscopy Filter Cassette



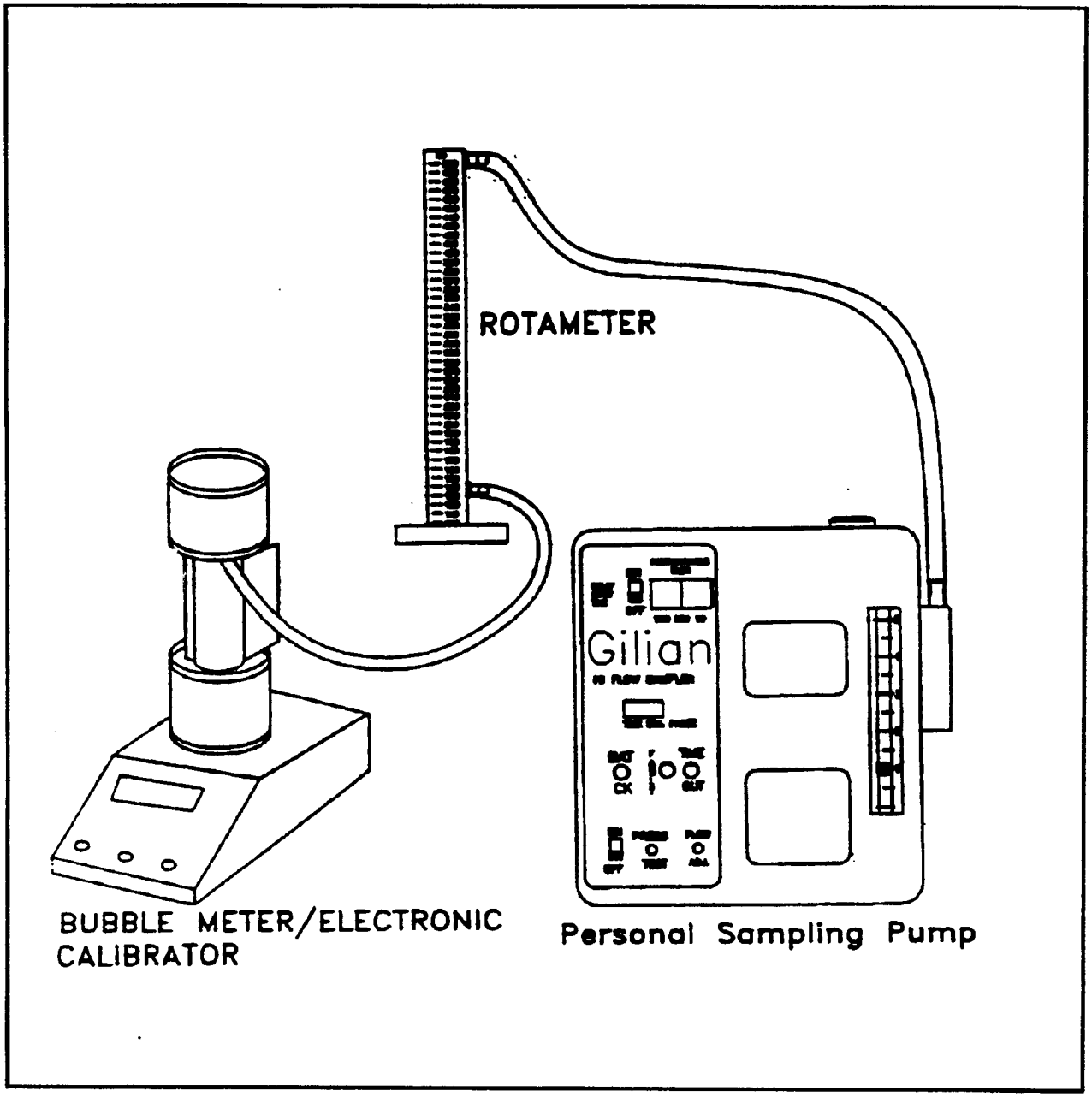
APPENDIX A

FIGURE 3: Calibrating a Personal Sampling Pump with a Bubble Meter



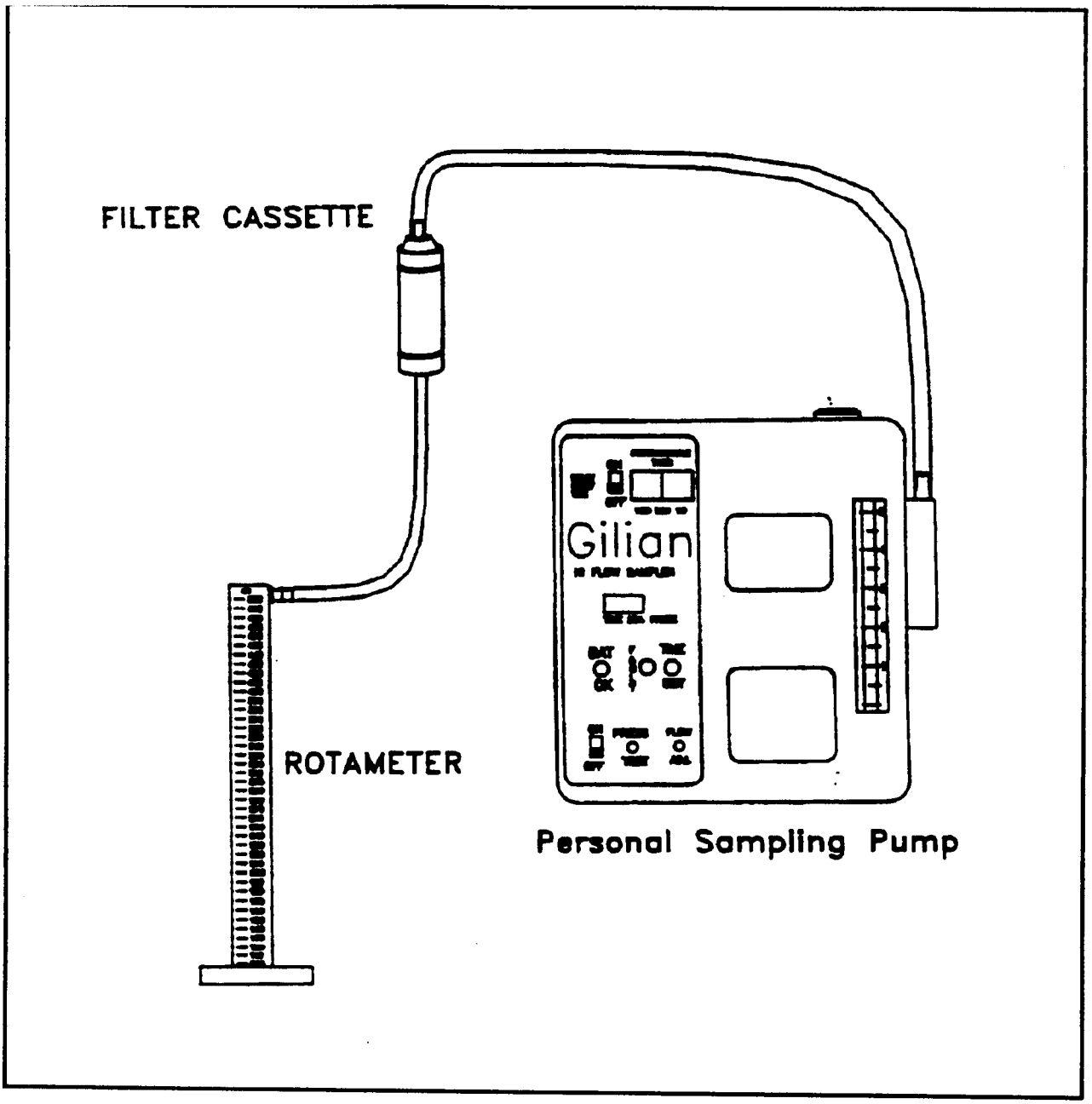
APPENDIX A

FIGURE 4: Calibrating a Rotameter with a Bubble Meter



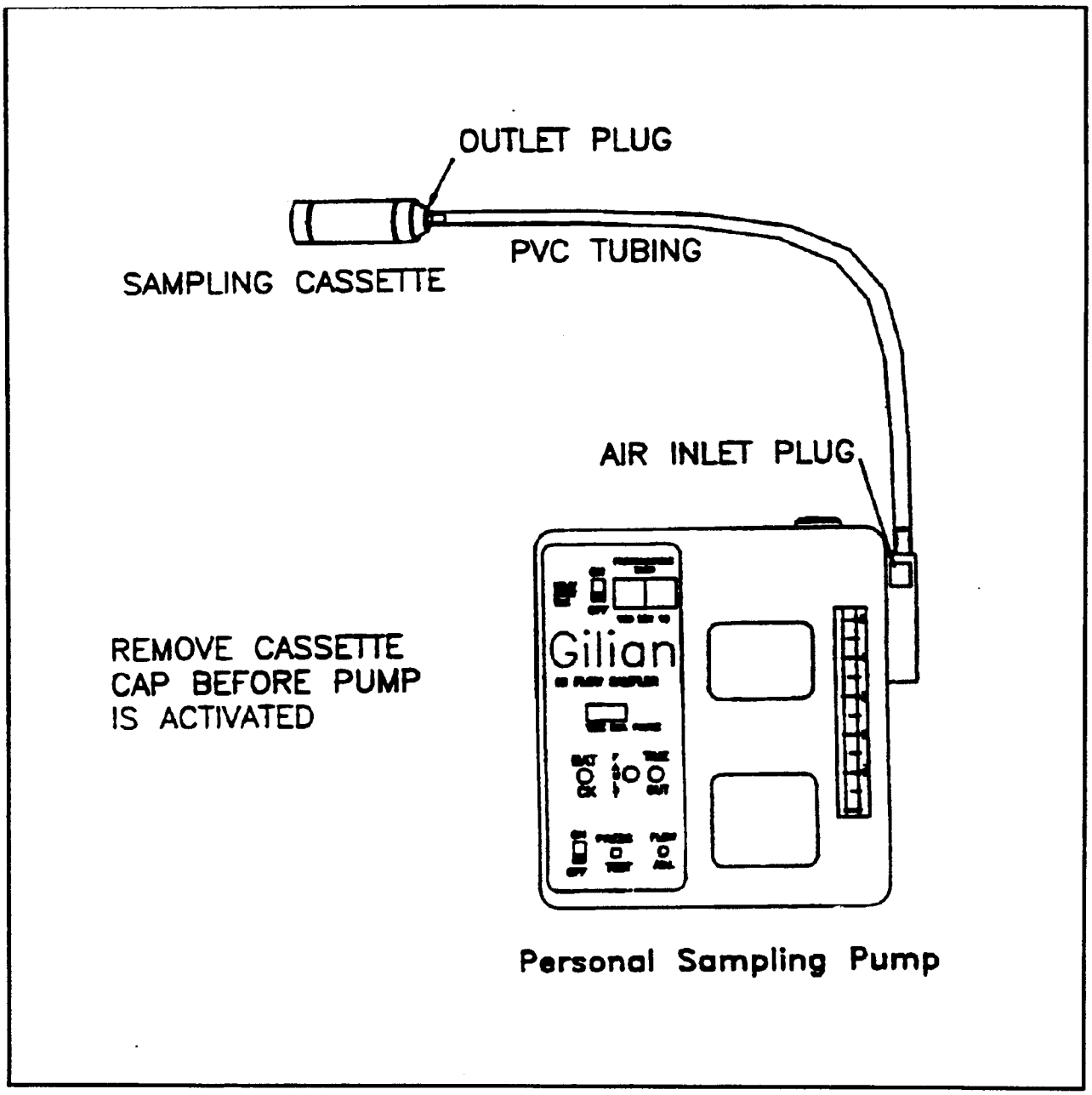
APPENDIX A

FIGURE 5: Calibrating a Sampling Pump with a Rotameter

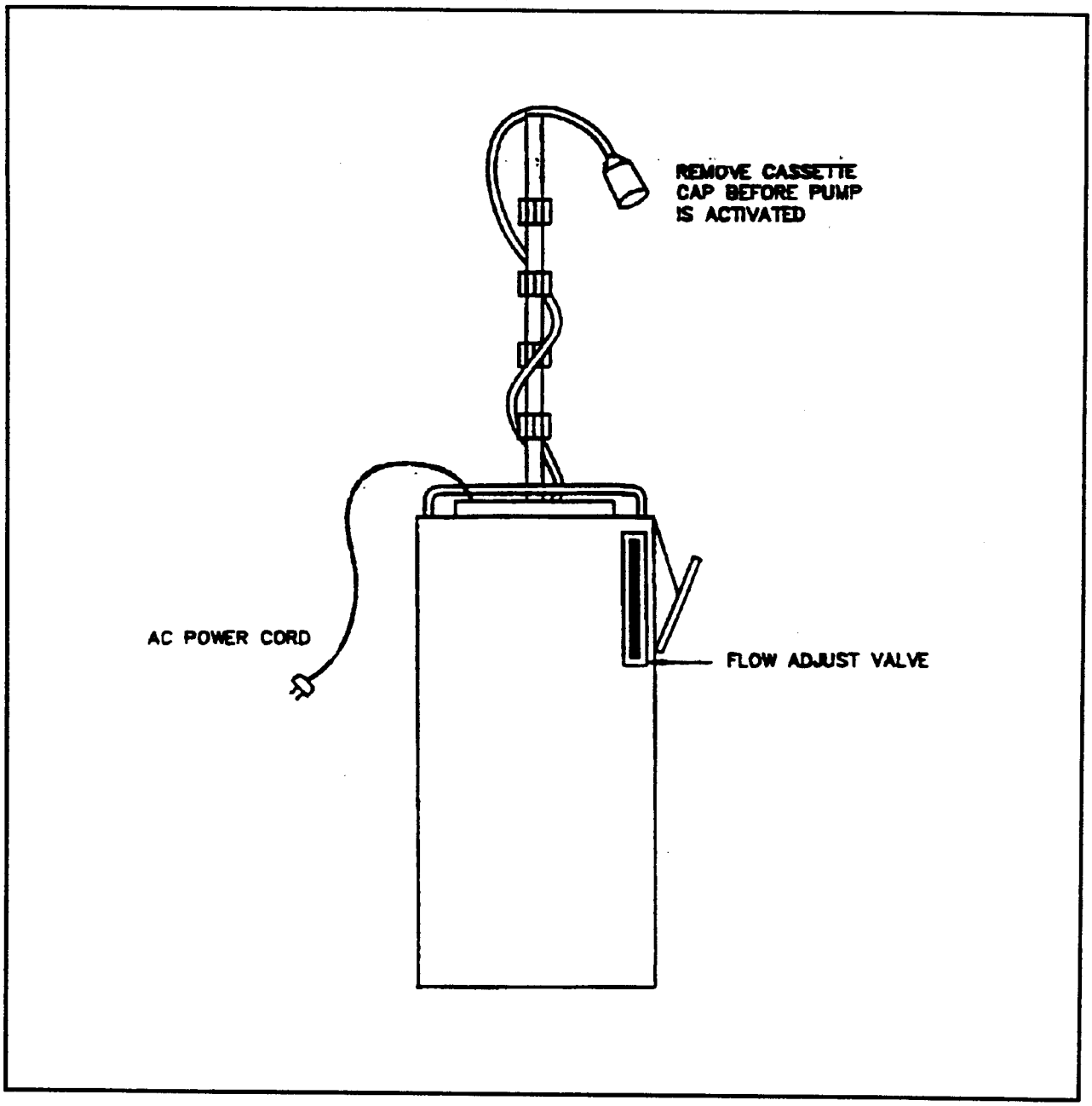


APPENDIX A

FIGURE 6: Personal Sampling Train for Asbestos



APPENDIX A
FIGURE 7: High Flow Sampling Train for Asbestos



STANDARD OPERATING PROCEDURE NO. 12.2
ASBESTOS SOLIDS SAMPLING

1.0 METHOD SUMMARY

This standard operation procedure (SOP) provides guidance for asbestos solids sampling. **A certified asbestos inspector must conduct the sampling in accordance with 40 CFR 763.**

2.0 EQUIPMENT/APPARATUS/REAGENTS

2.1 Equipment List

- Full face respirator
- High efficiency disposable filter cartridges
- Disposable clothing
- Plastic bags with twisters
- Labels
- Ladder
- Flashlight
- Airtight rigid sampling containers (e.g. film canisters)
- Plastic spray mister bottle with water
- Knife, linoleum cutter, cork borer, or other tools appropriate for taking samples
- Caulking gun and compound for filling holes
- Spray acrylic or adhesive
- Duct tape
- Cloths (pre-moistened)
- Vacuum cleaner equipped with high efficiency particulate air (HEPA) filter
- Ink pen
- Camera and film
- Log book
- Plastic drop cloth

3.0 PROCEDURES

1. A certified asbestos inspector must conduct the sampling in accordance with 40 CFR 763.

2. For each sampling area, prepare a diagram approximately to scale, showing all friable materials in the sampling area. It should include: an identification number, description of the sampling area, area dimensions and scale, name and telephone number of the asbestos program manager, the name of the inspector and the inspection date, and the name of the person preparing the diagram and the date prepared.

3. Decide how many samples should be taken according to the following requirements in 40 CFR 763.86.

Size of the Sampling Area	Recommended Number of Samples to be Collected	Minimum Number of Samples to be Collected
<1000 ft^2	9	3
Between 1000 and 5000 ft^2	9	5
>5000 ft^2	9	7

4. Decide on sample locations so that they are representative of the sampling area and evenly distributed throughout the sampling area.

5. Give a unique sampling identification number to each sample location

6. Spread a plastic drop cloth and set up equipment.

7. Put on protective equipment including a respirator with full face mask, high efficiency disposable filter cartridges, and disposable clothing .

8. Label container with its identification number and record number, sample location, and type of material sampled on a sampling data form. Place the label on the container itself.

9. Mark the location of the sample on the sampling diagram and record the sample identification number on the plan diagram.

10. Spray the immediate area where the sample is to be extracted with water.

11. Extract the sample using a clean knife to cut out or scrape off a piece of the material. Penetrate all layers of the material and be careful not to disturb the adjacent material.

12. Put the sample in the container and tightly seal it.

13. Wipe the outside container with a damp wipe to remove any material which may have adhered to during sampling.

14. Place the sample in a plastic bag.

15. Clean tools with damp wipes and vacuum the area with a HEPA vacuum to clean all debris.

16. Fill the hole with caulking compound on highly friable material and/or spray with an encapsulant.

17. Repeat steps 6-16 at each sample location.

18. Discard protective clothing, damp wipes and rags, cartridge filters, and drop cloth in a labeled plastic bag. Seal the bag. Retain the bag until lab results are received. Dispose of the bag as asbestos-contaminated waste (ACM) if the test results are positive for asbestos. Unless every sample tests negative for asbestos, discard the bag as ACM.

4.0 CAUTIONS AND INTERFERENCES

4.1 Thermal System Insulation

Insulation on a pipe is likely to be much more varied than material on surfaces. A building may contain insulated pipes for hot water, cold water, chilled water, steam supply, roof or system drain, and chemical or waste transport. Each system may be composed of a variety of materials such as corrugated cardboard pipe wrap, chalky white pipe wrap, fibrous glass insulation covering a pipe wrap of unknown characteristics, cementitious mud around pipe fittings, hard canvas-wrapped insulation on pipe elbows, block insulation on boilers, white batt insulation on boiler breeching, black batt insulation inside ducts, rope around pipe sleeves in ceiling and

floor slabs. Fibrous glass, foam glass, rubber, and Styrofoam are not suspect material. Each insulation type should be considered a separate component of the system and a separate area for sampling purposes. To sample thermal insulation materials follow the above procedures except holes can be patched with plastic spackling, caulk, or fibrous glass plus wetable fibrous glass cloth.

4.2 Miscellaneous Materials

Miscellaneous suspect materials are normally non-friable (with the exception of ceiling tiles). Thus, sampling is more difficult and destructive. Sampling is not recommended for these material. They should be documented in permanent records as suspect ACM.

STANDARD OPERATING PROCEDURE NO. 13.1
SOIL GAS WELL INSTALLATION USING A SLAM BAR

1.0 METHOD SUMMARY

This standard operating procedure (SOP) outlines methods used for installing soil gas wells using a slam bar. Soil gas monitoring is often shown to be an effective, non-disruptive means of quickly and broadly delineating the extent of subsurface materials containing volatile organic compounds.

A 3/8 inches diameter hole is driven into the ground to a depth of four to five feet using a commercially available slam bar. Soil gas can also be sampled at other depths by the use of a longer bar or bar attachments. A 1/4 inches O.D. stainless steel probe is inserted into the hole. The gas contained in the interstitial spaces of the soil is sampled by pulling the sample through the probe using an air sampling pump. The sample may be stored in Tedlar bags, drawn through sorbent cartridges, or analyzed directly using a direct reading instrument. The air sampling pump is not used for Summa canister sampling of soil gas. Sampling is achieved by soil gas equilibration with the evacuated Summa canister.

2.0 EQUIPMENT/APPARATUS/REAGENTS

2.1 Equipment List

- Slam Bar (1 per sampling team).
- Soil gas probes, stainless steel tubing, 1/4" O.D., 5 ft length.
- Flexible wire or cable used for clearing the tubing during insertion into the well.
- "Quick Connect" fittings to connect sampling probe tubing, monitoring instruments, and Gilian pumps to appropriate fittings on vacuum box.
- Modeling clay.
- Metal detector or magnetometer, for detecting underground utilities/pipes/drums (1 per sampling team).
- Tedlar bags
- Sorbent Cartridges
- Direct reading instrument

3.0 PROCEDURES

1. Advance a hole slightly deeper than the desired depth. For sampling up to 5 feet, a 5-ft single piston slam bar is used. For deeper depths, a piston slam bar with threaded 4-foot-long extensions can be used. Other techniques can be used, so long as holes are of narrow diameter and no contamination is introduced.
2. Carefully withdraw the slam bar to prevent collapse of the walls of the hole. The soil gas probe is then inserted.
3. Insert a metal wire or cable, slightly longer than the probe, into the probe prior to inserting into the hole to prevent plugging of the probe. Insert the probe to full depth, then pull up three to six inches. Clear the probe by moving the cable up and down. Remove the cable before sampling.
4. Seal the top of the sample hole at the surface against ambient air infiltration by using modeling clay molded around the probe at the surface of the hole.
5. If conditions preclude hand installation of the soil gas wells, the power driven system may be

employed. The generator powered demolition hammer is used to drive the probe to the desired depth (up to 12 ft may be attained with extensions). The probe is pulled up 1-3 inches if the retractable point is used. No clay is needed to seal the hole. After sampling, the probe is retrieved using the high lift jack assembly.

6. If semi-permanent soil gas wells are required, the dedicated aluminum probe points are used. These points are inserted into the bottom of the power driven probe and attached to the Teflon tubing. The probe is inserted as in step 5. When the probe is removed, the point and Teflon tube remain in the hole, which may be sealed by backfilling with clean sand, soil, or bentonite.
7. Decontaminate all equipment prior to moving to the next location (see SOP 1.5).

4.0 CAUTIONS AND INTERFERENCES

Prior to selecting sample locations, an underground utility search is recommended. The local utility companies can be contacted and requested to mark the locations of their underground lines. Sampling plans can then be drawn up accordingly. Each sample location should also be screened with a metal detector or magnetometer to verify that no underground pipes or drums exist.

STANDARD OPERATING PROCEDURE NO. 13.2
SOIL GAS WELL INSTALLATION USING A DEMOLITION HAMMER

1.0 METHOD SUMMARY

This standard operating procedure (SOP) outlines methods used for installing soil gas wells using a demolition hammer. Soil gas monitoring is often shown to be an effective, non-disruptive means of quickly and broadly delineating the extent of subsurface materials containing volatile organic compounds.

A 3/8 inch diameter hole is driven into the ground to a depth of four to five feet using a power driven sampling probe when soil conditions make sampling by hand unfeasible (e.g., frozen ground, very dense clays, pavement, etc.). Commercially available soil gas sampling probes (hollow, ½ inch O.D. steel probes) can be driven to the desired depth using a Demolition Hammer. Samples can be drawn through the probe itself, or through Teflon tubing inserted through the probe and attached to the probe point. Soil gas can also be sampled at other depths by the use of a longer bar or bar attachments. A 1/4 inch O.D. stainless steel probe is inserted into the hole. The hole is then sealed around the top of the probe using modeling clay. The gas contained in the interstitial spaces of the soil is sampled by pulling the sample through the probe using an air sampling pump. The sample may be stored in Tedlar bags, drawn through sorbent cartridges, or analyzed directly using a direct reading instrument. The air sampling pump is not used for Summa canister sampling of soil gas. Sampling is achieved by soil gas equilibration with the evacuated Summa canister.

2.0 EQUIPMENT/APPARATUS/REAGENTS

2.1 Equipment List

- Bosch demolition hammer.
- ½ inch O.D. steel probes, extensions, and points.
- Dedicated aluminum sampling points.
- 1/4 inch Teflon tubing
- "Quick Connect" fittings to connect sampling probe tubing, monitoring instruments, and Gilian pumps to appropriate fittings on vacuum box.
- Modeling clay.
- Metal detector or magnetometer, for detecting underground utilities/pipes/drums (1 per sampling team).
- Generator with extension cords.
- High lift jack assembly for removing probes.

6.0 PROCEDURES

6.1 Soil Gas Well Installation

If conditions preclude hand installation of the soil gas wells, the power driven system may be employed.

1. Drive the probe to the desired depth (up to 12 ft may be attained with extensions) using the generator powered demolition hammer. The probe is pulled up 1-3 inches if the retractable point is used. No clay is needed to seal the hole.

2. Insert a metal wire or cable, slightly longer than the probe into the probe prior to inserting into the hole to prevent plugging of the probe. Insert the probe to a full depth then pull up three to six inches and then clear by moving the cable up and down. Remove the cable before sampling.

3. If semi-permanent soil gas wells are required, the dedicated aluminum probe points are used. These points are inserted into the bottom of the power driven probe and attached to the Teflon tubing. The probe is inserted as in step 1. When the probe is removed, the point and Teflon tube remain in the hole, which may be sealed by backfilling with clean sand, soil, or bentonite.

4. The probe is retrieved using the high lift jack assembly after sampling.

5. Decontaminate all equipment prior to moving to the next location (see SOP 1.5).

4.0 CAUTIONS AND INTERFERENCES

Prior to selecting sample locations, an underground utility search is recommended. The local utility companies can be contacted and requested to mark the locations of their underground lines. Sampling plans can then be drawn up accordingly. Each sample location should also be screened with a metal detector or magnetometer to verify that no underground pipes or drums exist. See SOP 2.4 (Facility Survey).

STANDARD OPERATING PROCEDURE NO. 13.3
SOIL GAS POINT INSTALLATION USING A GEOPROBE™

1.0 METHOD SUMMARY

This standard operating procedure (SOP) outlines methods for installing soil gas wells using a Geoprobe™. Soil gas monitoring is often shown to be an effective, non-disruptive means of quickly and broadly delineating the extent of subsurface materials containing volatile organic compounds.

A 3/8 inch diameter hole is driven into the ground to a depth of four to five feet using a power driven sampling probes when soil conditions make sampling by hand unfeasible (i.e., frozen ground, very dense clays, pavement, etc.). Commercially available soil gas sampling probes (hollow, ½ inch O.D. steel probes) can be driven to the desired depth using a Geoprobe™. Samples can be drawn through the probe itself, or through Teflon tubing inserted through the probe and attached to the probe point. Soil gas can also be sampled at other depths by the use of a longer bar or bar attachments.

2.0 EQUIPMENT/APPARATUS/REAGENTS

2.1 Equipment List

- Geoprobe™.
- ½ inch O.D. steel probes, extensions, and points.
- Dedicated aluminum sampling points.
- 1/4 inch Teflon tubing
- "Quick Connect" fittings to connect sampling probe tubing, monitoring instruments, and Gilian pumps to appropriate fittings on vacuum box.
- Metal detector or magnetometer, for detecting underground utilities/pipes/drums (1 per sampling team).
- Glass barreled syringe
- Tedlar bags

3.0 PROCEDURE

The Geoprobe is a hydraulically-operated sampling device. The sampling device can be deployed from the vehicle and positioned over a sample location. The base of the sampling device is positioned on the ground. The weight of the vehicle is hydraulically raised on the base. As the weight of the vehicle is transferred to the probe, the probe is pushed into the ground. A built-in hammer mechanism allows the probe to be driven past some dense stratigraphic horizons. When the probe reaches the sample depth, up to 50 feet under favorable geologic conditions, samples can be collected.

Soil gas can be collected from specific depths in two general ways. One method involves withdrawing a sample directly from the probe rods, after evacuating a sufficient volume of air from the probe rods. The other method involves collecting a sample through tubing attached by an adaptor to the bottom probe rod section. Correctly used, this method provides more reliable results. Manufacturer's instructions for the Geoprobe™ operation should be followed.

Probes will be installed on a varying spacing depending on the availability of existing data and the previous uses of a given area. Probes consist of nominal 1-inch diameter pipes which are generally driven to a depth of 4 to 5 feet. The interval typically sampled from is 4 to 5 feet. Pipes are constructed of chrom/moly steel Geoprobes™ that are either perforated or have a perforated sampling tip installed at the end. Procedures are as follows:

1. A 1/4 inch O.D. stainless steel probe is inserted into the hole. The hole is then sealed around the top of the probe using modeling clay. The gas contained in the interstitial spaces of the soil is sampled by pulling the sample through the probe using an air sampling pump. The sample may be stored in Tedlar bags, drawn through sorbent cartridges, or analyzed directly using a direct reading instrument.

2. Remove a minimum of three probe volumes of air.

3. Using a oil-less vacuum system powered by either hand or a 12-volt battery collect soil gas samples at a rate of 1 liter/minute from individual probes.

4. Monitor the weather conditions, flow rate, vacuum, and other pertinent parameters and note them on a soil gas sampling log (see Appendix A).

5. With draw the sample from the sampling port with a glass barreled syringe through a membrane (septum) in the gas sampling line and inject directly into the GC for analysis. In cases where longer term storage is necessary they may be collected in Tedlar bags or other suitable containers. The holding times with the syringe-held samples are minimal (less than 15 minutes) and Tedlar bags are held less than 72 hours.

6. Decontaminate all equipment prior to moving to the next location (see SOP 1.5).

4.0 CAUTIONS AND INTERFERENCES

Prior to selecting sample locations, an underground utility search should be conducted in accordance with SOP 2.4

APPENDIX A
Soil Gas Sampling Log

Date: _____
Facility: _____
Field Analyst: _____
Technicians: _____
Other: _____

	Morning	Midday	Afternoon	End
Cover				
Weather				
Wind Speed				
Wind Direction				
Temperature				
Time				

No.	Probe ID	Sample Time	Vacuum (in. Hg.)	Flow (l/min)	Pump Volumes (liters)	Temperature (°F)	Syringe No. and Time Analyzed	Other Notes
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

STANDARD OPERATING PROCEDURE NO. 13.4
SOIL GAS SAMPLING USING A TEDLAR BAG

1.0 METHOD SUMMARY

This standard operating procedure (SOP) outlines methods used for soil gas samples using a Tedlar bag. Soil gas monitoring is often shown to be an effective, non-disruptive means of quickly and broadly delineating the extent of subsurface materials containing volatile organic compounds.

A 3/8 inch diameter hole is driven into the ground to a depth of four to five feet using a commercially available slam bar. Soil gas can also be sampled at other depths by the use of a longer bar or bar attachments. A 1/4 inch O.D. stainless steel probe is inserted into the hole. The gas contained in the interstitial spaces of the soil is sampled by pulling the sample through the probe using an air sampling pump. The sample may be stored in 1.0-L Tedlar bags, drawn through sorbent cartridges, or analyzed directly using a direct reading instrument. Bagged samples are best stored in dark plastic bags placed in coolers to protect the bags from any damage that may occur in the field or in transit. In addition, coolers insure the integrity of the samples by keeping them at a cool temperature and out of direct sunlight. Samples should be analyzed as soon as possible, preferably within 24 - 48 hours.

2.0 EQUIPMENT/APPARATUS/REAGENTS

2.1 Equipment List

- Vacuum box for drawing a vacuum around Tedlar bag for sample collection (1 per sampling team).
- Gilian pump Model HFS113A adjusted to approximately 3.0 L/min (1 to 2 per sample team).
- 1/4 inch Teflon tubing, 2 ft to 3 ft lengths, for replacement of contaminated sample line.
- 1/4 inch Tygon tubing, to connect Teflon tubing to probes and quick connect fittings.
- Tedlar bags, 1.0 L, at least 1 bag per sample point.
- Soil Gas Sampling labels, field data sheets, logbook, etc.
- PID/FID, or other field air monitoring devices, (1 per sampling team).
- Ice chest, for carrying equipment and for protection of samples (2 per sampling team).
- Photovac GC, for field-lab analysis of bagged samples.
- Large dark plastic garbage bags.

3.0 PROCEDURES

3.1 Screening with Field Instruments

1. Evacuate the well volume prior to sampling. Connect the Gilian pump, adjusted to 3.0 L/min, to the sample probe using a section of Teflon tubing as a connector. The pump is turned on, and a vacuum is pulled through the probe for approximately 15 seconds. Longer time is required for sample wells of greater depths.

2. After evacuation, the monitoring instrument(s) (i.e. HNu or OVA) is connected to the probe using a Teflon connector. When the reading is stable, or peaks, the reading is recorded on soil gas data sheets.
3. Of course, readings may be above or below the range set on the field instruments. The range may be reset, or the response recorded as a greater than or less than figure. Recharge rate of the well with soil gas must be considered when resampling at a different range setting.2

3.2 Tedlar Bag Sampling

1. Perform air monitoring instrument screening as directed in 3.1 or evacuate the well volume.
2. Use the vacuum box and sampling train to take the sample. The sampling train is designed to minimize the introduction of contaminants and losses due to adsorption. All wetted parts are either Teflon or stainless steel. The vacuum is drawn indirectly to avoid contamination from sample pumps.
3. Place the Tedlar bag inside the vacuum box, and attach it to the sampling port. The sample probe is attached to the sampling port via Teflon tubing and a "Quick Connect" fitting.
4. Draw a vacuum around the outside of the bag, using a Gilian pump connected to the vacuum box evacuation port, via Tygon tubing and a "Quick Connect" fitting. The vacuum causes the bag to inflate, drawing the sample.
5. Break the vacuum by removing the Tygon line from the pump. Remove the bagged sample from the box and close valve. Record data on data sheets or in logbooks. Record the date, time, sample location ID, and the PID/FID instrument reading(s) on sample bag label. Chain of Custody Sheets must accompany all samples submitted to the field laboratory for analysis.

4.0 CAUTIONS AND INTERFERENCES

Caution must be taken to ensure that the correct depth is being sampled due to site specific factors such as moisture conditions, porosity, ground water depth, and analyte specific factors such as solubility, volatility, and degradability. (VOC samples may be disturbed due to the pumping action.)

4.1 Labeling

Labels should not be pasted directly onto the bags, nor should bags be labeled directly using a marker or pen. Inks and adhesive may diffuse through the bag material, contaminating the sample. Place labels on the edge of the bags, or tie the labels to the metal eyelets provided on the bags. Markers with inks containing volatile organics (i.e., permanent ink markers) should not be used.

4.2 PID Measurements

A number of factors can affect the response of a PID (such as the HNu PI 101). High humidity can cause lamp fogging and decreased sensitivity. This can be significant when soil moisture levels are high, or when a soil gas well is actually in groundwater. High concentrations of methane can cause a downscale deflection of the meter. High and low temperature, electrical fields, FM radio transmission, and naturally occurring compounds, such as terpenes in wooded areas, will also affect instrument response. Other field screening instruments can be affected by interferences. Consult the manufacturer’s manuals.

4.3 FID Measurements

A number of factors can affect the response of an FID (such as the OVA model 128). High humidity can cause the FID to flame out or not ignite at all. This can be significant when soil moisture levels are high, or when a soil gas well is actually in groundwater. The FID can only read organic based compounds (they must contain carbon in the molecular structure). The FID also responds poorly to hydrocarbons and halogenated hydrocarbons (such as gasoline, propane fuel). High and low temperature, electrical fields and FM radio transmission will also affect instrument response.

4.4 Factors Affecting Organic Concentrations in Soil Gas

Concentrations in soil gas are affected by dissolution, adsorption, and partitioning. Partitioning refers to the ratio of component found in a saturated vapor above an aqueous solution to the amount in the solution; this can, in theory, be calculated using the Henry's Law constants. Contaminants can also be adsorbed onto inorganic soil components or "dissolved" in organic components. These factors can result in a lowering of the partitioning coefficient.

Soil "tightness" or amount of void space in the soil matrix, will affect the rate of recharging of gas into the soil gas well.

Existence of a high, or perched, water table, or of an impermeable underlying layer (such as a clay lens or layer of buried slag) may interfere with sampling of the soil gas. Knowledge of site geology is useful in such situations, and can prevent inaccurate sampling.

4.5 Soil Probe Clogging

A common problem with this sampling method is soil probe clogging. A clogged probe can be identified by using an in-line vacuum gauge or by listening for the sound of the pump laboring. This problem can usually be eliminated by using a wire cable to clear probe.

STANDARD OPERATING PROCEDURE NO. 13.5
SOIL GAS SAMPLING USING A TENAX TUBE

1.0 METHOD SUMMARY

This standard operating procedure (SOP) outlines methods for soil gas sampling using a Tedlar bag and Tenax tubes. Soil gas monitoring is often shown to be an effective, non-disruptive means of quickly and broadly delineating the extent of subsurface materials containing volatile organic compounds.

A 3/8 inch diameter hole is driven into the ground to a depth of four to five feet using a commercially available slam bar. Soil gas can also be sampled at other depths by the use of a longer bar or bar attachments. A 1/4 inch O.D. stainless steel probe is inserted into the hole. The gas contained in the interstitial spaces of the soil is sampled by pulling the sample through the probe using an air sampling pump. The sample may be stored in Tedlar bags, drawn through sorbent cartridges, or analyzed directly using a direct reading instrument. Bagged samples can be drawn onto Tenax or other sorbent tubes to undergo lab GC/MS analysis. If Tenax tubes are to be utilized, special care must be taken to avoid contamination. Handling of the tubes should be kept to a minimum and only while wearing nylon or other lint-free gloves. After sampling, each tube should be stored in a clean, sealed culture tube; the ends packed with clean glass wool to protect the sorbent tube from breakage. The culture tubes should be kept cool and wrapped in aluminum foil to prevent any photodegradation of samples.

2.0 EQUIPMENT/APPARATUS/REAGENTS

2.1 Equipment List

- Vacuum box for drawing a vacuum around Tedlar bag for sample collection (1 per sampling team).
- Gilian pump Model HFS113A adjusted to approximately 3.0 L/min (1 to 2 per sample team).
- 1/4 inch Teflon tubing, 2 ft to 3 ft lengths, for replacement of contaminated sample line.
- 1/4 inch Tygon tubing, to connect Teflon tubing to probes and quick connect fittings.
- Tedlar bags, 1.0 L, at least 1 bag per sample point.
- Soil Gas Sampling labels, field data sheets, logbook, etc.
- PID/FID, or other field air monitoring devices, (1 per sampling team).
- Ice chest, for carrying equipment and for protection of samples (2 per sampling team).
- Photovac GC, for field-lab analysis of bagged samples.
- Large dark plastic garbage bags.
- Syringe with a luer-lock tip capable of drawing a soil gas or air sample from a Tedlar bag onto a Tenax/CMS sorbent tube.
- Adapters for fitting the sorbent tube between the Tedlar bag and the sampling syringe.
- The adapter attaching the sampling syringe to the sorbent tube
- Two-stage glass sampling cartridge (1/4 inch O.D. x 1/8 inch I.D. x 5 1/8 inch) contained in a flame-sealed tube

(Manufacturer: Supelco Custom Tenax/Spherocarb Tubes) containing two sorbent sections retained by glass wool:

Front section: 150 mg of Tenax-GC

Back section: 150 mg of CMS (Carbonized Molecular Sieve)

- Teflon-capped culture tubes or stainless steel tube containers for sorbent tube storage and shipping. The culture tubes should contain a glass wool plug to prevent sorbent tube breakage during transport.
- Nylon gloves or lint-free cloth

3.0 PROCEDURE

Samples collected in Tedlar bags may be adsorbed onto Tenax tubes for further analysis by GC/MS. Refer to SOP 13.4 for sample collection procedures using a Tedlar bag.

3.1 Sample Collection

1. Handle sorbent tubes with care, using nylon gloves (or other lint-free material) to avoid contamination.
2. Break one end of the sealed tube and remove the Tenax cartridge immediately before sampling.
3. Connect the valve on the Tedlar bag to the sorbent tube adapter. Connect the sorbent tube to the sorbent tube adapter with the Tenax (white granular) side of the tube facing the Tedlar bag.
4. Connect the sampling syringe assembly to the CMS (black) side of the sorbent tube. Fittings on the adapters should be finger-tight.
5. Open the valve on the Tedlar bag.
6. Open the on/off valve of the sampling syringe. Depending on work plan stipulations, at least 10% of the soil gas samples analyzed by this GC method must be submitted for conformational GC/MS analysis (according to modified methods TO-1 [Tenax absorbent] and TO-2 [Carbon Molecular Sieve (CMS) absorbent]). Each soil gas sample must be absorbed on replicate Tenax/CMS tubes. The volume absorbed on a Tenax/CMS tube is dependent on the total concentration of the compounds measured by the photovac/GC or other applicable GC:

TOTAL CONCENTRATION	SAMPLE VOLUME
>10	Use Serial Dilution
10	10-50

5	20-100
1	100-250

1. After sampling, remove the tube from the sampling train with gloves or a clean cloth. DO NOT LABEL OR WRITE ON THE TENAX/CMS TUBE.
2. Place the sorbent tube in a conditioned stainless steel tube holder or culture tube. Culture tube caps should be sealed with Teflon tape.

3.2 Sample Labeling

Each sample tube container (not tube) must be labeled with the site name, sample station number, date sampled, and volume sampled. Chain of custody sheets must accompany all samples to the laboratory.

3.3 Quality Assurance (QA)

Before field use, a QA check should be performed on each batch of sorbent tubes by analyzing a tube by thermal desorption/cryogenic trapping GC/MS.

At least one blank sample must be submitted with each set of samples collected at a site. This trip blank must be treated the same as the sample tubes except no sample will be drawn through the tube. Sample tubes should be stored out of UV light (i.e., sunlight) and kept on ice until analysis. Samples should be taken in duplicate, when possible.

4.0 CAUTIONS AND INTERFERENCES

Caution must be taken to ensure that the correct depth is being sampled due to site specific factors such as moisture conditions, porosity, ground water depth, and analyte specific factors such as solubility, volatility, and degradability. (VOC samples may be disturbed due to the pumping action.)

Concentrations in soil gas are affected by dissolution, adsorption, and partitioning. Partitioning refers to the ratio of component found in a saturated vapor above an aqueous solution to the amount in the solution; this can, in theory, be calculated using the Henry's Law constants. Contaminants can also be adsorbed onto inorganic soil components or "dissolved" in organic components. These factors can result in a lowering of the partitioning coefficient.

Soil "tightness" or amount of void space in the soil matrix, will affect the rate of recharging of gas into the soil gas well.

Existence of a high, or perched, water table, or of an impermeable underlying layer (such as a clay lens or layer of buried slag) may interfere with sampling of the soil gas. Knowledge of site geology is useful in such situations, and can prevent inaccurate sampling.

STANDARD OPERATING PROCEDURE NO. 13.6
SOIL GAS SAMPLING USING A SUMMA CANISTER

1.0 METHOD SUMMARY

This standard operating procedure (SOP) outlines methods used for soil gas sampling using a Summa canisters. Soil gas monitoring is often shown to be an effective, non-disruptive means of quickly and broadly delineating the extent of subsurface materials containing volatile organic compounds.

A 3/8 inch diameter hole is driven into the ground to a depth of four to five feet using a commercially available slam bar. Soil gas can also be sampled at other depths by the use of a longer bar or bar attachments. A 1/4 inch O.D. stainless steel probe is inserted into the hole. The gas contained in the interstitial spaces of the soil is sampled by pulling the sample through the probe using an air sampling pump. The Summa canisters used for soil gas sampling have a 6 liter sample capacity and are certified clean by GC/MS analysis before being utilized in the field. After sampling is completed, they are stored and shipped in travel cases.

2.0 EQUIPMENT/APPARATUS/REAGENTS

2.1 Equipment List

- Gilian pump Model HFS113A adjusted to approximately 3.0 L/min (1 to 2 per sample team).
- Soil Gas Sampling labels, field data sheets, logbook, etc.
- PID/FID, or other field air monitoring devices, (1 per sampling team).
- Metal detector or magnetometer, for
- Summa canisters (plus their shipping cases) for sample, storage and transportation.

3.0 PROCEDURES

1. Take PID/FID readings prior to taking a sample and evacuate the well volume.
2. Insert Teflon tubing into the hole.
3. Attach a certified clean, evacuated 6-liter Summa canister via the 1/4 inch Teflon tubing.
4. Open valve on Summa canister. The soil gas sample is drawn into the canister by pressure equilibration. The approximate sampling time for a 6 liter canister is 20 minutes.
5. Record site name, sample location, number, and date on a chain of custody form and on a blank tag attached to the canister.

4.0 CAUTIONS AND INTERFERENCES

Caution must be taken to ensure that the correct depth is being sampled due to site specific factors such as moisture conditions, porosity, ground water depth, and analyte specific factors such as solubility, volatility, and degradability. (VOC samples may be disturbed due to the pumping action.)

4.1 Factors Affecting Organic Concentrations in Soil Gas

Concentrations in soil gas are affected by dissolution, adsorption, and partitioning. Partitioning refers to the ratio of component found in a saturated vapor above an aqueous solution to the amount in the solution; this can, in theory, be calculated using the Henry's Law constants. Contaminants can also be adsorbed onto inorganic soil components or "dissolved" in organic components. These factors can result in a lowering of the partitioning coefficient.

Soil "tightness" or amount of void space in the soil matrix, will affect the rate of recharging of gas into the soil gas well.

Existence of a high, or perched, water table, or of an impermeable underlying layer (such as a clay lens or layer of buried slag) may interfere with sampling of the soil gas. Knowledge of site geology is useful in such situations, and can prevent inaccurate sampling.

4.2 Soil Probe Clogging

A common problem with this sampling method is soil probe clogging. A clogged probe can be identified by using an in-line vacuum gauge or by listening for the sound of the pump laboring. This problem can usually be eliminated by using a wire cable to clear probe.

STANDARD OPERATING PROCEDURE NO. 14.1
AIR SAMPLING AND MONITORING DESIGN

1.0 METHOD SUMMARY

This standard operating procedure (SOP) provides guidance in developing and implementing sampling plans to assess the impact of hazardous waste sites on ambient air. It is not within the scope of this SOP to provide a generic air sampling plan. Experience, objectives, site characteristics, and chemical characteristics will dictate sampling strategy. This SOP does not address indoor air sampling.

2.0 EQUIPMENT/APPARATUS/REAGENTS

2.1 Tools/Material and Equipment List

- Camera
- Clipboard
- Laptop computer
- Site logbook

3.0 PROCEDURES

3.1 Air Monitoring Design

3.1.1 Initial Surveys

In general, the initial survey is considered to be a relatively rapid screening process for collecting preliminary data at hazardous waste sites. However, initial surveys may require many hours to complete and may consist of more than one entry.

Some information is generally known about the site; therefore, real-time instrumentation for specific compounds (i.e., detector tubes and electrochemical sensors) can be used to identify hot spots. Sufficient data should be obtained with real-time instruments during the initial entry to screen the site for various contaminants. When warranted, intrinsically safe or explosion-proof instruments should be used. An organic vapor analyzer (OVA) is typically used during this survey. These gross measurements may be used on a preliminary basis to (1) determine levels of personal protection, (2) establish site work zones, and (3) map candidate areas for more thorough qualitative and quantitative studies involving air sampling.

In some situations, the information obtained may be sufficient to preclude additional monitoring.

Materials detected during the initial survey may call for a more comprehensive evaluation of hazards and analyses for specific compounds. Since site activities and weather conditions change, a continuous program to monitor the ambient atmosphere must be established.

3.1.2 Off-Site Monitoring

Typically, perimeter monitoring with the same instruments employed for on-site monitoring is utilized to determine site boundaries. Because air is a dynamic matrix, physical boundaries like property lines and fences do not necessarily delineate the site boundary or area influenced by a release. Whenever possible, atmospheric hazards in the areas adjacent to the on-site zone should be monitored with direct- reading instruments. Monitoring at the fenceline or at varying locations off site provides useful information regarding pollutant

migration. Three to four locations downwind of the source (i.e., plume) at breathing-zone height, provide a basic fingerprint of the plume. Negative instrument readings off site should not be interpreted as the complete absence of airborne toxic substances; rather, they should be considered another piece of information to assist in the preliminary evaluation. The interpretation of negative readings is instrument-dependent. The lack of instrument readings off site should not be interpreted as the complete absence of all airborne toxic substances; rather, it is possible that the particular compound or class of compounds to which the monitoring instrument responds is not present or that the concentration of the compound(s) is below the instrument's detection limit.

3.2 Air Sampling Design

3.2.1 Sampling Plan Design

The goal of air sampling is to accurately assess the impact of a contaminant source(s) on ambient air quality. This impact is expressed in terms of overall average and/or maximum air concentrations for the time period of concern and may be affected by the transport and release of pollutants from both on- and off-site sources. The location of these sources must be taken into account as they impact the selection of sampling locations. Unlike soil and groundwater concentrations, air concentrations at points of interest can easily vary by orders of magnitude over the period of concern. This variability plays a major role in designing an air sampling plan.

Downwind air concentration is determined by the amount of material being released from the site into the air (the emission rate) and by the degree that the contamination is diluted as it is transported. Local meteorology and topography govern downwind dilution. Contaminant emission rates can also be heavily influenced by on-site meteorology and on-site activities. All of these concerns must be incorporated into an air sampling plan.

A sampling strategy can be simple or complex, depending on the sampling program objectives. Programs involving characterization of the pollutant contribution from a single point source tend to be simple, whereas sampling programs investigating fate and transport characteristics of components from diverse sources require a more complex sampling strategy. In addition, resource constraints may affect the complexity of the sampling design.

An optimal sampling strategy accounts for the following site parameters:

- Location of stationary as well as mobile sources
- Access to the sampling location
- Analytes of concern
- Analytical detection limit to be achieved
- Rate of release and transport of pollutants from sources
- Availability of space and utilities for operating sampling equipment
- Meteorological monitoring data
- Meteorological conditions in which sampling is to be conducted

The sampling strategy typically requires that the concentration of contaminants at the source or area of concern as well as background contributions be quantified. It is important to establish background levels of contaminants in order to develop a reference point from which to evaluate the source data. Field blanks and lot blanks, as well as various other types of QA/QC samples, can be utilized to determine other sources. The impact of extraneous sources on sampling results can frequently be accounted for by placing samplers upwind, downwind and crosswind from the subject source. The analytical data from these different sampling locations may be compared to determine statistical differences.

3.2.2 Sampling Objectives

The objectives of the sampling must be determined prior to developing the sampling plan. Does the sampling plan verify adequate levels of protection for on-site personnel, or address potential off-site impacts associated with the site or with site activities? In addition, the assumptions associated with the sampling program must be defined. These assumptions include whether the sampling is to take place under "typical," "worst case," or "one-time" sampling conditions. If the conditions present at the time of sampling are different from those assumed during the development of the sampling plan, then quality of the data collected may be affected. The following definitions have been established:

- Typical: routine daily sampling or routine scheduled sampling at pre-established locations.
- Worst case: sampling conducted under the worst meteorological and/or site conditions which would result in elevated ambient concentrations.
- One-time: only one chance is given to collect a sample without regard to time or conditions.

Qualitative data acquired under these conditions are usually applicable only to the time period during which the data were collected and may not provide accurate information to be used in estimating the magnitude of an air impact during other periods or over a long time interval.

The sampling objectives also dictate the detection limits. Sampling methods for airborne contaminants will depend upon the nature and state (solid, liquid or gas) of the contaminant. Gases and vapors may be collected in aqueous media or adsorbents, in molecular sieves, or in suitable containers. Particulates are collected by filters or impactors. The volume of sample to be collected is dependent upon an estimate of the contaminant concentration in the air, the sensitivity of the analytical method, and the standard or desired detection limit. A sufficient amount of sample must be collected to achieve the desired detection limit without interference from other contaminants. In addition, the selected method must be able to detect the target compound(s).

3.2.3 Location and Number of Individual Sampling Points

Choose the number and location of sampling points according to the variability, or sensitivity, of the sampling and analytical methods being utilized, the variability of contaminant concentration over time at the site, the level of precision required and cost limitations. In addition, determine the number of locations and placement of samplers by considering the nature of the response, local terrain, meteorological conditions, location of the site (with respect to other conflicting background sources), size of the site, and the number, size, and relative proximity of separate on-site emission sources and upwind sources. The following are several considerations

for sampler placement:

- Location of potential on-site emission sources, as identified from the review of site background information or from preliminary on-site inspections.
- Location of potential off-site emission sources upwind of the sampling location(s). Review local wind patterns to determine the location of off-site sources relative to wind direction.
- Topographic features that affect the dispersion and transport of airborne toxic constituents.

Avoid natural obstructions when choosing air sampling station locations, and account for channelization around those obstructions.

- Large water bodies, which affect atmospheric stability and the dispersion of air contaminants.
- Roadways (dirt or paved), which may generate dust that could mask site contaminants.
- Vegetation, such as trees and shrubs, which stabilizes soil and retards subsurface contaminants from becoming airborne. It also affects air flow and scrubs some contaminants from the air. Sometimes thick vegetation can make an otherwise ideal air monitoring location inaccessible.

Consider the duration of sampling activities when choosing the location and number of samples to be collected. For example, if the sampling period is limited to a few hours, one or two upwind and several downwind samples would typically be adequate, especially around major emission sources.

A short-term monitoring program ranges from several days to a few weeks and generally includes gathering data for site assessments, removal actions, and source determination data (for further modeling). Activities involved in a short-term sampling strategy must make the most of the limited possibilities for data collection. Consider moving upwind/downwind locations daily based on National Oceanic and Atmospheric Administration (NOAA) weather forecasts. Weather monitoring becomes critical where complex terrain and local meteorological effects frequently change wind direction. Often, a number of alternatives can fulfill the same objective.

Prevailing winds running the length of a valley usually require a minimum number of sampler locations; however, a complex valley may require more sampler locations to account for the wide variety of winds. Ocean/lake effects may require a radical plan to collect enough samples to reach a low detection limit.

Two sets of samplers may be placed next to each other: one set would be activated during the sea breeze while the other set is turned off, and vice versa when there is no sea breeze. After the sampling event, the respective upwind and downwind samples would be combined. Another alternative for sampling near a large body of water may be to use automatic, wind- vector-operated samplers, which turn the sampler on only when the wind comes from a specified vector. At sites located on hillsides, wind will move down a valley and produce an upward fetch at the same time. Sampling locations may have to ring the site to measure the wind's impact.

Off-site sources may affect on-site monitoring. In this case, on-site meteorological data, concurrent with

sampling data, is essential to interpreting the acquired data. Also, additional upwind sampling sites may be needed to fully characterize ambient background contaminant levels. Multiple off-site sources may require several monitoring locations, but if the sources are at a sufficient distance, only one monitoring location is needed.

Topography and weather are not the only factors in sampler location; the sampling sites must be secure from vandals and mishap. Secure all sampling locations to maintain chain of custody, and to prevent tampering with samples or loss of sampling units. High-volume sampling methods often require the use of 110 VAC electric power. When portable generators are used, the power quality may affect sampler operation. Also, be aware that the generators themselves could be a potential pollution source if their placement is not carefully considered.

Air quality dispersion models can be used to place samplers. The models incorporate source information, surrounding topography, and meteorological data to predict the general distance and directions of maximum ambient concentrations. Modeling results should be used to select sampling locations in areas of maximum pollutant concentrations.

3.2.4 Time, Duration and Frequency of Sampling Events

After choosing appropriate sampling or monitoring locations, determine the sampling frequency and the number of samples to be collected. The time of day, duration and frequency of sampling events is governed by:

- The effects of site activities and meteorology on emission rates
- The diurnal effect of the meteorology on downwind dispersion
- The time period(s) of concern as defined by the objective
- The variability in the impact from other off-site sources
- If defined, the degree of confidence needed for either the mean or maximum downwind concentrations observed
- The precision requirements for single measurements
- Cost and other logistical considerations

The duration of the removal action and the number of hours per day that site work is conducted determine the time, duration, and frequency of samples. Short-term sampling programs may require daily sampling, while long-term programs may require 24-hour sampling every sixth or twelfth day. If the site will be undergoing removal activities 24 hours a day, continuous air sampling may be warranted. However, if the site activities will be conducted for only eight hours a day, and there are no emissions likely to occur during the remaining 16 hours, then sampling would be appropriate prior to the start of daily activities, would continue during operations, and end at the conclusion of the daily activities. An off-peak sample collection can ensure that emissions are not persisting after the conclusion of daily cleanup activities. For some sites, emissions are still a factor several hours after daily site activities have been completed. Because of the typically decreased downwind dispersion in the evening, higher downwind concentrations than were present during daytime site

activities may be detected. For sites where this is possible, the sampling duration needs to be lengthened accordingly.

Sampling duration and flow rate dictate the volume of air collected, and to a major degree, the detection limit. The analytical method selected will provide a reference to flow rate and volume. Flow rates are limited to the capacity of the pumps being employed and the contact time required by the collection media.

The duration or period of air sampling is commonly divided into two categories (1) samples collected over a brief time period are referred to as "instantaneous" or "grab" samples and are usually collected in less than five minutes and (2) average or integrated samples are collected over a significantly longer period of time. Integrated samples provide an average concentration over the entire sampling period. Integrated samples are not suited to determining cyclical releases of contaminants because periodic or cyclical events are averaged out by the proportionally long sampling duration.

Air quality dispersion models can predict the maximum air contaminant concentration expected from a source. The meteorological and site conditions expected to cause the highest concentration are known as worst-case conditions and can be identified by analyzing the modeling results. Depending upon the objective, one may sample when the model predicts worst-case conditions will exist.

4.0 CAUTIONS AND INTERFERENCES

4.1 Meteorological Cautions and Interferences

A meteorological monitoring program is an integral part of site monitoring activities. Meteorological data, which define local terrain impacts on air flow paths, are needed to interpret air concentration data.

Meteorological data may be available from an existing station located near the site (i.e., at a local airport), otherwise a station should be set up at the site. This data will document the degree that samples actually were downwind and verify whether other worst-case assumptions were met. Meteorological parameters to be monitored are, at a minimum, wind speed, wind direction, and sigma theta (which is the horizontal wind direction standard deviation and an indicator of atmospheric stability). The remaining parameters primarily affect the amount of a contaminant available in the air.

4.1.1 Wind Speed

When the contaminant of concern is a particulate, wind speed is critical in determining whether the particulate will become airborne, the quantity of the particulate that becomes airborne, and the distance the particulate will travel from the source. Wind speed also contributes to the volatilization of contaminants from liquid sources. Also, under stagnant wind conditions, exhaust air can be re-sampled.

4.1.2 Wind Direction

Wind direction highly influences the path of airborne contaminants. In addition, variations in wind direction increase the dispersion of pollutants from a given source. Upwind sources can contribute to sample concentration. During periods when the sampler is inoperative, particulate matter may be deposited on the filter by wind.

4.1.3 Atmospheric Stability

Atmospheric stability refers to the degree to which the atmosphere tends to dampen vertical and horizontal motion. Stable atmospheric conditions (i.e., evenings) result in low dispersion, and unstable atmospheric conditions (i.e., hot sunny days) result in higher dispersion.

4.1.4 Temperature

Higher temperatures increase the rate of volatilization of organic and some inorganic compounds and affect the initial rise of gaseous or vapor contaminants. Therefore, worst-case emission of volatiles and semivolatiles occurs at the hottest time of day, or on the hottest day.

4.1.5 Humidity

High humidity affects water-soluble chemicals and particulates. Humid conditions may dictate the sampling media used to collect the air sample, or limit the volume of air sampled and thereby increase the detection limit.

4.1.6 Atmospheric Pressure

Migration of landfill gases through the landfill surface and through surrounding soils are governed by changes in atmospheric pressure. Atmospheric pressure will influence upward migration of gaseous contaminants from shallow aquifers into the basements of overlying structures. In many cases, the transport and dispersion of air pollutants is complicated by local meteorology.

4.1.7 Physical/Chemical Considerations

Normal diurnal variations (i.e., temperature inversions) affect dispersion of airborne contaminants. Terrain features can enhance or create air inversions and can also influence the path and speed of air flow, complicating transport and dispersion patterns. The chemical characteristics of a contaminant (i.e., molecular weight, physical state, vapor pressure, aerodynamic size, temperature, reactive compounds, and photodegradation) affect its behavior and can influence the method used to sample and analyze it.

4.2 Other Influences

4.2.1 Loss of Volatiles

During subsequent sampling, shipping, or storage of the filter prior to the post-sampling weighing, volatile particles collected on the filter can be lost. Thus, the filter should be re-weighed as soon as practical after sampling.

4.2.2 Artifact Particulate Matter

A higher than true TSP determination can result from artifact particulate matter forming on the surface of alkaline glass fiber filters by oxidation of acid gases in the sample air.

4.2.3 Filter Handling

The filter should be handled carefully between the pre-sampling and post-sampling weighing in order to avoid

loss of fibers or particles from the filter. To minimize error from handling, a filter paper cartridge or cassette can be used to protect the filter.

4.3 Detection Limits

Detection limits depend on the contaminants being investigated and the particular site situation. It is important to know why the data are needed and how the data will be used. Care should be taken to ensure the detection limits are adequate for the intended use of the final results. Some equipment may be sensitive to humidity and temperature extremes.

STANDARD OPERATING PROCEDURE NO. 14.2
AIR SAMPLING USING A HIGH VOLUME SAMPLER

1.0 METHOD SUMMARY

This standard operating procedure (SOP) provides guidance for the collection of total suspended particulates (TPS) using high-volume samplers. These guidelines are derived from 40 CFR 50 Chapter I, Appendix B.

2.0 EQUIPMENT/APPARATUS/REAGENTS

2.1 High-Volume, TSP Samplers

High-volume TSP samplers collect all suspended particles by drawing air across an 8- by 10-inch glass-quartz filter. The sample rate is adjusted to 40 cubic feet per minute (CFM), or 1,134 liters per minute (L/min), and it is held constant by a flow controller over the sample period. The mass of TSPs can be determined by weighing the filter before and after sampling. The composition of the filter varies according to the analytical method and the detection limit required.

2.2 Equipment List

- Camera
- Site logbook
- Clipboard
- Chain of custody records
- Custody seals
- Air sampling worksheets
- Filters supplied by the EPA National Filter Distribution Program
- High-volume sampler
- Sampler Shelter
- Flow rate measurement devices
- Manometer
- Thermometer
- Barometer
- Timing/control device
- Flow rate transfer standard, traceable to a primary standard
- Filter conditioning environment
- Analytical balance
- Area light source
- Numbering device (capable of printing identification numbers on the filters before they are placed in the filter conditioning environment)
- Positive displacement standard volume meter
- Stop-watch
- High-Volume air pump
- Large diameter rubber stopper, wide cellophane tape, or other means
- blower motor
- Glassine envelope or manila folder.

3.0 PROCEDURES

3.1 Calibration

These calibration instructions are based on 40 CFR 50 Chapter I, Appendix B, 9.0. Calibration of the high-volume samplers flow indicating device or control devices is necessary to establish traceability of the field measurement to primary standard via a flow rate transfer standard.

3.1.1 Certification of the flow indicator.

1. Get a positive displacement standard volume meter, stop-watch, manometer, thermometer, and barometer.
2. Connect the flow rate transfer standard to the inlet of the standard volume meter.
3. Connect the manometer to measure the pressure at the inlet of the standard volume meter.
4. Connect the orifice manometer to the pressure tap on the transfer standard.
5. Connect the high volume air pump to the outlet side of the standard volume meter.
6. Check for leaks by clamping both manometer lines and blocking the orifice with a large-diameter rubber stopper, wide cellophane tape, or other means. Start the high-volume air pump and note any changes in the standard volume meter reading. The reading should stay constant but if it does not, check for leaks.
7. Un-clamp both manometer lines and zero both manometers.
8. By means of variable flow resistance in the transfer standard or by varying the voltage to the air pump, achieve the appropriate flow rate through the system. The system requires at least five different but constant flow rates with at least three in the specified flow interval of 1.1 to 1.7 m^3/min or 39-60 ft^3/min.
9. Observe the barometric pressure and record as P_1.
10. Read the ambient temperature in the vicinity of the standard volume meter and record it as T_1.
11. Start the blower motor, adjust the flow, and allow the system to run for at least 1 min for a constant motor speed to be attained.
12. Observe the standard volume meter reading and simultaneously start a stopwatch. Record the initial meter reading (V_i).
13. Maintain this constant flow rate until at least 3 m^3 of air have passed through the standard volume meter. Record the standard volume meter inlet pressure manometer reading as ΔP, and the orifice manometer reading as ΔH. Be sure to indicate the correct units of measurement.
14. Observe the standard volume meter reading while simultaneously stopping the stopwatch. Record the final meter reading (V_f) and the elapsed time (t).
15. Calculate the volume measured by the standard volume meter at meter conditions of temperature and pressures as $V_m=V_f-V_i$.

16. Correct this volume to standard volume (std m^3) as follows:

$$V_{std} = V_m((P_1 - D_P)T_{std})/(P_{std}T_1)$$

where:

V_{std}=standard volume, std m^3;

V_m=actual volume measured by the standard volume meter;

P_1=barometric pressure during calibration, mm Hg or kPa;

ΔP=differential pressure at inlet to volume meter, mm Hg or kPa;

P_{std}=760 mm Hg or 101 kPa;

T_{std}=298 K;

T_1=ambient temperature during calibration, K.

Calculate the standard flow rate (std m^3/min) as follows:

$$Q_{std} = V_{std}/t$$

where:

Q_{std}=standard volumetric flow rate, std m^3/min

t=elapsed time, minutes.

Record Qstd to the nearest 0.01 std m^3/min.

17. Repeat steps 12 through 16 for at least four additional constant flow rates, evenly spaced over the approximate range of 1.0 to 1.8 std m^3/min (35-64 ft^3/min).

18. For each flow, compute

$$\sqrt{(\Delta\Delta H\ (P_1/P_{std})(298/T_1))}$$

and plot these value against Qstd. Be sure to use consistent units (mm Hg or kPa) for barometric pressure. Draw the orifice transfer standard certification curve or calculate the linear least squares slope (m) and intercept (b) of the certification curve:

$$\sqrt{(\Delta\Delta H\ (P_1/P_{std})(298/T_1))}=mQ_{std}+b$$

A certification graph should be readable to 0.02 std m^3/min.

19. Recalibrate the transfer standard annually or as required by applicable quality control procedures.

3.1.2 Calibration of Sampler Flow Indicator

Note: For samplers equipped with a flow controlling device, the flow controller must be disabled to

allow flow changes during calibration of the sampler's flow indicator, or the alternate calibration of the flow controller given in 3.1.3 may be used. For samplers using an orifice-type flow indicator downstream of the motor, do not vary the flow rate by adjusting the voltage or power supplied to the sampler.

1. A form should be used to record the calibration data.

2. Connect the transfer standard to the inlet of the sampler. Connect the orifice manometer to the orifice pressure tap. Make sure there are no leaks between the orifice unit and the sampler.

3. Operate the sampler for at least 5 minutes to establish thermal equilibrium prior to the calibration.

4. Measure and record the ambient temperature, T_2, and the barometric pressure, P_2, during calibration.

5. Adjust the variable resistance or, if applicable, insert the appropriate resistance plate (or no plate) to achieve the desired flow rate.

6. Let the sampler run for at least 2 min to re-establish the run-temperature conditions. Read and record the pressure drop across the orifice (ΔH) and the sampler flow rate indication (I).

7. Calculate $\sqrt{(\Delta\Delta H\ (P_2/P_{std})(298/T_2))}$ and determine the flow rate at standard conditions (Q_{std}) either graphically from the certification curve or by calculating Q_{std} from the least square slope and intercept of the transfer standard's transposed certification curve:

   $$Q_{std}=1/m\ \sqrt{(\Delta H\ (P_2/P_{std})(298/T_2)-b)}$$

   Record the value of Q_{std}.

8. Repeat steps 5-7 for several additional flow rates distributed over a range that includes 1.1 to 1.7 std m^3/min.

9. Determine the calibration curve by plotting values of the appropriate expression involving I, selected from Table 1, against Q_{std}.

10. Draw the sampler calibration curve or calculate the linear least squares slope (m), intercept (b), and correlation coefficient of the calibration curve: [Expression from Table 1]= m Q_{std}+b. Calibration curves should be readable to 0.02 std m^3/min.

11. For a sampler equipped with a flow controller, the flow controlling mechanism should be re-enabled and set to a flow near the lower flow limit to allow maximum control range. The sample flow rate should be verified at this time with a clean filter installed. Then add two or more filters to the sampler to see if the flow controller maintains a constant flow; this is particularly important at high altitudes where the range of the flow controller may be reduced.

3.1.3 Alternate Calibration of Flow-Controlled Samplers

A flow-controlled sampler may be calibrated solely at its controlled flow rate, provided that previous

operating history of the sampler demonstrates that the flow rate is stable and reliable. In this case, the flow indicator may remain uncalibrated but should be used to indicate any relative change between initial and final flows, and the sampler should be recalibrated more often to minimize potential loss of samples because of controller malfunction.

1. Set the flow controller for a flow near the lower limit of the flow range to allow maximum control range.
2. Install a clean filter in the sampler and carry out steps 2, 3, 4, 6, and 7 from 3.1.2.
3. Following calibration, add one or two additional clean filters to the sampler, reconnect the transfer standard, and operate the sampler to verify that the controller maintains the same calibrated flow rate; this is particularly important at high altitudes where the flow control range may be reduced.

3.2 Procedures

These procedures are based on 40 CFR 50 Chapter I, Appendix B, 8.0.

1. Number each filter, if not already numbered, near its edge with a unique identification number.
2. Back light each filter and inspect for pinholes, particles, and other imperfections; filters with visible imperfections must not be used.
3. Equilibrate each filter in the conditioning environment for at least 24-hr.
4. Following equilibration, weigh each filter to the nearest milligram and record this tare weight (W_i) with the filter identification number.
5. Do not bend or fold the filter before collection of the sample.
6. Open the shelter and install a numbered, pre-weighed filter in the sampler, following the sampler manufacturer's instructions. During inclement weather, precautions must be taken while changing filters to prevent damage to the clean filter and loss of sample from or damage to the exposed filter. Filter cassettes that can be loaded and unloaded in the laboratory may be used to minimize this problem.
7. Close the shelter and run the sampler for at least 5 min to establish run-temperature conditions.
8. Record the flow indicator reading, the barometric pressure (P_3), and the ambient temperature (T_3) (see NOTE following step12). Stop the sampler and determine the sampler flow rate (see Section 3.3). If the sample flow rate is outside the acceptable range (1.1 to 1.7 m^3/min or 39-60 ft^3/min), use a different filter, or adjust the sampler flow rate. Substantial flow adjustments may affect the calibration of the orifice-type flow indicators and may necessitate re-calibration.
9. Record the sampler identification information (filter number, site location or identification number, sample date, and starting time).
10. Set the timer to start and stop the sampler such that the sampler runs 24-hrs, from midnight to midnight (local time).

11. As soon as practical following the sampling period, run the sampler for at least 5 min to again establish run-temperature conditions.

12. Record the flow indicator reading, the barometric pressure (P_3), and the ambient temperature (T_3).

Note: No onsite pressure or temperature measurements are necessary if the sampler flow indicator does not require pressure or temperature corrections (e.g., a mass flowmeter) or if average barometric pressure and seasonal average temperature for the site are incorporated into the sampler calibration (see section 3.2.2, step 9). For individual pressure and temperature corrections, the ambient pressure and temperature can be obtained by onsite measurements or from a nearby weather station. Barometric pressure readings obtained from airports must be station pressure, not corrected to sea level, and may need to be corrected for differences in elevation between the sampler site and the airport. For samplers having flow recorders but not constant flow controllers, the average temperature and pressure at the site during the sampling period should be estimated from weather bureau or other available data.

13. Stop the sampler and carefully remove the filter, following the sampler manufacturer's instructions. Touch only the outer edges of the filter. See the precautions in step 6.

14. Fold the filter in half lengthwise so that only surfaces with collected particulate matter are in contact and place it in the filter holder (glassine envelope or manila folder).

15. Record the ending time or elapsed time on the filter information record, either from the stop set-point time, from an elapsed time indicator, or from a continuous flow record. The sample period must be 1,440 +/- 60 min. for a valid sample.

16. Record on the filter information record any other factors, such as meteorological conditions, construction activity, fires or dust storms, etc., that might be pertinent to the measurement. If the sample is known to be defective, void it at this time.

17. Equilibrate the exposed filter in the conditioning environment for at least 24-hrs.

18. Immediately after equilibration, re-weigh the filter to the nearest milligram and record the gross weight with the filter identification number. See Section 3.3 for TSP concentration calculations.

3.3 Calculations of TSP Concentrations

These calculation instructions are based on 40 CFR 50 Chapter I, Appendix B, 10.0.

1. Determine the average sampler flow rate during the sampling period according to either a or b below.

   a. For a sampler without a continuous flow recorder, determine the appropriate expression to be used from Table 2 corresponding to the one from Table 1 used in section 3.1.2 step 9. Using this appropriate expression, determine Q_{std} for the initial flow rate from the sampler calibration curve, either graphically or from the transposed regression equation:

   Q_{std} = 1/m ([Appropriate expression from Table 2] - b)

Similarly, determine Q_{std} from the final flow reading, and calculate the average flow Q_{std} as one-half the sum of the initial and final flow rates.

b. For a sampler with a continuous flow recorder, determine the average flow rate device reading, I, for the period. Determine the appropriate expression from Table 2 corresponding to the one from Table 1 used in 3.1.2 step 9. Then using this expression and the average flow rate reading, determine Q_{std} from the sampler calibration curve, either graphically or from the transposed regression equation:

Q_{std} =1/m ([Appropriate expression from Table 2] - b)

If the trace shows substantial flow change during the sampling period, greater accuracy may be achieved by dividing the sampling period into intervals and calculating an average reading before determining Q_{std}

2. Calculate the total air volume sampled as:

$V\text{-}Q_{std} \times t$

where:

V=total air volume sampled, in standard volume units, std m^3;

Q_{std}=average standard flow rate, std m^3 min;

t=sampling time, min.

3. Calculate and report the particulate matter concentration as:

$TSP=((W_f - W_i) \times 10^6)/V$

Where:

TSP=mass concentration of total suspended particulate matter, µg/std m^3 ;

W_i=initial weight of clean filter, g;

W_f=final weight of exposed filter, g;

V=air volume sampled, converted to standard conditions, std m^3,

10^6=conversion of g to µg.

4. If desired, the actual particulate matter concentration can be calculated as follows:

$(TSP)_a=TSP\ (P_3/P_{std})(298/T_3)$

where:

$(TSP)_a$=actual concentration at field conditions, $\mu g/m^3$;

TSP=concentration at standard conditions, $\mu g/std\ m^3$;

P_3=average barometric pressure during sampling period, mm Hg;

P_{std}=760 mn Hg (or 101 kPa);

T_3=average ambient temperature during sampling period, K.

4.0 CAUTIONS AND INTERFERENCES

4.1 Meteorological Cautions and Interferences

A meteorological monitoring program is an integral part of site monitoring activities. Meteorological data, which define local terrain impacts on air flow paths, are needed to interpret air concentration data.

Meteorological data may be available from an existing station located near the site (i.e., at a local airport), otherwise a station should be set up at the site. This data will document the degree that samples actually were downwind and verify whether other worst-case assumptions were met. Meteorological parameters to be monitored are, at a minimum, wind speed, wind direction, and sigma theta (which is the horizontal wind direction standard deviation and an indicator of atmospheric stability). The remaining parameters primarily affect the amount of a contaminant available in the air.

4.1.1 Wind Speed

When the contaminant of concern is a particulate, wind speed is critical in determining whether the particulate will become airborne, the quantity of the particulate that becomes airborne, and the distance the particulate will travel from the source. Wind speed also contributes to the volatilization of contaminants from liquid sources. Also, under stagnant wind conditions, exhaust air can be re-sampled.

4.1.2 Wind Direction

Wind direction highly influences the path of airborne contaminants. In addition, variations in wind direction increase the dispersion of pollutants from a given source. Upwind sources can contribute to sample concentration. During periods when the sampler is inoperative, particulate matter may be deposited on the filter by wind.

4.1.3 Atmospheric Stability

Atmospheric stability refers to the degree to which the atmosphere tends to dampen vertical and horizontal motion. Stable atmospheric conditions (i.e., evenings) result in low dispersion, and unstable atmospheric conditions (i.e., hot sunny days) result in higher dispersion.

4.1.4 Temperature

Higher temperatures increase the rate of volatilization of organic and some inorganic compounds and affect the initial rise of gaseous or vapor contaminants. Therefore, worst-case emission of volatiles and semivolatiles

occurs at the hottest time of day, or on the hottest day.

4.1.5 Humidity

High humidity affects water-soluble chemicals and particulates. Humid conditions may dictate the sampling media used to collect the air sample, or limit the volume of air sampled and thereby increase the detection limit.

4.1.6 Atmospheric Pressure

Migration of landfill gases through the landfill surface and through surrounding soils are governed by changes in atmospheric pressure. Atmospheric pressure will influence upward migration of gaseous contaminants from shallow aquifers into the basements of overlying structures. In many cases, the transport and dispersion of air pollutants is complicated by local meteorology.

4.1.7 Physical/Chemical Considerations

Normal diurnal variations (i.e., temperature inversions) affect dispersion of airborne contaminants. Terrain features can enhance or create air inversions and can also influence the path and speed of air flow, complicating transport and dispersion patterns. The chemical characteristics of a contaminant (i.e., molecular weight, physical state, vapor pressure, aerodynamic size, temperature, reactive compounds, and photodegradation) affect its behavior and can influence the method used to sample and analyze it.

4.2 Other Influences

4.2.1 Loss of Volatiles

During subsequent sampling, shipping, or storage of the filter prior to the post-sampling weighing, volatile particles collected on the filter can be lost. Thus, the filter should be re-weighed as soon as practical after sampling.

4.2.2 Artifact Particulate Matter

A higher than true TSP determination can result from artifact particulate matter forming on the surface of alkaline glass fiber filters by oxidation of acid gases in the sample air.

4.2.3 Filter Handling

The filter should be handled carefully between the pre-sampling and post-sampling weighing in order to avoid loss of fibers or particles from the filter. To minimize error from handling, a filter paper cartridge or cassette can be used to protect the filter.

4.3 Detection Limits

Detection limits depend on the contaminants being investigated and the particular site situation. It is important to know why the data are needed and how the data will be used. Care should be taken to ensure the detection limits are adequate for the intended use of the final results. Some equipment may be sensitive to humidity and temperature extremes.

Table 1. Expressions for Plotting Sampler Calibration Curves

Type of sampler flow rate measuring device	Expression	
	For actual pressure and temperature corrections	For incorporation of geographic average pressure and seasonal average temperature
Mass flow meter	1	1
Orifice and pressure indicator	$\sqrt{(I(P_2/P_{std})(298/T_2))}$	$\sqrt{(I(P_2/P_a)(T_a/T_2))}$
Rotameter or orifice and pressure recorder having square root scale.	$I\sqrt{((P_2/P_{std})(298/T_2))}$	$I\sqrt{((P_2/P_a)(T_a/T_2))}$

Table 2. Expressions for Determining Flow Rate During Sampler Operation

Type of sampler flow rate measuring device	Expression	
	For actual pressure and temperature corrections	For use when geographic average pressure and seasonal average temperature have been incorporated into the sampler calibration
Mass flowmeter	1	1
Orifice and pressure indicator	$\sqrt{(I(P_2/P_{std})(298/T_3))}$	$\sqrt{I}$
Rotameter or orifice and pressure recorder having square root scale.	$I\sqrt{((P_2/P_{std})(298/T_3))}$	I

STANDARD OPERATING PROCEDURE NO. 14.3
AIR SAMPLING USING A PM_{10} SAMPLER

1.0 METHOD SUMMARY

This standard operating procedure (SOP) provides guidance for the collection of particulates with an aerodynamic diameter of 10 microns or less from ambient air over a 24-hour period using a PM_{10} sampler.

2.0 EQUIPMENT/APPARATUS/REAGENTS

2.1 PM_{10} Samplers

PM_{10} samplers collect particulates with an aerodynamic diameter of 10 microns or less from ambient air. Particulates of this size represent the respirable fraction, and thus are of special significance. PM_{10} samplers can be high-volume or low-volume. The high-volume sampler operates in the same manner as the total suspended particulate sampler at a constant flow rate of 40 cubic feet per minute (CFM); it draws the sample through a special impactor head which collects particulates of 10 microns or less. The particulate is collected on an 8- by 10-inch quartz filter. The low-volume sampler operates at a rate of approximately 17 L/min. The flow must remain constant through the impactor head to maintain the 10-micron cut-off point. The low-volume PM_{10} collects the sample on 37-mm Teflon® filters.

2.2 Equipment List

- Camera
- Site logbook
- Clipboard
- Chain of custody records
- Custody seals
- Air sampling worksheets
- PM-10 Sampler
- Filters
- Flow rate transfer standard
- Filter conditioning environment
- Analytical balance
- Petri dish, glassine envelope, or manila folder

3.0 PROCEDURES

3.1 Calibration

These calibration instruction a re based on 40 CFR 50 Chapter I, Appendix J, 8.0.

3.1.1 General Requirements

1. A flow rate transfer standard calibrated against a primary flow or volume standard shall be used to calibrate or verify the accuracy of the sampler's flow measurement device.

2. Particle size discrimination by inertial separation requires that specific air velocities be maintained throughout the sampling period within the design flow rate range specified by the manufacturer in the sampler's air inlet system. Design flow rates are specified as actual volumetric flow rates, measured at existing conditions of temperature and pressure (Q_a). In contrast, mass concentrations of PM_{10} are

computed using flow rates corrected to EPA reference conditions of temperature and pressure (Q_{std}).

3.1.2 Flow Rate Calibration Procedure

The specific procedure used for flow rate calibration or verification will vary depending on the type of flow controller and flow indicator employed. Calibration in terms of actual volumetric flow rates (Q_a) is generally recommended, but other measures of flow rate (e.g., Q_{std}) may be used provided the requirements of section 3.1.1 are met. See the sampler manufacturer's instruction manual and for further guidance on calibration.

Calibrate the flow rate transfer standard against a primary flow or volume standard traceable to NBS. Establish a calibration equation or family of curves accurate to within 2 percent over the expected range of ambient conditions (i.e., temperatures and pressures) under which the transfer standard will be used. Recalibrate the transfer standard periodically.

1. Following the sampler manufacturer's instruction manual, remove the sampler inlet and connect the flow rate transfer standard to the sampler such that the transfer standard accurately measures the sampler's flow rate. Check to make sure there are no leaks between the transfer standard and the sampler.

2. Choose a minimum of three flow rates (m^3/min), spaced over the acceptable flow rate range specified for the inlet, that can be obtained by suitable adjustment of the sampler flow rate. In accordance with the sampler manufacturer's instruction manual, obtain or verify the calibration relationship between the flow rate (m^3/min) as indicated by the transfer standard and the sampler's flow indicator response. Record the ambient temperature and barometric pressure. Temperature and pressure corrections to subsequent flow indicator readings may be required for certain types of flow measurement devices. Consult the sampler manufacturer's instruction manual for additional guidance.

3. Verify that the sampler is operating at its design flow rate (m^3/min) with a clean filter in place.

4. Replace the sampler inlet.

3.2 Procedure

These procedures are based on 40 CFR 50 Chapter I, Appendix J, 9.0.

The sampler shall be operated in accordance with the sampler manufacturer's instruction manual. The general procedure given here assumes that the sampler's flow rate calibration is based on flow rates at ambient conditions (Q_a) and discusses the steps involved in the operation of a PM_{10} sampler.

1. Inspect each filter for pinholes, particles, and other imperfections. Assign an identification number to each filter and create a form to record filter information.

2. Equilibrate each filter in the conditioning environment for at least 24 hours.

3. Weigh each filter and record the pre-sampling weight with the filter identification number.

4. Install a pre-weighed filter in the sampler following the instructions provided in the sampler manufacturer's instruction manual.

5. Turn on the sampler and allow it to establish run-temperature conditions. Record the flow indicator reading, the ambient temperature, and barometric pressure. Determine the sampler flow rate (m^3/min) in

accordance with the instructions provided in the sampler manufacturer's instruction manual.

NOTE.- Onsite temperature or pressure measurements are necessary if the sampler's flow indicator requires temperature or pressure corrections or if seasonal average temperature and average barometric pressure for the sampling site are incorporated into the sampler calibration. Ambient temperature and barometric pressure can be obtained by on-site measurements or from a nearby weather station.

6. If the flow rate is outside the acceptable range specified by the manufacturer, check for leaks, and if necessary, adjust the flow rate to the specified set point. Stop the sampler.

7. Set the timer to start and stop the sampler at appropriate times over a 24-hour period. Set the elapsed time meter to zero or record the initial meter reading.

8. Record the sample information including: site location or identification number, sample date, filter identification number, and sampler model and serial number.

9. Sample for 24+/-1 hours.

10. Determine and record the average flow rate (Q_a) in actual m^3/min for the sampling period in accordance with the instructions provided in the sampler manufacturer's instruction manual. Record the elapsed time meter final reading, the average ambient temperature, and barometric pressure for the sampling period (see note following step 6).

11. Carefully remove the filter from the sampler, following the sampler manufacturer's instruction manual. Touch only the outer edges of the filter.

12. Place the filter in a protective holder or container (e.g., petri dish, glassine envelope, or manila folder).

13. Record any factors such as meteorological conditions, construction activity, fires or dust storms, etc., that might be pertinent to the measurement on the filter information record.

14. Transport the exposed sample filter to the filter conditioning environment as soon as possible for equilibration and subsequent weighing.

15. Equilibrate the exposed filter in the conditioning environment for at least 24 hours under the same temperature and humidity conditions used for pre-sampling filter equilibration (see 3).

16. Immediately after equilibration, re-weigh the filter and record the post-sampling weight with the filter identification number.

3.3 Calculations

These calculation instruction are based on 40 CFR 50 Chapter I, Appendix J, 11.0.

1. Calculate the average flow rate over the sampling period corrected to EPA reference conditions as Q_{std}. When the sampler's flow indicator is calibrated in actual volumetric units (Q_a), Q_{std} is calculated as: $Q_{std}=Q_a \times (P_{av}/T_{av})(T_{std}/P_{std})$

   where

Q_{std}=average flow rate at EPA reference conditions, std m^3/min

Q_a=average flow rate at ambient conditions, m^3/min

P_{av}=average barometric pressure during the sampling period or average barometric pressure for the sampling site, kPa (or mm Hg)

T_{av}=average ambient temperature during the sampling period or seasonal average ambient temperature for the sampling site, K

T_{std}=standard temperature, defined as 298 K; P_{std}=standard pressure, defined as 101.3 kPa (or 760 mm Hg).

2. Calculate the total volume of air sampled as: $V_{std}=Q_{std} \times t$

where

V_{std}=total air sampled in standard volume units, std m^3;

t=sampling time, min.

3. Calculate the PM_{10} concentration as: $PM_{10}=(W_f-W_i)x10^6/V_{std}$

where

PM_{10}=mass concentration of PM_{10}, µg/std m^3

Wf, Wi=final and initial weights of filter collecting PM_{10} particles, g

10^6=conversion of g to µg.

Note: If more than one size fraction in the PM_{10} size range is collected by the sampler, the sum of the net weight gain by each collection filter [$\Sigma(W_f-W_i)$] is used to calculate the PM_{10} mass concentration.

4.0 CAUTIONS AND INTERFERENCES

4.1 Meteorological Cautions and Interferences

A meteorological monitoring program is an integral part of site monitoring activities. Meteorological data, which define local terrain impacts on air flow paths, are needed to interpret air concentration data.

Meteorological data may be available from an existing station located near the site (i.e., at a local airport), otherwise a station should be set up at the site. This data will document the degree that samples actually were downwind and verify whether other worst-case assumptions were met. Meteorological parameters to be monitored are, at a minimum, wind speed, wind direction, and sigma theta (which is the horizontal wind direction standard deviation and an indicator of atmospheric stability). The remaining parameters primarily affect the amount of a contaminant available in the air.

4.1.1 Wind Speed

When the contaminant of concern is a particulate, wind speed is critical in determining whether the particulate will become airborne, the quantity of the particulate that becomes airborne, and the distance the particulate will

travel from the source. Wind speed also contributes to the volatilization of contaminants from liquid sources.

4.1.2 Wind Direction

Wind direction highly influences the path of airborne contaminants. In addition, variations in wind direction increase the dispersion of pollutants from a given source. Upwind sources can contribute to sample concentration.

4.1.3 Atmospheric Stability

Atmospheric stability refers to the degree to which the atmosphere tends to dampen vertical and horizontal motion. Stable atmospheric conditions (i.e., evenings) result in low dispersion, and unstable atmospheric conditions (i.e., hot sunny days) result in higher dispersion.

4.1.4 Temperature

Higher temperatures increase the rate of volatilization of organic and some inorganic compounds and affect the initial rise of gaseous or vapor contaminants. Therefore, worst-case emission of volatiles and semivolatiles occurs at the hottest time of day, or on the hottest day.

4.1.5 Humidity

High humidity affects water-soluble chemicals and particulates. Humid conditions may dictate the sampling media used to collect the air sample, or limit the volume of air sampled and thereby increase the detection limit.

4.1.6 Atmospheric Pressure

Migration of landfill gases through the landfill surface and through surrounding soils are governed by changes in atmospheric pressure. Atmospheric pressure will influence upward migration of gaseous contaminants from shallow aquifers into the basements of overlying structures. In many cases, the transport and dispersion of air pollutants is complicated by local meteorology.

4.1.7 Physical/Chemical Considerations

Normal diurnal variations (i.e., temperature inversions) affect dispersion of airborne contaminants. Terrain features can enhance or create air inversions and can also influence the path and speed of air flow, complicating transport and dispersion patterns. The chemical characteristics of a contaminant (i.e., molecular weight, physical state, vapor pressure, aerodynamic size, temperature, reactive compounds, and photodegradation) affect its behavior and can influence the method used to sample and analyze it.

4.2 Other Influences

4.2.1 Surrounding Contaminants

Natural sources, such as biological waste, can produce hydrogen sulfide and methane which may contribute to the overall contaminant level. Extraneous anthropogenic contaminants (i.e., burning of fossil fuels; emissions from vehicular traffic, especially diesel; volatile compounds from petrochemical facilities; and effluvium from smoke stacks) may also contribute. Air sampling stations should be strategically placed to identify contributing sources. Positive errors in concentrations may occur due to retention of gaseous species, such as sulfur dioxide and nitric acid, on filters.

4.2.2 Volatile Particles

During subsequent sampling, shipping, or storage of the filter prior to the post-sampling weighing, volatile particles collected on the filter can be lost. Thus, the filter should be re-weighed as soon as practical after sampling.

4.2.3 Filter Handling

The filter should be handled carefully between the pre-sampling and post-sampling weighing in order to avoid loss of fibers or particles from the filter. To minimize error from handling, a filter paper cartridge or cassette can be used to protect the filter.

4.3 Detection Limits

Detection limits depend on the contaminants being investigated and the particular site situation. It is important to know why the data are needed and how the data will be used. Care should be taken to ensure the detection limits are adequate for the intended use of the final results. Some equipment may be sensitive to humidity and temperature extremes.

1.0 METHOD SUMMARY

This standard operating procedure (SOP) provides guidance for the collection semivolatiles, PCBs, pesticides, or chlorinated dioxins in ambient air using a PS-1 Sampler.

2.0 EQUIPMENT/APPARATUS/REAGENTS

2.1 High-Volume PS-1 Samplers

High-volume PS-1 samplers draw a sample through polyurethane foam (PUF) or a combination foam and XAD-2 resin plug, and a glass quartz filter at a rate of 5-10 CFM (144 to 282 L/min). This system is for measuring low concentrations of semivolatiles, PCBs, pesticides, or chlorinated dioxins in ambient air.

2.2 Equipment List

- Camera
- Site logbook
- Clipboard
- Chain of custody records
- Custody seals
- Air sampling worksheets
- High-volume sampler
- Sampling module
- High-volume sampler calibrator
- Ice chest
- Quartz fiber filter
- Polyurethane foam (PUF) plugs
- XAD-2® resin
- Teflon® end caps
- Sample cartridge aluminum shipping containers
- Glass sample cartridge
- Aluminum foil
- Hexane, reagent grade, in a Teflon® squeeze
- Wide duct tape or a rubber stopper
- Disposable lint-free nylon or cotton gloves
- Teflon®-tipped forceps

3.0 PROCEDURES

3.1 Calibration

These calibration instructions are based on Method TO-13 of the Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air.

These calibration instructions were developed for the PS-1 semi-volatile sampler provided by General Metal Works, Village of Cleves, OH as a guideline. Other manufacturers' equipment should work as well; however, modifications to these procedures may be necessary.

Each sampler should be calibrated:

- When new
- After major repairs or maintenance
- Whenever any audit point deviates from the calibration curve by more than 7 percent
- Before/after each sampling event
- When a different sample collection medium, other than that which the sampler was originally calibrated to, will used for sampling

3.1.1 Calibration of Orifice Transfer Standard

Calibrate the modified high volume air sampler in the field using a calibrated orifice flow rate transfer standard. Certify the orifice transfer standard in the laboratory against a positive displacement rootsmeter (see Figure 7 of TO -13). Once certified, the recertification is performed rather infrequently if the orifice is protected from damage. Recertify the orifice transfer standard performed once per year utilizing a set of five multi-hole resistance plates.

The following procedure outlines the steps to calibrate the orifice transfer standard in the laboratory.

1. Record the room temperature (T_1 in °C) and barometric pressure (P_b in mm Hg) on the Orifice Calibration Data Sheet (see Figure 8 of TO-13). Calculate the room temperature in K and record on Orifice Calibration Data Sheet.

   T_1 K = 273° + T_1 °C

2. Set up laboratory orifice calibration equipment as illustrated in Figure 7 of TO-13. Check the oil level of the rootsmeter prior to starting. There are three oil level indicators, one at the clear plastic end, and two sight glasses, one at each end of the measuring chamber.
3. Check for leaks by clamping both manometer lines, blocking the orifice with cellophane tape, turning on the high-volume motor, and noting any change in the rootsmeter's reading. If the rootsmeter's reading changes, there is a leak in the system, which needs to be eliminated before proceeding. If the rootsmeter's reading remains constant, turn off the hi-vol motor, remove the cellophane tape, and unclamp both manometer lines.
4. Install the 5-hole resistance plate between the orifice and the filter adapter.
5. Turn manometer tubing connectors one turn counter-clockwise. Make sure all connectors are open.
6. Adjust both manometer midpoints by sliding their movable scales until the zero point corresponds with the meniscus. Gently shake or tap to remove any air bubbles and/or liquid remaining on tubing connectors.
7. Turn on the high-volume motor and let it run for 5 minutes to set the motor brushes. Turn the motor off. Ensure manometers are set to zero and turn the high-volume motor on.
8. Record the time in minutes required to pass a known volume of air (through the rootsmeter by using the rootsmeter's digital volume dial and a stopwatch.
9. Record both the orifice water manometer (ΔH) and rootsmeter mercury manometer (ΔP) on Orifice Calibration Data Sheet (see Figure 8 of TO-13).
10. Turn off the high-volume motor
11. Repeat steps 3 through 11 for each resistance plate.

12. The placement of the orifice prior to the rootsmeter causes the pressure at the inlet of the rootsmeter to be reduced below atmospheric conditions, thus causing the measured volume to be incorrect. The volume measured by the rootsmeter must be corrected. Correct the measured volumes on the Orifice Calibration Data Sheet:

$V_{std} = V_m ((P_a - \Delta P)T_{std})/(P_{std}T_a)$

where:

V_{std} = standard volume, std m^3

V_m = actual volume measured by the rootsmeter, m^3

P_a = barometric pressure during calibration, mm Hg

ΔP = differential pressure at inlet to volume meter, mm Hg

P_{std} = 760 mm Hg

T_{std} = 298 K

T_a = ambient temperature during calibration, K.

13. Record standard volume on Orifice Calibration Data Sheet.

14. The standard flow rate as measured by the rootsmeter can now be calculated using the following formula:

$Q_{std} = V_{std}/\theta$

where:

Q_{std} = standard volumetric flow rate, std m /min $_{std}$

θ= elapsed time, min

15. Record the standard flow rates to the nearest 0.01 std m^3/min.

16. Calculate and record $\sqrt{(\Delta H(P_1/P_{std})(298/T_1))}$value for each standard flow rate.

17. Plot each $\sqrt{(\Delta H(P_1/P_{std})(298/T_1))}$ value (y-axis) versus its associated standard flow rate (x-axis) on arithmetic graph paper and draw a line of best fit between the individual plotted points. This graph will be used in the field to determine standard flow rate.

3.1.2 Calibration of the High-Volume Sampling System Utilizing Calibrated Orifice Transfer Standard

1. Set up the calibration system as illustrated in Figure 9 of TO-13. Monitor the airflow through the sampling system with a venturi/Magnehelic assembly, as illustrated in Figure 9 of TO-13. Audit the field sampling system once per quarter using a flow rate transfer standard, as described in the EPA High-Volume Sampling Method, 40 CFR 50, Appendix B or SOP 14.1. Perform a single-point calibration before and after each sample collection.

2. Prior to initial multi-point calibration, place an empty glass cartridge in the sampling head and activate the sampling motor. Fully open the flow control valve and adjust the voltage variator so that a sample flow rate corresponding to 110 percent of the desired flow rate (typically 0.20 to 0.28 m^3/min) is indicated on the Magnehelic gauge (from the previously obtained multipoint calibration curve). Allow the motor to warm up for 10 min and then adjust the flow control valve to achieve the desire flow rate. Turn off the sampler. Record the ambient temperature and barometric pressure on the Field Calibration Data Sheet (see Figure 10 of TO-13).

3. Place the orifice transfer standard on the sampling head and attach a manometer to the tap on the transfer standard, as illustrated in Figure 9 of TO-13. Properly align the retaining rings with the filter holder and secure by tightening the three screw clamps. Connect the orifice transfer standard by way of the pressure tap to a manometer using a length of tubing. Set the zero level of the manometer or Magnehelic. Attach the Magnehelic gauge to the sampler venturi quick release connections. Adjust the zero using the zero adjust screw on face of the gauge.

4. To leak test, block the orifice with a rubber stopper, wide duct tape, or other suitable means. Seal the pressure port with a rubber cap or similar device. Turn on the sampler.

5. Gently rock the orifice transfer standard and listen for a whistling sound that would indicate a leak in the system. All leaks must be eliminated before proceeding with the calibration. When the sample is determined to be leak-free, turn off the sampler and unblock the orifice. Now remove the rubber stopper or plug from the calibrator orifice.

6. Turn the flow control valve to the fully open position and turn the sampler on. Adjust the flow control valve until a Magnehelic reading of approximately 70 in. is obtained. Allow the Magnehelic and manometer readings to stabilize and record these values on the orifice transfer Field Calibration Data Sheet (see Figure 10 of TO-13).

7. Record the manometer reading under Y1 and the Magnehelic reading under Y2 on the Field Calibration

8. Repeat the above steps using Magnehelic settings of 60, 50, 40, 30, 20, and 10 inches.

9. Turn the voltage variator to maximum power, open the flow control valve, and confirm that the Magnehelic reads at least 100 inches. Turn off the sampler and confirm that the Magnehelic reads zero.

10. Read and record the following parameters on the Field Calibration Data Sheet:

    - Data, job number, and operator's signature.
    - Ambient barometric pressure.
    - Sampler serial number.
    - Ambient temperature.

11. Remove the "dummy" cartridge and replace with a sample cartridge.

12. Obtain the manufacturer high volume orifice calibration certificate.

13. If not performed by the manufacturer, calculate values for each calibrator orifice static pressure (Column 6, inches of water) on the manufacturer's calibration certificate using the following equation:

    $\sqrt{(\Delta H(P_a/760)[298/(T_a+273)])}$

    where:

    P_a = the barometric pressure (mm Hg) at time of manufacturer calibration, mm Hg

    T_a = temperature at time of calibration,°C

14. Perform a linear regression analysis using the values in Column 7 of the manufacturer's High Volume Orifice Calibration Certificate for flow rate (Q_{std}) as the "X" values and the calculated values as the Y values. From this relationship, determine the correlation (CC1), intercept (B1), and slope (M1) for the Orifice Transfer Standard.

15. Record these values on the Field Calibration Data Sheet (see Figure 10 of TO-13).

16. Using the Field Calibration Data Sheet values (see Figure 10 of TO-13), calculate and record the Orifice Manometer Calculated Values (Y3) for each orifice manometer reading using the following equation:

Y3 Calculation

$Y3 = \{Y1(P_a /760)[298/(T_a + 273)]\}^{1/2}$

17. Calculate and record the Sampler Magnehelic Calculated Value (Y4) using the following equation:

Y4 Calculation

$Y4 = \{Y2(P_a /760)[298/(T_a + 273)]\}^{1/2}$

18. Calculate and record the Orifice Flow Rate (X1) in scm using the following equation:

X1 Calculation

X1 = (Y3 - B1)/M1

19. Perform a linear regression of the values in Column X1 (as X) and the values in Column Y4 (as Y). Record the relationship for correlation (CC2), intercept (B2), and slope (M2) on the Field Calibration Data Sheet. The correlation coefficient must be 0.990 or greater.

20. Using the following equation, calculate a set point (SP) for the manometer to represent a desired flow rate:

Set Point

Set point (SP) = $[(\text{Expected } P_a)/(\text{Expected } T_a)(T_{std} /P_{std})][M2 (\text{Desired flow rate}) + B2]^2$

where:

P_a = Expected atmospheric pressure (P_a), mm Hg

T_a = Expected atmospheric temperature (T_a), 273 + °C

M2 = Slope of developed relationship

B2 = Intercept of developed relationship

T_{std} = Temperature standard, 273 + 25°C

P_{std} = Pressure standard, 760 mm Hg

21. During monitoring, calculate a flow rate from the observed Magnehelic reading using the following equations:

Flow Rate

$Y5 = [\text{Average Magnehelic Reading } (\Delta H) (P_a /T_a)(T_{std} /P_{std})]^{1/2}$

where:

Y5 = Corrected average magnehelic reading

X2 = Instant calculated flow rate, scm

22. The relationship in calibration of a sampling system between Orifice Transfer Standard and flow rate through the sampler is illustrated in Figure 11 of TO-13.

3.1.3 Single-Point Audit of the High Volume Sampling System Utilizing Calibrated Orifice Transfer Standard

For samplers, perform a calibration check for the operational flow rate before each 24-hour sampling event and when required as outlined in the user quality assurance program. Maintain a control chart presenting the percentage difference between a sampler's indicated and measured flow rates to a quick reference of sampler flow-rate drift problems.

1. Perform a single point flow audit check before and after each sampling period utilizing the Calibrated Orifice Transfer Standard.
2. Prior to single point audit, place a "dummy" glass cartridge in the sampling head and activate the sampling motor. Fully open the flow control valve and adjust the voltage variator so that a sample flow rate corresponding to 110 percent of the desired flow rate (typically 0.19 to 0.28 m3/min) is indicated on the Magnehelic gauge (based on the previously obtained multipoint calibration curve). Allow the motor to warm up for 10 minutes and then adjust the flow control valve to achieve the desired flow rate. Turn off the sampler. Record the ambient temperature and barometric pressure on the Field Test Data Sheet (see Figure 12 of TO-13).
3. Place the flow rate transfer standard on the sampling head.
4. Properly align the retaining rings with the filter holder and secure by tightening the three screw clamps. Connect the flow rate transfer standard to the manometer using a length of tubing.
5. Using tubing, attach one manometer connector to the pressure tap of the transfer standard. Leave the other connector open to the atmosphere.
6. Adjust the manometer midpoint by sliding the movable scale until the zero point corresponds with the water meniscus. Gently shake or tap to remove any air bubbles and/or liquid remaining on tubing connectors. (If additional liquid is required, remove tubing connector and add clean water.)
7. Turn on the high-volume motor and let run for 5 minutes.
8. Record the pressure differential indicated, ΔH, in inches of water, on the Field Test Data Sheet.
9. Record the observed Magnehelic gauge reading in inches of water on the Field Test Data Sheet.
10. Using previous established Orifice Transfer Standard curve, calculate Q_{xs} (see Section 3.3.2 number 23).
11. This flow should be within ±10 percent of the sampler set point, normally, 0.224 m^3 . If not, perform a new multipoint calibration of the sampler.
12. Remove flow rate transfer standard and dummy sorbent cartridge.

3.2 Procedure

These procedures are based on Method TO-13 of the Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air.

These procedures were developed for the PS-1 semi-volatile sampler provided by General Metal Works, Village of Cleves, OH as a guideline. Other manufacturers' equipment should work as well; however, modifications to these procedures may be necessary if another commercially available sampler is selected.

3.2.1 General Requirements

- The sampler should be located in an unobstructed area, at least 2 meters from any obstacle to air flow.

The exhaust hose should be stretched out in the downwind direction to prevent recycling of air into the sample head.

- All cleaning and sample module loading and unloading should be conducted in a controlled environment, to minimize any chance of potential contamination.
- When new or when using the sampler at a different location, all sample contact areas need to be cleaned. Use triple rinses of reagent grade hexane or methylene chloride contained in Teflon® rinse bottles. Allow the solvents to evaporate before loading the PUF modules.

3.2.2 Preparing Cartridge for Sampling

1. Detach the lower chamber of the cleaned sample head. While wearing disposable, clean, lint-free nylon or cotton gloves, remove a clean glass sorbent module from its shipping container.
2. Remove the Teflon® end caps (if applicable). Place the end caps in the sample container to be reused after the sample has been collected.
3. Insert the glass module into the lower chamber and tightly reattach the lower chambers to the module.
4. Using clean rinsed (with hexane) Teflon®-tipped forceps, carefully place a clean conditioned fiber filter atop the filter holder and secure in place by clamping the filter holder ring over the filter. Place the aluminum protective cover on top of the cartridge head.
5. Tighten the 3 screw clamps. Ensure that all module connections are tightly assembled.
6. Place a small piece of aluminum foil on the ball-joint of the sample cartridge to protect from back-diffusion of semi-volatiles into the cartridge during transporting to the site.
7. Place the cartridge in a carrying bag to take to the sampler.

3.2.3 Collection

1. After the sampling system has been assembled, perform a single point flow check as described in Section 3.1.3.
2. With the empty sample module removed from the sampler, rinse all sample contact areas using reagent grade hexane in a Teflon® squeeze bottle. Allow the hexane to evaporate from the module before loading the samples.
3. With the sample cartridge removed from the sampler and the flow control valve fully open, turn the pump on and allow it to warm-up for approximately 5 minutes.
4. Attach a "dummy" sampling cartridge loaded with the exact same type of filter and PUF media to be used for sample collection.
5. Turn the sampler on and adjust the flow control valve to the desired flow as indicated by the Magnehelic gauge reading determined in Section 3.1.2 number 20. Once the flow is properly adjusted, take extreme care not to inadvertently alter its setting.
6. Turn the sampler off and remove the "dummy" module.
7. Check the zero reading of the sampler Magnehelic. Record the ambient temperature, barometric pressure, elapsed time meter setting, sampler serial number, filter number, and PUF cartridge number on the Field Test Data Sheet (see Figure 12 of TO-13). Attach the loaded sampler cartridge assembly to the sampler.
8. Place the voltage variator and flow control valve at the settings used in Section 3.2.2, and the power

switch. Activate the elapsed time meter and record the start time. Adjust the flow (Magnehelic setting) using the flow control valve.

9. Record the Magnehelic reading every 6 hours during the sampling period. Use the calibration factors (see Section 3.1.2 number 20) to calculate the desired flow rate. Record the ambient temperature, barometric pressure, and Magnehelic reading at the beginning and during sampling period.

3.2.4 Sample Recovery

1. At the end of the desired sampling period, turn the power off. Carefully remove the sampling head containing the filter and sorbent cartridge. Place the protective "plate" over the filter to protect the cartridge during transport to a clean recovery area. Also, place a piece of aluminum foil around the bottom of the sampler cartridge assembly.
2. Perform a final calculated sampler flow check using the calibration orifice assembly. If calibration deviates by more than 10 percent from initial reading, mark the flow data for that sample as suspect and inspect and/or remove from service, record results on Field Test Data Sheet, Figure 12 of TO-13.
3. Transport the sampler cartridge assembly to a clean recovery area.
4. While wearing white cotton gloves, remove the PUF glass cartridge from the lower module chamber and lay it on the retained aluminum foil in which the sample was originally wrapped.
5. Carefully remove the quartz fiber filter from the upper chamber using clean Teflon®-tipped forceps.
6. Fold the filter in half twice (sample side inward) and place it in the glass cartridge atop the PUF.
7. Wrap the combined samples in the original hexane-rinsed aluminum foil, attach Teflon® end caps if applicable) and place them in their original aluminum shipping container. Complete a sample label and affix it to the aluminum shipping container.
8. Chain-of-custody should be maintained for all samples. Store the containers under blue ice or dry ice and protect from UV light to prevent possibly photo-decomposition of collected analytes. If the time span between sample collection and laboratory analysis is to exceed 24 hours, refrigerate sample at 4°C.
9. Ship and store field samples chilled (<4°C) using blue ice until receipt at the analytical laboratory. Return at least one field blank filter/PUF cartridge to the laboratory with each group of samples.

4.0 CAUTIONS AND INTERFERENCES

4.1 Meteorological Cautions and Interferences

A meteorological monitoring program is an integral part of site monitoring activities. Meteorological data, which define local terrain impacts on air flow paths, are needed to interpret air concentration data.

Meteorological data may be available from an existing station located near the site (i.e., at a local airport), otherwise a station should be set up at the site. This data will document the degree that samples actually were downwind and verify whether other worst-case assumptions were met. Meteorological parameters to be monitored are, at a minimum, wind speed, wind direction, and sigma theta (which is the horizontal wind direction standard deviation and an indicator of atmospheric stability). The remaining parameters primarily affect the amount of a contaminant available in the air.

4.1.1 Wind Speed

When the contaminant of concern is a particulate, wind speed is critical in determining whether the particulate will become airborne, the quantity of the particulate that becomes airborne, and the distance the particulate will travel from the source. Wind speed also contributes to the volatilization of contaminants from liquid sources.

4.1.2 Wind Direction

Wind direction highly influences the path of airborne contaminants. In addition, variations in wind direction increase the dispersion of pollutants from a given source. Upwind sources can contribute to sample concentration.

4.1.3 Atmospheric Stability

Atmospheric stability refers to the degree to which the atmosphere tends to dampen vertical and horizontal motion. Stable atmospheric conditions (i.e., evenings) result in low dispersion, and unstable atmospheric conditions (i.e., hot sunny days) result in higher dispersion.

4.1.4 Temperature

Higher temperatures increase the rate of volatilization of organic and some inorganic compounds and affect the initial rise of gaseous or vapor contaminants. Therefore, worst-case emission of volatiles and semivolatiles occurs at the hottest time of day, or on the hottest day.

4.1.5 Humidity

High humidity affects water-soluble chemicals and particulates. Humid conditions may dictate the sampling media used to collect the air sample, or limit the volume of air sampled and thereby increase the detection limit.

4.1.6 Atmospheric Pressure

Migration of landfill gases through the landfill surface and through surrounding soils are governed by changes in atmospheric pressure. Atmospheric pressure will influence upward migration of gaseous contaminants from shallow aquifers into the basements of overlying structures. In many cases, the transport and dispersion of air pollutants is complicated by local meteorology.

4.1.7 Physical/Chemical Considerations

Normal diurnal variations (i.e., temperature inversions) affect dispersion of airborne contaminants. Terrain features can enhance or create air inversions and can also influence the path and speed of air flow, complicating transport and dispersion patterns. The chemical characteristics of a contaminant (i.e., molecular weight, physical state, vapor pressure, aerodynamic size, temperature, reactive compounds, and photodegradation) affect its behavior and can influence the method used to sample and analyze it.

4.2 Other Influences

4.2.1 Surrounding Contaminants

Natural sources, such as biological waste, can produce hydrogen sulfide and methane which may contribute to the overall contaminant level. Extraneous anthropogenic contaminants (i.e., burning of fossil fuels; emissions from vehicular traffic, especially diesel; volatile compounds from petrochemical facilities; and effluvium from smoke stacks) may also contribute. Air sampling stations should be strategically placed to identify contributing

sources. Positive errors in concentrations may occur due to retention of gaseous species, such as sulfur dioxide and nitric acid, on filters.

4.2.2 Volatile Particles

During subsequent sampling, shipping, or storage of the filter prior to the post-sampling weighing, volatile particles collected on the filter can be lost.

4.2.3 Filter Handling

The filter should be handled carefully between the pre-sampling and post-sampling weighing in order to avoid loss of fibers or particles from the filter. To minimize error from handling, a filter paper cartridge or cassette can be used to protect the filter.

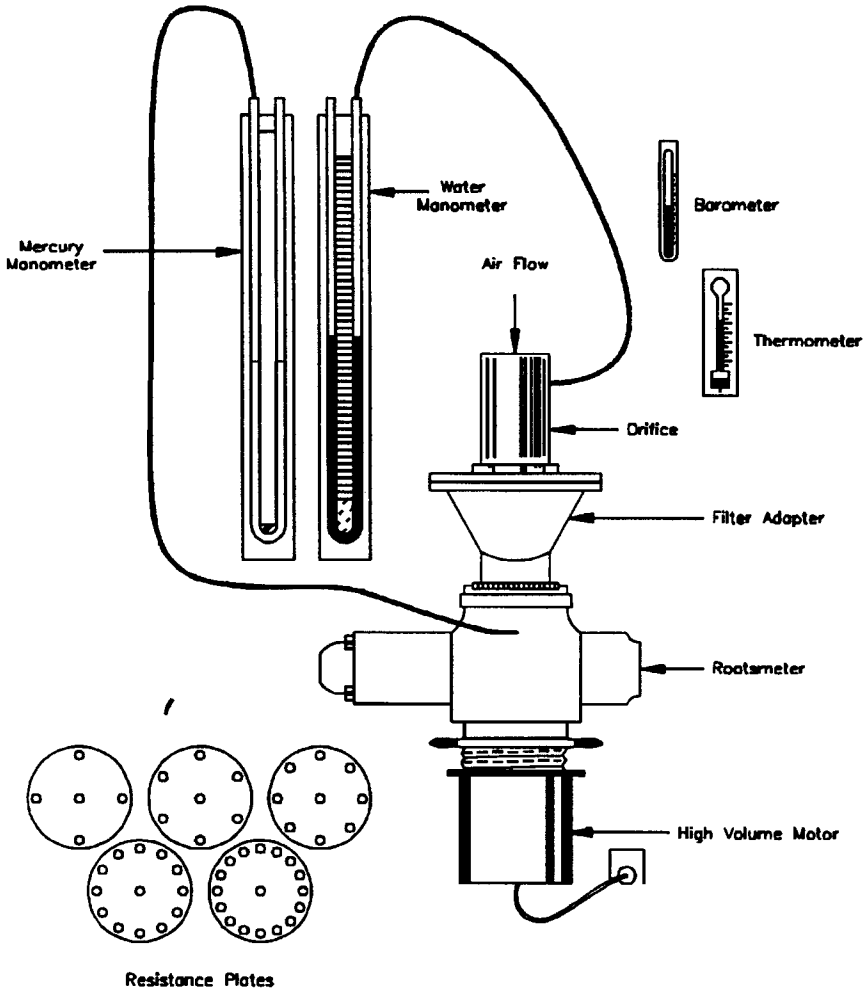


Figure 7. Positive displacement rootsmeter used to calibrate orifice transfer standard used in Compendium Method TO-13A.

COMPENDIUM METHOD TO-13A
ORIFICE CALIBRATION DATA SHEET

T_1 _____ Name _____

P_1 _____ mmHg Date _____

Orifice No. _____

Rootsmeter No. _____

Resistance Plants (No. of holes)	Air Volume Measured by Rootsmeter V_m		Standard Volume, V_{std} (std m^3)	Time for Air Volume to Pass Through Rootsmeter, θ (min)	Rootsmeter Pressure Differential, ΔP (mm Hg)	Pressure Drop Across Orifice, ΔH (in. H_2O)	x-Axis Standard Flowrate, Q_{std} (std m^3/min)	
	(R^3)	(m^3)						
5	200	5.66						
7	200	5.66						
10	300	8.50						
13	300	8.50						
18	300	8.50						

Factors: $(R^3)(0.02832\ \frac{m^3}{R^3}) = m^3$ and (in. Hg) $25.4\ (\frac{mm\ Hg}{in.\ Hg}) = mm\ Hg$

Calculation Equations:

1. $V_{std} = V_m\ (\frac{P_1 - \Delta P}{P_{std}})(\frac{T_{std}}{T_1})$

where:

$T_{std} = 296°K$
$P_{std} = 760.0$ mm Hg

2. $Q_{std} = \frac{V_{std}}{\theta}$

Figure 8. Example of a high-volume orifice calibration data sheet for Compendium Method TO-13A.

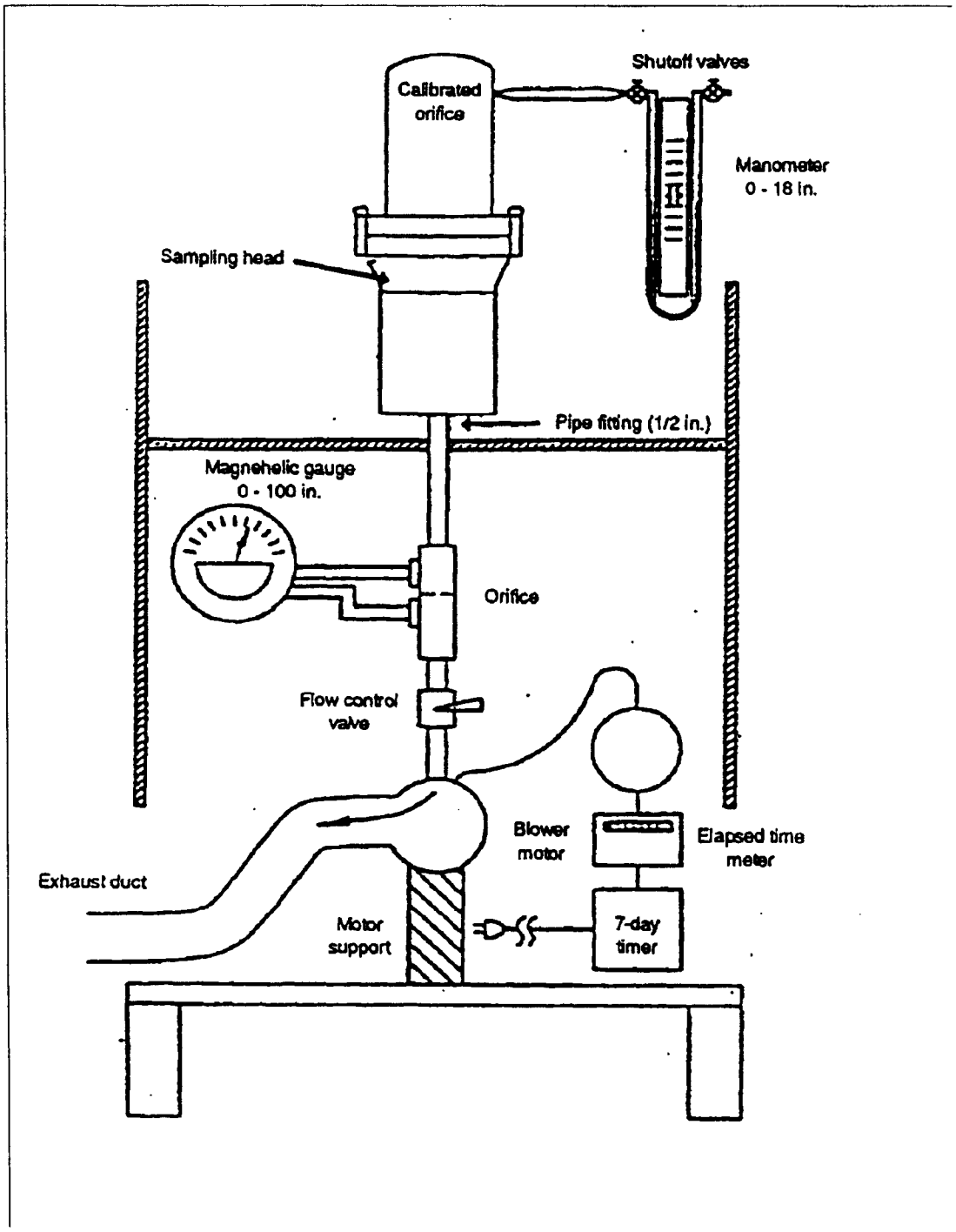


Figure 9. Typical field calibration configuration for Compendium Method TO-13A sampler.

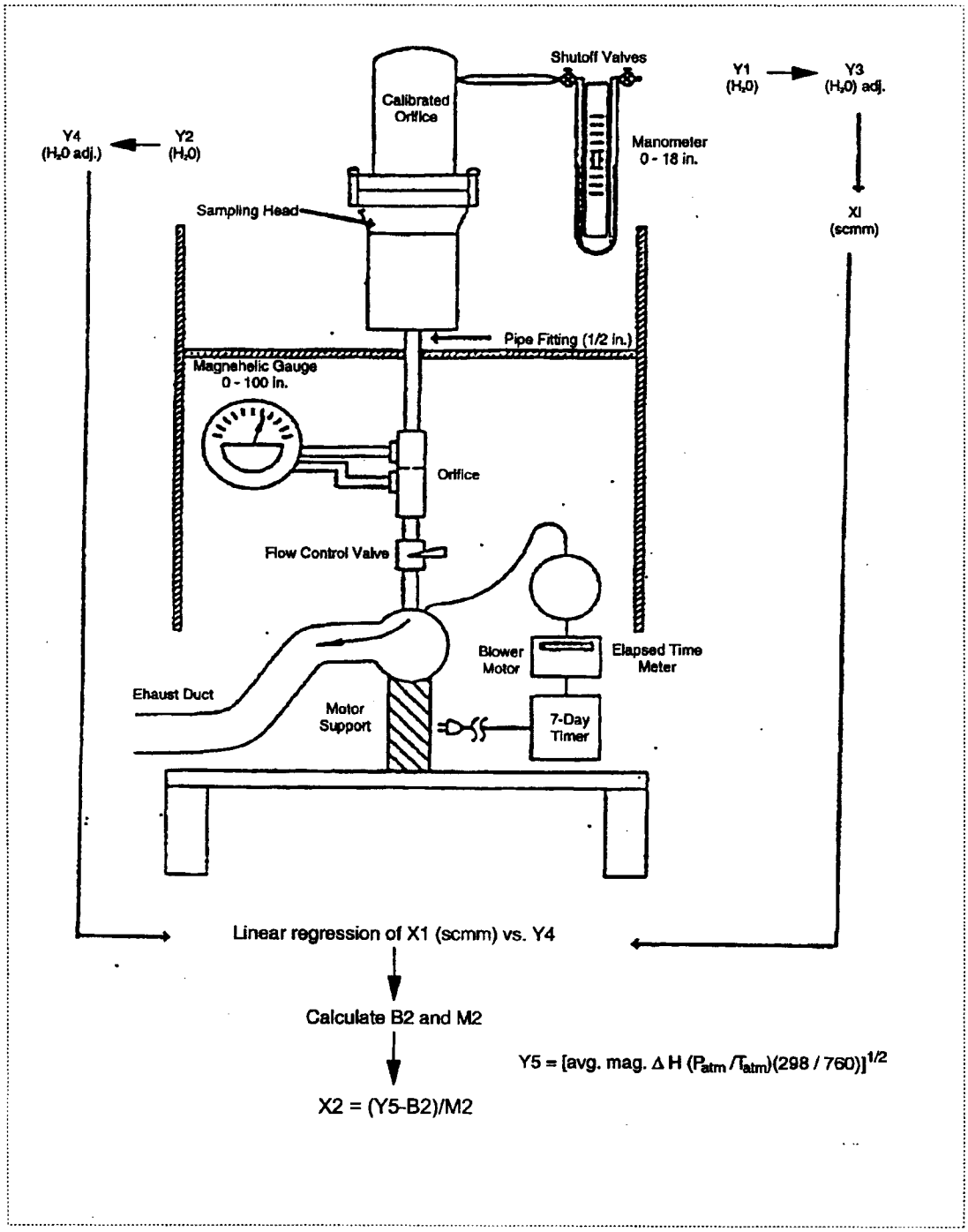


Figure 11. Example of relationship between orifice transfer standard and flow rate through Compendium Method TO-13A sampler.

COMPENDIUM METHOD TO-13A
FIELD TEST DATA SHEET
GENERAL INFORMATION

Sampler I.D. No.: _____
Lab PUF Sample No.: _____
Sample location: _____
_____
_____

Operator: _____
Other: _____
_____
_____

PUF Cartridge Certification Date: _____
Date/Time PUF Cartridge Installed: _____
Elapsed Timer: _____
Start _____
Stop _____
Diff. _____

Sampling

M1 _____ **B1** _____
M2 _____ **B2** _____

	Start	Stop
Barometric pressure ("Hg)	_____	_____
Ambient Temperature (°F)	_____	_____
Rain	Yes _____ No _____	Yes _____ No _____

Sampling time
Start _____
Stop _____
Diff. _____

Audit flow check within ±10 of set point
_____ Yes
_____ No

TIME	TEMP	BAROMETRIC PRESSURE	MAGNEHELIC READING	CALCULATED FLOW RATE (std. m³)	READ BY
Avg.					

Comments
_____
_____
_____

Figure 12. Example of typical Compendium Method TO-13A field test data sheet (FTDS).

STANDARD OPERATING PROCEDURE NO. 14.5
AIR SAMPLING USING A SUMMA CANISTER FOR VOC SAMPLING

1.0 METHOD SUMMARY

This standard operating procedure (SOP) provides guidance for the sampling of volatile organic compounds (VOCs) in ambient air using a Summa® canister for both subatmospheric and pressurized sampling modes. Both modes typically use an initially evacuated canister and pump-ventilated sample line during sample collection. Pressurized sampling requires and additional pump to provide positive pressure to the sample canister. The sampling process involves an ambient air sample being pulled through a sampling train containing components that regulate the rate and duration of sampling into a pre-evacuated specially prepared canister.

2.0 EQUIPMENT/APPARATUS/REAGENTS

2.1 Summa Canisters

Summa® canisters are highly polished passivated stainless steel cylinders. The Summa® polishing process brings chrome and nickel to the surface of the canisters, which results in an inert surface. This surface restricts adsorption or reactions that occur on the canister's inner surface after collection. The sampler is drawn to a vacuum at the laboratory prior to use at the site. At the site, the canister is either placed in a sampler to control sample collection rate, or opened to collect a grab sample. Samples can be collected by allowing air to bleed into or be pumped into the canister. The sample canister is sent to the laboratory for mass spectroscopy (MS) or FID analysis.

2.2 Equipment List

- Camera
- Site logbook
- Clipboard
- Chain of custody records
- Custody seals
- Air sampling worksheets
- Sampling inlet line
- 6-liter specially-treated Summa® canister
- Stainless steel vacuum/pressure gauge
- Electronic mass flow controller
- Particulate matter filter
- Electronic timer
- Solenoid valve
- Chromatographic grade stainless steel tubing and fittings
- Thermostatically controlled heater
- Heater thermostat
- Fan
- Fan thermostat
- Maximum-minimum thermometer
- Stainless steel shut-off valve
- Auxiliary vacuum pump
- Elapsed time meter
- Optional fixed orifice, capillary, or adjustable micrometering valve
- Sample pump

3.0 PROCEDURES

STANDARD OPERATING PROCEDURE NO. 14.5
AIR SAMPLING USING A SUMMA CANISTER
FOR VOC SAMPLING

These procedures are based on Method TO-14 of the Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air.

1. The sample canister should be cleaned and certified according Method TO-14 of the Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air by the laboratory prior to use.

2. A sample collection system is assembled as shown in Figure 1 (and Figure 2).

3. Prior to locating the sampling system, the user may want to perform "screening analyses" using a portable GC system, as outlined in Appendix B of TO-14, to determine potential volatile organics present and potential "hot spots." The information gathered from the portable GC screening analysis would be used in developing a monitoring protocol, which includes the sampling system location, based upon the "screening analysis" results.

4. The sampling system is located. Temperatures of ambient air and sampler box interior are recorded on the field test data sheet (see Appendix A).

5. To verify correct sample flow, a "practice" (evacuated) canister is used in the sampling system. A certified mass flow meter is attached to the inlet line of the manifold, just in front of the filter. The canister is opened. The sampler is turned on and the reading of the certified mass flow meter is compared to the sampler mass flow controller.

6. The valves should agree within ±10%. If not, the sampler mass flow meter needs to be recalibrated or there is a leak in the system. This should be investigated and corrected. After two minutes, the desired canister flow rate is adjusted to the proper value (as indicated by the certified mass flow meter) by the sampler flow control unit controller (e.g., 3.5 mL/min for 24 hr, 7.0 mL/min for 12 hr). Record final flow under "CANISTER FLOW RATE," on Appendix A.

7. The sampler is turned off and the elapsed time meter is reset to 000.0.

8. The "practice" canister and certified mass flow meter are disconnected and a clean certified canister is attached to the system.

9. The canister valve and vacuum/pressure gauge valve are opened.

10. Pressure/vacuum in the canister is recorded on the canister sampling field data sheet (see Appendix A) as indicated by the sampler vacuum/pressure gauge.

11. The vacuum/pressure gauge valve is closed and the maximum-minimum thermometer is reset to current temperature. Time of day and elapsed time meter readings are recorded on the canister sampling field data sheet.

12. The electronic timer is set to begin and stop the sampling period at the appropriate times. Sampling commences and stops by the programmed electronic timer.

13. After the desired sampling period, the maximum, minimum, current interior temperature and current

ambient temperature are recorded on the sampling field data sheet. The current reading from the flow controller is recorded.

14. At the end of the sampling period, the vacuum/pressure gauge valve on the sampler is briefly opened and closed and the pressure/vacuum is recorded on the sampling FTDS. Pressure should be close to desired pressure. Time of day and elapsed time meter readings are also recorded.

15. The canister valve is closed. The sampling line is disconnected from the canister and the canister is removed from the system.

16. For a subatmospheric system, a certified mass flow meter is once again connected to the inlet manifold in front of the in-line filter and a "practice" canister is attached to the Magnelatch valve of the sampling system. The final flow rate is recorded on the canister sampling field data sheet (see Appendix A). The sampler is turned off.

17. An identification tag is attached to the canister. Canister serial number, sample number, location, and date are recorded on the tag. Complete the Chain-of-Custody (COC) for the canister and ship back to the laboratory for analysis.

4.0 CAUTIONS AND INTERFERENCES

4.1 Meteorological Cautions and Interferences

A meteorological monitoring program is an integral part of site monitoring activities. Meteorological data, which define local terrain impacts on air flow paths, are needed to interpret air concentration data.

Meteorological data may be available from an existing station located near the site (i.e., at a local airport), otherwise a station should be set up at the site. This data will document the degree that samples actually were downwind and verify whether other worst-case assumptions were met. Meteorological parameters to be monitored are, at a minimum, wind speed, wind direction, and sigma theta (which is the horizontal wind direction standard deviation and an indicator of atmospheric stability). The remaining parameters primarily affect the amount of a contaminant available in the air.

4.1.1 Wind Speed

When the contaminant of concern is a particulate, wind speed is critical in determining whether the particulate will become airborne, the quantity of the particulate that becomes airborne, and the distance the particulate will travel from the source. Wind speed also contributes to the volatilization of contaminants from liquid sources.

4.1.2 Wind Direction

Wind direction highly influences the path of airborne contaminants. In addition, variations in wind direction increase the dispersion of pollutants from a given source. Upwind sources can contribute to sample concentration.

4.1.3 Atmospheric Stability

Atmospheric stability refers to the degree to which the atmosphere tends to dampen vertical and horizontal motion. Stable atmospheric conditions (i.e., evenings) result in low dispersion, and unstable atmospheric conditions (i.e., hot sunny days) result in higher dispersion.

4.1.4 Temperature

Higher temperatures increase the rate of volatilization of organic and some inorganic compounds and affect the initial rise of gaseous or vapor contaminants. Therefore, worst-case emission of volatiles and semivolatiles occurs at the hottest time of day, or on the hottest day.

4.1.5 Humidity

High humidity affects water-soluble chemicals and particulates. Humid conditions may dictate the sampling media used to collect the air sample, or limit the volume of air sampled and thereby increase the detection limit.

4.1.6 Atmospheric Pressure

Migration of landfill gases through the landfill surface and through surrounding soils are governed by changes in atmospheric pressure. Atmospheric pressure will influence upward migration of gaseous contaminants from shallow aquifers into the basements of overlying structures. In many cases, the transport and dispersion of air pollutants is complicated by local meteorology.

4.1.7 Physical/Chemical Considerations

Normal diurnal variations (i.e., temperature inversions) affect dispersion of airborne contaminants. Terrain features can enhance or create air inversions and can also influence the path and speed of air flow, complicating transport and dispersion patterns. The chemical characteristics of a contaminant (i.e., molecular weight, physical state, vapor pressure, aerodynamic size, temperature, reactive compounds, and photodegradation) affect its behavior and can influence the method used to sample and analyze it.

4.2 Other Influences

Natural sources, such as biological waste, can produce hydrogen sulfide and methane which may contribute to the overall contaminant level. Extraneous anthropogenic contaminants (i.e., burning of fossil fuels; emissions from vehicular traffic, especially diesel; volatile compounds from petrochemical facilities; and effluvium from smoke stacks) may also contribute. Air sampling stations should be strategically placed to identify contributing sources. Positive errors in concentrations may occur due to retention of gaseous species, such as sulfur dioxide and nitric acid, on filters.

APPENDIX A

Canister Field Test Data Sheet

STANDARD OPERATING PROCEDURE NO. 14.5
AIR SAMPLING USING A SUMMA CANISTER FOR VOC SAMPLING

Canister Field Test Data Sheet

A. General Information

Site Location: _____
Site Address: _____
Sampling Date: _____

Shipping Date: _____
Canister Serial No.: _____
Operator: _____
Canister Leak Check Date: _____

B. Sampling Information

	Temperature				Pressure	
	Interior	Ambient	Maximum	Minimum	Canister Pressure	
Start						
Stop						

	Sampling Times		Flow Rates		
	Local Time	Elapsed Time Meter Readings			
Start					
Stop					

Sampling System Certification Date: _____
Quarterly Rcertification Date: _____

C. Laboratory Information

Data Received: _____
Initial Pressure: _____
Final Pressure: _____
Dilution Factor: _____

Analysis
GC/FID/ECD Date: _____
GC/MSD/SCAN Date: _____
GC/MSD/SIM Date: _____

Results*: _____
_____
GC/FID/ECD: _____
GC/MSD/SCAN: _____
GC/MSD/SIM: _____

_____
Signature/Title

* Attach Data Sheets

Figure 2. Example of alternative sampler configuration for pressurized canister sampling used in Compendium Method TO-14

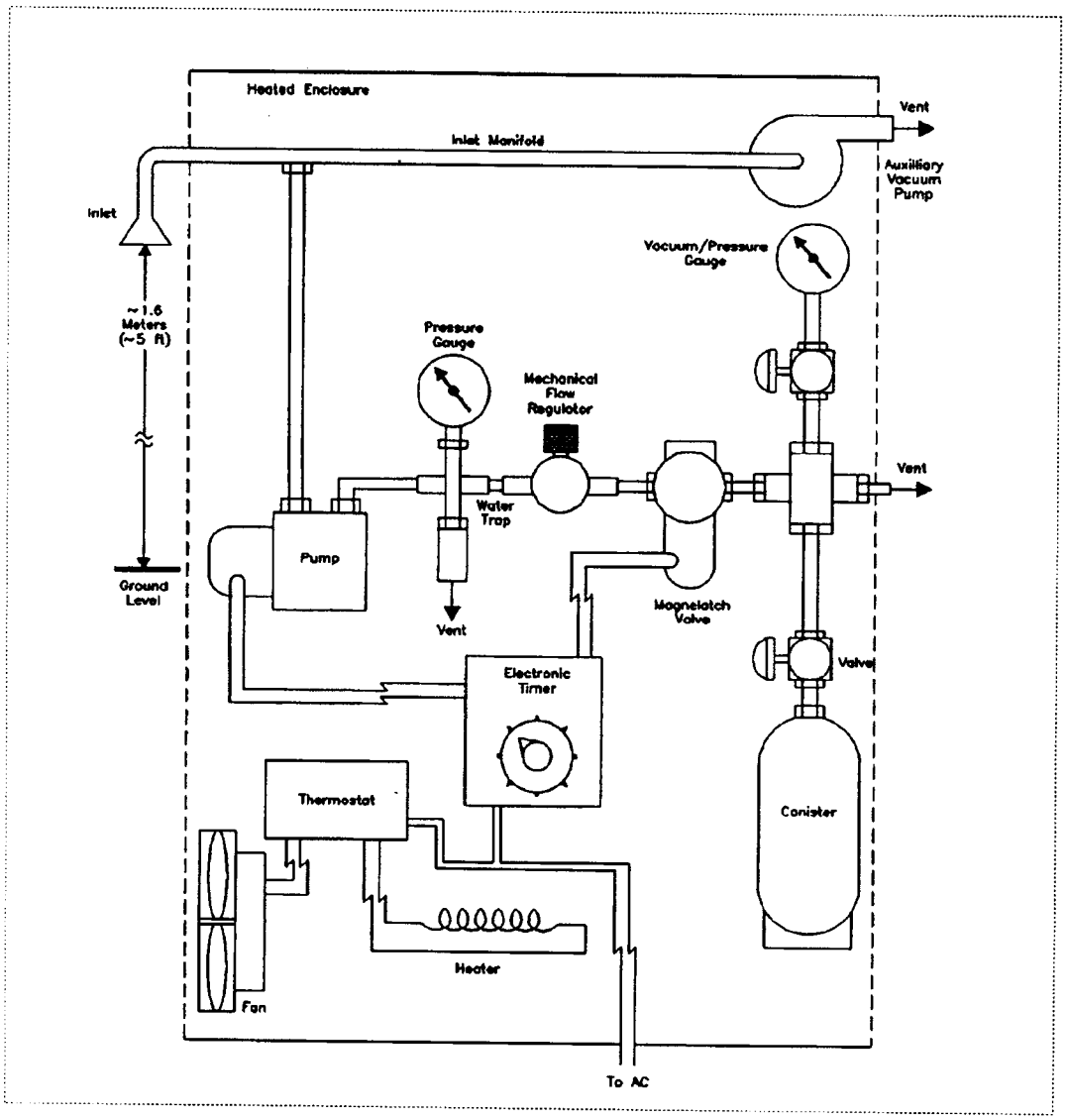
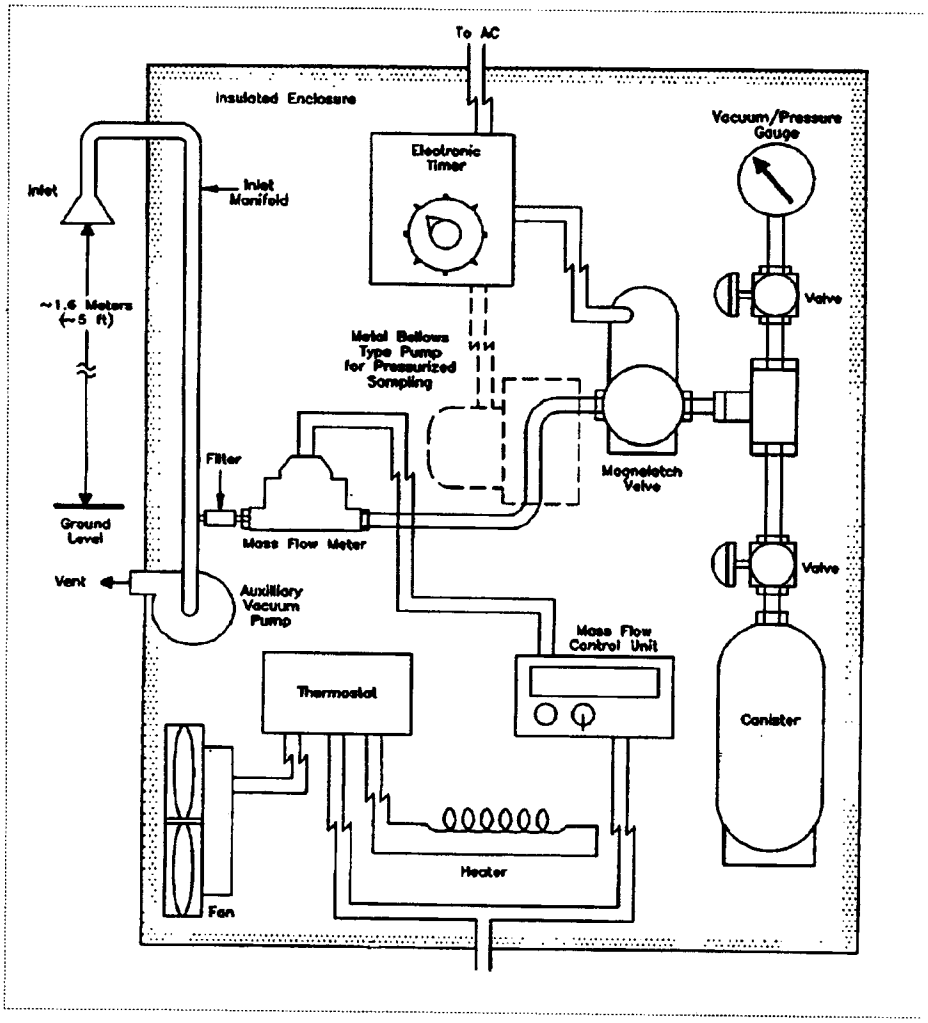


Figure 1. Example of sampler configuration for subatmospheric pressure or pressurized canister sampling used in Compendium Method TO-14



STANDARD OPERATING PROCEDURE NO. 14.6
REAL-TIME AIR MONITORING

1.0 METHOD SUMMARY

This standard operating procedure (SOP) provides guidance for real-time air monitoring

2.0 EQUIPMENT/APPARATUS/REAGENTS

2.1 Direct Reading Instruments (Air Monitoring Instruments)

There are two general types of direct reading instruments: portable screening devices and specialized analytical instruments. Generally all these techniques involve acquiring, for a specific location or area, continuous or sequential direct air concentrations in real-time. None of these instruments acquires true time-weighted average concentrations. In addition, these instruments are not capable of acquiring simultaneous concentration readings at multiple locations, although several are able to sequentially analyze samples taken remotely from different locations. The document, "Guide to Portable Instruments for Assessing Airborne Pollutants Arising from Hazardous Waste Sites," provides additional information about air sampling and monitoring. See the ACGIH TLVs and the OSHA PELs for safe working levels as hazard levels for airborne contaminants vary.

2.2 Equipment List

- Camera
- Site logbook
- Clipboard
- Chain of custody records
- Custody seals
- Air sampling worksheets
- Appropriate real-time air monitoring instrumentation

3.0 PROCEDURES

3.1 Calibration

Follow manufacturer's instructions for calibration of a particular real-time air monitor.

3.2 Procedure

Follow the manufacturer's instructions for the proper use of a particular real-time air monitor. The monitor should be appropriate for the analytes of concern and analytical detection limit to be achieved. See the sampling plan for proper monitor.

4.0 CAUTIONS AND INTERFERENCES

4.1 Meteorological Cautions and Interferences

A meteorological monitoring program is an integral part of site monitoring activities. Meteorological data, which define local terrain impacts on air flow paths, are needed to interpret air concentration data.

Meteorological data may be available from an existing station located near the site (i.e., at a local airport), otherwise a station should be set up at the site. This data will document the degree that samples actually were downwind and verify whether other worst-case assumptions were met. Meteorological parameters to be

monitored are, at a minimum, wind speed, wind direction, and sigma theta (which is the horizontal wind direction standard deviation and an indicator of atmospheric stability). The remaining parameters primarily affect the amount of a contaminant available in the air.

4.1.1 Wind Speed

When the contaminant of concern is a particulate, wind speed is critical in determining whether the particulate will become airborne, the quantity of the particulate that becomes airborne, and the distance the particulate will travel from the source. Wind speed also contributes to the volatilization of contaminants from liquid sources.

4.1.2 Wind Direction

Wind direction highly influences the path of airborne contaminants. In addition, variations in wind direction increase the dispersion of pollutants from a given source. Upwind sources can contribute to sample concentration.

4.1.3 Atmospheric Stability

Atmospheric stability refers to the degree to which the atmosphere tends to dampen vertical and horizontal motion. Stable atmospheric conditions (e.g, evenings) result in low dispersion, and unstable atmospheric conditions (e.g., hot sunny days) result in higher dispersion.

4.1.4 Temperature

Higher temperatures increase the rate of volatilization of organic and some inorganic compounds and affect the initial rise of gaseous or vapor contaminants. Therefore, worst-case emission of volatiles and semivolatiles occurs at the hottest time of day, or on the hottest day.

4.1.5 Humidity

High humidity affects water-soluble chemicals and particulates. Humid conditions may dictate the sampling media used to collect the air sample, or limit the volume of air sampled and thereby increase the detection limit.

4.1.6 Atmospheric Pressure

Migration of landfill gases through the landfill surface and through surrounding soils is governed by changes in atmospheric pressure. Atmospheric pressure will influence upward migration of gaseous contaminants from shallow aquifers into the basements of overlying structures. In many cases, the transport and dispersion of air pollutants is complicated by local meteorology.

4.1.7 Physical/Chemical Considerations

Normal diurnal variations (i.e., temperature inversions) affect dispersion of airborne contaminants. Terrain features can enhance or create air inversions and can also influence the path and speed of air flow, complicating transport and dispersion patterns. The chemical characteristics of a contaminant (e.g., molecular weight, physical state, vapor pressure, aerodynamic size, temperature, reactive compounds, and photodegradation)

affect its behavior and can influence the method used to sample and analyze it.

4.2 Other Influences

Natural sources, such as biological waste, can produce hydrogen sulfide and methane which may contribute to the overall contaminant level. Extraneous anthropogenic contaminants (i.e., burning of fossil fuels; emissions from vehicular traffic, especially diesel; volatile compounds from petrochemical facilities; and effluvium from smoke stacks) may also contribute. Air sampling stations should be strategically placed to identify contributing sources. Positive errors in concentrations may occur due to retention of gaseous species, such as sulfur dioxide and nitric acid, on filters.

STANDARD OPERATING PROCEDURE NO. 14.7
COLLECTION OF METEOROLOGIC DATA

1.0 METHOD SUMMARY

This standard operating procedure (SOP) provides guidance for collection of meteorologic data.

2.0 EQUIPMENT/APPARATUS/REAGENTS

2.1 Meteorologic Stations

An on-site meteorological station can consists of:

- anemometers
- barometers
- evaporimeters
- hygrometers
- pyranometers
- pyreliometers
- radiation balance meters
- rain gages
- thermometers
- weathervanes

Data can be stored on data logger at regular intervals during each 24-hr period. Meteorological Stations generate simple time-series streams, typically produced from sensors measuring wind speed and direction, air temperature, relative humidity, and barometric pressure. In addition, precipitation, solar irradiance, wind gusts, as well as other measurements may be produced.

2.2 Equipment List

- Camera
- Site logbook
- Clipboard
- Meteorological Station

3.0 PROCEDURES

3.1 Calibration

Follow manufacturer's instructions for the calibration of the devices of the Meteorological Station.

3.2 Procedure

Follow the manufacture's instructions for the proper set up and use of a particular meteorological station.

4.0 CAUTIONS AND INTERFERENCES

Note the cautions and interferences discussed in the manufacturers instructions.

STANDARD OPERATING PROCEDURE NO. 15.1
CONDUCTING A MAGNETOMETRY SURVEY

1.0 METHOD SUMMARY

Magnetometer surveys measure variations in the earth's magnetic field. Measurements of the magnetic gradient can be used to identify buried ferrous objects such as tanks, pipelines and metallic debris.

2.0 EQUIPMENT/APPARATUS/REAGENTS

Equipment for performing many surface geophysical surveys is available from a variety of sources, and include modern, computerized microprocessors and electronics. Although the equipment can generally be operated by trained technicians, all aspects of data collection, processing and interpretation will require the oversight of a qualified geophysicist, geologist, or groundwater scientist having extensive experience with the equipment operation and data interpretation.

3.0 PROCEDURES

Contractor shall have a geologist or engineer experienced with the equipment operation and data interpretation. to supervise work on TNRCC projects.

Magnetometer surveys are conducted using a magnetometer/gradiometer or equivalent equipment (e.g., Geometrics model 856AG proton precession magnometer/gradiometer). The unit, which has two sensors and an electronics package, can collect both total field data and vertical gradient data and can discriminate to 0.2 gammas in a total field of 40,000 to 60,000 gammas. The procedure for collecting measurements is as follows:

1. Check to see that calibration/maintenance has been performed by the manufacturer. If field measurements indicate a malfunction, the instrument may need maintenance.
2. Inspect equipment at the start of the day to ensure that it is in working order.
3. Establish a base station at the start of each day's measurements.
4. Perform field calibration (if recommended by manufacturer).
5. Collect and record magnetic readings from the base station in the morning, at noon, and at the end of the day to evaluate instrument drift. The base station should be outside the influence of possible sources of man-made sources of magnetic fields (e.g., power lines, pipelines).
6. Collect survey data and keep a record on a project assigned form. Magnetic readings should be stored in memory with the time of day, station numbers, and line numbers of the readings.
7. Correlate surface data (profiles and soundings) with at least one soil boring, well bore, or outcrop at the same site as the survey.
8. Reference the location and elevation of at least two points of the geophysical survey grid to state plane coordinates.
9. The locations of surface geophysical grid system layouts shall be shown on a site map.

10. Final results shall be presented in plain views and cross sections. Contours shall be used where appropriate.

11. The interpretation of results shall discuss positive and negative results as well as limitations of the method and data.

12. The interpretation of the data shall be incorporated into the conceptual site model.

4.0 CAUTIONS AND INTERFERENCES

Geophysical testing can involve a large variety of methods to collect data, and the data itself is subject to interpretation. Some of the problems that are commonly encountered when using geophysical techniques to investigate the shallow subsurface include:

- Incorrect method applied-possible causes include lack of understanding of geophysical technology, site conditions or survey objectives;
- Poor data quality-possible causes include high ambient noise, poor field procedures, improper use of equipment, faulty equipment, adverse geologic conditions, or inexperienced operators;
- Poor interpretation-possible causes include an inadequate interpretation method, insufficient background information, or insufficient or noisy data;
- Insufficient data-possible causes include a lack of understanding of methods and/or site conditions and objectives, operator inexperience, or a lack of up-to-date plotted data in the field (some contractors gather data but do not plot it or look at it until they are back in the office).

STANDARD OPERATING PROCEDURE NO. 15.2
CONDUCTING AN ELECTROMAGNETIC SURVEY

1.0 METHOD SUMMARY

An electromagnetic survey measures the electrical conductivity of a subsurface volume, which is a function of the soil or rock type, porosity/permeability, and fluid content. The measured values are referred to as terrain conductivity, and are obtained without direct contact through electromagnetic induction. Data collected during an electromagnetic survey can be used to map the location of buried metallic objects; depth or thickness determinations cannot be made solely by this method. The electromagnetic technique can also detect chemicals or contaminant plumes (e.g. hydrocarbons in high concentrations or other conductive or resistive chemicals).

2.0 EQUIPMENT/APPARATUS/REAGENTS

Equipment for performing many surface geophysical surveys is available from a variety of sources, and include modern, computerized microprocessors and electronics. Although the equipment can generally be operated by trained technicians, all aspects of data collection, processing and interpretation will require the oversight of a qualified geophysicist, geologist, or groundwater scientist having extensive experience with the equipment operation and data interpretation.

3.0 PROCEDURES

Contractor shall have a geologist or engineer experienced with the equipment operation and data interpretation. to supervise work on TNRCC projects.

A ground conductivity meter (e.g., Geonics Ltd. EM-31DL® or EM-34) is used to obtain terrain conductivity data. The transmitting and receiving coils on this instrument are mounted at the ends of 4-foot tubes that project horizontally from either end of the instrument console. The 8-foot coil separation results in a depth of penetration of approximately 15 to 18 feet. A data logger records quadrature and in-phase data at each measuring station.

1. Check to see that calibration/maintenance has been performed by the manufacturer. If field measurements indicate a malfunction, the instrument may need maintenance.
2. Inspect equipment at the start of the day to ensure that it is in working order.
3. Establish a reference base station at the start of each day's measurements.
4. Perform field calibrations twice daily (before and after the day's surveying activities). The calibration activities should be conducted at the base station; away from man-made interferences.
5. Conduct the EM survey in accordance with the manufacturers operating instructions.
6. Show on a site map the locations of surface geophysical grid system layouts.
7. Final results shall be presented in plain views and cross sections. Contours shall be used where appropriate.
8. The interpretation of results shall discuss positive and negative results as well as limitations of the method and data.

9. The interpretation of the data shall be incorporated into the conceptual site model.

4.0 CAUTIONS AND INTERFERENCES

Geophysical testing can involve a large variety of methods to collect data, and the data itself is subject to interpretation. Some of the problems that are commonly encountered when using geophysical techniques to investigate the shallow subsurface include:

- Incorrect method applied-possible causes include lack of understanding of geophysical technology, site conditions or survey objectives;
- Poor data quality-possible causes include high ambient noise, poor field procedures, improper use of equipment, faulty equipment, adverse geologic conditions, or inexperienced operators;
- Poor interpretation-possible causes include an inadequate interpretation method, insufficient background information, or insufficient or noisy data;
- Insufficient data-possible causes include a lack of understanding of methods and/or site conditions and objectives, operator inexperience, or a lack of up-to-date plotted data in the field (some contractors gather data but do not plot it or look at it until they are back in the office).

STANDARD OPERATING PROCEDURE NO. 15.3
CONDUCTING A RESISTIVITY SURVEY

1.0 METHOD SUMMARY

In a resistivity survey, a direct current or low-frequency alternating current is sent through the ground between two metal stakes or electrodes. Earth materials offer resistance to the passage of a current, so there will be a loss of voltage as a result. This loss of voltage that occurs as the current moves through the ground can be measured at other electrodes placed between the current electrodes. Resistivity values can be obtained by two different surface exploration methods: electrical sounding and electrical profiling.

2.0 EQUIPMENT/APPARATUS/REAGENTS

Equipment for performing many surface geophysical surveys is available from a variety of sources, and include modern, computerized microprocessors and electronics. Although the equipment can generally be operated by trained technicians, all aspects of data collection, processing and interpretation will require the oversight of a qualified geophysicist, geologist, or groundwater scientist having extensive experience with the equipment operation and data interpretation.

3.0 PROCEDURES

Contractor shall have a geologist or engineer experienced with the equipment operation and data interpretation. to supervise work on TNRCC projects. General procedures for conducting resistivity surveys are as follows:

1. Check to see that calibration/maintenance has been performed by the manufacturer. If field measurements indicate a malfunction, the instrument may need maintenance.
2. Inspect equipment at the start of the day to ensure that it is in working order.
3. Establish a base station at the start of each day's measurements.
4. Perform field calibration (if recommended by manufacturer).
5. Establish a series of stations from which measurements are to be taken.

Electrical sounding is useful for estimating the depth to sand, gravel, bedrock, or water-bearing strata and is only accurate in an area with a simple geologic setting (horizontal layers parallel with the ground surface). The procedure for electrical sounding is as follows:

1. Operate the resistivity instrument in accordance with the manufacturers operating instructions..
2. Transfer soundings to a vertical depth chart.
3. The locations of surface geophysical grid system layouts shall be shown on a site map.
4. Final results shall be presented in plain views and cross sections. Contours shall be used where appropriate.
5. The interpretation of results shall discuss positive and negative results as well as limitations of the method and data.
6. The interpretation of the data shall be incorporated into the conceptual site model.

Electrical profiling is different from electrical sounding, in that material at only one depth is investigated. This is useful in searching for ore bodies, faults or fault zones, for evaluating sand and gravel deposits, for delineating boundaries, and for finding dipping contacts of different earth materials. The procedure for electrical profiling is as follows:

1. Establish a series of stations from which measurements are to be taken.
2. Take resistivity measurements for the same depth at each station.
3. Plot values to produce a numerical picture of the subsurface materials at the chosen depth across a horizontal plane.
4. The locations of surface geophysical grid system layouts shall be shown on a site map.
5. Final results shall be presented in plain views and cross sections. Contours shall be used where appropriate.
6. The interpretation of results shall discuss positive and negative results as well as limitations of the method and data.
7. The interpretation of the data shall be incorporated into the conceptual site model.

4.0 CAUTIONS AND INTERFERENCES

Geophysical testing can involve a large variety of methods to collect data, and the data itself is subject to interpretation. Some of the problems that are commonly encountered when using geophysical techniques to investigate the shallow subsurface include:

- Incorrect method applied-possible causes include lack of understanding of geophysical technology, site conditions or survey objectives;
- Poor data quality-possible causes include high ambient noise, poor field procedures, improper use of equipment, faulty equipment, adverse geologic conditions, or inexperienced operators;
- Poor interpretation-possible causes include an inadequate interpretation method, insufficient background information, or insufficient or noisy data;
- Insufficient data-possible causes include a lack of understanding of methods and/or site conditions and objectives, operator inexperience, or a lack of up-to-date plotted data in the field (some contractors gather data but do not plot it or look at it until they are back in the office).

STANDARD OPERATING PROCEDURE NO. 15.4 CONDUCTING A GROUND PENETRATING RADAR SURVEY

1.0 METHOD SUMMARY

Ground penetrating radar is a geophysical survey technique that provides a real-time measurement of subsurface layering using high frequency radio waves. The instrumentation that is used for this investigation consists of a radar control unit, signal processing and conditioning circuitry, and a graphical recorder, and is connected to a transducer (antenna) by an electrical umbilical cable.

2.0 EQUIPMENT/APPARATUS/REAGENTS

Equipment for performing many surface geophysical surveys is available from a variety of sources, and include modern, computerized microprocessors and electronics. Although the equipment can generally be operated by trained technicians, all aspects of data collection, processing and interpretation will require the oversight of a qualified geophysicist, geologist, or groundwater scientist having extensive experience with the equipment operation and data interpretation.

3.0 PROCEDURES

Contractor shall have a geologist or engineer experienced with the equipment operation and data interpretation. to supervise work on TNRCC projects.

To collect data, the transducer is towed along a traverse and radar impulses are transmitted into the ground. The physical properties of the subsurface change as a result of interfaces between soil layers. There is an abrupt change in the velocity of the impulse as it encounters the interfaces, causing some of the radar energy to be reflected back to the antenna. The time it takes for a radar signal to travel from the antenna to a reflecting soil interface and back is directly proportional to the interface depth. Recording these depth-dependent impulses on a scanning, time-based graphic chart recorder creates a cross section of the longitudinal distribution of subsurface layers and other features. The survey area shall be large enough to identify the natural distribution of layers.

1. Check to see that calibration/maintenance has been performed by the manufacturer. If field measurements indicate a malfunction, the instrument may need maintenance.
2. Inspect equipment at the start of the day to ensure that it is in working order.
3. Establish a base station at the start of each day's measurements.
4. Perform field calibration (per manufacturers instructions).
5. Show on a site map the locations of surface geophysical grid system layouts.
6. Perform a baseline traverse over a known feature before and after conducting the daily activities to verify that the instrument is working correctly.
7. Conduct the GPR traverse(s) as outlined in the project specific work plan.
8. Record pertinent information (e.g., measurements, calibration data, instrument settings) in the field logbook or on project forms.

9. Final results shall be presented in plain views and cross sections. Contours shall be used where appropriate.

10. The interpretation of results shall discuss positive and negative results as well as limitations of the method and data.

11. The interpretation of the data shall be incorporated into the conceptual site model.

4.0 CAUTIONS AND INTERFERENCES

Geophysical testing can involve a large variety of methods to collect data, and the data itself is subject to interpretation. Some of the problems that are commonly encountered when using geophysical techniques to investigate the shallow subsurface include:

- Incorrect method applied-possible causes include lack of understanding of geophysical technology, site conditions or survey objectives;
- Poor data quality-possible causes include high ambient noise, poor field procedures, improper use of equipment, faulty equipment, adverse geologic conditions, or inexperienced operators;
- Poor interpretation-possible causes include an inadequate interpretation method, insufficient background information, or insufficient or noisy data;
- Insufficient data-possible causes include a lack of understanding of methods and/or site conditions and objectives, operator inexperience, or a lack of up-to-date plotted data in the field (some contractors gather data but do not plot it or look at it until they are back in the office).

STANDARD OPERATING PROCEDURE NO. 15.5
CONDUCTING A SEISMIC SURVEY

1.0 METHOD SUMMARY

Seismic refraction/reflection methods use seismic waves to determine the thickness and extent of lithologic and aquifer units. Seismic surveys are based on creating seismic waves in the subsurface by hammering, dropping a heavy object, or through the use of explosives.

2.0 EQUIPMENT/APPARATUS/REAGENTS

Equipment for performing many surface geophysical surveys is available from a variety of sources, and include modern, computerized microprocessors and electronics. Although the equipment can generally be operated by trained technicians, all aspects of data collection, processing and interpretation will require the oversight of a qualified geophysicist, geologist, or groundwater scientist having extensive experience with the equipment operation and data interpretation.

3.0 PROCEDURES

Contractor shall have a geologist or engineer experienced with the equipment operation and data interpretation. to supervise work on TNRCC projects.

Seismic waves are created in the subsurface by hammering, dropping a heavy object, or through the use of explosives. The seismic waves are refracted and reflected as the waves travel through the subsurface. As the waves are refracted/reflected back to the surface, geophones placed firmly in the ground detect the seismic wave. The analyses of refracted/reflected waves can determine the depth to bedrock at a potential drilling site.

1. Check to see that calibration/maintenance has been performed by the manufacturer. If field measurements indicate a malfunction, the instrument may need maintenance.
2. Inspect equipment at the start of the day to ensure that it is in working order.
3. Monitor the seismic signal to verify that equipment (i.e., geophones, cables) is working properly.
4. Conduct the seismic survey in accordance with the project specific work plan.
5. Show on a site map the locations of all seismic arrays.
6. Correlate all seismic data with existing boring logs to verify the identified stratigraphy.
7. Final results shall be presented in plain views and cross sections. Contours shall be used where appropriate.
8. The interpretation of results shall discuss positive and negative results as well as limitations of the method and data.
9. The interpretation of the data shall be incorporated into the conceptual site model.

4.0 CAUTIONS AND INTERFERENCES

Geophysical testing can involve a large variety of methods to collect data, and the data itself is subject to interpretation. Some of the problems that are commonly encountered when using geophysical techniques to investigate the shallow subsurface include:

- Incorrect method applied-possible causes include lack of understanding of geophysical technology, site conditions or survey objectives;
- Poor data quality-possible causes include high ambient noise, poor field procedures, improper use of equipment, faulty equipment, adverse geologic conditions, or inexperienced operators;
- Poor interpretation-possible causes include an inadequate interpretation method, insufficient background information, or insufficient or noisy data;
- Insufficient data-possible causes include a lack of understanding of methods and/or site conditions and objectives, operator inexperience, or a lack of up-to-date plotted data in the field (some contractors gather data but do not plot it or look at it until they are back in the office).

STANDARD OPERATING PROCEDURE NO. 15.6 LOGGING A BOREHOLE USING A SINGLE POINT RESISTIVITY TOOL

1.0 METHOD SUMMARY

Single-point resistance measures the resistance of in-situ materials between and in-hole electrode and a surface electrode. Resistance logging has a small radius of investigation and is very sensitive to the conductivity of the borehole fluid and changes in hole diameter (e.g., caving, washouts, and fractures). The single-point resistance method is the simplest type of measurement that can be used for logging a borehole.

2.0 EQUIPMENT/APPARATUS/REAGENTS

Equipment for performing many surface geophysical surveys is available from a variety of sources, and include modern, computerized microprocessors and electronics. Although the equipment can generally be operated by trained technicians, all aspects of data collection, processing and interpretation will require the oversight of a qualified geophysicist, geologist, or groundwater scientist having extensive experience with the equipment operation and data interpretation. Borehole geophysical equipment is highly specialized and will require a qualified contractor to obtain the logs.

3.0 PROCEDURES

One current electrode is suspended in the borehole and one electrode is at the surface. Current is directed down the borehole to the current electrode where it spreads out into the formation around the borehole. Part of the current returns to the surface electrode where the current drop is measured. The following are general requirements for borehole geophysical surveys:

The contractor shall have a geologist or engineer experienced with the equipment operation and data interpretation supervise work on TNRCC projects.

1. All downhole equipment must be decontaminated according to project specifications or SOP 1.6 (Decotamination).
2. Paper copies of curves generated from each logging run shall show all the curves at a scale of 1 inch equals 20 feet; each paper log shall indicate the location of the well, date of log acquisition, type of survey instrument, and a list of other instruments used in that borehole; and interpretations shall be annotated on the margins of paper log records.
3. All logs shall be referenced to a measuring point notched in the surface casing or to ground level if the well is not cased.
4. Adverse borehole conditions shall be reported in the field log.

4.0 CAUTIONS AND INTERFERENCES

Geophysical testing can involve a large variety of methods to collect data, and the data itself is subject to interpretation. Some of the problems that are commonly encountered when using geophysical techniques to investigate the shallow subsurface include:

- Incorrect method applied-possible causes include lack of understanding of geophysical technology, site conditions or survey objectives;

- Poor data quality-possible causes include high ambient noise, poor field procedures, improper use of equipment, faulty equipment, adverse geologic conditions, or inexperienced operators;
- Poor interpretation-possible causes include an inadequate interpretation method, insufficient background information, or insufficient or noisy data;
- Insufficient data-possible causes include a lack of understanding of methods and/or site conditions and objectives, operator inexperience, or a lack of up-to-date plotted data in the field (some contractors gather data but do not plot it or look at it until they are back in the office).

STANDARD OPERATING PROCEDURE NO. 15.7
LOGGING A BOREHOLE USING ELECTRIC LOGS

1.0 METHOD SUMMARY

Electrical resistivity logging is conducted in conjunction with spontaneous potential (SP) logging. When used together, these methods are commonly referred to as "E" logs.

2.0 EQUIPMENT/APPARATUS/REAGENTS

Equipment for performing many surface geophysical surveys is available from a variety of sources, and include modern, computerized microprocessors and electronics. Although the equipment can generally be operated by trained technicians, all aspects of data collection, processing and interpretation will require the oversight of a qualified geophysicist, geologist, or groundwater scientist having extensive experience with the equipment operation and data interpretation. Borehole geophysical equipment is highly specialized and will require a qualified contractor to obtain the logs.

3.0 PROCEDURES

Resistivity and SP are simultaneously measured from the bottom of the hole upward. The measuring instruments shall be raised toward the surface at a rate no greater than 10 feet per minute. Monitor well screen depths are selected in the field based on interpretation of the strip-chart log. Equivalent measurement scales increase the accuracy of geologic interpretation in the field and, therefore, screen interval selection.

The scales selected for portraying resistivity or SP readings shall be the same at all boreholes. The appropriate scale is determined in the field by conducting offset logs prior to the final survey. Offset logs are a quality assurance and calibration step that involves logging an upper or lower portion of the borehole and adjusting the log response to obtain the optimum scale. Scales to be adjusted are the horizontal (millivolts for SP and ohm-meters for resistivity) and vertical (feet). The resistivity logs shall consist of the short-normal (16-inch) and long-normal (64-inch) configurations.

The contractor shall have a geologist or engineer experienced with the equipment operation and data interpretation supervise work on TNRCC projects.

1. All downhole equipment must be decontaminated according to project specifications or SOP 1.6 (Decontamination).
2. Borehole measurements shall be recorded both going into the hole and coming out of the hole.
3. Paper copies of curves generated from each logging run shall show all the curves at a scale of 1 inch equals 20 feet; each paper log shall indicate the location of the well, date of log acquisition, type of survey instrument, and a list of other instruments used in that borehole; and interpretations shall be annotated on the margins of paper log records.
4. All logs shall be referenced to a measuring point notched in the surface casing or to ground level if the well is not cased.
5. Adverse borehole conditions shall be reported in the field log.

4.0 CAUTIONS AND INTERFERENCES

Geophysical testing can involve a large variety of methods to collect data, and the data itself is subject to interpretation. Some of the problems that are commonly encountered when using geophysical techniques to investigate the shallow subsurface include:

- Incorrect method applied-possible causes include lack of understanding of geophysical technology, site conditions or survey objectives;
- Poor data quality-possible causes include high ambient noise, poor field procedures, improper use of equipment, faulty equipment, adverse geologic conditions, or inexperienced operators;
- Poor interpretation-possible causes include an inadequate interpretation method, insufficient background information, or insufficient or noisy data;
- Insufficient data-possible causes include a lack of understanding of methods and/or site conditions and objectives, operator inexperience, or a lack of up-to-date plotted data in the field (some contractors gather data but do not plot it or look at it until they are back in the office).

STANDARD OPERATING PROCEDURE NO. 15.8 LOGGING A BOREHOLE USING A NATURAL GAMMA TOOL

1.0 METHOD SUMMARY

Natural gamma ray logging is used to estimate lithologic characteristics of geologic formations by recording gamma radiation emissions.

2.0 EQUIPMENT/APPARATUS/REAGENTS

Equipment for performing many surface geophysical surveys is available from a variety of sources, and include modern, computerized microprocessors and electronics. Although the equipment can generally be operated by trained technicians, all aspects of data collection, processing and interpretation will require the oversight of a qualified geophysicist, geologist, or groundwater scientist having extensive experience with the equipment operation and data interpretation. Borehole geophysical equipment is highly specialized and will require a qualified contractor to obtain the logs.

3.0 PROCEDURES

The gamma ray logging tool contains one or more scintillation detectors which measure the natural radioactivity in soil layers adjacent to the borehole. Gamma logging may be used in conjunction with spontaneous potential (SP), resistivity, and caliper logs in fluid-filled boreholes. This technique allows logging through the casing or the well pipe after well construction; however, the radiation measurements are attenuated by well casing. Generally, this technique works very well in sand and clay formations.

The mineral distribution in subsurface layers reduces the potential for use of gamma ray logs, and the technique does not provide sufficient additional data to warrant widespread use. This technique shall therefore only be used where the mineral constituents of the geologic formations indicate the log shall provide additional interpretive information.

The contractor shall have a geologist or engineer experienced with the equipment operation and data interpretation supervise work on TNRCC projects.

1. All downhole equipment must be decontaminated according to project specifications or SOP 1.6 (Decontamination).
2. Borehole measurements shall be recorded both going into the hole and coming out of the hole.
3. Paper copies of curves generated from each logging run shall show all the curves at a scale of 1 inch equals 20 feet; each paper log shall indicate the location of the well, date of log acquisition, type of survey instrument, and a list of other instruments used in that borehole; and interpretations shall be annotated on the margins of paper log records.
4. All logs shall be referenced to a measuring point notched in the surface casing or to ground level if the well is not cased.
5. Adverse borehole conditions shall be reported in the field log.

4.0 CAUTIONS AND INTERFERENCES

Geophysical testing can involve a large variety of methods to collect data, and the data itself is subject to interpretation. Some of the problems that are commonly encountered when using geophysical techniques to investigate the shallow subsurface include:

- Incorrect method applied-possible causes include lack of understanding of geophysical technology, site conditions or survey objectives;
- Poor data quality-possible causes include high ambient noise, poor field procedures, improper use of equipment, faulty equipment, adverse geologic conditions, or inexperienced operators;
- Poor interpretation-possible causes include an inadequate interpretation method, insufficient background information, or insufficient or noisy data;
- Insufficient data-possible causes include a lack of understanding of methods and/or site conditions and objectives, operator inexperience, or a lack of up-to-date plotted data in the field (some contractors gather data but do not plot it or look at it until they are back in the office).

STANDARD OPERATING PROCEDURE NO. 15.9
LOGGING A BOREHOLE USING A CALIBER TOOL

1.0 METHOD SUMMARY

Caliper logs are used to measure variations in the borehole diameter.

2.0 EQUIPMENT/APPARATUS/REAGENTS

Equipment for performing many surface geophysical surveys is available from a variety of sources, and include modern, computerized microprocessors and electronics. Although the equipment can generally be operated by trained technicians, all aspects of data collection, processing and interpretation will require the oversight of a qualified geophysicist, geologist, or groundwater scientist having extensive experience with the equipment operation and data interpretation. Borehole geophysical equipment is highly specialized and will require a qualified contractor to obtain the logs.

3.0 PROCEDURES

A caliper is a spring-loaded mechanical device with one to four adjustable arms that press against the borehole wall and measure the diameter in cased and uncased boreholes. Variations in the borehole diameter, factors such as borehole erosion (washout), the presence of swelling clays or resistant strata, and the volume of filter pack or grout needed for well completion, are determined using caliper logging. Caliper logs are conducted by lowering the device to the bottom of the borehole and recording the measurements as the caliper is raised.

The contractor shall have a geologist or engineer experienced with the equipment operation and data interpretation supervise work on TNRCC projects.

1. All downhole equipment must be decontaminated according to project specifications or SOP 1.6 (Decontamination).
2. Borehole measurements shall be recorded coming out of the hole.
3. Paper copies of curves generated from each logging run shall show all the curves at a scale of 1 inch equals 20 feet; each paper log shall indicate the location of the well, date of log acquisition, type of survey instrument, and a list of other instruments used in that borehole; and interpretations shall be annotated on the margins of paper log records.
4. All logs shall be referenced to a measuring point notched in the surface casing or to ground level if the well is not cased.
5. Adverse borehole conditions shall be reported in the field log.

4.0 CAUTIONS AND INTERFERENCES

Geophysical testing can involve a large variety of methods to collect data, and the data itself is subject to interpretation. Some of the problems that are commonly encountered when using geophysical techniques to investigate the shallow subsurface include:

- Incorrect method applied-possible causes include lack of understanding of geophysical technology, site conditions or survey objectives;

- Poor data quality-possible causes include high ambient noise, poor field procedures, improper use of equipment, faulty equipment, adverse geologic conditions, or inexperienced operators;
- Poor interpretation-possible causes include an inadequate interpretation method, insufficient background information, or insufficient or noisy data;
- Insufficient data-possible causes include a lack of understanding of methods and/or site conditions and objectives, operator inexperience, or a lack of up-to-date plotted data in the field (some contractors gather data but do not plot it or look at it until they are back in the office).

STANDARD OPERATING PROCEDURE NO. 16.1
SLUG TEST

1.0 METHOD SUMMARY

This SOP describes the procedures used to perform slug tests to measure the rate of recovery of the ground water level in a monitoring well. The test involves the instantaneous injection or removal of a known volume or slug of water or solid object into a cylinder of known volume (the well). Slug tests are typically applicable in rock formations or deposits of low hydraulic conductivity.

2.0 EQUIPMENT/APPARATUS/REAGENTS

The contractor shall describe the equipment to be used, including calibration and QC requirements for the aquifer tests. Include the method for calculating aquifer characteristics.

Typical equipment required for conducting slug tests includes:

- Tape measure (in tenths of feet)
- Water level indicator
- Stainless steel or PVC slug
- Watch or stopwatch
- Field logbook
- Duct tape
- Data logger
- Pressure Transducer(s) and cable(s)
- Logs of boring and well construction
- Decontamination supplies
- Test forms
- Keys to well locks
- Paper towels
- Waterproof and permanent marking pens
- Appropriate personal protective equipment (PPE)
- Length of nylon rope

3.0 PROCEDURES

Prior to beginning any aquifer testing, any downhole equipment shall be decontaminated in accordance with SOP 1.5 (Decontamination).

The following are general procedures which should be completed prior to beginning a slug test.

1. Make initial water level measurements on monitoring wells in an upgradient to downgradient sequence. Measurements should be obtained to the nearest 0.01 ft. If possible, water levels should be measured several times before the test to determine interferences that could affect the water levels.

2. Cover sharp edges of the well with duct tape to protect pressure transducer cables.

3. Install pressure transducers and cables into the well to a depth below which the slug will be dropped. Ensure that the depth of submergence does not exceed the design range for the transducer (e.g, a 10 psi transducer can withstand a maximum of 23 ft of head). Be sure to include sufficient depth for the water level to rise if conducting a falling head test.

4. Secure the transducer cable to the well casing with duct tape to ensure that the reference point does not move once the test is started. Care must be taken to ensure that the transducer is submerged throughout the test. Once the test has started the transducer elevation must not be changed.

5. Connect the transducer to the data logger.

6. Enter test information into data logger as required. The type of data required will depend on the model of data logger used.

7. Enter the initial water level and transducer information into the data logger according to the manufacturers instructions.

8. Program the data logger to record in logarithmic mode as shown on the following table:

CYCLE	ELAPSED TIME	SAMPLE INTERVAL
1	0-2 sec	0.2 sec
2	2-20 sec	1 sec
3	20-120 sec	5 sec
4	2-10 min	30 sec
5	10-100 min	2 min
6	100-1,000 min	10 min

9. Measure the appropriate length of rope and secure the rope to both the slug and to the well casing or other solid object.

10. For a rising head, test introduce the slug to the well and allow the water level to recover to a minimum of 90 percent of the static level before starting the test.

11. For a falling head test, position the slug so that the bottom of the slug is just slightly above the static water level.

12. "Instantaneously" remove or add the slug to the well. It is important that the volume be added or removed as quickly as possible since the analysis assumes an "instantaneous" change in volume in the well.

13. At the moment of insertion or removal, start the data logger allowing the data logger to monitor the water level change.

14. Continue the test until the water level has recovered to within 90 percent of the static water level.

15. Remove and decontaminate the slug test equipment in accordance with SOP 1.5 (Decontamination).

16. Lock the well upon completion.

17. Dispose of all investigative derived waste (IDW) in accordance with SOP 1.4 (IDW).

18. Complete the field logbook with test information, including the method of testing (i.e., slug test), well identification number, location and elevation of reference point, depth to water and elevation (if reference elevation is known), well depth, screen length, riser pipe radius, and the borehole radius, types of equipment being used, and the names of personnel conducting the test.

4.0 CAUTIONS AND INTERFERENCES

Interferences and potential problems include atmospheric conditions (i.e. changes in barometric pressure), impact of local recovery wells, interference from nearby pumping wells, and loading (compression) of the aquifer.

If slug tests are to be conducted, it is important to test several wells since slug tests only measure aquifer properties immediately adjacent to the borehole or well.

STANDARD OPERATING PROCEDURE NO. 16.2
CONDUCTING A PUMP TEST

1.0 METHOD SUMMARY

This SOP provides methods for conducting ground water pump tests. A pump test involves pumping an aquifer and observing the water level response over time. Aquifer characteristics which may be obtained from pumping tests include hydraulic conductivity (K), transmissivity (T), specific yield (S_y) for unconfined aquifers, and storage coefficient (S) for confined aquifers. These parameters can be determined by graphical solutions and numerous commercially available computer programs.

2.0 EQUIPMENT/APPARATUS/REAGENTS

The contractor shall describe the equipment to be used, including calibration and QC requirements for the aquifer tests. Include the method for calculating aquifer characteristics.

Typical equipment required for conducting slug or pump tests includes:

- Tape measure (in tenths of feet)
- Water level indicator
- Watch or stopwatch
- Field logbook
- Duct tape
- Data logger
- Pressure transducer(s) and cable(s)
- Submersible pump
- Generator
- Logs of boring and well construction
- Decontamination supplies
- Test forms
- Keys to well locks
- Paper towels
- Waterproof and permanent marking pens
- Appropriate personal protective equipment (PPE)
- Length of nylon rope
- In-line totalizer and meter
- Drums for storage of water

3.0 PROCEDURES

The following steps should be followed when conducting an aquifer pump test. These steps assume that the pump test is being conducted immediately following the step drawdown test.

Prior to beginning any aquifer testing, any downhole equipment shall be decontaminated in accordance with SOP 1.5 (Decontamination).

The following are general procedures which should be completed prior to beginning a pump test.

1. Make initial water level measurements on monitoring wells in an upgradient to downgradient sequence. Measurements should be obtained to the nearest 0.01 ft. If possible, water levels should be measured several times before the test to determine interferences that could affect the water levels.

2. Cover sharp edges of the well with duct tape to protect pressure transducer cables.

3. Install pressure transducers and cables into all wells to a depth below the target drawdown estimated for the well. Ensure that the depth of submergence does not exceed the design range for the transducer (e.g, a 10 psi transducer can withstand a maximum of 23 ft of head).

4. Secure the transducer cable to the well casing with duct tape to ensure that the reference point does not move once the test is started. Care must be taken to ensure that the transducer is submerged throughout the test. Once the test has started the transducer elevation must not be changed.

5. Connect the discharge hose (pipe) to the pump.

6. Lower the pump into the well keeping the pump electric lines and discharge line (if flexible) taut to avoid entanglement of the lines within the well bore.

7. Position the pump below the level of maximum drawdown expected during the aquifer test.

8. Connect the discharge hose to the discharge control valve and flowmeter.

9. Connect the transducer to the data logger.

10. Enter test information into data logger as required. The type of data required will depend on the model of data logger used.

11. Enter the initial water level and transducer information into the data logger according to the manufacturers instructions.

12. Program the data logger to record the drawdown as shown on the following table:

Elapsed Time	Sample Interval
0 to 3 minutes	every 30 seconds
3 to 15 minutes	every minute
15 to 60 minutes	every 5 minutes
60 to 120 minutes	every 10 minutes
120 min. to 10 hours	every 30 minutes
10 hours to end of test	every 1 hour

13. Once again, measure the depth to water in all wells.

14. Allow the water levels in the recovery well and monitoring wells to recover to a minimum of 90 percent of the static water level.

15. Set flow rate of the pump equal to the pumping rate identified step-drawdown test in SOP 16.3 (Conducting a Step-Drawdown Test).

16. Start the pump and begin pumping the recovery well. Pumping should be kept constant.

17. Start the data logger to begin recording the drawdown in the monitoring wells.

18. Periodically check and record water levels in each of the wells with the water level meter.

19. Continue pumping the well until drawdown has stabilized. Stable drawdown conditions can be defined as + 1 percent fluctuation in total drawdown over an 8 hour period. A typical pump test may take 30 to 40 hours to complete.

20. Shut off the pump.

21. Continue to record water levels with the data logger until the water levels in the monitoring wells have recovered to 95 percent of the static water level. Do not remove the pump or pressure transducer in the recovery well until the water level has stabilized.

22. Disconnect the pump and remove it from the recovery well.

23. Disconnect the data logger from the pressure transducers and deliver it to the field office to download pump test data.

24. Remove the pressure transducers and cables.

25. Decontaminate the pump test equipment in accordance with SOP 1.5 (Decontamination).

26. Lock the well upon completion.

27. Dispose of all IDW in accordance with SOP 1.6 (IDW).

28. Complete the field logbook with test information, including the method of testing (i.e., slug test or pump test), well identification number, location and elevation of reference point, depth to water and elevation (if reference elevation is known), well depth, screen length, riser pipe radius, and the borehole radius, types of equipment being used, and the names of personnel conducting the test.

4.0 CAUTIONS AND INTERFERENCES

Interferences and potential problems include atmospheric conditions (i.e. changes in barometric pressure), impact of local recovery wells, interference from nearby pumping wells, and loading (compression) of the aquifer.

It is critical that any rainfall which occurs while conducting a pump test be recorded accurately. Rainfall will increase the rate of recharge and overestimate the groundwater recovery of the aquifer. If significant amounts of rainfall occur during the test of an unconfined aquifer, the test should be terminated and restarted once the rain has stopped and the aquifer has been allowed to fully recover.

STANDARD OPERATING PROCEDURE NO. 16.3
CONDUCTING A STEP-DRAWDOWN TEST

1.0 METHOD SUMMARY

This SOP describes the procedures used to conduct a step-drawdown test. A step-drawdown test is conducted prior to a groundwater pump test in order to identify the optimal pumping rate for the aquifer.

2.0 EQUIPMENT/APPARATUS/REAGENTS

The contractor shall describe the equipment to be used, including calibration and QC requirements for the aquifer tests. Include the method for calculating aquifer characteristics.

Typical equipment required for conducting slug or pump tests includes:

- Tape measure (in tenths of feet)
- Water level indicator
- Watch or stopwatch
- Field logbook
- Duct tape
- Data logger
- Pressure Transducer(s) and cable(s)
- Submersible pump
- Generator
- Logs of boring and well construction
- Decontamination supplies
- Test forms
- Keys to well locks
- Paper towels
- Waterproof and permanent marking pens
- Appropriate personal protective equipment (PPE)
- Length of nylon rope
- In-line totalizer and meter
- Drums for storage of water

3.0 PROCEDURES

Prior to beginning any aquifer testing, any downhole equipment shall be decontaminated in accordance with SOP 1.5 (Decontamination).

The following are general procedures which should be completed prior to beginning a pump test.

1. Make initial water level measurements on monitoring wells in an upgradient to downgradient sequence. Measurements should be obtained to the nearest 0.01 ft. If possible, water levels should be measured several times before the test to determine interferences that could affect the water levels.

2. Cover sharp edges of the well with duct tape to protect pressure transducer cables.

3. Install pressure transducers and cables into wells to a depth below the target drawdown estimated for the well. Ensure that the depth of submergence does not exceed the design range for the transducer (e.g, a 10 psi transducer can withstand a maximum of 23 ft of head).

4. Secure the transducer cable to the well casing with duct tape to ensure that the reference point does not move once the test is started. Care must be taken to ensure that the transducer is submerged throughout the test. Once the test has started the transducer elevation must not be changed.

5. Connect the transducer to the data logger.

6. Enter test information into data logger as required. The type of data required will depend on the model of data logger used.

7. Enter the initial water level and transducer information into the data logger according to the manufacturers instructions.

8. Make connections to the submersible pump including discharge tubing and air or electrical connections. Attach a safety line for raising and lower the pump.

9. Insert the pump into the well and position it at the required depth interval.

10. Pump the well at a low discharge rate until the fluid drawdown stabilizes. Drawdown can be considered stabilized when the water level declines less than 0.02 ft in 1 hour.

11. As soon as the pump is started, begin recording water levels with the data logger.

12. Once drawdown has stabilized, increase the pumping rate by approximately 50 percent and monitor water levels until drawdown stabilizes again.

13. Repeat Step 4 until a pumping rate is achieved that the recovery well cannot maintain.

14. Shut off the pump.

15. If pump test follows, omit steps 16 through 21 and proceed with Pump test in accordance with SOP 16.2 (Conducting a Pump Test)

16. Disconnect the pump and remove it from the recovery well.

17. Disconnect the data logger from the pressure transducers and deliver it to the field office to download pump test data.

18. Remove the pressure transducers and cables.

19. Decontaminate the pump test equipment in accordance with SOP 1.5 (Decontamination).

20. Lock the well upon completion.

21. Dispose of all IDW in accordance with SOP 1.6 (IDW).

22. Complete the field logbook with test information, including the method of testing (i.e., slug test or pump test), well identification number, location and elevation of reference point, depth to water and elevation (if reference elevation is known), well depth, screen length, riser pipe radius, and the borehole radius, types of equipment being used, and the names of personnel conducting the test.

4.0 CAUTIONS AND INTERFERENCES

Interferences and potential problems include atmospheric conditions (i.e. changes in barometric pressure), impact of local recovery wells, interference from nearby pumping wells, and loading (compression) of the aquifer.

STANDARD OPERATING PROCEDURE NO. 17.1
GLOBAL POSITIONING SYSTEM DATA COLLECTION AND SUBMISSION

1.0 METHOD SUMMARY

TCEQ requires the use of Global Positional System (GPS) in conjunction with other technologies to collect and maintain positional data that provides physical and environmental site information about plume and contaminate changes over time. Also GPS technologies are used to provide the boundaries of buildings, real property, waste areas, locations of wells and other relevant site features.

2.0 GPS CERTIFICATION

To ensure that TCEQ receives reliable and accurate positional data, TCEQ OPP 8.12 requires that the GPS data collector must be certified. The TCEQ staff may obtain GPS certification by attending a training course presented by either an internal GPS trainer or by a manufacturer-certified GPS trainer. Non-TCEQ staff may obtain GPS certification from a manufacturer-certified GPS trainer. All GPS data collectors must verify that the certification instruction they have received meets the minimum elements listed in Table 1 - GPS Certified Training Minimum Elements in the Third Party GPS Training Certification section of this SOP.

3.0 EQUIPMENT / APPARATUS

A DGPS (Differential Global Positioning System) receiver can be either a stand alone unit, or a GPS module with Differential GPS antenna and relevant satellite subscription, plugged into a portable computer. The DGPS receiver must:

- Have six channel parallel reception or better.
- Have sub-meter horizontal accuracy.
- Employ these processing parameters:

Position acquisition rate	-	1/second or better
Position mode	-	3D (uses 4 satellites)
Maximum PDOP	-	6(or less)
Minimum Elevation	-	User-Selectable (record elevation accuracy)

- Have the ability to perform real-time differential correction (no post processing).
- Receive correction data from a recognized, reliable source, and which is appropriate for real-time correction in the geographic area in which the GPS measurements will be made.
- Output correction data in RTCM-SC104 (Radio Technical Commission of Maritime Service - Special Committee Paper No.104) format via an RS-232 cable or other compatible connection which matches the DGPS receiver.
- Have ability to store at least 180 position measurements.

- Have ability to transfer almanac and position data to a personal computer via a serial port or USB connection.
- Include software to perform mission planning, differential correction, point data averaging, and conversion to common formats (Grid or ArcView).
- Have a water and shock resistant case.
- Include portable power source(s) which will last a full working day.
- All weather proof Field Log Book.
- A laser rangefinder (optional)

4.0 GPS DATA COLLECTION AND ACCURACY

Horizontal Accuracy - All horizontal positions collected using certified GPS units shall maintain sub-meter accuracy. In order to meet sub-meter accuracy, latitude and longitude coordinates should be carried out to at least 6 places for decimal degree and at least 2 place for decimal seconds.

DGPS - Differential Global Positioning System (DGPS) receiver which corrects the atmospheric effects. DGPS are used for realtime GPS mapping and tracking without the need for post-processing.

PDOP - Positional Dilution of Precision. A measure of the quality of a GPS measurement taken from a given set of four satellites at a given time. If the satellites are not widely distributed from the user's location, the PDOP value will be higher, and the quality of the measurement will be diminished. PDOP values greater than 6 are not acceptable.

Datum - A mathematical model used by cartographers to define the shape of the earth in a specific area. Always use North America Datum of 1983 (NAD 83).

Differential Correction - A process applied to raw GPS data that removes certain types of errors; primarily, the error introduced by Selective Availability. This process requires correction data from a reference GPS receiver operating from a precisely known location. Correction data must be obtained from a recognized, reliable source (such as the reference network maintained by the Texas Department of Transportation) or Racal LandStar , and certain Trimble units, provide a satellite delivered GPS correction service, which provide 24 hour accurate and reliable real time precise positioning on land and in the air. For full coverage in Texas, the differential signal is transmitted to the user by high-power geostationary satellites. The GPS and differential signal are both received by the GPS via a single antenna

A single position reading obtained through appropriate use of real-time correction must have sub-meter accuracy.

Collection Methods - GPS data may be collected using one of three methods:

- Superimposed - The superimposed method involves standing on top of or next to the subject for which you are collecting GPS locational data. Collect 60-100 readings.
- Centroid - The centroid method is used when the superimposed method cannot be used (e.g. well inside a locked fence or structure). Take points equal distance from the desired point by starting and stopping the GPS and by averaging these points. The unit will average the point for each reading and then all the points as one point which will be the center of all the readings. Collect a minimum of 30 readings per point prior to averaging.
- Offset - The offset method is used when the superimposed method cannot be used and only when accurate offset measurements can be made (e.g. Using a laser rangefinder, tape measure, etc.) The potential error associated with the offset measurement must be added to the potential error associated with the GPS measurement. A note in the GPS logging software and the field log book of bearing and distance from the offset location can be used but location must be corrected before it is entered into a table or shape file.
- Points - The point is used for well and sample locations, gates, sub-meter objects, etc.
- Line - The line is used for trail, road, stream, berm, etc.
- Polygon - The polygon is used for buildings, site boundary, waste area, ponds or piles, etc. If it is hard to walk the entire perimeter, readings can be taken at each corner of the polygon by starting and stopping the GPS at the corners and within the same Station. The program will add the line in between the points of the Station to create a polygon.

5.0 DATA SUBMITTALS

Correction Status - All GPS data submitted must have a field indicating each record's differential correction status. There are only two selections available:

- Differential Correction - Indicates that the record has been differentially corrected.
- Uncorrected - Indicates that the record has not been differentially corrected.

Offset - The offset points must be noted in the field log book and actual points calculated before entering the station into the final database or shape file.

Events - Each event must be in separate data table or shape file.

Data Sets - Each data set must be in separate file or layer (e.g All wells, buildings , site boundaries, sample results/event, site features, roads, trails, utilities, etc. must be in separate layers/tables).

Arc View files - All data must be in Decimal Degrees, NAD 83 exported to Arc View 3.2 as a shape files with the relevant metadata, a hard copy of the Arc View tables must accompany the electronic version for TCEQ submittal.

Field Log Book - Site name location and details of field activity must be noted in the field log book, including the name and coordinates of each station and bearing and distance details describing any station off-sets.

Minimum Attributes - All GPS data submitted to TCEQ should conform to the data attributes defined in Table 1.

Table 1

GPS Data Attributes

Attribute	Data Type	Field Length	Description
Latitude	**Number**	**Double**	Decimal Degree to a minimum of six decimal places
Longitude	**Number**	**Double**	Decimal Degree to a minimum of six decimal places
Site Name	**Text**	**50**	Superfund Site Name
Station Name	**Text**	**50**	Monitoring well number or Sample name
Station Reference / Comments	**Text**	**50**	Station Location Relative to Facility
Station Type	**Text**	**10**	Point, Line or Polygon
Collector Name	**Text**	**50**	Last Name, First Initial
GPS Certificate Number	**Text**	**8**	TCEQ GPS Certificate Number
Collection Method	**Text**	**15**	Superimposed, Centroid, Offset
Datum	**Text**	**5**	Horizontal Datum (NAD27, NAD83 or WGS84)
Max PDOP	**Number**	**Single**	Maximum PDOP value in effect during data collection (not > 6)
Receiver Type	**Text**	**50**	GPS model name & accuracy
Correction Status*	**Text**	**50**	Tells whether or not GPS data was differentially corrected
GPS Date	**Date**	**N/A**	Date GPS data was collected
GPS Time	**Text**	**8**	Time GPS data was collected
Total Positions Collected	**Number**	**Integer**	Number of positions collected/corrected

*** Data that is not differentially corrected will be rejected.**

Data Format - GPS data submitted to TCEQ should be in electronic format (dBASE IV, .dbf file format is preferred). The following is an example of how the data table should be structured. The data may be submitted via email, on diskette, or CD.

Table 2

Third Party GPS Data

Example Data Table

Latitude	Longitude	Site Name	Station Name	Station Reference / Comments	Collector Name	TCEQ GPS Certificate Number	Datum	Collection Method	Max PDOP	Receiver Type	Correction Status	GPS Date	GPS Time	Total Positions
11.111000	99.999000	Pioneer	MW-21	NW Corner	Terry, D	95081107	NAD83	Superimposed	4.4	Trimble XRS DGPS	Differential Correction	5/22/00	10:10 AM	61
11.111100	99.999100	Pioneer	MW-22	Center of the facility	Terry, D	95081107	NAD83	Centroid	5.2	Trimble XRS DGPS	Differential Correction	5/22/00	10:25 AM	108
11.111200	99.999200	Pioneer	MW-23	S of entrance	Terry, D.	95081107	NAD83	Superimposed	3.5	Trimble XRS DGPS	Differential Correction	5/22/00	1:38 PM	66
11.111200	99.999200	Pioneer	site location	South Entrance of facility	Terry, D.	95081107	NAD83	Superimposed	3.5	Trimble XRS DGPS	Differential Correction	5/22/00	3:38 PM	60

Third Party GPS Training Certification

Minimum Qualifications

Texas Natural Resource Conservation Commission

TCEQ OPP 8.12 requires all GPS training courses to include both lecture/classroom discussion and hands-on exercises. Table 1 contains the minimum elements that must be included in any TCEQ-recognized GPS certification training course

Table 1

GPS Certification Training

Minimum Elements

Minimum lecture and/or demonstration elements	Minimum hands-on exercises, to be successfully completed by each student
Q Background of the Global Positioning System.	Q Pre-planning, including data quality objectives, equipment and materials needed, logistics of field data collection, and prediction of GPS data collection conditions.
Q GPS accuracy issues.	Q Navigation to a given coordinate.
Q Relevant Agency operating policies.	Q Storing and transferring raw positional data.
Q Operation of GPS equipment, including basic troubleshooting.	Q Differential correction of raw data through post processing.
Q Data collection procedures.	Q Averaging corrected point data and outputting to a GIS file.
Q Differential correction, both real time processing and post processing.	
Q Coordinate averaging for point locations.	
Q Data output in formats appropriate for import to GIS or tabular databases.	

Class exercises shall also include computer plotting of point data to allow students to better understand GPS accuracy issues and the effects of differential correction and point data averaging.
Note: All certified GPS users recognized by TCEQ must be recertified every 2 years; • Sales or user demonstrations do NOT constitute GPS training; • GPS training courses should last a minimum of six to eight hours; • The TCEQ GPS operating policy is available online at: http://www.tceq.state.tx.us/gis/gisplcy.html

Individuals obtaining or with current GPS certification training must verify that the instruction they have received meets the minimum elements listed in Table 1. Therefore, fill out the attached form, along with copies of GPS training certificates, and return them to:

David P. Terry

TCEQ GPS Coordinator (MCC-155)

SWAP Team

Texas Commission on Environmental Quality

P.O. Box 13087

Austin, Texas 78711-3087

(512) 239 4755

Email: dterry@tceq.state.tx.us

GPS Certification Verification Form

Texas Commission on Environmental Quality

Contact Information

GPS Training Coordinator Information			Training Provider Information	
Name			Organization Providing GPS Training	
Organization			Instructor	
Mailing Address			Course Name	
City	State	ZIP	Course Date	Course Hours
Email Address			GPS System (Trimble, Magellan, etc.)	Manufacturer Certified? Yes ☐ No ☐

The following individual(s) have received GPS certification training that complies with TCEQ OPP 8.12 minimum training elements:

Name	Title

I hereby state that the information provided is true, accurate, and complete to the best of my abilities

Signature of GPS Training Coordinator or GPS Trainer _____ Title _____ Date _____

Printed Name _____ Telephone Number _____ Extension _____

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CHAINLINK FENCE AND GATES

CHAINLINK FENCES AND GATES

PART 1 GENERAL

The new fence will be installed at the location designated by the TNRCC representative. An adequate area shall be cleared for installation of new fence.

SUBMITTALS:

A. Submit the following items in accordance with Section 2.100000 – Submittals
   1. Shop Drawings that indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, and schedule of components for Approval purposes.
   2. Product Data on fabric, posts, accessories, fittings and hardware for Approval purposes.

REFERENCES

a. ANSI/ASTM A123 – Zinc (Hot Dip Galvanized) Coating on Iron and Steel Products.
b. ANSI/ASTM F567 – Installation of Chain-Link Fence.
c. ASTM A392 – Zinc-Coated Steel Chain-Link Fence Fabric.
d. ASTM A817 – # 9 gauge carbon steel zinc coated wire fabric.
e. ASTM A1011 – Steel Sheet and Strip, Hot-Rolled, Carbon, High-Strength Low-Alloy.
f. ASTM A307/AASHTO M232 – Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
g. ASTM F900-94(2000) – Industrial and Commercial Swing Gates.
h. ASTM F1184-94(2000) – Industrial and Commercial Horizontal Slide Gates.
i. ASTM C94 – Ready-mixed Concrete.

PART 2. PRODUCTS

GALVANIZED FENCING

a. Fence Fabric -No.9 steel wire, hot galvanized after weaving in accordance with ASTM A392. Use fabric woven in 2-inch chain link pattern, with knuckled selvages top and bottom in accordance with ASTM A817.
b. Framework- Hot-dipped galvanized with a minimum coating of 2 ounces per square foot, or 1 ounce per square foot plus 30 micrograms per square inch chromate conversion coating.
c. Line Posts -Conform to ASTM A1011 Hot Rolled Steel, High Strength Low -Alloy 2-3/8-inch outside diameter, 3.65 pounds/foot pipe.
d. End Corner, Angle, and Pull Posts - Conform to ASTM A1011 Hot Rolled Steel, High Strength Low -Alloy 2-7/8-inch outside diameter, 5.79 pounds/foot pipe.
e. Top Rails -1-5/8-inch outside diameter steel pipe, 2.27 pounds per linear foot.
f. Fabric Ties – Hog rings, galvanized steel wire not less than 9-gage with a zinc coating of not less than 1.2 ounces per square foot. Interlace a continuous 7 -gage galvanized steel wire with the fabric along the extreme bottom of the fence.
g. Bolts and Nuts – Conform to ASTM A307; galvanized in accordance with AASHTO M232.
h. Horizontal Braces - Fabricated of 1-5/8-inch, 2.27-pound copper bearing steel pipe.
i. Extension Arms and Barbed Wire
   1. Extension Arms -Project 45-degrees outward from the fenced area.
   2. Barbed Wire -3 strands per extension arm; each strand of double twisted 12.5-gage with 14-gage, 4-point barbed pattern spaced 5 inches.

Gates -Provide either swing or slide as shown on the Drawings.

1. Swing Gates-Hinged to swing 90 degrees from closed to open or hinged to

swing 180 degrees from close to open as shown on the Drawings.

2 . Slide Gates-Roller type with guard and sealed bearings. Bearing housing shall be connected to shaft with a castle nut and cotter pin.

3. Swing Gate Leaves-Provide intermediate members and diagonal stress rods as required for rigid construction to eliminate sag or twist.

4. Slide Gate Leaves-Provide 2-inch outside diameter, 2.72 pounds/foot pipe diagonal bracing as required for rigid construction to eliminate sag or twist.

5. Barbed Wire Extension-Fit gates with vertical extension arms or extended frame end members to carry barbed wire.

6. Swing and Slide Gate Posts- 4 inch outside diameter, 9.11 pounds/foot pipe.

7. Swing Gate Frames-2-inch outside diameter, castings.

8. Slide Gate Frames-2.5 inch outside diameter, 3.65 pounds/foot pipe.

9. Fabric-Same as for the fence.

10. Malleable Iron Fittings-Ball and socket hinges, catches and stops.

11. Padlocks-One for each gate with 3 keys each. The lock shall be made out of brass withstanding weathering with a resettable combination lock with at least five digits.

12. Posts for Single Swing Gates-Same as end posts.

CONCRETE

A. Concrete used for post anchorage shall have a strength of 2,500 psi at 28 days; and shall be Type II Portland cement with a 3-inch slump and maximum 1-inch size aggregates mixed with potable water.

B. For quantities less than 1 cubic yard, dry premixed concrete ("Sak-Crete" or equivalent in accordance with ASTM C94 – Ready-mixed Concrete.) will be acceptable.

SOURCE QUALITY CONTROL

A. Furnish materials manufactured by a company that specializes in manufacturing the products specified in this Section.

PART 3. EXECUTION

LOCATION

A. Install chain link fencing and gates at locations shown on the Drawings.

INSTALLATION

A. Install chainlink fence in accordance with the directions of the Manufacturer and this Section.

B. Install fence posts at not more than 10-foot centers and at least 36 inches into the ground. Utilize concrete specified in this section to set all posts. Allow concrete to cure for at least 7 days before erecting remainder offence. Fasten fabric to line Posts with wire ties spaced about 14 inches apart and to top rail spaced about 24 inches apart.

C. Use standard chain link fence-stretching equipment to stretch the fabric before tying it to the rails and posts. Repeat the stretching and tying operations about every l00 feet.

D. Erect gates so they swing or slide in the appropriate direction. Provide gate stops as required. Secure hardware, adjust, and leave in perfect working order. Adjust hinges and diagonal bracing so that gates will hang level. Adjust rollers and guides of sliding gates so that gates are level.

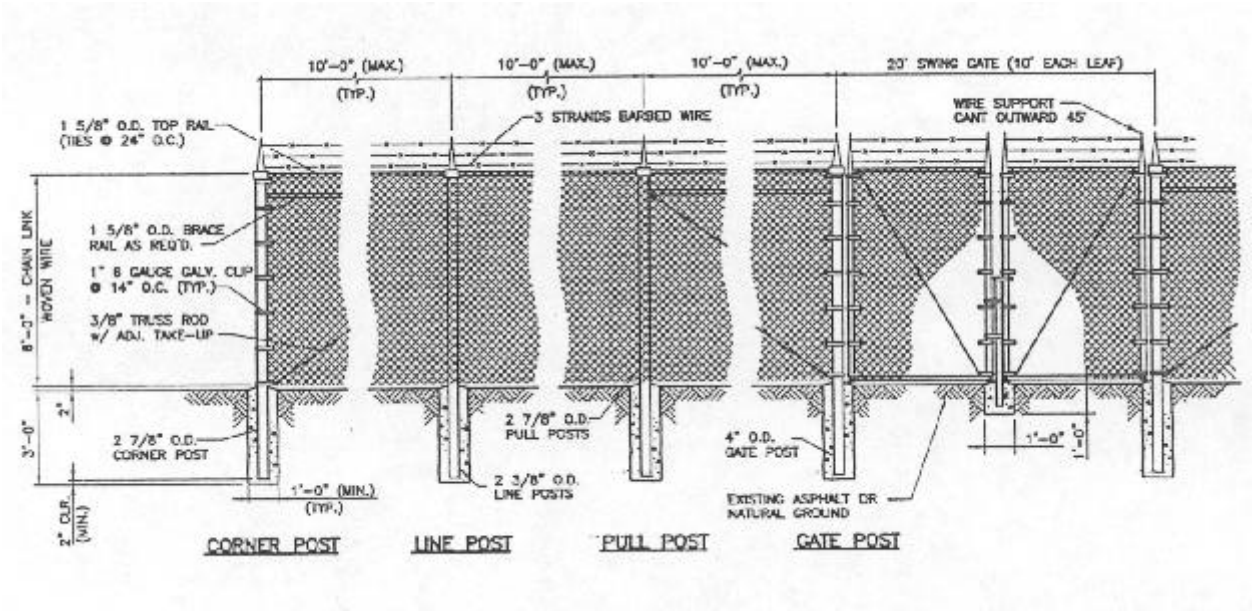
E. At small natural swales or drainage ditches where it is not practical for fence to conform to the ground contour, span the opening below the fence with wire fastened to stakes of required length. Install the finished fence plumb, taut, true to line and ground contour. Stake down the chain link fence at several points between posts.

F. Where new fence joins an existing fence, set a comer post and brace post at the junction and brace. If the connect-ion is made at other than the corner of the new fence, install a brace at the last span of the old fence.

SIGNS:

A. Signs will be furnished at the site by the TNRCC on or before the second day of fence construction. Mounting hardware and other materials shall be provided by the Contractor. The Contractor shall attach the signs to the fence line posts at no greater than 200-foot intervals. The signs shall be placed between the fence fabric and the line post with the wording on the sign visible from outside the site, and shall be secured to line posts using two steel U-bolts per sign. The U-bolt threads shall be abraded or treated with an epoxy base glue to prevent the nuts from being removed after installation.

DRAWINGS:


10'-0" (MAX.) (TYP.)
10'-0" (MAX.) (TYP.)
10'-0" (MAX.) (TYP.)
20' SWING GATE (10' EACH LEAF)
1 5/8" O.D. TOP RAIL (TIES @ 24" O.C.)
3 STRANDS BARBED WIRE
WIRE SUPPORT CANT OUTWARD 45°
1 5/8" O.D. BRACE RAIL AS REQ'D.
1" 8 GAUGE GALV. CLIP @ 14" O.C. (TYP.)
3/8" TRUSS ROD w/ ADJ. TAKE-UP
8'-0" - CHAIN LINK WOVEN WIRE
2 7/8" O.D. CORNER POST
2 7/8" O.D. PULL POSTS
2 3/8" O.D. LINE POSTS
4" O.D. GATE POST
EXISTING ASPHALT OR NATURAL GROUND
1'-0" (MIN.) (TYP.)
2" CLR. (MIN.)
CORNER POST
LINE POST
PULL POST
GATE POST

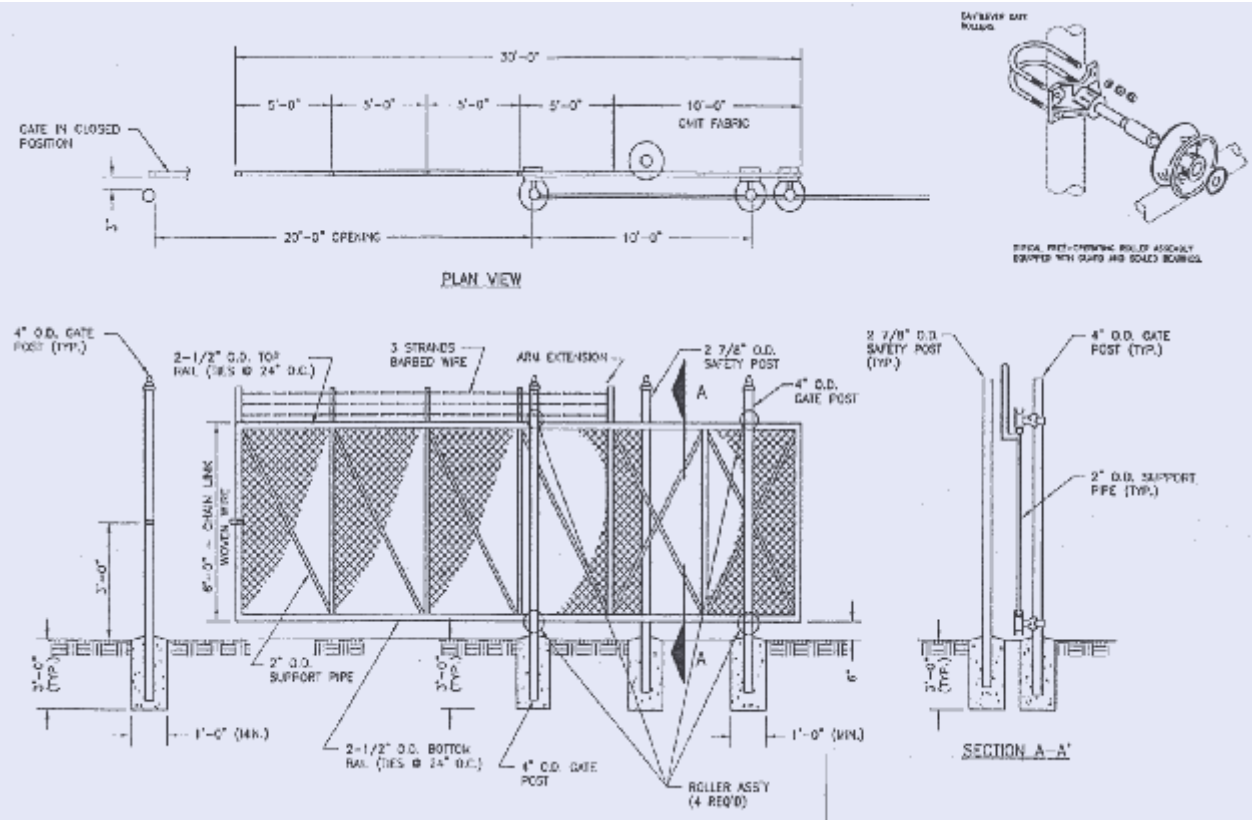

30'-0"
5'-0"
5'-0"
5'-0"
5'-0"
10'-0"
CMT FABRIC
GATE IN CLOSED POSITION
20'-0" OPENING
10'-0"
PLAN VIEW
4" O.D. GATE POST (TYP.)
2-1/2" O.D. TOP RAIL (TIES @ 24" O.C.)
3 STRANDS BARBED WIRE
ARM EXTENSION
2 7/8" O.D. SAFETY POST
4" O.D. GATE POST
2 7/8" O.D. SAFETY POST (TYP.)
4" O.D. GATE POST (TYP.)
2" O.D. SUPPORT PIPE (TYP.)
8'-0" - CHAIN LINK WOVEN WIRE
2" O.D. SUPPORT PIPE
1'-0" (MIN.)
2-1/2" O.D. BOTTOM RAIL (TIES @ 24" O.C.)
4" O.D. GATE POST
ROLLER ASS'Y (4 REQ'D)
SECTION A-A'

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TABLE OF CONTENT
FOR
FIELD SAMPLING PLAN

FIELD SAMPLING PLAN

TABLE OF CONTENTS

Title and Approval Sheet

Distribution List

Table of Contents

1.0 Introduction/Purpose

- ***Investigation Phase:*** *Purpose - Briefly states the specific purpose of this FSP relative to the Quality Assurance Project Plan, Work Plan and/or other documents. A schematic presentation of the project documents and the location of key planning components should be presented.*

- ***RA Phase:*** *Purpose - Briefly states the specific purpose of this FSP relative to the RA Contract Document, Quality Assurance Project Plan and/or other documents. A schematic presentation of the project documents and the location of key planning components should be presented.*

- *Project/Task Organization - Identifies the key individuals or organization participating in the project, their role(s) and responsibilities, and the organizational chart for the project. (Project specific information for QAPP Element A4)* [1]

2.0 Site and Project Summary

- ***Investigation Phase:*** *Problem Definition/Background - Briefly states the site description, surrounding area, historical information, previous investigation, suspected contamination source, probable transport pathways and other site information. Most of this information is available from the Conceptual Site Model developed during the planning phase. Any specific data gaps and methods to fill the data gaps should also be discussed. States the specific problem to be solved or the decision to be made and identifies the decision maker. (Project specific information for QAPP Element A5)* [1]

- ***RA Phase:*** *Problem Definition/Background - Briefly states the site description, historical information, previous investigation, a summary of the selected remedy, a brief discussion of the remedial action activities. States the specific problem to be solved or the decision to be made and identifies the decision maker. (Project specific information for QAPP Element A5)* [1]

- *Project/Task Description and Schedule - Briefly summarizes the project and the project tasks, the turnaround time for the project, including the turnaround time requirement for laboratory analysis. (Project specific information for QAPP Element A6)* [1]

- *Describes any special personnel and equipment required for the specific type of work being planned or measurement being taken. (Project specific information for QAPP Element A8)* [1]

- *Data Acquisition Requirements (Non-direct Measurements) -Defines the criteria for the use of non-measurement sources, such as computer databases, programs, literature files, and historical databases. (Project specific information for QAPP Element B9)* [1]
- *Assessment Techniques -Defines the number, frequency, and type of quality assessment activities, the responsible staff, the procedures to be performed during the life of the project, and any special training/certification requirements. (Project specific information for QAPP Element C1)* [1]

3.0 Sampling Objectives/Data Quality Objectives

- *Data Quality Objectives - Summarizes the project specific quality objectives and measurement performance criteria. This section should include the summary of the outcomes of the technical planning process (e.g., the 7-Step DQO process) used to develop the project objectives. The summary should also include a reference to Appendix B of the FSP, which contains a full discussion of the proposed DQOs for the project from which the summary was taken. Designates and briefly describes sampling units (e.g. AOCs, surface soil to 6 inches). States objectives by sampling unit or media. The project specific calculations or algorithms are also specified in this section. (Project specific information for QAPP Element A7)* [1]

4.0 Sampling Plan Design

- *Sampling Process Design - All the relevant components of the experimental design and the key parameters to be evaluated are included in this section. This section should include the sampling activities, the rational for the design (in terms of meeting the DQOs), the sampling design assumptions, the procedures for locating and selecting environmental samples, a classification of measurements as critical or noncritical, the type and number of samples required for the project including the required field QC samples, the sampling locations and frequency, the applicable sample matrices, and an identification of samples critical to the project. Most of this information should be available from the output from Step 7 of the DQO process. (Project specific information for QAPP Element B1)* [1]

- *Describes the sampling plan for each media, as applicable, including figures and tables.*

  Surface Soil
  Subsurface Soil
  Groundwater
  Surface Water and Sediment
  Air
  Other Matrices

- *This section should include a summary table containing a list of all chemicals of concern identified for the project with the corresponding Level of Required Performance (LORP) (e.g., action levels and preliminary remedial goals), analytical methods (including the preparation, analysis and cleanup methods), and the corresponding method detection limits for all analytes of concern.*

5.0 Sampling Method and Sample Handling

- *Sampling Method Requirements - Identifies sampling methods and equipment and describes the procedures for sample collection, preparation, and decontamination. This section should reference the Standard Operating Procedures located in Appendix A. (Project specific information for QAPP Element B2)* [1]

- *Sampling Handling and Custody Requirements - This section should include the required sample volumes, container types, and preservation requirements for non-standard or other analytical methods proposed for project work that are not listed in Table B2-1 of the site-specific QAPP. This section also includes the field sample handling and custody requirements for the project. (Project specific information for QAPP Element B3)* [1]

- *This section contains the specific requirements for field instrument/equipment testing, inspection and maintenance for the project. Additionally, field instrument calibration and frequency requirements for water level, pH, temperature, conductivity, dissolved oxygen, redox potential, and turbidity measurements are contained in this section. This section also includes the critical field supplies, the inspection or acceptance testing requirements, and the acceptance criteria. (Project specific information for QAPP Element B6, B7, and B8)* [1]

6.0 Field Survey and Measurements

- *This section describes the sampling methods and criteria for field survey and measurements, such as land surveys, hydrogeological tests and measurements, geophysical surveys and soil gas surveys, required for the project.*

7.0 Additional Field Activities

- *This section contains descriptions and procedures for other field activities, such as presampling/mobilization activities, required notification, property access, site restoration and IDW handling and disposal.*

8.0 Exceptions, Additions and Changes to the TNRCC Superfund Program QAPP

List any exceptions, additions and changes to the Superfund Program QAPP in each of the appropriate sub-sections corresponding to the table of contents of the Program QAPP. Site specific information (e.g., Group A and Group B elements) specified above should not be restated in this section. Please refer to the Program QAPP for details. This section should also include specifications for non-standard methods and other analytical methods not specified in the Program QAPP.

GROUP A: PROJECT MANAGEMENT

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A.6 Project/Task Description
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A.8 Special Training Requirements/Certification
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- *A.9.1 Field Operation Records*
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- *B.2.2 Sample Volumes, Container Types, and Preservation Requirements*

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- *Appendix A - Standard Operating Procedures*
- *Appendix B - Data Quality Objectives Document*
- *Appendix C-Z - Other supporting documents as necessary*.

[1] **Guidelines to be used in the preparation of the QAPP elements are:**

- **EPA Requirements for Quality Assurance Project Plans, Interim Final, EPA QA/R-5 (U.S. EPA, 1999)**
- **EPA Guidance for Quality Assurance Project Plans, Draft Final, EPA QA/G-5 (EPA, 1998)**