SAMPLING AND ANALYSIS PLAN

Phase II Subsurface Investigation and Asbestos and Lead-Based Paint Assessment

Tonopah Airport Fixed Base Operator (FBO) Building
1 Airport Road
Tonopah, Nevada 89049

Nye County Assessor Parcel Number (APN):
012-471-03

Prepared For:
Nye County
2100 East Walt Williams Drive, Suite 100
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On Behalf of:
Rural Desert Southwest Brownfields Coalition (RDSBC)

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Project No. 804.11.001
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Approval Page

Sampling and Analysis Plan for:

Volatile Organic Compounds, Resource Conservation and Recovery Act Metals, Total Petroleum Hydrocarbons, Asbestos, and Lead-Based Paints
Phase II Environmental Site Assessment
Tonopah Airport FBO Building
1 Airport Road
Tonopah, Nevada 89049

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ACRONYMS

AAS .....Atomic Absorption Spectrometry
ACM .....Asbestos containing material
AHERA.....Asbestos Hazard Emergency Response Act
APN .....Assessor's Parcel Number
ARARs.....Applicable or Relevant and Appropriate Requirements
AST.....Aboveground storage tank
ASTM .....American Society for Testing and Materials International
BGS.....Below ground surface
CEM.....Certified Environmental Manager
CFR.....Code of Federal Regulations
DQI .....Data Quality Indicator
DQO.....Data Quality Objectives
EDD .....Electronic Data Deliverable
EPA .....United States Environmental Protection Agency
ESA.....Environmental Site Assessment
FAA .....Federal Aviation Administration
FBO.....Fixed Base Operator
GPS .....Global Positioning System
HASP .....Health and Safety Plan
HUD.....Housing and Urban Development
IDW .....Investigation Derived Waste
MDL.....Method Detection Limit
MQO .....Method Quality Objective
NAC.....Nevada Administrative Code
NESHAP.....National Emissions Standard for Hazardous Air Pollutants (Federal Clean Air Act)
NDEP .....Nevada Division of Environmental Protection
NVLAP .....National Voluntary Laboratory Accreditation Program
OSHA.....Occupational Safety and Health Administration
PARCCS .....Precision, Accuracy, Representativeness, Completeness, Comparability, and Sensitivity
PPE.....Personal Protective Equipment
QA.....Quality Assurance
QC.....Quality Control RCRA Resource Conservation and Recovery Act
RCRA.....Resource Conservation and Recovery Act
RDSBC .....Rural Desert Southwest Brownfields Coalition
REC.....Recognized Environmental Condition
RL .....Reporting Limit
SAP .....Sampling and Analysis Plan
SD .....Standard Deviation
SOP .....Standard Operating Procedures
TPH.....Total petroleum hydrocarbons
TSCA .....Toxic Substances Control Act
US .....United States
USACE .....US Army Corps of Engineers
USGS .....United States Geological Survey
VOC.....Volatile organic compound
XRF.....X-ray Fluorescence

Units of measure:

sq ft or ft^2	square feet
mg/kg	milligrams per kilogram
mg/l	milligrams per liter
µg/l	micrograms per liter
ppb	parts per billion
ppm	parts per million

1 INTRODUCTION

BEC Environmental, Inc. has prepared this Sampling and Analysis Plan (SAP) for environmental assessment activities to be conducted at the Tonopah Airport Fixed Base Operator (FBO) Building located in Tonopah, Nevada. The Site is located at 1 Airport Road, Tonopah, Nevada 89049. The Site is owned and maintained by Nye County, assessor's parcel number (APN) 012-471-03. These assessment activities will be funded through the Rural Desert Southwest Brownfields Coalition (RDSBC) Grant.

The Site is a 0.75-acre portion of the 2,171 acre parcel and consists of the FBO Building, Federal Aviation Administration (FAA) support buildings and structures, a storage shed, and land immediately adjacent to these structures. Based upon records review and interviews the Site was first developed in the 1940's as the operations center for the United States (US) Army Tonopah Air Field. The air field is a Formerly Used Defense Site (site number J09NV0969) that was assessed by the US Army Corps of Engineers (USACE) as described through a series of technical documents dated between February 1991 (Ninyo and Moore, 2002) and May 2004 (Nevada Division of Environmental Protection [NDEP], 2004). On June 9, 2004, NDEP prepared a Draft Decision Document that provided a No Further Action Determination based upon information provided by the USACE. Additionally, the USACE prepared a map in March 2006 documenting known soil concentrations of various constituents of concern to assist Nye County in future redevelopment decisions (i.e. focusing redevelopment efforts in areas with concentrations of contaminants of concern below NDEP's reportable concentrations).

The site owner wishes to have the environmental issues addressed in order for the Site to safely continue its present use as the operations center (FBO building in particular) for the airport. Therefore, the objective of this SAP is to gather environmental data in order to inform decision makers regarding the presence of target analytes that pose risk to human health or the environment. Based on the results of the Phase I Environmental Site Assessment (ESA) (BEC Environmental, Inc., 2014) target analytes include: total petroleum hydrocarbons (TPH); volatile organic compounds (VOCs); and Resource Conservation and Recovery Act (RCRA) regulated metals from the above ground fuel storage tank; asbestos in the materials of the FBO building; and lead-based paint on the FBO building. This investigation will be performed in accordance with American Society for Testing and Materials (ASTM) Institute's *Standard Practice for Environmental Site Assessments: Phase II Environmental Site Assessment Process* (E1903-11).

1.1 Site Name

The Site is Tonopah Airport operations center, comprised of the FBO Building and immediately adjacent property.

1.2 Site Location

The site is a 0.75-acre portion of the 2,171 acre parcel located at 1 Airport Road, Tonopah, Nevada 89049. The legal description of the subject property is 0.75-acre portion of T3N R43E S36 & T3N R44E S31 & T2N R43E S1 & T2N R44E S5,6,7 & ALL OF S8 2,171 AC in the Tonopah Airport, Nevada. Please refer to the Site Vicinity Map (Figure 1).

1.3 Responsible Agency

This investigation will be conducted for Nye County under the Rural Desert Southwest Brownfields Coalition (RDSBC) Grant. The work will be performed by BEC Environmental, Inc. for the RDSBC. The investigation conforms to the requirements under United States Environmental Protection Agency's (EPA) Quality Assurance Project Plan (United States Environmental Protection Agency, 2001).

1.4 Project Organization

Please refer to Table 1-1.

Table 1-1 Key Project Personnel Contact Information and Responsibilities

Title	Name	Phone Number Email Address	Responsibilities
USEPA			
EPA Project Officer	Nova Blazej	(415) 972-3846 blazej.nova@epa.gov	Work Plan Review
EPA Quality Assurance Officer	Eugenia E. McNaughton, PhD	(415) 972-3411 mcnaughton.eugenia@epa.gov	USEPA QA Manager
RDSBC			
Grantee Program Administrator	Amy Fanning	(775) 751-7091 afanning@co.nye.nv.us	Project coordination liaison with Esmeralda, White Pine, Lincoln, and Inyo Counties
BEC Environmental, Inc.			
Project Principal	Eileen Christensen	(702) 340-9830 eileen@becnv.com	Senior review, regulatory liaison
Project Manager	Victoria Tyson-Bloyd	(702) 340-9830 victoria@becnv.com	Project management, field activities, date review, and report preparation
Quality Assurance Officer	Richard Nelson	(702) 340-9830 richard@becnv.com	SAP implementation, QA/QC review and data validation
Field Team Leader	Victoria Tyson-Bloyd	(702) 340-9830 victoria@becnv.com	Project management, field activities, date review, and report preparation
Graphical Information System	Jennifer Hill	(702) 304-9830 jennifer@becnv.com	GIS Support

Contractors/Vendors			
Converse Consultants	Philip Childers	(702) 263-7600 pchilders@ConverseConsultants.com	Lead-based paint and asbestos survey
TestAmerica Laboratories, Inc.	Elizabeth Baker	(602) 437-3340 Elizabeth.Baker@testamericainc.com	Analysis of samples

2 BACKGROUND

The 0.75-acre Site was developed in the 1940s to support airport operations for the US Army. Upon receipt of the property in 1949, Nye County maintained the Site as a municipal airport. The Site is primarily composed of concrete foundations and the FBO building structure coupled with ancillary support structures for the building and airport operations. Additional buildings located within the Site include a manufactured home and three prefabricated buildings for office space and storage. The unpaved portions of the site are sparse desert vegetation. Above ground storage tanks (ASTs) located within the Site include:

- 500 gallon propane tank which services the manufactured home
- 1,000 gallon propane tank noted as inactive
- 200 gallon steel tank which feeds the heating furnace for the FBO building through a below ground service line

The orientation of these features within the site is depicted on Figure 3. According to Nye County Planning there are no zoning requirements for the Tonopah Airport area.

Surrounding the Site is the remaining 2,170-acre parcel that comprises the main portion of the Tonopah General Aviation Airport (the airport). Significant features of the airport include two asphalt runways, three original (1940's airfield) aircraft hangars, three original bunkers, numerous former building remnants and foundation slabs. Development of property after transfer to Nye County included a residential subdivision, an oil refinery, and a sand and gravel quarry, and a race track (Ninyo and Moore, 2002). Nye County public works continues to operate and maintain the wastewater treatment plant located on the west side of Airport Road and south of the site.

The Site is currently used as the operational center for the airport. Built on a portion of the foundation of the historic operation building, three prefabricated buildings are currently used as a storage unit by the County and FAA. In addition, the manufactured home is currently owned and occupied by the airport operator. Note that the manufactured home will not be assessed under this evaluation.

2.1 Sampling Area Description

The sampling area will consist of soil directly under and around the 200 gallon steel AST which services the FBO building heating furnace through a below ground line. Sampling for asbestos containing material (ACM) and lead-based paint will be conducted in the FBO building, including evaluating the floor tiling, roofing material, piping insulation, and interior and exterior painted surfaces, as well as the soils around the exterior of the FBO building structure.

2.2 Operational History

Historical records and aerial photography showed the Site was first developed in the 1940's as the operations center for the Tonopah Army Air Field. The Site is currently in use as the operations center for the airport. Three prefabricated buildings have been built on a portion of the foundation of the historic FBO building, and are currently used as a storage unit by the County and as offices by the FAA. A manufactured home is located within the Site boundary and is currently owned and occupied by the airport operator. The FBO building has been leased to Mark Peterson (doing business as Desert Flying Services) since 1984. However, only the World War II-era FBO building and soils in the immediate vicinity of the FBO building and an associated heating fuel tank will be evaluated during the Phase II activities.

2.3 Previous Investigations/Regulatory Involvement

BEC conducted a Phase I Environmental Site Assessment (ESA) on the subject area for the RDSBC. The ESA, dated February 2014, was conducted in compliance with the ASTM Standard E-1527-13 to identify recognized environmental conditions (RECs) associated with past or current uses. The proposed sampling design is based on the findings of the Phase I ESA. Pertinent information from the Phase I ESA is discussed below.

The Phase I ESA recommended a limited Phase II investigation based on the age of the FBO building which suggests the potential presence of asbestos containing material ACM and lead-based paints and the presence of an AST which may have been subject to leakage and/or spills.

2.4 Scoping Meeting

Not applicable.

2.5 Geological/Meteorological Information

The ground surface of the Site is relatively flat and gently slopes to the southeast. Based on a review of the United States Geological Survey (USGS), East of Tonopah, Tonopah, Nevada, 7.5-minute quadrangle map (provisional Edition 1987), the Site is situated at an elevation of approximately 5,420 feet above mean sea level.

The airport property is located in west central Ralston Valley which extends northeast and south. The San Antonio Mountains are located to the west and the Monitor Mountain Range is located to the northeast. The Ralston Valley is within the western part of the Basin and Range physiographic province. The valley is a naturally formed, elongate valley resulting from northeast-trending block faulting, a fundamental characteristic of the Basin and Range physiographic province (Ninyo and Moore, 2002).

The valley deposits underlying the Site and vicinity are classified as quaternary alluvium, colluvium, and talus (Nevada Bureau of Mines and Geology, 1985). The soil deposits in this region of Nye County consist primarily of sandy gravel and gravelly sand on the flanks of the mountains and grading into alluvial silty sand with gravel and sandy silt in the valley.

No natural surface water bodies, including ponds, streams, or other bodies of water, are present on the Site.

2.6 Impact on Human Health and/or the Environment

No adverse human health effects associated with the recognized environmental concerns have been reported or documented, based upon BEC's review of readily accessible public information. However, Nye County's Board of County Commissioners has requested the Site be environmentally cleared to ensure the safety of the public and building occupants.

3 PROJECT AND DATA QUALITY OBJECTIVES

3.1 Project Task and Problem Definition

The purpose of this investigation will be to assess for the presence of TPH and RCRA 8 metal contamination in the surface soil at the Site. The investigation will also assess for the presence of ACM and lead-based paints within building materials of the FBO building and in the property immediately around the building that comprise the 0.75-acre site. The scope of the assessment is to provide relevant information regarding Site conditions and to determine if additional investigation activities are warranted.

3.2 Data Quality Objectives (DQO's)

The DQO process (United States Environmental Protection Agency, 2006) is a systematic planning tool used to establish performance or acceptance criteria. These criteria, in turn, serve as the basis for designing a plan for collecting data of sufficient quality and quantity to support the goals of a study. The DQO process consists of seven iterative steps, as described in the following sections.

Step 1: State the Problem

Site conditions are not known regarding recognized environmental conditions identified in the Phase I ESA. Therefore, the purpose of Phase II investigations is to evaluate if TPH, VOCs, and RCRA 8 metals exist in Site media. Also, prior to renovation or demolition of the FBO building, potential environmental concerns including asbestos and lead-based paint must be addressed. Chemical testing is required to evaluate the concentrations of target analytes and determine if additional assessment activities are necessary.

Step 2: Identify Decisions

The primary and secondary study questions for investigation are as follows:

What is the nature and extent of contamination in soil from the operations at the fuel tank?

1. Are concentrations of contaminants greater than background concentrations?
2. Are concentrations of contaminants greater than risk-based screening criteria?

What is the extent of ACM and lead-based contamination in the FBO building?

Testing data obtained from the assessment will guide investigators and stakeholders regarding Site conditions such that remedial action plans can be developed to protect workers during demolitions activities and address potentially impacted surface soil to ensure site conditions are safe for future redevelopment.

Step 3: Identify Inputs

Analytical data for collected samples will be evaluated to determine if concentrations exceed regulatory thresholds. Soil samples will be collected for analysis by EPA Method 8015B for TPH, EPA Method 8060 for VOCs, and by EPA Methods 6010B and 7471A for RCRA 8 metals. The laboratory analytical reporting results from these samples will be compared to the Nevada Division of Environmental Protection's Reportable Concentrations for soil. NDEP Reportable Concentrations are shown in Table 3-1.

Analytical data for samples collected from the on-site building materials also will be evaluated to determine if concentrations of asbestos and/or lead-based paint exceed regulatory action levels. Asbestos data will be compared to levels established in Occupational Safety and Health Administration (OSHA) 29 Code of Federal Regulations (CFR) 1926.1101, Nevada Administrative Code (NAC) 618,850 to 618.986, National Emissions Standard for Hazardous Air Pollutants (NESHAP) 40 CFR 61.141 and Asbestos Hazard Emergency Response Act (AHERA)

40 CFR part 763. Lead data for paint samples will be compared to levels established in 40 CFR Part 745 and Toxic Substances Control Act (TSCA) 402 (c). Results of the investigation will be used to determine if additional assessment and /or abatement is required prior to the redevelopment or demolition and removal of the on-site structures.

Information required to address project objectives includes analytical testing of collected samples and regulations regarding waste disposal. Analytical testing of lead, ACM, and soil will be conducted by TestAmerica Laboratories, Inc.

Step 4: Define Study Boundaries

Sample collection will occur within the boundaries of the Site as defined in Section 2.1 of this Plan and as shown on Figure 4. Sampling will be limited to surface soil under and around the AST, suspect ACMs, painted surfaces on existing structures, and soil around the building base. The estimated duration of activities described in this SAP is approximately two days.

Step 5: Develop Decision Rules

Decision rules from soil sampling activities will be based on the analytical results obtained, in comparison to the regulatory thresholds as specified in Table 3-1. These comparisons will be used to evaluate if additional assessment and/or remedial action is required (i.e. if the analytical data exceeds regulatory thresholds), prior to Site redevelopment. Soil data may also be used to assist in determining an appropriate approach to remediation methodology and/or institutional controls.

Step 6: Specify Tolerable Limits on Decision Errors

This is not a statistically based study; therefore, sampling locations will be selected based on professional judgment and site knowledge.

Step 7: Optimize Sampling Design

The number of samples will be determined in the field using professional judgment such that samples are representative of site conditions.

3.3 Data Quality Indicators (DQI's)

Data quality indicators (precision, accuracy, representativeness, completeness, comparability and sensitivity-PARCCS parameters) refer to quality control criteria established for various aspects of data gathering, sampling, and/or analyses. The DQI's are as follows:

- **Precision:** the degree of mutual agreement between or among independent measurements of a similar property (usually reported as standard deviation [SD] or relative percent difference) and relates to the analysis of duplicate laboratory or field samples.
- **Accuracy:** the degree of agreement of a measurement with a known or true value and is determined by comparing the reported laboratory value for a sample to a known or true concentration (i.e. matrix spikes, surrogate spikes, laboratory control samples and performance samples).
- **Representativeness:** the expression of the degree to which data accurately and precisely represent a characteristic of an environmental condition or population and relates to the method of collecting samples and determining sampling locations.
- **Completeness:** expressed as the percent of valid usable data obtained compared to the amount that was expected.
- **Comparability:** the degree of confidence with which one data set can be compared to another.
- **Sensitivity:** defined by the laboratory detection limits and generally expressed in terms of method detection limits (MDLs) or reporting limits (RLs).

3.3.1 *Precision and Accuracy*

DQO's will be met through adhering to required sampling methodology, required laboratory analytical methods, and data review. Data are accepted and rejected based on the data quality objectives. If the data are near the regulatory limit and could be affected by variability and accuracy measures, such as low recovery for spikes or surrogates, then further evaluation will be made. Audits will be initiated when data quality objectives are not being met.

3.3.1.1 Soil

Constituents of concern in soil include TPH, VOCs, and Arsenic, Barium, Cadmium, Chromium, Lead, Mercury, Selenium, and Silver (8 RCRA metals). Specific QC methods for determining the accuracy and precision for sampling and analysis of each of these constituents are discussed below.

Accuracy:
Accuracy is determined for field measures by field equipment calibration before and after sample measurement using appropriate standards. For laboratory measures, accuracy is determined through field blanks, lab matrix spikes, certified reference material, and laboratory control samples.

Precision:
Precision measurements are typically determined by the resolution of the instrument, and through evaluation of field and laboratory duplicates (or splits). Field duplicates account for both precision of sampling techniques and laboratory analysis, as well as environmental variability. Field splits consist of two aliquots from the same composite sample, and field duplicates will consist of two grab samples collected in rapid succession. Laboratory duplicates are used to evaluate precision of the laboratory process.

If results of the blind field blanks or field duplicates are outside the control limits, corrective action and/or data qualification will be determined after a review by the QA Officer. All analyses performed for this project must reference QC results to enable reviewers to validate the data. Sample analysis data, when reported by the laboratory, will include QC results. All data will be reviewed for internal consistency, transmittal errors, laboratory protocols, and for compete reference to the QC elements.

3.3.1.2 Asbestos

Precision is dependent on the total number of fibers counted and the uniformity of the fiber distribution on the filter. At least 20, but not more than 100 fibers will be counted. When 100 fibers are counted, the count will be discontinued. Counting more than 100 fibers will not result in a gain of precision. As the total count drops below ten, precision is decreased. Currently, there is no known method to determine accuracy of the asbestos analysis.

3.3.1.3 Lead-Based Paint

Data validation will include a review of field procedures and documentation for completeness and accuracy; verification of appropriate custody control of samples; and a review of laboratory records to verify that appropriate sample preservation and holding times are achieved. A review of the laboratory's internal QC results will include an evaluation of laboratory duplicates, matrix spike, and duplicate percent recoveries, method blanks, and laboratory control standards. Appropriate qualifiers will be applied to the data, as necessary, based on the data validation review.

Table 3-1 Target Analytes, Laboratory and Action Levels

Analytical Parameter (Contaminants of Concern)[1]	CAS Number	EPA Method (Soil)	TestAmerica Method Detection Limit (mg/kg) (Soil)	NDEP Action Level (mg/kg) (Soil)
TPH (GRO)		8015B	5.0	100
TPH (DRO)		8015B	7.2	100
TPH (ORO)		8015B	7.2	100
Arsenic	7440-38-2	6020B	0.3	0.39
Barium	7440-39-3	6010B	0.100	1600
Cadmuim	7440-43-9	6010B	0.0246	8
Chromium	7440-47-3	6010B	0.215	38
Lead	7439-92-1	6010B	0.137	400
Mercury	7439-97-6	7471A	0.100	6.7
Selenium	7782-49-2	6010B	0.561	5
Silver	7440-22-4	6010B	0.141	34
Benzene	71-43-2	8060	0.00975	0.03
Carbon Tetrachloride	56-23-5	8060	0.0121	0.07
Ethylbenzene	100-41-4	8060	0.00835	5.7
Methyl tert-Butyl Ether (MTBE)	1634-04-4	8060	0.0161	39
Toluene	108-88-3	8060	0.0108	12
Tetrachloroethylene (PCE)	127-18-4	8060	0.0103	0.06
Tricloroethylene (TCE)	79-01-6	8060	0.00825	0.06
Vinyl Chloride	75-01-4	8060	0.008	0.01
Xylene, Mixture	1330-20-7	8060	0.0213	210

3.3.2 *Representativeness*

Sampling at the site will entail several grab samples. During field activities, there is the potential for sample contamination that may interfere with laboratory analysis and associated validity of analytical results. Additionally, sample containers may be broken, lost, or otherwise invalidated. However, BEC expects the number of valid results from the analysis to be equal to or greater than 90%. This percentage will allow for the appropriate level of decision making in determining if the collected data is sufficient to characterize the site or if additional data are required.

3.3.3 *Completeness*

Sampling at the site will entail several grab samples. During field activities, there is the potential for sample contamination that may interfere with laboratory analysis and associated validity of analytical results. Additionally, sample containers may be broken, lost, or otherwise invalidated. However, BEC expects the number of valid results from the analysis to be equal to or greater than 90%. This percentage will allow for the appropriate level of decision making in determining if the collected data is sufficient to characterize the site or if additional data are required.

3.3.4 *Comparability*

Similar studies have not been performed at the Site in the past.

Comparability expresses the confidence with which one data set can be compared with another. Comparability of data will be achieved by consistently following standard field and laboratory procedures and by using standard measurement units in reporting analytical data.

3.3.5 *Sensitivity*

The laboratory reporting limits are adequate for this investigation.

3.4 Data Review and Validation

The limited scope of this environmental investigation warrants the use of a Tier 1A data validation effort.

Data verification is the process of evaluating the completeness, correctness, conformance, and compliance of a specific data set against the method, procedural, or contractual requirements. Data verification evaluates whether sampling protocols, standard operating procedures (SOPs), and analytical methods were followed during data generations. Verification also involves examining the data for errors or omissions. Field and laboratory staff will verify that the work is producing appropriate outputs.

Data validation is a systematic process for reviewing a body of data against a pre-established set of acceptance criteria defined in this plan. Data validation is an analyte and sample-specific process that extends the evaluation of data beyond data verification and is performed to determine the analytical quality of a specific data set. Validation involves a detailed examination of the data package to determine whether measurement quality objectives (MQOs) for precision, accuracy, and sensitivity have been met. For this environmental assessment, the intent of the data review and validation process is to verify that the specified levels of precision, accuracy, reproducibility, completeness, comparability, and analytical sensitivity of the final results are achieved, with respect to the project MQO's, and that the data fulfill project DQO's.

A verification level validation will be performed on all field documentation and analytical data reports. The data validation process will be used to verify the data quality. The following quality control (QC) elements will be reviewed, as appropriate, for sampling activities associated with TPH, VOCs, and RCRA 8 metals analyses:

- Analytical holding times
- Preparation blank contamination
- Check standard precision
- Analytical accuracy (blank, matrix spike and control sample recoveries)
- Analytical precision (comparison of replicate sample results)

BEC's Quality Assurance (QA) Officer will supervise or perform data quality assessment tasks. BEC will consistently evaluate and document data to monitor consistency with MQO's, to quantitatively assess data quality, and to identify potential limitations to data use. BEC will review field and analytical laboratory data generated for this project, including the following:

- Chain-Of-Custody documentation
- Laboratory batch QC frequency
- Results of batch and field QC analyses

The laboratory will generate and review all laboratory data. Each data point will be assessed as non-qualified or qualified based upon the acceptance criteria. Data may be qualified as "estimated" (J-qualified); these data are used as is. Some data may be qualified as "rejected" (R-qualified) if critical QC parameters are not met; these data are unusable for any purpose. Sample re-analysis, for data not meeting MQO's, will be considered as a possible corrective action. Third-party data validation will not be performed.

3.5 Data Management

Data management systems and procedures will be used to establish and maintain an efficient organization and reporting of the environmental information collected. Procedures and standards for conducting specific data management tasks (i.e., acquisition, handling, storage, and distribution of data) will be documented in a project log. Essential elements of data management and reporting activities associated with this assessment are discussed in the following section.

3.5.1 *Field Data*

Daily field records (a combination of field logbooks, field forms, global positioning system [GPS] records, and Chain-Of-Custody forms) will make up the main documentation for field activities, including sample location and selection justification. Upon completion of sampling, hardcopy notes and forms will be scanned to develop an electronic record for use in preparing the Site Characterization Report (i.e. Phase II Environmental Site Assessment). Information on sampling locations, dates, depths, equipment, and other conditions, and sample identifiers, will be entered into the project log. BEC's QA Officer will ensure 100% of hand-entered data is verified based on hard-copy records. Electronic QA checks to identify anomalous values will also be conducted following entry.

3.5.2 *Laboratory Data*

The analytical laboratories will each submit data in both electronic and hard-copy format. The project manager or his designated data manager will provide the desired format for Electronic Data Deliverables (EDDs) to the laboratories, and the project data manager and laboratory coordinator will discuss these specifications with laboratory QA managers prior to data delivery and tailor them as necessary to specific laboratory capabilities. QA checks of format and consistency will be applied to EDDs received from the laboratory.

3.5.3 *Reporting*

Qualitative (i.e., field logs, observations) and quantitative (i.e., sample results, measurements) will be evaluated, analyzed, and reported in the final Site Characterization Report. BEC's QA Officer ensures a

professional reviewer to examine the technical information provided in each report, including qualitative and quantitative data, are accurately reported and discussed within each report. BEC conducts a second, "professional review" to review grammar, formatting, and narrative components of the report are correct prior to final report submittal.

3.6 Assessment Oversight

Prior to commencing with field work, the SAP and Health and Safety Plan (HASP) will be reviewed by the Project Team. The BEC Project Manager will oversee QC of all field activities. If modifications to the proposed sampling program are required due to field conditions, the Project Manager will be notified and consulted for direction. Any modifications to the SAP will be documented in the field logs and in the project report as "deviations from the SAP".

4 SAMPLING DESIGN AND RATIONALE

The following sections describe the methods used in determining the sampling design, including location of samples and contaminants of concern.

4.1 Soil Sampling

Surface: Surface and/or near surface soil samples will be collected in the location of the 200 gallon AST (noted on Figure 4 using sampling ID Numbers in Table 4-1). Samples will be collected from under the tank and around the perimeter of the tank based on visual observation of tank and soil conditions. Soil samples will also be collected from around the base of the FBO building.

Table 4-1 Sampling Design and Rationale Matrix = Soil

Sampling Location/ID Number	Depth (inches)	Analytical Parameter	Rationale
SS-1	0-6 inches bgs	TPH-g/d/o, RCRA 8 metals, VOC's	Assess the potential migration of contaminants to surface and near surface soils directly below the AST.
SS-2	0-6 inches bgs	TPH-g/d/o, RCRA 8 metals, VOC's	Assess the potential migration of contaminants to surface and near surface soils around the perimeter of the AST.
SS-3	0-6 inches bgs	TPH-g/d/o, RCRA 8 metals, COC's	Assess the potential migration of contaminants to surface and near surface soils around the perimeter of the AST.
SS-4	0-6 inches bgs	RCRA 8 metals	Assess the level of background concentrations of RCRA 8 metals at the site.

TPH – g/d/o = total petroleum hydrocarbons as gasoline, diesel, and oil range
RCRA 8 – total metals for As, Ba, Cd, Pb, Se, Ag, Hg
bgs – below ground surface

4.2 Sediment Sampling

Not applicable.

4.3 Water Sampling
Not applicable.

4.4 Other Sampling
Asbestos samples will be collected from suspect ACM found within the facility structures and from soils adjacent to the exterior of the structures. Lead samples will be collected from suspect paint found on interior and exterior surfaces of facility structures and from soils adjacent to the exterior of the structures. An adequate number of samples shall be collected to represent site conditions for ACM and lead-based paint. Professional judgment will be used to select sampling locations that are likely to provide data to address project DQO's. Decision statements formulated in project DQO's are largely concerned with assessing for the presence of asbestos and lead-based paint within building materials and exterior soils.

4.4.1 *Asbestos Sampling*
The asbestos assessment will be conducted by a contractor certified in Asbestos-Containing Materials in Schools (AHERA), to identify the presence of any materials containing asbestos pursuant to the following requirements:

- EPA's 40 CFR Part 61 – National Emission Standard for Asbestos (NESHAP)
- EPA's 40 CFR Part 763, Subpart E – AHERA

The survey will identify the quantity and locations of ACM within the facility structures. This information can then be used to develop a project specification for the removal of ACM prior to building demolition and/or renovation. Additional samples will be collected from the soils immediately adjacent to the structures exterior, at the discretion of the contractor. An estimated 40 samples are anticipated to be collected.

4.4.2 *Lead-Based Paint Sampling*
A contractor licensed to conduct lead-based paint surveys in the State of Nevada will be conducting lead-based paint sampling to identify the presence of any materials containing lead-based paint pursuant to the following requirements:

- EPA's 40 CFR Part 745, Subpart L – Lead-Based Paint Activities

The purpose of the survey will be to aid in identifying building materials and exterior soils containing detectable levels of lead to assist with proper demolition and/or renovation debris disposal and for compliance with OSHA inorganic lead standard 29 CFR 1926.62.

5 REQUEST FOR ANALYSES

Laboratory analyses are discussed in Section 5.1 below.

5.1 Analysis Narrative
Surface soil samples collected from the location of the AST for laboratory analysis will be analyzed for TPH (using EPA Method 8015B), VOCs, and RCRA 8 metals (using EPA Methods 6010B and 7471A) as shown in Table 4-1. Upon collection and labeling as described in Sections 7 and 9, the samples will be immediately placed into an ice chest and chilled to approximately four (4) degrees Celsius.

Samples collected from suspect ACM shall be analyzed using polarized light microscopy /stereomicroscopy for bulk asbestos samples. These methods are described in 40 CFR Part 763, Appendix

E to Subpart E (interim and EPA 600/R-93/116, improved). Bulk paint chip samples will be analyzed by atomic absorption spectrometry (AAS) using method SW-846-7420. Samples will be analyzed under normal turnaround times, typically between five and seven days.

5.2 Analytical Laboratory

BEC proposes to use TestAmerica Laboratories, Inc. of Las Vegas, Nevada to perform all laboratory analysis for this project. Analytical testing and sample handling, including container types and preservation methods, will be conducted in accordance with TestAmerica's Quality Assurance Program Plan as shown in Appendix A. TestAmerica is a State of Nevada certified analytical laboratory, and is certified for metals analysis, TPH, and VOCs in the State of Nevada. TestAmerica contracts asbestos analysis to laboratories which are accredited by the National Voluntary Laboratory Accreditation Program (NVLAP). Sample containers and preservation methods for each proposed soil analysis at the site have been summarized from TestAmerica's Quality Assurance Plan and are provided in Table 5-1, below.

Table 5-1 Soil Sample Collection Information

Analysis	EPA Method	Sample Container[1]	No. of Containers	Preservation	Holding Time
TPH Gas Range	8015B	5 gram En Core Sample Container	3	Cool, 4° C	48 Hours
TPH Diesel/Oil Range	8015B	4-oz Glass Jar	1	Cool, 4° C	14 Days
RCRA 8 Metals (Mercury)	7471A	Collect aliquot from metals jar	1	Cool, 4° C	28 Days
RCRA 8 Metals (ExcludingMercury)	6010B	8-oz Glass Jar	1	Cool, 4° C	6 Months
Volatile Organic Compounds	8260 B	5 gram En Core Sample Container	3	Cool, 4° C	48 hours

1 – Soil samples to be collected per EPA Method 5035. See Appendix B.

6 FIELD METHODS AND PROCEDURES

The following sections describe the procedures and equipment to be used to collect soil samples at the site.

6.1 Field Equipment

This section outlines the necessary field equipment for sample collection.

List of Equipment Needed

- Field logbook and field data sheets
- Personal protective equipment (Level D)
- Knife/box cutter with retractable blade
- Tape measure
- Camera
- Zip-lock type bags

- Sample containers, labels, and appropriate Chain-Of-Custody paperwork
- Disposable trowel
- Disposable containers (sample homogenization)
- Cooler and sealed ice packs
- Shipping labels
- Indelible ink pens

6.1.1 *Calibration of Field Equipment*

Field equipment requiring calibration will not be in use during sampling activities.

6.2 Surface Soil Sampling

Exact soil sampling locations will be determined in the field based on accessibility, visible signs of potential contamination (i.e., stained soils), proximity to suspected contaminant sources and topographical features which may indicate location of hazardous substance disposal (i.e., depressions that may indicate a historic excavation). Soil sample locations will be recorded in the field logbook as sampling is completed. A sketch of the sample location will be entered into the logbook and any physical reference points will be labeled. If possible, distances to the reference points will be given.

Surface soil samples will be collected as grab samples (independent, discrete samples) from a depth of zero to six inches below ground surface (bgs). Surface soil samples to be analyzed for RCRA 8 metals will be collected using disposable trowels and placed in disposable, sample-dedicated pans and homogenized with the trowel. Material in the pan will be transferred with the trowel from the pan to the appropriate sample containers, consistent with the information provided in Table 5-1. Sample containers will be filled to the top, taking care to prevent soil from remaining in the lid threads prior to being cased to prevent potential contaminant migration to or from the sample. See Section 7.1 for preservation and shipping procedures.

Surface soil samples also will be collected as grab samples for TPH and VOC analysis. For each sample location, the number and type of containers specified in Table 5-1 will be collected in accordance with the methodology, preservation, and holding times specified in the EPA Method 5035 Guidance Document located in Appendix C-1. Samples will be chilled to approximately four (4) degrees Celsius immediately upon collection.

6.3 Sediment Sampling

Not applicable.

6.4 Water Sampling

Not applicable.

6.5 Other Sampling

This section will discuss the methods used for collection and transportation of asbestos containing materials and lead-based paint samples.

6.5.1 *Asbestos Sampling*

An initial walk through of the subject site will be conducted in order to identify homogeneous suspect materials containing asbestos and their respective locations. This information will then be used to develop a sample collection strategy. Samples will be collected and recorded on a Chain-Of-Custody form. This form accompanies the samples to laboratories, which are accredited by the NVLAP for analysis of asbestos. The location of each collected sample will be documented through the use of field

notes. Samples shall be collected from suspect ACM by cutting material using a clean, stainless steel knife. Samples will be at least two square inches or two tablespoon in size. Care will be taken to minimize disturbance to the material. The samples will be placed in a zip-lock type bag which will be sealed and labeled prior to delivery to the receiving laboratory.

6.5.2 *Lead-Based Paint Sampling*

An initial walk through of the subject site will be conducted in order to identify and list all testing combinations and room equivalents. Testing will be conducted in accordance with Chapter 7 of the *Guidelines of the Evaluation and Control of Lead Based Paint Hazards in Housing* published by the Department of Housing and Urban Development (HUD). The HUD definition of lead-based paint is a lead value equal to or greater than 1.0 mb/cm$^{3.}$ All results above this level are considered positive and all results found below this level are considered negative. Bulk paint chip samples will be collected from painted surfaces. All samples will be collected from painted surfaces with a clean, disposable knife. The samples will be placed in a zip-lock type bag which will be sealed and labeled prior to delivery to the receiving laboratory.

6.6 Decontamination Procedures

Decontamination procedures that will be followed are in accordance with approved procedures. Decontamination of sampling equipment must be conducted consistently as to assure the quality of samples collected. All material that comes into contact with potentially contaminated soil will be decontaminated. Disposable equipment intended for one-time use will not be decontaminated, but will be packaged for appropriate disposal. Decontamination will occur prior to and after each use of a piece of equipment. All sampling devices used, including sampling knives, will be decontaminated according to EPA Region 9 recommended procedures. At the conclusion of sampling activities, all disposable sampling materials and/or PPE will be packaged for appropriate disposal.

The following, to be carried out in sequence, is an EPA Region 9 recommended procedure for the decontamination of sampling equipment.

- Non-phosphate detergent and tap water wash, using a spray bottle and if necessary, a brush.
- Tap-water rinse using a spray bottle.
- Deionized/distilled water rinse using a spray bottle.

Table 6-1 Field and Sampling Equipment

Description of Equipment	Material/Model (if available)	Dedicated (Yes/No)
Sampling Trowel (Soil)	Plastic disposable	Yes
Sampling Knifes (Lead-based Paint, ACM)	Stainless steel	Yes
Sample Pans	Aluminum/Disposable	Yes

7 SAMPLE CONTAINERS, PRESERVATION, PACKAGING AND SHIPPING

The number and type of sample containers, required sample volumes, and preservatives are listed in Section 5.0 of this plan. The sample containers will be provided by the contracted analytical laboratory. The containers will be pre-cleaned and will not be rinsed prior to sample collection. Preservatives, if

required, will be added to the containers, by the laboratory, prior to shipment of the sample containers to the field.

7.1 Soil Samples

Soil samples will be collected in containers with appropriate preservation for each analytical method, as specified in Table 5-1. After sample collection, surface soil samples will be placed in airtight zip-lock type bags, wrapped in bubble wrap to prevent container breakage, placed in a cooler, and chilled to approximately four (4) degrees Celsius immediately upon collection. Samples will be transported directly to the laboratory, under proper Chain-Of-Custody protocol, either by the sample collector or via FedEx.

7.2 Sediment Samples

Not applicable.

7.3 Water Samples

Not applicable.

7.4 Other Samples

Asbestos samples will not be chilled. Care will be taken to prevent deterioration or damage to samples during transit. Paint chip samples will not be chilled. Care will be taken to prevent deterioration or damage to samples during transit.

7.5 Packaging and Shipping

All sample containers will be placed in a strong-outside shipping container such as a cooler. The following outlines the packaging procedures that will be followed for low concentration samples.

1. When ice is used, pack it in zip-lock type, double plastic bags. Seal the drain plug of the cooler with fiberglass tape to prevent melting ice from leaking out of the cooler.
2. The bottom of the cooler should be lined with bubble wrap to prevent breakage during shipment.
3. Check screw caps for tightness and, if not full, mark the sample volume level of liquid samples on the outside of the sample bottles with indelible ink.
4. Secure bottle/container tops with clear tape and custody seal all container tops.
5. Affix sample labels onto the containers with clear tape.
6. Wrap all glass sample containers in bubble wrap to prevent breakage.
7. Seal all sample containers in heavy duty plastic zip-lock type bags. Write the sample numbers on the outside of the plastic bags with indelible ink.
8. Place samples in a sturdy cooler(s) lined with a large plastic trash bag. Enclose the appropriate Chain-Of-Custody(s) in a zip-lock type plastic bag affixed to the underside of the cooler lid.
9. Fill empty space in the cooler with bubble wrap or Styrofoam peanuts to prevent movement and breakage during shipment. Vermiculite should also be placed in the cooler to absorb spills if they occur.
10. Ice used to cool samples will be double sealed in two zip-lock type plastic bags and placed on top and around the samples to chill them to the correct temperature.
11. Each ice chest will be securely taped shut with fiberglass strapping tape, and custody seals will be affixed to the front, right, and back of each cooler.

8 DISPOSAL OF RESIDUAL MATERIALS

In the process of collecting environmental samples, the sampling team will generate different types of potentially contaminated investigation-derived waste (IDW) that include the following:

- Used PPE
- Disposable sampling equipment
- Decontamination fluids

The EPA's National Contingency Plan requires that management of IDW generated during sampling comply with all applicable or relevant and appropriate requirements (ARARs) to the extent practicable. The sampling plan will follow the *Office of Emergency and Remedial Response Directive 9345.3-02* (May 1991), which provides the guidance for the management of IDW. In addition, other legal and practical considerations that may affect the handling of IDW will be considered.

- Used PPE and disposable equipment will be double bagged and placed in a municipal refuse dumpster. These wastes are not considered hazardous and can be sent to a municipal landfill. Any PPE and disposable equipment that is to be disposed of, which can still be reused, will be rendered inoperable before disposal in the refuse dumpster.
- Decontamination fluids that will be generated in the sampling event will consist of deionized water, residual contaminants, and water with non-phosphate detergent. Spray bottles will be used for deionized water and water with non-phosphate detergent during the decontamination process in order to minimize the amount of fluids used. The volume and concentration of the decontamination fluid will be sufficiently low to allow disposal at the Site or sampling area.

9 SAMPLE DOCUMENTATION

The following sections will outline all documentation processes to be followed during sampling.

9.1 Field Notes

The sections below describe the project documentation and record keeping.

9.1.1 *Field Logbooks*

Field logs will be completed describing all field activities and will include, at a minimum, the following information:

- Sample location and description
- Site or sampling area sketch showing sample location and measured distances
- Sampler's name(s)
- Date and time of sample collection
- Designation of sample as composite or grab
- Type of sample (soil, sediment, water, etc)
- Type of sampling equipment used
- Field instrument readings and calibration
- Field observations an details related to analysis or integrity of samples (i.e., weather conditions, noticeable odors, colors, etc)
- Preliminary sample descriptions (i.e., for soils: clay loam, very wet; for water: clear water with strong ammonia-like odor)
- Sample preservation
- Lot numbers of the sample containers, sample identification numbers and any explanatory codes, and Chain-Of-Custody form numbers
- Shipping arrangements (overnight air bill number)
- Name(s) of recipient laboratory(ies)

In addition to the sampling information, the following specific information will also be recorded in the field logbook for each day of sampling:

- Team members and their responsibilities
- Time of arrival/entry on site and time of site departure
- Other personnel on site
- Summary of any meetings or discussions with tribal, contractor, or federal agency personnel
- Deviations from sampling plans, site safety plans, and SAP procedures
- Changes in personnel and responsibilities with reasons for the changes
- Levels of safety protection
- Calibration readings for any equipment used and equipment model and serial number

9.1.2 *Photographs*

Photographs will be taken at the sampling locations and at other areas of interest on site or at the sampling area. They will serve to verify information entered in the field logbook. For each photograph taken, the following information will be written in the logbook or recorded in a separate field photography log:

- Time, date, location, and weather conditions
- Description of the subject photographed
- Name of person taking the photograph

9.2 Sample Labeling

All samples collected will be labeled in a clear and precise way for proper identification in the field and for tracking in the laboratory. A copy of the sample label is included in Appendix G. At a minimum, the sample labels will contain the following information: station location, date of collection, analytical parameter(s), and method of preservation.

Every sample, including samples collected from a single location but going to separate laboratories, will be assigned to each sample. The number will be an alphanumeric sequence that serves as an acronym to identify the sample. Each sample will be identified by a unique code that denotes the sample type (surface soil) and sample number. The following are examples of sample identification codes for this project:

Primary Soil Samples: Sample Type - Sample Number
Example: SS-1

Quality Control Samples: Sample Type - Sample Number
Example: SS-4

Asbestos Samples (AB): Sample ID: LVBECXXX-AB-1
LVBECXXX
AB-1 – Asbestos Sample #1

Lead-paint Samples (L): Sample ID: LVBECXXX-L-1
LVBECXXX
L-1 – Lead Paint Sample #1

Duplicate samples will be given a unique sample number which does not connect it with the primary sample, but will be noted as a duplicate in the field sampling form and the sampler's copy of the Chain-Of-Custody. The identification of a sample as a duplicate will not be made on the Chain-Of-Custody that accompanies the samples to the laboratory.

9.3 Sample Chain-Of-Custody Forms and Custody Seals

All sample shipments for analyses will be accompanied by a Chain-of-Custody record. A copy of the form is found in Appendix D. Forms will be completed and sent with the samples for each laboratory and each shipment (i.e., each day). If multiple coolers are sent to a single laboratory on a single day, form(s) will be completed and sent with the samples with each cooler.

The Chain-of-Custody form will identify the contents of each shipment and maintain the custodial integrity of the samples. Generally, a sample is considered to be in someone's custody if it is either in someone's physical possession, in someone's view, locked up, or kept in a secured area that is restricted to authorized personnel. Until the samples are shipped, the custody of the samples will be the responsibility of BEC Environmental, Inc. The sampling team leader or designee will sign the Chain-Of-Custody form in the "relinquished by" box and note date, time, and air bill number.

A self-adhesive custody seal will be placed across the lid of each sample. For volatile organic compound (VOC) samples, the seal will be wrapped around the cap. The shipping containers in which samples are stored (usually a sturdy picnic cooler or ice chest) will be sealed with self-adhesive custody seals any time they are not in someone's possession or view before shipping. All custody seals will be signed and dated.

A Chain-Of-Custody form (example shown in Appendix E) will be completed for each sample shipped to the laboratory. Custody seals, if necessary, will be used on each ice chest scheduled for commercial shipment to provide tampering detection.

10 QUALITY CONTROL

This section will describe the steps taken to ensure QC throughout the sampling process.

10.1 Field Quality Control Samples

Samples will be collected in accordance with industry standard procedure. Field QC samples are intended to accomplish two primary goals, the evaluation of field contamination and the evaluation of sampling variability.

10.1.1 *Assessment of Field Contamination (Blanks)*

Field contaminations arising from inadequately decontaminated sampling equipment are generally evaluated through the use of equipment blanks collected in the field. Field blanks and laboratory prepared trip blanks will not be taken.

10.1.1.1 Equipment Blanks

No equipment blanks will be collected, as soil sampling will be conducted using disposable supplies.

10.1.1.2 Field Blanks

Not required.

10.1.1.3 Trip Blanks

Not required.

10.1.1.4 Temperature Blanks

For each cooler shipped or transported to an analytical laboratory, a 40 mL volatile organic assessment vial will be included that is marked "temperature blank". This blank will be used by the sample custodian to check the temperature of samples upon receipt.

10.1.2 *Assessment of Field Variability (Field Duplicate or Co-Located Samples)*

At the discretion of the on-site Certified Environmental Manager (CEM), duplicate soil samples may be collected at locations of moderate or significant contamination based on visual and field screening evaluation. However, a minimum number of duplicate samples, consistent with at least 10% of the total number of samples for each matrix will be collected for analysis by each proposed analytical method.

Duplicate samples will be preserved, packaged, and sealed in the same manner as other samples of the same matrix. A separate sample number and station number will be assigned to each duplicate, each will be recorded on the Chain-Of-Custody, and each will be submitted blind to the laboratory.

10.2 Background Samples

One background soil sample will be collected from an area of the Site that appears to be undisturbed for RCRA 8 metals analysis. Central Nevada soils have been documented by NDEP as often exhibiting background concentrations of arsenic and other heavy metals that exceed NDEP regulatory standards for reportable concentrations in soil. The purpose of the background sample will be to compare concentrations of heavy metals that may be detected from soils in the disturbed areas of the site with background levels of the heavy metals in soils from undisturbed areas within the same geological vicinity.

The background soil sample will be preserved, packaged, and sealed in the same manner as other samples of the same matrix. A separate sample number and station number will be assigned to each background sample, each will be recorded on the Chain-Of-Custody, and each will be submitted blind to the laboratory.

10.3 Field Screening, Including Confirmation Samples, and Split Samples

No field screening or confirmation samples will be collected during this investigation. Split samples will not be collected for this investigation.

10.3.1 *Field Screening Samples*

No field screening will occur for this investigation.

10.3.2 *Confirmation Samples*

No confirmation samples will be taken for this investigation.

10.4 Laboratory Quality Control Samples

Laboratory QC samples and associated procedures are provided in Appendix A for each laboratory used to obtain analytical data for the site.

11 FIELD VARIANCES

As conditions in the field may vary, it may become necessary to implement minor modifications to sampling as presented in this plan. When appropriate, the QA Officer will be notified and a verbal

approval will be obtained before implementing the changes. Modifications to the approved plan will be documented in the sampling project report.

12 FIELD HEALTH AND SAFETY PROCEDURES

A site specific HASP is provided in Appendix E. The HASP will be reviewed and signed by all on-site personnel prior to commencing work.

13 BIBLIOGRAPHY

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Nevada Bureau of Mines and Geology. (1985). *Bulletin 99A Geology of Northern Nye County, Nevada.* University of Nevada, Reno.

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United States Environmental Protection Agency. (2001). *Quality Assurance Project Plan* .

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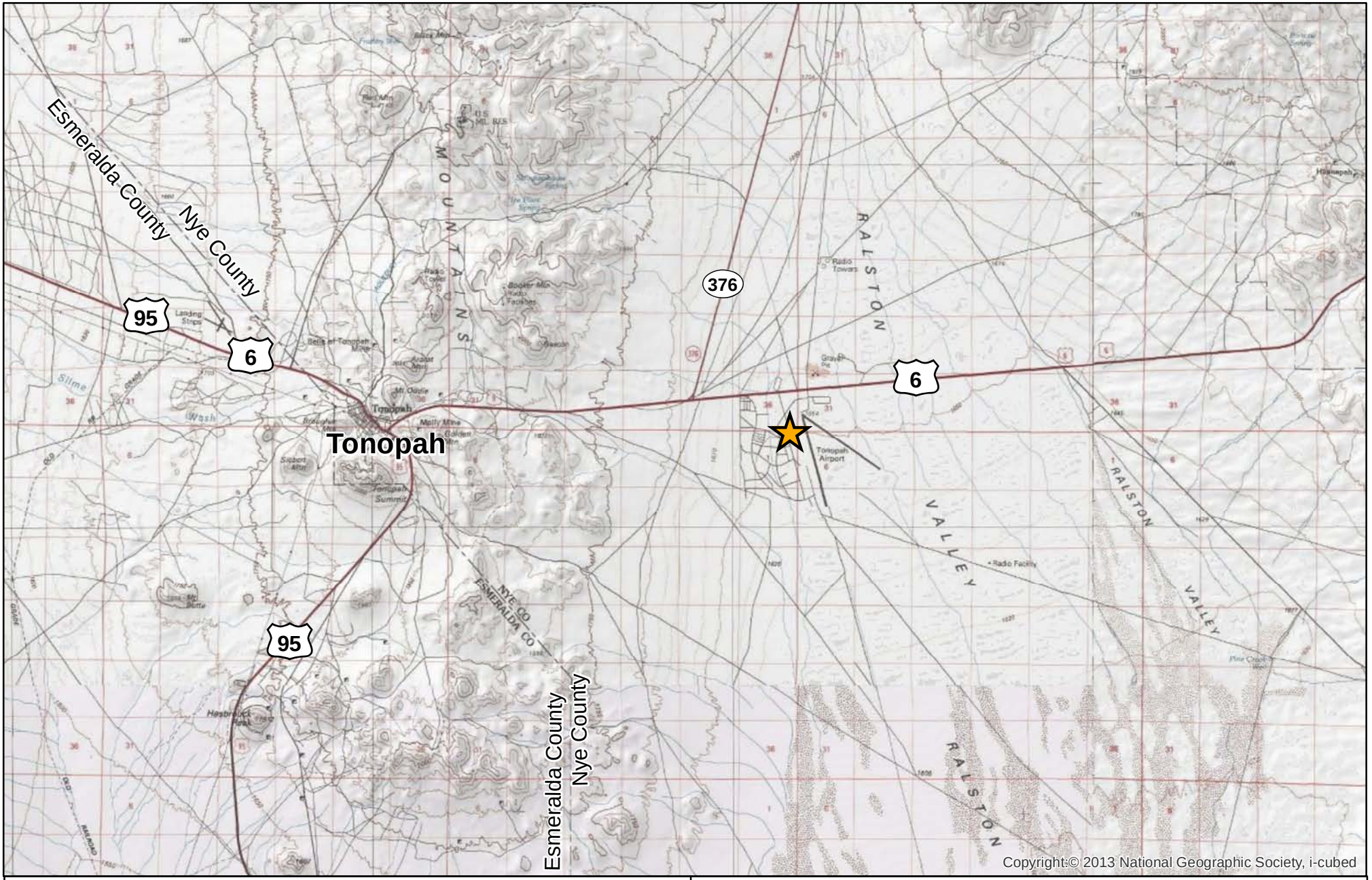


Figure 1 - Vicinity Map

Tonopah FBO Building
Tonopah, Nye County, Nevada

0 1.25 2.5 5 7.5 10
Miles

N

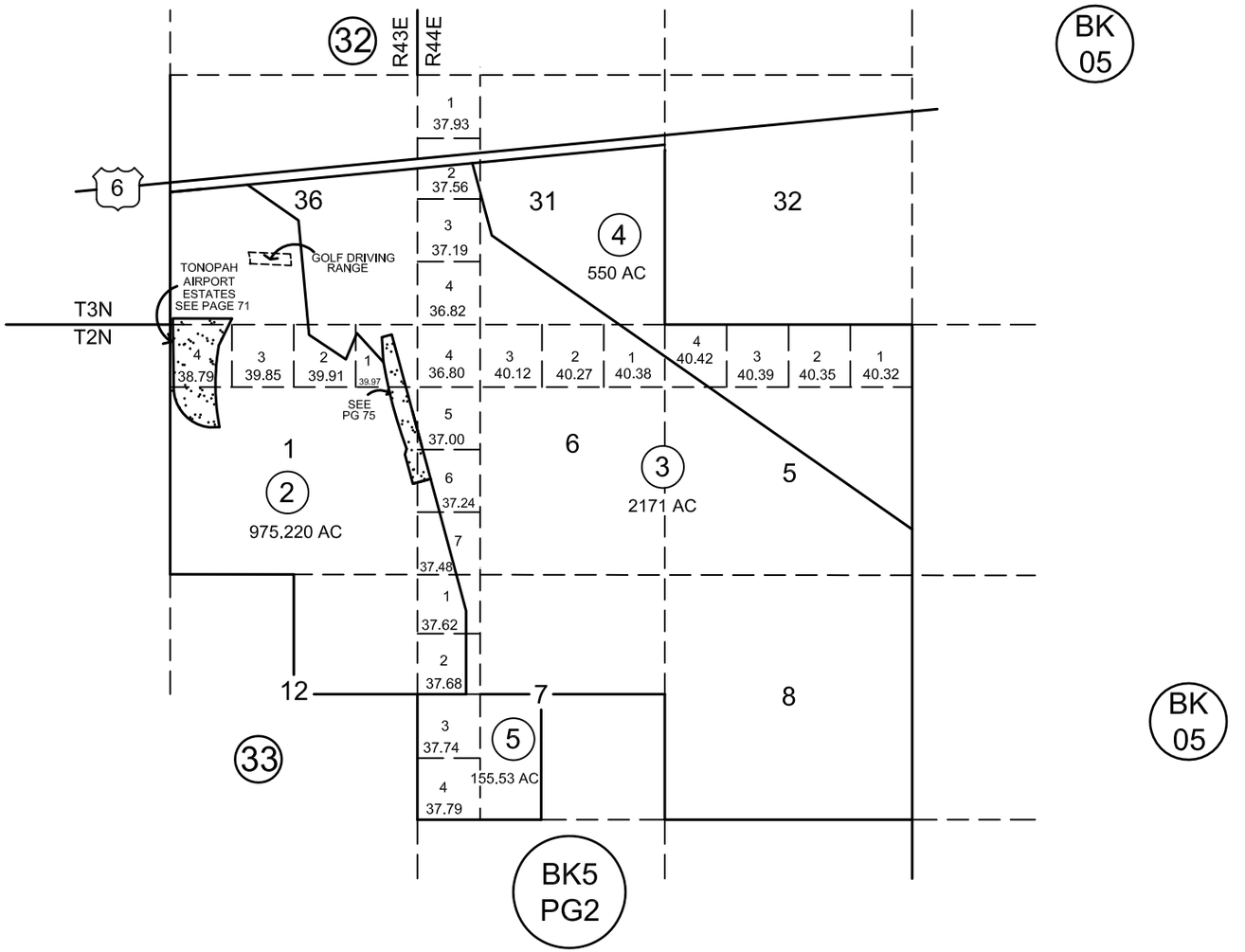
bec environmental, inc.

POR. T2N & T3N
POR. R43E & R44E

12-47

NYE COUNTY

REV. 11-15-94
10-30-01
11-01-10



N

MAR83/RLW
PG ENLARGED
MAY94/NMT
CAD FILE 11/01/10-DO
NYE COUNTY ASSESSOR

NOTE: THIS PLAT IS FOR ASSESSMENT USE ONLY AND DOES NOT REPRESENT A SURVEY. NO LIABILITY IS ASSUMED AS TO THE ACCURACY OF THE DATA DELINEATED HEREON.

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TONOPAH AIRPORT

Figure 2

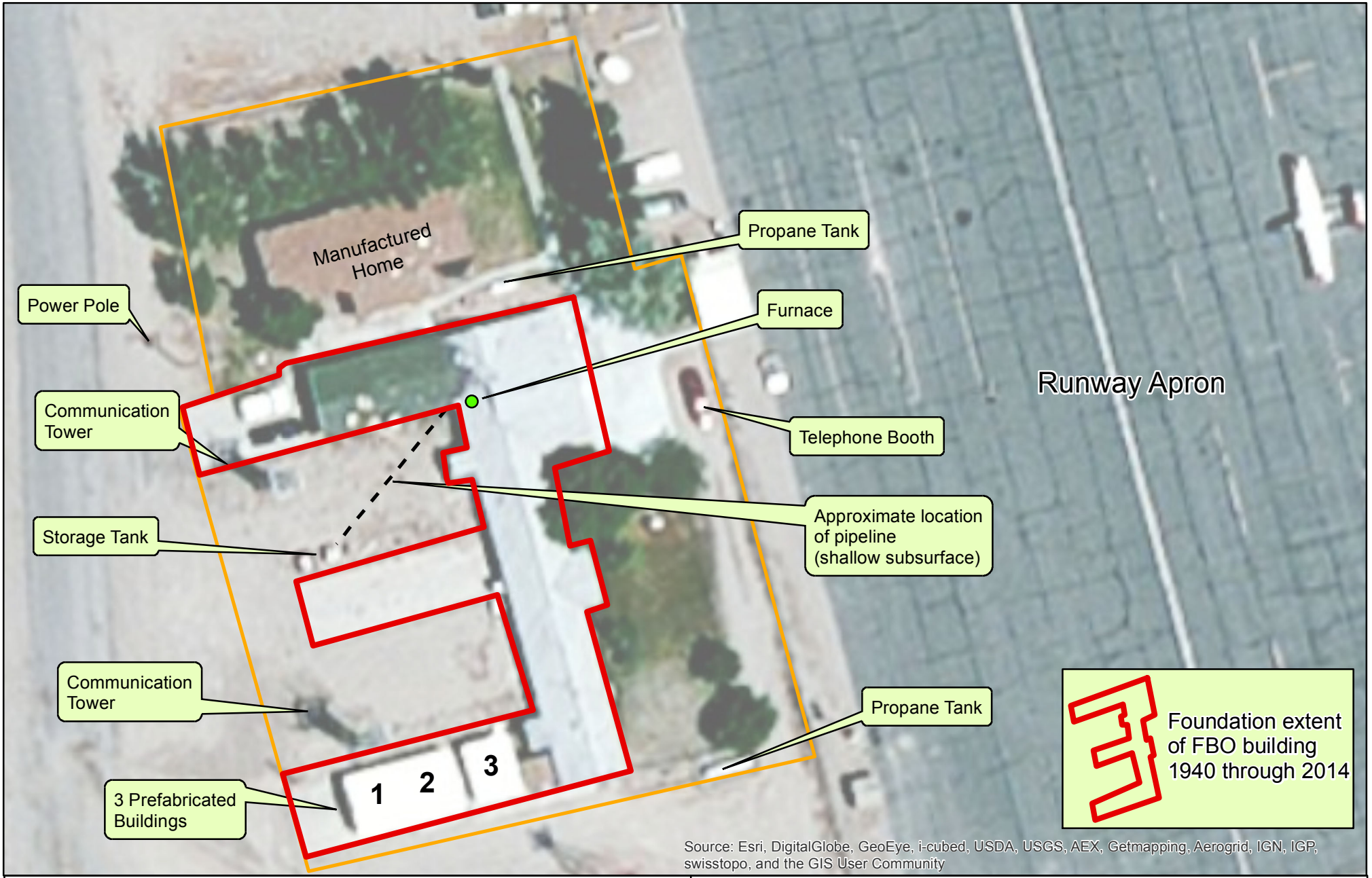


Figure 3 - Site Reconnaissance Map

Tonopah FBO Building
Tonopah, Nye County, Nevada

0 37.5 75 150
Feet

N

bec environmental, inc.

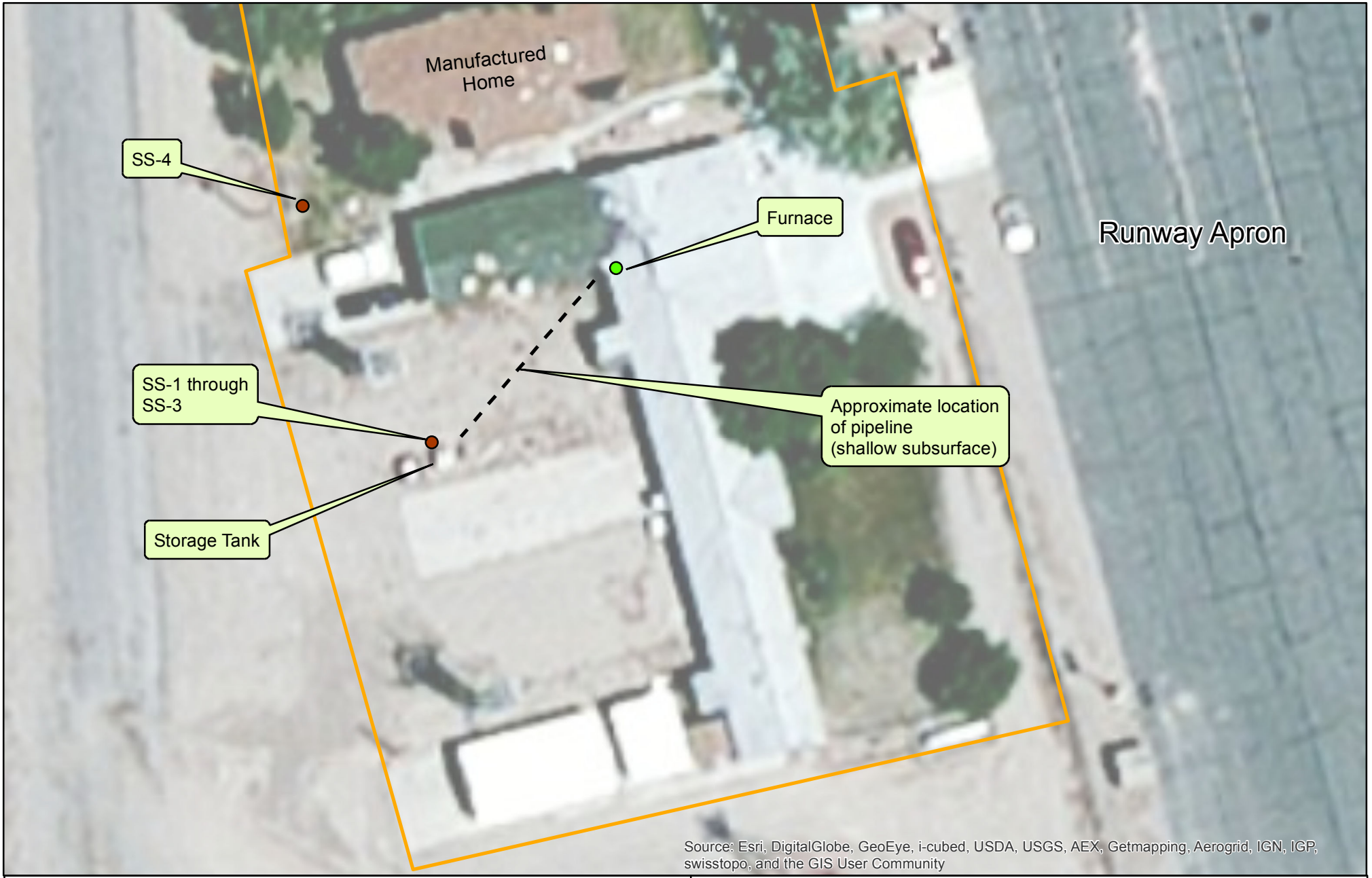


Figure 4 - Proposed Sample Location Map

Tonopah FBO Building
Tonopah, Nye County, Nevada

0 30 60 120
Feet

N

bec environmental, inc.

Appendix A

Laboratory Information: TestAmerica
- Quality Assurance Program Plan
- Statement of Procedures & Reporting
- Accuracy and Precision Limits (Method Detection Limits)

Quality Assurance Manual

TestAmerica Phoenix
4625 East Cotton Center Boulevard
Suite 189
Phoenix, Arizona 85040
Phone No. 602-437-3340
Fax No. 602-454-9303

www.testamericainc.com

Title Page:

Quality Assurance Manual
Approval Signatures

Laboratory Director – Shawn Kusma	12/9/2011 Date
Quality Manager - Mary Tyer	12/9/2011 Date
Technical Manager, **(Industrial Hygiene and Metals)** – Stephanie Stimson	12/5/2011 Date
Department Manager, **(Customer Services)** – Elizabeth Baker	12/6/2011 Date
Department Manager, **(Sample Receiving)** – Carlene McCutcheon	12/9/2011 Date
Department Manager, **(Volatile Organics)** – Melissa Spencer	12/9/2011 Date
Department Manager, **(Semi-Volatile Organics)** – Jessica Reichers	12/8/2011 Date
Department Manager, **(Wet Chemistry)** – Brad Kryst	12/8/2011 Date

SECTION 2. TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

REFERENCED CORPORATE SOPs AND POLICIES

SOP / Policy Reference	Title
CA-Q-S-001	Solvent and Acid Lot Testing and Approval
CA-Q-S-002	Acceptable Manual Integration Practices
CA-Q-S-004	Method Compliance & Data Authenticity Audits
CA-Q-S-006	Detection Limits
CA-Q-S-008	Management Systems Review
CW-Q-S-001	Corporate Document Control and Archiving
CW-Q-S-002	Writing a Standard Operating Procedure (SOPs)
CW-L-S-002	Internal Investigation of Potential Data Discrepancies and Determination for Data Recall
CA-L-S-002	Subcontracting Procedures
CW-L-P-004	Ethics Policy
CA-L-P-002	Contract Compliance Policy
CW-F-P-002	Authorization Matrix
CW-F-P-004	Procurement and Contracts Policy
CA-C-S-001	Work Sharing Process
CA-T-P-001	Qualified Products List
CW-F-S-007	Controlled Purchases Policy
CW-F-S-018	Vendor Selection
CA-Q-M-002	Corporate Quality Management Plan
CW-E-M-001	Corporate Environmental Health & Safety Manual

REFERENCED LABORATORY SOPs

SOP Reference	Title
PE-ADM-001	Computer Security
PE-ADM-002	Back-up for Network Data Files
PE-PMD-001	Data Reporting, Validation and Distribution
PE-QAD-001	Control Charts and Statistical Process Control
PE-QAD-002	Pipette Calibration
PE-QAD-003	Sub-sampling
PE-QAD-004	Thermometer Calibration
PE-QAD-006	Logbook Documentation

SOP Reference	Title
PE-QAD-007	Corrective Actions
PE-QAD-008	Personnel Certification and Training
PE-QAD-009	Manual Integration / Data Integrity
PE-QAD-010	Document Control
PE-QAD-012	Receipt Process for General Supplies and Chemicals
PE-QAD-013	Reagent and Standard Preparation, Control and Documentation
PE-QAD-014	Creation and Maintenance of SOPs
PE-QAD-015	Initial Demonstration of Capability
PE-QAD-016	Balance Calibration and Documentation
PE-QAD-017	Record Archiving
PE-QAD-018	Use of Data Qualifiers
PE-QAD-019	Determination of Method Detection Limits
PE-QAD-024	General Data Review
PE-QAD-026	Internal Chain of Custody Procedures
PE-SMP-001	Sample Control
PE-PMD-002	Project Management Communication and Documentation
PE-SMP-004	Field Sampling
PE-SMP-005	Bottle Preparation
PE-SMP-006	Receiving and Waste Management of Foreign Soils
PE-SMP-007	Calibrating Sampling Pumps

SECTION 3. INTRODUCTION, SCOPE AND APPLICABILITY

3.1 Introduction and Compliance References

TestAmerica Phoenix's Quality Assurance Manual (QAM) is a document prepared to define the overall policies, organization objectives and functional responsibilities for achieving TestAmerica's data quality goals. The laboratory maintains a local perspective in its scope of services and client relations and maintains a national perspective in terms of quality.

The QAM has been prepared to assure compliance with The NELAC Institute (TNI) Standard, dated 2009, Volume 1 Modules 2 and 4, AIHA Policies, and ISO/IEC Guide 17025:2005(E). In addition, the policies and procedures outlined in this manual are compliant with TestAmerica's Corporate Quality Management Plan (CQMP) and the various accreditation and certification programs listed in Appendix 3. The CQMP provides a summary of TestAmerica's quality and data integrity system. It contains requirements and general guidelines under which all TestAmerica facilities shall conduct their operations. Please note that the 2003 NELAC standard is based on the 1999 version of 17025.

The QAM has been prepared to be consistent with the requirements of the following documents:

- EPA 600/4-88/039, Methods for the Determination of Organic Compounds in Drinking Water, EPA, Revised July 1991.
- EPA 600/R-95/131, Methods for the Determination of Organic Compounds in Drinking Water, Supplement III, EPA, August 1995.
- EPA 600/4-79-019, Handbook for Analytical Quality Control in Water and Wastewater Laboratories, EPA, March 1979.
- Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846), Third Edition, September 1986, Final Update I, July 1992, Final Update IIA, August 1993, Final Update II, September 1994; Final Update IIB, January 1995; Final Update III, December 1996; Final Update IV, January 2008.
- Federal Register, 40 CFR Parts 136, 141, 172, 173, 178, 179 and 261.
- Statement of Work for Inorganics & Organics Analysis, SOM and ISM, current versions, USEPA Contract Laboratory Program Multi-media, Multi-concentration.
- APHA, Standard Methods for the Examination of Water and Wastewater, 18th Edition, 19th, 20th and on-line Editions.
- U.S. Department of Energy Order 414.1B, Quality Assurance, Approved April 29, 2004.
- Toxic Substances Control Act (TSCA).
- Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, EPA, Second Edition, 1999.
- NIOSH Manual of Analytical Methods, Fourth Edition, 1994.
- U.S. Department of Labor, Occupational Safety & Health Administration, Index of Sampling & Analytical Methods, Revision Date: 21 November 2001.
- AIHA Policies for Laboratory Quality Assurance Programs, 2010 Policy Modules, Effective September 13, 2011.

- Arizona Administrative Code, Department of Health Services, Title 9. Health Services, Chapter 14. Department of Health Services Laboratories, December 31, 2006.
- EPA 815-R-05-004, Manual for the Certification of Laboratories Analyzing Drinking Water, EPA, 5th Edition, January 2005.
- New York State Regulations, Title 10 – Department of Health, Chapter 11 – Administrative Rules and Regulations, Part 55 – Approval of Laboratories Performing Environmental Analysis, Revision Date: February 20, 2008.
- Oregon Administrative Rules, Chapter 333, Division 64, October 2000.
- Nevada Administrative Code, Chapter 445A Water Controls – Certification of Laboratories to Analyze Substances in Water; Chapter 445A – Certification of Laboratories to Analyze Drinking Water; November 2008.
- California Environmental Laboratory Improvement Act (Chapter 4 commencing with Section 100825, Part 1, Division 101, of the California Health And Safety Code). ELAP, January 1989.
- California Code of Regulations, Title 22. Social Security, Division 4. Environmental Health, Chapter 19. Certification of Environmental Laboratories; NELAP, January 2000.
- SKC EPA IP-6 Method Update: DETERMINATION OF FORMALDEHYDE AND OTHER ALDEHYDES IN INDOOR AIR; Publication 1661 Rev 1001.
- "Compendium of Methods for the Determination of Pollutants in Indoor Air, "U.S. EPA PB 90-200288, 1990
- American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103, 04.09, 1986.

3.2 Terms and Definitions

A Quality Assurance Program is a company-wide system designed to ensure that data produced by the laboratory conforms to the standards set by state and/or federal regulations. The program functions at the management level through company goals and management policies, and at the analytical level through Standard Operating Procedures (SOPs) and quality control. The TestAmerica program is designed to minimize systematic error, encourage constructive, documented problem solving, and provide a framework for continuous improvement within the organization.

Refer to Appendix 2 for the Glossary/Acronyms.

3.3 Scope / Fields of Testing

The laboratory analyzes a broad range of environmental and industrial samples every month. Sample matrices vary among air, drinking water, effluent water, groundwater, hazardous waste, sludge, soils and air for industrial hygiene on varying types of media. The Quality Assurance Program contains specific procedures and methods to test samples of differing matrices for chemical, physical and biological parameters. The Program also contains guidelines on maintaining documentation of analytical processes, reviewing results, servicing clients and tracking samples through the laboratory. The technical and service requirements of all analytical requests are thoroughly evaluated before commitments are made to accept the work. Measurements are made using published reference methods or methods developed and validated by the laboratory.

The methods covered by this manual include the most frequently requested methodologies needed to provide analytical services in the United States and its territories. The specific list of test methods used by the laboratory can be found in Appendix 4. The approach of this manual is to define the minimum level of quality assurance and quality control necessary to meet these requirements. All methods performed by the laboratory shall meet these criteria as appropriate. In some instances, quality assurance project plans (QAPPs), project specific data quality objectives (DQOs) or local regulations may require criteria other than those contained in this manual. In these cases, the laboratory will abide by the requested criteria following review and acceptance of the requirements by the Laboratory Director, Account Executive, Business Development Manager, Client Services Manager and/or the Quality Assurance (QA) Manager. In some cases, QAPPs and DQOs may specify less stringent requirements. The Laboratory Director and/or Industrial Hygiene Program Manager and the QA Manager must determine if it is in the lab's best interest to follow the less stringent requirements.

3.4 Management of the Manual

3.4.1 Review Process

The template on which this manual is based is reviewed annually by Corporate Quality Management Personnel to assure that it remains in compliance with Section 3.1. This manual is reviewed every two years by senior laboratory management to assure that it reflects current practices and meets the requirements of the laboratory's clients and regulators as well as the CQMP. Occasionally, the manual may need changes in order to meet new or changing regulations and operations. The QA Manager will review the changes in the normal course of business and incorporate changes into revised sections of the document. All updates will be reviewed by the senior laboratory management staff. The laboratory updates and approves such changes according to our Document Control procedures (refer to SOP PE-QAD-010 Document Control).

SECTION 4. MANAGEMENT REQUIREMENTS

4.1 Overview

TestAmerica Phoenix is a local operating unit of TestAmerica Laboratories, Inc. The organizational structure, responsibilities and authorities of the corporate staff of TestAmerica Laboratories, Inc. are presented in the CQMP. The laboratory has day-to-day independent operational authority overseen by corporate officers (e.g., President, Chief Executive Officer, Corporate Quality, etc.). The laboratory operational and support staff work under the direction of the Laboratory Director. The organizational structure for both Corporate & TestAmerica Phoenix is presented in Figure 4-1.

4.2 Roles and Responsibilities

In order for the Quality Assurance Program to function properly, all members of the staff must clearly understand and meet their individual responsibilities as they relate to the quality program. The following descriptions briefly define each role in its relationship to the Quality Assurance Program.

4.2.1 Additional Requirements for Laboratories

The responsibility for quality resides with every employee of the laboratory. All employees have access to the QAM, are trained to this manual, and are responsible for upholding the standards therein. Each person carries out his/her daily tasks in a manner consistent with the goals and in accordance with the procedures in this manual and the laboratory's SOPs. Role descriptions for Corporate personnel are defined in the Corporate Quality Management Plan (CQMP CA-Q-M-002). This manual is specific to the operations of TestAmerica's Phoenix laboratory.

4.2.2 Laboratory Director

TestAmerica Phoenix's Laboratory Director is responsible for the overall quality, safety, financial, technical, human resource and service performance of the whole laboratory and reports to their respective GM. The Laboratory Director provides the resources necessary to implement and maintain an effective and comprehensive Quality Assurance and Data Integrity Program. The Laboratory Director who is absent for a period of time exceeding 15 consecutive calendar days shall designate another full time staff member who meets the minimum qualifications of the Laboratory Manager to temporally perform the Laboratory Director function. Also, if this absence exceeds 65 consecutive calendar days, the primary TNI accrediting authority must be notified in writing.

Specific responsibilities include, but are not limited to:

- Captains the management team, consisting of the QA Manager, the Industrial Hygiene Program Manager, the Business Development Manager, and the Department Manager(s) as direct reports.
- Ensures that all staff has the appropriate education and training to properly carry out the duties assigned to them and ensures that this training has been documented.
- Ensures that personnel are free from any commercial, financial and other undue pressures which might adversely affect the quality of their work.
- Ensures TestAmerica's human resource policies are adhered to and maintained.
- Ensures that sufficient numbers of qualified personnel are employed to supervise and perform the work of the laboratory.
- Ensures that appropriate corrective actions are taken to address analyses identified as requiring such actions by internal and external performance or procedural audits. Procedures that do not meet the standards set forth in the QAM or laboratory SOPs may be temporarily suspended by the Laboratory Director.
- Reviews and approves all SOPs prior to their implementation and ensures all approved SOPs are implemented and adhered to.
- Pursues and maintains appropriate laboratory certification and contract approvals. Supports ISO 17025 requirements.
- Ensures client specific reporting and quality control requirements are met.
- Evaluates the level of internal/external non-conformances for all departments.
- Continuously evaluates production capacity and improves capacity utilization.

- Continuously evaluates turnaround time and addresses any problems that may hinder meeting the required and committed turnaround time from the various departments.
- Develops and improves the training of all analysts in cooperation with the Laboratory Director, the Department Manager(s) and QA Manager and in compliance with regulatory requirements.
- Works to ensure that scheduled instrument maintenance is completed.
- Is responsible for efficient utilization of supplies.
- Constantly monitors and modifies the processing of samples through the departments.
- Fully supports the quality system and, if called upon in the absence of the QA Manager, serves as his/her substitute in the interim.

4.2.3 Quality Assurance (QA) Manager or Designee

The QA Manager reports directly to the Laboratory Director and has access to Corporate QA for advice and resources. This position is able to evaluate data objectively and perform assessments without outside (e.g., managerial) influence. Corporate QA may be used as a resource in dealing with regulatory requirements, certifications and other quality assurance related items. The QA Manager directs the activities of the QA officers to accomplish specific responsibilities, which include, but are not limited to:

- Serves as the focal point for QA/QC in the laboratory.
- Has functions independent from laboratory operations for which he/she has quality assurance oversight.
- Maintains and updates the QAM.
- Monitors and evaluates laboratory certifications
- Schedules proficiency testing samples.
- Monitors and communicates regulatory changes that may affect the laboratory to management.
- Trains and advises the laboratory staff on quality assurance/quality control procedures that are pertinent to their daily activities.
- Evaluates the thoroughness and effectiveness of training.
- Maintains records of all ethics-related training, including the type and proof of attendance.
- Arranges for or conducts internal audits on quality systems and the technical operation.
- Maintains, improves, and evaluates the corrective action database and the corrective and preventive action systems.
- Notifies laboratory management of deficiencies in the quality system and ensuring corrective action is taken. Procedures that do not meet the standards set forth in the QAM or laboratory SOPs shall be investigated following procedures outlined in Section 12 and if deemed necessary may be temporarily suspended during the investigation.
- Objectively monitors standards of performance in quality control and quality assurance without outside (e.g., managerial) influence.

- Coordinates of document control of SOPs, MDLs, control limits, and miscellaneous forms and information.
- Reviews a percentage of all final data reports for internal consistency. Review of Chain of Custody (COC), correspondence with the analytical request, batch QC status, completeness of any corrective action statements, 5% of calculations, format, holding time, sensibility and completeness of the project file contents.
- Reviews external audit reports and data validation requests.
- Follows up with audits to ensure client QAPP requirements are met.
- Establishes reporting schedule and preparation of various quality reports for the Laboratory Director, clients and/or Corporate QA.
- Develops suggestions and recommendations to improve quality systems.
- Researches current state and federal requirements and guidelines.
- Captains the QA team to enable communication and to distribute duties and responsibilities.
- Ensures monitoring standards of performance to ensure that systems are in place to produce the level of quality as defined in this document.
- The QA Manager has responsibility and authority to ensure the continuous implementation of the quality system based on ISO 17025.
- Has documented training and/or experience in QA/QC procedures and the laboratory's Quality System.
- Has a general knowledge of the analytical test methods for which data audit/review is performed (and/or having the means of getting this information when needed).

Qualifications: The Quality Manager of the laboratory shall possess a bachelor's degree in an applicable basic or applied science and have at least one year of nonacademic analytical or quality control experience appropriate to the types of analyses performed by the laboratory; or quality control experience appropriate to the types of analyses performed by the laboratory; or in lieu of a bachelor's degree, four years of nonacademic analytical or quality control experience. The Quality Manager shall have documented training in statistics or laboratory quality assurance/quality control. The Quality Manager may be a part-time employee or consultant.

NOTE: Appropriate documentation of training in statistics or laboratory quality assurance/quality control shall include at least one of the following: 1) College level course in statistics; 2) Continuing education in laboratory quality assurance/quality control (e.g., AIHA-LAP, LLC or equivalent course); or 3) Relevant experience – documented examples of the level of quality assurance/quality control used in applicable work experience.

4.2.4 Industrial Hygiene Program/Technical Manager

The Industrial Hygiene Program/Technical Manager reports directly to the Laboratory Director and shall posses the qualifications and assume the responsibilities listed below in addition to the responsibilities listed under the department/program manager title.

- The laboratory shall provide day to day supervision of its technical operations by designating at least one Technical Manager (TM) per program.

- The Industrial Hygiene Program/Technical Manager shall be an employee of the laboratory.
- The Industrial Hygiene Program/Technical Manager shall be present on site at least 20 hours per week or 50 percent of the laboratory operating hours (whichever is less) to address technical issues for laboratory staff and customers.
- The Industrial Hygiene Program/Technical Manager shall authorize and document that all analyses for which the laboratory is accredited are completed by personnel with appropriate education and/or technical background in the Industrial Hygiene department. The Laboratory Director shall have the responsibility to ensure that personnel in other departments, performing industrial hygiene analyses, have appropriate education and/or technical background.
- The Industrial Hygiene Program/Technical Manager shall ensure that adequate supervision is provided for all laboratory technical personnel.
- The Industrial Hygiene Program/Technical Manager or their designee shall function as the approved signatory. The IH Program/Technical Manager/Laboratory Director/Customer Service Manager shall designate those individuals that may function as approved signatories using the Demonstration of Capability form for IH, PX-QAD-005.
- The Industrial Hygiene Program/Technical Manager/Laboratory Director/Customer Service Manager shall designate those individuals that may direct projects from setup through data interpretation and reporting.
- The Industrial Hygiene Program/Technical Manager shall in conjunction with the QA Department Manager ensure on-going proficiency for analysts and technicians that perform analyses that fall under the Industrial Hygiene Program: Every six months a chemist/tech must demonstrate ongoing proficiency. This can be accomplished through the analysis of PAT samples, at least 2 pairs of LCS/LCSD during the six month period, or by repeating the IDC as described in this SOP studies (every six months).
- The Industrial Hygiene Program/Technical Manager shall in conjunction with the QA Department Manager ensure initial/annual reporting level verification spikes are completed as appropriate for each analyte by analysts and technicians that perform analyses that fall under the Industrial Hygiene Program.
- The Industrial Hygiene Program/Technical Manager shall ensure method validation/desorption efficiency studies are performed as appropriate by for analysts and technicians that perform analyses that fall under the Industrial Hygiene Program.
- The Industrial Hygiene Program/Technical Manager shall research and development of new analytical procedures and improvements to current procedures.
- The Industrial Hygiene Program/Technical Manager or their designee, during an absence, shall perform secondary review of all data produced for analyses that fall under the Industrial Hygiene Program.
- The Industrial Hygiene Program/Technical Manager shall posses the following authority:

Stop work on analytical methods that fall under the Industrial Hygiene Program.

Hold or stop issuance of reports that fall under the Industrial Hygiene Program.

Any changes in laboratory ownership, location (except for mobile and field operations laboratories), management, quality control personnel, or any other change that significantly affects the laboratory's capability, scope of accreditation, or ability to meet the policy requirements, shall be reported in writing to AIHA-LAP, LLC within twenty (20) business days of the change. Any absence of personnel for a period in excess of twenty (20) consecutive working days, that impacts the laboratory's ability to perform its scope of testing, shall be reported to AIHA-LAP, LLC within twenty (20) business days. This notification requirement shall be in effect if the Technical Manager, the Quality Manager, or an analyst who is the only staff member that performs a given test, are absent for reasons of extended family leave, illness, temporary disability, etc.

Qualifications of the Industrial Hygiene Program/Technical Manager: Minimum of three (3) years relevant nonacademic analytical experience. A minimum of two (2) years experience shall be in industrial hygiene analyses within the scope of accreditation. The remaining one (1) year may be from other laboratory analytical procedures. Relevant academic experience may be substituted for the remaining one (1) year work experience. A relevant post-graduate degree (MS or Ph.D.) shall also be considered equivalent to one (1) year of work experience. Academic experience and post-graduate degrees may not be substituted for the two (2) years industrial hygiene experience. (Environmental, forensic, or similar microanalytical experience shall be reviewed to determine if the specific experience is a reasonable substitute.) The Industrial Hygiene Program/Technical Manager shall possess a bachelor's degree in an applicable physical or biological science.

4.2.5 Technical Manager or Designee

The Technical Manager(s) report(s) directly to the Laboratory Director. He/she is accountable for all analyses and analysts under their experienced supervision **and for compliance with the ISO 17025 Standard**. The Department Manager acts as a designee for the Technical Director(s). The scope of responsibility ranges from the new-hire process and existing technology through the ongoing training and development programs for existing analysts and new instrumentation. Specific responsibilities include, but are not limited to:

- Exercises day-to-day supervision of laboratory operations for the appropriate field of accreditation and reporting of results. Coordinating, writing, reviewing preparation of all test methods, i. e., SOPs, with regard to quality, integrity, regulatory and optimum and efficient production techniques, and subsequent analyst training and interpretation of the SOPs for implementation and unusual project samples. He/she insures that the SOPs are properly managed and adhered to at the bench. He/she develops standard costing of SOPs to include supplies, labor, overhead, and capacity (design vs. demonstrated versus first-run yield) utilization.
- Reviews and approves, with input from the QA Manager, proposals from marketing, in accordance with an established procedure for the review of requests and contracts. This procedure addresses the adequate definition of methods to be used for analysis and any limitations, the laboratory's capability and resources, the client's expectations. Differences

are resolved before the contract is signed and work begins. A system documenting any significant changes is maintained, as well as pertinent discussions with the client regarding their requirements or the results of the analyses during the performance of the contract. All work subcontracted by the laboratory must be approved by the client. Any deviations from the contract must be disclosed to the client. Once the work has begun, any amendments to the contract must be discussed with the client and so documented.

- Monitors the validity of the analyses performed and data generated in the laboratory. This activity begins with reviewing and supporting all new business contracts, insuring data quality, analyzing internal and external non-conformances to identify root cause issues and implementing the resulting corrective and preventive actions, facilitating the data review process (training, development, and accountability at the bench), and providing technical and troubleshooting expertise on routine and unusual or complex problems.
- Provides training and development programs to applicable laboratory staff as new hires and, subsequently, on a scheduled basis. Training includes instruction on calculations, instrumentation management to include troubleshooting and preventive maintenance.
- Enhances efficiency and improves quality through technical advances and improved LIMS utilization. Capital forecasting and instrument life cycle planning for second generation methods and instruments as well as asset inventory management.
- Coordinates sample management from “cradle to grave,” insuring that no time is lost in locating samples.
- Schedules all QA/QC-related requirements for compliance, e.g., MDLs, etc..
- Captains department personnel to communicate quality, technical, personnel, and instrumental issues for a consistent team approach.
- Coordinates audit responses with the QA Manager.

4.2.6 Environmental Health and Safety Coordinator

The Environmental Health and Safety Coordinator reports directly to the Laboratory Director and has a dotted line reporting responsibility to the Corporate Environmental Health and Safety Officer. The Environmental Health and Safety Coordinator may also act as the Hazardous Waste Manager or delegate the duties to an authorized and properly trained employee.

- Ensures compliance with air permits.
- Conducts ongoing, required safety training and conduct new employee safety orientation.
- Assists in developing and maintaining the Facility Addendum to the Corporate Employee Health and Safety Manual.
- The Environmental Health and Safety and Hazardous Waste Coordinators shall be tasked with reviewing and updating annually the Hazardous Waste Contingency Plan in the Facility Addendum to the Corporate Environmental Health & Safety Manual
- Administers dispersal of all Material Safety Data Sheet (MSDS) information.
- Performs regular chemical hygiene and housekeeping instruction.
- Gives instruction on proper labeling and practice.
- Serves as chairman of the laboratory safety committee.

- Provides and trains personnel on protective equipment.
- Oversees the inspection and maintenance of general safety equipment – fire extinguishers, safety showers, eyewash stations, etc. and ensure prompt repairs as needed.
- Supervises and schedules fire drills and emergency evacuation drills.
- The Environmental Health and Safety and Hazardous Waste Coordinators shall be tasked to determine what initial and subsequent exposure monitoring, if necessary to determine potential employee exposure to chemicals used in the laboratory.
- Conducts exposure monitoring assessments when determined necessary.
- Determines when a complaint of possible over-exposure is "reasonable" and should be referred for medical consultation.
- Assists in the internal and external coordination of the medical consultation/monitoring program conducted by TestAmerica's medical consultants.

4.2.7 Hazardous Waste Coordinator

The Hazardous Waste Coordinator reports directly to the Laboratory Director. The duties consist of:

- Stays current with the hazardous waste regulations.
- Continues training on hazardous waste issues.
- The Hazardous Waste and Environmental Health and Safety Coordinators shall be tasked with reviewing and updating annually the Hazardous Waste Contingency Plan in the Facility Addendum to the Corporate Environmental Health & Safety Manual.
- Contacts the hazardous waste subcontractors for review of procedures and opportunities for minimization of waste.
- The Hazardous Waste and Environmental Health and Safety Coordinators shall be tasked to determine what initial and subsequent exposure monitoring, if necessary to determine potential employee exposure to chemicals used in the laboratory.
- Ensures proper collection and disposal of all hazardous waste.

4.2.8 Industrial Hygiene Laboratory Analysts/Technicians

The industrial hygiene program distinguishes two titles for those conducting analytical procedures within the laboratory. An analyst is one who has a bachelor's degree in chemistry or a related science. A technician is one who does not have a degree in chemistry or a related science.

Analysts and Technicians that perform analyses which fall under the Industrial Hygiene Program shall report directly to the Industrial Hygiene Program/Technical Manager information regarding any analysis that fall under the Industrial Hygiene Program. Analysts and technicians may in addition to the IH Program/Technical Manager report to the designated department manager regarding other non-industrial Hygiene analyses and personnel issues.

Analysts and Technicians that perform analyses which fall under the Industrial Hygiene Program shall posses the qualifications and assume the responsibilities listed below in addition to the responsibilities listed under the Laboratory Analyst title.

This position is responsible for a variety of routine analyses or preparation procedures to determine and evaluate chemical and physical properties. Responsible for interpretation, organization, coordination and completion of routine and/or complex assignments as well as preparation of sampling equipment and materials.

- Successful training (in-house courses are acceptable) in specific methodologies used in the laboratory shall be documented. In house training to be provided on sample preparation and instrument analysis prior to performing independent analysis of laboratory samples. All analysts and technicians shall have a minimum of twenty (20) business days of hands-on experience conducting analyses in an industrial hygiene laboratory before initiation of independent work on customer samples. The criteria and training requirements for laboratory personnel shall be clearly defined, documented and maintained on file in the Quality Assurance office.

- Training Program content, duration, qualifications of the trainer, and objective evidence that the analyst/technician has successfully analyzed unknown reference samples of the matrices/analytes of concern within specified criteria. The dates of authorization to perform specific tasks shall be recorded on the DOC form, PX-QAD-005 and a copy be placed on file in the Quality Assurance office.

- Analysts and Technicians shall have demonstrated ability to produce reliable results through accurate analysis of certified reference materials (CRMs), proficiency testing samples, or in-house quality control samples. Their performance must be documented.

- Analysts and Technicians shall be responsible for complying with all quality assurance and quality control requirements pertaining to their technical functions.

- Analysts and Technicians shall be responsible to perform on-going proficiency for analyses that fall under the Industrial Hygiene Program: Every six months a chemist/tech must demonstrate ongoing proficiency. This can be accomplished through the analysis of PAT samples, at least 2 pairs of LCS/LCSD during the six month period, or by repeating the IDC as described in the SOP studies (every six months).

- Analysts and Technicians shall be responsible to ensure initial and/or annual reporting level verification spikes are completed as appropriate for each analyte for each method as appropriate, that fall under the Industrial Hygiene Program.

- Analysts and Technicians shall ensure method validation/desorption efficiency studies are performed as appropriate by for analysts and technicians that perform analyses that fall under the Industrial Hygiene Program.

- Analysts and Technicians may assist in research and development of new analytical procedures and improvements to current procedures.

- Analysts and Technicians shall perform preparation and analyses on a variety of samples according to the associated SOP.

- Analysts and Technicians shall train new analysts and technicians in proper use of equipment, maintenance, setup and procedures, as appropriate.

- Analysts and Technicians shall operate, maintain, and trouble shoot as applicable various analytical instrumentation including but not limited to GC-MS, GC, ICP, ICP-MS, cold vapor AA, IC, HPLC UV/VIS, etc.

- Analysts and Technicians shall be responsible to prepare data, perform routine calculations, prepare graphs, tables, and control charts, maintain appropriate organization and cleanliness in lab areas and keep inventory of supplies.

4.2.9 Laboratory Analysts

Laboratory analysts are responsible for conducting analysis and performing all tasks assigned to them by the Department Manager or designee. The responsibilities of the analysts are listed below:

- Performs analyses by adhering to analytical and quality control protocols prescribed by current SOPs, this QA Manual, and project-specific plans honestly, accurately, timely, safely, and in the most cost-effective manner.
- Documents standard and sample preparation, instrument calibration and maintenance, data calculations, sample matrix effects, and any observed non-conformance on logbooks, benchsheets, lab notebooks and/or the Non-Conformance Database.
- Reports all non-conformance situations, instrument problems, matrix problems and QC failures, which might affect the reliability of the data, to their Department or Program Manager as applicable, and/or the QA Manager or member of QA staff.
- Performs 100% review of the data generated prior to entering and submitting for secondary level review.
- Suggests method improvements to their Department/Program Manager, and the QA Manager. These improvements, if approved, will be incorporated. Ideas for the optimum performance of their assigned area, for example, through the proper cleaning and maintenance of the assigned instruments and equipment, are encouraged.
- Works cohesively as a team in their department to achieve the goals of accurate results, optimum turnaround time, cost effectiveness, cleanliness, complete documentation, and personal knowledge of environmental analysis.
- Lead analyst additional responsibilities - In addition to the responsibilities listed above supports the Technical/Department Manager by monitoring sample throughput, supports adherence to QA and safety protocols, and helps with the daily functions of the department.

4.2.10 LIMS Specialist

The LIMS Specialist is the individual responsible for the operation, validation, and implementation of the laboratory information management system. LIMS consist of the computer and software used to identify, schedule, prioritize, perform calculations, generate reports, store results, and perform any other computerized function necessary to control the flow

of samples through the laboratory. This person should have a bachelor's degree and/or appropriate laboratory and/or computer skills and education.

4.2.11 Client Services Manager (CSM)

The Client Services Manager reports to the Laboratory Director and serves as the interface between the laboratory's technical departments and the laboratory's clients. The staff consists of the Project Management team. With the overall goal of total client satisfaction, the functions of this position are outlined below:

- Technical training and growth of the Project Management team.
- Technical liaison for the Project Management team.
- Human resource management of the Project Management team.

The Project Management Team and CSM are:

- Ensures that clients receive the proper sampling supplies.
- Responds to client inquiries concerning sample status.
- Assists clients regarding the resolution of problems concerning COC.
- Ensures that client specifications, when known, are met by communicating project and quality assurance requirements to the laboratory.
- Notifies the Department Managers of incoming projects and sample delivery schedules.
- Accountable to clients for meeting agreed-upon due dates by communicating with the laboratory and relaying pertinent information to the client
- Discusses with client any project-related problems, resolving service issues, and coordinating technical details with the laboratory staff.
- Familiarizes staff with specific quotes, sample log-in review, and final report completeness.
- Monitors the status of all data package projects in-house to ensure timely and accurate delivery of reports.
- Informs clients of data package-related problems and resolve service issues.
- Coordinates requests for sample containers and other services (data packages).

4.2.12 Sample Receiving

The Sample Receiving Department Manager oversees the Sample Receiving Department. He/She, or designee is responsible for ensuring the timely and correct shipment of sample containers, including proper preservatives and instructions, to clients. He/She maintains accurate records of sample container shipments. The responsibilities are outlined below:

- Directs the logging of incoming samples into the LIMS.
- Ensures the verification of data entry from login.
- Supervises the organized storage and appropriate climate control of samples.

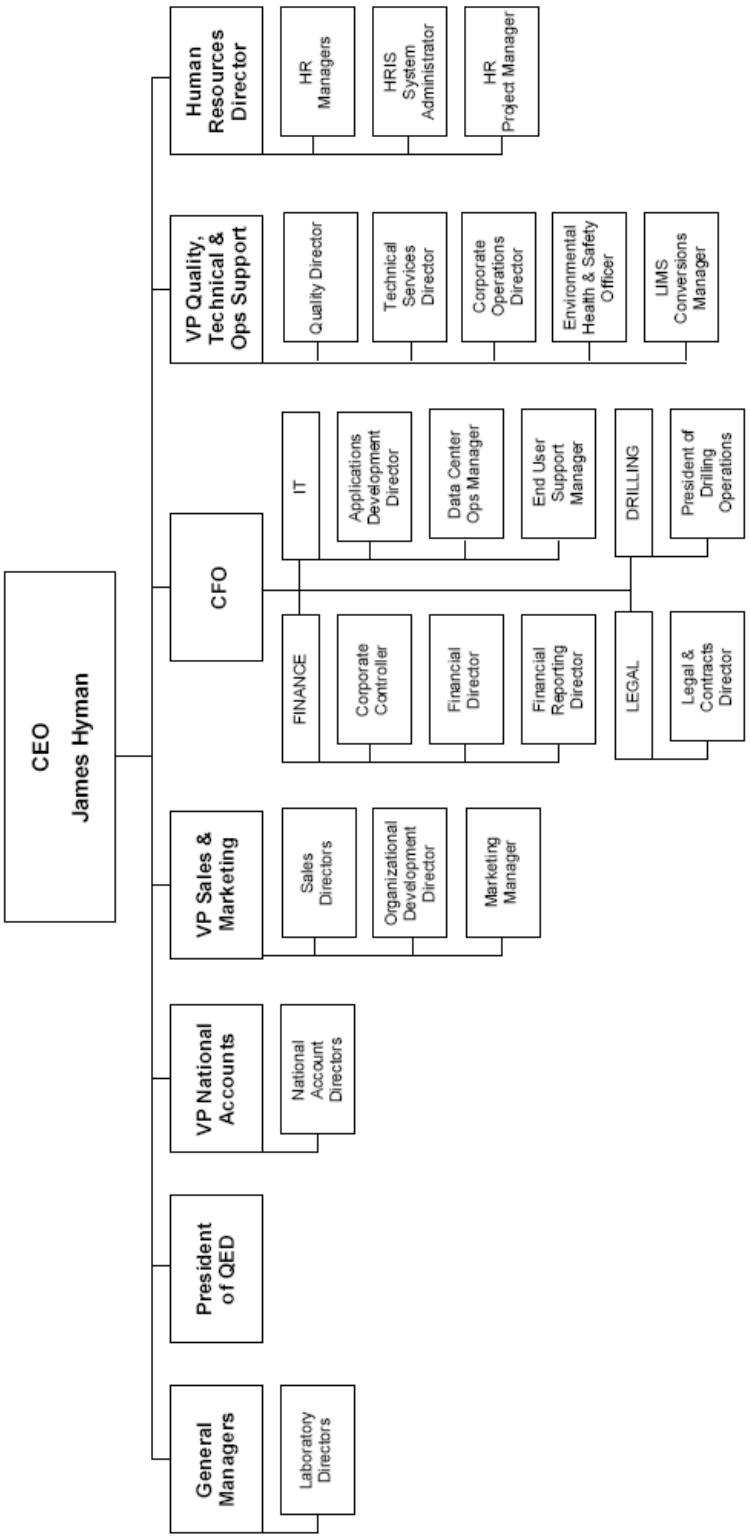
- Supervises the disposal of samples in accordance with the Waste Disposal SOP, the corporate Environmental Health and Safety Manual, the Hazardous Waste Contingency Plan in the facility addendum to the corporate safety manual, and the U. S. Department of Agriculture requirements.

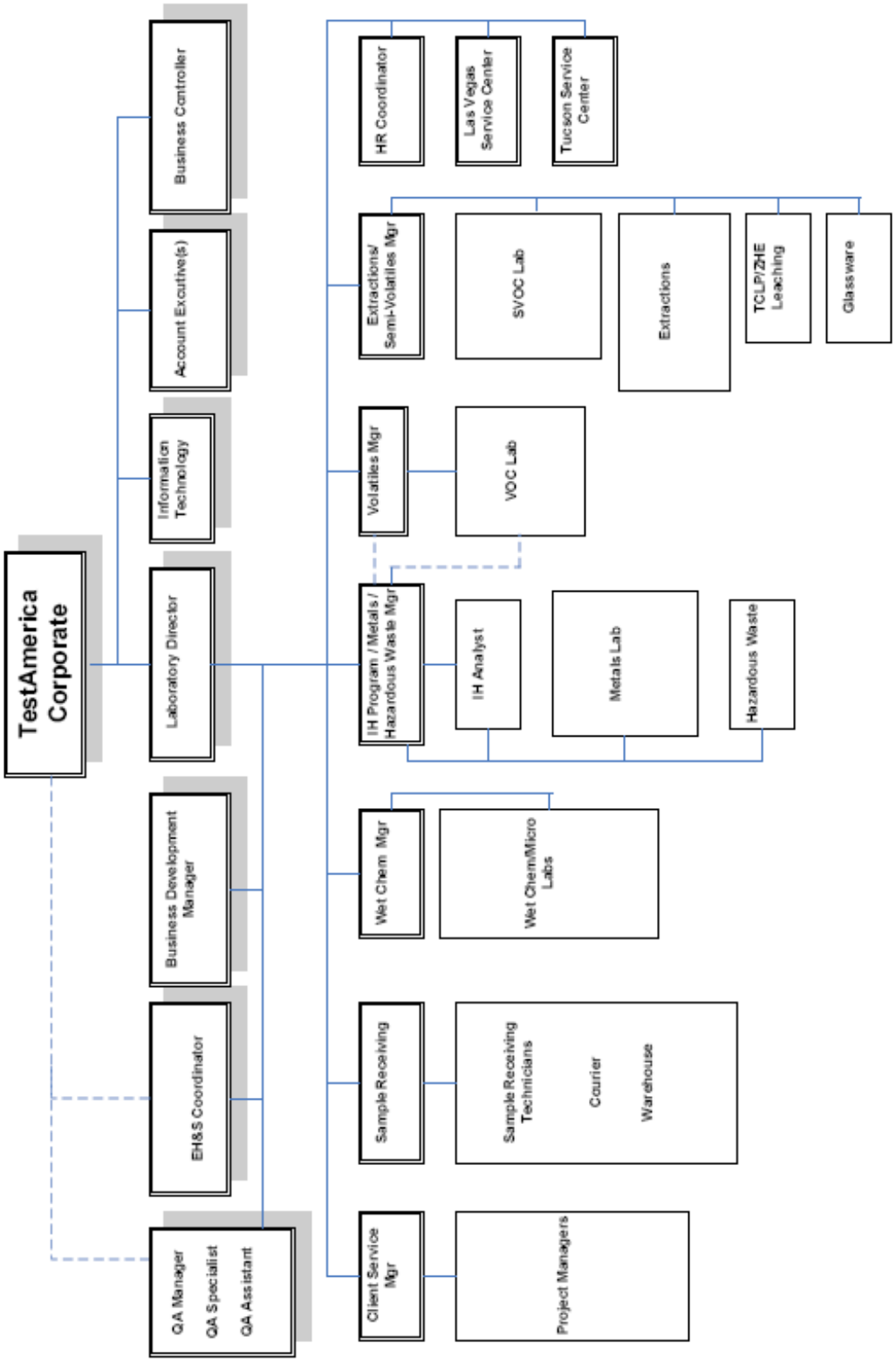
4.3 Deputies

The following table defines who assumes the responsibilities of key personnel in their absence:

Key Personnel	Deputy
Laboratory Director	Client Services Manager
QA Manager	Laboratory Director and / or QA Specialist
Client Services Manager	Laboratory Director
Industrial Hygiene Program/Technical Manager	Client Services Manager
VOA Department Manager	VOAs Lead, SVOAs Manager and /or Laboratory Director
SVOA/Extractions Department Manager	SVOAs Lead, VOAs Manager and / or Laboratory Director
Wet Chemistry Department Manager	Wet Chem Lead and / or Laboratory Director
Metals Department Manager	SVOA Manger, Metals Lead, and / or Laboratory Director or CSM
Sample Receiving Department Manager	Sample Receiving Group Leader, Client Services Manager
Hazardous Waste Coordinator	Environmental Health & Safety Coordinator and / or Laboratory Director
Environmental Health & Safety Coordinator	Hazardous Waste Coordinator/ or Laboratory Director

Figure 4-1. Corporate and Laboratory Organization Charts





Note: An organizational chart with employee names is kept on file in the QA Department

SECTION 5. QUALITY SYSTEM

5.1 Quality Policy Statement

It is TestAmerica's Policy to:

- ❖ Provide data of known quality to its clients by adhering to approved methodologies, regulatory requirements and the QA/QC protocols.
- ❖ Effectively manage all aspects of the laboratory and business operations by the highest ethical standards.
- ❖ Continually improve systems and provide support to quality improvement efforts in laboratory, administrative and managerial activities. TestAmerica recognizes that the implementation of a quality assurance program requires management's commitment and support as well as the involvement of the entire staff.
- ❖ Provide clients with the highest level of professionalism and the best service practices in the industry.
- ❖ Comply with the ISO/IEC 17025:2005(E) International Standard, the 2009 TNI Standard and to continually improve the effectiveness of the management system.

Every staff member at the laboratory plays an integral part in quality assurance and is held responsible and accountable for the quality of their work. It is, therefore, required that all laboratory personnel are trained and agree to comply with applicable procedures and requirements established by this document.

5.2 Ethics and Data Integrity

TestAmerica is committed to ensuring the integrity of its data and meeting the quality needs of its clients. The elements of TestAmerica's Ethics and Data Integrity Program include:

- An Ethics Policy (Corporate Policy No. CW-L-P-004 and Employee Ethics Statements).
- Ethics and Compliance Officers (ECOs).
- A Training Program.
- Self-governance through disciplinary action for violations.
- A Confidential mechanism for anonymously reporting alleged misconduct and a means for conducting internal investigations of all alleged misconduct. (Corporate SOP No. CW-L-S-002).
- Procedures and guidance for recalling data if necessary (Corporate SOP No. CW-L-S-002).
- Effective external and internal monitoring system that includes procedures for internal audits (Section 15).
- Produce results, which are accurate and include QA/QC information that meets client pre-defined Data Quality Objectives (DQOs).
- Present services in a confidential, honest and forthright manner.

- Provide employees with guidelines and an understanding of the Ethical and Quality Standards of our Industry.
- Operate our facilities in a manner that protects the environment and the health and safety of employees and the public.
- Obey all pertinent federal, state and local laws and regulations and encourage other members of our industry to do the same.
- Educate clients as to the extent and kinds of services available.
- Assert competency only for work for which adequate personnel and equipment are available and for which adequate preparation has been made.
- Promote the status of environmental laboratories, their employees, and the value of services rendered by them.

5.3 Quality System Documentation

The laboratory's Quality System is communicated through a variety of documents.

- Quality Assurance Manual – Each laboratory has a lab-specific quality assurance manual.
- Corporate SOPs and Policies – Corporate SOPs and Policies are developed for use by all relevant laboratories. They are incorporated into the laboratory's normal SOP distribution, training and tracking system. Corporate SOPs may be general or technical.
- Work Instructions – A subset of procedural steps, tasks or forms associated with an operation of a management system (e.g., checklists, preformatted bench sheets, forms).
- Laboratory SOPs – General and Technical
- Laboratory QA/QC Policy Memorandums

5.3.1 Order of Precedence

In the event of a conflict or discrepancy between policies, the order of precedence is as follows:

- Corporate Quality Management Plan (CQMP)
- Corporate SOPs and Policies
- Laboratory QA/QC Policy Memorandum
- Laboratory Quality Assurance Manual (QAM)
- Laboratory SOPs and Policies
- Other (Work Instructions (WI), memos, flow charts, etc.)

Note: The laboratory has the responsibility and authority to operate in compliance with regulatory requirements of the jurisdiction in which the work is performed. Where the CQMP conflicts with those regulatory requirements, the regulatory requirements of the jurisdiction shall hold primacy. The laboratory's QAM shall take precedence over the CQMP in those cases.

5.4 QA/QC Objectives for the Measurement of Data

Quality Assurance (QA) and Quality Control (QC) are activities undertaken to achieve the goal of producing data that accurately characterize the sites or materials that have been sampled. Quality Assurance is generally understood to be more comprehensive than Quality Control. Quality Assurance can be defined as the integrated system of activities that ensures that a product or service meets defined standards.

Quality Control is generally understood to be limited to the analyses of samples and to be synonymous with the term *"analytical quality control"*. QC refers to the routine application of statistically based procedures to evaluate and control the accuracy of results from analytical measurements. The QC program includes procedures for estimating and controlling precision and bias and for determining reporting limits.

Request for Proposals (RFPs) and Quality Assurance Project Plans (QAPP) provide a mechanism for the client and the laboratory to discuss the data quality objectives in order to ensure that analytical services closely correspond to client needs. The client is responsible for developing the QAPP. In order to ensure the ability of the laboratory to meet the Data Quality Objectives (DQOs) specified in the QAPP, clients are advised to allow time for the laboratory to review the QAPP before being finalized. Additionally, the laboratory will provide support to the client for developing the sections of the QAPP that concern laboratory activities.

Historically, laboratories have described their QC objectives in terms of precision, accuracy, representativeness, comparability, completeness, selectivity and sensitivity (PARCCSS). For AIHA we add Bias and Measurement Uncertainty.

5.4.1 Precision

The laboratory objective for precision is to meet the performance for precision demonstrated for the methods on similar samples and to meet data quality objectives of the EPA and/or other regulatory programs. Precision is defined as the degree of reproducibility of measurements under a given set of analytical conditions (exclusive of field sampling variability). Precision is documented on the basis of replicate analysis, usually duplicate or matrix spike (MS) duplicate samples.

5.4.2 Accuracy

The laboratory objective for accuracy is to meet the performance for accuracy demonstrated for the methods on similar samples and to meet data quality objectives of the EPA and/or other regulatory programs. Accuracy is defined as the degree of bias in a measurement system. Accuracy may be documented through the use of laboratory control samples (LCS) and/or MS. A statement of accuracy is expressed as an interval of acceptance recovery about the mean recovery.

5.4.3 Representativeness

The laboratory objective for representativeness is to provide data which is representative of the sampled medium. Representativeness is defined as the degree to which data represent a characteristic of a population or set of samples and is a measurement of both analytical and field sampling precision. The representativeness of the analytical data is a function of the procedures used in procuring and processing the samples. The representativeness can be documented by the relative percent difference between separately procured, but otherwise identical samples or sample aliquots.

The representativeness of the data from the sampling sites depends on both the sampling procedures and the analytical procedures. The laboratory may provide guidance to the client regarding proper sampling and handling methods in order to assure the integrity of the samples.

5.4.4 Comparability

The comparability objective is to provide analytical data for which the accuracy, precision, representativeness and reporting limit statistics are similar to these quality indicators generated by other laboratories for similar samples, and data generated by the laboratory over time.

The comparability objective is documented by inter-laboratory studies carried out by regulatory agencies or carried out for specific projects or contracts, by comparison of periodically generated statements of accuracy, precision and reporting limits with those of other laboratories.

5.4.5 Completeness

The completeness objective for data is 90% (or as specified by a particular project), expressed as the ratio of the valid data to the total data over the course of the project. Data will be considered valid if they are adequate for their intended use. Data usability will be defined in a QAPP, project scope or regulatory requirement. Data validation is the process for reviewing data to determine its usability and completeness. If the completeness objective is not met, actions will be taken internally and with the data user to improve performance. This may take the form of an audit to evaluate the methodology and procedures as possible sources for the difficulty or may result in a recommendation to use a different method.

5.4.6 Selectivity

Selectivity is defined as: The capability of a test method or instrument to respond to a target substance or constituent in the presence of non-target substances. Target analytes are separated from non-target constituents and subsequently identified/detected through one or more of the following, depending on the analytical method: extractions (separation), digestions (separation), interelement corrections (separation), use of matrix modifiers (separation), specific retention times (separation and identification), confirmations with different columns or detectors (separation and identification), specific wavelengths (identification), specific mass spectra (identification), specific electrodes (separation and identification), etc..

5.4.7 Sensitivity

Sensitivity refers to the amount of analyte necessary to produce a detector response that can be reliably detected (Method Detection Limit) or quantified (Reporting Limit).

5.5 Criteria for Quality Indicators

The laboratory precision and accuracy acceptability limits for performed analyses can be found in Element. This summary includes an effective date, is updated each time new limits are generated and are managed by the laboratory's QA department. Unless otherwise noted, limits within these tables are laboratory generated. Some acceptability limits are derived from published methods (US EPA methods and other regulatory methods) when they are required. Where method limits are not required, the laboratory has developed limits from evaluation of data from similar matrices. Criteria for development of control limits are contained in SOP PE-QAD-001 Control Charts and Statistical Process Control and/or Section 24

5.6 Statistical Quality Control

Statistically-derived precision and accuracy limits are required by selected methods (such as SW-846) and programs [such as Arizona Department of Health Services (ADHS)]. The laboratory routinely utilizes statistically-derived limits to evaluate method performance and determine when corrective action is appropriate. The analysts are instructed to use the current limits, dated and approved by the Department Manager and QA Manager, The limits are entered into the Laboratory Information Management System (LIMS). The test's limits associated with data are archived in LIMS.

If a method defines the QC limits, the method limits are used. On occasion, a client may request contract-specified limits for a specific project. These limits may be used if they are equal to or more restrictive than those specified by the method.

If a method requires the generation of historical limits, the lab develops such limits from recent data in the QC database of the LIMS following the guidelines described in Section 24. All calculations and limits are documented and dated when approved and effective. On occasion, a client requests contract-specified limits for a specific project.

Current QC limits are entered and maintained in the LIMS analyte database. As sample results and the related QC are entered into LIMS, the sample QC values are compared with the limits in LIMS to determine if they are within the acceptable range. The analyst then evaluates if the sample needs to be rerun or re-extracted/rerun or if a comment should be added to the report explaining the reason for the QC outlier

5.6.1 QC Charts

QC charts are generated as part of statistical control (see SOP PE-QAD-001). The QA Manager and Department Manager evaluate these to determine if adjustments need to be made or for corrective actions to methods. All findings are documented and kept on file. The charts are available for analyst review on the shared laboratory directory.

5.7 Quality System Metrics

In addition to the QC parameters discussed above, the entire Quality System is evaluated on a monthly basis through the use of specific metrics (refer to Section 16). These metrics are used to drive continuous improvement in the laboratory's Quality System.

SECTION 6. DOCUMENT CONTROL

6.1 Overview

The QA Department is responsible for the control of documents used in the laboratory to ensure that approved, up-to-date documents are in circulation and out-of-date (obsolete) documents are archived or destroyed. The following documents, at a minimum, must be controlled:

- Laboratory Quality Assurance Manual
- Laboratory Standard Operating Procedures (SOP)
- Laboratory Policies
- Work Instructions and Forms
- Corporate Policies and Procedures distributed outside the intranet

Corporate Quality posts Corporate Manuals, SOPs, Policies, Work Instructions, White Papers and Training Materials on the company intranet site. These Corporate documents are only considered controlled when they are read on the intranet site. Printed copies are considered uncontrolled unless the laboratory physically distributes them as controlled documents. A detailed description of the procedure for issuing, authorizing, controlling, distributing, and archiving Corporate documents is found in Corporate SOP No. CW-Q-S-001, Corporate Document Control and Archiving. The laboratory's internal document control procedure is defined in SOP PE-QAD-010 Document Control.

The laboratory QA Department also maintains access to various references and document sources integral to the operation of the laboratory. This includes reference methods and regulations. Instrument manuals (hard or electronic copies) are also maintained by the laboratory.

The laboratory maintains control of records for raw analytical data and supporting records such as internal audit reports and responses, logbooks, standard logs, training files, MDL studies, Proficiency Testing (PT) studies, certifications and related correspondence, and corrective action reports. Raw analytical data consists of bound logbooks, instrument printouts, any other notes, magnetic media, electronic data and final reports.

6.2 Document Approval and Issue

The pertinent elements of a document control system for each document include a unique document title and number, pagination, the total number of pages of the item or an 'end of document' page, the effective date, revision number and the laboratory's name. The QA personnel are responsible for the maintenance of this system.

Controlled documents are authorized by the QA Department and other management personnel. In order to develop a new document, a Technical/Department Manager submits an electronic draft to the QA Department for suggestions and approval before use. Spreadsheets used for calculations and data evaluation must be verified to be accurate and locked down prior to approval. Upon approval, QA personnel add the identifying version information to the document and retains that document as the official document on file. That document is then provided to all applicable operational units (may include electronic access). Controlled documents are identified as such and records of their distribution are kept by the QA Department. Document control may be achieved by either electronic or hardcopy distribution.

The QA Department maintains a list of the official versions of controlled documents.

Quality System Policies and Procedures will be reviewed at a minimum of every year for drinking water and AIHA methods, and every two years for all other methods and are revised as appropriate. Changes to documents occur when a procedural change warrants.

6.3 Procedures for Document Control Policy

For changes to the QA Manual, refer to SOP PE-QAD-010 Document Control. Previous revisions and back-up data are stored by the QA Department. Electronic copies are stored on the Public server in the QA folder for the applicable revision, accessible to all Phoenix employees.

For changes to SOPs, refer to SOP PE-QAD-014 Creation and Maintenance of SOPs. The SOP identified above also defines the process of changes to SOPs.

Forms, worksheets, work instructions and information are organized and maintained by the QA Department. A table of contents and electronic versions are kept on the QA department server. The procedure for the care of these documents is in SOP PE-QAD-010 Document Control.

6.4 Obsolete Documents

All invalid or obsolete documents are removed, or otherwise prevented from unintended use. The laboratory has specific procedures as described above to accomplish this. At least one copy of the obsolete document is archived according to SOP PE-QAD-014 Creation and Maintenance of SOPs and SOP PE-QAD-010 Document Control.

SECTION 7. SERVICE TO THE CLIENT

7.1 Overview

The laboratory has established procedures for the review of work requests and contracts, oral or written. The procedures include evaluation of the laboratory's capability and resources to meet the contract's requirements within the requested time period. All requirements, including the methods to be used, must be adequately defined, documented and understood. For many environmental sampling and analysis programs, testing design is site or program specific and does not necessarily "fit" into a standard laboratory service or product. It is the laboratory's intent to provide both standard and customized environmental laboratory services to our clients.

A thorough review of technical and QC requirements contained in contracts is performed to ensure project success. The appropriateness of requested methods, and the lab's capability to perform them must be established. Projects, proposals and contracts are reviewed for adequately defined requirements and the laboratory's capability to meet those requirements. Alternate test methods that are capable of meeting the clients' requirements may be proposed by the lab. A review of the lab's capability to analyze non-routine analytes is also part of this review process.

All projects, proposals and contracts are reviewed for the client's requirements in terms of compound lists, test methodology requested, sensitivity (detection and reporting levels), accuracy, and precision requirements (% Recovery and RPD). The reviewer ensures that the laboratory's test methods are suitable to achieve these requirements and that the laboratory holds the appropriate certifications and approvals to perform the work. The laboratory and any potential subcontract laboratories must be certified, as required, for all proposed tests.

The laboratory must determine if it has the necessary physical, personnel and information resources to meet the contract, and if the personnel have the expertise needed to perform the testing requested. Each proposal is checked for its impact on the capacity of the laboratory's equipment and personnel. As part of the review, the proposed turnaround time will be checked for feasibility.

Electronic or hard copy deliverable requirements are evaluated against the laboratory's capacity for production of the documentation.

If the laboratory cannot provide all services but intends to subcontract such services, whether to another TestAmerica facility or to an outside firm, this will be documented and discussed with the client prior to contract approval. (Refer to Section 8 for Subcontracting Procedures.)

The laboratory informs the client of the results of the review if it indicates any potential conflict, deficiency, lack of accreditation, or inability of the lab to complete the work satisfactorily. Any discrepancy between the client's requirements and the laboratory's capability to meet those requirements is resolved in writing before acceptance of the contract. It is necessary that the contract be acceptable to both the laboratory and the client. Amendments initiated by the client and/or TestAmerica, are documented in writing.

All contracts, QAPPs, Sampling and Analysis Plans (SAPs), contract amendments, and documented communications become part of the project record. The same contract review process used for the initial review is repeated when there are amendments to the original contract by the client, and the participating personnel are informed of the changes.

7.2 Review Sequence and Key Personnel

Appropriate personnel will review the work request at each stage of evaluation.

For routine projects and other simple tasks, a review by the Project Manager (PM) is considered adequate. The PM confirms that the laboratory has any required certifications, that it can meet the clients' data quality and reporting requirements and that the lab has the capacity to meet the clients turn around needs. It is recommended that, where there is a sales person assigned to

the account, an attempt should be made to contact that sales person to inform them of the incoming samples.

For new, complex or large projects, the proposed contract is given to the National Account Director or other appropriate personnel, who will decide which lab will receive the work based on the scope of work and other requirements, including certification, testing methodology, and available capacity to perform the work. The contract review process is outlined in TestAmerica's Corporate SOP CA-L-P-002, Contract Compliance Policy.

This review encompasses all facets of the operation. The scope of work is distributed to the appropriate personnel, as needed based on scope of contract, to evaluate all of the requirements shown above (not necessarily in the order below):

- Legal & Contracts Director
- General Manager
- The Laboratory Client Services Manager/Business Development Manager
- Laboratory and/or Corporate Technical/Department Managers
- Laboratory and/or Corporate Information Technology Managers/Directors
- Account Executives
- Laboratory and/or Corporate Quality Assurance Personnel
- Laboratory and/or Corporate Environmental Health and Safety Managers/Directors
- The Laboratory Director reviews the formal laboratory quote and makes final acceptance for their facility.

The National Account Director, Legal Contracts Director, or local account representative then submits the final proposal to the client.

In the event that one of the above personnel is not available to review the contract, his or her back-up will fulfill the review requirements.

The Legal & Contracts Director maintains copies of all signed contracts. The Business Development Manager or the Project Manager maintains the local copies of the contracts.

7.3 Documentation

Appropriate records are maintained for every contract or work request. All stages of the contract review process are documented and include records of any significant changes. Those records are maintained locally as needed.

The contract will be distributed to and maintained by the appropriate sales/marketing personnel. A copy of the contract and formal quote will be filed with the laboratory Project Manager (PM).

Records are maintained of pertinent discussions with a client relating to the client's requirements or the results of the work during the period of execution of the contract. The PM keeps a phone log of conversations with the client. Client correspondence and internal communications regarding projects are kept in the project file or stored electronically.

7.3.1 Project-Specific Quality Planning

Communication of contract specific technical and QC criteria is an essential activity in ensuring the success of site specific testing programs. To achieve this goal, the laboratory assigns a PM to each client. It is the PM's responsibility to ensure that project specific technical and QC requirements are effectively evaluated and communicated to the laboratory personnel before and during the project. QA Department involvement may be needed to assist in the evaluation of custom QC requirements.

PMs are the primary client contact and they ensure resources are available to meet project requirements. Although PM's do not have direct reports or staff in production, they coordinate opportunities and work with laboratory management and supervisory staff to ensure available resources are sufficient to perform work for the client's project. Project management is positioned between the client and laboratory resources.

Prior to working on a new project, the dissemination of project information and/or project opening meetings may occur to discuss schedules and unique aspects of the project. Items to be discussed may include the project technical profile, turnaround times, holding times, methods, analyte lists, reporting limits, deliverables, sample hazards, or other special requirements. The PM introduces new projects to the laboratory staff through project kick-off meetings or to the supervisory staff during status meetings. These meetings provide direction to the laboratory staff in order to maximize production and client satisfaction, while maintaining quality. In addition, project notes may be associated with each sample batch as a reminder upon sample receipt and analytical processing.

During the project, any change that may occur within an active project is agreed upon between the client/regulatory agency and the PM/laboratory. These changes (e.g., use of a non-standard method or modification of a method) and approvals must be documented prior to implementation. Documentation pertains to any document, e.g., letter, e-mail, variance or contract addendum, which has been signed by both parties.

Such changes are also communicated verbally to the laboratory during status meetings. Such changes are updated to the project notes and are introduced to the managers at these meetings. The laboratory staff is then introduced to the modified requirements via the PM or the individual laboratory Department Manager. After the modification is implemented into the laboratory process, documentation of the modification is made in the case narrative of the data report(s).

The laboratory strongly encourages client visits to the laboratory and for formal/informal information sharing session with employees in order to effectively communicate ongoing client needs as well as project specific details for customized testing programs.

7.4 Special Services

The laboratory cooperates with clients and their representatives to monitor the laboratory's performance in relation to work performed for the client. It is the laboratory's goal to meet all client requirements in addition to statutory and regulatory requirements. The laboratory has procedures to ensure confidentiality to clients (Section 15 and 25).

Note: ISO/IEC 17025 states that a laboratory "shall afford clients or their representatives' cooperation to clarify the client's request".

The laboratory's standard procedures for reporting data are described in Section 25. Special services are also available and provided upon request. These services include:

- Reasonable access for our clients or their representatives to the relevant areas of the laboratory for the witnessing of tests performed for the client.
- Assist client-specified third party data validators as specified in the client's contract.
- Supplemental information pertaining to the analysis of their samples. Note: An additional charge may apply for additional data/information that was not requested prior to the time of sample analysis or previously agreed upon.

7.5 Client Communication

Project Managers are the primary communication link to the clients. They shall inform their clients of any delays in project completion as well as any non-conformances in either sample receipt or sample analysis. Project Management will maintain ongoing client communication throughout the entire client project.

Technical Manager/Department Managers are available to discuss any technical questions or concerns that the client may have.

7.6 Reporting

The laboratory works with our clients to produce any special communication reports required by the contract.

7.7 Client Surveys

The laboratory assesses both positive and negative client feedback. The results are used to improve overall laboratory quality and client service. TestAmerica's Sales and Marketing teams periodically develops lab and client specific surveys to assess client satisfaction.

SECTION 8. SUBCONTRACTING OF TESTS

8.1 Overview

For the purpose of this quality manual, the phrase subcontract laboratory refers to a laboratory external to the TestAmerica laboratories. The phrase "work sharing" refers to internal transfers of samples between the TestAmerica laboratories. The term outsourcing refers to the act of subcontracting tests.

When contracting with our clients, the laboratory makes commitments regarding the services to be performed and the data quality for the results to be generated. When the need arises to outsource testing for our clients because project scope, changes in laboratory capabilities, capacity or unforeseen circumstances, we must be assured that the subcontractors or work sharing laboratories understand the requirements and will meet the same commitments we

have made to the client. Refer to TestAmerica's Corporate SOP's on Subcontracting Procedures (CA-L-S-002) and the Work Sharing Process (CA-C-S-001).

When outsourcing analytical services, the laboratory will assure, to the extent necessary, that the subcontract or work sharing laboratory maintains a program consistent with the requirements of this document, the requirements specified in State/TNI/AIHA/ISO 17025 and/or the client's Quality Assurance Project Plan (QAPP). All QC guidelines specific to the client's analytical program are transmitted to the subcontractor and agreed upon before sending the samples to the subcontract facility. Additionally, work requiring accreditation will be placed with an appropriately accredited laboratory. The laboratory performing the subcontracted work will be identified in the final report, as will non-TNI/AIHA or regulatory accredited work where required.

Project Managers (PMs), Customer Service Manager (CSM), or Account Executives for the Export Lab are responsible for obtaining client approval prior to outsourcing any samples. The laboratory will advise the client of a subcontract or work sharing arrangement in writing and when possible approval from the client shall be retained in the project folder.

Note: In addition to the client, some regulating agencies (e.g, USDA) or contracts may require notification prior to placing such work**.**

8.2 Qualifying and Monitoring Subcontractors

Whenever a PM, Account Executive or CSM becomes aware of a client requirement or laboratory need where samples must be outsourced to another laboratory, the other laboratory(s) shall be selected based on the following:

- The first priority is to attempt to place the work in a qualified TestAmerica laboratory;
- Firms specified by the client for the task (Documentation that a subcontractor was designated by the client must be maintained with the project file. This documentation can be as simple as placing a copy of an e-mail from the client in the project folder);
- Firms listed as pre-qualified and currently under a subcontract with TestAmerica: A listing of all approved subcontracting laboratories is available on the TestAmerica intranet site. Supporting documentation is maintained by corporate offices and by the TestAmerica laboratory originally requesting approval of the subcontract lab. Verify necessary accreditation, where applicable, (e.g., on the subcontractors TNI, A2LA accreditation or State Certification).
- Firms identified in accordance with the company's Small Business Subcontracting program as small, women-owned, veteran-owned and/or minority-owned businesses;
- TNI or AIHA accredited laboratories.
- In addition, the firm must hold the appropriate certification/accreditation to perform the work required. For TNI and AIHA accreditation, this would include accreditation to the same Field of Testing.

All TestAmerica laboratories are pre-qualified for work sharing provided they hold the appropriate accreditations, can adhere to the project/program requirements, and the client approved sending samples to that laboratory. The client must provide acknowledgement that

the samples can be sent to that facility (an e-mail is sufficient documentation or if acknowledgement is verbal, the date, time, and name of person providing acknowledgement must be documented). The originating laboratory is responsible for communicating all technical, quality, and deliverable requirements as well as other contract needs. (Corporate SOP No. CA-C-S-001, Work Sharing Process).

When the potential sub-contract laboratory has not been previously approved, Account Executives or PMs may nominate a laboratory as a subcontractor based on need. The decision to nominate a laboratory must be approved by the Laboratory Director. The Laboratory Director requests that the QA Manager begin the process of approving the subcontract laboratory as outlined in Corporate SOP CA-L-S-002, Subcontracting Procedures. The client must provide acknowledgement that the samples can be sent to that facility (an e-mail is sufficient documentation or if acknowledgement is verbal, the date, time, and name of person providing acknowledgement must be documented).

8.2.1 Once the appropriate accreditation and legal information is received by the laboratory, it is evaluated for acceptability (where applicable) and forwarded to Corporate Contracts for formal contracting with the laboratory. They will add the lab to the approved list on the intranet site and notify the finance group for JD Edwards.

8.2.2 The client will assume responsibility for the quality of the data generated from the use of a subcontractor they have requested the lab to use. The qualified subcontractors on the intranet site are known to meet minimal standards. TestAmerica does not certify laboratories. The subcontractor is on our approved list and can only be recommended to the extent that we would use them.

8.2.3 The status and performance of qualified subcontractors will be monitored periodically by the Corporate Contracts and/or Quality Departments. Any problems identified will be brought to the attention of TestAmerica's Corporate Finance or Corporate Quality personnel.

- Complaints shall be investigated. Documentation of the complaint, investigation and corrective action will be maintained in the subcontractor's file on the intranet site. Complaints are posted using the Vendor Performance Report.
- Information shall be updated on the intranet when new information is received from the subcontracted laboratories.
- Subcontractors in good standing will be retained on the intranet listing. The QA Manager will notify all TestAmerica laboratories, Corporate Quality and Corporate Contracts if any laboratory requires removal from the intranet site. This notification will be posted on the intranet site and e-mailed to all Laboratory Directors, QA Managers and Sales Personnel.

8.3 Oversight and Reporting

The PM, CSM or Account Executive must request that the selected subcontractor be presented with a subcontract, if one is not already executed between the laboratory and the subcontractor. The subcontract must include terms which flow down the requirements of our clients, either in the subcontract itself or through the mechanism of work orders relating to individual projects. A standard subcontract and the Lab Subcontractor Vendor Package (posted on the intranet) can be used to accomplish this, and the Legal & Contracts Director can tailor the document or assist with negotiations, if needed. The PM, CSM or Account Executive responsible for the project

must advise and obtain client consent to the subcontract as appropriate, and provide the scope of work to ensure that the proper requirements are made a part of the subcontract and are made known to the subcontractor

Prior to sending samples to the subcontracted laboratory, the PM confirms their certification status to determine if it's current and scope-inclusive. The information is documented on the Client Approved Subcontracted Sample Form, PX-PDM-012 and the form is retained in the project folder. The form is not required if the need to subcontract the analysis has been identified in the project quote. For TestAmerica laboratories, certifications can be viewed on the company's TotalAccess Database.

The Sample Control department is responsible for ensuring compliance with QA requirements and applicable shipping regulations when shipping samples to a subcontracted laboratory.

All subcontracted samples must be accompanied by a TestAmerica Chain of Custody (COC). A copy of the original COC sent by the client must also be included with all samples workshared within TestAmerica. Client CoCs are only forwarded to external subcontractors when samples are shipped directly from the project site to the subcontractor lab. Under routine circumstances, client CoCs are not provided to external subcontractors.

Through communication with the subcontracted laboratory, the PM monitors the status of the subcontracted analyses, facilitates successful execution of the work, and ensures the timeliness and completeness of the analytical report.

Non-TNI, non-ADHS or non-AIHA accredited work must be identified in the subcontractor's report as appropriate. If accreditations are not required, the report does not need to include this information.

Reports submitted from subcontractor laboratories are not altered and are included in their original form in the final project report. This clearly identifies the data as being produced by a subcontractor facility. If subcontract laboratory data is incorporated into the laboratories EDD (i.e., imported), the report must explicitly indicate which lab produced the data for which methods and samples.

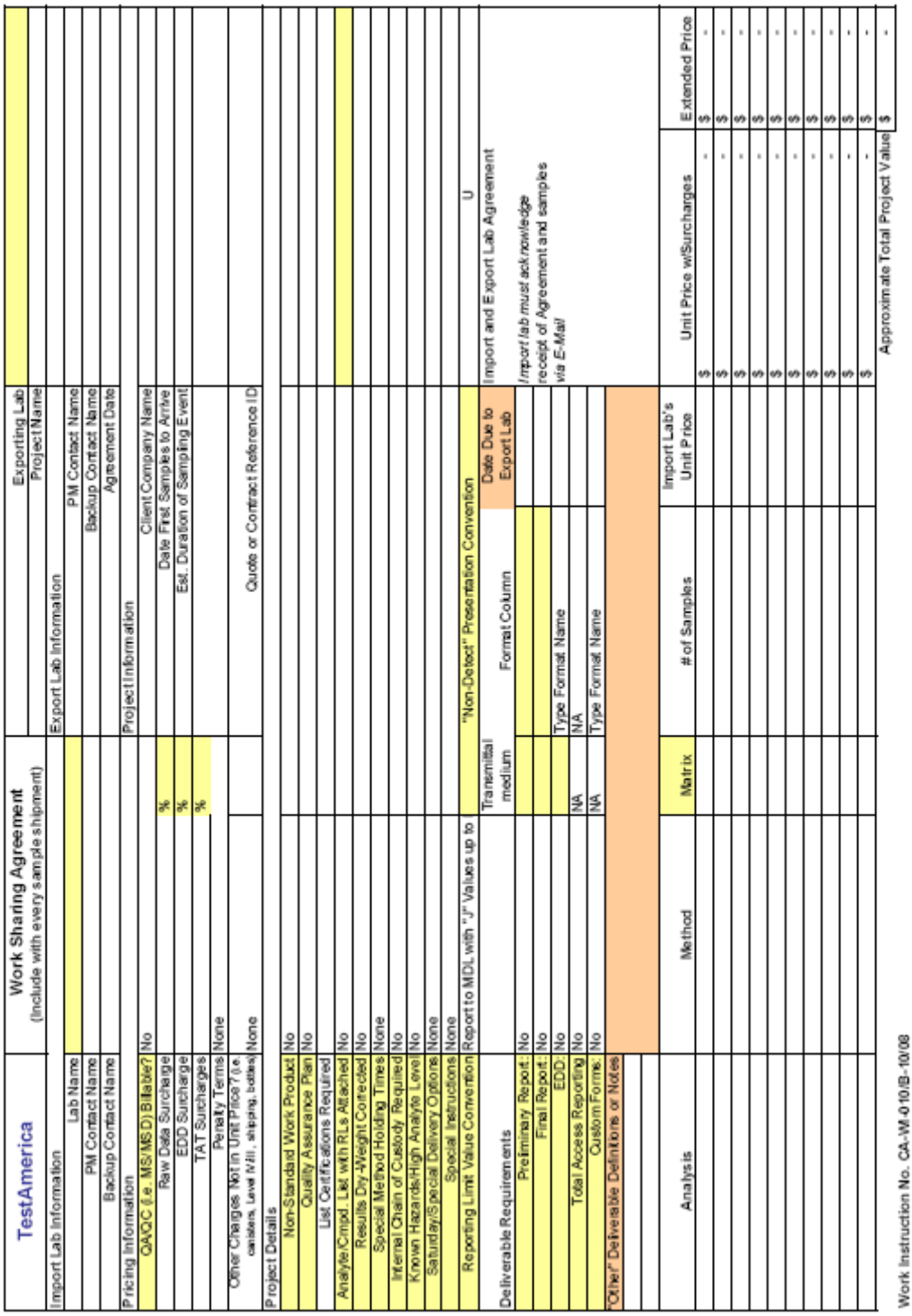
Note: The results submitted by a TestAmerica work sharing laboratory may be transferred electronically and the results reported by the TestAmerica work sharing lab are identified on the final report. The report must explicitly indicate which lab produced the data for which methods and samples. The final report must include a copy of the completed COC for all work sharing reports.

8.4 Contingency Planning

The Laboratory Director may waive the full qualification of a subcontractor process temporarily to meet emergency needs; however, this decision & justification must be documented in the project files, and the 'Purchase Order Terms And Conditions For Subcontracted Laboratory Services' must be sent with the samples and Chain-of-Custody. In the event this provision is utilized, the laboratory (e.g., PM) will be required to verify and document the applicable accreditations of the subcontractor. All other quality and accreditation requirements will still be applicable, but the subcontractor need not have signed a subcontract with TestAmerica at this

time. The comprehensive approval process must then be initiated within 30 calendar days of subcontracting.

Figure 8-1. Example Work Share Agreement



SECTION 9. PURCHASING SERVICES AND SUPPLIES

9.1 Overview

Evaluation and selection of suppliers and vendors is performed, in part, on the basis of the quality of their products, their ability to meet the demand for their products on a continuous and short term basis, the overall quality of their services, their past history, and competitive pricing. This is achieved through evaluation of objective evidence of quality furnished by the supplier, which can include certificates of analysis, recommendations, and proof of historical compliance with similar programs for other clients. To ensure that quality critical consumables and equipment conform to specified requirements, which may affect quality, all purchases from specific vendors are approved by a member of the supervisory or management staff. Capital expenditures are made in accordance with TestAmerica's Corporate Controlled Purchases Procedure, SOP No. CW-F-S-007.

Contracts will be signed in accordance with TestAmerica's Corporate Authorization Matrix Policy, Policy No. CW-F-P-002. Request for Proposals (RFP's) will be issued where more information is required from the potential vendors than just price. Process details are available in TestAmerica's Corporate Procurement and Contracts Policy (Policy No. CW-F-P-004). RFP's allow TestAmerica to determine if a vendor is capable of meeting requirements such as supplying all of the TestAmerica facilities, meeting required quality standards and adhering to necessary ethical and environmental standards. The RFP process also allows potential vendors to outline any additional capabilities they may offer.

9.2 Glassware

Glassware used for volumetric measurements must be Class A or verified for accuracy according to laboratory procedure. Pyrex (or equivalent) glass should be used where possible. For safety purposes, thick-wall glassware should be used where available.

9.3 Reagents, Standards & Supplies

Purchasing guidelines for equipment and reagents must meet the requirements of the specific method and testing procedures for which they are being purchased. Solvents and acids are pre-tested in accordance with TestAmerica's Corporate SOP on Solvent & Acid Lot Testing & Approval, SOP No. CA-Q-S-001.

9.3.1 Purchasing

Chemical reagents, solvents, glassware, and general supplies are ordered as needed to maintain sufficient quantities on hand. Materials used in the analytical process must be of a known quality. The wide variety of materials and reagents available makes it advisable to specify recommendations for the name, brand, and grade of materials to be used in any determination. This information is contained in the method SOP.

The requisitioning department employee will complete an ordering template found on the shared server. Once completed the template should be saved in the proper folder with the employee's initials and date. This will be forwarded to the Administrative personnel in charge of ordering who will complete a General Requisition in JD Edwards. Alternatively, some departments complete the General Requisition in JD Edwards directly. The Lab Director will approve the

requisition via the orders awaiting approval application in JDE. Properly approved requisitions are generated into purchase orders and are procured by the Corporate Purchasing Coordinator.

9.3.2 Receiving

It is the responsibility of warehouse personnel to receive the shipment. They must also document date the material when received and compare the information on the label or packaging to the original order to ensure that the purchase meets the quality level specified. A unique tracking identifier is assigned at this time. The laboratory department receiving the item confirms that the quality of the item received meets the level specified. Material Safety Data Sheets (MSDSs) are available online through the Company's intranet website. Anyone may review these for relevant information on the safe handling and emergency precautions of on-site chemicals. Any MSDS should be given to EHS for review. The intranet is checked to determine if the MSDS is already available. If it is not an electronic copy of the MSDS is sent to corporate EHS where it is added to the Company's intranet.

9.3.3 Specifications

Methods in use in the laboratory specify the grade of reagent that must be used in the procedure. If the quality of the reagent is not specified, analytical reagent grade will be used. It is the responsibility of the analyst to check the procedure carefully for the suitability of grade of reagent.

Chemicals must not be used past the manufacturer's expiration date and must not be used past the expiration time noted in a method SOP unless the conditions outlined below are followed. If expiration dates are not provided, the laboratory may contact the manufacturer to determine an expiration date.

The laboratory assumes a five year expiration date on inorganic dry chemicals and solvents unless noted otherwise by the manufacturer or by the reference source method. Chemicals/solvents should not be used past the manufacturers' or SOPs expiration date unless 'verified' (refer to item 3 listed below).

- An expiration date **cannot** be extended if the dry chemical/solvent is discolored or appears otherwise physically degraded, the dry chemical/solvent must be discarded.
- Expiration dates can be extended if the dry chemical/solvent is found to be satisfactory based on acceptable performance of quality control samples (Continuing Calibration Verification (CCV), Blanks, Laboratory Control Sample (LCS), etc.).
- If the dry chemical/solvent is used for the preparation of standards, the expiration dates can be extended 6 months if the dry chemical/solvent is compared to an unexpired independent source in performing the method and the performance of the dry chemical/solvent is found to be satisfactory. The comparison must show that the dry chemical/solvent meets CCV limits. The comparison studies are maintained in the QA office.

Note: The five year expiration date applies to all Industrial Hygiene standards that are considered 'neat'.

Wherever possible, standards must be traceable to national or international standards of measurement or to national or international reference materials. Records to that effect are available to the user.

Compressed gases in use are checked for pressure and secure positioning daily. To prevent a tank from going to dryness or introducing potential impurities, the pressure should be closely watched as it decreases to approximately 15% of the original reading, at which point it should be replaced. For example, a standard sized laboratory gas cylinder containing 3,000 psig of gas should be replaced when it drops to approximately 500 psig. The quality of the gases must meet method or manufacturer specification or be of a grade that does not cause any analytical interference. Gas cylinders are tracked by manufacturer, pressure, and lot number.

Water used in the preparation of standards or reagents must have a specific conductivity of less than 1- µmho/cm (or specific resistivity of greater than 1.0 megohm-cm) at 25^{o}C. The specific conductivity is checked and recorded daily. If the water's specific conductivity is greater than the specified limit, the Facility Manager and appropriate Technical/Department Managers must be notified immediately in order to notify all departments, decide on cessation (based on intended use) of activities, and make arrangements for correction.

The laboratory may purchase reagent grade (or other similar quality) water for use in the laboratory. This water must be certified "clean" by the supplier for all target analytes or otherwise verified by the laboratory prior to use. This verification is documented.

Standard lots are verified before first time use if the laboratory switches manufacturers or has historically had a problem with the type of standard.

Purchased bottleware used for sampling must be certified clean and the certificates must be maintained. If uncertified sampling bottleware is purchased, all lots must be verified clean prior to use. This verification must be maintained.

Records of manufacturer's certification and traceability statements are entered into LIMS. They may also be maintained in files or binders in each laboratory section. These records include date of receipt, lot number (when applicable), and expiration date (when applicable).

9.3.4 Storage

Reagent and chemical storage is important from the aspects of both integrity and safety. Light-sensitive reagents may be stored in brown-glass containers. Storage conditions are per the Corporate Environmental Health & Safety Manual (Corp. Doc. No. CW-E-M-001) and method SOPs or manufacturer instructions.

9.4 Purchase of Equipment / Instruments / Software

When a new piece of equipment is needed, either for additional capacity or for replacing inoperable equipment, the analyst or supervisor makes a supply request to the Technical or Department Manager or and/or the Laboratory Director. If they agree with the request, the procedures outlined in TestAmerica's Corporate Policy No. CA-T-P-001, Qualified Products List, are followed. A decision is made as to which piece of equipment can best satisfy the requirements. The appropriate written requests are completed and purchasing places the order.

Upon receipt of a new or used piece of equipment, an identification name is assigned and added to the equipment list. IT must also be notified so that they can synchronize the instrument for back-ups. Its capability is assessed to determine if it is adequate or not for the specific application. For instruments, a calibration curve is generated, followed by MDLs, Demonstration of Capabilities (DOCs), and other relevant criteria (refer to Section 19). For software, its operation must be deemed reliable and evidence of instrument verification must be retained by the IT Department. Software certificates supplied by the vendors are filed with the local IT Department. The manufacturer's operation manual is retained at the bench.

9.5 Services

Service to analytical instruments (except analytical balances) is performed on an as needed basis. Routine preventative maintenance is discussed in Section 20. The need for service is determined by analysts and/or Technical/Department Managers. The service providers that perform the services are approved by the Technical Manager/Department Manager/Laboratory Director.

9.6 Suppliers

TestAmerica selects vendors through a competitive proposal / bid process, strategic business alliances or negotiated vendor partnerships (contracts). This process is defined in the Corporate Finance documents on Vendor Selection (SOP No. CW-F-S-018) and Procurement & Contracts Policy (Policy No. CW-F-P-004). The level of control used in the selection process is dependent on the anticipated spending amount and the potential impact on TestAmerica business. Vendors that provide test and measuring equipment, solvents, standards, certified containers, instrument related service contracts or subcontract laboratory services shall be subject to more rigorous controls than vendors that provide off-the-shelf items of defined quality that meet the end use requirements. The JD Edwards purchasing system includes all suppliers/vendors that have been approved for use.

Evaluation of suppliers is accomplished by ensuring the supplier ships the product or material ordered and that the material is of the appropriate quality. This is documented by signing off on packing slips or other supply receipt documents. The purchasing documents contain the data that adequately describe the services and supplies ordered.

Any issues of vendor performance are to be reported immediately by the laboratory staff to the Corporate Purchasing Group by completing a Vendor Performance Report.

The Corporate Purchasing Group will work through the appropriate channels to gather the information required to clearly identify the problem and will contact the vendor to report the problem and to make any necessary arrangements for exchange, return authorization, credit, etc.

As deemed appropriate, the Vendor Performance Reports will be summarized and reviewed to determine corrective action necessary, or service improvements required by vendors

The laboratory has access to a listing of all approved suppliers of critical consumables, supplies and services. This information is provided through the JD Edwards purchasing system.

9.6.1 New Vendor Procedure

TestAmerica employees who wish to request the addition of a new vendor must complete a J.D. Edwards Vendor Add Request Form.

New vendors are evaluated based upon criteria appropriate to the products or services provided as well as their ability to provide those products and services at a competitive cost. Vendors are also evaluated to determine if there are ethical reasons or potential conflicts of interest with TestAmerica employees that would make it prohibitive to do business with them as well as their financial stability. The QA Department and/or the Laboratory Director are consulted with vendor and product selection that have an impact on quality.

SECTION 10. COMPLAINTS

10.1 Overview

The laboratory considers an effective client complaint handling processes to be of significant business and strategic value. Listening to and documenting client concerns captures 'client knowledge' that enables our operations to continually improve processes and client satisfaction. An effective client complaint handling process also provides assurance to the data user that the laboratory will stand behind its data, service obligations and products.

A client complaint is any expression of dissatisfaction with any aspect of our business services (e.g., communications, responsiveness, data, reports, invoicing and other functions) expressed by any party, whether received verbally or in written form. Client inquiries, complaints or noted discrepancies are documented, communicated to management, and addressed promptly and thoroughly.

The laboratory has procedures for addressing both external and internal complaints with the goal of providing satisfactory resolution to complaints in a timely and professional manner.

The nature of the complaint is identified, documented and investigated, and an appropriate action is determined and taken. In cases where a client complaint indicates that an established policy or procedure was not followed, the QA Department must evaluate whether a special audit must be conducted to assist in resolving the issue. A written confirmation or letter to the client, outlining the issue and response taken is recommended as part of the overall action taken.

The process of complaint resolution and documentation utilizes the procedures outlined in Section 12 (Corrective Actions) and SOP PE-QAD-027 Procedures to Address Customer Complaints. It is documented following laboratory SOP PE-PMD-002 Project Management Communication and Documentation, including entry into LIMS.

10.2 External Complaints

An employee that receives a complaint initiates the complaint resolution process by first documenting the complaint according to SOPs PE-QAD-027, Procedures to Address Customer Complaints, and PE-PMD-002 Project Management Communication and Documentation.

Complaints fall into two categories: correctable and non-correctable. An example of a correctable complaint would be one where a report re-issue would resolve the complaint. An example of a non-correctable complaint would be one where a client complains that their data was repeatedly late. Non-correctable complaints should be reviewed for preventive action measures to reduce the likelihood of future occurrence and mitigation of client impact.

The general steps in the complaint handling process are:

- Receiving and Documenting Complaints
- Complaint Investigation and Service Recovery
- Process Improvement

The laboratory shall inform the initiator of the complaint of the results of the investigation and the corrective action taken, if any.

10.3 Internal Complaints

Internal complaints include, but are not limited to: errors and non-conformances, training issues, internal audit findings, and deviations from methods. Corrective actions may be initiated by any staff member who observes a nonconformance and shall follow the procedures outlined in Section 12. In addition, Corporate Management, Sales and Marketing and IT may initiate a complaint by contacting the laboratory or through the corrective action system described in Section 12.

10.4 Management Review

The number and nature of client complaints is reported by the QA Manager to the laboratory and QA Director in the QA Monthly report. Monitoring and addressing the overall level and nature of client complaints and the effectiveness of the solutions is part of the Annual Management Review (Section 16).

SECTION 11. CONTROL OF NON-CONFORMING WORK

11.1 Overview

When data discrepancies are discovered or deviations and departures from laboratory SOPs, policies and/or client requests have occurred, corrective action is taken immediately. First, the laboratory evaluates the significance of the nonconforming work. Then, a corrective action plan is initiated based on the outcome of the evaluation. If it is determined that the nonconforming work is an isolated incident, the plan could be as simple as adding a qualifier to the final results and/or making a notation in the case narrative. If it is determined that the nonconforming work is a systematic or improper practices issue, the corrective action plan could include a more in depth

investigation and a possible suspension of an analytical method. In all cases, the actions taken are documented using the laboratory's corrective action system (refer to Section 12).

Due to the frequently unique nature of environmental samples, sometimes departures from documented policies and procedures are needed. When an analyst encounters such a situation, the problem is presented to the Technical/Department Manager for resolution. The Manager may elect to discuss it with the Laboratory Director and/or the QA Manager or have a representative contact the client to decide on a logical course of action. Once an approach is agreed upon, the analyst documents it in the analytical data. This information can then be supplied to the client in the form of a footnote or a case narrative with the report.

Project Management may encounter situations where a client may request that a special procedure be applied to a sample that is not standard lab practice. Based on a technical evaluation, the lab may accept or opt to reject the request based on technical or ethical merit. An example might be the need to report a compound that the lab does not normally report. The lab would not have validated the method for this compound following the procedures in Section 19. The client may request that the compound be reported based only on the calibration. Such a request would need to be approved by the Technical/Department Director and QA Manager, documented and included in the project folder. Deviations must also be noted on the final report with a statement that the compound is not reported in compliance with TNI (or the analytical method) requirements and the reason. Data being reported to a non- TNI state would need to note the change made to how the method is normally run.

11.2 Responsibilities and Authorities

TestAmerica's Corporate SOP entitled Internal Investigation of Potential Data Discrepancies and Determination for Data Recall (SOP No. CW-L-S-002), outlines the general procedures for the reporting and investigation of data discrepancies and alleged incidents of misconduct or violations of TestAmerica's data integrity policies as well as the policies and procedures related to the determination of the potential need to recall data.

Under certain circumstances, the Laboratory Director, a Technical/Department Manager or a member of the QA team may authorize departures from documented procedures or policies. The departures may be a result of procedural changes due to the nature of the sample; a one-time procedure for a client; QC failures with insufficient sample to reanalyze, etc.. In most cases, the client will be informed of the departure prior to the reporting of the data. Any departures must be well documented using the laboratory's corrective action procedures. This information may also be documented in logbooks and/or data review checklists as appropriate. Any impacted data must be referenced in a case narrative and/or flagged with an appropriate data qualifier.

Any misrepresentation or possible misrepresentation of analytical data discovered by any laboratory staff member must be reported to facility Senior Management within 24-hours. The Senior Management staff is comprised of the Laboratory Director, the QA Manager, the Client Services Manager and the Department Managers. The reporting of issues involving alleged violations of the company's Data Integrity or Manual Integration procedures must be conveyed to an Ethics and Compliance Officer (ECO), the Director of Quality & Client Advocacy and the laboratory's Quality Director within 24 hours of discovery.

Whether an inaccurate result was reported due to calculation or quantitation errors, data entry errors, improper practices, or failure to follow SOPs, the data must be evaluated to determine the possible effect.

The Laboratory Director, QA Manager, ECOs, Corporate Quality, General Managers and the Quality Directors have the authority and responsibility to halt work, withhold final reports, or suspend an analysis for due cause as well as authorize the resumption of work. Any employee has the right to stop their work if they feel the quality may be compromised or cannot be completed as required.

11.3 Evaluation of Significance and Actions Taken

For each nonconforming issue reported, an evaluation of its significance and the level of management involvement needed is made. This includes reviewing its impact on the final data, whether or not it is an isolated or systematic issue, and how it relates to any special client requirements.

TestAmerica's Corporate Data Investigation & Recall Procedure (SOP No. CW-L-S-002) distinguishes between situations when it would be appropriate for laboratory management to make the decision on the need for client notification (written or verbal) and data recall (report revision) and when the decision must be made with the assistance of the ECO's and Corporate Management. Laboratory level decisions are documented and approved using the laboratory's standard nonconformance/corrective action reporting in lieu of the data recall determination form contained in TestAmerica's Corporate SOP No. CW-L-S-002.

11.4 Prevention of Nonconforming Work

If it is determined that the nonconforming work could recur, further corrective actions must be made following the laboratory's corrective action system. Periodically as defined by the laboratory's preventive action schedule, the QA Department evaluates non-conformances to determine if any nonconforming work has been repeated multiple times. If so, the laboratory's corrective action process may be followed.

11.5 Method Suspension / Restriction (Stop Work Procedures)

In some cases, it may be necessary to suspend/restrict the use of a method or target compound which constitutes significant risk and/or liability to the laboratory. Suspension/restriction procedures can be initiated by any of the persons noted in Section 11.2, Paragraph 5.

Prior to method suspension/restriction, confidentiality will be respected, and the problem with the required corrective and preventive action will be stated in writing and presented to the Laboratory Director.

The Laboratory Director shall arrange for the appropriate personnel to meet with the QA Manager as needed. This meeting shall be held to confirm that there is a problem, that suspension/restriction of the method is required and will be concluded with a discussion of the steps necessary to bring the method/target or test fully back on line. In some cases, that may not be necessary if all appropriate personnel have already agreed there is a problem and there is agreement on the steps needed to bring the method, target or test fully back on line.

The QA Manager will also initiate a corrective action report as described in Section 12 if one has not already been started. A copy of any meeting notes and agreed upon steps should be faxed or e-mailed by the laboratory to the appropriate General Manager and member of Corporate QA. This fax/e-mail acts as notification of the incident.

After suspension/restriction, the lab will hold all reports to clients pending review. No faxing, mailing or distributing through electronic means may occur. The report must not be posted for viewing on the internet. It is the responsibility of the Laboratory Director to hold all reporting and to notify all relevant laboratory personnel regarding the suspension/restriction (e.g., Project Management, Log-in, etc…). Clients will NOT generally be notified at this time. Analysis may proceed in some instances depending on the non-conformance issue.

Within 72 hours, the QA Manager will determine if compliance is now met and reports can be released, OR determine the plan of action to bring work into compliance, and release work. A team, with all principals involved (Laboratory Director, Technical/ Department Manager, QA Manager, Client Services Manager) can devise a start-up plan to cover all steps from client notification through compliance and release of reports. Project Management, and the Directors of Client Services and Sales and Marketing must be notified if clients must be notified or if the suspension/restriction affects the laboratory's ability to accept work. The QA Manager must approve start-up or elimination of any restrictions after all corrective action is complete. This approval is given by final signature on the completed corrective action report.

SECTION 12. CORRECTIVE ACTION

12.1 Overview

A major component of TestAmerica's Quality Assurance (QA) Program is the problem investigation and feedback mechanism designed to keep the laboratory staff informed on quality related issues and to provide insight to problem resolution. When nonconforming work or departures from policies and procedures in the quality system or technical operations are identified, the corrective action procedure provides a systematic approach to assess the issues, restore the laboratory's system integrity, and prevent reoccurrence. Non-conformance events and corrective actions are documented using Corrective Action Reports (CAR) (refer to Figure 12-1).

12.2 General

Problems within the quality system or within analytical operations may be discovered in a variety of ways, such as QC sample failures, internal or external audits, proficiency testing (PT) performance, client complaints, staff observation, etc..

The purpose of a corrective action system is to:

- Identify non-conformance events and assign responsibility(s) for investigating.
- Resolve non-conformance events and assign responsibility for any required corrective action.
- Identify systematic problems before they become serious.

- Identify and track client complaints and provide resolution.

12.2.1 Corrective Action Report (CAR) - is used to document the following types of corrective actions:

- Client complaints
- Deviations from an established procedure or SOP
- QC outside of limits
- Isolated reporting / calculation errors
- Reissued reports

This will provide background documentation to enable root cause analysis and preventive action.

12.2.2 Nonconformance Database - is used to document the following types of corrective actions:

- Internal Audits findings
- External Audit findings
- Questionable trends that are found in the review of CARs
- Issues found while reviewing CARs that warrant further investigation.
- Corrective actions that cross multiple departments in the laboratory.
- Systematic reporting / calculation errors
- Identified poor process or method performance trends
- Data recall
- Corrective actions that cross multiple departments in the laboratory
- Failed or unacceptable PT results
- Excessive revised reports

This too will provide background documentation to enable root cause analysis and preventive action.

12.3 Closed Loop Corrective Action Process

Any employee in the company can initiate a corrective action. There are four main components to a closed-loop corrective action process once an issue has been identified: Cause Analysis, Selection and Implementation of Corrective Actions (both short and long term), Monitoring of the Corrective Actions, and Follow-up.

12.3.1 Cause Analysis

- Upon discovery of a non-conformance event, the event must be defined and documented. A CAR must be initiated, someone is assigned to investigate the issue and the event is investigated for cause. Table 12-1 provides some general guidelines on determining responsibility for assessment.
- The cause analysis step is the key to the process as a long term corrective action cannot be determined until the cause is determined.
- If the cause is not readily obvious, the Technical/Department Manager, Laboratory Director or QA Manager (or QA designee) is consulted.

12.3.2 Selection and Implementation of Corrective Actions

- Where corrective action is needed, the laboratory shall identify potential corrective actions. The action(s) most likely to eliminate the problem and prevent recurrence are selected and implemented. Responsibility for implementation is assigned.
- Corrective actions shall be to a degree appropriate to the magnitude of the problem identified through the cause analysis.
- Whatever corrective action is determined to be appropriate, the laboratory shall document and implement the changes. The CAR is used for this documentation.

12.3.3 Root Cause Analysis

Root Cause Analysis is a class of problem solving (investigative) methods aimed at identifying the basic or causal factor(s) that underlie variation in performance or the occurrence of a significant failure. The root cause may be buried under seemingly innocuous events, many steps preceding the perceived failure. At first glance, the immediate response is typically directed at a symptom and not the cause. Typically, root cause analysis would be best with three or more incidents to triangulate a weakness.

Systematically analyze and document the Root Causes of the more significant problems that are reported. Identify, track, and implement the corrective actions required to reduce the likelihood of recurrence of significant incidents. Trend the Root Cause data from these incidents to identify Root Causes that, when corrected, can lead to dramatic improvements in performance by eliminating entire classes of problems.

Identify the one event associated with problem and ask why this event occurred. Brainstorm the root causes of failures; for example, by asking why events occurred or conditions existed; and then why the cause occurred 5 consecutive times until you get to the root cause. For each of these sub events or causes, ask why it occurred. Repeat the process for the other events associated with the incident.

Root cause analysis does not mean the investigation is over. Look at technique, or other systems outside the normal indicators. Often creative thinking will find root causes that ordinarily would be missed, and continue to plague the laboratory or operation.

12.3.4 Monitoring of the Corrective Actions

- The Laboratory Director, Department Manager and/or QA Manager are responsible to ensure that the corrective action taken was effective.
- Ineffective actions are documented and re-evaluated until acceptable resolution is achieved. Department Managers are accountable to the Laboratory Director to ensure final acceptable resolution is achieved and documented appropriately.
- The QA Manager reviews CARs monthly for trends. Highlights are included in the QA monthly report (refer to Section 16). If a significant trend develops that adversely affects quality, an audit of the area is performed and corrective action implemented.
- Any out-of-control situations that are not addressed acceptably at the laboratory level may be reported to the Corporate Quality Director by the QA Manager, indicating the nature of the out-of-control situation and problems encountered in solving the situation.

12.3.5 Follow-up Audits

- Follow-up audits may be initiated by the QA Manager and shall be performed as soon as possible when the identification of a nonconformance casts doubt on the laboratory's compliance with its own policies and procedures, or on its compliance with state or federal requirements.
- These audits often follow the implementation of the corrective actions to verify effectiveness. An additional audit would only be necessary when a critical issue or risk to business is discovered.

(Also refer to Section 15.1.4, Special Audits.)

12.4 Technical Corrective Actions

In addition to providing acceptance criteria and specific protocols for technical corrective actions in the method SOPs, the laboratory has general procedures to be followed to determine when departures from the documented policies and procedures and quality control have occurred (refer to Section 11). The documentation of these procedures is through the use of a CAR.

Table 12-1 includes examples of general technical corrective actions. For specific criteria and corrective actions, refer to the analytical methods or specific method SOPs. The laboratory may also maintain Work Instructions on these items that are available upon request.

Table 12-1 provides some general guidelines for identifying the individual(s) responsible for assessing each QC type and initiating corrective action. The table also provides general guidance on how a data set should be treated if associated QC measurements are unacceptable. Specific procedures are included in Method SOPs, Work Instructions and QAM Sections 19 and 20. All corrective actions are reviewed monthly, at a minimum, by the QA Manager and highlights are included in the QA monthly report.

To the extent possible, samples shall be reported only if all quality control measures are acceptable. If the deficiency does not impair the usability of the results, data will be reported with an appropriate data qualifier and/or the deficiency will be noted in the case narrative. Where

sample results may be impaired, the Project Manager is notified by a CAR and appropriate corrective action (e.g., reanalysis) is taken and documented.

12.5 Basic Corrections

When mistakes occur in records, each mistake shall be crossed-out, [not obliterated (e.g. no white-out)], and the correct value entered alongside. All such corrections shall be initialed (or signed) and dated by the person making the correction. In the case of records stored electronically, the original “uncorrected” file must be maintained intact and a second “corrected” file is created.

This same process applies to adding additional information to a record. All additions made later than the initial must also be initialed (or signed) and dated.

When corrections are due to reasons other than obvious transcription errors, the reason for the corrections (or additions) shall also be documented.

Figure 12-1. Example - Corrective Action Report

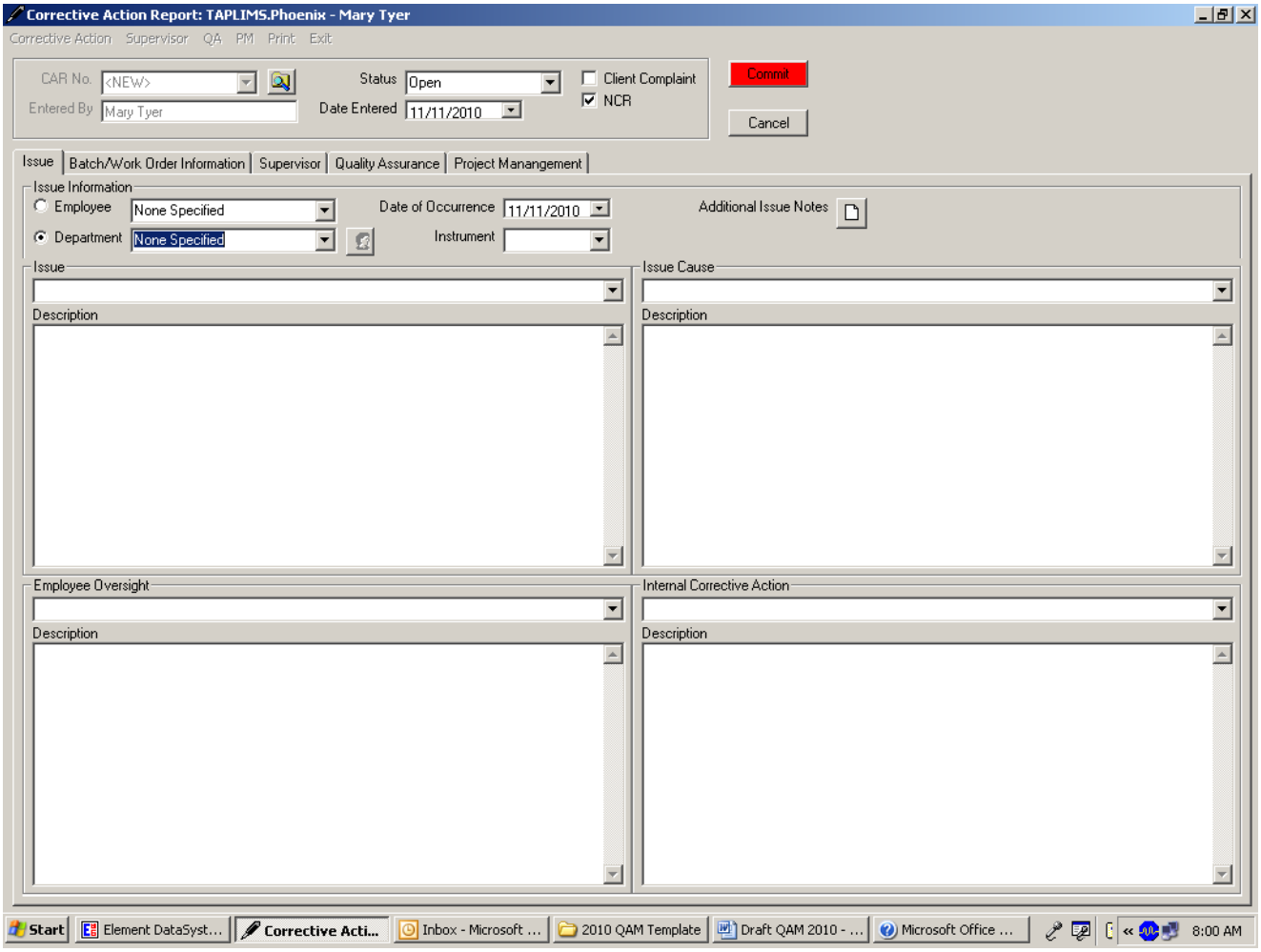


Table 12-1. Example – General Corrective Action Procedures

QC Activity *(Individual Responsible for Initiation/Assessment)*	Acceptance Criteria	Recommended Corrective Action
Initial Instrument Blank *(Analyst)*	- Instrument response < MDL.	- Prepare another blank. - If same response, determine cause of contamination: reagents, environment, instrument equipment failure, etc.
Initial Calibration Standards *(Analyst, Technical /Department Manager(s)*	- Correlation coefficient > 0.99 or standard concentration value. - % Recovery within acceptance range. - See details in Method SOP.	- Reanalyze standards. - If still unacceptable, remake standards and recalibrate instrument. - Perform Instrument maintenance
Independent Calibration Verification (Second Source) *(Analyst, Technical /Department Manager(s)*	- % Recovery within acceptance criteria	- Remake and reanalyze standard. - If still unacceptable, then remake calibration standards or use new primary standards and recalibrate instrument.
Continuing Calibration Standards *(Analyst, Data Reviewer)*	- % Recovery within acceptance criteria	- Reanalyze standard. - If still unacceptable, then recalibrate and rerun affected samples.
Reporting Limit Verification Standards *(Analyst, Data Reviewer)*	- % Recovery within acceptance criteria	- Reanalyze standard. - If still unacceptable, batch must be re-prepared and re-analyzed.
Duplicate *(Analyst, Data Reviewer)*	- % RPD within acceptance criteria	- Reanalyze once, evaluate. Flag data if reanalysis remains out of control outside of limit.
Matrix Spike / Matrix Spike Duplicate (MS/MSD) *(Analyst, Data Reviewer)*	- % Recovery within acceptance criteria - % RPD within acceptance criteria	- If the acceptance criteria for duplicates or matrix spikes are not met because of matrix interferences, the acceptance of the analytical batch is determined by the validity of the LCS. - If the LCS is within acceptable limits the batch is acceptable. - The results of the duplicates, matrix spikes and the LCS are reported with the data set. - For matrix spike or duplicate results outside criteria the data for that sample shall be reported with qualifiers.

QC Activity *(Individual Responsible for Initiation/Assessment)*	Acceptance Criteria	Recommended Corrective Action
Laboratory Control Sample / Laboratory Control Sample Duplicate (LCS/LCSD) *(Analyst, Data Reviewer)*	- % Recovery within acceptance criteria - % RPD within acceptance criteria	- Batch must be re-prepared and re-analyzed. This includes any allowable marginal exceedance. When not using marginal exceedances, the following exceptions apply: 1) when the acceptance criteria for the positive control are exceeded high (i.e., high bias) and there are associated samples that are non-detects, then those non-detects may be reported with data qualifying codes; 2) when the acceptance criteria for the positive control are exceeded low (i.e., low bias), those sample results may be reported if they exceed a maximum regulatory limit/decision level with data qualifying codes. **Note:** If there is insufficient sample or the holding time cannot be met, contact client and report with flags.
Surrogates *(Analyst, Data Reviewer)*	- % Recovery within acceptance criteria	- Individual sample must be repeated. Place comment on whether initial results confirmed/did not confirm in LIMS. - Surrogate results outside criteria shall be reported with qualifiers.
Internal Standards *(Analyst, Data Reviewer)*	Refer to Method SOP.	- Evaluate data and instrument. If no instrument issue found, flag data.
Method Blank (MB) *(Analyst, Data Reviewer)*	< Reporting Limit [1]	- Reanalyze blank. - If still positive, determine source of contamination. If necessary, reprocess (i.e. digest or extract) entire sample batch. Report blank results. - Qualify the result(s) if the concentration of a targeted analyte in the MB is at or above the reporting limit AND is > 1/10 of the amount measured in the sample.
Proficiency Testing (PT) Samples *(QA Manager, Technical / Department Manager(s)*	- Criteria supplied by PT Supplier.	- Any failures or warnings must be investigated for cause. Failures may result in the need to repeat a PT sample to show the problem is corrected.

QC Activity ***(Individual Responsible for Initiation/Assessment)***	**Acceptance Criteria**	**Recommended Corrective Action**
Internal / External Audits *(QA Manager, Technical /Department Manager(s) Laboratory Director)*	- Defined in Quality System documentation such as SOPs, QAM, etc..	- Non-conformances must be investigated and necessary corrections must be made.
Reporting / Calculation Errors (*Depends on issue – possible individuals include: Analysts, Data Reviewers, Project Managers, Technical/ Department Managers, QA Manager, Corporate QA, Corporate Management*)	- SOP CW-L-S-002, Internal Investigation of Potential Data Discrepancies and Determination for Data Recall.	- Corrective action is determined by type of error. Follow the procedures in SOP CW-L-S-002 and your lab's CA SOP.
Client Complaints *(Project Managers, Lab Director/Manager, Sales and Marketing)*		- Corrective action is determined by the type of complaint. For example, a complaint regarding an incorrect address on a report will result in the report being corrected and then follow-up must be performed on the reasons the address was incorrect (e.g., database needs to be updated).
QA Monthly Report (*QA Manager, Lab Director/Manager, Technical / Department Manager)*	- QAM, SOPs.	- Corrective action is determined by the type of issue. For example, CARs for the month are reviewed and possible trends are investigated.
Health and Safety Violation *(Safety Officer, Lab Director, Technical /Department Manager(s)*	- Environmental Health and Safety (EHS) Manual.	- Non-conformance is investigated and corrected immediately or reported via the KMI Incident Tracking Online Program.

Note:

1. These tables provide general corrective action procedures. Not all QC samples are listed in the table. Frequency, acceptance criteria and corrective actions may vary. Standard Operating Procedures (SOPs) provide detailed information on corrective action for each method or procedure.

2. For instrument and analytical QC, the acceptance criteria are that listed in the applicable method or program (e.g. AIHA) requirements). If no criteria are listed the laboratory utilizes Arizona Department of Health Services default limits or generates control limits using historical laboratory data.

3. QC acceptance criteria is listed in SOPs. QC limits can be found in LIMS.

SECTION 13. PREVENTIVE ACTION / IMPROVEMENT

13.1 Overview

The laboratory's preventive action programs improve or eliminate potential causes of nonconforming product and/or nonconformance to the quality system. This preventive action process is a proactive and continuous process of improvement activities that can be initiated through feedback from clients, employees, business providers, and affiliates. The QA Department has the overall responsibility to ensure that the preventive action process is in place, and that relevant information on actions is submitted for management review.

Dedicating resources to an effective preventive action system emphasizes the laboratory's commitment to its Quality Program. It is beneficial to identify and address negative trends before they develop into complaints, problems and corrective actions. Additionally, customer service and client satisfaction can be improved through continuous improvements to laboratory systems.

Opportunities for improvement may be discovered during management reviews, the monthly QA Metrics Report, evaluation of internal or external audits, results & evaluation of proficiency testing (PT) performance, data analysis & review processing operations, client complaints, staff observation, etc.

The monthly Management Systems Metrics Report shows performance indicators in all areas of the laboratory and quality system. These areas include revised reports, corrective actions, audit findings, internal auditing and data authenticity audits, client complaints, PT samples, holding time violations, SOPs, ethics training, etc. These metrics are used in evaluating the management and quality system performance on an ongoing basis and provide a tool for identifying areas for improvement.

The laboratory's corrective action process is integral to implementation of preventive actions. A critical piece of the corrective action process is the implementation of actions to prevent further occurrence of a non-compliance event. Historical review of corrective action provides a valuable mechanism for identifying preventive action opportunities.

13.1.1 The following elements are part of a preventive action system:

- Identification of an opportunity for preventive action.

- Process for the preventive action.
- Define the measurements of the effectiveness of the process once undertaken.
- Execution of the preventive action.
- Evaluation of the plan using the defined measurements.
- Verification of the effectiveness of the preventive action.
- Close-Out by documenting any permanent changes to the Quality System as a result of the Preventive Action. Documentation of Preventive Action is incorporated into the monthly QA reports, corrective action process and management review.

13.1.2 Any Preventive Actions undertaken or attempted shall be taken into account during the annual Management Systems Review (Section 16). A highly detailed report is not required; however, a summary of successes and failures within the preventive action program is sufficient to provide management with a measurement for evaluation.

SECTION 14. CONTROL OF RECORDS

The laboratory maintains a records management system appropriate to its needs and that complies with applicable standards or regulations as required. The system produces unequivocal, accurate records that document all laboratory activities. The laboratory retains all original observations, calculations and derived data, calibration records and a copy of the analytical report for a minimum of five years after it has been issued.

14.1 Overview

The laboratory has established procedures for identification, collection, indexing, access, filing, storage, maintenance and disposal of quality and technical records. A record index is listed in Table 14-1. Quality records are maintained by the QA Department which is backed up as part of the regular laboratory backup. Records are of two types; either electronic or hard copy paper formats depending on whether the record is computer or hand generated (some records may be in both formats). Technical records are maintained by the QA Department and Corporate IT Department.

Table 14-1. Record Index[1]

	Record Types [1]:	Retention Time:
Technical Records	- Raw Data - Logbooks[2] - Standards - Certificates - Analytical Records - MDLs/IDLs/DOCs - Lab Reports	5 Years from analytical report issue*

	Record Types [1]:	**Retention Time:**
Official Documents	- Quality Assurance Manual (QAM) - Work Instructions - Policies - SOPs - Policy Memorandums - Manuals	5 Years from document retirement date*
QA Records	- Internal & External Audits/Responses - Certifications - Corrective/Preventive Actions - Management Reviews - Method & Software Validation / Verification Data - Data Investigation	5 Years from archival* **Data Investigation:** 5 years or the life of the affected raw data storage whichever is greater (beyond 5 years if ongoing project or pending investigation)
Project Records	- Sample Receipt & COC Documentation - Contracts and Amendments - Correspondence - QAPP - SAP - Telephone Logbooks - Lab Reports	5 Years from analytical report issue*
Administrative Records	Finance and Accounting	10 years
	EH&S Manual, Permits	7 years
	Disposal Records	Indefinitely
	Employee Handbook	Indefinitely
	Personnel files, Employee Signature & Initials, Administrative Training Records (e.g., Ethics)	7 Years (HR Personnel Files must be maintained indefinitely)
	Administrative Policies Technical Training Records	7 years

[1] Record Types encompass hardcopy and electronic records.
[2] Examples of Logbook types: Maintenance, Instrument Run, Preparation (standard and samples), Standard and Reagent Receipt, Archiving, Balance Calibration, Temperature (hardcopy or electronic records).
* Exceptions listed in Table 14-2.

14.1.1 All records are stored and retained in such a way that they are secure and readily retrievable at the laboratory facility that provides a suitable environment to prevent damage or deterioration and to prevent loss. All records shall be protected against fire, theft, loss, environmental deterioration, and vermin. In the case of electronic records, electronic or magnetic sources, storage media are protected from deterioration caused by magnetic fields and/or electronic deterioration.

Access to the data is limited to laboratory and company employees and shall be documented with an access log. If records are archived off-site they are stored in a secure location where a record is maintained of any entry into the storage facility. Whether on-site or off-site storage is used, logs are maintained in each storage area to note removal and return of records. Retention of records must be maintained on-site at the laboratory for approximately 2 years

after their generation. After two years they may be moved offsite for the remainder of the required storage time. Records are maintained for a minimum of five years unless otherwise specified by a client or regulatory requirement.

For raw data and project records, record retention shall be calculated from the date the project report is issued. For other records, such as Controlled Documents, QA, or Administrative Records, the retention time is calculated from the date the record is formally retired. Records related to the programs listed in Table 14-2 have lengthier retention requirements and are subject to the requirements in Section 14.1.3.

14.1.2 Programs with Longer Retention Requirements

Some regulatory programs have longer record retention requirements than the standard record retention time. These are detailed in Table 14-2 with their retention requirements. In these cases, the longer retention requirement is enacted. If special instructions exist such that client data cannot be destroyed prior to notification of the client, the container or box containing that data is marked as to who to contact for authorization prior to destroying the data.

Table 14-2. Example: Special Record Retention Requirements

Program	[1]Retention Requirement
Drinking Water – All States	5 years (project records) 10 years - Radiochemistry (project records)
Drinking Water Lead and Copper Rule	12 years (project records)
Housing and Urban Development (HUD) Environmental Lead Testing	10 years
TSCA - 40 CFR Part 792	10 years after publication of final test rule or negotiated test agreement

[1]Note: Extended retention requirements must be noted with the archive documents or addressed in facility-specific records retention procedures.

14.1.3 The laboratory has procedures to protect and back-up records stored electronically and to prevent unauthorized access to or amendment of these records. All analytical data is maintained as hard copy or in a secure readable electronic format. For analytical reports that are maintained as copies in PDF format, refer to Section 19.14.1 for more information. See SOPs PE-ADM-002 Data Back-up Procedures and PE-QAD-017 Record Archiving.

14.1.4 The record keeping system allows for historical reconstruction of all laboratory activities that produced the analytical data, as well as rapid recovery of historical data. The history of the sample from when the laboratory took possession of the samples must be readily understood through the documentation. This shall include inter-laboratory transfers of samples and/or extracts.

- The records include the identity of personnel involved in sampling, sample receipt, preparation, or testing. All analytical work contains the initials (at least) of the personnel involved. The laboratory's copy of the COC is stored with the invoice and the work order sheet generated by the LIMS. The chain of custody would indicate the name of the sampler.

If any sampling notes are provided with a work order, they are kept with this package.

- All information relating to the laboratory facilities equipment, analytical test methods, and related laboratory activities, such as sample receipt, sample preparation, or data verification are documented.

- The record keeping system facilitates the retrieval of all working files and archived records for inspection and verification purposes (e.g., set format for naming electronic files, set format for what is included with a given analytical data set as defined by method SOPs). Instrument data is stored sequentially by instrument. A given day's analyses are maintained in the order of the analysis. Run logs are maintained for each instrument or method; a copy of each day's run long or instrument sequence is stored with the data to aid in re-constructing an analytical sequence. Where an analysis is performed without an instrument, bound logbooks or bench sheets are used to record and file data. Standard and reagent information is recorded in logbooks or entered into the LIMS for each method as required.

- Changes to hardcopy records shall follow the procedures outlined in Section 12 and 19. Changes to electronic records in LIMS or instrument data are recorded in audit trails.

- The reason for a signature or initials on a document is clearly indicated in the records such as "sampled by," "prepared by," "reviewed by", or "analyzed by".

- All generated data except those that are generated by automated data collection systems, are recorded directly, promptly and legibly in permanent dark ink.

- Hard copy data may be scanned into PDF format for record storage as long as the scanning process can be verified in order to ensure that no data is lost and the data files and storage media must be tested to verify the laboratory's ability to retrieve the information prior to the destruction of the hard copy that was scanned. The procedure for this verification can be found in SOP PE-PMD-001 Data Reporting, Validation and Distribution.

- Also refer to Section 19.14.1 'Computer and Electronic Data Related Requirements'**.**

14.2 Technical and Analytical Records

14.2.1 The laboratory retains records of original observations, derived data and sufficient information to establish an audit trail, calibration records, staff records and a copy of each analytical report issued, for a minimum of five years unless otherwise specified by a client or regulatory requirement. The records for each analysis shall contain sufficient information to enable the analysis to be repeated under conditions as close as possible to the original. The records shall include the identity of laboratory personnel responsible for sampling, performance of each analysis and reviewing results.

14.2.2 Observations, data and calculations are recorded real-time and are identifiable to the specific task.

14.2.3 Changes to hardcopy records shall follow the procedures outlined in Section 12 and 19. Changes to electronic records in LIMS or instrument data are recorded in audit trails.

The essential information to be associated with analysis, such as strip charts, tabular printouts, computer data files, analytical notebooks, and run logs, include:

- laboratory sample ID code**;**
- Date of analysis; time of analysis is also required if the holding time is seventy-two (72) hours or less, or when time critical steps are included in the analysis (e.g., drying times, incubations, etc.); instrumental analyses have the date and time of analysis recorded as part of their general operations. Where a time critical step exists in an analysis, location for such a time is included as part of the documentation in a specific logbook or on a bench sheet.
- Instrumentation identification and instrument operating conditions/parameters. Operating conditions/parameters are typically recorded in instrument maintenance logs where available or indicated in method SOPs.
- analysis type**;**
- all manual calculations and manual integrations**;**
- analyst's or operator's initials/signature**;**
- Sample preparation including cleanup, separation protocols, incubation periods or subculture, ID codes, volumes, weights, instrument printouts, meter readings, calculations, reagents;
- test results**;**
- standard and reagent origin, receipt, preparation, and use**;**
- calibration criteria, frequency and acceptance criteria**;**
- data and statistical calculations, review, confirmation, interpretation, assessment and reporting conventions**;**
- quality control protocols and assessment**;**
- electronic data security, software documentation and verification, software and hardware audits, backups, and records of any changes to automated data entries; and
- Method performance criteria including expected quality control requirements. These are indicated both in the LIMS and on specific analytical report formats**.**

14.3 Laboratory Support Activities

In addition to documenting all the above-mentioned activities, the following are retained QA records and project records (previous discussions in this section relate where and how these data are stored):

- all original raw data, whether hard copy or electronic, for calibrations, samples and quality control measures, including analysts' work sheets and data output records (chromatograms, strip charts, and other instrument response readout records)**;**
- a written description or reference to the specific test method used which includes a description of the specific computational steps used to translate parametric observations into a reportable analytical value**;**
- copies of final reports**;**

- archived SOPs**;**
- correspondence relating to laboratory activities for a specific project**;**
- all corrective action reports, audits and audit responses**;**
- proficiency test results and raw data; and
- results of data review, verification, and crosschecking procedures

14.3.1 Sample Handling Records

Records of all procedures to which a sample is subjected while in the possession of the laboratory are maintained. These include but are not limited to records pertaining to:

- sample preservation including appropriateness of sample container and compliance with holding time requirement;
- sample identification, receipt, acceptance or rejection and login;
- sample storage and tracking including shipping receipts, sample transmittal / COC forms; and
- procedures for the receipt and retention of samples, including all provisions necessary to protect the integrity of samples.

14.4 Administrative Records

The laboratory also maintains the administrative records in either electronic or hard copy form. Refer to Table 14-1.

14.5 Records Management, Storage and Disposal

All records (including those pertaining to test equipment), certificates and reports are safely stored, held secure and in confidence to the client. Certification related records are available upon request.

All information necessary for the historical reconstruction of data is maintained by the laboratory. Records that are stored only on electronic media must be supported by the hardware and software necessary for their retrieval.

Records that are stored or generated by computers or personal computers have hard copy, write-protected backup copies, or an electronic audit trail controlling access**.**

The laboratory has a record management system (a.k.a. document control) for control of laboratory notebooks, instrument logbooks, standards logbooks, and records for data reduction, validation, storage and reporting. Laboratory notebooks are issued on a per analysis basis, and are numbered sequentially. All data are recorded sequentially within a series of sequential notebooks. Bench sheets are filed sequentially. Standards are maintained in the LIMS – no logbooks are used to record that data. Records are considered archived when moved from current storage within the laboratory department.

14.5.1 Transfer of Ownership

In the event that the laboratory transfers ownership or goes out of business, the laboratory shall ensure that the records are maintained or transferred according to client's instructions. Upon ownership transfer, record retention requirements shall be addressed in the ownership transfer agreement and the responsibility for maintaining archives is clearly established. In addition, in cases of bankruptcy, appropriate regulatory and state legal requirements concerning laboratory records must be followed. In the event of the closure of the laboratory, all records will revert to the control of the corporate headquarters. Should the entire company cease to exist, as much notice as possible will be given to clients and the accrediting bodies who have worked with the laboratory during the previous 5 years of such action.

14.5.2 Records Disposal

Records are removed from the archive and destroyed after 5 years unless otherwise specified by a client or regulatory requirement. On a project specific or program basis, clients may need to be notified prior to record destruction. Records are destroyed in a manner that ensures their confidentiality such as shredding, mutilation or incineration. (Refer to Tables 14-1 and 14-2).

Electronic copies of records must be destroyed by erasure or physically damaging off-line storage media so no records can be read.

If a third party records management company is hired to dispose of records, a "Certificate of Destruction" is required.

SECTION 15. AUDITS

15.1 Internal Audits

Internal audits are performed to verify that laboratory operations comply with the requirements of the lab's quality system and with the external quality programs under which the laboratory operates. Audits are planned and organized by the QA staff. Personnel conducting the audits should be independent of the area being evaluated. Auditors will have sufficient authority, access to work areas, and organizational freedom necessary to observe all activities affecting quality and to report the assessments to laboratory management and**,** when requested**,** to corporate management.

Audits are conducted and documented as described in the TestAmerica Corporate SOP on performing Internal Auditing, SOP No. CA-Q-S-004. The types and frequency of routine internal audits are described in Table 15-1. Special or ad hoc assessments may be conducted as needed under the direction of the QA staff.

Table 15-1. Types of Internal Audits and Frequency

Description	Performed by	Frequency
Quality Systems Audits	QA Department, QA approved designee, or Corporate QA	All areas of the laboratory annually
Method Audits	Joint responsibility: a) QA Manager or designee b) Technical Manager or Designee (Refer to CA-Q-S-004)	Methods Audits Frequency: 50% of methods annually
Special	QA Department or Designee	Surveillance or spot checks performed as needed, e.g., to confirm corrective actions from other audits.
Performance Testing	Analysts with QA oversight	Two successful per year for each TNI field of testing or as dictated by regulatory requirements

15.1.1 Annual Quality Systems Audit

An annual quality systems audit is required to ensure compliance to analytical methods and SOPs, TestAmerica's Data Integrity and Ethics Policies, TNI quality systems client and state requirements, and the effectiveness of the internal controls of the analytical process, including but not limited to data review, quality controls, preventive action and corrective action. The completeness of earlier corrective actions is assessed for effectiveness & sustainability. The audit is divided into sections for each operating or support area of the lab, and each section is comprehensive for a given area. The area audits may be performed on a rotating schedule throughout the year to ensure adequate coverage of all areas. This schedule may change as situations in the laboratory warrant.

15.1.2 QA Technical Audits

QA technical audits are based on client projects, associated sample delivery groups, and the methods performed. Reported results are compared to raw data to verify the authenticity of results. The validity of calibrations and QC results are compared to data qualifiers, footnotes, and case narratives. Documentation is assessed by examining run logs and records of manual integrations. Manual calculations are checked. Where possible, electronic audit miner programs (e.g., MintMiner) are used to identify unusual manipulations of the data deserving closer scrutiny. QA technical audits will include all methods within a two-year period.

15.1.3 SOP Method Compliance

Compliance of all SOPs with the source methods and compliance of the operational groups with the SOPs will be assessed by the Technical/Department Manager or qualified designee at least every two years. It is also recommended that the work of each newly hired analyst is assessed within 3 months of working independently, (e.g., completion of method IDOC). In addition, as analysts add methods to their capabilities, (new IDOC) reviews of the analyst work products will be performed within 3 months of completing the documented training.

15.1.4 Special Audits

Special audits are conducted on an as needed basis, generally as a follow up to specific issues such as client complaints, corrective actions, PT results, data audits, system audits, validation comments, regulatory audits or suspected ethical improprieties. Special audits are focused on a specific issue, and report format, distribution, and timeframes are designed to address the nature of the issue.

15.1.5 Performance Testing

The laboratory participates annually or semi-annually in performance audits conducted through the analysis of PT samples provided by a third party. The laboratory generally participates in the following types of PT studies: Water Supply, Water Pollution, Underground Storage Tank, Hazardous Waste, Air, AIHA IHPAT, WASP and other Round Robin studies.

It is TestAmerica's policy that PT samples be treated as typical samples in the production process. Furthermore, where PT samples present special or unique problems, in the regular production process they may need to be treated differently, as would any special or unique request submitted by any client. The QA Manager must be consulted and in agreement with any decisions made to treat a PT sample differently due to some special circumstance.

Written responses to unacceptable PT results are required. In some cases it may be necessary for blind QC samples to be submitted to the laboratory to show a return to control.

15.2 External Audits

External audits are performed when certifying agencies or clients conduct on-site inspections or submit performance testing samples for analysis. It is TestAmerica's policy to cooperate fully with regulatory authorities and clients. The laboratory makes every effort to provide the auditors with access to personnel, documentation, and assistance. Laboratory supervisors are responsible for providing corrective actions to the QA Manager who coordinates the response for any deficiencies discovered during an external audit. Audit responses are due in the time allotted by the client or agency performing the audit. When requested, a copy of the audit report and the labs corrective action plan will be forwarded to Corporate Quality.

The laboratory cooperates with clients and their representatives to monitor the laboratory's performance in relation to work performed for the client. The client may only view data and systems related directly to the client's work. All efforts are made to keep other client information confidential.

15.2.1 Confidential Business Information (CBI) Considerations

During on-site audits, auditors may come into possession of information claimed as business confidential. A business confidentiality claim is defined as "a claim or allegation that business information is entitled to confidential treatment for reasons of business confidentiality or a request for a determination that such information is entitled to such treatment." When information is claimed as business confidential, the laboratory must place on (or attach to) the information at the time it is submitted to the auditor, a cover sheet, stamped or typed legend or other suitable form of notice, employing language such as "trade secret", "proprietary" or

"company confidential". Confidential portions of documents otherwise non-confidential must be clearly identified. CBI may be purged of references to client identity by the responsible laboratory official at the time of removal from the laboratory. However, sample identifiers may not be obscured from the information. Additional information regarding CBI can be found in within the 2009 TNI standards.

15.3 Audit Findings

Audit findings are documented using the corrective action process and Non Conformance database. The laboratory's corrective action responses for both types of audits may include action plans that could not be completed within a predefined timeframe. In these instances, a completion date must be set and agreed to by operations management and the QA Manager.

Developing and implementing corrective actions to findings is the responsibility of the Technical/Department Manager where the finding originated. Findings that are not corrected by specified due dates are reported monthly to management in the QA monthly report. When requested, a copy of the audit report and the labs corrective action plan will be forwarded to Corporate Quality.

If any audit finding casts doubt on the effectiveness of the operations or on the correctness or validity of the laboratory's test results, the laboratory shall take timely corrective action, and shall notify clients in writing if the investigations show that the laboratory results have been affected. Once corrective action is implemented, a follow-up audit is scheduled to ensure that the problem has been corrected.

Clients must be notified promptly in writing, of any event such as the identification of defective measuring or test equipment that casts doubt on the validity of results given in any test report or amendment to a test report. The investigation must begin within 24-hours of discovery of the problem and all efforts are made to notify the client within two weeks after the completion of the investigation.

SECTION 16. MANAGEMENT REVIEWS

16.1 Quality Assurance Report

A comprehensive QA Report shall be prepared each month by the laboratory's QA Department and forwarded to the Laboratory Director, Technical Managers or designee, their Quality Director as well as the General Manager. All aspects of the QA system are reviewed to evaluate the suitability of policies and procedures. During the course of the year, the Laboratory Director, General Manager or Corporate QA may request that additional information be added to the report.

On a monthly basis, Corporate QA compiles information from all the monthly laboratory reports. The Corporate Quality Directors prepare a report that includes a compilation of all metrics and notable information and concerns regarding the QA programs within the laboratories. The report also includes a listing of new regulations that may potentially impact the laboratories. This report is presented to the Executive Committee and General Managers.

16.2 Annual Management Review

The senior lab management team (Laboratory Director, Technical Managers or designee, QA Manager) conducts a review annually of its quality systems and LIMS to ensure its continuing suitability and effectiveness in meeting client and regulatory requirements and to introduce any necessary changes or improvements. It will also provide a platform for defining goals, objectives and action items that feed into the laboratory planning system. Corporate Operations and Corporate QA personnel can be included in this meeting at the discretion of the Laboratory Director. The LIMS review consists of examining any audits, complaints or concerns that have been raised through the year that are related to the LIMS. The laboratory will summarize any critical findings that can not be solved by the lab and report them to Corporate IT.

This management systems review (Corporate SOP No. CA-Q-S-008 & Work Instruction No. CA-Q-WI-020) uses information generated during the preceding year to assess the "big picture" by ensuring that routine actions taken and reviewed on a monthly basis are not components of larger systematic concerns. The monthly review should keep the quality systems current and effective, therefore, the annual review is a formal senior management process to review specific existing documentation. Significant issues from the following documentation are compiled or summarized by the QA Manager prior to the review meeting:

- Matters arising from the previous annual review.
- Prior Monthly QA Reports issues.
- Laboratory QA Metrics.
- Review of report reissue requests.
- Review of client feedback and complaints.
- Issues arising from any prior management or staff meetings.
- Minutes from prior senior lab management meetings. Issues that may be raised from these meetings include:
    - Adequacy of staff, equipment and facility resources.
    - Adequacy of policies and procedures.
    - Future plans for resources and testing capability and capacity.
- The annual internal double blind PT program sample performance (if performed),
- Compliance to the Ethics Policy and Data Integrity Plan. Including any evidence/incidents of inappropriate actions or vulnerabilities related to data Integrity.

A report is generated by the QA Manager and management. The report is distributed to the appropriate General Manager and the Quality Director. The report includes, but is not limited to:

- The date of the review and the names and titles of participants.
- A reference to the existing data quality related documents and topics that were reviewed.
- Quality system or operational changes or improvements that will be made as a result of the review [e.g., an implementation schedule including assigned responsibilities for the changes (Action Table)].

Changes to the quality systems requiring update to the laboratory QA Manual shall be included in the next revision of the QA Manual.

16.3 Potential Integrity Related Managerial Reviews

Potential integrity issues (data or business related) must be handled and reviewed in a confidential manner until such time as a follow-up evaluation, full investigation, or other appropriate actions have been completed and issues clarified. TestAmerica's Corporate Data Investigation/Recall SOP shall be followed (SOP No. CW-L-S-002). All investigations that result in finding of inappropriate activity are documented and include any disciplinary actions involved, corrective actions taken, and all appropriate notifications of clients.

TestAmerica's CEO, VP of Quality, Technical & Operations Support, General Managers and Quality Directors receive a monthly report from the Corporate Quality Director summarizing any current data integrity or data recall investigations. The General Manager's are also made aware of progress on these issues for their specific labs.

SECTION 17. PERSONNEL

17.1 Overview

The laboratory's management believes that its highly qualified and professional staff is the single most important aspect in assuring a high level of data quality and service. The staff consists of professionals and support personnel as outlined in the organization chart in Figure 4-1.

All personnel must demonstrate competence in the areas where they have responsibility. Any staff that is undergoing training shall have appropriate supervision until they have demonstrated their ability to perform their job function on their own. Staff shall be qualified for their tasks based on appropriate education, training, experience and/or demonstrated skills as required.

The laboratory employs sufficient personnel with the necessary education, training, technical knowledge and experience for their assigned responsibilities.

All personnel are responsible for complying with all QA/QC requirements that pertain to the laboratory and their area of responsibility. Each staff member must have a combination of experience and education to adequately demonstrate a specific knowledge of their particular area of responsibility. Technical staff must also have a general knowledge of lab operations, test methods, QA/QC procedures and records management.

Laboratory management is responsible for formulating goals for lab staff with respect to education, training and skills and ensuring that the laboratory has a policy and procedures for identifying training needs and providing training of personnel. The training shall be relevant to the present and anticipated responsibilities of the lab staff.

The laboratory only uses personnel that are employed by or under contract to, the laboratory. Contracted personnel, when used, must meet competency standards of the laboratory and work in accordance to the laboratory's quality system.

17.2 Education and Experience Requirements for Technical Personnel

The laboratory makes every effort to hire analytical staffs that possess a college degree (AA, BA, BS) in an applied science with some chemistry in the curriculum. Exceptions can be made based upon the individual's experience and ability to learn. There are competent analysts and technicians in the industry who have not earned a college degree. Selection of qualified candidates for laboratory employment begins with documentation of minimum education, training, and experience prerequisites needed to perform the prescribed task. Minimum education and training requirements for TestAmerica employees are outlined in job descriptions and are generally summarized for analytical staff in the table below.

The laboratory maintains job descriptions for all personnel who manage, perform or verify work affecting the quality of the environmental testing the laboratory performs. Job Descriptions are located on the TestAmerica intranet site's Human Resources web-page (Also see Section 4 of this manual for position descriptions/responsibilities)

Experience and specialized training are occasionally accepted in lieu of a college degree (basic lab skills such as using a balance, colony counting, aseptic or quantitation techniques, etc., are also considered).

As a general rule for analytical staff:

Table 17-2. General Personnel Educational Requirements/Experience

Specialty	Education	Experience
Extractions, Digestions, some electrode methods (pH, DO, etc.), or Titrimetric and Gravimetric Analyses	H.S. Diploma	On the job training (OJT)
GFAA, CVAA, FLAA, Single component or short list Chromatography (e.g., Fuels, BTEX-GC, IC	A college degree in an applied science or 2 years of college and at least 1 year of college chemistry	Or 2 years prior analytical experience is required
ICP, ICPMS, Long List or complex chromatography (e.g., Pesticides, PCB, Herbicides, HPLC, etc.), GCMS	A college degree in an applied science or 2 years of college chemistry	or 5 years of prior analytical experience
Spectra Interpretation	A college degree in an applied science or 2 years of college chemistry	And 2 years relevant experience Or 5 years of prior analytical experience

Specialty	Education	Experience
Technical/Department Managers – **General**	Bachelors Degree in an applied science or engineering with 24 semester hours in chemistry An advanced (MS, PhD.) degree may substitute for one year of experience	And 2 years experience in environmental analysis of representative analytes for which they will oversee
Technical/Department Managers – **Wet Chem** only (no advanced instrumentation)	Associates degree in an applied science or engineering or 2 years of college with 16 semester hours in chemistry	And 2 years relevant experience
Technical/Department Managers - Microbiology	Bachelors degree in applied science with at least 16 semester hours in general microbiology and biology An advanced (MS, PhD.) degree may substitute for one year of experience	And 2 years of relevant experience

Table 17-2. Personnel Educational Requirements/Experience: Industrial Hygiene

Specialty	Education	Experience
Technician - Industrial Hygiene	H.S. Diploma or equivalent	On the job training (OJT Demonstrated and documented ability to produce reliable results through accurate analysis of certified reference materials (CRMs), proficiency testing samples, or in-house quality control samples (IDOCs). This demonstration shall be done at a minimum of every six (6) months and documented.

Specialty	Education	Experience
Analyst - Industrial Hygiene	Bachelors Degree in Chemistry or related science	One year or more prior analytical laboratory experience desired. Demonstrated and documented ability to produce reliable results through accurate analysis of certified reference materials (CRMs), proficiency testing samples, or in-house quality control samples (IDOCs). This demonstration shall be done at a minimum of every six (6) months and documented.
Technical Director – Industrial Hygiene * The TD shall be present on site at least 20 hours per week or 50 percent of the laboratory operating hours (whichever is less) to address technical issues for laboratory staff and customers.	Bachelors Degree in an applicable physical or biological science An advanced (MS, PhD.) degree may substitute for one year of experience	And a minimum of 3 years relevant nonacademic analytical chemistry experience which includes a minimum of 2 years industrial hygiene experience within the scope of accreditation

When an analyst does not meet these requirements, they can perform a task under the direct supervision of a qualified analyst, peer reviewer or Technical/Department Managers, and are considered an analyst in training. The person supervising an analyst in training is accountable for the quality of the analytical data and must review and approve data and associated corrective actions.

17.3 Training

The laboratory is committed to furthering the professional and technical development of employees at all levels.

Orientation to the laboratory's policies and procedures, in-house method training, and employee attendance at outside training courses and conferences all contribute toward employee proficiency. Examples of various areas of required employee training are listed in Table 17-3.

Table 17-3. Required Employee Training

Required Training	Time Frame	Employee Type
Environmental Health & Safety	Prior to lab work	All
Ethics – New Hires	1 week of hire	All
Ethics – Comprehensive	90 days of hire	All
Data Integrity	30 days of hire	Technical and PMs
Quality Assurance	90 days of hire	All

Required Training	Time Frame	Employee Type
Ethics – Refresher	Annually (Training sessions presented throughout the year)	All
Initial Demonstration of Capability (IDOC)	Prior to unsupervised method performance	Technical
Complete a training course (an in-house course is acceptable) for the applicable analysis. Courses on sample preparation and instrument analysis may be taken separately or combined.	Prior to performing unsupervised analysis on laboratory samples.	Industrial Hygiene Technician/Analyst
Minimum of twenty (20) business days of hands-on experience conducting analyses in an industrial hygiene laboratory	Before initiation of independent work on customer samples.	Industrial Hygiene Technician/Analyst

The laboratory maintains records of relevant authorization/competence, education, professional qualifications, training, skills and experience of technical personnel (including contracted personnel) as well as the date that approval/authorization was given. These records are kept on file at the laboratory. Also refer to “Demonstration of Capability” in Section 19.

The training of technical staff is kept up to date by:

- Each employee must have documentation in their training file that they have read, understood and agreed to follow the most recent version of the laboratory QA Manual and SOPs in their area of responsibility. This documentation is updated as SOPs are updated.
- Documentation from any training courses or workshops on specific equipment, analytical techniques or other relevant topics are maintained in their training file.
- Documentation of proficiency (refer to Section 19).
- An Ethics Agreement signed by each staff member (renewed each year) and evidence of annual ethics training.
- A Confidentiality Agreement signed by each staff member signed at the time of employment.
- Human Resources maintains documentation and attestation forms on employment status & records; benefit programs; timekeeping/payroll; and employee conduct (e.g., ethics). This information is maintained in the employee’s secured personnel file.

Further details of the laboratory's training program are described in the SOP PE-QAD-008 Personnel Certification and Training.

17.4 Data Integrity and Ethics Training Program

Establishing and maintaining a high ethical standard is an important element of a Quality System. Ethics and data integrity training is integral to the success of TestAmerica and is provided for each employee at TestAmerica. It is a formal part of the initial employee orientation

within 1 week of hire followed by technical data integrity training within 30 days, comprehensive training within 90 days, and an annual refresher for all employees. Senior management at each facility performs the ethics training for their staff.

In order to ensure that all personnel understand the importance TestAmerica places on maintaining high ethical standards at all times; TestAmerica has established a Corporate Ethics Policy (Policy No. CW-L-P-004) and an Ethics Statement. All initial and annual training is documented by signature on the signed Ethics Statement demonstrating that the employee has participated in the training and understands their obligations related to ethical behavior and data integrity.

Violations of this Ethics Policy will not be tolerated. Employees who violate this policy will be subject to disciplinary actions up to and including termination. Criminal violations may also be referred to the Government for prosecution. In addition, such actions could jeopardize TestAmerica's ability to do work on Government contracts, and for that reason, TestAmerica has a Zero Tolerance approach to such violations.

Employees are trained as to the legal and environmental repercussions that result from data misrepresentation. Key topics covered in the presentation include:

- Organizational mission and its relationship to the critical need for honesty and full disclosure in all analytical reporting.
- Ethics Policy
- How and when to report ethical/data integrity issues. Confidential reporting.
- Record keeping.
- Discussion regarding data integrity procedures.
- Specific examples of breaches of ethical behavior (e.g. peak shaving, altering data or computer clocks, improper macros, etc., accepting/offering kickbacks, illegal accounting practices, unfair competition/collusion)
- Internal monitoring. Investigations and data recalls.
- Consequences for infractions including potential for immediate termination, debarment, or criminal prosecution.
- Importance of proper written narration / data qualification by the analyst and project manager with respect to those cases where the data may still be usable but are in one sense or another partially deficient.

Additionally, a data integrity hotline (1-800-736-9407) is maintained by TestAmerica and administered by the Corporate Quality Department.

SECTION 18. ACCOMMODATIONS AND ENVIRONMENTAL CONDITIONS

18.1 Overview

The laboratory is a 24,000 ft^2 secure laboratory facility with controlled access and designed to accommodate an efficient workflow and to provide a safe and comfortable work environment for

employees. All visitors sign in and are escorted by laboratory personnel. Access is controlled by various measures.

The laboratory is equipped with structural safety features. Each employee is familiar with the location, use, and capabilities of general and specialized safety features associated with their workplace. The laboratory provides and requires the use of protective equipment including safety glasses, protective clothing, gloves, etc., OSHA and other regulatory agency guidelines regarding required amounts of bench and fume hood space, lighting, ventilation (temperature and humidity controlled), access, and safety equipment are met or exceeded.

Traffic flow through sample preparation and analysis areas is minimized to reduce the likelihood of contamination. Adequate floor space and bench top area is provided to allow unencumbered sample preparation and analysis space. Sufficient space is also provided for storage of reagents and media, glassware, and portable equipment. Ample space is also provided for refrigerated sample storage before analysis and archival storage of samples after analysis. Laboratory HVAC and deionized water systems are designed to minimize potential trace contaminants.

The laboratory is separated into specific areas for sample receiving, sample preparation, volatile organic sample analysis, non-volatile organic sample analysis, inorganic sample analysis, microbiological sample analysis, and administrative functions.

18.2 Environment

Laboratory accommodation, test areas, energy sources, and lighting are adequate to facilitate proper performance of tests. The facility is equipped with heating, ventilation, and air conditioning (HVAC) systems appropriate to the needs of environmental testing performed at this laboratory.

The environment in which these activities are undertaken does not invalidate the results or adversely affect the required accuracy of any measurements.

The laboratory provides for the effective monitoring, control and recording of environmental conditions that may affect the results of environmental tests as required by the relevant specifications, methods, and procedures. Such environmental conditions include humidity, voltage, temperature, and vibration levels in the laboratory.

When any of the method or regulatory required environmental conditions change to a point where they may adversely affect test results, analytical testing will be discontinued until the environmental conditions are returned to the required levels.

Environmental conditions of the facility housing the computer network and LIMS are regulated to protect against raw data loss.

18.3 Work Areas

There is effective separation between neighboring areas when the activities therein are incompatible with each other. Examples include:

- Microbiological culture handling and sample incubation areas.

- Volatile organic chemical handling areas, including sample preparation and waste disposal, and volatile organic chemical analysis areas.

Access to and use of all areas affecting the quality of analytical testing is defined and controlled by secure access to the laboratory building as described below in the Building Security section.

Adequate measures are taken to ensure good housekeeping in the laboratory and to ensure that any contamination does not adversely affect data quality. These measures include regular cleaning to control dirt and dust within the laboratory. Work areas are available to ensure an unencumbered work area. Work areas include:

- Access and entryways to the laboratory.
- Sample receipt areas.
- Sample storage areas.
- Chemical and waste storage areas.
- Data handling and storage areas.
- Sample processing areas.
- Sample analysis areas.

Refer to the following documents and procedures for specific requirements for microbiological laboratory facility requirements.

- Standard Methods, 20th Ed., 9020B, Sec. 2
- TNI V1M5, 1.7.3.7.a
- EPA Manual for the Certification of Laboratories Analyzing Drinking Water, 5th Edition

18.4 Floor Plan

A floor plan can be found in Appendix 1.

18.5 Building Security

Magnetic building keys and alarm codes are distributed to employees as necessary. Access to the laboratory is controlled to prevent entry by non-laboratory personnel.

Visitors to the laboratory sign in a visitor's logbook. A visitor is defined as any person who visits the laboratory who is not an employee of the laboratory. In addition to signing into the laboratory, the Environmental, Health and Safety Manual contain requirements for visitors and vendors. There are specific safety forms that must be reviewed and signed.

Visitors (with the exception of company employees) are escorted by laboratory personnel at all times, or the location of the visitor is noted in the visitor's logbook

SECTION 19. TEST METHODS AND METHOD VALIDATION

19.1 Overview

The laboratory uses methods that are appropriate to meet our clients' requirements and that are within the scope of the laboratory's capabilities. These include sampling, handling, transport, storage and preparation of samples, and, where appropriate, an estimation of the measurement of uncertainty as well as statistical techniques for analysis of environmental data.

Instructions are available in the laboratory for the operation of equipment as well as for the handling and preparation of samples. All instructions, Standard Operating Procedures (SOPs), reference methods and manuals relevant to the working of the laboratory are readily available to all staff. Deviations from published methods are documented (with justification) in the laboratory's approved SOPs. SOPs are submitted to clients for review at their request. Significant deviations from published methods require client approval and regulatory approval where applicable.

19.2 Standard Operating Procedures (SOPS)

The laboratory maintains SOPs that accurately reflect all phases of the laboratory such as assessing data integrity, corrective actions, handling customer complaints as well as all analytical methods and sampling procedures. The method SOPs are derived from the most recently promulgated/approved, published methods and are specifically adapted to the laboratory facility. Modifications or clarifications to published methods are clearly noted in the SOPs. All SOPs are controlled by the laboratory.

- All SOPs contain a revision number, effective date, and appropriate approval signatures. SOP copies (as uncontrolled documents) are available online to all staff. Controlled copies are utilized as requested by laboratory personnel.
- Procedures for writing a SOP are incorporated by reference to TestAmerica's Corporate SOP CW-Q-S-002 entitled 'Writing a Standard Operating Procedure (SOP)', or the laboratory's SOP PE-QAD-014 Creation and Maintenance of SOPs.
- SOPs are reviewed at a minimum of every 2 years (annually for Drinking Water SOPs), and where necessary, revised to ensure continuing suitability and compliance with applicable requirements.

19.3 Laboratory Methods Manual

For each test method, the laboratory shall have available the published referenced method as well as the laboratory developed SOP.

Note: If more stringent standards or requirements are included in a mandated test method or regulation than those specified in this manual, the laboratory shall demonstrate that such requirements are met. If it is not clear which requirements are more stringent, the standard from the method or regulation is to be followed. Any exceptions or deviations from the referenced methods or regulations are noted in the specific analytical SOP.

The laboratory maintains an SOP Index for both technical and non-technical SOPs. Technical SOPs are maintained to describe a specific test method. Non-technical SOPs are maintained to describe functions and processes not related to a specific test method.

19.4 Selection of Methods

Since numerous methods and analytical techniques are available, continued communication between the client and laboratory is imperative to assure the correct methods are utilized. Once client methodology requirements are established, this and other pertinent information is summarized by the Project Manager. These mechanisms ensure that the proper analytical methods are applied when the samples arrive for log-in. For non-routine analytical services (e.g., special matrices, non-routine compound lists), the method of choice is selected based on client needs and available technology. The methods selected should be capable of measuring the specific parameter of interest, in the concentration range of interest, and with the required precision and accuracy.

19.4.1 Sources of Methods

- *Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act, and Appendix A-C; 40 CFR Part 136, USEPA Office of Water. Revised as of July 1, 1995, Appendix A to Part 136 - Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater (EPA 600 Series*
- *Methods for Chemical Analysis of Water and Wastes, EPA 600 (4-79-020), 1983.*
- *Methods for the Determination of Inorganic Substances in Environmental Samples, EPA-600/R-93/100, August 1993.*
- *Methods for the Determination of Metals in Environmental Samples, EPA/600/4-91/010, June 1991. Supplement I: EPA-600/R-94/111, May 1994.*
- *Methods for the Determination of Organic Compounds in Drinking Water, EPA-600/4-88-039, December 1988, Revised, July 1991, Supplement I, EPA-600-4-90-020, July 1990, Supplement II, EPA-600/R-92-129, August 1992. Supplement III EPA/600/R-95/131 - August 1995 (EPA 500 Series) (EPA 500 Series methods)*
- *Handbook for Analytical Quality Control in Water and Wastewater Laboratories, EPA 600/4-79-019, EPA, March 1979.*
- *Technical Notes on Drinking Water Methods, EPA-600/R94-173, October 1994*
- *Standard Methods for the Examination of Water and Wastewater, 18th/19th /20th edition; Eaton, A.D. Clesceri, L.S. Greenberg, A.E. Eds; American Water Works Association, Water Pollution Control Federation, American Public Health Association: Washington, D.C.*
- *Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846), Third Edition, September 1986, Final Update I, July 1992, Final Update IIA, August 1993, Final Update II, September 1994; Final Update IIB, January 1995; Final Update III, December 1996; Final Update IV, January 2008.*
- *Annual Book of ASTM Standards, American Society for Testing & Materials (ASTM), Philadelphia, PA.*
- *Manual for the Certification of Laboratories Analyzing Drinking Water (EPA 815-R-05-004, January 2005)*
- *Code of Federal Regulations (CFR) 40, Parts 136, 141, 172, 173, 178, 179 and 261*
- *NIOSH Manual of Analytical Methods (NMAM®), 4th ed.*
- *DHHS (NIOSH) Publication 94-113 (August, 1994), 1st Supplement Publication 96-135, 2nd Supplement Publication 98-119,3rd Supplement 2003-154 Schlecht, P.C. & O'Connor, P.F. (pfo1@cdc.gov), Eds.*

- *Index of Sampling & Analytical Methods, U.S. Department of Labor, Occupational Safety & Health Administration, Revision Date: 21 November 2001.*
- *8015AZ R1, C10 – C32 Hydrocarbons in Soil, Arizona Department of Health Services, Revision 1, September 25th, 1998.*
- *VOCs in Vapor by 8260B AZ Method, Arizona Department of Health Services, Revision 0.0, April 4th 2009.*
- *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, EPA-625/R96/010b, January 1999.*
- *Method 1664, Revision A: N-Hexane Extractable Material (HEM; Oil and Grease) and Silica Gel Treated N-Hexane Extractable Material (SGT-HEM); Non-polar Material) by Extraction and Gravimetry, EPA-821-R-98-002, February 1999*
- *The Determination of Organo-Phosphorus Pesticides in Municipal and Industrial Wastewater, EPA method 1657.*

The laboratory reviews updated versions to all the aforementioned references for adaptation based upon capabilities, instrumentation, etc., and implements them as appropriate. As such, the laboratory strives to perform only the latest versions of each approved method as regulations allow or require.

Other reference procedures for non-routine analyses may include methods established by specific states (e.g., Underground Storage Tank methods), ASTM or equipment manufacturers. Sample type, source, and the governing regulatory agency requiring the analysis will determine the method utilized.

The laboratory shall inform the client when a method proposed by the client may be inappropriate or out of date. After the client has been informed, and they wish to proceed contrary to the laboratory's recommendation, it will be documented.

19.4.2 Demonstration of Capability

Before the laboratory may institute a new method and begin reporting results, the laboratory shall confirm that it can properly operate the method. In general, this demonstration does not test the performance of the method in real world samples, but in an applicable and available clean matrix sample. If the method is for the testing of analytes that are not conducive to spiking, demonstration of capability may be performed on quality control samples.

A demonstration of capability (Personnel Training and Certification, PE-QAD-008 and Demonstration of Competency DOC for Industrial Hygiene Fields of Testing Not Covered by AIHA PT Samples, PE-QAD-025) is performed whenever there is a change in instrument type (e.g., new instrumentation), method or personnel (e.g., analyst hasn't performed the test within the last 12 months, in the last 6 months for AIHA test methods).

A method's initial demonstration of capability must be thoroughly documented and approved by the Laboratory Director and Technical/Department Manager along with the QA Manager prior to independently analyzing client samples. All associated documentation must be retained in accordance with the laboratory's archiving procedures.

The laboratory must have an approved SOP, demonstrate satisfactory performance, and conduct an MDL study (when applicable). There may be other requirements as stated within the published method or regulations (i.e., retention time window study).

Note: In some instances, a situation may arise where a client requests that an unusual analyte be reported using a method where this analyte is not normally reported. If the analyte is being reported for regulatory purposes, the method must meet all procedures outlined within this QA Manual (SOP, MDL, and Demonstration of Capability). If the client states that the information is not for regulatory purposes, the result may be reported as long as the following criteria are met:

- The instrument is calibrated for the analyte to be reported using the criteria for the method and ICV/CCV criteria are met (unless an ICV/CCV is not required by the method or criteria are per project DQOs).
- The laboratory's nominal or default reporting limit (RL) is equal to the quantitation limit (QL), must be at or above the lowest non-zero standard in the calibration curve and must be reliably determined. Project RLs are client specified reporting levels which may be higher than the QL. Results reported below the QL must be qualified as estimated values. Also see Section 19.6.1.3, Relationship of Limit of Detection (LOD) to Quantitation Limit (QL). The final report must be footnoted: *Reporting Limit based on the low standard of the calibration curve.*
- If applicable, the analyte was be qualified to note that the laboratory is not accredited for the analyte and/or the analyte is not referenced method does not contain the analyte as part of its method compound list.
- The client request is documented and the lab informs the client of its procedure for working with unusual compounds.

19.4.3 Analyst Initial Demonstration of Capability (IDOC) Procedures

Prior to reporting any data, each analyst must have on file with the QA office information demonstrating proficiency with the analytical technique. Both precision and accuracy are measured for the target analytes.

19.4.3.1 The spiking standard used must be prepared independently from those used in instrument calibration.

19.4.3.2 The analyte(s) shall be diluted in a volume of clean matrix sufficient to prepare four aliquots at the concentration specified by a method or the laboratory SOP.

19.4.3.3 At least four aliquots shall be prepared (including any applicable clean-up procedures) and analyzed according to the test method (either concurrently or over a period of days).

19.4.3.4 Using all of the results, calculate the mean recovery in the appropriate reporting units and the standard deviations for each parameter of interest.

19.4.3.5 When it is not possible to determine the mean and standard deviations, such as for presence, absence and logarithmic values, the laboratory will assess performance against criteria described in the Method SOP.

19.4.3.6 Compare the information obtained above to the corresponding acceptance criteria for precision and accuracy in the test method (if applicable) or in laboratory generated acceptance criteria (LCS or interim criteria) if there is no mandatory criteria established. If any one of the parameters do not meet the acceptance criteria, the performance is unacceptable for that parameter.

19.4.3.7 When one or more of the tested parameters fail at least one of the acceptance criteria, the analyst must proceed according to either option listed below:

- Locate and correct the source of the problem.
- Beginning with 19.4.3.3 above, repeat the test for all parameters that failed to meet criteria. Repeated failure, however, will confirm a general problem with the measurement system. If this occurs, locate and correct the source of the problem and repeat the test for all compounds of interest beginning with 19.4.3.1 above.

Note: Results of successive LCS analyses can be used to fulfill the DOC requirement.

19.4.3.8 For AIHA Demonstration of Proficiency, all analysts and technicians shall have demonstrated ability to produce reliable results through accurate analysis of certified reference materials (CRMs), proficiency testing samples, or in-house quality control samples. This demonstration shall be done at a minimum of every six (6) months and documented.

A certification statement (refer to Figure 19-1) shall be used to document the completion of each initial demonstration of capability for all NELAC and AIHA listed methods. A copy of the certification is archived in the analyst's training folder.

Methods on line prior to the effective date of this Section shall be updated to the procedures outlined above as new analysts perform their demonstration of capability. A copy of the new record will replace that which was used for documentation in the past. At a minimum, the precision and accuracy of four mid-level laboratory control samples (LCS) must have been compared to the laboratory's quality control acceptance limits. For AIHA, refer to the individual analytical SOP for precision and accuracy demonstration.

19.4.3.9 For additional information see the laboratory SOP PE-QAD-015 Initial Demonstration of Capability.

19.5 Laboratory Developed Methods and Non-Standard Methods

Any new method developed by the laboratory must be fully defined in an SOP and validated by qualified personnel with adequate resources to perform the method. Method specifications and the relation to client requirements must be clearly conveyed to the client if the method is a non-standard method (not a published or routinely accepted method). The client must also be in agreement to the use of the non-standard method.

19.6 Validation of Methods

Validation is the confirmation by examination and the provision of objective evidence that the particular requirements for a specific intended use are fulfilled.

All non-standard methods, laboratory designed/developed methods, standard methods used outside of their scope, and major modifications to published methods must be validated to confirm they are fit for their intended use. The validation will be as extensive as necessary to meet the needs of the given application. The results are documented with the validation procedure used and contain a statement as to the fitness for use.

19.6.1 Method Validation and Verification Activities for All New Methods

While method validation can take various courses, the following activities can be required as part of method validation. Method validation records are designated QC records and are archived accordingly.

19.6.1.1 Determination of Method Selectivity

Method selectivity is the demonstrated ability to discriminate the analyte(s) of interest from other compounds in the specific matrix or matrices from other analytes or interference. In some cases to achieve the required selectivity for an analyte, a confirmation analysis is required as part of the method.

19.6.1.2 Determination of Method Sensitivity

Sensitivity can be both estimated and demonstrated. Whether a study is required to estimate sensitivity depends on the level of method development required when applying a particular measurement system to a specific set of samples. Where estimations and/or demonstrations of sensitivity are required by regulation or client agreement, such as the procedure in 40 CFR Part 136 Appendix B, under the Clean Water Act, these shall be followed.

19.6.1.3 Relationship of Limit of Detection (LOD) to the Quantitation Limit (QL)

An important characteristic of expression of sensitivity is the difference in the LOD and the QL. The LOD is the minimum level at which the presence of an analyte can be reliably concluded. The QL is the minimum concentration of analyte that can be quantitatively determined with acceptable precision and bias. For most instrumental measurement systems, there is a region where semi-quantitative data is generated around the LOD (both above and below the estimated MDL or LOD) and below the QL. In this region, detection of an analyte may be confirmed but quantification of the analyte is unreliable within the accuracy and precision guidelines of the measurement system. When an analyte is detected below the QL, and the presence of the analyte is confirmed by meeting the qualitative identification criteria for the analyte, the analyte can be reliably reported, but the amount of the analyte can only be estimated. If data is to be reported in this region, it must be done so with a qualification that denotes the semi-quantitative nature of the result.

19.6.1.4 Determination of Interferences

A determination that the method is free from interferences in a blank matrix is performed.

19.6.1.5 Determination of Range

Where appropriate to the method, the quantitation range is determined by comparison of the response of an analyte in a curve to established or targeted criteria. Generally the upper quantitation limit is defined by highest acceptable calibration concentration. The lower quantitation limit or QL cannot be lower than the lowest non-zero calibration level, and can be constrained by required levels of bias and precision.

19.6.1.6 Determination of Accuracy and Precision

Accuracy and precision studies are generally performed using replicate analyses, with a resulting percent recovery and measure of reproducibility (standard deviation, relative standard deviation) calculated and measured against a set of target criteria.

19.6.1.7 Documentation of Method

The method is formally documented in an SOP. If the method is a minor modification of a standard laboratory method that is already documented in an SOP, an SOP Attachment describing the specific differences in the new method is acceptable in place of a separate SOP.

19.6.1.8 Continued Demonstration of Method Performance

Continued demonstration of Method Performance is addressed in the SOP. Continued demonstration of method performance is generally accomplished by batch specific QC samples such as LCS, method blanks or PT samples.

19.7 Method Detection Limits (MDL) / Limits of Detection (LOD)

Method detection limits (MDL) are initially determined in accordance with 40 CFR Part 136, Appendix B or alternatively by other technically acceptable practices that have been accepted by regulators. MDL is also sometimes referred to as Limit of Detection (LOD). The MDL theoretically represents the concentration level for each analyte within a method at which the Analyst is 99% confident that the true value is not zero. The MDL is determined for each analyte initially during the method validation process and updated as required in the analytical methods, whenever there is a significant change in the procedure or equipment, or based on project specific requirements (refer to 19.7.10). Generally, the analyst prepares at least seven replicates of a solution spiked at one to five times the estimated method detection limit (most often at the lowest standard in the calibration curve) into the applicable matrix with all the analytes of interest. Each of these aliquots is extracted (including any applicable clean-up procedures) and analyzed in the same manner as the samples. Where possible, the seven replicates should be analyzed over 2-4 days to provide a more realistic MDL. Drinking Water method MDLs must be analyzed over a period of 3 or more days.

Refer to the Corporate SOP CA-Q-S-006 Detection Limits or the laboratory's SOP PE-QAD-019 Determination of Method Detection Limits for details on the laboratory's MDL process.

19.8 Instrument Detection Limits (IDL)

The IDL is sometimes used to assess the reasonableness of the MDLs or in some cases required by the analytical method or program requirements. IDLs are most used in metals analyses but may be useful in demonstration of instrument performance in other areas.

IDLs are calculated to determine an instrument's sensitivity independent of any preparation method. IDLs are calculated either using 7 replicate spike analyses, like a MDL but without sample preparation, or by the analysis of 10 instrument blanks and calculating 3 times the absolute value of the standard deviation.

19.9 Verification of Detection and Reporting Limits

Once an MDL is established, it must be verified, on each instrument, by analyzing a quality control sample (prepared as a sample) at no more than 3 times the calculated MDL for single analyte analyses (e.g. most wet chemistry methods, Atomic Absorption, etc.) and no more than 4 times the calculated MDL for multiple analyte methods (e.g. GC, GCMS, ICP, etc.). The analytes must be qualitatively identified. This verification does not apply to methods that are not readily spiked (e.g. pH, turbidity, etc.) or where the lab does not report to the MDL. If the MDL does not verify, then the lab will either not report to the MDL, redevelop their MDL or use the level where qualitative identification is established. MDLs must be verified at least annually

When the laboratory establishes a quantitation limit, it must be initially verified by the analysis of a low level standard or QC sample at 1 - 2 times the reporting limit and annually thereafter. The annual requirement is waved for methods that have an annually verified MDL. The laboratory will comply with any regulatory requirements. Unless there are requirements to the contrary the acceptance criteria is ± 50%.

19.10 Retention Time Windows

Most organic analyses and some inorganic analyses use chromatography techniques for qualitative and quantitative determinations. For every chromatography analysis or as specified in the reference method, each analyte will have a specific time of elution from the column to the detector. This is known as the analyte retention time. The variance in the expected time of elution is defined as the retention time window. As the key to analyte identification in chromatography, retention time windows must be established on every column for every analyte used for that method. These records are kept with the files associated with an instrument for later quantitation of the analytes. Complete details are available in the laboratory SOPs.

19.11 Evaluation of Selectivity

The laboratory evaluates selectivity by following the checks within the applicable analytical methods, which include mass spectral tuning, second column confirmation, ICP interelement interference checks, chromatography retention time windows, sample blanks, spectrochemical, atomic absorption or fluorescence profiles, co-precipitation evaluations and specific electrode response factors.

19.12 Estimation of Uncertainty of Measurement

19.12.1 Uncertainty is "a parameter associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the measurand" (as defined by the International Vocabulary of Basic and General Terms in Metrology, ISO Geneva, 1993, ISBN 92-67-10175-1). Knowledge of the uncertainty of a measurement provides additional confidence in a result's validity. Its value accounts for all the factors which could possibly affect the result, such as adequacy of analyte definition, sampling, matrix effects and interferences, climatic conditions, variances in weights, volumes, and standards, analytical procedure, and random variation. Some national accreditation organizations require the use of an "expanded uncertainty": which is the range within which the value of the measurand is believed to lie within at least a 95% confidence level with the coverage factor k=2.

19.12.2 Uncertainty is not error. Error is a single value, the difference between the true result and the measured result. On environmental samples, the true result is never known. The measurement is the sum of the unknown true value and the unknown error. Unknown error is a combination of systematic error, or bias, and random error. Bias varies predictably, constantly, and independently from the number of measurements. Random error is unpredictable, assumed to be Gaussian in distribution, and reducible by increasing the number of measurements.

19.12.3 The minimum uncertainty associated with results generated by the laboratory can be determined by using the Laboratory Control Sample (LCS) accuracy range for a given analyte. The LCS limits are used to assess the performance of the measurement system since they take into consideration all of the laboratory variables associated with a given test over time (except for variability associated with the sampling and the variability due to matrix effects). The percent recovery of the LCS is compared either to the method-required LCS accuracy limits or to the statistical, historical, in-house LCS accuracy limits.

19.12.4 To calculate the uncertainty for the specific result reported, multiply the result by the decimal of the lower end of the LCS range percent value for the lower end of the uncertainty range, and multiply the result by the decimal of the upper end of the LCS range percent value for the upper end of the uncertainty range. These calculated values represent a 99%-certain range for the reported result. As an example, suppose that the result reported is 1.0 mg/l, and the LCS percent recovery range is 50 to 150%. The uncertainty range would be 0.5 to 1.5 mg/l, which could also be written as 1.0 ± 0.5 mg/l.

19.12.5 Alternatively, the information provided by the AHIA can be used to calculate uncertainty. This information can be found in the AIHA Laboratory Accreditation Program, LLC Policy Modules – Appendix G.

19.12.6 In the case where a well recognized test method specifies limits to the values of major sources of uncertainty of measurement (e.g., 524.2, 525, etc.) and specifies the form of presentation of calculated results, no further discussion of uncertainty is required.

19.12.7 The laboratory provides measurement uncertainty data only at client request. An additional fee is charged for the reporting of measurement uncertainty

19.13 Sample Reanalysis Guidelines

Because there is a certain level of uncertainty with any analytical measurement, a sample re-preparation (where appropriate) and subsequent analysis (hereafter referred to as 'reanalysis') may result in either a higher or lower value from an initial sample analysis. There are also variables that may be present (e.g., sample homogeneity, analyte precipitation over time, etc.) that may affect the results of a reanalysis. Based on the above comments, the laboratory will reanalyze samples at a client's request with the following caveats. **Client specific Contractual Terms & Conditions for reanalysis protocols may supersede the following items.**

- Homogenous samples: If a reanalysis agrees with the original result to within the RPD limits for MS/MSD or Duplicate analyses, or within ± 1 reporting limit for samples ≤ 5x the reporting limit, the original analysis will be reported. At the client's request, both results may be reported on the same report but not on two separate reports.

- If the reanalysis does not agree (as defined above) with the original result, then the laboratory will investigate the discrepancy and reanalyze the sample a third time for confirmation if sufficient sample is available.

- Any potential charges related to reanalysis are discussed in the contract terms and conditions or discussed at the time of the request. The client will typically be charged for reanalysis unless it is determined that the lab was in error.

- Due to the potential for increased variability, reanalysis may not be applicable to Non-homogenous, Encore, and Sodium Bisulfate preserved samples. See the Department Manager or Laboratory Director if unsure.

19.14 Control of Data

The laboratory has policies and procedures in place to ensure the authenticity, integrity, and accuracy of the analytical data generated by the laboratory.

19.14.1 Computer and Electronic Data Related Requirements

The three basic objectives of our computer security procedures and policies are shown below. More detail is outlined in SOP PE-ADM-001 Computer Security. The laboratory is currently running the Element LIMS which is a 3rd party LIMS system that has been highly customized to meet the needs of the laboratory. It is referred to as LIMS for the remainder of this section. The LIMS utilizes Sequel Server / Access database which is an industry standard relational database platform. It is referred to as Database for the remainder of this section.

19.14.1.1 Maintain the Database Integrity: Assurance that data is reliable and accurate through data verification (review) procedures, password-protecting access, anti-virus protection, data change requirements, as well as an internal LIMS permissions procedure.

- LIMS Database Integrity is achieved through data input validation, internal user controls, and data change requirements.

- Spreadsheets and other software developed in-house must be verified with documentation through hand calculations prior to use. Cells containing calculations must be lock-protected and controlled.
- Instrument hardware and software adjustments are safeguarded through maintenance logs, audit trails and controlled access.

19.14.1.2 **Ensure Information Availability:** Protection against loss of information or service is ensured through scheduled back-ups, stable file server network architecture, secure storage of media, line filter, Uninterruptible Power Supply (UPS), and maintaining older versions of software as revisions are implemented.

19.14.1.3 **Maintain Confidentiality:** Ensure data confidentiality through physical access controls such as password protection or website access approval when electronically transmitting data.

19.14.2 Data Reduction

The complexity of the data reduction depends on the analytical method and the number of discrete operations involved (e.g., extractions, dilutions, instrument readings and concentrations). The analyst calculates the final results from the raw data or uses appropriate computer programs to assist in the calculation of final reportable values.

For manual data entry, e.g., Wet Chemistry, the data is reduced by the analyst and then verified by the Department Manager or alternate analyst prior to updating the data in LIMS. The spreadsheets, or any other type of applicable documents, are signed by both the analyst and alternate reviewer to confirm the accuracy of the manual entry(s).

Analytical results are reduced to appropriate concentration units specified by the analytical method, taking into account factors such as dilution, sample weight or volume, etc. Blank correction will be applied only when required by the method or per manufacturer's indication; otherwise, it should not be performed. Calculations are independently verified by appropriate laboratory staff. Calculations and data reduction steps for various methods are summarized in the respective analytical SOPs or program requirements.

Manual integration of peaks will be documented and reviewed and the raw data will be flagged in accordance with the TestAmerica Corporate SOP CA-Q-S-002, Acceptable Manual Integration Practices and the laboratory SOP PE-QAD-009 Manual Integration / Data Integrity.

Analytical results are reduced to appropriate concentration units specified by the analytical method, taking into account factors such as dilution, sample weight or volume, etc. Blank correction will be applied only when required by the method or per manufacturer's indication; otherwise, it should not be performed. Calculations are independently verified by appropriate laboratory staff. Calculations and data reduction steps for various methods are summarized in the respective analytical SOPs or program requirements.

19.14.2.1 All raw data must be retained in the worklist folder, computer file (if appropriate), and/or runlog. All criteria pertinent to the method must be recorded. The documentation is recorded at the time observations or calculations are made and must be signed or initialed/dated (month/day/year). It must be easily identifiable who performed which tasks if multiple people were involved.

19.14.2.2 In general, concentration results are reported in milligrams per liter (mg/l) or micrograms per liter (µg/l) for liquids and milligrams per kilogram (mg/kg) or micrograms per kilogram (µg/kg) for solids. For values greater than 10,000 mg/l, results can be reported in percent, i.e., 10,000 mg/l = 1%. Units are defined in each lab SOP.

19.14.2.3 In reporting, the analyst or the instrument output records the raw data result using values of known certainty plus one uncertain digit. If final calculations are performed external to LIMS, the results should be entered in LIMS with at least three significant figures. In general, results are reported to 2 significant figures on the final report.

19.14.2.4 For those methods that do not have an instrument printout or an instrumental output compatible with the LIMS System, the raw results and dilution factors are entered directly into LIMS by the analyst, and the software calculates the final result for the analytical report. LIMS has a defined significant figure criterion for each analyte.

19.14.2.5 The laboratory strives to import data directly from instruments or calculation spreadsheets to ensure that the reported data are free from transcription and calculation errors. For those analyses with an instrumental output compatible with the LIMS, the raw results and dilution factors are transferred into LIMS electronically after reviewing the quantitation report, and removing unrequested or poor spectrally-matched compounds. The analyst prints a copy of what has been entered to check for errors. This printout and the instrument's printout of calibrations, concentrations, retention times, chromatograms, and mass spectra, if applicable, are retained with the data file. The data file is stored in a monthly folder on the instrument computer; periodically, this file is transferred to the server and, eventually, to a tape file.

19.14.3 Logbook / Worksheet Use Guidelines

Logbooks and worksheets are filled out 'real time' and have enough information on them to trace the events of the applicable analysis/task. (e.g. calibrations, standards, analyst, sample ID, date, time on short holding time tests, temperatures when applicable, calculations are traceable, etc.)

- Corrections are made following the procedures outlined in Section 12.
- Logbooks are controlled by the QA department. A record is maintained of all logbooks in the lab.
- Unused portions of pages must be Z'd out, signed and dated.
- Worksheets are created with the approval of the Department Manager / QA Manager at the facility. The QA Manager controls all worksheets following the procedures in Section 6.

19.14.4 Review / Verification Procedures

Review procedures are outlined in the following SOPs to ensure that reported data are free from calculation and transcription errors, that QC parameters have been reviewed and evaluated before data is reported:

- PE-QAD-024 General Data Review
- PE-QAD-018 Use of Data Qualifiers
- PE-SMP-001 Sample Control
- PE-PMD-001 Data Reporting, Validation and Distribution

- PE-QAD-006 Logbook Documentation
- PE-QAD-007 Corrective Actions
- PE-QAD-022 Good Calibration Practices

The laboratory also has an SOP discussing Manual Integrations to ensure the authenticity of the data (SOP PE-QAD-009 Manual Integration / Data Integrity). The general review concepts are discussed below, more specific information can be found in the SOPs.

19.14.4.1 The data review process at the laboratory starts at the Sample Control level. Sample Control personnel review chain-of-custody forms and input the sample information and required analyses into the laboratory LIMS program. The Project Managers perform final review of the chain-of-custody forms and inputted information.

19.14.4.2 The next level of data review occurs with the Analysts. As results are generated, analysts review their work to ensure that the results generated meet QC requirements and relevant methodologies. The Analysts transfer the data into the LIMS and add data qualifiers if applicable. To ensure data compliance, a different analyst performs a second level of review. Second level review is accomplished by checking reported results against raw data and evaluating the results for accuracy. During the second level review, blank runs, QA/QC check results, initial and continuing calibration results, laboratory control samples, sample data, qualifiers and spike information are evaluated. Where calibration is not required on a daily basis, secondary review of the initial calibration results may be conducted at the time of calibration. Approximately 15% of all sample data from manual methods and from automated methods, all GC/MS spectra and all manual integrations are reviewed. For some methods, manual integrations are also electronically reviewed utilizing auditing software to help ensure compliance to ethics and manual integration policies. Issues that deem further review include the following:

- QC data are outside the specified control limits for accuracy and precision
- Reviewed sample data does not match with reported results
- Unusual detection limit changes are observed
- Samples having unusually high results
- Samples exceeding a known regulatory limit
- Raw data indicating some type of contamination or poor technique
- Inconsistent peak integration
- Transcription errors
- Results outside of calibration range

19.14.4.3 Unacceptable analytical results may require reanalysis of the samples. Any problems are brought to the attention of the Laboratory Director, Project Manager, Quality Assurance Manager, or Department Manager for further investigation. Corrective action is initiated whenever necessary.

19.14.4.4 The results are then entered or directly transferred into the computer database and a hard copy (or .pdf) is printed for the client.

19.14.4.5 As a final review prior to the release of the report, the Project Manager reviews the results for appropriateness and completeness. This review and approval ensures that client requirements have been met and that the final report has been properly completed. The process includes, but is not limited to, verifying that chemical relationships are evaluated, COC is followed, cover letters/ narratives are present, flags are appropriate, and project specific requirements are met.

19.14.4.6 Any project that requires a data package is subject to a tertiary data review for transcription errors and acceptable quality control requirements. The Project Manager then signs the final report. When complete, the report is sent out to the client.

19.14.4.7 A visual summary of the flow of samples and information through the laboratory, as well as data review and validation, is presented in Figure 19-2.

19.14.5 Manual Integrations

Computerized data systems provide the analyst with the ability to re-integrate raw instrument data in order to optimize the interpretation of the data. Though manual integration of data is an invaluable tool for resolving variations in instrument performance and some sample matrix problems, when used improperly, this technique would make unacceptable data appear to meet quality control acceptance limits. Improper re-integrations lead to legally indefensible data, a poor reputation, or possible laboratory decertification. Because guidelines for re-integration of data are not provided in the methods and most methods were written prior to widespread implementation of computerized data systems, the laboratory trains all analytical staff on proper manual integration techniques using TestAmerica's Corporate SOP CA-Q-S-002 as the guideline for the laboratory's internal SOP PE-QAD-009 Manual Integration / Data Integrity.

- The analyst must adjust baseline or the area of a peak in some situations, for example when two compounds are not adequately resolved or when a peak shoulder needs to be separated from the peak of interest. The analyst must use professional judgment and common sense to determine when manual integrating is required. Analysts are encouraged to ask for assistance from a senior analyst or manager when in doubt.

- Analysts shall not increase or decrease peak areas for the sole purpose of achieving acceptable QC recoveries that would have otherwise been unacceptable. The intentional recording or reporting of incorrect information (or the intentional omission of correct information) is against company principals and policy and is grounds for immediate termination.

- Client samples, performance evaluation samples, and quality control samples are all treated equally when determining whether or not a peak area or baseline should be manually adjusted.

- All manual integrations receive a second level review. Manual integrations must be indicated on an expanded scale "after" chromatograms such that the integration performed can be easily evaluated during data review. Expanded scale "before" chromatograms are also required for all manual integrations on QC parameters (calibrations, calibration verifications, laboratory control samples, internal standards, surrogates, etc.) unless the laboratory has another documented corporate approved

procedure in place that can demonstrate an active process for detection and deterrence of improper integration practices.

Figure 19-1. Example - Demonstration of Capability Documentation

TestAmerica Laboratories, Inc.
Demonstration of Capability
Authorization/Certification Statement

Date:

Laboratory Name: TestAmerica Laboratories, Inc.
Laboratory Address: 4625 East Cotton Center Boulevard, Suite 189
Phoenix, AZ 85040

Analyst Name: Matrix: Media Type:

Method Number: SOP / Rev No.:

Analyte, or Class of Analytes or Measured Parameters:

We, the undersigned, CERTIFY that:

1. The analyst identified above, using the cited test method(s), which is in use at this facility for the analyses of samples under the National Environmental Laboratory Accreditation Program and/or the American Industrial Hygiene Association (AIHA) Accreditation Program, has met the Demonstration of Capability and is authorized to perform the above named analysis on the date listed.
2. The test method(s) was performed by the analyst identified on this certification.
3. A copy of the test method(s) and the SOP(s) are available for all personnel on-site.
4. The data associated with the demonstration of capability are true, accurate, and complete.
5. All raw data (including a copy of this certification form) necessary to reconstruct and validate these analyses have been retained at the facility, and that the associated information is well-organized and available for review by authorized assessors.

☐ Initial Demonstration Study (4 consecutive) ☐ Ongoing DOC (AIHA every 6 months/NELAC annually)

Demonstrated by (Select one):

☐ BS / BSD (4 consecutive spikes) ☐ RLV
☐ BS / BSD (2 consecutive batches) ☐ Desorption Efficiency Study
☐ 4 Consecutive QCS ☐ MDL / MDLV (Circle one)
☐ Side by Side Analysis/Supervisor Approval – when no spike is available
☐ Acceptable Proficiency Testing Sample ☐ PT/Work Order ID

_____ _____ _____
Analyst Supervisor Name and Title Signature Date

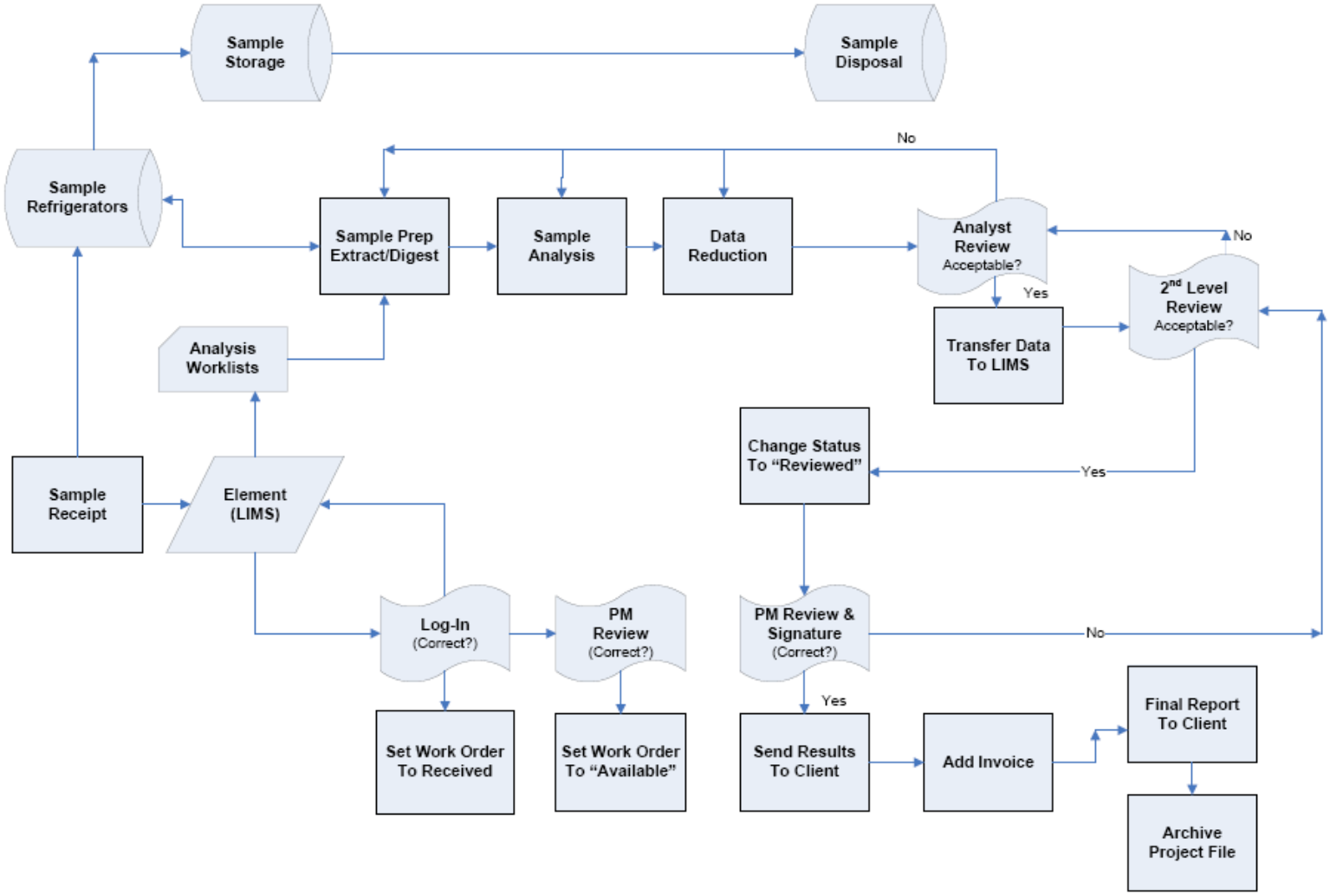
_____ _____ _____
Quality Assurance Officer's Name Signature Date

This certification form must be completed each time a NELAC and/or AIHA demonstration of capability study is completed.

True: Consistent with supporting data.
Accurate: Based on good laboratory practices consistent with sound scientific principles/practices.
Complete: Includes the results of all performance testing.

Comments:

Figure 19-2. Example: Work Flow



SECTION 20. EQUIPMENT and CALIBRATIONS

20.1 Overview

The laboratory purchases the most technically advanced analytical instrumentation for sample analyses. Instrumentation is purchased on the basis of accuracy, dependability, efficiency and sensitivity. Each laboratory is furnished with all items of sampling, preparation, analytical testing and measurement equipment necessary to correctly perform the tests for which the laboratory has capabilities. Each piece of equipment is capable of achieving the required accuracy and complies with specifications relevant to the method being performed. Before being placed into use, the equipment (including sampling equipment) is calibrated and checked to establish that it meets its intended specification. The calibration routines for analytical instruments establish the range of quantitation. Calibration procedures are specified in the Corporate SOP CA-Q-S-005 Calibration Curves (General), laboratory SOPs and in SOP PE-QAD-022 Good Calibration Procedures. A list of laboratory instrumentation is presented in Table 20-1.

Equipment is only operated by authorized and trained personnel. Manufacturers' instructions for equipment use are readily accessible to all appropriate laboratory personnel.

20.2 Preventive Maintenance

The laboratory follows a well-defined maintenance program to ensure proper equipment operation and to prevent the failure of laboratory equipment or instrumentation during use. This program of preventive maintenance helps to avoid delays due to instrument failure.

Routine preventive maintenance procedures and frequency, such as cleaning and replacements, should be performed according to the procedures outlined in the manufacturer's manual. Qualified personnel must also perform maintenance when there is evidence of degradation of peak resolution, a shift in the calibration curve, loss of sensitivity, or failure to continually meet one of the quality control criteria.

Table 20-2 lists examples of scheduled routine maintenance. It is the responsibility of each Technical/Department Manager to ensure that instrument maintenance logs are kept for all equipment in his/her department. Preventative maintenance procedures may be / are also outlined in analytical SOPs or instrument manuals. (Note: for some equipment, the log used to monitor performance is also the maintenance log. Multiple pieces of equipment may share the same log as long as it is clear as to which instrument is associated with an entry.)

Instrument maintenance logs are controlled and are used to document instrument problems, instrument repair and maintenance activities. Maintenance logs shall be kept for all major pieces of equipment. Instrument maintenance logs may also be used to specify instrument parameters.

- Documentation must include all major maintenance activities such as contracted preventive maintenance and service and in-house activities such as the replacement of electrical components, lamps, tubing, valves, columns, detectors, cleaning and adjustments.
- Each entry in the instrument log includes the Analyst's initials, the date, a detailed description of the problem (or maintenance needed/scheduled), a detailed explanation of the solution or

maintenance performed, and a verification that the equipment is functioning properly (state what was used to determine a return to control. e.g. CCV run on *'date'* was acceptable, or instrument recalibrated on 'date' with acceptable verification, etc.) must also be documented in the instrument records.

- When maintenance or repair is performed by an outside agency, service receipts detailing the service performed can be affixed into the logbooks adjacent to pages describing the maintenance performed. This stapled in page must be signed across the page entered and the logbook so that it is clear that a page is missing if only half a signature is found in the logbook.

If an instrument requires repair (subjected to overloading or mishandling, gives suspect results, or otherwise has shown to be defective or outside of specified limits) it shall be taken out of operation and tagged as out-of-service or otherwise isolated until such a time as the repairs have been made and the instrument can be demonstrated as operational by calibration and/or verification or other test to demonstrate acceptable performance. The laboratory shall examine the effect of this defect on previous analyses.

In the event of equipment malfunction that cannot be resolved, service shall be obtained from the instrument vendor manufacturer, or qualified service technician, if such a service can be tendered. If on-site service is unavailable, arrangements shall be made to have the instrument shipped back to the manufacturer for repair. Back up instruments, which have been approved, for the analysis shall perform the analysis normally carried out by the malfunctioning instrument. If the back up is not available and the analysis cannot be carried out within the needed timeframe, the samples shall be subcontracted.

If an instrument is sent out for service or transferred to another facility, it must be recalibrated and verified (including new initial MDL study) prior to return to lab operations.

20.3 Support Equipment

This section applies to all devices that may not be the actual test instrument, but are necessary to support laboratory operations. These include but are not limited to: balances, ovens, refrigerators, freezers, incubators, water baths, field sampling devices, temperature measuring devices, thermal/pressure sample preparation devices and volumetric dispensing devices if quantitative results are dependent on their accuracy, as in standard preparation and dispensing or dilution into a specified volume. All raw data records associated with the support equipment are retained to document instrument performance.

20.3.1 Weights and Balances

The accuracy of the balances used in the laboratory is checked every working day, before use. All balances are placed on stable counter tops.

Each balance is checked prior to initial serviceable use with at least two certified ASTM type 1 weights spanning its range of use (weights that have been calibrated to ASTM type 1 weights may also be used for daily verification). ASTM type 1 weights used only for calibration of other weights (and no other purpose) are inspected for corrosion, damage or nicks at least annually and if no damage is observed, they are calibrated at least every 5 years by an outside calibration laboratory. Any weights (including ASTM Type 1) used for daily balance checks or

other purposes are recalibrated/recertified annually to NIST standards (this may be done internally if laboratory maintains “calibration only” ASTM type 1 weights).
All balances are serviced annually by a qualified service representative, who supplies the laboratory with a certificate that identifies traceability of the calibration to the NIST standards.

All balances are serviced annually by a qualified service representative accredited to ISO 17025, who supplies the laboratory with a certificate that identifies traceability of the calibration to NIST standards.

All of this information is recorded in logs, and the recalibration/recertification certificates are kept on file in QA. For additional information, reference laboratory SOP PE-QAD-016 Balance Calibration and Documentation.

20.3.2 pH, Conductivity, and Turbidity Meters

The pH meters used in the laboratory are accurate to ± 0.1 pH units, and have a scale readability of at least 0.05 pH units. The meters automatically compensate for the temperature, and are calibrated with at least two working range buffer solutions before each use.

Conductivity meters are also calibrated before each use with a known standard to demonstrate the meters do not exceed an error of 1% or one umhos/cm.

Turbidity meters are also calibrated before each use. All of this information is documented in logs.

Consult pH and Conductivity, and Turbidity SOPs for further information.

20.3.3 Thermometers

All thermometers are verified on at least an annual basis with a NIST-traceable thermometer. IR thermometers are verified semi- annually, digital thermometers are verified quarterly.

The mercury and digital NIST thermometers are recalibrated every five years (mercury) and one year (digital) (unless thermometer has been exposed to temperature extremes or apparent separation of internal liquid) by an approved outside service and the provided certificate of traceability is kept on file. The NIST thermometer(s) have increments of 0.1 degree (0.5 degree or less increments are required for drinking water microbiological laboratories), and have ranges applicable to method and certification requirements. The NIST traceable thermometers are used for no other purpose than to calibrate other thermometers

All of this information is documented in logsheets. Monitoring method-specific temperatures, including incubators, heating blocks, water baths, and ovens, is documented in LIMS, instrument or method-specific logbooks or logsheets. More information on this subject can be found in the SOP PE-QAD-004 Thermometer Calibration.

20.3.4 Refrigerators/Freezer Units, Waterbaths, Ovens and Incubators

The temperatures of all refrigerator units and freezers used for sample and standard storage are monitored each working day. All of this information is documented in Daily Temperature Logsheets located in the QA office or in the Microbiology laboratory.

Ovens, waterbaths and incubators are monitored on days of use.

All of this equipment has a unique identification number, and is assigned a unique thermometer for monitoring.

Sample storage refrigerator temperatures are kept between 0ºC and ≤6 ºC.

Specific temperature settings/ranges for other refrigerators, freezers, ovens, waterbaths, and incubators can be found in method specific SOPs.

20.3.5 Autopipettors, Dilutors, and Syringes

Mechanical volumetric dispensing devices including burettes (except Class A Glassware and Glass microliter syringes) are given unique identification numbers and the delivery volumes are verified gravimetrically, at a minimum, on a quarterly basis.

For those dispensers that are not used for analytical measurements, a label is / can be applied to the device stating that it is not calibrated. Any device not regularly verified can not be used for any quantitative measurements.

Refer to SOP PE-QAD-002 Pipette Calibration for more information.

Micro-syringes are purchased from Hamilton Company. Each syringe is traceable to NIST. Hamilton attests to established accuracy and information is available on their website.

20.3.6 Field Sampling Devices (Auto Samplers)

Each Auto Sampler is assigned a unique identification number in order to keep track of the calibration. This number is also recorded on the sampling documentation.

The Auto Sampler is calibrated monthly by setting the sample volume to 100ml and recording the volume received. The results are filed in a logbook/binder. The Auto Sampler is programmed to run three (3) cycles and each of the three cycles is measured into a graduated cylinder to verify 100ml are received.

If the RSD (Relative Standard Deviation) between the 3 cycles is greater than 10%, the procedure is repeated and if the result is still greater than 10%, then the Auto Sampler is taken out of service until it is repaired and calibration verification criteria can be met. The results of this check are kept in a logbook/binder. (Please reference Table 20-5 for additional information.)

20.4 Instrument Calibrations

Calibration of analytical instrumentation is essential to the production of quality data. Strict calibration procedures are followed for each method. These procedures are designed to determine and document the method detection limits, the working range of the analytical instrumentation and any fluctuations that may occur from day to day.

Sufficient raw data records are retained to allow an outside party to reconstruct all facets of the initial calibration. Records contain, but are not limited to, the following: calibration date, method, instrument, analyst(s) initials or signatures, analysis date, analytes, concentration, response, type of calibration (Avg RF, curve, or other calculations that may be used to reduce instrument responses to concentration).

Sample results must be quantitated from the initial calibration and may not be quantitated from any continuing instrument calibration verification unless otherwise required by regulation, method or program.

If the initial calibration results are outside of the acceptance criteria, corrective action is performed and any affected samples are reanalyzed if possible. If the reanalysis is not possible, any data associated with an unacceptable initial calibration will be reported with appropriate data qualifiers (refer to Section 12).

Note: Instruments are calibrated initially and as needed after that and at least annually (the annual requirement does not apply to Isotope dilution).

20.4.1 Calibration Standards

Calibration standards are prepared using the procedures indicated in the Reagents and Standards section of the determinative method SOP. If a reference method does not specify the number of calibration standards, a minimum of 3 calibration points (exception being ICP and ICP/MS methods) will be used.

Standards for instrument calibration are obtained from a variety of sources. All standards are traceable to national or international standards of measurement, or to national or international standard reference materials.

The lowest concentration calibration standard that is analyzed during an initial calibration must be at or below the stated reporting limit for the method based on the final volume of extract (or sample).

The other concentrations define the working range of the instrument/method or correspond to the expected range of concentrations found in actual samples that are also within the working range of the instrument/method. Results of samples not bracketed by initial instrument calibration standards (within calibration range to at least the same number of significant figures used to report the data) must be reported as having less certainty, e.g., defined qualifiers or flags (additional information may be included in the case narrative). The exception to these rules is ICP methods or other methods where the referenced method does not specify two or more standards.

All initial calibrations are verified with a standard obtained from a second source and traceable to a national standard, when available (or vendor certified different lot if a second source is not available). This verification occurs immediately after the calibration curve has been analyzed, and before the analysis of any samples.

20.4.1.1 Calibration Verification

The calibration relationship established during the initial calibration must be verified initially and at least daily as specified in the laboratory method SOPs in accordance with the referenced analytical methods and in the 2009 TNI Standard and AIHA Industrial Hygiene Laboratory Accreditation Program (IHLAP). The process of calibration verification applies to both external standard and internal standard calibration techniques, as well as to linear and non-linear calibration models. Initial calibration verification is with a standard source secondary (second source standard), when available (or vendor certified different lot if a second source is not available). For unique situations, such as air analysis where no other source or lot is available, a standard made by a different analyst at a different time or a different preparation would be considered a second source to the calibration standards, but continuing calibration verifications may use the same source standards as the calibration curve.

Note: The process of calibration verification referred to here is fundamentally different from the approach called "calibration" in some methods. As described in those methods, the calibration factors or response factors calculated during calibration are used to update the calibration factors or response factors used for sample quantitation. This approach, while employed in other EPA programs, amounts to a daily single-point calibration.

All target analytes and surrogates, including those reported as non-detects, must be included in periodic calibration verifications for purposes of retention time confirmation and to demonstrate that calibration verification criteria are being met, i.e., RPD, per 2009 TNI Std. EL-V1M4 Sec. 1.7.2.

All samples must be bracketed by periodic analyses of standards that meet the QC acceptance criteria (e.g., calibration and retention time). The frequency is found in the determinative methods or SOPs.

Generally, the initial calibrations must be verified at the beginning of each 12-hour analytical shift during which samples are analyzed. (Some methods may specify more or less frequent verifications). The 12-hour analytical shift begins with the injection of the calibration verification standard (or the MS tuning standard in MS methods). The shift ends after the completion of the analysis of the last sample, QC, or standard that can be injected within 12 hours of the beginning of the shift.

A continuing instrument calibration verification (CCV) must be repeated at the beginning and, for methods that have quantitation by external calibration models, at the end of each analytical batch. Some methods have more frequent CCV requirements see specific SOPs. Most Inorganic methods require the CCV to be analyzed after ever 10 samples or injections, including matrix or batch QC samples.

If the results of a CCV are outside the established acceptance criteria and analysis of a second consecutive (and immediate) CCV fails to produce results within acceptance criteria, corrective

action shall be performed. Once corrective actions have been completed & documented, the laboratory shall demonstrate acceptable instrument / method performance by analyzing two consecutive CCVs, or a new initial instrument calibration shall be performed.

Sample analyses and reporting of data may not occur or continue until the analytical system is calibrated or calibration verified. However, data associated with an unacceptable calibration verification may be fully useable under the following special conditions:

a). when the acceptance criteria for the CCV are exceeded high (i.e., high bias) and the associated samples within the batch are non-detects, then those non-detects may be reported with a footnote or case narrative explaining the high bias. Otherwise the samples affected by the unacceptable CCV shall be re-analyzed after a new calibration curve has been established, evaluated and accepted; or

b). when the acceptance criteria for the CCV are exceeded low (i.e., low bias), those sample results may be reported if they exceed a maximum regulatory limit/decision level. Otherwise the samples affected by the unacceptable CCV shall be re-analyzed after a new calibration curve has been established, evaluated and accepted.

Samples reported by the 2 conditions identified above will be appropriately flagged.

20.4.1.2 Verification of Linear and Non-Linear Calibrations

Calibration verification for calibrations involves the calculation of the percent drift or the percent difference of the instrument response between the initial calibration and each subsequent analysis of the verification standard. (These calculations are available in the laboratory method SOPs. Verification standards are evaluated based on the % Difference from the average CF or RF of the initial calibration or based on % Drift or % Recovery if a linear or quadratic curve is used.

Regardless of whether a linear or non-linear calibration model is used, if initial verification criterion is not met, then no sample analyses may take place until the calibration has been verified or a new initial calibration is performed that meets the specifications listed in the method SOPs. If the calibration cannot be verified after the analysis of a single verification standard, then adjust the instrument operating conditions and/or perform instrument maintenance, and analyze another aliquot of the verification standard. If the calibration cannot be verified with the second standard, then a new initial calibration is performed.

20.5 Tentatively Identified Compounds (TICs) – GC/MS Analysis

For samples containing components not associated with the calibration standards, a library search may be made for the purpose of tentative identification. The necessity to perform this type of identification will be determined by the purpose of the analyses being conducted. Data system library search routines should not use normalization routines that would misrepresent the library or unknown spectra when compared to each other. TICs must be identified as such when reported to the client.

Note: If the TIC compound is not part of the client target analyte list but is calibrated by the laboratory and is both qualitatively and/or quantitatively identifiable, it should not be reported as

a TIC. If the compound is reported on the same form as true TICs, it should be qualified and/or narrated that the reported compound is qualitatively and quantitatively (if verification in control) reported compared to a known standard that is in control (where applicable).

For example, the RCRA permit or waste delisting requirements may require the reporting of non-target analytes. Only after visual comparison of sample spectra with the nearest library searches may the analyst assign a tentative identification.

20.6 GC/MS Tuning

Prior to any GCMS analytical sequence, including calibration, the instrument parameters for the tune and subsequent sample analyses within that sequence must be set.

Prior to tuning/auto-tuning the mass spec, the parameters may be adjusted within the specifications set by the manufacturer or the analytical method. These generally don't need any adjustment but it may be required based on the current instrument performance. If the tune verification does not pass it may be necessary to clean the source or perform additional maintenance. Any maintenance is documented in the maintenance log.

Table 20-1. Instrumentation List

Instrument Type	Manufacture	Model Number	Serial Number	Year Put into Service	Condition When Received
Volatiles:					
GCMS 1 Gas Chromatograph Mass Spectrometer P&T Concentrator Autosampler	Hewlett Packard Agilent Tekmar Varian	6890 5973 3000 Archon	US00007754 US70810388 95325005 13472	1997	-
GCMS 2 Gas Chromatograph Mass Spectrometer P&T Concentrator Autosampler	Hewlett Packard Hewlett Packard OI OI	5890 5971 4560 Archon	3033A30276 2950A00789 224071 13559	2001	-
GCMS 4 Gas Chromatograph Mass Spectrometer P&T Concentrator Autosampler	Hewlett Packard Hewlett Packard OI OI	5890 5971 4560 Archon	3240G18320 3234A04143 N124460502 13025	2001	-
GCMS 6 Gas Chromatograph Mass Spectrometer P&T Concentrator Autosampler	Agilent Agilent Tekmar Varian	6850 5973 3000 Archon	US00002193 US10440932 96055001 13624	2001	-
GCMS 7 Gas Chromatograph Mass Spectrometer P&T Concentrator Autosampler	Agilent Agilent Tekmar Tekmar	5890 5972 3100 2016	3336A60504 3524A03129 US01281001 95298002	--	-
GCMS 9 Gas Chromatograph Mass Spectrometer P&T Concentrator Autosampler	Hewlett Packard Hewlett Packard OI Analytical Varian	5890 5972 4660 Archon	- 3307A00428 D611466185P 14623	--	-

Instrument Type	Manufacture	Model Number	Serial Number	Year Put into Service	Condition When Received
GCMS 13 Gas Chromatograph Mass Spectrometer P&T Concentrator Autosampler	Hewlett Packard Hewlett Packard Tekmar EST	5890 5972 3000 Centurion	3133A37877 3549A03207 97223016 CENTS120100709	--	-
GCMS 10 Gas Chromatograph Mass Spectrometer Autosampler Preconcentrator Canister Cleaner Dynamic Diluter *(Shared with IH)*	Agilent Agilent Entech Entech Entech Entech	6890 5973 7032L 7100 3100 4600	US0039506 US03960554 0043 0162 0103 0041	--	-
GCMS 11 Gas Chromatograph Mass Spectrometer Autosampler Preconcentrator Canister Cleaner *(Shared with IH)*	Agilent Agilent Entech Entech Entech	6890N 5973 7032L 7100 3100	US10133093 US10461255 0061 0259 0155	--	-

Semi-Volatiles:					
Gas Chromatograph 1: (*shared with IH)* ALS Tower ALS Tray Controller Box FPD1 FPD2	 Agilent Agilent Agilent Agilent Agilent	 5890 18593B 18596B 18594B 19256A 19256A	 2750A18397 3108A25342 3106A24228 3018A22248 NA NA	 1990	 --
Gas Chromatograph 2 ALS Tower ALS Tray Controller Box ECD1 ECD2	Agilent Agilent Agilent Agilent Agilent Agilent	5890 Series II 18593B 18596C G1512A G1223A G1223A	3108A34049 3508A41897 US30608322 CN00003596 K0668 F5885	 1988	 --
Gas Chromatograph 3 Linkbox ALS Concentrator PID Lam Power Source ECD/PID	Agilent OI Analytical EST Analytical EST Analytical OI Analytical OI Analytical	5890 Series II 600 Series CentWS Encon EV 4430 NA	3336A51039 5192110120 CENTS138022210 EV239012910 B348430309 NA	1995 2010 1995	
Gas Chromatograph 4 Concentrator ALS PID Lamp Power Source ECD/PID	Agilent OI Analytical OI Analytical OI Analytical OI Analytical	5890 Series II 4560 MPM16 4430 NA	2950A26451 D309335 91-369 91-171 NA	 1995	
Gas Chromatograph 5 ALS Tower ALS Tray Controller Box FID MACH MACH Power Box	Agilent Agilent Agilent Agilent Agilent Agilent (former RVM Scientific Agilent	5890 18593B 18596M 18594B NA NA LTMA58/A68PS	2643A9891 3042A23537 3251A30857 3239A30053 NA NA G E-01	1990 2005 	 --

Instrument Type	Manufacture	Model Number	Serial Number	Year Put into Service	Condition When Received
Gas Chromatograph 7					
(shared with IH)	Agilent	6890	US00000197		
ALS Tower	Agilent	G2613	CN33832614		
ALS Tray	Agilent	G2614A	US91605057		
u-ECD1	Agilent	G2397A	U1290		
u-ECD2	Agilent	G2397A	U6313	2003	--
Gas Chromatograph 11	Agilent	5890A	3140A38412		
ALS Tower	Agilent	18593B	3048A24494		
ALS Tray	Agilent	18596B	3246A30486		
Controller Box	Agilent	18594A	2929A15556		
ECD2	Agilent	G1223A	F6883	1990	--
Gas Chromatograph 12	Agilent	6890	US00001438		
ALS Tower	Agilent	G1513A	US05012072		
ALS Tray	Agilent	18596M	US30608322		
Controller Box	Agilent	G1512A	3530A02441		
u-ECD1	Agilent	G2397A	U2666		
u-ECD2	Agilent	G2397A	U0495	1997	
High-Performance Liquid Chromatograph 3				2004	New
ALS	Agilent	G131A	DE23922078		
COL COM	Agilent	G1316A	DE23930798		
FLD	Agilent	G1321A	DE92001260	2009	
Dual-DAD	Agilent	G1315B	DE30518838	2004	
DEGASSER	Agilent	G1379A	JP13205067		
QUAD PUMP	Agilent	G1311A	DE23920683		
GCMS12					
Gas Chromatograph	Agilent	G1530A	US00040094		
Mass Spectrometer	Agilent	G2578A	US21853018		
ALS Tower	Agilent	G2613A	US93909504		
ALS Tray	Agilent	G2614A	US92905661	2000	--
GCMS14					
Gas Chromatograph	Agilent	G1530N	CN10430038		
Mass Spectrometer	Agilent	G3172A	US54431689		
ALS Tower	Agilent	G2913A	CN81247973		
ALS Tracy	Agilent	G2614A	CN80647378	2004	--
Extractions:					
Accelerated Solvent Extractor #3	Dionex	200	99030374	2003	--
Accelerated Solvent Extractor #4	Dionex	ASE 200	97040459	2002	--
Accelerated Solvent Extractor #5	Dionex	ASE 200	3040683	2005	--
Accelerated Solvent Extractor #6	Dionex	ASE 200	03110492	2011	New
Accelerated Solvent Extractor #7	Dionex	ASE 200	03110490	2011	New
Nanopure Water System	Barnstead	4741	747940357923	1998	--
Muffle Furnace	Thermolyne	62700	627970243372	1999	--
BL006: Analytical Balance *(Shared with IH)*	Sartorius	CP225D	14204830	--	--
Refrigerator Recirculator	Neslab	CFT-75	87KML60200-20	1999	--
Metals:					
ICP03 *(Shared with IH)*	Perkin Elmer	5300DV	077C7070202	2006	New

Instrument Type	Manufacture	Model Number	Serial Number	Year Put into Service	Condition When Received
ICP02 *(Shared with IH)*	Perkin Elmer	5300DV	077N6041401	2006	New
ICP/MS01 *(Shared with IH)*	Perkin Elmer	ELAN 6100	G2700107	2001	New
ICP/MS02 *(Shared with IH)*	Thermo	X - Series	X0376		Used
Mercury Analyzer 02 *(Shared with IH)*	Perkin Elmer	FIMS 100	101S4080502	2004	New
Mercury Analyzer 03	Perkin Elmer	FIMS 400	135951	2000	--
Hot Block Digestor A *(Shared with IH)*	Environ. Expr.	SC154	1423CEC1098	--	--
Hot Block Digestor C *(Shared with IH)*	Environ. Expr.	SC154	526CEC0747		
Hot Block Digestor D *(Shared with IH)*	Environ. Expr.	SC154	2484CEC1296		
Hot Block Digestor E *(Shared with IH)*	Environ. Expr.	SC154	1423CEC1099		
Hot Block Digestor F *(Shared with IH)*	Environ. Expr.	SC154	424CEC0592	2003	New
Hot Block Digestor B *(Shared with IH)*	Environ. Expr.	SC154	1944CEC1006	2001	New
TCLP Rotator	Environ. Expr.	--	--	--	--
TCLP Rotator	Environ. Expr.	--	--	--	--

Wet Chemistry:					
Ion Chromatograph 3	Dionex	ICS1000	04050018	2004	New
Autosampler	Dionex	AS40	95090256	1995	--
Ion Chromatograph 4	Dionex	ICS2000	05090476	2005	New
Autosampler	Dionex	AS40	05090256	2005	New
Ion Chromatograph 5	Dionex	ICS2000	04050699	2006	New
Autosampler	Dionex	AS40	94110334	1994	--
Ion Chromatograph 6	Dionex	ICS2000	07020086	2007	New
Autosampler	Dionex	AS40	04040861	2004	New
PC Titrator 1					
PC Titrate Interface Module	ManTech	PC-1000-102/4	MS-0A4-357	2003	New
Titra-Sip Titration Module	ManTech	PC-1300-475	MS-0D4-634	2003	New
Burivar I/2 Buret Module	ManTech	PC-1104-00	MS-9B9-399	2003	New
Titra-Rinse/A Module	ManTech	PC-1000-408	MS-0J3-167	2003	New
Conductivity Meter	Jenway	4510	1106	2003	New
Autosampler	ManTech	--	270J3XB590	2003	New
PC Titrator 2					
Titra-Sip SA Interface Module	ManTech	PC-1075-00	MS-1H0-105	2010	New
Titra-Sip Titration Module	ManTech	PC-1300-475	MS-1F0-817	2010	New
Titra-Rinse/A Module	ManTech	PCM-1000-470	MS-0F4-191	2010	New
Titra-Rinse/A Module	ManTech	PCM-1000-400	MS-0J2-535	2010	New
Autosampler	ManTech	PC-1000-681	190A3032	2010	New

Instrument Type	Manufacture	Model Number	Serial Number	Year Put into Service	Condition When Received
BOD Auto-Analyzer					
Interface Module	ManTech	PC-1085-00	MS-1B0-136	2010	New
Titra-Rinse/A Module	ManTech	PC-1000-480	MS-0F5-243	2010	New
Titra-Rinse/A Module	ManTech	PC-1000-443	MS-1A0-111	2010	New
Sensor &Stirrer Control	ManTech	PB-10030	MS-1B0-106	2010	New
Inhibitor Pump	ManTech	PC-1000-475	MS-1B0-118	2010	New
Rinse Pump	ManTech	PC-1000-470	MS-1B0-113	2010	New
Dissolved Oxygen Meter 2	YSI	52CE	03J0616	2003	New
Autosampler	ManTech	PBM-1000-688	260A8N025	2010	New
Total Organic Carbon Analyzer	Shimadzu	TOC-V-CSH	40D91227	2002	--
Autosampler	Shimadzu	ASI-V	H52104100104	2002	--
Pensky-Martins Flash Tester	Fisher Scientific	--	20800023	--	--
UV-Vis Spectrophotometer	Shimadzu	UV Pharma Spec 1700	A11024136179 CS	2003	New
Turbidimeter	HF Scientific	Micro-100	200702190	2007	New
Dissolved Oxygen Meter	YSI	5000	99D0533	--	--
pH / ISE Meter 3	Thermo/Orion	710A	060237	--	--
pH / ISE Meter 4	Orion	420A	014395	--	--
pH / ISE Meter 5	Orion	420A	24440	--	--
Conductivity / pH Meter	Hach	HQ30d	060600000983	2006	New
Conductivity Meter	Control Company		98291048	--	--
COD Block Reactor 3	Hach	45600-00	010700022054	--	--
COD Block Reactor 4	Hach	LTG082.54.42001	1218899	2006	NEW
COD Block Reactor	Hach	LTG082.54.44001	1156212	2007	NEW
TKN Digestion System					
Block	Aim Lab	AIM600	4904A14055	2008	New
Controller	Aim Lab	AIM 600	4906A14087	2008	New
Cyanide MIDI - Distillation System	Lab Crest	110-10-REG	SNA4U0072	--	--
Cyanide MIDI - Distillation System	Lab Crest	110-10-R	A9P0209	--	--
Hot Block Digestor	Environ. Expr.	SC100	615CEC0860	--	--
BOD Incubator 04	VWR	2020	05103004	--	--
BOD Incubator 05	Revco	--	--	--	--
BOD Incubator 06	Lab Line	3554-40	1097-001	--	--
Analytical Balance 009	Ohaus	Scout Pro SP601	7122181160	--	--
Analytical Balance 012	Mettler Toledo	AX205	1122481540	--	--
Analytical Balance 017	Sartorius	A1205-**D20	39050003	--	--
Analytical Balance 019	Mettler	AE260-5	G31175	--	--
Drying Oven 004	VWR	1305U	0705590	--	--
Drying Oven 006	VWR	1320	0800599	--	--
Drying Oven 007	Blue M	OV-500C-2	OV3-24912		
Drying Oven 010	Fisher Scientific	630G	20400063	--	--
Muffle Furnace 01	ThermoLyne	62700	--	--	--
E-Pure System	Barnsted	D4641	1090050246637	--	--
Centrifuge	Beckman	TJ-6	0A058	--	--
Reciprocal Shaker	Lab Line	3506	0793-0453	--	--
Mini Vortexer	VWR	VM3000	25347	--	--

Microbiology :					
Quanti Tray Sealer	Idexx	2020	--	2002	Used
Quanti Tray Sealer	Idexx	QT001	4120	2005	Used
Water Bath 8	Precision	51221033	601121635	2002	New

Instrument Type	Manufacture	Model Number	Serial Number	Year Put into Service	Condition When Received
Water Bath 6	Boekel	GD100L	GL054300	--	New
Water Bath 5	Boekel	GD100L	GL0450003	--	New
Incubator 4	Thermo	3973	304764	2005	New
Incubator 5	VWR	1915	--	1992	New
Mini Vortexer	VWR	VM3000	060223015	2003	--
Analytical Balance	Ohaus	Adventuer-Pro	8026421198	2005	New
Microscope	Nikon	Nme	135387	--	New
Microscope	Leica	Zoom 2000	132DEZ	--	New

Industrial Hygiene:					
HPLC2 High Performance Liquid Chromatograph 1100 ALS	Agilent	G1313A G1322A G1311A G1316A G1321A G1315B	DE91610196 JP73020320 DE11114347 DE91612722 DE92001665 DE11112225	--	--
HPLC4 High Performance Liquid Chromatograph 1100 ALS / LCQ Advantage Mass Spectrometer w/ DAD and Fluorescence Detectors	Agilent / Thermo -Finnigan	G1313A G1322A G1311A G1316A G1321A G1315A LCQADV	DE11115352 JP05029135 DE91608229 DE11120753 DE11103117 DE91607422 LAD00192	--	--
GC1: Controller 7673 Autosampler Injector 7673 Gas Chromatograph w/ dual FPD Detectors *(Shared with SVOA)*	Agilent	7673 18596 B 7673 5890	3018A22248 3106A24228 3108A25342 7750A18397	-- -- -- 1990	--
GC14: Controller Autosampler Injector Gas Chromatograph w/ dual FID Detectors	Agilent	7673 18596 B 7673 5890 Series II	3007A20952 3201A27340 3237A32148 3140A39271	-- -- -- --	--
GC13: Controller Injector Gas Chromatograph w/ FID and TCD Detectors	Agilent	7673 7673 5890 Series II	3113A25897 3048A24489 3140A38303	-- -- -- --	--
GC9: Controller Autosampler Injector Gas Chromatograph w/ FID Detector	Agilent	7673 18596 B 7673 5890 Series II	3251A30932 3334A32981 3120A26800 3118A35369	-- -- -- --	--
GC7: Autosampler Injector Gas Chromatograph w/ dual ECD Detectors *(Shared with SVOA)*	Agilent	G2614A 7683 6890	US91605057 CN33832614 US00000197	-- -- -- --	--
GC-MS 8: Gas Chromatograph Mass Spectrometer ATD	Hewlett Packard Agilent Perkin Elmer	6890 5973 TurboMatrix 650	3235A44760 3329A00483 TD650L0605128	2010	Used

Instrument Type	Manufacture	Model Number	Serial Number	Year Put into Service	Condition When Received
GCMS 10 Gas Chromatograph Mass Spectrometer Autosampler Preconcentrator Canister Cleaner Dynamic Diluter *(Shared with VOA)*	Agilent Agilent Entech Entech Entech Entech	6890 5973 7032L 7100 3100 4600	U50039506 U503960554 0043 0162 0103 0041		
GCMS 11 Gas Chromatograph Mass Spectrometer Autosampler Preconcentrator Canister Cleaner *(Shared with VOA)*	Agilent Agilent Entech Entech Entech Entech	6890 5973 7032L 7100 3100 4600	U50039506 U503960554 0043 0162 0103 0041		
ICP03 *(Shared with Metals)*	Perkin Elmer	5300DV	077C7070202	2006	New
ICP02 *(Shared with Metals)*	Perkin Elmer	5300DV	077N6041401	2006	New
ICP/MS01 *(Shared with Metals)*	Perkin Elmer	ELAN 6100	G2700107	2001	New
ICP/MS02 *(Shared with Metals)*	Thermo	X - Series	X0376		Used
Mercury Analyzer 02 *(Shared with Metals)*	Perkin Elmer	Fims 100	101S4080502	2004	New
Hot Block Digestor A *(Shared with Metals)*	Environ. Expr.	SC154	1423CEC1098	--	--
Hot Block Digestor B *(Shared with Metals)*	Environ. Expr.	SC154	1944CEC1006	--	--
Hot Block Digestor C *(Shared with Metals)*	Environ. Expr.	SC154	526CEC0747		
Hot Block Digestor D *(Shared with Metals)*	Environ. Expr.	SC154	2484CEC1296		
Hot Block Digestor E *(Shared with Metals)*	Environ. Expr.	SC154	1423CEC1099		
Hot Block Digestor F *(Shared with Metals)*	Environ. Expr.	SC154	424CEC0592	2003	New
IC2: Ion Chromatograph Interface AS-40 Autosampler	Dionex PE Nelson Dionex	DX-120 900 AS-40	97070800 1036512763 94120305	-- -- --	Used
IC7: Ion Chromatograph Pump TC VWD Pneumatic Controller Autosampler	Dionex	ICS 3000 ICS 3000 ICS 3000 ICS 3000 PC-10 AS-40	-- 08050969 08041101 08050957 063334 08051080	2008 2008 2008 2008 2008 2008	New New New New New New
SPEC2: Spectrophotometer	Turner	SP-830	1102980604474	--	--
BL006 : Analytical Balance *(Shared with SVOA)*	Sartorius	CP225D	14204830	--	--
BL020: Analytical Balance	Denver Instrument	XL-3100	0079735	2010	Used

Table 20-2. Example: Schedule of Routine Maintenance

Instrument	Procedure	Frequency
Mercury Analyzer	Check tubing for wear	Daily
	Fill rinse tank with 10% HCl	Daily
	Insert clean drying tube filled with Magnesium Perchlorate	Daily
	Fill reductant bottle with 10% Stannous Chloride	Daily
ICP	Check pump tubing	Daily
	Check liquid argon supply	Daily
	Check fluid level in waste container	Daily
	Check filters	Weekly
	Clean or replace filters	As required
	Check torch	Daily
	Check sample spray chamber for debris	Monthly
	Clean and align nebulizer	Monthly
	Check entrance slit for debris	Monthly
	Change printer ribbon	As required
	Replace pump tubing	As required
ICP MS	Change pump tubing	Weekly
	Clean torch	Weekly
	Check / clean nebulizer	Weekly
	Clean cones	Daily
	Check air filters	Weekly
	Check multiplier voltages & do cross calibration	Weekly
	Replace sample uptake tubing	Monthly
	Check rotary pump oil	Monthly
	Check oil mist filters	Monthly
	Check chiller water level	Monthly
UV-Vis Spectrophotometer	Clean ambient flow cell	As required
	Precision check/alignment of flow cell	As required
	Wavelength verification check	Semi-annually
Auto Analyzers	Clean sampler	Daily
	Check all tubing	Daily
	Clean inside of colorimeter	Daily
	Clean pump well and pump rollers	Quarterly
	Clean wash fluid receptacle	Weekly
	Oil rollers/chains/side rails	Weekly
	Clean optics and cells	Quarterly
Hewlett Packard GC/MS	Ion gauge tube degassing	As required
	Pump oil-level check	Monthly
	Pump oil changing	Annually
	Analyzer bake-out	As required
	Analyzer cleaning	As required
	Resolution adjustment	As required
	COMPUTER SYSTEM AND PRINTER:	
	Air filter cleaning	As required
	Change data system air filter	As required
	Printer head carriage lubrication	As required
	Paper sprocket cleaning	As required
	Drive belt lubrication	As required

Instrument	Procedure	Frequency
Gas Chromatograph	Compare standard response to previous day or since last initial calibration Check carrier gas flow rate in column Check temp. of detector, inlet, column oven Septum replacement Check system for gas leaks with SNOOP Check for loose/frayed wires and insulation ½"Bake injector/column Change/remove sections of guard column Replace connectors/liners Change/replace column(s)	Daily Daily via use of known compound retention Daily As required W/cylinder change as required Monthly As Required As Required As Required As Required
Electron Capture Detector (ECD)	Detector wipe test (Ni-63) Detector cleaning	Semi-annually As required
Flame Ionization Detector (FID)	Detector cleaning	As required
Flame Photoionization Detector (FPD)	Clean and/or Replace Lamp	As required
Photoionization Detector (PID)	Change O-rings Clean lamp window	As required As required
HPLC	Change guard columns Change lamps Change pump seals Replace tubing Change fuses in power supply Filter all samples Change autosampler rotor/stator	As required As required Semi-annually or as required As required As required Daily As required
Balances	Class "S" traceable weight check Clean pan and check if level Field service	Daily, when used Daily At least Annually
Conductivity Meter	0.01M KCl calibration Conductivity cell cleaning	Daily As required
Turbidimeter	Check light bulb	Daily, when used
Deionized/Distilled Water	Conductivity Point Sources Daily conductivity check Check deionizer light Monitor for VOA's System cleaning Replace cartridge & large mixed bed resins	Water Quality Daily Daily As required As required
Drying Ovens	Temperature monitoring Temperature adjustments	Daily As required
Refrigerators/ Freezers	Temperature monitoring Temperature adjustment Defrosting/cleaning	Daily As required As required
Vacuum Pumps/ Air Compressor	Drained Belts checked Lubricated	As required As required Semi-annually

Instrument	Procedure	Frequency
pH/Specific Ion Meter	Calibration/check slope Clean electrode	Daily As required
BOD Incubator	Temperature monitoring Coil and incubator cleaning	Daily Monthly
Water baths	Temperature monitoring Water replaced	Daily Monthly or as needed

Table 20-3. Preventative Maintenance for Laboratory Equipment

Instrument/ Equipment Type	Preventative Maintenance	Frequency
Gas Chromatograph	Replace Gas line dryers and filters	As needed
	Replace Gas cylinders	As needed
	Check or adjust column gas flow and/or detector make-up flow	As needed
	Replace Injection port Septa	As needed
	Replace Injection port liners/re-silonize liners	GC, As needed; GC/MS, Daily
	Replace Injection port liner o-ring	GC, As needed; GC/MS, Daily
	Replace inlet seal and ring	GC, As needed, GC/MS, Daily
	Replace column ferrules	GC, As needed; *
	Clip column (injector and detector end)	GC, As needed; GC/MS, Daily
	Replace syringes on autosamplers	As needed
	Replace heated-zones heaters and sensors	As needed
	Replace inlet assembly	As needed
	Empty solvent rinse and solvent rinse-waste vials (on autosampler tower)	Daily or as needed
	Replace column	As needed
Flame Ionization Detector (FID)	Clean/replace jet	As needed
	Clean collector	As needed
	Check and/or adjust gas flows	As needed
	Replace graphite ferrule	After each cleaning (OI detectors only)
Photoionization Detector (PID)	Clean window	As needed
	Replace o-ring seat	As needed
	Replace Lamp	As needed
	Check and/or adjust gas flows	As needed
	Adjust Lamp power supply intensity	As needed
Flame Photometric Detector (FPD)	Clean mirrors/lenses	As needed
	Replace mirrors/lenses	As needed
	Replace o-rings	As needed
Mass Spectrometer (MS)	Clean source, replace source parts, replace filaments	As needed
	Clean analyzer	As needed

Instrument/ Equipment Type	Preventative Maintenance	Frequency
	Replace electron multiplier	As needed
	Clean or replace glass jet separator, replace transfer line from jet separator to MS	As needed
	Change rough pump oil	As needed
Purge and Trap Equipment	Refill rinse water supply/Empty rinse water waste	Weekly or as needed
	Refill spiking solutions vials	As needed
	Rinse sparge tubes	Daily
	Clean or replace 6-port valve	As needed
	Replace Transfer lines (from Autosampler to LSC and from LSC to GC)	As needed
	Adjust gas flows and pressures	As needed
	Perform leak check	As needed
High Pressure Liquid Chromatography (HPLC)	Calibrate Detector	As needed
	Replace pre-column filter	As needed
	Refill Solvent reservoirs	Daily or as needed
	Reverse column and rinse with solvents	Daily or as needed*
	Replace column	As needed
	Clean solvent reservoir filters	As needed
	Replace Guard Column	As needed
	Replace solvent reservoir frits	As needed
	Replace ball-valve cartridges on high pressure pump	As needed*
	Replace DAD flow cell windows	As needed*
	Check system solvent pressure	Daily
Inductively Coupled Plasma, Atomic Emission Spectrometer (ICP-AES)	Replace Peristaltic pump tubing	As needed
	Clean autosampler, change tubing	As needed
	Clean nebulizer and torch assembly	As needed
	Replace nitrogen and argon tanks	As needed
	Refill rinse water receptacle	Daily
	Empty waste receptacle	Daily
	Check for internal standard and sample flow through peristaltic pump tubing	As often as possible
	Replace internal standard solution receptacle	As needed
	Operate and check vents	Daily
	Perform Hg alignment	Daily
	Check water level and water filter on recirculating-cooling unit, refill and replace filter	Check daily, refill and replace as needed
	Check purge windows	Daily, replace as needed
	Replace nebulizer and o-rings	As needed
	Replace torch	As needed
	Drain air compressor	Weekly

Instrument/ Equipment Type	Preventative Maintenance	Frequency
	Replace mixing chambers	As needed
	Clean or replace air filters	Weekly
	Check pneumatic filters	Weekly, replace as needed
	Perform wave calibration (UV and Vis)	Quarterly*
Mercury Analyzer	Change Argon supply tank	As needed
	Change drying tube	Daily or as needed
	De-clog drying tube and/or reductant tubing	Daily or as needed
	Change system tubing	2-3 weeks
	Rinse tubing prior to operation and following operation	Daily
	Clean optical cell	As needed (when aperture is out of line)
pH Meters	Clean or replace electrode	As needed
	Refill electrode electrolyte	As needed
Balance	Clean pan and platform	After each use
	Check Level bubble	Daily
	Check calibration	Daily
	Check sensitivity	Weekly
	Cleaning and calibration by authorized service	Annually
Conductivity Meter	Clean probe	As needed
Dissolved Oxygen Meter	Replace membrane	As needed
	Clean probe	As needed
ZHE vessels	Replace o-rings and screens	As needed
ZHE and TCLP Tumblers	Check Rotation Rate	Monthly
Spectrophotometers	Clean and check tubing	As needed
Burettes and Pipettes	Clean and check calibration	Quarterly
Thermometers	Check calibration	Annually, Quarterly for Digitals and IR Thermometer
Ovens	Check and/or adjust temperature, record temperature on log sheet	Daily
Refrigerators and Freezers	Check and/or adjust temperature, record temperature on log sheet	Daily
	Defrost freezers	As needed

Table 20-4. Periodic Calibrations

Instrument	Type of Calibration/ Number of Standards	Frequency	Acceptance Limits	Corrective Action
Analytical Balance	Accuracy determined using NIST calibrated weights. Minimum of 2 standards bracketing the weight of interest. Annually inspected and calibrated by ISO accredited firm.	Daily	See logbook	Clean, check level, insure lack of drafts, and that unit is warmed up, recheck. If fails, call service or replace.
Top Loading Balance	Accuracy determined using-NIST calibrated weights. Minimum of 2 standards bracketing the weight of interest. Annually inspected and calibrated by ISO accredited firm.	Daily	See logbook	Clean. If fails, call service or replace.
NIST Weights	Accuracy determined by accredited weights and measurement laboratory.	5 year	As per certificate.	Replace.
Working Weights	Examine for wear, compare against NIST weights.	Annually	ASTM Type 1, Class 1 or 2 standards	Replace.
NIST-Traceable Thermometer	Accuracy determined by accredited weights and measurement laboratory.	5 years	As per certificate.	Replace.
Working Thermometers	Against NIST-traceable thermometer	Yearly (or more frequently e.g. digital are checked quarterly) at appropriate temperature range for intended use	± 1.0°C	Replace.

Instrument	Type of Calibration/ Number of Standards	Frequency	Acceptance Limits	Corrective Action
InfraRed Temperature Guns	Against calibrated liquid thermometer at ambient and storage temps Against NIST-traceable thermometer	Daily Semi-annually at appropriate temperature range for intended use.	± 0.5°C ± 1.0°C	Repair/replace. Repair/replace.
Dial-type Thermo-meters	Against NIST-traceable thermometer	Quarterly at appropriate temperature range for intended use.	± 1.0°C	Replace.
Refrigerator	Temperature checked using NIST-traceable thermometer.	Daily. If out of range, recheck in two hours.	0 to ≤ 6°C	Adjust. Repair. While waiting for repair, seal door, attach "Out of Service" sign, move items to functional unit. Notify Department Manager.
Freezer	Temperature checked using NIST-traceable thermometer	Daily. If out of range, recheck in two hours.	≤ (-10)°C	Adjust. Repair. While waiting for repair, seal door, attach "Out of Service" sign, move items to functional unit. Notify Department Manager.
Oven	Temperature checked using NIST-traceable thermometer.	When in use.	104 ± 1°C (drying) 180 ± 2°C (TDS); or as per method.	Adjust. Replace.
Incubator	Temperature checked using NIST-traceable thermometer.	When in use. For micro-biology, twice daily when in use.	BOD: 20 ± 1.0°C Micro: 35 ± 0.5°C	Adjust. Replace.
Water Bath	Temperature checked using NIST-traceable thermometer.	When in use.	See analytical SOP.	Adjust. Replace.

Instrument	Type of Calibration/ Number of Standards	Frequency	Acceptance Limits	Corrective Action
Volumetric Dispensing Devices (Eppendorf ® pipette, automatic dilutor or dispensing devices)	One delivery by weight. Using DI water, dispense into tared vessel. Record weight with device ID number. See SOP.	Monthly	± 2% Calculate accuracy by dividing weight by stated volume times 100 for percent.	Adjust. Replace.
Glass Microliter Syringes	None	Hamilton syringes are ordered with a certificate attesting to their accuracy.	Re-verified.	Replaced.
Conductivity Meter	Cell impedance calibrated with three KCl standards.	Each use.	r ≥ 0.99	Recalibrate.
Nanopure Water	Check in-line conductivity meter on system with conductivity meter in Inorganics Department.	Each day of use.	<10 µmhos/cm^2	Record in logbook. Report discrepancies to the Department Manager.
	Check for compliance with Standard Methods reagent water requirements	Monthly	Ammonia <.01mg/L Res. Cl <0.01 mg/L pH 5.5 – 7.5 SU TOC <1 mg/L HPC <1000 CFU/mL	Record in logbook. Report discrepancies to the Department Manager.

Table 20-5. Preventative Maintenance for Field Equipment

Instrument/ Equipment Type	Activity	Frequency	Maintenance
Automatic Sampler – ISCO 3710/3910	Check tubing and connections through pump head	Before and after use	Replace tubing when necessary
	Check battery power and program	Before and after use	Replace battery when necessary
	Clean tubing in pump head	After each use	Replace pump head tubing when necessary
	Clean tubing for sample collection	After each use	Not applicable
	Check functionality – manual sample; program sample	Prior to use	Not applicable
	Check sample container for breakage, etc.	Prior to use	Replace if needed

SECTION 21. MEASUREMENT TRACEABILITY

21.1 Overview

Traceability of measurements shall be assured using a system of documentation, calibration, and analysis of reference standards. Laboratory equipment that are peripheral to analysis and whose calibration is not necessarily documented in a test method analysis or by analysis of a reference standard shall be subject to ongoing certifications of accuracy. At a minimum, these must include procedures for checking specifications of ancillary equipment: balances, thermometers, temperature, Deionized (DI) and Reverse Osmosis (RO) water systems, automatic pipettes and other volumetric measuring devices (Refer to Section 20.3). With the exception of Class A Glassware and Glass microliter syringes, quarterly accuracy checks are performed for all mechanical volumetric devices. Wherever possible, subsidiary or peripheral equipment is checked against standard equipment or standards that are traceable to national or international standards. Class A Glassware and Glass microliter syringes should be routinely inspected for chips, acid etching or deformity (e.g., bent needle). If the Class A glassware or syringe is suspect, the accuracy of the glassware will be assessed prior to use.

21.2 NIST-Traceable Weights and Thermometers

Reference standards of measurement shall be used for calibration only and for no other purpose, unless it can be shown that their performance as reference standards would not be invalidated.

For NIST-traceable weights and thermometers, the laboratory requires that all calibrations be conducted by a calibration laboratory accredited by A2LA, NVLAP (National Voluntary Laboratory Accreditation Program), APLAC (Asia-Pacific Laboratory Accreditation Cooperation), or EA (European Cooperation for Accreditation). A certificate and scope of accreditation is kept on file at the laboratory.

21.3 Reference Standards / Materials

Reference standards/materials, where commercially available, are traceable to certified reference materials. Commercially prepared standard materials are purchased from vendors accredited by A2LA, NVLAP, or other ISO 17025 accreditation with an accompanying Certificate of Analysis that documents the standard purity. If a standard cannot be purchased from a vendor that supplies a Certificate of Analysis, the purity of the standard is documented by analysis. The receipt of all reference standards must be documented. Reference standards are labeled with a unique Standard Identification Number as assigned in Element and expiration date. All documentation received with the reference standard is retained as a QC record and references the Standard Identification Number.

All reference, primary and working standards/materials, whether commercially purchased or laboratory prepared, must be checked regularly to ensure that the variability of the standard or material from the ‘true’ value does not exceed method requirements. The accuracy of calibration standards is checked by comparison with a standard from a second source. This standard is known as the Initial Calibration Verification (ICV) or Quality Control Standard (QCS). In cases where a second standard manufacturer is not available, a vendor certified different lot is acceptable for use as a second source. For unique situations, such as air analysis where no

other source or lot is available, a standard made by a different analyst would be considered a second source. The appropriate Quality Control (QC) criteria for specific standards are defined in laboratory SOPs. In most cases, the analysis of an ICV/QCS or LCS (where there is no sample preparation) is used as the second source confirmation. These checks are generally performed as an integral part of the analysis method (e.g. calibration checks, laboratory control samples).

All standards and materials must be stored and handled according to method or manufacturer's requirements in order to prevent contamination or deterioration. For safety requirements, please refer to laboratory method SOPs, the Corporate Environmental Health and Safety Manual (EHSM) and/or the facility EHSM addendum.

Standards and reference materials shall not be used after their expiration dates unless their reliability is verified by the laboratory and their use is approved by the Quality Assurance Manager. The laboratory must have documented contingency procedures for re-verifying expired standards.

21.4 Documentation and Labeling of Standards, Reagents, and Reference Materials

Reagents must be at a minimum the purity required in the test method. The date of reagent receipt and the expiration date are documented. The lots for most of the common solvents and acids are tested for acceptability prior to company wide purchase. (Refer to TestAmerica's Corporate SOP CA-Q-S-001, Solvent and Acid Lot Testing and Approval.)

All manufacturer or vendor supplied Certificates of Analysis or Purity must be retained, stored appropriately, and readily available for use and inspection. These records are maintained in Element LIMS. Records must be kept of the date of receipt and date of expiration of standards, reagents and reference materials. In addition, records of preparation of laboratory standards, reagents, and reference materials must be retained, stored appropriately, and be readily available for use and inspection. For detailed information on receipt, documentation and labeling of laboratory standards, reagents, and reference materials; please refer to SOPs PE-QAD-012 Receipt Process for General Supplies and Chemicals and PE-QAD-013 Reagent and Standard Preparation, Control and Documentation.

Commercial materials purchased for preparation of calibration solutions, spike solutions, etc.., are usually accompanied with an assay certificate or the purity is noted on the label. If the assay purity is 96% or better, the weight provided by the vendor may be used without correction. If the assay purity is less than 96% a correction will be made to concentrations applied to solutions prepared from the stock commercial material.

21.4.1 All standards, reagents, and reference materials must be labeled in an unambiguous manner. Standards are logged into the laboratory's LIMS system, and are assigned a unique identification number. The following information is typically recorded in the electronic database within the LIMS.

- Standard ID
- Description of Standard
- Department

- Preparer's name
- Final volume and number of vials prepared
- Solvent type and lot number
- Preparation Date
- Expiration Date
- Standard source type (stock or daughter)
- Standard type (spike, surrogate, other)
- Parent standard ID (if applicable)
- Parent Standard Analyte Concentration (if applicable)
- Parent Standard Amount used (if applicable)
- Component Analytes
- Final concentration of each analyte
- Comment box (text field)

Records are maintained electronically for standard and reference material preparation. These records show the traceability to purchased stocks or neat compounds. These records also include method of preparation, date of preparation, expiration date and preparer's name or initials. Preparation procedures are provided in the Method SOPs.

21.4.2 All standards, reagents, and reference materials must be clearly labeled with a minimum of the following information:

- Expiration Date
- Standard ID (generated from LIMS)
- Special Health/Safety warnings if applicable

Records must also be maintained of the date of receipt for commercially purchased items or date of preparation for laboratory prepared items. Special Health/Safety warnings must also be available to the analyst. This information is maintained as part of the applicable method SOP.

21.4.3 In addition, the following information may be helpful:

- Date of receipt for commercially purchased items or date of preparation for laboratory prepared items
- Date opened (for multi-use containers, if applicable)
- Description of standard (if different from manufacturer's label or if standard was prepared in the laboratory)
- Recommended Storage Conditions
- Concentration (if applicable)
- Initials of analyst preparing standard or opening container

All containers of prepared reagents must include an expiration date and an ID number to trace back to preparation.

Procedures for preparation of reagents can be found in the Method SOPs.

Standard ID numbers must be traceable through associated logbooks, worksheets and raw data.

All reagents and standards must be stored in accordance to the following priority: 1) with the manufacturer's recommendations; 2) with requirements in the specific analytical methods as specified in the laboratory SOP.

SECTION 22. SAMPLING

22.1 Overview

The laboratory provides sampling services. Sampling procedures are described in SOP PE-SMP-004 Field Sampling for:

- Groundwater Sampling
- Wastewater Sampling
- Soil Sampling

22.2 Sampling Containers

The laboratory offers clean sampling containers for use by clients. These containers are obtained from reputable container manufacturers and meet EPA specifications as required. Any certificates of cleanliness that are provided by the supplier are maintained at the laboratory. Additional information is available in SOP PE-SMP-005 Bottle Preparation.

For Industrial Hygiene, at the client's request, sample media and sampling instructions can be provided. Sample media is shipped to the client via either TestAmerica's courier service or a commercial courier service. Sampling instructions, if requested, are shipped to the client with the sample media.

22.2.1 Preservatives

Upon request, preservatives are provided to the client in pre-cleaned sampling containers. In some cases containers may be purchased pre-preserved from the container supplier. Whether prepared by the laboratory or bought pre-preserved, the grades of the preservatives are at a minimum:

- Ammonium Chloride – ACS Grade or equivalent
- Ascorbic Acid – ACS Grade or equivalent
- Hydrochloric Acid – Reagent ACS (Certified VOA Free) or equivalent
- MCAA (Chloroacetic Acid) = ACS Grade or equivalent
- Methanol – Purge and Trap grade
- Nitric Acid – Instra-Analyzed or equivalent

- Sodium Hydroxide – Instra-Analyzed or equivalent
- Sulfuric Acid – Instra-Analyzed or equivalent
- Sodium Sulfite – ACS Grade or equivalent
- Sodium Thiosulfate – ACS Grade or equivalent
- Zinc Acetate – ACS Grade or equivalent

22.2.2 Industrial Hygiene Sampling Equipment

In addition to providing clients with sample media and sampling instructions, the laboratory offers sampling equipment for client loan or rental. Loan and rental equipment includes air sampling pumps, impingers, and cyclones. The air sampling pumps are calibrated according to the procedures outlined in SOP PE-SMP-007 – Calibrating Sampling Pumps.

22.3 Definition of Holding Time

The date and time of sampling documented on the COC form will be used to establish the zero (start) date and time at which point the holding time commences. As a general rule, when the maximum allowable holding time is expressed in “days” (e.g., 14 days, 28 days), the holding time is based on each calendar day measured. Holding times expressed in “hours” (e.g., 6 hours, 24 hours, etc.) are measured from the zero date and time listed on the COC. The first day of holding time ends twenty-four hours after sampling. Holding times for analysis include any necessary reanalysis. However there are some programs that determine holding time compliance based on the date and specific time of analysis compared to the time of sampling regardless of how long the holding time is.

22.3.1 Semi-Volatiles - Holding times for sample preparation for semi-volatile organics are measured from the sampling date (and time where applicable) until the day of (and time where applicable) extraction. If a sample is to be extracted on the day of expiration, the actual time of extraction must be recorded on the sample preparation worksheet. Holding times for analysis are measured from the date (and time where applicable) of initiation of extraction to the time of injection into the instrument.

22.3.2 Volatiles - Holding times for volatile organics are measured from the date (and time where applicable) of sampling to the date and time of injection into the Instrument. The data systems record the start of the analytical run. Extractions, e.g., for high-level soils, must be completed in time to allow for analysis to be initiated within the maximum allowable holding time. Holding time is regulatory program driven.

22.3.3 Inorganics - For inorganic and metals analysis, the preparation/digestion/distillation must be started within the maximum holding time as measured from the sampling date (and time where applicable).

22.4 Sampling Containers, Preservation Requirements, Holding Times

The preservation and holding time criteria specified in the laboratory SOPs are derived from the source documents for the methods. General Criteria is specified in Tables 22-1 and 22-2 are. If method required holding times or preservation requirements are not met, the reports will be

qualified using a flag, footnote or case narrative. As soon as possible or “ASAP” is an EPA designation for tests for which rapid analysis is advised, but for which neither EPA nor the laboratory have a basis for a holding time.

22.5 Sample Aliquots / Subsampling

Taking a representative sub-sample from a container is necessary to ensure that the analytical results are representative of the sample collected in the field. The size of the sample container, the quantity of sample fitted within the container, and the homogeneity of the sample need consideration when sub-sampling for sample preparation. It is the laboratory’s responsibility to take a representative sub-sample or aliquot of the sample provided for analysis.

Analysts should handle each sample as if it is potentially dangerous. At a minimum, safety glasses, gloves, and lab coats must be worn when preparing aliquots for analysis.

Guidelines on taking sample aliquots & subsampling are located in SOP PE-QAD-003 Sub-sampling.

Table 22-1.

General Holding Times, Preservation and Container Requirements

P-Poly ***G***-Glass ***AG***-Amber Glass ***E***-Encore ***TC***-Terracore* ***TLC*** Teflon®-lined cap ***TLS*** Teflon®-lined septum
PTFE Fluoropolymer Resin / Teflon® ***WMG*** Wide-Mouth Glass ***ZHS*** Zero HeadSpace ***MK*** Methanol Kit
W Water **S** Soil

Analysis	Matrix	Method(s)	Recommended Quantity	Preservation	Minimum Volume / Size	Holding Time
Volatile Organics [1]						
Dissolved Gasses	**W**	RSK-175	[2]3 x 40 ml G-TLS, ZHS	[3]Cool ≤6°C, HCl	1 x 40 ml	14 days
EDB, DBCP & 1,2,3-Trichloropropane	**W**	EPA 504.1 / SW 8011	3 x 40 ml AG-TLS, ZHS	[4]Cool ≤6°C, HCl	1 x 40 ml	14 days
	S	SW 8011	2-oz.jar	Cool ≤6°C, HCl	10 g	48 hours -14 days[8]
Acrolein, Acrylonitrile & 2-Chloroethyl Vinyl Ether	**W**	EPA 624 / SW 8260 (5030)	3 x 40 ml G-TLS	Cool ≤6°C	1 x 40 ml	8260 7 days *(unpreserved)* 624 – 72 hrs *(unpreserved)*
	S	EPA 8260 (5030/5035)	2-oz. jar [7]3 x 5g E, 2 x MK or TC	Cool ≤6°C	10 g 1 E	7 days
[5]Gasoline Range Organics (GRO)	**W**	SW 8015 (5030)	3 x 40 ml G-TLS, ZHS	Cool ≤6°C, HCl	1 x 40 ml	14 days
	S	SW 8015 (Low-Level 5030; High-Level 5035)	2-oz. jar [7]3 x 5g E, 2 x MK or TC	Cool ≤6°C [6]Frozen w/in 48 hours	10 g 1 E	48 hours -14 days[8]
Hydrocarbons (C6-C10)	**S**	Arizona 8015AZ	4-oz. jar	Cool ≤6°C	30 g	48 hours -14 days[8]
Purgeable Halocarbons	**W**	EPA 601 / SW 8021, 8015 (5030)	3 x 40 ml G-TLS, ZHS	Cool ≤6°C, HCl	1 x 40 ml	14 days *(preserved)* 7 days *(unpreserved)*
	S	SW 8021 / 8015 (5035)	[7]3 x 5g E, 2 x MK or TC	Cool ≤6°C	10 g 1 E	48 hours -14 days[8]
Purgeable Aromatics	**W**	EPA 602 / SW 8021, 8015 (5030)	3 x 40 ml G-TLS, ZHS	Cool ≤6°C, HCl	1 x 40 ml	14 days *(preserved)* 7 days *(unpreserved)*
	S	SW 8021 / 8015 (5030 / 5035)	2-oz. jar [7]3 x 5g E, 2 x MK or TC	Cool ≤6°C	10 g 1 E	48 hours -14 days[8]
TPH by GC/MS	**W**	SW 8260 Mod. (5030)	3 x 40 ml G-TLS, ZHS	Cool ≤6°C, HCl	1 x 40 ml	14 days
	S	SW 8260 Mod. (5030/5035)	2-oz. jar [7]3 x 5g E, 2 x MK or TC	Cool ≤6°C [7]Frozen w/in 48 hours	10 g 1 E	48 hours -14 days[8]
[8]Volatile Organics by GC/MS	**W**	EPA 624 / SW 8260 (5030)	3 x 40 ml G-TLS	Cool ≤6°C, HCl	1 x 40 ml	14 days *(preserved)* 7 days *(unpreserved)*
	S	EPA 8260 (5030/5035)	2-oz. jar [7]3 x 5g E, 2 x MK or TC	[7]Frozen w/in 48 hours	10 g 1 E	48 hours -14 days[8]

Semi-Volatile Organics						
Chlorinated Herbicides	**W**	EPA 615 / SW 8151	2 x 1L-AG or WMG TLC	Cool ≤6°C	1L	7 days to extract 40 days to analyze
	S	SW 8151	4-oz. jar	Cool ≤6°C	30 g	14 days to extract 40 days to analyze
[5] Diesel or Oil Range Organics (DRO/ORO)	**W**	SW 8015	2 x 1L-AG or WMG TLC	Cool ≤6°C	1L	7 days to extract 40 days to analyze
	S	SW 8015	4-oz. jar	Cool ≤6°C	30 g	14 days to extract 40 days to analyze
Hydrocarbons (C10-C32)	**S**	Arizona 8015AZ	4-oz. jar	Cool ≤6°C	30 g	14 days
Dioxin/Furans	**W**	EPA 1613 / SW 8280, 8290	2 x 1L-AG or WMG TLC	Cool ≤6°C	1L	7 days to extract 40 days to analyze
	S	SW 8280, 8290	4-oz. jar	Cool ≤6°C	30 g	14 days to extract 40 days to analyze
Formaldehydes / Acetaldehydes	**W**	SW 8315 A	2 x 1L-AG or WMG TLC	Cool ≤6°C	1L	7 days to extract 40 days to analyze
	S	SW 8315 A	4-oz. jar	Cool ≤6°C	30 g	14 days to extract 40 days to analyze
Nitroaromatics/Nitramines (Explosives)	**W**	SW 8321, 8330, 8332	2 x 1L-AG or WMG TLC	Cool ≤6°C	1L	7 days to extract 40 days to analyze
	S	SW 8321, 8330, 8332	2-oz. jar	Cool ≤6°C	30 g	14 days to extract 40 days to analyze
Oil & Grease	**W**	EPA 1664A; SM 5520B & C	2 x 1L-AG or WMG TLC	Cool ≤6°C, HCl	1L	28 days
	S	SW 9071B Mod.	4-oz. jar	Cool ≤6°C	30 g	28 days
Organophosphorus Pesticides	**W**	EPA 614 / SW 8141	2 x 1L-AG or WMG TLC	Cool ≤6°C	1L	7 days to extract 40 days to analyze
	S	SW 8141	4-oz. jar	Cool ≤6°C	30 g	14 days to extract 40 days to analyze
Pesticides and/or PCBs	**W**	EPA 608 / SW 8081 or 8082	2 x 1L-AG or WMG TLC	Cool ≤6°C	1L	7 days to extract 40 days to analyze
	S	SW 8081 or 8082	4-oz. jar	Cool ≤6°C	60 g	14 days to extract 40 days to analyze
Polynuclear Aromatics	**W**	EPA 610 / SW 8310, 8270	2 x 1L-AG or WMG TLC	Cool ≤6°C	1L	7 days to extract 40 days to analyze
	S	SW 8310, 8270	4-oz. jar	Cool ≤6°C	30 g	14 days to extract 40 days to analyze
Semi-Volatile Organics	**W**	EPA 625 / SW 8270	2 x 1L-AG or WMG	Cool ≤6°C	1L	7 days to extract

			TLC			40 days to analyze
	S	SW 8270	4-oz. jar	Cool ≤6°C	30 g	14 days to extract 40 days to analyze
Air Samples						
Volatile Organics	**A**	EPA 8260	Entech or Summa type Canister	None	6L OR 1L	30 days
Volatile Organics	**A**	EPA 8021B/8260B	Tedlar Bag	None	1 L	72 hrs[14, 15]
Organochlorine Pesticides	**A**	TO-10A	PUF Tube, 76 mm	4ºC	1 TUBE	7 Days
General Chemistry						
Acidity	**W / S**	EPA 305.1 / SM 2310B	500 ml, P / 4-oz. jar	Cool ≤6°C	100 ml / 25 g	14 days[10]
Alkalinity	**W / S**	EPA 310.1, 310.2 / SM2320B	500 ml, P / 4-oz. jar	Cool ≤6°C	100 ml / 25 g	14 days[10]
Ammonia (as N)	**W /S**	EPA 350.1, 350.3 / Lachat 10-107-06-1-B SM 4500-NH3 C,D,E,F,G, H	1 L, P / 8-oz jar	Cool ≤6°C, H_2SO_4 to pH <2	100 ml / 100 g	28 days[10]
Anions by IC: Cl, F, Br, SO4	**W / S**	EPA 300.0 / SM 4110B / SW 9056	500 ml, P / 4-oz. jar	Cool ≤6°C	100 g / 50 ml	28 days
Biochemical Oxygen Demand (BOD)	**W**	EPA 405.1 / SM 5210B	1L, P	Cool ≤6°C	370 ml	48 hours
Carbon Dioxide	**W**	SM4500-CO2 C	500 ml, P	Cool ≤6°C	100 ml	Immediate[11]
Chemical Oxygen Demand (COD)	**W / S**	EPA 410.1, 410.4 / SM5220 C / HACH 8000	500 ml, P / 4-oz. jar	Cool ≤6°C, H_2SO_4 to pH <2	100 ml / 25 g	28 days[10]
Chloride	**W / S**	EPA 300.0, 325.2 / SM 4110B, 4500-Cl B, C, D, E / SW 9056, 9251, 9253	500 ml, P / 4-oz. jar	Cool ≤6°C	100 ml / 25 g	28 days[10]
Chlorine, Residual	**W**	EPA 330.4, 330.5 / SM 4500-Cl F, G HACH 8167	500 ml, P	Cool ≤6°C	100 ml	Immediate[11]

Chromium VI	**W / S**	EPA 218.4, 218.6 / SW 7196, 7199 / SM 3500-Cr B, D	500 ml, P / 4-oz. jar	Cool ≤6°C	100 ml / 25 g	24 hours[10] unpreserved, 28 days preserved[13] *(Aqueous);*
	S	EPA 6800	4-oz. jar	Cool ≤6°C	25 g	28 days extract, 7 days to analysis (optional 96 hrs. from ext. to analysis in alkaline state)
Color	**W**	EPA 110.1, 110.2, 110.3 / SM 2120 B, E	500 ml P	Cool ≤6°C	100 ml	48 hours
Conductivity	**W**	SM 2510B / EPA 120.1 / SW 9050	500 ml, P	Cool ≤6°C	100 ml	28 days
Cyanide, Amenable or Total	**W / S**	SM 4500-CN C, E, G / EPA 335.1, 335.3, 335.4 / W 9010, 9012, 9013, 9014 / Lachat 10-201-00-1-A EPA OIA-1677	1L, P / 4-oz. jar (Note: NPDES may require field preservation kit.)	Cool ≤6°C, NaOH pH > 12; Cool ≤6°C	100 ml / 5 g	14 days[10]
Cyanide, Available	**W / S**	EPA OIA-1677	Contact the TestAmerica laboratory performing the analysis for method-exclusive containers			14 days
Flashpoint / Ignitability	**W / S**	SW 1010, 1020, 1030	250 ml, G / 4-oz. jar	Cool ≤6°C	100 ml / 50 g	28 days
Fluoride	**W / S**	EPA 300.0, 340.2 / SW 9056, 9214 / SM 4110B, 4500-F C	500 ml, P / 4-oz. jar	Cool ≤6°C	100 ml / 25 g	28 days[10]
Hardness	**W**	EPA 130.2 / SM 2340C	500 ml, P	Cool 4°C, HNO_3 pH <2	100 ml	180 days
MBAS (Surfactants)	**W**	SM 5540C	1L, P	Cool ≤6°C	100 ml	48 hours
Nitrate	**W / S**	EPA 300.0, 353.2 / SM 4110B, SM 4500-NO3 D, E, F, H / SW 9056	1L, P / 4-oz. jar	Cool ≤6°C	100 ml / 25 g	48 hours[10]

Nitrate + Nitrite	**W / S**	EPA 300.0, 353.2 / SW 9056 SM 4110B, 4500-NO3 D, E, F, H Lachat 10-107-04-1-C	1L, P / 4-oz. jar	Cool ≤6°C, H_2S0_4 to pH < 2; Cool ≤6°C	200 ml / 25 g	28 days[10]
Nitrite	**W / S**	EPA 300.0, 354.1 / SM 4110B, 4500-NO_2 B / SW 9056 / HACH 8507	1L, P / 4-oz. jar	Cool ≤6°C	100 ml / 25 g	48 hours[10]
Nitrogen, Kjeldahl (TKN)	**W / S**	SM 4500 NorgC / EPA 351.2, 351.3, 351.4 Lachat 10-107-06-2-E	1L, P / 4-oz. jar	Cool ≤6°C, H_2SO_4 pH < 2; Cool ≤6°C	100 ml / 25 g	28 days[10]
Odor	**W**	EPA 140.1 / SM 2150B	500 ml, G	Cool ≤6°C	100 ml	24 hours
Oxygen, Dissolved (DO)	**W**	EPA 360.1, 360.2 / SM 4500-O G	2 x 40 ml-VOA; 250 ml P	Cool ≤6°C, no HS	100 ml	Immediate[11]
Perchlorate	**W / S**	EPA 314.0	500 ml, P / 4-oz. jar	Cool ≤6°C	100 g / 50 ml	28 days
Perchlorate	**W**	EPA 331 / SW 6850, 6860, 8321	500 ml, P	Cool ≤6°C, Sterile	50 ml	28 days
pH	**W / S**	EPA 150.1 / SM4500-H B / SW 9040, 9045	500 ml, P, / 4-oz. jar	Cool ≤6°C	100 ml / 5 g	Immediate[11]
Phenols, Total	**W / S**	EPA 420.1, 420.2, 420.4 / SW 9065, 9066	1L, AG / 4-oz. jar	Cool ≤6°C, H_2SO_4 pH < 2; Cool ≤6°C	100 ml / 5 g	28 days
Phosphate, Ortho	**W / S**	EPA 300.0, 365.1, 365.2, 365.3, 365.4 / SM 4110B, 4500-P E / SW 9056	500 ml, P / 4-oz. jar	Cool ≤6°C	5 g / 50 ml	48 hours
Phosphorus (ICP)	**W / S**	EPA 200.7 / SW 6010	500 ml, P / 4-oz. jar	Cool ≤6°C, HNO_3 pH <2;	100 ml / 10 g	180 days

				Cool ≤6°C		
Phosphorus (Gen Chem)	**W / S**	EPA 365.1, 365.2, 365.3, 365.4 / SM 4500-P B, E, F	500 ml, P / 4-oz. jar	Cool ≤6°C, H_2SO_4 pH < 2; Cool ≤6°C	100 ml / 5 g	28 days
Silica	**W**	EPA 200.7 / SM 4500-SiO_2 C, D; SM 3120B	500 ml P, PTFE, Quartz	Cool ≤6°C	100 ml	28 days
Solids, Settleable	**W**	EPA 160.5 / SM 2540F	1L, P	Cool ≤6°C	1000 ml	48 hours
Solids, Total Dissolved (TDS)	**W**	EPA 160.1 / SM 2540C	500 ml, P	Cool ≤6°C	100 ml	7 days
Solids, Total Suspended (TSS)	**W**	EPA 160.2 / SM 2540D / USGS I-3765-85	500 ml, P	Cool ≤6°C	100 ml	7 days
Solids, Total Volatile (TVS)	**W**	EPA 160.4	500 ml, P	Cool ≤6°C	100 mL	7 days
Solids, Total (TS)	**W**	SM 2540B	1 L, P	Cool ≤6°C	500 mL	7 days
Sulfate	**W / S**	EPA 300.0, 375.4 / SM 4110B, 4500-SO_4 E, 426 C, 15th Ed. / SW 9038, 9056 / ASTM D516-90,02	500 ml, P / 4-oz. jar	Cool ≤6°C	50 ml / 50 g	28 days[10]
Sulfide, Total (TS)	**W / S**	EPA 376.1, 376.2 / SM 4500-S-2 D, E, F / SW 9030, 9034 / HACH 8216	500 ml, P / 4-oz. jar	Cool ≤6°C, NaOH+Zn Acetate pH >9; Cool ≤6°C	100 ml / 50 g	7 days
Total Organic Carbon (TOC)	**W / S**	EPA 415.1, 415.2 / SM 5310 B, C / SW 9060 / Lloyd Kahn	250 ml, AG or 2 x 40 ml G-TLS, ZHS 4-oz. jar	Cool ≤6°C, H_2SO_4 or HCl pH < 2; Cool ≤6°C	100 ml / 5 g	28 days 14 days (Lloyd Khan)
	S	Walkley Black	4-oz. jar w/PFTE-lined lid	Cool ≤6°C	50 g	28 days
Total Organic Halides (TOX)	**W / S**	EPA 450.1 / SM 5350B / SW 9020	500 ml AG-TLC / 4-oz. jar	Cool ≤6°C, H_2SO_4 pH <	100 ml / 50 g	28 days

				2; Cool ≤6°C		
Total Petroleum Hydrocarbon (TPH)	**W**	EPA 1664 (SGT HEM)	2 x 1 L- AG, TLC	Cool ≤6°C, H_2SO_4 pH < 2;	100 m	28 days
	S	SW 9071B Mod.	4-oz. jar	Cool ≤6°C	50 g	28 days
Turbidity	**W**	EPA180.1 / SM 2130B	500 ml, P	Cool ≤6°C	50 ml	48 hours
Metals						
Cation Exchange Capacity (CEC)	**S**	SW 9081	4-oz. jar	Cool ≤6°C	50 g	28 days
Chromium VI	**W**	EPA 218.6 / SW 7199, 7196	500 ml, P	Cool ≤6°C	50 ml	24 hours
	S	SW 7199, 7196A	4-oz. jar	Cool ≤6°C	20 g	30 days
Mercury	**W**	EPA 245.1, 245.2 / SW 7470	500 ml, P	HNO_3 to pH < 2	100 ml	28 days
	S	EPA 1630, 1631 / SW 7471A	4-oz. jar	Cool ≤6°C	10 g	28 days
Metals, Dissolved (Field Filtered)	**W**	EPA 200.7, 200.8 / SW 6010, 6020	500 ml, P	HNO_3 to pH < 2	100 ml	180 days
Metals, Total	**W**	EPA 200.7, 200.8 / SW 6010, 6020	500 ml, P	HNO_3 to pH < 2	100 ml	180 days
	S	SW 6010, 6020	4-oz. jar	Cool ≤6°C	5 g	180 days
Organic Lead by GFAA	**W**	HML 939-M	1L AG, ZHS	Cool ≤6°C	200 ml	14 days
	S	HML 939-M	4-oz. jar	Cool ≤6°C	50 g	14 days
TCLP, STLC, SPLP metals	**W**	40 CFR Part 136, Md. 1311, 1312	4 x 40 ml G-TLS, ZHS 4 x 1 L, G 1 x 500 ml, P	Cool ≤6°C	100g / 50g / 100g	180 days[12]
	S	40 CFR Part 136, Md. 1311, 1312	8-oz. jar	Cool ≤6°C	100g / 50g / 100g	180 days[12]
Microbiology						
Chlorophyll a	**W**	SM 10200 H	1 L, AP or AG foil wrapped	Cool ≤6°C	100 ml	48 hours
Coliform, Total	**W**	SM 9222	250 ml P,G	Cool 10°C,	100 ml	6 hours;

			(sterile)	$Na_2S_2O_3$		30 hours (MA)
Coliform, Fecal	**W**	SM 9221, 9222	250 ml P,G (sterile)	Cool 10°C, $Na_2S_2O_3$	100 ml	6 hours
E. Coli	**W**	SM 9221, 9223 / IDEXX / Colisure	250 ml P,G (sterile)	Cool 10°C, $Na_2S_2O_3$	100 ml	6 hours; 30 hours (MA)
Enterococci	**W**	SM 9230 / ENTEROLERT / ASTM D6503-99	250 ml P,G (sterile)	Cool 10°C	100 ml	6 hours
Hetrotrophic Plate Count	**W / S**	SM 9215 / IDEXX	250 ml P,G (sterile)	Cool 10°C, $Na_2S_2O_3$	100 ml	8 hours
Radiochemistry						
Carbon-14	**W**	EERF C-01-1	100 mL	none	75 mL	6 months
	S	EERF C-01-1	5 grams, P	none	1 gram	6 months
Cesium-134	**W**	EPA 901; DOE GA-01-R	1 L, P	None	1 L	6 months
	S	EPA 901; DOE GA-01-R	650 grams, P	None	650 grams	6 months
Gross Alpha/Beta	**W**	EPA 900 & SW 9000 Series	1 L, P	HNO_3 pH < 2	500 ml	6 months
	S	EPA 900 & SW 9000 Series	10 grams, P	None	5 grams	6 months
Iodine-129	**W**	Standard Method 7500-IB	2 L, P	None	2 L	6 months
Iodine-131	**W**	EPA 902.0, 901.1	1 L, P	None	1 L	16 days
Isotopic Analysis: Am, Cm, Np, Pu, Th, U	**W**	DOE A-01-R	1 L, P	HNO_3 pH < 2	1 L	6 months
	S	DOE A-01-R	10 grams, P	None	10 gram	6 months
Nickel 59/63; Iron-55	**W**	Eichrom Technologies Methods	1 L, P	HNO_3 pH < 2	500 mL	6 months
	S	Eichrom Technologies Methods	5 grams, P	None	5 grams	6 months
Plutonium-241	**W**	Lab SOP/Liquid Scintillation Counting	1 L, P	HNO_3 pH < 2	500 mL	6 months

	S	Lab SOP/Liquid Scintillation Counting	10 grams, P	None	10 gram	6 months
Radium 226/228	**W**	EPA 903.1, 904.0	1 L, P	HNO_3 pH < 2	1 L	6 months
	S	EPA 903.1, 904.0 SW 846 9315/9320	10 grams, P	None	10 gram	6 months
Radon 222	**W**	EPA 913	3 x 40 mL	None	40 ml	4 days
Strontium 89, 90	**W**	EPA 905	1 L, P	HNO_3 pH < 2	1 L	6 months
	S	EPA 905; DOE Sr-03-RC	10 grams, P	None	2 grams	6 months
Technetium-99	**W**	Eichrom Method TCW01	500 mL	HNO_3 pH < 2	250 mL	6 months
	S	Eichrom Method TCS01	10 grams, P	None	5 grams	6 months
Tritium	**W**	EPA 906.0	1 L, P	None	100 mL	6 months
	S	EPA 906.0	100 grams, P	None	30 gram	6 months
Uranium-12	**W**	EPA 908.0, 908.1	2 L, P	HNO_3 pH < 2	2 L	6 months
Bioassay						
Acute-24/48-hr	**W**	EPA 821-R-02-012	2gal Eff & 3gal River (if required)	Cool $\leq 6^{o}C$	See Quantity	36 hours
Acute-96-hr	**W**	EPA 821-R-02-012	2gal Eff & 3gal River (if req)	Cool $\leq 6^{o}C$	See Quantity	36 hours
Chronic-7-day	**W**	EPA 821-R-02-013	2gal Eff & 3gal River (if req) per species x 3days	Cool $\leq 6^{o}C$	See Quantity	36 hours

Footnotes:

∗ Terracore kits usually include 3-vial kits as (MeOH/H2O/H2O); 3-vial kits as (MeOH/Na2S2O3/Na2S2O3); or 4-vial kits (MeOH/MeOH/H2O/H2O). Some kits come with the % moisture cup/jar, and a disposable t-handle. The kits with the H2O do not have the stir-bar.

> CLP Methods are also available - contact a Project Manager for additional information. <

[1] Additional soil volume of 20 grams is required for Total Solids determination. This can be collected in a 2 oz. jar.

[2]Samples for analysis of carbon dioxide should be collected in 40 mL VOA vials without preservative.

[3] Sample temperatures to be maintained at 0-≤6°C.

[4] EPA 504.1: If residual chlorine is expected to be present, samples should be neutralized with Sodium Thiosulfate.

[5] Contact the laboratory for information on other state-specific DRO and GRO methods.

[6] Samples can be frozen within 48-hrs of collection. Preserve prior to analysis. Analyze within 14 days of collection (samples need to be extruded prior to freezing).

[7]Within 48 hours of sample collection, the sample in the EnCore™ sampler must be transferred to the sample vial containing organic-free water and frozen or if required, transferred to vial containing preservative if effervescence test was negative.

[8] Holding times for soil samples are regulatory program specific Contact the laboratory for additional information.

[9] Samples where vinyl chloride, styrene, or 2-chloroethyl vinyl ether are analytes of interest, collect a second set of samples without acid preservatives and analyze as soon as possible.

NIOSH & OSHA methods under the Industrial Hygiene Program; and EPA methods for the Clean Air Program are also available for the analysis of Volatile Organics.

[10] For a Solid/Waste matrix, some inorganic parameters will undergo a DI water leach prior to analysis.

[11] Immediate equals 15 minutes from sampling or field test

[12] TCLP/STLC/SPLP Hold Times:

Metals -Liquids:	Collection to extract 180 (28d Hg), prep to analysis 180d (28d Hg)
Semi-volatile - Liquids:	Collection to extract 14d, extract to prep 7d, prep to analysis 40d
Volatiles - Liquids:	Collection to extraction 14d, extraction to analysis 14d
Metals -Solids:	Collection to extract 180 (28d Hg), prep to analysis 180d (28d Hg)
Semi-volatiles - Solids:	Collection to extract 14d, extract to prep 7d, prep to analysis 40d
Volatiles - Solids:	Collection to extraction 14d, extraction to analysis 14d

[13] To achieve the 28-day holding time, use the ammonium sulfate buffer solution specified in EPA Method 218.6

[14]. Holding Time is based on SW 846 Method 0040 “SAMPLING OF PRINCIPAL ORGANIC HAZARDOUS CONSTITUENTS FROM COMBUSTION SOURCES USING TEDLAR® BAGS”. Some states specifically enforce this holding time (e.g., Florida, New Jersey) and others have not specified this information in their regulatory requirements.

[15] The holding time is 72 hours unless the laboratory has a documented validation study that indicates a longer HT is acceptable for the analytes of interest.

Additional Comments:

a. For samples requiring MS/MSD, collect triple the quantity.

b. For bacteriological and organic parameters, add sodium thiosulfate if residual chlorine is present.

c. Trademarks & trade names used in this document are the property of their respective owners.

Volume Conversion Guide:
2 oz. Jar = 50 g
4 oz. Jar = 100 g
8 oz. Jar = 200 g
16 oz. Jar = 400 g

Table 22-2. Industrial Hygiene – Sample Receiving Guide

Analyte	Method Reference	Sample Media	Sampling Rate	Air Volume	Sample Stability	Preservation
Acetaldehyde	OSHA 1007 (Modified)	AT N571 Passive Monitor	0.00977 L/min	8 Hrs	28 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.
Acetone	NIOSH 1300	150-mg Charcoal Tube	0.01 - 0.2	0.5 - 3	Undetermined	May be shipped on ice or equivalent; refrigerate upon receipt.
	OSHA 69	225-mg Anasorb CMS Tube	0.05	3	17 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	3M (Modified)	3M Badge (3500 or 3520)	0.0401	2 Hrs Max.	3 Weeks	May be shipped on ice or equivalent; refrigerate upon receipt.
	SKC (Modified)	SKC 575-002 Passive Badge	0.0152	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	Assay Technology(Mod)	Assay N546 or N566 Badge	0.00160 (#546) 0.0106 (#566)	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
Acetonitrile	3M (Modified)	3M 3520	0.0482	2 Hrs	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
Acetylene	EPA 3C/ASTM D1946	Entech Canister	400 ml or 1 L	Grab or Time integrated	30 Days	Should be stored at room temperature.
	EPA 3C/ASTM D1946	Flex Foil Bag	1 L	Grab	5 Days	Should be stored at room temperature.
Acrylonitrile	NIOSH 1604	150-mg Charcoal Tube	0.01 - 0.2	3.5 - 20	7 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.
	3M (Modified)	3M Badge (3500 or 3520)	0.0438	8 Hrs Max.	14 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.
Aldehydes	EPA TO-11A	DNPH-coated Silica Gel	0.1 - 1.5	1 - 15	14 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.
	EPA IP-6A (Modified)	DNPH-coated Silica	0.1 - 1.5	1 - 15	14 Days	Should be shipped on ice or equivalent;

Analyte	Method Reference	Sample Media	Sampling Rate	Air Volume	Sample Stability	Preservation
		Gel				refrigerate upon receipt.
	EPA IP-6C (Modified)	SKC UMEx-100 Passive Badge	28.6	15 min. or 8 Hrs	21 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.
Aluminum	N7300/OSHA ID-121	37-mm, 0.8-um, MCE Filter	1 - 4	5 - 960 / 5 - 100	Indefinite	Should be stored at room temperature.
Antimony	N7300/OSHA ID-121	37-mm, 0.8-um, MCE Filter	1 - 4	30 - 960 / 50 - 2000	Indefinite	Should be stored at room temperature.
Arsenic	NIOSH 7300	37-mm, 0.8-um, MCE Filter	1 - 4	5-2000	Indefinite	Should be stored at room temperature.
Barium	N7300/OSHA ID-121	37-mm, 0.8-um, MCE Filter	1 - 4	30 - 960 / 50-2000	Indefinite	Should be stored at room temperature.
Benzaldehyde	OSHA 1007 (Modified)	Assay N571 Passive Badge	0.00581 L/min	8 Hrs	28 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.
Benzene	NIOSH 1501	150-mg Charcoal Tube	< 0.2	5 - 30	30 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	3M (Modified)	3M Badge (3500 or 3520)	0.0355	8 Hrs Max.	3 Weeks	May be shipped on ice or equivalent; refrigerate upon receipt.
	SKC (Modified)	SKC 575-002 Passive Badge	0.0160	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	Assay Technology(Mod)	Assay N546 or N566 Badge	0.00096 (#546) 0.00785 (#566)	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
Beryllium	NIOSH 7300	37-mm, 0.8-um, MCE Filter	1 - 4	1250 - 2000	Indefinite	Should be stored at room temperature.
Boron	NIOSH 7300	37-mm, 0.8-um, MCE Filter	1 - 4	25 - 2000	Indefinite	Should be stored at room temperature.
Butane (n-Butane)	ASTM D1945-03	Entech Canister	0.01 - 1	1 L	30 Days	Should be stored at room temperature.
	ASTM D1945-03	Tedlar Bag	0.01 - 1	1 L	72 Hrs.	Should be stored at room temperature.
1-Butanol (n-butyl alcohol; n-butanol)	NIOSH 1401/1405	150-mg Charcoal Tube	0.01 - 0.2	2 - 10	Not Determined	Should be shipped on ice or equivalent; refrigerate upon receipt.
	3M (Modified)	3M Badge (3500 or 3520)	0.0343	8 Hrs.	3 Weeks	May be shipped on ice or equivalent; refrigerate upon receipt.

Analyte	Method Reference	Sample Media	Sampling Rate	Air Volume	Sample Stability	Preservation
2-Butoxyethanol (Butyl Cellosolve)	NIOSH 1403	150-mg Charcoal Tube	0.01 - 0.05	2 - 10	30 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	3M (Modified)	3M Badge (3500 or 3520)	0.0282	8 Hrs Max.	21 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
n-Butyl Acetate	NIOSH 1450	150-mg Charcoal Tube	0.01 - 0.2	1 - 10	30 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	3M (Modified)	3M Badge (3500 or 3520)	0.0316	8 Hrs.	3 Weeks	May be shipped on ice or equivalent; refrigerate upon receipt.
	SKC (Modified)	SKC 575-002 Passive Badge	0.0132	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	Assay Technology(Mod)	Assay N546 or N566 Badge	0.00087 (#546) 0.00651 (#566)	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
Butyraldehyde	OHA 1007 (Modified)	Assay N571 Passive Badge	0.00683	8 Hrs	28 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.
Cadmium	NIOSH 7300	37-mm, 0.8-um, MCE Filter	1 - 4	13 - 2000	Indefinite	Should be stored at room temperature.
Calcium	N7300/OSHA ID-121	37-mm, 0.8-um, MCE Filter	1 - 4	30 - 960 / 5 - 2000	Indefinite	Should be stored at room temperature.
Carbon Black	NIOSH 5000	37-mm pre-weighed PVC Filter, 5-um pore size	1 - 2	30 - 570	Indefinite	Should be stored at room temperature.
Carbon Dioxide	EPA 3C/ASTM D1946	Entech Canister	400ml or 1 L	Grab or Time integrated	30 Days	Should be stored at room temperature.
	EPA 3C/ASTM D1946	Flex Foil Bag	1 L	Grab	5 Days	Should be stored at room temperature.
Carbon Monoxide	EPA 3C/ASTM D1946	Entech Canister	400ml or 1 L	Grab or Time integrated	30 Days	Should be stored at room temperature.
	EPA 3C/ASTM D1946	Flex Foil Bag	1 L	Grab	5 Days	Should be stored at room temperature.
Carbon Tetrachloride	NIOSH 1003	150-mg Charcoal Tube	0.01 - 0.2	3 - 150	30 Days	May be shipped on ice or equivalent; refrigerate upon receipt.

Analyte	Method Reference	Sample Media	Sampling Rate	Air Volume	Sample Stability	Preservation
	3M (Modified)	3M Badge (3500 or 3520)	0.0302	8 Hrs Max.	21 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	SKC (Modified)	SKC 575-002 Passive Badge	0.0145	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	Assay Technology(Mod)	Assay N546 or N566 Badge	0.00109 (#546) 0.00605 (#566)	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
Chlorobenzene	NIOSH 1003	150-mg Charcoal Tube	0.01 - 0.2	1.5 - 40	Undetermined	May be shipped on ice or equivalent; refrigerate upon receipt.
	3M (Modified)	3M Badge (3500 or 3520)	0.0293	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	SKC (Modified)	SKC 575-002 Passive Badge	0.0142	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	Assay Technology (Modified)	Assay N546 or N566 Badge	0.00102 (#546) 0.00708 (#566)	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
Chloroform	NIOSH 1003	150-mg Charcoal Tube	0.01 - 0.2	1 - 50	30 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	3M (Modified)	3M Badge (3500 or 3520)	0.0335	8 Hrs Max.	21 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	SKC (Modified)	SKC 575-002 Passive Badge	0.0130	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	Assay Technology (Modified)	Assay N546 or N566 Badge	0.00146 (#546) 0.00688 (#566)	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
Chromium	NIOSH 7300	37-mm, 0.8-um, MCE Filter	1 - 4	5 - 1000	Indefinite	Should be stored at room temperature.
Cobalt	NIOSH 7300	37-mm, 0.8-um, MCE Filter	1 - 4	25 - 2000	Indefinite	Should be stored at room temperature.
Copper	NIOSH 7300	37-mm, 0.8-um, MCE Filter	1 - 4	5 - 1000	Indefinite	Should be stored at room temperature.
Cresols	NIOSH 2546	150-mg XAD-7	0.01 - 0.1	1 - 24	Undetermin	Should be shipped on ice or equivalent;

Analyte	Method Reference	Sample Media	Sampling Rate	Air Volume	Sample Stability	Preservation
		Tube			ed	refrigerate upon receipt.
Crotonaldehyde	Assay Technology(Mod)	AT N571 Passive Monitor	0.00716 L/min	8 Hrs	28 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.
Cumene	NIOSH 1501	150-mg Charcoal Tube	< 0.2	1 - 30	30 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	3M (Modified)	3M Badge (3500 or 3520)	0.0245	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	SKC (Modified)	SKC 575-002 Passive Badge	0.0128	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	Assay Technology (Modified)	Assay N546 or N566 Badge	0.00083 (#546) 0.00685 (#566)	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
Cyclohexane	NIOSH 1500	150-mg Charcoal Tube	0.01 - 0.2	2.5 - 5	30 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.
Cyclohexanone	NIOSH 1300	150-mg Charcoal Tube	0.01 - 0.2	1 - 10	Undetermined	May be shipped on ice or equivalent; refrigerate upon receipt.
	3M (Modified)	3M Badge (3500 or 3520)	0.0289	8 Hrs.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
Diborane	NIOSH 6006	PTFE filter + oxidizer impregnated charcoal tube	0.5 - 1.0	60 - 260	7 Days	Should be stored at room temperature.
1,2-Dichlorobenzene	NIOSH 1003	150-mg Charcoal Tube	0.01 - 0.2	1 - 10	30 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	3M (Modified)	3M Badge (3500 or 3520)	0.0278	8 Hrs.	3 Weeks	May be shipped on ice or equivalent; refrigerate upon receipt.
1,3-Dichlorobenzene	3M (Modified)	3M Badge (3500 or 3520)	0.0267	8 Hrs.	3 Weeks	May be shipped on ice or equivalent; refrigerate upon receipt.
1,4-Dichlorobenzene	NIOSH 1003	150-mg Charcoal Tube	0.01 - 0.2	1 - 8	30 Days	May be shipped on ice or equivalent; refrigerate upon receipt.

Analyte	Method Reference	Sample Media	Sampling Rate	Air Volume	Sample Stability	Preservation
	3M (Modified)	3M Badge (3500 or 3520)	0.0278	8 Hrs.	3 Weeks	May be shipped on ice or equivalent; refrigerate upon receipt.
1,1-Dichloroethane	NIOSH 1003	150-mg Charcoal Tube	0.01 - 0.2	0.5 - 15	30 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
1,2-Dichloroethane	NIOSH 1003	150-mg Charcoal Tube	0.01 - 0.2	1 - 50	30 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	3M (Modified)	3M Badge (3500 or 3520)	0.0332	8 Hrs Max.	21 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
cis-1,2-Dichloroethylene	NIOSH 1003	150-mg Charcoal Tube	0.01 - 0.2	0.2 - 5	30 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
trans-1,2-Dichloroethylene	NIOSH 1003	150-mg Charcoal Tube	0.01 - 0.2	0.2 - 5	30 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
Diesel Range Hydrocarbons C10 - C22	NIOSH 1550	150-mg Charcoal Tube	0.01 - 0.2	1.3 - 20	14 Days	Should be stored at room temperature.
Diethyl Ether (Ethyl ether, Ethyl oxide)	3M (Modified)	3M 3520 Passive Monitor	0.0368	4 Hr	3 Weeks	May be shipped on ice or equivalent; refrigerate upon receipt.
2,5-Dimethylbenzaldehyde	Assay Technology(Mod)	AT N571 Passive Monitor	0.00479 L/min	8 Hrs	28 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.
1,4-Dioxane	NIOSH 1602	150-mg Charcoal Tube	0.01 - 0.2	0.5 - 15	6 Weeks	May be shipped on ice or equivalent; refrigerate upon receipt.
n-Dodecane (C12)	3M (Modified)	3M Badge (3500 or 3520)	0.0215	Undetermined	3 Weeks	May be shipped on ice or equivalent; refrigerate upon receipt.
Epichlorohydrin	NIOSH 1010	150-mg Charcoal Tube	0.01 - 0.2	2 - 30	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
Ethane	ASTM D1945-03	Entech Canister	0.01 - 1	1	30 Days	Should be stored at room temperature.
	ASTM D1945-03	Tedlar Bag	0.01 - 1	1	72 Hrs	Should be stored at room temperature.
Ethanol	NIOSH 1400	150-mg Charcoal Tube	0.05	0.1 - 10	Undetermined	May be shipped on ice or equivalent; refrigerate upon receipt.
	3M (Modified)	3M 3520 Passive Monitor	0.0437	1 Hr Max.	21 Days	May be shipped on ice or equivalent; refrigerate upon receipt.

Analyte	Method Reference	Sample Media	Sampling Rate	Air Volume	Sample Stability	Preservation
	SKC (Modified)	SKC 575-002 Passive Badge	0.0209	4 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	Assay Technology(Mod)	Assay N546 or N566 Badge	0.00154 (#546) 0.0111 (#566)	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
Ethyl Acetate	NIOSH 1457	150-mg Charcoal Tube	0.01 - 0.2	0.1 - 10	6 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	SKC (Modified)	SKC 575-002 Passive Badge	0.0144	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
Ethylbenzene	NIOSH 1501	150-mg Charcoal Tube	< 0.2	1 - 24	30 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	3M (Modified)	3M Badge (3500 or 3520)	0.0273	8 Hrs. Max	21 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	Assay Technology(Mod)	Assay N545 or N546 Badge	0.00091 (#546) 0.0073 (#566)	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
Fixed Gas Screen (H2, C2H2, CO_2, CO, CH_4, N_2, O_2)	EPA 3C/ASTM D1946	Entech Canister	400 mL or 1L	Grab or Time Integrated	30 Days	Should be stored at room temperature.
	EPA 3C/ASTM D1946	Flex Foil Bag	1	Grab	5 Days	Should be stored at room temperature.
Formaldehyde	NIOSH 2016 (Modified)	DNPH-coated Silica Gel	0.03 - 1.5	1 - 15	34 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.
	OSHA 1007 (Modified)	AT N571 Passive Monitor	0.01305 L/min	8 Hrs	28 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.
	OSHA 1007 (Modified)	SKC UMEx-100 Passive Badge	28.6	15 min. or 8 Hrs	21 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.
	EPA IP-6C (Modified)	SKC UMEx-100 Passive Badge	28.6	15 min. or 8 Hrs	21 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.
Gasoline Range Hydrocarbons C6 - C10	EPA TO-15 (Modified)	Entech Canister	400ml or 1 L	Grab or Time integrated	30 Days	Should be stored at room temperature.

Analyte	Method Reference	Sample Media	Sampling Rate	Air Volume	Sample Stability	Preservation
Gasoline Range Hydrocarbons C6 - C10	NIOSH 1550	150-mg Charcoal Tube	0.01 - 0.2	1.3 - 20	14 Days	Should be stored at room temperature.
Glutaraldehyde	OSHA 64 (Modified)	DNPH-coated Glass Fiber Filters	1 - 2	15 - 480	17 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.
	NIOSH 2532 (Modified)	DNPH-coated Silica Gel	0.05 - 0.5	1 - 30	30 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.
	Assay Technology (Modified)	AT N571 Passive Monitor	0.00603 L/min	8 Hrs	28 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.
Heptane (n-Heptane)	NIOSH 1500	150-mg Charcoal Tube	0.01 - 0.2	Undetermined	30 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.
Hexaldehyde	OSHA 1007 (Modified)	AT N571 Passive Monitor	0.00540 L/min	8 Hrs	28 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.
1,6-Hexamethylene Diisocyanate (1,6-HDI)	OSHA 42	37-mm Glass Fiber Filter coated with 1,2PP	1	15	18 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.
Hexane (n-Hexane)	NIOSH 1500	150-mg Charcoal Tube	0.01 - 0.2	Undetermined	30 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	3M (Modified)	3M Badge (3500 or 3520)	0.032	8 Hrs Max.	3 Weeks	May be shipped on ice or equivalent; refrigerate upon receipt.
	SKC (Modified)	SKC 575-002 Passive Badge	0.0143	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	ASTM D1945-03	Entech Canister	0.01 - 1	1	30 Days	Should be stored at room temperature.
	ASTM D1945-03	Tedlar Bag	1	Grab	72 Hrs	Should be stored at room temperature.
2-Hexanone	NIOSH 1300	150-mg Charcoal Tube	0.01 - 0.2	1 - 10	7 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.
Hexavalent Chromium (Soluble)	NIOSH 7600	37-mm PVC Filter, 5-um	1 - 4	100 - 400	14 Days	Should be stored at room temperature.
Hexavalent Chromium	OSHA ID-215	37-mm PVC Filter, 5-um	2	30 - 960	Ship overnight, within	Should be stored at room temperature.

Analyte	Method Reference	Sample Media	Sampling Rate	Air Volume	Sample Stability	Preservation
					24 hours of sampling.	
Hydrobromic Acid	NIOSH 7903	600-mg Cleaned Silica Gel Tube	0.2 - 0.5	3 - 100	21 Days	Should be stored at room temperature.
Hydrochloric Acid	NIOSH 7903	600-mg Cleaned Silica Gel	0.2 - 0.5	3 - 100	21 Days	Should be stored at room temperature.
Hydrofluoric Acid	NIOSH 7903	600-mg Cleaned Silica Gel	0.2 - 0.3	3 - 100	21 Days	Should be stored at room temperature.
Hydrogen	EPA 3C/ASTM D1946	Entech Canister	400 mL or 1L	Grab or Time Integrated	30 Days	Should be stored at room temperature.
	EPA 3C/ASTM D1946	Flex Foil Bag	1	Grab	5 Days	Should be stored at room temperature.
Hydrogen Cyanide	NIOSH 6010	800-mg Soda Lime Tube	0.05 - 0.2	2 - 90	14 Days	Should be stored at room temperature.
Hydrogen Sulfide	NIOSH 6013	600 mg - LOW SO4 Charcoal tube, Orbo 34	0.1 - 1.5	20 - 40	30 Days	Should be stored at room temperature.
Iron	N7300/OSHA ID-121	37-mm, 0.8-um, MCE Filter	1 - 4	5 - 960 / 5 - 100	Indefinite	Should be stored at room temperature.
Isopropanol (2-Propanol)	NIOSH 1400	150-mg Charcoal Tube	0.01 - 0.2	0.3 - 3	Undetermined	May be shipped on ice or equivalent; refrigerate upon receipt.
	3M (Modified)	3M 3520 Passive Monitor	0.0994	8 Hrs	3 Weeks	May be shipped on ice or equivalent; refrigerate upon receipt.
	SKC (Modified)	SKC 575-002 Passive Badge	0.0178	4 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
Isobutyl Acetate	3M (Modified)	3M Badge (3500 or 3520)	0.0310	8 Hrs	3 Weeks	May be shipped on ice or equivalent; refrigerate upon receipt.
Isopropyl Acetate	3M (Modified)	3M Badge (3500 or 3520)	0.0317	7 Hrs	3 Weeks	May be shipped on ice or equivalent; refrigerate upon receipt.
Isovaleraldehyde	OSHA 1007 (Modified)	AT N571 Passive Monitor	0.00601 L/min	8 Hrs	28 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.
Lead	NIOSH 7300	37-mm, 0.8-um, MCE Filter	1 - 4	50 - 2000	Indefinite	Should be stored at room temperature.

Analyte	Method Reference	Sample Media	Sampling Rate	Air Volume	Sample Stability	Preservation
Lithium	NIOSH 7300	37-mm, 0.8-um, MCE Filter	1 - 4	100 - 2000	Indefinite	Should be stored at room temperature.
Magnesium	N7300/OSHA ID-121	37-mm, 0.8-um, MCE Filter	1 - 4	30 - 960 / 5 - 67	Indefinite	Should be stored at room temperature.
Manganese	N7300/OSHA ID-121	37-mm, 0.8-um, MCE Filter	1 - 4	5 - 960 / 5 - 200	Indefinite	Should be stored at room temperature.
Mercury	NIOSH 6009	200-mg Anasorb C300 Tube	0.15 - 0.25	2 - 100	30 Days	Should be stored at room temperature.
Mercury, Inorganic	OSHA ID-140	800-mg Anasorb C300 Cartridge	0.02	9.6	30 Days	Should be stored at room temperature.
Methane	EPA 3C/ASTM D1946	Entech Canister	Grab or Time integrated	400 mL or 1L	30 Days	Should be stored at room temperature.
	EPA 3C/ASTM D1946	Flex Foil Bag	Grab	1 L	5 Days	Should be stored at room temperature.
	ASTM D1945-03	Entech Canister	Grab or Time Integrated	400 mL or 1 L	30 Days	Should be stored at room temperature.
	ASTM D1945-03	Tedlar Bag	Grab	1	72 Hrs	Should be stored at room temperature.
Methanol	NIOSH 2000	150-mg Silica Gel Tube	0.02 - 0.2	1 - 5	30 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.
4-4'-Methylene Bisphenyl Isocyanate (4,4'-MDI)	OSHA 47	37-mm Glass Fiber Filter coated with 1,2PP	1 L/min	15	15 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.
Methylal	NIOSH 1611	150-mg Charcoal Tube	0.1-0.2	1-3	Unknown	Should be shipped on ice or equivalent; refrigerate upon receipt.
Methylene Chloride	NIOSH 1005	2 Charcoal Tubes in series, 150-mg each	0.01 - 0.2	0.5 - 2.5	30 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	3M (Modified)	3M 3520 Passive Monitor	0.03$79*	6 Hrs Max.	3 Weeks	May be shipped on ice or equivalent; refrigerate upon receipt.
Methyl Ethyl Ketone	OSHA 1004	225-mg Anasorb CMS Tube	0.05	≤ 12	15 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	3M (Modified)	3M Badge (3500	0.0363	8 Hrs Max.	3 Weeks	May be shipped on ice or equivalent;

Analyte	Method Reference	Sample Media	Sampling Rate	Air Volume	Sample Stability	Preservation
		or 3520)				refrigerate upon receipt.
	SKC + OSHA 1004	SKC 575-002 Passive Badge	0.01688	8 Hrs Max.	25 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
Methyl Isobutyl Ketone	OSHA 1004	225-mg Anasorb CMS Tube	0.05	≤ 12	15 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	SKC + OSHA 1004	SKC 575-002 Passive Badge	0.01362	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	NIOSH 1300	150-mg Charcoal Tube	1 - 10	0.01 - 0.2	Undetermined	May be shipped on ice or equivalent; refrigerate upon receipt.
	3M (Modified)	3M Badge (3500 or 3520)	0.0300	8 Hrs	3 Weeks	May be shipped on ice or equivalent; refrigerate upon receipt.
	Assay Technology(Mod)	Assay N546 or N566 Badge	0.00092 (#546) 0.00751 (#566)	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
Methyl Methacrylate	3M (Modified)	3M Badge (3500 or 3520)	0.0318	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	SKC (Modified)	SKC 575-002 Passive Badge	0.0131	8 Hrs Max.	21 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	Assay Technology(Mod)	Assay N546 or N566 Badge	0.00100 (#546) 0.00751 (#566)	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
Methyl tert-Butyl Ether (MTBE)	NIOSH 1615	150-mg Charcoal Tube	0.1 - 0.2	2 - 96	5 Days / 3 Weeks	May be shipped on ice or equivalent; refrigerate upon receipt.
	3M (Modified)	3M Badge (3500 or 3520)	0.0308	8 Hrs.	28 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
Molybdenum	N7300/OSHA ID-121	37-mm, 0.8-um, MCE Filter	1 - 4	5 - 960 / 5 - 67	Indefinite	Should be stored at room temperature.
Naphthas (client must submit bulk liquid sample to be used as reference	NIOSH 1550	150-mg Charcoal Tube	0.01 - 0.2	1.3 - 20	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.

Analyte	Method Reference	Sample Media	Sampling Rate	Air Volume	Sample Stability	Preservation
standard)						
Natural Gas Screen (CH_4, C_2H_6, C_3H_8, C_4H_{10}, C_5H_{12}, C_6H_{14})	ASTM D1945-03	Entech Canister	400ml or 1 L	Grab or Time integrated	30 Days	Should be stored at room temperature.
	ASTM D1945-03	Tedlar Bag	Grab	1	72 Hrs.	Should be stored at room temperature.
Nickel	NIOSH 7300	37-mm, 0.8-um, MCE Filter	1 - 4	5 - 1000	Indefinite	Should be stored at room temperature.
Nicotine	NIOSH 2551	120-mg XAD-4 Tube	0.1 - 1	0.5 - 600	14 Days - Dark	Should be shipped on ice or equivalent; refrigerate upon receipt. Avoid Light exposure.
Nitric Acid	NIOSH 7903	600-mg Cleaned Silica Gel Tube	0.2 - 0.5	3 - 100	21 Days	Should be stored at room temperature.
Nitrogen	EPA 3C/ASTM D1946	Entech Canister	400ml or 1 L	Grab or Time integrated	30 Days	Should be stored at room temperature.
	EPA 3C/ASTM D1946	Flex Foil Bag	1 L	Grab	5 Days	Should be stored at room temperature.
Octane (n-Octane)	NIOSH 1500	150-mg Charcoal Tube	0.01 - 0.2	4	30 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	3M (Modified)	3M Badge (3500 or 3520)	0.0266	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	SKC (Modified)	SKC 575-002 Passive Badge	0.0127	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	Assay Technology(Mod)	Assay N546 or N566 Badge	0.00078 (#546) 0.00703 (#546)	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
Oxygen	EPA 3C/ASTM D1946	Entech Canister	400ml or 1 L	Grab or Time integrated	30 Days	Should be stored at room temperature.
	EPA 3C/ASTM D1946	Flex Foil Bag	1 L	Grab	5 Days	Should be stored at room temperature.

Analyte	Method Reference	Sample Media	Sampling Rate	Air Volume	Sample Stability	Preservation
Particulates, Respirable Dusts	NIOSH 0600	37-mm pre-weighed PVC Filter, 5-um pore size, w/al cyclone	2.5	20 - 400	Indefinite	Should be stored at room temperature.
Particulates, Total Dusts	NIOSH 0500	37-mm pre-weighed PVC Filter, 5-um pore size	1 - 2	7 - 133	Indefinite	Should be stored at room temperature.
Pentane (n-Pentane)	NIOSH 1500	150-mg Charcoal Tube	0.01 - 0.4	4	30 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.
	3M (Modified)	3M 3520 Passive Monitor	0.0353	3 Hrs Max.	14 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.
	SKC (Modified)	SKC 575-002 Passive Monitor	0.0149	8 Hrs Max.	14 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.
	Assay Technology (Modified)	Assay N546 or N566 Badge	0.00105 (#546) 0.00886 (#566)	8 Hrs Max.	14 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.
	ASTM D1945-03	Entech Canister	400ml or 1 L	Grab or Time integrated	30 Days	Should be stored at room temperature.
	ASTM D1945-03	Tedlar Bag	1 L	Grab	72 Hrs	Should be stored at room temperature.
Pesticides, Organochlorine	TO-10A	PUF Tube, 76 mm	1 - 5	240 - 7200	10 Days	Must be shipped on wet ice; refrigerate upon receipt.
Pesticides, Organophosphorus	NIOSH 5600	OVS-2 Tube; 13-mm Quartz Filter with 450-mg XAD-2	0.2 - 1	12 - 240	30 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.
Pesticides, Organophosphorus	TO-10A	PUF Tube, 76 mm	1 - 5	240 - 7200	10 days	Must be shipped on wet ice; refrigerate upon receipt.
Phenol	NIOSH 2546	150-mg XAD-7 Tube	0.01 - 0.1	1 - 24	Undetermined	Should be shipped on ice or equivalent; refrigerate upon receipt.
4-Phenylcyclohexene	OSHA In-House Method (Modified)	150 or 600 mg Charcoal Tube	0.2	10 - 360	Undetermined	May be shipped on ice or equivalent; refrigerate upon receipt.

Analyte	Method Reference	Sample Media	Sampling Rate	Air Volume	Sample Stability	Preservation
Phosphine	OSHA 1003	37-mm glass fiber filter with a mercuric chloride treated polyester filter	TWA: 1.0 STEL: 2.0	TWA: 240 L max STEL: 30 L max	17 Days (filter extremely short holdtime)	Should be shipped on ice or equivalent; refrigerate upon receipt.
Phosphoric Acid	NIOSH 7903	600-mg Cleaned Silica Gel	0.2 - 0.5	3 - 100	21 Days	Should be stored at room temperature.
Polychlorinated Biphenyls (PCBs) - Aroclors 1016, 1221, 1232, 1242, 1248, 1254, and 1260.	NIOSH 5503	13-mm, Glass fiber filter in series with a 150-mg Florisil	0.05 - 0.2	1 - 50	2 Months for Tubes	Should be shipped on ice or equivalent; refrigerate upon receipt.
Polychlorinated Biphenyls (PCBs) - Aroclors 1016, 1221, 1232, 1242, 1248, 1254, and 1260.	TO-10A	PUF Tube, 76 mm	1 - 5	240 - 7200	10 Days	Must be shipped on wet ice; refrigerate upon receipt.
Polynuclear Aromatic Hydrocarbons (PAH/PNA)	NIOSH 5506	37-mm, 2-um PTFE filter in series with a 120-mg XAD-2	2	200 - 1000	Unknown-Protect from light/heat	Should be shipped on ice or equivalent; refrigerate upon receipt.
Potassium	N7300/OSHA ID-121	37-mm, 0.8-um, MCE Filter	1 - 4	30 - 960 / 5 - 1000	Indefinite	Should be stored at room temperature.
Propane	ASTM D1945-03	Entech Canister	400ml or 1 L	Grab or Time integrated	28 Days	Should be stored at room temperature.
	ASTM D1945-03	Tedlar Bag	1 L	Grab	72 Hrs.	Should be stored at room temperature.
1-Propanol	NIOSH 1401/1405	150-mg Charcoal Tube	0.01-0.2	1-10	14 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.
Propionaldehyde	OSHA 1007 (Modified)	AT N571 Passive Badge	0.00798 L/min	8 Hours	28 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.

Analyte	Method Reference	Sample Media	Sampling Rate	Air Volume	Sample Stability	Preservation
n-Propyl Acetate	NIOSH 1450	150-mg Charcoal Tube	0.01-0.2	18-150	30 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.
Pyridine	NIOSH 1613	150-mg Charcoal Tube	0.01-1.0	1 - 10	Undetermined	Should be shipped on ice or equivalent; refrigerate upon receipt.
Selenium	N7300/OSHA ID-121	37-mm, 0.8-um, MCE Filter	1 - 4	60 - 2000 / 13 - 2000	Indefinite	Should be stored at room temperature.
Silicon Tetrahydride (Silane)	OSHA CSI	15 mL of 0.01 N KOH in a MGFB	1.0 L/min Max	480 L Max	7 days	Should be stored at room temperature.
Silver	N7300/OSHA ID-121	37-mm, 0.8-um, MCE Filter	1 - 4	60 - 2000 / 250-2000	Indefinite	Should be stored at room temperature.
Sodium	N7300/OSHA ID-121	37-mm, 0.8-um, MCE Filter	1 - 4	30 - 2000 / 30 - 960	Indefinite	Should be stored at room temperature.
Strontium	NIOSH 7300	37-mm, 0.8-um, MCE Filter	1 - 4	25 - 2000 / 10 - 1000	Indefinite	Should be stored at room temperature.
Styrene	NIOSH 1501	150-mg Charcoal Tube	< 1.0	1 - 14	30 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	3M (Modified)	3M Badge (3500 or 3520)	0.0289	8 Hrs. Max.	21 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	SKC (Modified)	SKC 575-002 Passive Badge	0.0137	8 Hrs Max.	21 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	Assay Technology(Mod)	Assay N546 or N566 Badge	0.00094 (#546) 0.00755 (#566)	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
Sulfuric Acid	NIOSH 7903	600-mg Cleaned Silica Gel	0.2 - 0.5	3 - 100	21 Days	Should be stored at room temperature.
Tetrachloro-ethylene	NIOSH 1003	150-mg Charcoal Tube	0.01 - 0.2	1.0 - 40	30 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	3M (Modified)	3M Badge (3500 or 3520)	0.0283	8 Hrs Max.	21 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	SKC (Modified)	SKC 575-002 Passive Badge	0.0131	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.

Analyte	Method Reference	Sample Media	Sampling Rate	Air Volume	Sample Stability	Preservation
	Assay Technology(Mod)	Assay N546 or N566 Badge	0.00101 (#546) 0.00583 (#566)	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
Tetrahydrofuran	NIOSH 1609	150-mg Charcoal Tube	0.01 - 0.2	1 - 9	Undetermined	May be shipped on ice or equivalent; refrigerate upon receipt.
	3M (Modified)	3M Badge (3500 or 3520)	0.0372	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	SKC (Modified)	SKC 575-002 Passive Badge	0.0174	4 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	Assay Technology(Mod)	Assay N546 or N566 Badge	0.00121 (#545) 0.00886 (#546)	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
Thallium	NIOSH 7300	37-mm, 0.8-um, MCE Filter	1 - 4	50 - 2000 / 25 - 2000	Indefinite	Should be stored at room temperature.
Tolualdehyde	OSHA 1007 (Modified)	AT N571 Passive Badge	0.00524 L/min	8 Hours	28 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.
Toluene	NIOSH 1501	150-mg Charcoal Tube	< 0.2	1 - 8	30 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.
	3M (Modified)	3M Badge (3500 or 3520)	0.0314	8 Hrs Max.	3 Weeks	Should be shipped on ice or equivalent; refrigerate upon receipt.
	SKC (Modified)	SKC 575-002 Passive Badge	0.0149	8 Hrs Max.	14 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.
	Assay Technology(Mod)	Assay N546 or N566 Badge	0.00095 (#546) 0.00735 (#566)	8 Hrs Max.	14 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.
Toluene-2,4-Diisocyanate (2,4-TDI)	OSHA 42	37-mm Glass Fiber Filter coated with 1,2PP	1 L/min	15	18 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.
Toluene-2,6-Diisocyanate	OSHA 42	37-mm Glass Fiber Filter	1 L/min	15	18 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.

Analyte	Method Reference	Sample Media	Sampling Rate	Air Volume	Sample Stability	Preservation
(2,6-TDI)		coated with 1,2PP				
Toxaphene	NIOSH 5039	37-mm, 0.8-um, MCE Filter	0.2 - 1	2 - 30	14 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.
1,1,1-Trichloroethane	NIOSH 1003	150-mg Charcoal Tube	0.01 - 0.2	0.1 - 8	30 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	3M (Modified)	3M Badge (3500 or 3520)	0.0309	8 Hrs Max.	21 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	SKC (Modified)	SKC 575-002 Passive Monitor	0.0145	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	Assay Technology(Mod)	Assay N546 or N566 Badge	0.00108 (#546) 0.0065 (#566)	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
1,1,2-Trichloroethane	NIOSH 1003	150-mg Charcoal Tube	0.01 - 0.2	2 - 60	30 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	3M (Modified)	3M Badge (3500 or 3520)	0.0297	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	SKC (Modified)	SKC 575-002 Passive Monitor	0.0125	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	Assay Technology(Mod)	Assay N546 or N566 Badge	0.00109 (#546) 0.0065 (#566)	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
Trichloroethylene	NIOSH 1022	150-mg Charcoal Tube	0.01 - 0.2	1 - 30	17 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	3M (Modified)	3M Badge (3500 or 3520)	0.0311	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	SKC (Modified)	SKC 575-002 Passive Badge	0.0143	4 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	Assay Technology(Mod)	Assay N546 or N566 Badge	0.00109 (#546) 0.00705 (#566)	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.

Analyte	Method Reference	Sample Media	Sampling Rate	Air Volume	Sample Stability	Preservation
Valeraldehyde	OSHA 1007 (Modified)	AT N571 Passive Badge	0.00601 L/min	8 Hrs	28 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.
Vanadium	NIOSH 7300	37-mm, 0.8-um, MCE Filter	1 - 4	5 - 2000	Indefinite	Should be stored at room temperature.
Vinyl Acetate	3M (Modified)	3M Badge (3500 or 3520)	0.0358	8 Hrs Max.	21 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	SKC (Modified)	SKC 575-002 Passive Badge	0.0163	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	Assay Technology(Mod)	Assay N545 or N546 Badge	0.00112 (#546) 0.00811 (#566)	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
Vinyl Chloride	NIOSH 1007	(2) 150-mg Charcoal Tube	0.05	3 - 5	10 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
Vinylidene Chloride	NIOSH 1015	150-mg Charcoal Tube	0.01 - 0.2	2.5 - 7	21 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	3M (Modified)	3M Badge (3500 or 3520)	0.0351	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	SKC (Modified)	SKC 575-002 Passive Badge	0.0123	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	Assay Technology(Mod)	Assay N546 or N566 Badge	0.00130 (#546) 0.00764 (#566)	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
Volatile Organic Compounds	OSHA PV2120	Entech Canister	400ml or 1 L	Grab or Time integrated	30 Days	Should be stored at room temperature.
Volatile Organic Compounds	EPA TO-15	Entech Canister	1 L	Grab or Time integrated	30 Days	Should be stored at room temperature.
Xylene isomers	NIOSH 1501	150-mg Charcoal Tube	< 0.2	2 - 23	30 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
	3M (Modified)	3M Badge (3500 or 3520)	0.0273	8 Hrs Max.	3 Weeks	May be shipped on ice or equivalent; refrigerate upon receipt.
	SKC (Modified)	SKC 575-002 Passive Monitor	Isomer specific	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.

Analyte	Method Reference	Sample Media	Sampling Rate	Air Volume	Sample Stability	Preservation
	Assay Technology(Mod)	Assay N546 or N566 Badge	0.00093(#546) 0.00668 (#566)	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.
Zinc	N7300/OSHA ID-121	37-mm, 0.8-um, MCE Filter	1 - 4	5 - 960 / 5 - 200	Indefinite	Should be stored at room temperature.

SECTION 23. HANDLING OF SAMPLES

Sample management procedures at the laboratory ensure that sample integrity and custody are maintained and documented from sampling/receipt through disposal. This section applies to all samples (environmental, air, industrial hygiene, etc.) received at the laboratory except as noted in individual method SOPs.

23.1 Chain of Custody (COC)

The COC form is the written documented history of any sample and is initiated when bottles are sent to the field, or at the time of sampling. This form is completed by the sampling personnel and accompanies the samples to the laboratory where it is received and stored under the laboratory's custody. The purpose of the COC form is to provide a legal written record of the handling of samples from the time of collection until they are received at the laboratory. It also serves as the primary written request for analyses from the client to the laboratory. The COC form acts as a purchase order for analytical services when no other contractual agreement is in effect. An example of a COC form may be found in Figure 23-1.

23.1.1 Field Documentation

The information the sampler needs to provide at the time of sampling on the container label is:

- Sample identification
- Date and time
- Preservative

During the sampling process, the COC form is completed and must be legible (see Figure 23-1). This form includes information such as:

- Client name, address, phone number and fax number (if available)
- Project name and/or number
- The sample identification
- Date, time and location of sampling
- Sample collectors name
- The matrix description
- The container description
- The total number of each type of container
- Preservatives used
- Analysis requested
- Requested turnaround time (TAT)
- Any special instructions
- Purchase Order number or billing information (e.g. quote number) if available
- The date and time that each person received or relinquished the sample(s), including their signed name

When the sampling personnel deliver the samples directly to TestAmerica personnel, the samples are stored in a cooler with ice, as applicable, and remain solely in the possession of the client's field technician until the samples are delivered to the laboratory personnel. The sample collector must assure that each container is in his/her physical possession or in his/her view at all times, or stored in such a place and manner to preclude tampering. The field technician relinquishes the samples in writing on the COC form to the sample control personnel at the laboratory or to a TestAmerica courier. When sampling personnel deliver the samples through a common carrier (Fed-Ex, UPS), the CoC relinquished date/time is completed by the field personnel and samples are released to the carrier. Samples are only considered to be received by lab when personnel at the fixed laboratory facility have physical contact with the samples.

Note: Independent couriers are not required to sign the COC form. The COC is usually kept in the sealed sample cooler. The receipt from the courier is stored in the project folder.

23.1.2 Legal / Evidentiary Chain-of-Custody

If samples are identified for legal/evidentiary purposes, the Project Manager or Sample Control will enter "Legal ICOC" or "LCOC" into the comments section of Element. Sample control signs the samples into the secure walk-in refrigerator or freezer. Each time the sample is removed or returned to secure storage it is recorded in Element LIMS for that sample. Refer to SOP PE-QAD-026 Internal Chain of Custody Procedures for more detailed information.

23.2 Sample Receipt

Samples are received at the laboratory by designated sample receiving personnel and a unique laboratory project identification number is assigned. Each sample container shall be assigned a unique sample identification number that is cross-referenced to the client identification number such that traceability of test samples is unambiguous and documented. Each sample container is affixed with a durable sample identification label. Sample acceptance, receipt, tracking and storage procedures are summarized in the following sections. SOP No. PE-SMP-001, Sample Receiving describes these procedures.

23.2.1 Laboratory Receipt

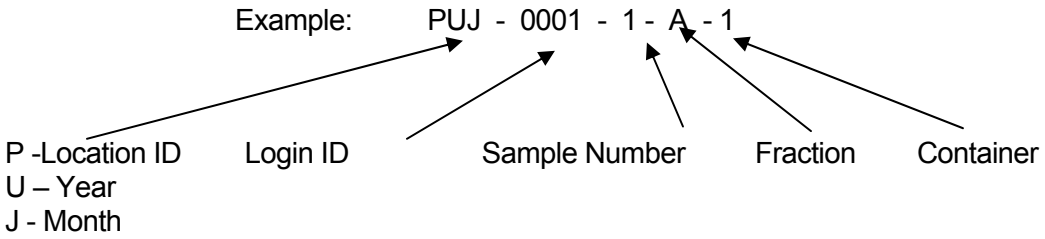
When samples arrive at the laboratory, sample receiving personnel inspect the coolers and samples. The integrity of each sample must be determined by comparing sample labels or tags with the COC and by visual checks of the container for possible damage. Any non-conformance, irregularity, or compromised sample receipt must be documented on a Notification of Discrepancy form and brought to the immediate attention of the client. The COC, shipping documents, documentation of any non-conformance, irregularity, or compromised sample receipt, record of client contact, and resulting instructions become part of the project record.

23.2.1.1 Unique Sample Identification

All samples that are processed through the laboratory receive a unique sample identification to ensure that there can be no confusion regarding the identity of such samples at anytime. This

system includes identification for all samples, subsamples and subsequent extracts and/or digestates.

The laboratory assigns a unique identification (e.g., Sample ID) code to each sample container received at the laboratory. This Primary ID is made up of the following information (consisting of 7 components):



The above example states that TestAmerica Phoenix Laboratory (Location) received samples in 2011 (Year) in October (Month). Login ID is 0001 (start at 0001 each month). The container code indicates it is the first sample ("1") of the work order and the first fraction ("A") of Sample #1 and the first container of the fraction ("1").

With this system, a client sample can literally be tracked throughout the laboratory in every step from receipt to disposal.

23.3 Sample Acceptance Policy

The laboratory has a written sample acceptance policy (Figure 23-2) that clearly outlines the circumstances under which samples shall be accepted or rejected. These include:

- A COC filled out completely;
- Samples must be properly labeled;
- Proper sample containers with adequate volume for the analysis of both environmental and IH samples and necessary QC;
- Samples must be preserved according to the requirements of the requested analytical method or IH Sampling Guide;
- Sample holding times must be adhered to;
- All samples submitted for water Volatile Organic analyses must have a Trip Blank submitted at the same time;
- The Project Manager will be notified if any sample is received in damaged condition.

Data from samples which do not meet these criteria are flagged and the nature of the variation from policy is defined.

23.3.1 After inspecting the samples, the sample receiving personnel sign and date the COC form, make any necessary notes of the samples' conditions and store them in appropriate refrigerators or storage locations.

23.3.2 Sample condition at the time of receipt is documented on the Sample Receipt Forms. A form generated by Element documents general information. A second form, generated by sample receipt personnel documents the verification of sample preservation. This form is not required for samples which do not require chemical preservation (e.g. soil, air) or where verification cannot be performed (e.g. aqueous volatile organics).

23.3.3 Any deviations from these checks that question the suitability of the sample for analysis, or incomplete documentation as to the tests required will be resolved by consultation with the client. If the sample acceptance policy criteria are not met, the laboratory shall either:

- Retain all correspondence and/or records of communications with the client regarding the disposition of rejected samples, or
- Fully document any decision to proceed with sample analysis that does not meet sample acceptance criteria.

Once sample acceptance is verified, the samples are logged into the LIMS according SOP PE-SMP-001 Sample Control.

23.4 Sample Storage

In order to avoid deterioration, contamination or damage to a sample during storage and handling, from the time of receipt until all analyses are complete, samples are stored in refrigerators freezers or protected locations suitable for the sample matrix. Aqueous Metal samples and some IH samples are stored unrefrigerated. In addition, samples to be analyzed for volatile organic analytes are stored in separate refrigerators designated for volatile organic parameters only. Samples are never to be stored with reagents, standards or materials that may create contamination.

To ensure the integrity of the samples during storage, refrigerator blanks are maintained in the volatile sample refrigerators and analyzed every two weeks.

Analysts and technicians retrieve the sample container allocated to their analysis from the designated refrigerator and place them on carts, analyze the sample, and return the remaining sample or empty container to the refrigerator from which it originally came. All samples are kept in the refrigerators for two to four weeks after analysis, which meets or exceeds most sample holding times. After two to four weeks the samples are moved to the room temperature sample archive area where they are stored for an additional four weeks before they are disposed of. This eight week holding period allows samples to be checked if a discrepancy or question arises. Special arrangements may be made to store samples for longer periods of time. This extended holding period allows additional metal analyses to be performed on the archived sample and assists clients in dealing with legal matters or regulatory issues.

Access to the laboratory is controlled such that sample storage need not be locked unless a project specifically demands it. Samples are accessible to laboratory personnel only. Visitors to the laboratory are prohibited from entering the refrigerator and laboratory areas unless accompanied by an employee of TestAmerica.

To minimize exposure to personnel and to avoid potential accidents, hazardous and foreign soil samples are stored in Hazardous Sample bins in an isolated area designated for storage of hazardous samples and foreign soils only. For any sample that is known to be hazardous at the time of receipt or, if after completion of analysis the result exceeds the acceptable regulatory levels, a Hazardous Sample Notification Form must be completed by the analyst.

This form may be completed by Sample Control, Project Managers, or analysts and must be attached to the report. The sample itself is clearly marked with a red tag reading "HAZARDOUS" or "FOREIGN SOIL" and is placed in the Hazardous Samples Bins. A copy of the form must be included with the original COC and Work Order and the original must be given to the Sample Control Custodian. Analysts will present any sample determined to be hazardous after completion of analysis for storage in the assigned area to the Sample Control Custodian.

All hazardous samples are either returned to the client or disposed of appropriately through a hazardous waste disposal firm or via a laboratory waste stream. Depending on the circumstances, clients may be asked to bear the disposal cost if the laboratory is asked to dispose of the hazardous sample. Additional information about handling Hazardous Samples is contained in SOP PE-SMP-001 Sample Control and SOP PE-SFT-001 Sample Disposal and Waste Management. Foreign soil samples are handled according to the procedures in SOP PE-SMP-006 Receiving and Waste Management of Foreign Soils.

23.5 Sample Shipping

In the event that the laboratory needs to ship samples, the samples are placed in a cooler with enough ice to ensure the samples remain just above freezing and at or below 6.0°C during transit. The samples are carefully surrounded by packing material to avoid breakage (yet maintain appropriate temperature). A trip blank is enclosed for those samples requiring water/solid volatile organic analyses (see Note). The chain-of-custody form is signed by the sample control technician and attached to the shipping paperwork. Samples are generally shipped overnight express or hand-delivered by a TestAmerica courier to maintain sample integrity. All personnel involved with shipping and receiving samples must be trained to maintain the proper chain-of-custody documentation and to keep the samples intact and on ice. The Environmental, Health and Safety Manual contains additional shipping requirements.

23.6 Sample Disposal

Samples should be retained for a minimum of 30 days after the project report is sent, however, provisions may be made for earlier disposal of samples once the holding time is exceeded. Some samples are required to be held for longer periods based on regulatory or client requirements (e.g., 60 days after project report is sent). The laboratory must follow the longer sample retention requirements where required by regulation or client agreement. Several possibilities for sample disposal exist: the sample may be consumed completely during analysis, the sample may be returned to the customer or location of sampling for disposal, or the sample may be disposed of in accordance with the laboratory's waste disposal procedures (SOP PE-SFT-001 Sample Disposal and Waste Management). All procedures in the laboratory Environmental, Health and Safety Manual are followed during disposal. Samples are normally maintained in the laboratory no longer than two months from receipt unless otherwise requested. Unused portions of samples found or suspected to be hazardous according to state or federal guidelines may be returned to the client upon completion of the analytical work.

If a sample is part of a known litigation, the affected legal authority, sample data user, and/or submitter of the sample must participate in the decision about the sample's disposal. All documentation and correspondence concerning the disposal decision process must be kept on file.

Figure 23-1. Example: Chain of Custody (COC)

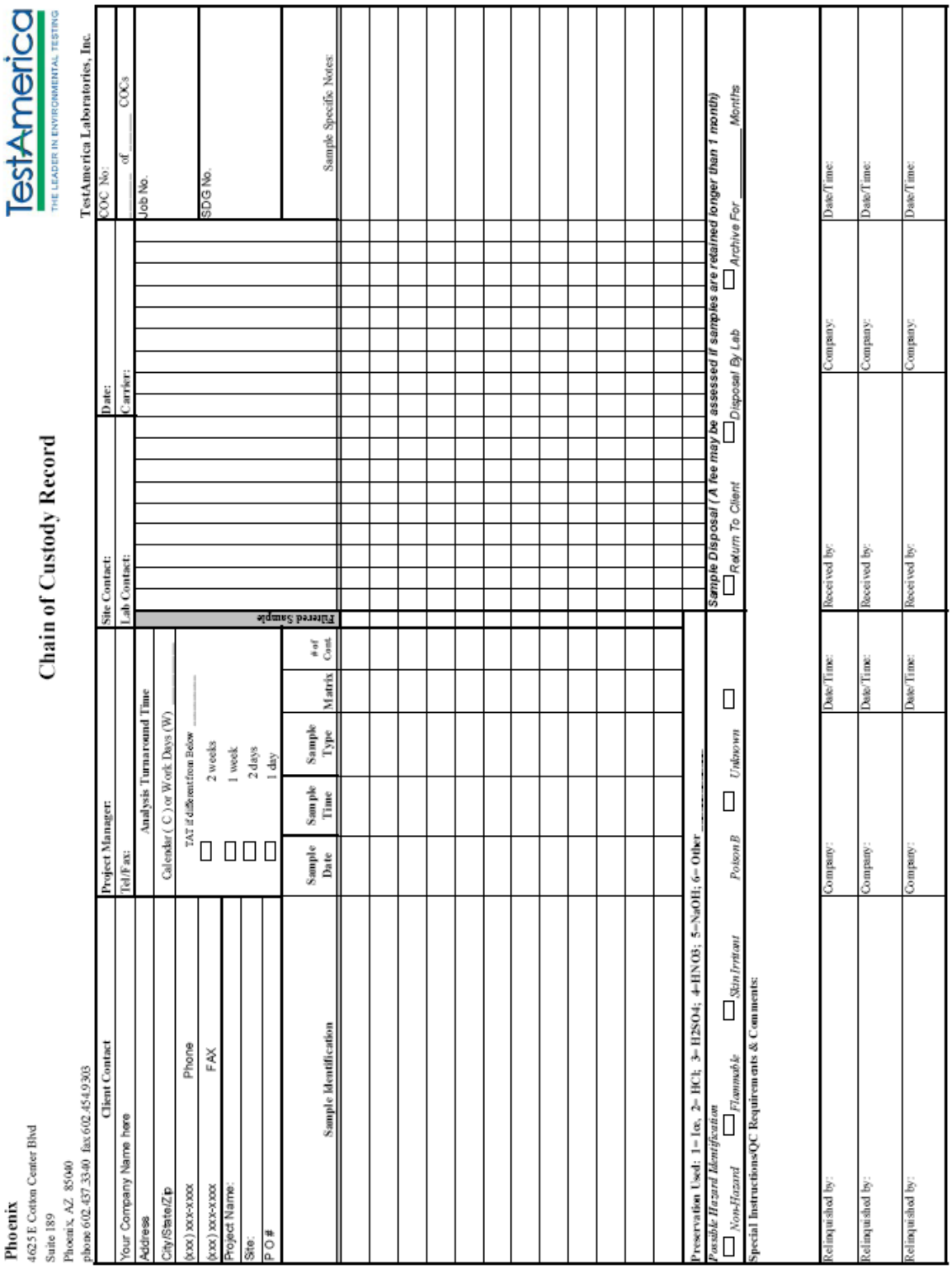


Figure 23-2 Sample Acceptance Policy

Sample Acceptance Policy
Phoenix Sample Acceptance Policy

All incoming work will be evaluated against the criteria listed below. Where applicable, data from any samples that do not meet the criteria listed below will be noted on the laboratory report defining the nature and substance of the variation. In addition, the client will be notified either by telephone, fax or e-mail ASAP after the receipt of the samples.

1) Samples must arrive with labels intact with a Chain of Custody filled out completely. The following information must be recorded.
- *Client name, address, phone number and fax number (if available)*
- *Project name and/or number*
- *The sample identification*
- *Date, time and location of sampling*
- *The collectors name*
- *The matrix description*
- *The container description*
- *The total number of each type of container*
- *Preservatives used*
- *Analysis requested*
- *Requested turnaround time (TAT)*
- *Any special instructions*
- *Purchase Order number or billing information (e.g., quote number) if available*
- *The date and time that each person received or relinquished the sample(s), including their signed name.*
- ***The date and time of receipt must be recorded between the last person to relinquish the samples and the person who receives the samples in the lab. The date and time relinquished/received must be exactly the same.***
  - **Information must be legible**

2) Samples must be properly labeled.
   - Use durable labels (labels provided by the Phoenix laboratory are preferred)
   - Include a unique identification number
   - Include sampling date and time & sampler ID
   - Include preservative used
   - Use indelible ink
   - **Information must be legible**

3) Proper sample containers with adequate volume for the analysis and necessary QC are required for each analysis requested.

4) Samples must be preserved according to the requirements of the requested analytical method. This includes samples (other than water samples for metals analysis) being chilled to below 6° C and above freezing (0°C). **Note:** Samples that are hand delivered to the laboratory immediately after collection may not have had time to cool sufficiently. In this case the samples will be considered acceptable as long as there is evidence that the chilling process has begun (arrival on ice).

- Chemical preservation (pH) will be verified prior to analysis and the project manager will be notified immediately if there is a discrepancy. If analyses will still be performed, all affected results will be flagged to indicate improper preservation.

- For Volatile Organic analyses in drinking water (Method 524.2). Residual chlorine must be neutralized prior to preservation. If there is prior knowledge that the samples are not chlorinated, state it on the COC and use the VOA vials pre-preserved with HCl. The following are other options for a sampler and laboratory where the presence of chlorine is not known:
  - 1. Test for residual chlorine in the field prior to sampling.
    - If no chlorine is present, the samples are to be preserved using HCl as usual.
    - If chlorine is present, add ascorbic acid prior to adding HCl.
  - 2. Use VOA vials pre-preserved with ascorbic acid and add HCl after filling the VOA vial with the sample.

5) Sample Holding Times
   - The Phoenix laboratory will make every effort to analyze samples within the regulatory holding time. Samples must be received in the laboratory with enough time to perform the sample analysis. Except for short holding time samples (< 48 hr HT) samples must be received with at least 48 hrs (working days) remaining on the holding time for us to ensure analysis.

   - Analyses that are "field" analyses (e.g., pH, Dissolved Oxygen, Residual Chlorine) will be analyzed within 24 hours from receipt of the samples in the laboratory. Field analysis received after 4:00 PM on Friday or on the weekend will be analyzed no later then the next business day after receipt (Monday, unless a holiday).

6) Samples submitted for Volatile Organic analyses must also have a Trip Blank submitted at the same time. TestAmerica's Phoenix laboratory will supply a blank with the bottle order.

7) The project manager will be notified if any sample is received in damaged condition. The Phoenix laboratory will request that a sample be resubmitted for analysis.

8) Recommendations for packing samples for shipment.

   - Pack samples in Ice rather than "Blue" ice packs.

   - Soil samples should be placed in plastic zip-lock bags. The containers often have dirt around the top and do not seal very well and are prone to intrusion from the water from melted ice.

   - Water samples are best if wrapped with bubble-wrap or paper (newspaper or paper towels work) and then placed in plastic zip-lock bags.

   - Fill extra cooler space with bubble wrap.

Figure 23-3 Sample Receipt Forms

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

SAMPLE RECEIPT FORM

Date/Time: 10/17/2011 10:43:32

Client Code: 8000

TAL Project Number: PUJ0953

Received By: Peter Floyd Logged By: Peter Floyd

Sample Temperature: 0.8°C

Samples Received: [X] On Ice [ ] On Blue Ice [ ] Unchilled

Check All that Apply:

Analysis	N/A	pH Verified	Additional Preservative Added?	Sample Numbers Needing Adjustment
500ml Amber w/HCL	[ ]	[ ]	[ ] HCL	
1L Amber w/HCL	[ ]	[ ]	[ ] HCL	
Poly w/HNO3	[ ]	[ ]	[ ] HNO3	
Poly w/H2SO4	[ ]	[ ]	[ ] H2SO4	
500ml Amber w/H2SO4	[ ]	[ ]	[ ] H2SO4	
1L Amber w/H2SO4	[ ]	[ ]	[ ] H2SO4	
Poly w/NaOH	[ ]	[ ]	[ ] NaOH	
Poly w/ NaOH + Zinc Acetate	[ ]	[ ]	[ ] NaOH + Zinc Acetate	

Volatile Soil Samples Received in: ____ N/A ____ Brass Sleeves ____ Glass Jars ____ Encore ____ Field Methanol

____ Other: _____

Date	Initials	Sample Number	Comments
10/17/2011		PUJ0953-01	
10/17/2011		PUJ0953-02	
10/17/2011		PUJ0953-03	
10/17/2011		PUJ0953-04	

CM 10/17/11 _____
Reviewed By Date Time

10/17/2011 10:43:32AM
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TestAmerica
Phoenix

Sample Receipt Presevation Verification

Work Order: _____
Sample Tech: _____
Date: _____

Preservative	Sample Numbers Verified	Sample Numbers with Incorrect Preservation
HNO3 pH ≤ 2		
H2SO4 pH ≤ 2		
NaOH pH ≥ 12		
NaOH+ Zinc Acetate pH ≥ 9		

pH of Incorrect Samples

HNO3 _____

H2SO4 _____

NaOH _____

NaOH+ Zinc Acetate _____

PX-QAD-023A-1/11

SECTION 24. ASSURING THE QUALITY OF TEST RESULTS

24.1 Overview

In order to assure our clients of the validity of their data, the laboratory continuously evaluates the quality of the analytical process. The analytical process is controlled not only by instrument calibration as discussed in Section 20, but also by routine process quality control (QC) measurements (e.g. Blanks, Laboratory Control Samples (LCS) (also known as a Blank Spike (BS)), Matrix Spikes (MS), duplicates (DUP), surrogates, Internal Standards (IS)). These quality control checks are performed as required by the method or regulations to assess precision and accuracy. In addition to the routine process quality control samples, Proficiency Testing (PT) Samples (concentrations unknown to laboratory) are analyzed to help ensure laboratory performance.

Required QC is method/program dependant (EPA methods, TNI, AIHA) and may vary depending on analytes requested. For more definitive information, reference the individual laboratory method SOPs. The following is a generalized discussion of common quality control measures in use in the laboratory.

24.2 Controls

Sample preparation or pre-treatment is commonly required before analysis. Typical preparation steps include homogenization, solvent extraction, sonication, acid digestion, distillation, reflux, evaporation, and drying. During these pre-treatment steps, samples are arranged into discreet manageable groups referred to as preparation (prep) batches. Prep batches provide a means to control variability in sample treatment. Control samples are added to each prep batch to monitor method performance and are processed through the entire analytical procedure with investigative/field samples.

24.3 Negative Controls

Table 24-1. Example – Negative Controls

Control Type	Details
Method Blank (MB)	Are used to assess preparation and analysis for possible contamination during the preparation and processing steps.
	The specific frequency of use for method blanks during the analytical sequence is defined in the specific standard operating procedure for each analysis. Generally it is 1 for each batch of samples (including IH samples); not to exceed 20 environmental samples.
	The method blank is prepared from a clean matrix similar to that of the associated samples that is free from target analytes (e.g., Reagent water, Ottawa sand, glass beads, sample media (IH Samples), etc.) and is processed along with and under the same conditions as the associated samples. The method blank goes through all of the steps of the process (including as necessary: filtration, clean-ups, etc.).

Control Type	Details
	Reanalyze or qualify associated sample results when the concentration of a targeted analyte in the blank is at or above the reporting limit as established by the method or by regulation, AND is greater than 1/10 of the amount measured in the sample.
Calibration Blanks	Are prepared and analyzed along with calibration standards where applicable. They are prepared using the same reagents that are used to prepare the standards. In some analyses the calibration blank may be included in the calibration curve.
Instrument Blanks	Are blank reagents or reagent water that may be processed during an analytical sequence in order to assess contamination in the analytical system. In general, instrument blanks are used to differentiate between contamination caused by the analytical system and that caused by the sample handling or sample prep process. Instrument blanks may also be inserted throughout the analytical sequence to minimize the effect of carryover from samples with high analyte content.
Trip Blank [1]	Are required to be submitted by the client with each shipment of samples requiring aqueous and solid volatiles analyses (or as specified in the client's project plan).. Additionally, trip blanks may be prepared and analyzed for volatile analysis of air samples, when required by the client. A trip blank may be purchased (certified clean) or is prepared by the laboratory by filling a clean container with pure deionized water that has been purged to remove any volatile compounds. Appropriate preservatives are also added to the container. The trip blank is sent with the bottle order and is intended to reflect the environment that the containers are subjected to throughout shipping and handling and help identify possible sources if contamination is found. The field sampler returns the trip blank in the cooler with the field samples. For IH methods, this may include a media blank submitted with the IH samples.
Field Blanks [1]	Are sometimes used for specific projects by the field samplers. A field blank is prepared in the field by filling a clean container with pure reagent water and appropriate preservative, if any, for the specific sampling activity being undertaken. (EPA OSWER and AIHA IH Program)
Equipment Blanks [1]	Are also sometimes created in the field for specific projects. An equipment blank is a sample of analyte-free media which has been used to rinse common sampling equipment to check effectiveness of decontamination procedures. (TNI)
Media Blank[1]	Sorbent or media that is treated exactly as a sample including exposure to all glassware, equipment, solvents, filtration and reagents that are used with other samples.
Holding Blanks	Also referred to as refrigerator or freezer blanks, are used to monitor the sample storage units for volatile organic compounds during the storage of VOA samples in the laboratory.

[1] When known, these field QC samples should not be selected for matrix QC as it does not provide information on the behavior of the target compounds in the field samples. Usually, the client sample ID will provide information to identify the field blanks with labels such as "FB", "EB", or "TB."

Evaluation criteria and corrective action for these controls are defined in the specific standard operating procedure for each analysis.

24.3.1 Negative Controls for Microbiological Methods

Microbiological Methods utilize a variety of negative controls throughout the process to ensure that false positive results are not obtained. These controls are critical to the validity of the microbiological analyses. Some of these negative controls are:

Table 24-2. Negative Controls for Microbiology

Control Type	Details
Sterility Checks (Media)	Are analyzed for each lot of pre-prepared media, ready-to-use media and for each batch of medium prepared by the laboratory.
Filtration Blanks	Blanks are run at the beginning and/or end of each batch depending on the type of water sample. For pre-sterilized single use funnels a sterility check is performed on at least one funnel per lot.
Sterility checks (Sample Containers)	Are performed on at least one container per lot of purchased, pre-sterilized containers. If containers are prepared and sterilized by the laboratory, one container per sterilization batch is checked. Container sterility checks are performed using non-selective growth media.
Sterility Checks (Dilution Water)	Are performed on each batch of dilution water prepared by the laboratory and on each batch of pre-prepared dilution water. All checks are performed using non-selective growth media.
Sterility Checks (Filters)	Are also performed on at least one filter from each new lot of membrane filters using non-selective growth media.

Negative culture controls demonstrate that a media does not support the growth of non-target organisms and ensures that there is not an atypical positive reaction from the target organisms. Prior to the first use of the media, each lot of pre-prepared selective media or batch of laboratory prepared selective media is analyzed with at least one known negative culture control as appropriate to the method.

24.4 Positive Controls

Control samples (e.g., QC indicators) are analyzed with each batch of samples to evaluate data based upon (1) Method Performance (Laboratory Control Sample (LCS) or Blank Spike (BS)), which entails both the preparation and measurement steps; and (2) Matrix Effects (Matrix Spike (MS) (Matrix spikes are not applicable to air samples) or Sample Duplicate (MD, DUP), which evaluates field sampling accuracy, precision, representativeness, interferences, and the effect of the matrix on the method performed. Each regulatory/accreditation program (SDW, TNI, AIHA, etc.) and each method within those programs specify the control samples that are prepared and/or analyzed with a specific batch.

Note that frequency of control samples vary with specific regulatory, methodology and project specific criteria. Complete details on method control samples are as listed in each analytical SOP.

24.4.1 Method Performance Control - Laboratory Control Sample (LCS)

24.4.1.1 The LCS measures the accuracy of the method in a blank matrix and assesses method performance independent of potential field sample matrix affects in a laboratory batch.

24.4.1.2 The LCS is prepared from a clean matrix similar to that of the associated samples that is free from target analytes (for example: Reagent water, Ottawa sand, glass beads, etc.) and is processed along with and under the same conditions as the associated samples. The LCS is spiked with verified known amounts of analytes or is made of a material containing known and verified amounts of analytes, taken through all preparation and analysis steps along

with the field samples. Where there is no preparation taken for an analysis (such as in aqueous volatiles), or when all samples and standards undergo the same preparation and analysis process (such as Phosphorus), a calibration verification standard is reported as the LCS. In some instances where there is no practical clean solid matrix available, aqueous LCSs may be processed for solid matrices; final results may be calculated as mg/kg or µg/kg, assuming 100% solids and a weight equivalent to the aliquot used for the corresponding field samples, to facilitate comparison with the field samples.

24.4.1.3 Certified pre-made reference material purchased from a NIST/A2LA accredited vendor may also be used for the LCS when the material represents the sample matrix or the analyte is not easily spiked (e.g. solid matrix LCS for metals, TDS, etc.).

24.4.1.4 The specific frequency of use for LCS during the analytical sequence is defined in the specific standard operating procedure for each analysis. It is generally 1 for each batch of samples; not to exceed 20 environmental samples. For IH Samples it is generally 1 for each analysis day.

24.4.1.5 If the mandated or requested test method, or project requirements, do not specify the spiking components, the laboratory shall spike all reportable components to be reported in the Laboratory Control Sample (and Matrix Spike) where applicable (e.g. no spike of pH). However, in cases where the components interfere with accurate assessment (such as simultaneously spiking Chlordane, Toxaphene and PCBs in Method 608), the test method has an extremely long list of components or components are incompatible, at a minimum, a representative number of the listed components (see below) shall be used to control the test method. The selected components of each spiking mix shall represent all chemistries, elution patterns and masses, permit specified analytes and other client requested components. However, the laboratory shall ensure that all reported components are used in the spike mixture within a two-year time period.

- For methods that have 1-10 target analytes, spike all components.
- For methods that include 11-20 target analytes, spike at least 10 or 80%, whichever is greater.
- For methods with more than 20 target analytes, spike at least 16 components.
- Exception: Due to analyte incompatibility in pesticides, Toxaphene and Chlordane are only spiked at client request based on specific project needs.
- Exception: Due to analyte incompatibility between the various PCB Aroclors, Aroclors 1016 and 1260 are used for spiking for methods 8082 and 608 as they cover the range of all of the Aroclors. Aroclor 1242 is spiked for TO-10. Specific Aroclors may be used by request on a project specific basis.

24.4.2 Positive Controls for Microbiological Methods

- Each lot of pre-prepared media (including chromofluorogenic reagent) and each batch of laboratory prepared media is tested with a pure culture of known positive reaction.

- In addition, every analytical batch also contains a pure culture of known positive reaction.
- A pure culture of known negative reaction is also tested with each analytical batch to ensure specificity of the procedure.

24.5 Sample Matrix Controls

Table 24-3. Sample Matrix Control

Control Type	Details	
Matrix Spikes (MS)	Use	Used to assess the effect sample matrix of the spiked sample has on the precision and accuracy of the results generated by the method used.
	Typical Frequency [1]	At a minimum, with each matrix-specific batch of samples processed, an MS is carried through the complete analytical procedure. Unless specified by the client, samples used for spiking are randomly selected and rotated between different client projects. If the mandated or requested test method does not specify the spiking components, the laboratory shall spike all reportable components to be reported in the Laboratory Control Sample and Matrix Spike. Refer to the method SOP for complete details
	Description	Essentially a sample fortified with a known amount of the test analyte(s).
Surrogate	Use	Measures method performance to sample matrix (organics only).
	Typical Frequency [1]	Are added to all samples, standards, and blanks, for all organic chromatography methods except when the matrix precludes its use or when a surrogate is not available. The recovery of the surrogates is compared to the acceptance limits for the specific method. Poor surrogate recovery may indicate a problem with sample composition and shall be reported, with data qualifiers, to the client whose sample produced poor recovery.
	Description	Are similar to matrix spikes except the analytes are compounds with properties that mimic the analyte of interest and are unlikely to be found in environment samples.
Duplicates[2]	Use	For a measure of analytical precision, with each matrix-specific batch of samples processed, a matrix duplicate (MD or DUP) sample, matrix spike duplicate (MSD), or LCS duplicate (LCSD) is carried through the complete analytical procedure.
	Typical Frequency [1]	Duplicate samples are usually analyzed with methods that do not require matrix spike analysis.
	Description	Performed by analyzing two aliquots of the same field sample independently or an additional LCS.
Internal Standards	Use	Are spiked into all environmental and quality control samples (including the initial calibration standards) to monitor the qualitative aspect of organic and some inorganic analytical measurements.
	Typical Frequency [1]	All organic and ICP methods as required by the analytical method.
	Description	Used to correct for matrix effects and to help troubleshoot variability in analytical response and are assessed after data acquisition. Possible sources of poor internal standard response are sample matrix, poor analytical technique or instrument performance.

[1] See the specific analytical SOP for type and frequency of sample matrix control samples.

[2] LCSDs may not be required except when regulatory agencies or client specifications require them. The recoveries for the spiked duplicate samples must meet the same laboratory established recovery limits as the accuracy QC samples. If an LCSD is analyzed, both the LCS and LCSD must meet the same recovery criteria and be included in the final report. The precision measurement is reported as "Relative Percent Difference" (RPD). Poor precision between duplicates (except LCS/LCSD) may indicate non-homogeneous matrix or sampling.

24.6 Acceptance Criteria (Control Limits)

As mandated by the test method and regulation, each individual analyte in the LCS, MS, or Surrogate Spike is evaluated against the control limits published in the test method. Where there are no established acceptance criteria, the laboratory calculates in-house control limits with the use of control charts or, in some cases, utilizes client project specific control limits. When this occurs, the regulatory or project limits will supersede the laboratory's in-house limits.

Note: For methods, analytes and matrices with very limited data (e.g., unusual matrices not analyzed often), interim limits are established using available data or by analogy to similar methods or matrices.

Once control limits have been established, they are verified, reviewed, and updated if necessary on an annual basis unless the method requires more frequent updating (e.g. EPA SW846 8000 series methods are reviewed and updated if necessary approximately every six months). Control limits are established per method (as opposed to per instrument) regardless of the number of instruments utilized.

Laboratory generated Percent (%) Recovery acceptance (control) limits are generally established by taking ± 3 Standard Deviations (99% confidence level) from the average recovery of a minimum of 20 – 30 data points (more points are preferred). (Element LIMS: The system defaults to collecting the previous 3 months data. This time frame should be shortened if there are more than 200 points since the system slows down tremendously. The time frame should be extended if there are not 20-30 points).

- Regardless of the calculated limit, the limit should be no tighter than the Calibration Verification (ICV/CCV) unless the analytical method specifies a tighter limit.

- In-house limits cannot be any wider than those mandated in a regulated analytical method. Client or contract required control limits are evaluated against the laboratory's statistically derived control limits to determine if the data quality objectives (DQOs) can be achieved. If laboratory control limits are not consistent with DQOs, then alternatives must be considered, such as method improvements or use of an alternate analytical method.

- The lowest acceptable recovery limit will be 10% (the analyte must be detectable and identifiable). Exception: The lowest acceptable recovery limit for Benzidine will be 5% and the analyte must be detectable and identifiable.

- The maximum acceptable recovery limit will be 150%.

- Unless method specified, the maximum acceptable RPD limit will be 35% for waters and 40% for soils. The minimum RPD limit is 20%.

- If either the high or low end of the control limit changes by ≤ 5% from the previous control limits, the control chart is visually inspected and, using professional judgment, they may be left unchanged if there is no affect on laboratory ability to meet the existing limits.

24.6.1 The lab must be able to generate a current listing of their control limits and track when the updates are performed. In addition, the laboratory must be able to recreate historical control limits. Refer to SOP PE-QAD-001 Control Limits and Statistical Process Control for additional information.

24.6.2 A LCS that is within the acceptance criteria establishes that the analytical system is in control and is used to validate the process. Samples that are analyzed with an LCS with recoveries outside of the acceptance limits may be determined as out of control and should be reanalyzed if possible. If reanalysis is not possible, then the results for all affected analytes for samples within the same batch must be qualified when reported. The internal corrective action process (see Section 12) is also initiated if an LCS exceeds the acceptance limits. Sample results may be qualified and reported without reanalysis if:

- The analyte results are below the reporting limit and the LCS is above the upper control limit.

- If the analytical results are above the relevant regulatory limit and the LCS is below the lower control limit.

Or, for TNI work, there is an allowable number of Marginal Exceedances (ME):

<11 analytes	0 marginal exceedances are allowed.
11 – 30 Analytes	1 marginal exceedance is allowed
31-50 Analytes	2 marginal exceedances are allowed
51-70 Analytes	3 marginal exceedances are allowed
71-90 Analytes	4 marginal exceedances are allowed
> 90 Analytes	5 marginal exceedances are allowed

- Marginal exceedances are recovery exceedances between 3 SD and 4 SD from the mean recovery limit (TNI).

- Marginal exceedances must be random. If the same analyte exceeds the LCS control limit repeatedly, it is an indication of a systematic problem. The source of the error must be located and corrective action taken. The laboratory has a system to monitor marginal exceedances to ensure that they are random.

Though marginal exceedances may be allowed, the data must still be qualified to indicate it is outside of the normal limits.

24.6.3 If the MS/MSDs do not meet acceptance limits, the MS/MSD and the associated spiked sample is reported with a qualifier for those analytes that do not meet limits. If obvious preparation errors are suspected, or if requested by the client, unacceptable MS/MSDs are

reprocessed and reanalyzed to prove matrix interference. A more detailed discussion of acceptance criteria and corrective action can be found in the lab's method SOPs and in Section 12.

24.6.4 If a surrogate standard falls outside the acceptance limits, if there is not obvious chromatographic matrix interference, reanalyze the sample to confirm a possible matrix effect. If the recoveries confirm or there was obvious chromatographic interference, results are reported from the original analysis and a qualifier is added. If the reanalysis meets surrogate recovery criteria, the second run is reported (or both are reported if requested by the client). Under certain circumstances, where all of the samples are from the same location and share similar chromatography, the reanalysis may be performed on a single sample rather than all of the samples and if the surrogate meets the recovery criteria in the reanalysis, all of the affected samples would require reanalysis.

24.7 Additional Procedures to Assure Quality Control

24.7.1 The laboratory has written and approved method SOPs to assure the accuracy of the test method including calibration (see Section 20), use of certified reference materials (see Section 21) and use of PT samples (see Section 15).

24.7.2 A discussion regarding MDLs, Limit of Detection (LOD) and Limit of Quantitation (LOQ) can be found in Section 19.

24.7.3 Use of formulae to reduce data is discussed in the method SOPs and in Section 20.

24.7.4 Selection of appropriate reagents and standards is included in Section 9 and 21.

24.7.5 A discussion on selectivity of the test is included in Section 5.

24.7.6 Constant and consistent test conditions are discussed in Section 18.

24.7.7 The laboratories sample acceptance policy is included in Section 23.

SECTION 25. REPORTING RESULTS

25.1 Overview

The results of each test are reported accurately, clearly, unambiguously, and objectively in accordance with State and Federal regulations as well as client requirements. Analytical results are issued in a format that is intended to satisfy customer and laboratory accreditation requirements as well as provide the end user with the information needed to properly evaluate the results. Where there is conflict between client requests and laboratory ethics or regulatory requirements, the laboratory's ethical and legal requirements are paramount, and the laboratory will work with the client during project set up to develop an acceptable solution. Refer to Section 7.

A variety of report formats are available to meet specific needs.

In cases where a client asks for simplified reports, there must be a written request from the client. There still must be enough information that would show any analyses that were out of conformance (QC out of limits) and there should be a reference to a full report that is made available to the client.

Review of reported data is included in Section 19.

25.2 Test Reports

Analytical results are reported in a format that is satisfactory to the client and meets all requirements of applicable accrediting authorities and agencies. A variety of report formats are available to meet specific needs. The report is printed on laboratory letterhead, reviewed, and signed by the appropriate Project Manager. At a minimum, the standard laboratory report shall contain the following information:

25.2.1 A report title (e.g. Laboratory Report) with a “Sample Result” column header.

25.2.2 Each report page printed on company letterhead, which includes the laboratory name, address and telephone number.

25.2.3 A unique identification of the report (e.g. report number) and on each page an identification in order to ensure the page is recognized as part of the report and a clear identification of the end.

Note: Page numbers of report are represented as page # of ##. Where the first number is the page number and the second is the total number of pages.

25.2.4 A copy of the chain of custody (COC).

- Any CoCs involved with Subcontracting are included.
- In most cases, the applicable COC is not paginated but is an integral part of the report. If the COC is not a paginated portion of the report then there will be a statement on the front of the report to effect of “The Chain of Custody, X page(s), is included and is an integral part of this report.". The number of pages of the CoC (X) is entered into Element so that it is correct for each report
- CoC Exception: For IH laboratory reports, the COC is considered a separate document.
- Any additional addenda to the report must be treated in a similar fashion so it is a recognizable part of the report and cannot accidentally get separated from the report (e.g. Sampling information).

25.2.5 The name and address of client and a project name/number, if applicable.

25.2.6 Client project manager or other contact.

25.2.7 Description and unambiguous identification of the tested sample(s) including the client identification code.

25.2.8 Date of receipt of sample, date and time of collection, and date(s) of test preparation and performance, and time of preparation or analysis if the required holding time for either activity is less than or equal to 72 hours.

25.2.9 Date reported or date of revision, if applicable.

25.2.10 Method of analysis including method code (EPA, Standard Methods, etc); and in the case of IH methods, any modifications to the methods. For Industrial Hygiene reports, test results not covered under AIHA-LAP accreditation must be clearly identified on the final test report.

25.2.11 Reporting limits.

25.2.12 Method detection limits (if requested).

25.2.13 Definition of Data qualifiers and reporting acronyms (e.g. ND).

25.2.14 Sample results. Measurement below the reporting limit are reported as < the reporting limit or ND. Results are not reported as"0".

25.2.15 For AIHA projects, the final report includes the measured quantitative result of the analysis of any blank samples submitted to the laboratory. Additionally, a statement is included that discloses whether on not the sample results have been corrected for contamination based on the field blank or method blank.

25.2.16 QC data consisting of method blank, surrogate, LCS, and MS/MSD recoveries and control limits.

25.2.17 Condition of samples at receipt including temperature. This may be accomplished in a narrative or by attaching sample login sheets (Refer to Sec. 25.2.4 – Item 4 regarding additional addenda).

25.2.18 A statement expressing the validity of the results, that the source methodology was followed and all results were reviewed for error.

25.2.19 A statement to the effect that the results relate only to the items tested and the sample as received by the laboratory.

25.2.20 A statement that the report shall not be reproduced except in full, without prior express written approval by the laboratory.

25.2.21 A signature and title of the person(s) accepting responsibility for the content of the report and date of issue. Signatories are appointed by the Lab Director.

25.2.22 When TNI accreditation is required, the lab shall certify that the test results meet all requirements of TNI or provide reasons and/or justification if they do not.

25.2.23 Where applicable, a narrative to the report that explains the issue(s) and corrective action(s) taken in the event that a specific accreditation or certification requirement was not met.

25.2.24 When soil samples are analyzed, a specific identification as to whether soils are reported on a "wet weight" or "dry weight" basis.

25.2.25 Appropriate laboratory certification number for the state of origin of the sample, if applicable.

25.2.26 If only part of the report is provided to the client (client requests some results before all of it is complete), it must be clearly indicated on the report (e.g., partial report or draft report). A complete report must be sent once all of the work has been completed.

25.2.27 Any non-TestAmerica subcontracted analysis results are provided as a separate report on the official letterhead of the subcontractor. All TestAmerica subcontracting is clearly identified on the report as to which laboratory performed a specific analysis.

25.2.28 Non-accredited tests shall be clearly identified in the case narrative when claims of accreditation to the TNI standard are made.

Note: Refer to the Corporate SOP on Electronic Reporting and Signature Policy (No. CA-I-P-002) for details on internally applying electronic signatures of approval.

25.3 Reporting Level or Report Type

The laboratory offers four levels of quality control reporting. Each level, in addition to its own specific requirements, contains all the information provided in the preceding level. The packages provide the following information in addition to the information described above:

- Level I/II is a report with all the features described in Section 25.2 plus summary information; including results for the method blank; percent recovery for laboratory control samples and matrix spike samples; and the RPD values for all MSD and sample duplicate analyses.
- Level III contains all the information supplied in Level I/II; chromatograms, including QC, calibration standards and samples; quantitation reports; initial and continuing calibration information; and copies of bench sheets/instrument printouts where required.
- Level IV is the same as Level III with the addition of multiple sample dilutions; extraction/preparation logs; analysis logs and standard preparation logs.

In addition to the various levels of QC packaging, the laboratory also provides reports in diskette deliverable form. Initial reports may be provided to clients by facsimile. All faxed reports are followed by hardcopy. Procedures used to ensure client confidentiality are outlined in Section 25.6.

25.3.1 Electronic Data Deliverables (EDDs)

EDDs are routinely offered as part of TestAmerica's services. TestAmerica Phoenix offers a variety of EDD formats including Excel, ASCII, Dbase, and Access.

EDD specifications are submitted to the IT department by the PM for review and undergo the contract review process. Once the facility has committed to providing data in a specific electronic format, the coding of the format may need to be performed. This coding is

documented and validated. The validation of the code is retained by the IT staff coding the EDD.

EDDs shall be subject to a review to ensure their accuracy and completeness. If EDD generation is automated, review may be reduced to periodic screening if the laboratory can demonstrate that it can routinely generate that EDD without errors. Any revisions to the EDD format must be reviewed until it is demonstrated that it can routinely be generated without errors. If the EDD can be reproduced accurately and if all subsequent EDDs can be produced error-free, each EDD does not necessarily require a review.

25.4 Supplemental Information for Test

The lab identifies any unacceptable QC analyses or any other unusual circumstances or observations such as environmental conditions and any non-standard conditions that may have affected the quality of a result. This is typically in the form of a footnote or a qualifier and/or a narrative explaining the discrepancy in the front of the report.

Numeric results with values outside of the calibration range, either high or low are qualified as 'estimated'.

Where quality system requirements are not met, a statement of compliance/non-compliance with requirements and/or specifications is required, including identification of test results derived from any sample that did not meet TNI sample acceptance requirements such as improper container, holding time, or temperature.

Where applicable, a statement on the estimated uncertainty of measurements; information on uncertainty is needed when a client's instructions so require.

Opinions and Interpretations - The test report contains objective information, and generally does not contain subjective information such as opinions and interpretations. If such information is required by the client, the Laboratory Director will determine if a response can be prepared. If so, the Laboratory Director will designate the appropriate member of the management team to prepare a response. The response will be fully documented, and reviewed by the Laboratory Director, before release to the client. There may be additional fees charged to the client at this time, as this is a non-routine function of the laboratory.

Note: Review of data deliverable packages for submittal to regulatory authorities requires responses to non-conforming data concerning potential impact on data quality. This necessitates a limited scope of interpretation, and this work is performed by the QA Department. This is the only form of "interpretation" of data that is routinely performed by the laboratory.

When opinions or interpretations are included in the report, the laboratory provides an explanation as to the basis upon which the opinions and interpretations have been made. Opinions and interpretations are clearly noted as such and where applicable, a comment should be added suggesting that the client verify the opinion or interpretation with their regulator.

25.5 Environmental Testing Obtained From Subcontractors

If the laboratory is not able to provide the client the requested analysis, the samples would be subcontracted following the procedures outlined in the Corporate SOP on Subcontracting (SOP CA-L-S-002).

Data reported from analyses performed by a subcontractor laboratory are clearly identified as such on the analytical report provided to the client. Results from a subcontract laboratory outside of TestAmerica are reported to the client on the subcontract laboratory's original report stationary and the report includes any accompanying documentation.

25.6 Client Confidentiality

In situations involving the transmission of environmental test results by telephone, facsimile or other electronic means, client confidentiality must be maintained.

TestAmerica will not intentionally divulge to any person (other than the Client or any other person designated by the Client in writing) any information regarding the services provided by TestAmerica or any information disclosed to TestAmerica by the Client. Furthermore, information known to be potentially endangering to national security or an entity's proprietary rights will not be released.

Note: This shall not apply to the extent that the information is required to be disclosed by TestAmerica under the compulsion of legal process. TestAmerica will, to the extent feasible, provide reasonable notice to the client before disclosing the information.

Note: Authorized representatives of an accrediting authority are permitted to make copies of any analyses or records relevant to the accreditation process, and copies may be removed from the laboratory for purposes of assessment.

25.6.1 Report deliverable formats are discussed with each new client. If a client requests that reports be faxed or e-mailed, the reports are faxed with a cover sheet or e-mailed with the following note that includes a confidentiality statement similar to the following:

This material is intended only for the use of the individual(s) or entity to whom it is addressed and may contain information that is privileged and confidential. It is our policy that facsimiles are intended for and should be used for business purposes only. If you are not the intended recipient, or the employee or agent responsible for delivering this material to the intended recipient, you are hereby notified that any dissemination, distribution or copying of this facsimile is strictly prohibited. If you have received this communication in error, please notify the sender. Thank you for your professional consideration and cooperation.

25.7 Format of Reports

The format of reports is designed to accommodate each type of environmental or industrial hygiene test carried out and to minimize the possibility of misunderstanding or misuse.

25.8 Amendments to Test Reports

Corrections, additions, or deletions to reports are only made when justification arises through supplemental documentation. Justification is documented using the laboratory's corrective action system (refer to Section 12).

The revised report is retained on the Archive data server, as is the original report. The revised report is stored in the Archive data server under the sample number followed by "REVISION". The revised report will have the word "revised" or "amended" next to the date rather than the word "Issued" or "Reported".

When the report is re-issued, a notation of "report reissued" is placed on the case narrative/signature page of the report in the Comments or Additional Information section of the Case Narrative with a brief explanation of reason for the re-issue and a reference back to the last final report generated. *For Example*: *Report was revised on 11/3/08 to include toluene in sample NQA1504 per client's request. This final report replaces the final report generated on 10/27/08 at 10:47am.*

Note: Re-issued or revised Industrial Hygiene reports are generated with the current date the report is issued. Information concerning the revision is clearly stated in the Case Narrative and references the original report date.

25.9 Policies on Client Requests for Amendments

25.9.1 Policy on Data Omissions or Reporting Limit Increases

Fundamentally, our policy is simply to not omit previously reported results (including data qualifiers) or to not raise reporting limits and report sample results as ND. This policy has few exceptions. Exceptions are:

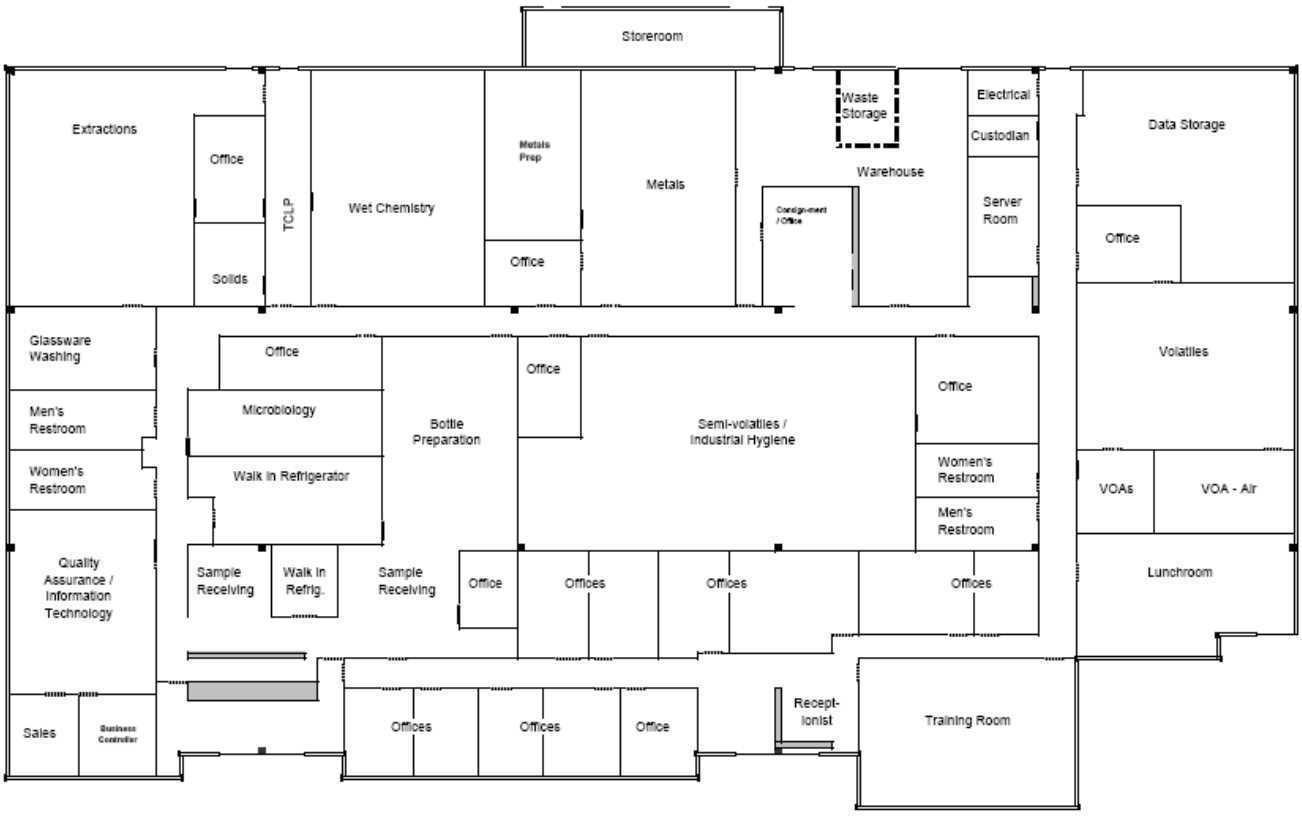
- Laboratory error.
- Sample identification is indeterminate (confusion between COC and sample labels).
- An incorrect analysis (not analyte) was requested (e.g., COC lists 8315 but client wanted 8310). A written request for the change is required.
- Incorrect limits reported based on regulatory requirements.
- The requested change has absolutely *no possible* impact on the interpretation of the analytical results and there is *no possibility* of the change being interpreted as misrepresentation by anyone inside or outside of our company.

25.9.2 Multiple Reports

TestAmerica does not issue multiple reports for the same workorder where there is different information on each report (this does not refer to copies of the same report) unless required to meet regulatory needs and approved by QA.

Appendix 1. Laboratory Floor Plan

TestAmerica Phoenix Laboratory Floor Plan



Appendix 2. Glossary/Acronyms

Glossary:

Acceptance Criteria: Specified limits placed on characteristics of an item, process, or service defined in requirement documents. (ASQC)

Accreditation: The process by which an agency or organization evaluates and recognizes a laboratory as meeting certain predetermined qualifications or standards, thereby accrediting the laboratory.

Accuracy: The degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components which are due to sampling and analytical operations; a data quality indicator. (QAMS)

Analyst: The designated individual who performs the "hands-on" analytical methods and associated techniques and who is the one responsible for applying required laboratory practices and other pertinent quality controls to meet the required level of quality. (NELAC)

Analytical Uncertainty: A subset of Measurement Uncertainty that includes all laboratory activities performed as part of the analysis. (TNI)

Assessment: The evaluation process used to measure or establish the performance, effectiveness, and conformance of an organization and/or its systems to defined criteria (to the standards and requirements of laboratory accreditation). (TNI)

Audit: A systematic and independent examination of facilities, equipment, personnel, training, procedures, record-keeping, data validation, data management, and reporting aspects of a system to determine whether QA/QC and technical activities are being conducted as planned and whether these activities will effectively achieve quality objectives. (TNI)

Batch: Environmental samples which are prepared and/or analyzed together with the same process and Environmental samples that are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents. A **preparation batch** is composed of one (1) to twenty (20) environmental samples of the same quality systems matrix, meeting the above mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be twenty-four (24) hours. An **analytical batch** is composed of prepared environmental samples (extracts, digestates or concentrates) which are analyzed together as a group. An analytical batch can include prepared samples originating from various quality system matrices and can exceed twenty (20) samples. (TNI)

Bias: The systematic or persistent distortion of a measurement process, which causes errors in one direction (i.e., the expected sample measurement is different from the sample's true value). (TNI)

Blank: A sample that has not been exposed to the analyzed sample stream in order to monitor contamination during sampling, transport, storage or analysis. The blank is subjected to the usual analytical and measurement process to establish a zero baseline or background value and is sometimes used to adjust or correct routine analytical results. (ASQC)

Calibration: A set of operations that establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument or measuring system, or values represented by a material measure or a reference material, and the corresponding values realized by standards. (TNI)

1) In calibration of support equipment the values realized by standards are established through the use of reference standards that are traceable to the International System of Units (SI).

2) In calibration according to methods, the values realized by standards are typically established through the use of Reference Materials that are either purchased by the laboratory with a certificate of analysis or purity, or prepared by the laboratory using support equipment that has been calibrated or verified to meet specifications.

Calibration Blank (CB) A volume of reagent water. The results must fall below the reporting level, the MDL, or a multiplier of the MDL.

Calibration Curve: The graphical relationship between the known values, such as concentrations, of a series of calibration standards and their instrument response. (NELAC)

Calibration Standard (CAL): A substance or reference material used to calibrate an instrument (QAMS), usually prepared from the primary dilution standard solution(s) or stock standard solutions.

Certified Reference Material (CRM): A reference material accompanied by a certificate, having a value, measurement uncertainty, and stated metrological traceability chain to a national metrology institute. (TNI)

Chain of Custody: **Chain of Custody (COC) Form:** Record that documents the possession of the samples from the time of collection to receipt in the laboratory. This record generally includes: the number and types of containers; the mode of collection; the collector; time of collection; preservation; and requested analyses. (TNI)

Compromised Samples: Those samples which are improperly sampled, insufficiently documented (chain of custody and other sample records and/or labels), improperly preserved, collected in improper containers, or exceeding holding times when delivered to a laboratory. Under normal conditions, compromised samples are not analyzed. If emergency situation require analysis, the results must be appropriately qualified.

Confidential Business Information (CBI): Information that an organization designates as having the potential of providing a competitor with inappropriate insight into its management, operation or products. TNI and its representatives agree to safe guarding identified CBI and to maintain all information identified as such in full confidentiality.

Confirmation: Verification of the identity of a component through the use of an approach with a different scientific principle from the original method. These may include, but are not limited to: (TNI)

Second column confirmation
Alternate wavelength
Derivatization
Mass spectral interpretation
Alternative detectors or
Additional Cleanup procedures

Conformance: An affirmative indication or judgment that a product or service has met the requirements of the relevant specifications, contract, or regulation; also the state of meeting the requirements. (ANSI/ASQC E4-1994)

Continuing Calibration Verification Standard (CCV): A CAL solution which is analyzed after every tenth field sample analysis, not including QC samples, which verifies the previously established calibration curve and confirms accurate analyte quantitation for the previous field samples analyzed.

Correction: Actions necessary to correct or repair analysis specific non-conformances. The acceptance criteria for method specific QC and protocols as well as the associated corrective actions. The analyst will most frequently be the one to identify the need for this action as a result of calibration checks and QC sample analysis**.** No significant action is taken to change behavior, process or procedure.

Corrective Action: The action taken to eliminate the causes of an existing nonconformity, defect or other undesirable situation in order to prevent recurrence. (ISO 8402)

Data Audit: A qualitative and quantitative evaluation of the documentation and procedures associated with environmental measurements to verify that the resulting data re of acceptable quality (i.e., that they meet specified acceptance criteria).

Data Reduction: The process of transforming the number of data items by arithmetic or statistical calculations, standard curves, and concentration factors, and collation into a more useable form. (TNI)

Deficiency: An unauthorized deviation from acceptable procedures or practices, or a defect in an item. (ASQC)

Demonstration of Capability: A procedure to establish the ability of the analyst to generate analytical results of acceptable accuracy and precision. (TNI)

Detection Limit: See LOD

Document Control: The act of ensuring that documents (and revisions thereto) are proposed, reviewed for accuracy, approved for release by authorized personnel, distributed properly, and controlled to ensure use of the correct version at the location where the prescribed activity if performed. (ASQC)

Duplicate Analyses: The analyses or measurements of the variable of interest performed identically on two subsamples of the same sample. The results from duplicate analyses are used to evaluate analytical or measurement precision but not the precision of sampling, preservation or storage internal to the laboratory. (EPA-QAD)

Equipment Blank: Sample of analyte-free media which has been used to rinse common sampling equipment to check effectiveness of decontamination procedures.

External Standard Calibration: Calibrations for methods that do not utilize internal standards to compensate for changes in instrument conditions.

Field Blank: Blank prepared in the field by filing a clean container with pure de-ionized water and appropriate preservative, if any, for the specific sampling activity being undertaken (EPA OSWER)

Field of Accreditation: Those matrix, technology/method, and analyte combinations for which the accreditation body offers accreditation.

Holding Times (Maximum Allowable Holding Times): The maximum times that samples may be held prior to analyses and still be considered valid or not compromised. (40 CFR Part 136)

Initial Calibration Standards (ICAL): A series of CAL solutions used to initially establish instrument calibration and develop calibration curves.

Initial Calibration Verification Standard (ICV): A CAL solution, which is analyzed initially prior to any field sample analysis, which verifies the previously established calibration curve.

Initial Demonstration of Capability (IDC): A procedure to establish the ability of the analyst to generate acceptable accuracy and precision.

Inspection: An activity such as measuring, examining, testing, or gauging one or more characteristics of an entity and comparing the results with specified requirements in order to establish whether conformance is achieved for each characteristic. (ANSI/ASQC E4-1994)

Internal Standard: A known amount of standard added to a test portion of a sample as a reference for evaluating and controlling the precision and bias of the applied analytical test method. (TNI)

Internal Standard Calibration: Calibrations for methods that utilize internal standards to compensate for changes in instrument conditions.

Instrument Blank: A clean sample (e.g., distilled water) processed through the instrumental steps of the measurement process; used to determine instrument contamination. (EPA-QAD)

Instrument Detection Limit (IDL): The minimum amount of a substance that can be measured with a specified degree of confidence that the amount is greater than zero using a specific instrument. The IDL is associated with the instrumental portion of a specific method only, and sample preparation steps are not considered in its derivation. The IDL is a statistical estimation at a specified confidence interval of the concentration at which the relative uncertainty is ± 100%. The IDL represents a range where qualitative detection occurs on a specific instrument. Quantitative results are not produced in this range.

Instrument Response: Instrument response is normally expressed as either peak area or peak height however it may also reflect a numerical representation of some type of count on a detector (e.g. Photomultiplier tube, or Diode array detector) and is used in this document to represent all types.

Laboratory: A defined facility performing environmental analyses in a controlled and scientific manner. (NELAC)

Laboratory Control Sample (LCS): **(however named, such as laboratory fortified blank, spiked blank, or QC check sample):** A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes, taken through all preparation and analysis steps of the procedure unless otherwise noted in a reference method. It is generally used to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or a portion of the measurement system.

An LCS shall be prepared at a minimum of 1 per batch of 20 or less samples per matrix type per sample extraction or preparation method except for analytes for which spiking solutions are not available such as total suspended solids, total dissolved solids, total volatile solids, total solids, pH, color, odor, temperature, dissolved oxygen or turbidity. The results of these samples shall be used to determine batch acceptance.

Laboratory Control Sample Duplicate (LSCD): A second sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes, taken through all preparation and analysis steps.

An LCSD shall be prepared at a minimum of 1 per batch of 20 or less samples per matrix type per sample extraction or preparation method except for analytes for which spiking solutions are not available such as total suspended solids, total dissolved solids, total volatile solids, total solids, pH, color, odor, temperature, dissolved oxygen or turbidity. The results of these samples shall be used to determine batch acceptance.

Laboratory Duplicate: Aliquots of a sample taken from the same container under laboratory conditions and processed and analyzed independently. (NELAC)

Least Squares Regression (1st Order Curve): The least squares regression is a mathematical calculation of a straight line over two axes. The y axis represents the instrument response (or Response ratio) of a standard or sample and the x axis represents the concentration. The regression calculation will generate a correlation coefficient (r) that is a measure of the "goodness of fit" of the regression line to the data. A value of 1.00 indicates a perfect fit. In order to be used for quantitative purposes, r must be greater than or equal to 0.99 for organics and 0.995 for inorganics.

Limit(s) of Detection (LOD) [a.k.a., Method Detection Limit (MDL)]: A laboratory's estimate of the minimum amount of an analyte in a given matrix that an analytical process can reliably detect in their facility. (TNI)

Manager (however named): The individual designed as being responsible for the overall operation, all personnel, and the physical plant of the environmental laboratory. A Department Manager may report to the manager. In some cases, the Department Manager and the manager may be the same individual. (NELAC)

Matrix: The component or substrate that contains the analyte of interest. For purposes of batch and QC requirement determinations, the following matrix distinctions shall be used:

> Aqueous: Any aqueous sample excluded from the definition of Drinking Water matrix or Saline/Estuarine source. Includes surface water, groundwater, effluents, and TCLP or other extracts.
>
> Drinking Water: any aqueous sample that has been designated as a potable or potential potable water source.
>
> Saline/Estuarine: any aqueous sample from an ocean or estuary, or other salt water source such as the Great Salt Lake.
>
> Non-aqueous Liquid: any organic liquid with <15% settleable solids.
>
> Biological Tissue: any sample of a biological origin such as fish tissue, shellfish, or plant material. Such samples shall be grouped according to origin.
>
> Solids: includes soils, sediments, sludges, and other matrices with >15% settleable solids.
>
> Chemical Waste: a product or by-product of an industrial process that results in a matrix not previously defined.
>
> Air: whole gas or vapor samples including those contained in flexible or rigid wall containers and the extracted concentrated analytes of interest from a gas or vapor that are collected with a sorbant tube, impinger solution, filter, or other device. (NELAC)

Matrix Spike (spiked sample or fortified sample): A sample prepared, taken through all sample preparation and analytical steps of the procedure unless otherwise noted in a referenced method, by adding a known amount of target analyte to a specified amount of sample for which an independent test result of target analyte concentration is available. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency.

Matrix Spike Duplicate (spiked sample or fortified sample duplicate): A second replicate matrix spike is prepared in the laboratory and analyzed to obtain a measure of the precision of the recovery for each analyte.

Media Blank: Sorbent or media, that is treated exactly as a sample including exposure to all glassware, equipment, solvents, filtration and reagents that are used with other samples.

Method Blank (also known as Laboratory Reagent Blank): A sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses.

Method Detection Limit: The minimum concentration of a substance (an analyte) that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte. (40 CFR Part 136, Appendix B)

Method Detection Limit Verification: The validity of the MDL is verified by analysis of the analyte(s) in a QC sample in each matrix. This QC sample shall contain the analyte at no more than 3X the LOD for single analyte tests and 4X the LOD for multiple analyte tests. This verification is performed on every instrument that is to be used for analysis of samples and reporting of data. The validity of the LOD is verified as part of the LOD determination process

Negative Control:
Measures taken to ensure that a test, its components, or the environment do not cause undesired effects, or produce incorrect test results. (NELAC)

Non-conformance: An indication, judgment, or state of not having met the requirements of the relevant specifications, contract, or regulation.

Performance Audit:
The routine comparison of independently obtained qualitative and quantitative measurement system data with routinely obtained data in order to evaluate the proficiency of an analyst or laboratory. (NELAC)

Positive Control: Measures taken to ensure that a test and/or its components are working properly and producing correct or expected results from positive test subjects. (TNI)

Precision: The degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves; a data quality indicator. Precision is usually expressed as standard deviation, variance or range, in either absolute or relative terms. (NELAC)

Preservation: Any conditions under which a sample must be kept in order to maintain chemical and/or biological integrity prior to analysis. (TNI)

Proficiency Testing: A means of evaluating a laboratory's performance under controlled conditions relative to a given set of criteria through analysis of unknown samples provided by an external source. (TNI)

Proficiency Testing Program: The aggregate of providing rigorously controlled and standardized environmental samples to a laboratory for analysis, reporting of results, statistical evaluation of the results and the collective demographics and results summary of all participating laboratories. (TNI)

Proficiency Test Sample (PT): A sample, the composition of which is unknown to the analyst and is provided to test whether the analyst/laboratory can produce analytical results within specified acceptance criteria. (TNI)

Quality Assurance: An integrated system of management activities involving planning, implementation, assessment, reporting and quality improvement to ensure that a process, item, or service is of the type of quality needed and expected by the client. (TNI)

Quality Assurance [Project] Plan (QAPP): A formal document describing the detailed quality control procedures by which the quality requirements defined for the data and decisions pertaining to a specific project are to be achieved. (EAP-QAD)

Quality Control: The overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established by the customer; operational techniques and activities that are used to fulfill requirements for quality; also the system of activities and checks used to ensure that measurement systems are maintained within prescribed limits, providing protection against “out of control” conditions and ensuring that the results are of acceptable quality. (TNI)

Quality Control Sample: A sample used to assess the performance of all or a portion of the measurement system. One of any number of samples, such as Certified Reference Materials, a quality system matrix fortified by spiking, or actual samples fortified by spiking, intended to demonstrate that a measurement system or activity is in control. (TNI)

Quality Manual: A document stating the management policies, objectives, principles, organizational structure and authority, responsibilities, accountability, and implementation of an agency, organization, or laboratory, to ensure the quality of its product and the utility of its product to its users. (NELAC)

Quality System: A structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for ensuring quality in its work processes, products (items), and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required QA and QC activities. (TNI)

Quantitation Limits: See LOQ

Raw Data: The documentation generated during sampling and analysis. This documentation includes, but is not limited to, field notes, electronic data, magnetic tapes, untabulated sample results, QC sample results, print outs of chromatograms, instrument outputs, and handwritten records. (TNI)

Record Retention: The systematic collection, indexing and storing of documented information under secure conditions.

Reference Material: Material or substance one or more properties of which are sufficiently well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials. (ISO Guide 30-2.1)

Reference Standard: Standard used for the calibration of working measurement standards in a given organization or a given location. (TNI)

Relative Percent Difference (RPD): The difference between two values divided by the average of the values as expressed as a percent, used to determine the closeness of two related values.

Replicate Analyses: The measurements of the variable of interest performed identically on two or more sub-samples of the same sample within a short time interval. (NELAC)

Sampling: Activity related to obtaining a representative sample of the object of conformity assessment, according to a procedure.

Second Order Polynomial Curve (Quadratic): The 2nd order curves are a mathematical calculation of a slightly curved line over two axis. The y axis represents the instrument response (or Response ratio) of a standard or sample and the x axis represents the concentration. The 2nd order regression will generate a coefficient of determination (COD or r^2) that is a measure of the "goodness of fit" of the quadratic curvature the data. A value of 1.00 indicates a perfect fit. In order to be used for quantitative purposes, r^2 must be greater than or equal to 0.99.

Selectivity: The ability to analyze, distinguish, and determine a specific analyte or parameter from another component that may be a potential interferent or that may behave similarly to the target analyte or parameter within the measurement system. (TNI)

Sensitivity: The capability of a method or instrument to discriminate between measurement responses representing different levels (e.g., concentrations) of a variable of interest. (NELAC)

Spike: A known mass of target analyte added to a blank, sample or sub-sample; used to determine recovery efficiency or for other quality control purposes.

Standard: The document describing the elements of laboratory accreditation that has been developed and established within the consensus principles of standard setting and meets the approval requirements of standard adoption organizations procedures and policies. (TNI)

Standard Operating Procedures (SOPs): A written document which details the method for an operation, analysis, or action, with thoroughly prescribed techniques and steps. SOPs are officially approved as the methods for performing certain routine or repetitive tasks. (TNI)

Storage Blank: A blank matrix stored with field samples of a similar matrix (volatiles only) that measures storage contribution to any source of contamination.

Surrogate: A substance with properties that mimic the analyte of interest. It is unlikely to be found in environment samples and is added to them for quality control purposes.

Surrogate compounds must be added to all samples, standards, and blanks, for all organic chromatography methods except when the matrix precludes its use or when a surrogate is not available. Poor surrogate recovery may indicate a problem with sample composition and shall be reported to the client whose sample produced poor recovery. (QAMS)

Systems Audit (also Technical Systems Audit): A thorough, systematic, qualitative on-site assessment of the facilities, equipment, personnel, training, procedures, record keeping, data validation, data management, and reporting aspects of a total measurement system. (EPA-QAD)

Technical Manager: A member of the staff of an environmental laboratory who exercises actual day-to-day supervision of laboratory operations for the appropriate fields of accreditation and reporting of results. The Technical Manager must meet TNI requirements for education and experience. The Department Manager acts as a Technical Director designee.

Technology: A specific arrangement of analytical instruments, detection systems, and/or preparation techniques.

Test: A technical operation that consists of the determination of one or more characteristics or performance of a given product, material, equipment, organism, physical phenomenon, process, or service according to a specified procedure. The result of a test is normally recorded in a document sometimes called a test report or a test certificate. (ISO/IEC Guide 2-12.1, amended)

Test Method: An adoption of a scientific technique for a specific measurement problem, as documented in a laboratory SOP. (NELAC)

Traceability: The ability to trace the history, application, or location of an entity by means of recorded identifications. In a calibration sense, traceability relates measuring equipment to national or international standards, primary standards, basic physical constants or properties, or reference materials. In a data collection sense, it relates calculations and data generated throughout the project back to the requirements for the quality of the project. (TNI)

Trip Blank: A blank matrix placed in a sealed container at the laboratory that is shipped, held unopened in the field, and returned to the laboratory in the shipping container with the field samples.

Uncertainty: A parameter associated with the result of a measurement that characterizes the dispersion of the value that could reasonably be attributed to the measured value.

Validation: The process of substantiating specified performance criteria. (EPA-QAD)

Acronyms:

BS – Blank Spike
BSD – Blank Spike Duplicate
CAR – Corrective Action Report
CCV – Continuing Calibration Verification
CF – Calibration Factor
CFR – Code of Federal Regulations
COC – Chain of Custody
CRS – Change Request Form
DOC – Demonstration of Capability
DQO – Data Quality Objectives
DU – Duplicate
DUP - Duplicate
EHS – Environment, Health and Safety
EPA – Environmental Protection Agency
GC - Gas Chromatography
GC/MS - Gas Chromatography/Mass Spectrometry
HPLC - High Performance Liquid Chromatography
ICP - Inductively Coupled Plasma Atomic Emission Spectroscopy
ICP/MS – ICP/Mass Spectrometry
ICV – Initial Calibration Verification
IDL – Instrument Detection Limit
IH – Industrial Hygiene
IS – Internal Standard
LCS – Laboratory Control Sample
LCSD – Laboratory Control Sample Duplicate
LIMS – Laboratory Information Management System
MDL – Method Detection Limit
MDLV - Method Detection Limit Verification
MS – Matrix Spike
MSD – Matrix Spike Duplicate
MSDS - Material Safety Data Sheet
NELAP - National Environmental Laboratory Accreditation Program
PT – Performance Testing
TNI – The NELAC Institute
QAM – Quality Assurance Manual
QA/QC – Quality Assurance / Quality Control
QAPP – Quality Assurance Project Plan
QCS - Quality Control Sample
RF – Response Factor
RPD – Relative Percent Difference
RSD – Relative Standard Deviation
SD – Standard Deviation
SOP: Standard Operating Procedure
TAT – Turn-Around-Time
VOA – Volatiles
VOC – Volatile Organic Compound

Appendix 3.

Laboratory Certifications, Accreditations, Validations

TestAmerica Phoenix maintains certifications, accreditations, certifications, and validations with numerous state and national entities. Programs vary but may include on-site audits, reciprocal agreements with another entity, performance testing evaluations, review of the QA Manual, Standard Operating Procedures, Method Detection Limits, training records, etc. At the time of this QA Manual revision, the laboratory has accreditation/certification/licensing with the following organizations:

Organization	Certificate Number
American Industrial Hygiene Association	154268
Arizona Department of Health Services	AZ0728
California ELAP	2704
California NELAP	01109CA
Nevada	AZ010302009
New York	11898
Oregon (ORELAP)	AZ100001
US Department of Agriculture	P330-10-00310

The certificates and parameter lists (which may differ) for each organization may be found on the corporate web site, the laboratory's public server, the final report review table, and in the following offices: QA, marketing, and project management.

Appendix 4.
Methods Performed

Preparation Only Methods

Method	Aqueous	Solid	Waste	Air
Organics				
EPA 1311	X	X	X	
EPA 3500B	X		X	
EPA 3510C	X		X	
EPA 3520C	X		X	
EPA 3600C	X	X	X	
EPA 3665A H2SO4/Permanganate	X	X	X	
EPA 3545 PFE		X		
EPA 3580A	X	X	X	
EPA 5000	X	X	X	
EPA 5030 B & C	X	X	X	
EPA 5035 & 5035A		X	X	
Inorganics				
EPA 1311	X	X	X	
EPA 1312	X	X	X	
EPA 3005A	X			
EPA 3010A	X		X	
EPA 3020A	X		X	
EPA 3050B		X	X	

Organics Methods Performed

Parameter	Method	Aqueous	Solid	Waste	Air
Volatile Organics (VOC)	EPA 8260B	X	X	X	X
	EPA 524.2	X			
	EPA 624	X		X	
	EPA TO-15				X
	EPA TO-17				X
VOC Aromatic & MTBE	EPA 8021B	X	X	X	X
Base Neutrals and Acids (BNAs)	EPA 8270C	X	X	X	
	EPA 625	X			
Organochlorine Pesticides	EPA 8081A	X	X	X	
	EPA 608	X		X	
	EPA 625				
	EPA TO-10A				X
Chlorinated Herbicides	EPA 8151A	X	X	X	
Organophosphorus Pesticides	EPA 8141A	X	X	X	
	EPA 1657	X		X	
	EPA TO-10A				X
PCBs	EPA 8082	X	X	X	
	EPA TO-10A				X
Petroleum Hydrocarbons	ADHS 8015AZ R1		X		
Diesel Range Organics	EPA 8015B/8015D	X	X	X	
Gasoline Range Organics	EPA 8015B/8015D	X	X	X	X
PAHs	EPA 8310	X	X	X	
Formaldehyde	EPA TO-11A				X

Metals Methods Performed

Parameter	Methods	Aqueous	Solid	Waste	Air
Trace Metals	EPA 200.7	X			
	EPA 200.8	X			
	EPA 6010B	X	X	X	
	EPA 6020	X	X	X	
	NIOSH 7300				X
Hardness	SM 2340B	X			
	EPA 200.7	X			
Mercury	EPA 245.1	X			
	EPA 7470A	X		X	
	EPA 7471A		X	X	
	NIOSH 6009				X

Microbiology Methods Performed

Parameter	Method	Aqueous	Solid	Waste	Air
Fecal Coliform by Mtf	SM 9221E	X	X	X	
Fecal Coliform by Membrane Filtration	SM 9222D	X			
Heterotrophic Bacteria	SIMPLATE	X			
Total Coliforms & E. Coli by Colilert	SM 9223B	X			
Total Coliform by Mf	SM 9221B & C	X			
E. Coli (not for NPDES)	SM9221F	X			

Inorganics Methods Performed

Parameter	Method	Aqueous	Solid	Waste	Air
n-Hexane Extractables	9070A	X			
SGT treated n-Hexane Extractables	9070A	X			
Alkalinity (Carbonate, Bicarbonate, Total)	SM 2320B	X			
Ammonia	SM 4500 NH3 D	X			
Bromide	EPA 300.0	X			
	EPA 9056	X	X	X	
Carbon, Total Organic	SM 5310B	X			
	EPA 9060A	X		X	
Carbon, Dissolved Organic	SM 5310B	X			
Chloride	EPA 300.0	X			
	EPA 9056	X	X	X	
Chlorine, Total Residual	HACH 8167	X			
Chromium, Hexavalent	SM 3500 CR D	X	X		
Corrosivity	SM 2330B	X			
Conductivity	SM 2510B	X			
	EPA 9050A	X		X	
Cyanide, Total	SM 4500 CN E	X	X	X	
	SM 4500CN B C	X	X	X	
	EPA 9010C		X	X	
	EPA 9013		X	X	
	EPA 9014	X	X	X	
Cyanide, Amenable	SM 4500 CN G	X			
Demand, Biological Oxygen	SM 5210B	X		X	
Demand, Carbonaceous (CBOD)	SM 5210B	X		X	
Demand, Chemical Oxygen	SM 5220D	X		X	
Dissolved Oxygen	SM 4500-O G				
Fluoride	EPA 300.0	X	X		
	EPA 9056	X	X	X	
	SM 4500 F C	X			
Flashpoint	EPA 1010A	X		X	
	EPA 1030		X		
n-Hexane Extractable Materials	EPA 1664A	X			
	EPA 9060A	X		X	
Silica Gel Treated n-	EPA 1664A	X			

Inorganics Methods Performed

Parameter	Method	Aqueous	Solid	Waste	Air
Hexane Extractable Materials	EPA 9060A	X		X	

Inorganics Methods Performed

Nitrate	EPA 300.0	X			
	EPA 9056	X	X	X	
Nitrate & Nitrite	EPA 300.0	X			
	EPA 9056	X	X	X	
Nitrite	EPA 300.0	X			
	EPA 9056	X	X		
	SM 4500 NO2 B	X			
Total Kjeldahl Nitrogen	SM 4500 NH3 D	X			
Total Kjeldahl Nitrogen (NV Only)	SM 4500 Norg C	X			
Orthophosphate	EPA 300.0	X			
	EPA 9056	X	X	X	
Paint Filter Liquids Test	EPA 9095B	X		X	X
Perchlorate	EPA 314.0	X			
pH	SM 4500 H+ B	X			
	EPA 9040B	X			
	EPA 9041A	X			
	EPA 9045D		X	X	
Phosphorus, Total	SM 4500 P B E	X	X	X	
Solids, Total	SM 2540B	X		X	
Solids, Total Dissolved	SM 2540C	X		X	
Solids, Total Suspended	SM 2540D	X		X	
Solids, Total Volatile	EPA 160.4	X		X	
Settleable Solids	SM 2540F	X			
Solids, Total, Fixed and Volatile	SM 2540G	X	X		
Sulfate	EPA 300.0	X			
	EPA 9056	X	X	X	
Sulfide	SM 4500 S D	X			
Temperature	SM 2550	X			
Turbidity	EPA 180.1	X			

Industrial Hygiene Testing Performed		
Instrumentation	**Technology/Detector**	**Method**
Gas Chromatography	GC / FID	NIOSH 1003 (mod) NIOSH 1005 (mod) NIOSH 1010 (mod) NIOSH 1015 (mod) NIOSH 1022 (mod) NIOSH 1300 (mod) NIOSH 1400 (mod) NIOSH 1401 (mod) NIOSH 1405 (mod) NIOSH 1450 (mod) NIOSH 1457 (mod) NIOSH 1500 (mod) NIOSH 1501 (mod) NIOSH 1602 (mod) NIOSH 1604 (mod) NIOSH 1609 (mod) NIOSH 1605 (mod) NIOSH 1615 (mod) NIOSH 1610 (mod) In-house method for 4-PCH OSHA 7 (mod) NIOSH 2000 (mod) NIOSH 1403 (mod) NIOSH 2551 (mod) NIOSH 1550 (mod) OSHA 48 (mod) NIOSH 2546 (mod) NIOSH 1611 (mod) NIOSH 1613 (mod) NIOSH 1606 (mod) NIOSH 1007 (mod) NIOSH 5523
	GC/ECD	NIOSH 5039 (mod) NIOSH 5503
	GC/FPD	NIOSH 5600
	GC/MS	OSHA PV 2120 (mod)
Gas Chromatography (Diffusive Samplers)	GC / FID	3M 3500 3M 3520 OSHA 111 (mod) OSHA 1005 (mod) OSHA 1004 (mod) OSHA 7 (mod) SKC

Industrial Hygiene Testing Performed		
Instrumentation	**Technology/Detector**	**Method**
		Assay Technologies OSHA 69 (mod) OSHA 1001 (mod) OSHA 1002 (mod)
Ion Chromatography (IC)		NIOSH 6013 OSHA ID-215 NIOSH 7903 (mod)
Liquid Chromatography	HPLC/ UV	NIOSH 2016 (mod) OSHA 1007 OSHA42 OSHA 47 OSHA 64 (mod) NIOSH 2532 (mod) Using Assay Technologies 571 Passive monitor Formaldehyde, Carbonyls by HPLC EPA TO-11A EPA IP6A & EPA IP6C NIOSH 5506 (mod)
	HPLC/ FL	NIOSH 5506 (mod)
Atomic Absorption	CVAA	NIOSH 6009 OSHA ID-140
Inductively-Couple Plasma	ICP/MS	NIOSH 7300 (mod) OSHA ID-121 (mod) OSHA ID-125G (mod) NIOSH 7303 (mod)
	ICP/AES	NIOSH 7300 (mod) OSHA ID-121 (mod) OSHA ID-125G (mod) NIOSH 7303 (mod) NIOSH 9100 (mod) NIOSH 9102 (mod) OSHA 121 (mod) OSHA 125G (mod) OSHA CSI Method for Silane OSHA 1003 (mod) NIOSH 6006 (mod)
Spectrometry	UV/Vis (Colorimetric)	NIOSH 7600 (mod) H2S Radiello NIOSH 6010 (mod)
Miscellaneous	Gravimetric	NIOSH 0500 (mod) NIOSH 0600 (mod) NIOSH 5000 (mod)
	Ion Selective Electrode	OSHA ID-188

Analysis Group Description	Method Description	Method Code
Lead & Asbestos	General Sub Contract Method	SUBCONTRACT
Lead & Asbestos	Metals (ICP)	6010B

Analyte Description	CAS Number
Lead	7439-92-1

Lead & Asbestos	Preparation, Metals	3050B
Soil Analyses	Gasoline Range Organics - (GC)	8015B_GRO

Analyte Description	CAS Number
Volatile Fuel Hydrocarbons (C6-C10)	8006-61-9
4-Bromofluorobenzene (Surr)	460-00-4

Soil Analyses	Closed System Purge and Trap	5035A_M_Calc
Soil Analyses	Diesel Range Organics (DRO) (GC)	8015B_DRO

*ORO is tested under this analyte.

Analyte Description	CAS Number
EFH (C10-C32)	STL00141
o-Terphenyl (Surr)	84-15-1

Soil Analyses	Pressurized Fluid Extraction	3545
Soil Analyses	Volatile Organic Compounds (GC/MS)	8260B_PREC

Analyte Description	CAS Number
1,1,1,2-Tetrachloroethane	630-20-6
1,1,1-Trichloroethane	71-55-6
1,1,2,2-Tetrachloroethane	79-34-5
1,1,2-Trichloroethane	79-00-5
1,1-Dichloroethane	75-34-3
1,1-Dichloroethene	75-35-4

1,1-Dichloropropene	563-58-6
1,2,3-Trichlorobenzene	87-61-6
1,2,3-Trichloropropane	96-18-4
1,2,4-Trichlorobenzene	120-82-1
1,2,4-Trimethylbenzene	95-63-6
1,2-Dibromo-3-Chloropropane	96-12-8
Ethylene Dibromide	106-93-4
1,2-Dichlorobenzene	95-50-1
1,2-Dichloroethane	107-06-2
1,2-Dichloropropane	78-87-5
1,3,5-Trimethylbenzene	108-67-8
1,3-Dichlorobenzene	541-73-1
1,3-Dichloropropane	142-28-9
1,4-Dichlorobenzene	106-46-7
2,2-Dichloropropane	594-20-7
2-Butanone (MEK)	78-93-3
2-Chlorotoluene	95-49-8
2-Hexanone	591-78-6
4-Chlorotoluene	106-43-4
4-Methyl-2-pentanone (MIBK)	108-10-1
Acetone	67-64-1
Benzene	71-43-2
Bromobenzene	108-86-1
Chlorobromomethane	74-97-5
Dichlorobromomethane	75-27-4
Bromoform	75-25-2
Bromomethane	74-83-9
Carbon disulfide	75-15-0
Carbon tetrachloride	56-23-5

Chlorobenzene	108-90-7
Chloroethane	75-00-3
Chloroform	67-66-3
Chloromethane	74-87-3
cis-1,2-Dichloroethene	156-59-2
cis-1,3-Dichloropropene	10061-01-5
Chlorodibromomethane	124-48-1
Dibromomethane	74-95-3
Dichlorodifluoromethane	75-71-8
Ethylbenzene	100-41-4
Hexachlorobutadiene	87-68-3
Iodomethane	74-88-4
Isopropylbenzene	98-82-8
m-Xylene & p-Xylene	179601-23-1
Methyl tert-butyl ether	1634-04-4
Methylene Chloride	75-09-2
Naphthalene	91-20-3
n-Butylbenzene	104-51-8
N-Propylbenzene	103-65-1
o-Xylene	95-47-6
4-Isopropyltoluene	99-87-6
sec-Butylbenzene	135-98-8
Styrene	100-42-5
tert-Butylbenzene	98-06-6
Tetrachloroethene	127-18-4
Toluene	108-88-3
trans-1,2-Dichloroethene	156-60-5
trans-1,3-Dichloropropene	10061-02-6
Trichloroethene	79-01-6

Trichlorofluoromethane	75-69-4
Vinyl acetate	108-05-4
Vinyl chloride	75-01-4
Xylenes, Total	1330-20-7
Dibromofluoromethane (Surr)	1868-53-7
Toluene-d8 (Surr)	2037-26-5
4-Bromofluorobenzene (Surr)	460-00-4

Soil Analyses	Closed System Purge and Trap	5035A_M_Calc
Soil Analyses	Metals (ICP)	6010B

Analyte Description	CAS Number
Arsenic	7440-38-2
Barium	7440-39-3
Cadmium	7440-43-9
Chromium	7440-47-3
Lead	7439-92-1
Selenium	7782-49-2
Silver	7440-22-4

Soil Analyses	Preparation, Metals	3050B
Soil Analyses	Mercury (CVAA)	7471A

Analyte Description	CAS Number
Mercury	7439-97-6

Soil Analyses	Preparation, Mercury	7471A_Prep

Reference RL - Limit	Reference RL - Units	Reference MDL - Limit	Reference MDL - Units	Reference LCSREC - Recovery Low
5.00	mg/Kg	0.137	mg/Kg	84

Reference RL - Limit	Reference RL - Units	Reference MDL - Limit	Reference MDL - Units	Reference LCSREC - Recovery Low
20.0	mg/Kg	5.00	mg/Kg	54
	mg/Kg		mg/Kg	

Reference RL - Limit	Reference RL - Units	Reference MDL - Limit	Reference MDL - Units	Reference LCSREC - Recovery Low
25.0	mg/Kg	7.20	mg/Kg	53
	mg/Kg		mg/Kg	

Reference RL - Limit	Reference RL - Units	Reference MDL - Limit	Reference MDL - Units	Reference LCSREC - Recovery Low
250	ug/Kg	12.3	ug/Kg	70
100	ug/Kg	12.7	ug/Kg	67
100	ug/Kg	12.6	ug/Kg	62
100	ug/Kg	22.5	ug/Kg	65
100	ug/Kg	9.55	ug/Kg	60
250	ug/Kg	14.2	ug/Kg	54

100	ug/Kg	10.6	ug/Kg	58
250	ug/Kg	13.0	ug/Kg	70
100	ug/Kg	12.0	ug/Kg	62
250	ug/Kg	11.0	ug/Kg	70
100	ug/Kg	10.4	ug/Kg	70
250	ug/Kg	73.9	ug/Kg	43
25.0	ug/Kg	10.8	ug/Kg	68
100	ug/Kg	7.37	ug/Kg	70
100	ug/Kg	19.3	ug/Kg	67
100	ug/Kg	11.4	ug/Kg	64
100	ug/Kg	6.88	ug/Kg	70
100	ug/Kg	8.11	ug/Kg	70
100	ug/Kg	11.1	ug/Kg	68
100	ug/Kg	7.39	ug/Kg	70
100	ug/Kg	16.7	ug/Kg	65
500	ug/Kg	131	ug/Kg	42
250	ug/Kg	7.65	ug/Kg	70
500	ug/Kg	56.5	ug/Kg	50
250	ug/Kg	8.65	ug/Kg	70
500	ug/Kg	54.1	ug/Kg	52
1000	ug/Kg	404	ug/Kg	37
50.0	ug/Kg	9.75	ug/Kg	67
250	ug/Kg	10.8	ug/Kg	70
250	ug/Kg	15.0	ug/Kg	66
100	ug/Kg	14.0	ug/Kg	69
250	ug/Kg	23.6	ug/Kg	59
250	ug/Kg	29.7	ug/Kg	63
250	ug/Kg	18.9	ug/Kg	56
250	ug/Kg	12.1	ug/Kg	65

50.0	ug/Kg	8.60	ug/Kg	70
250	ug/Kg	15.5	ug/Kg	51
100	ug/Kg	7.74	ug/Kg	66
250	ug/Kg	20.7	ug/Kg	54
100	ug/Kg	11.1	ug/Kg	61
100	ug/Kg	14.0	ug/Kg	64
100	ug/Kg	8.82	ug/Kg	61
100	ug/Kg	17.3	ug/Kg	67
250	ug/Kg	18.1	ug/Kg	29
100	ug/Kg	8.35	ug/Kg	68
250	ug/Kg	11.1	ug/Kg	71
250	ug/Kg	12.3	ug/Kg	70
100	ug/Kg	11.3	ug/Kg	70
150	ug/Kg	9.89	ug/Kg	64
50.0	ug/Kg	16.1	ug/Kg	57
500	ug/Kg	49.5	ug/Kg	61
250	ug/Kg	11.0	ug/Kg	57
250	ug/Kg	9.30	ug/Kg	64
100	ug/Kg	10.8	ug/Kg	68
150	ug/Kg	11.4	ug/Kg	70
100	ug/Kg	8.41	ug/Kg	67
250	ug/Kg	6.72	ug/Kg	66
100	ug/Kg	5.27	ug/Kg	67
250	ug/Kg	7.89	ug/Kg	70
100	ug/Kg	10.3	ug/Kg	65
100	ug/Kg	10.8	ug/Kg	68
100	ug/Kg	9.63	ug/Kg	59
100	ug/Kg	9.56	ug/Kg	64
100	ug/Kg	8.25	ug/Kg	68

250	ug/Kg	9.49	ug/Kg	63
1250	ug/Kg	31.5	ug/Kg	51
50.0	ug/Kg	8.00	ug/Kg	10
300	ug/Kg	21.3	ug/Kg	70
	ug/Kg		ug/Kg	
	ug/Kg		ug/Kg	
	ug/Kg		ug/Kg	

Reference RL - Limit	Reference RL - Units	Reference MDL - Limit	Reference MDL - Units	Reference LCSREC - Recovery Low
5.00	mg/Kg	0.552	mg/Kg	81
5.00	mg/Kg	0.100	mg/Kg	86
0.500	mg/Kg	0.0246	mg/Kg	83
2.00	mg/Kg	0.215	mg/Kg	87
5.00	mg/Kg	0.137	mg/Kg	84
5.00	mg/Kg	0.561	mg/Kg	78
2.50	mg/Kg	0.141	mg/Kg	83

Reference RL - Limit	Reference RL - Units	Reference MDL - Limit	Reference MDL - Units	Reference LCSREC - Recovery Low
0.100	mg/Kg			80

Reference LCSREC - Recovery High	Reference LCSREC - Units	Reference LCSRPD - Precision	Reference LCSRPD - Units
107	%	20	%

Reference LCSREC - Recovery High	Reference LCSREC - Units	Reference LCSRPD - Precision	Reference LCSRPD - Units
152	%	20	%
	%		%

Reference LCSREC - Recovery High	Reference LCSREC - Units	Reference LCSRPD - Precision	Reference LCSRPD - Units
133	%	20	%
	%		%

Reference LCSREC - Recovery High	Reference LCSREC - Units	Reference LCSRPD - Precision	Reference LCSRPD - Units
130	%	20	%
119	%	20	%
125	%	29	%
125	%	26	%
112	%	20	%
118	%	20	%

120	%	20	%
137	%	24	%
129	%	32	%
130	%	22	%
130	%	20	%
136	%	36	%
126	%	26	%
130	%	20	%
128	%	26	%
117	%	21	%
130	%	20	%
130	%	20	%
120	%	22	%
130	%	20	%
118	%	20	%
132	%	40	%
130	%	20	%
140	%	36	%
130	%	20	%
129	%	36	%
148	%	40	%
118	%	20	%
130	%	20	%
124	%	26	%
118	%	20	%
115	%	27	%
111	%	21	%
119	%	20	%
130	%	20	%

130	%	20	%
113	%	22	%
116	%	21	%
101	%	32	%
115	%	23	%
124	%	22	%
119	%	24	%
124	%	25	%
90	%	40	%
124	%	20	%
140	%	20	%
130	%	21	%
130	%	20	%
122	%	20	%
126	%	32	%
117	%	23	%
147	%	30	%
131	%	20	%
132	%	20	%
130	%	20	%
122	%	20	%
127	%	20	%
121	%	20	%
130	%	20	%
124	%	20	%
122	%	20	%
115	%	20	%
123	%	24	%
117	%	20	%

139	%	21	%
134	%	37	%
99	%	30	%
120	%	20	%
	%		%
	%		%
	%		%

Reference LCSREC - Recovery High	Reference LCSREC - Units	Reference LCSRPD - Precision	Reference LCSRPD - Units
106	%	20	%
110	%	20	%
105	%	20	%
110	%	20	%
107	%	20	%
103	%	20	%
107	%	20	%

Reference LCSREC - Recovery High	Reference LCSREC - Units	Reference LCSRPD - Precision	Reference LCSRPD - Units
120	%	20	%

Reference MSREC - Recovery Low	Reference MSREC - Recovery High	Reference MSREC - Units	Reference MSRPD - Precision	Reference MSRPD - Units
75	125	%	20	%

Reference MSREC - Recovery Low	Reference MSREC - Recovery High	Reference MSREC - Units	Reference MSRPD - Precision	Reference MSRPD - Units
12	163	%	30	%
		%		%

Reference MSREC - Recovery Low	Reference MSREC - Recovery High	Reference MSREC - Units	Reference MSRPD - Precision	Reference MSRPD - Units
70	130	%	20	%
		%		%

Reference MSREC - Recovery Low	Reference MSREC - Recovery High	Reference MSREC - Units	Reference MSRPD - Precision	Reference MSRPD - Units
52	122	%	36	%
50	119	%	29	%
41	132	%	37	%
47	128	%	34	%
46	111	%	26	%
36	114	%	32	%

45	117	%	29	%
41	150	%	38	%
51	129	%	40	%
43	150	%	36	%
42	137	%	40	%
27	140	%	40	%
49	130	%	39	%
54	130	%	38	%
53	124	%	32	%
48	118	%	30	%
50	131	%	36	%
56	127	%	33	%
50	124	%	35	%
52	128	%	33	%
47	117	%	27	%
32	130	%	40	%
54	123	%	33	%
32	144	%	40	%
56	123	%	32	%
37	134	%	40	%
32	148	%	40	%
51	118	%	27	%
58	127	%	36	%
50	123	%	32	%
51	122	%	33	%
45	115	%	39	%
28	115	%	40	%
32	116	%	38	%
48	128	%	31	%

57	122	%	34	%
32	107	%	40	%
52	116	%	29	%
28	100	%	40	%
47	113	%	29	%
41	130	%	34	%
44	122	%	40	%
49	128	%	34	%
10	73	%	40	%
50	130	%	32	%
33	150	%	37	%
39	147	%	40	%
59	143	%	33	%
43	128	%	37	%
41	125	%	35	%
45	115	%	26	%
34	150	%	34	%
44	140	%	34	%
52	135	%	33	%
48	127	%	39	%
51	126	%	34	%
49	131	%	34	%
49	123	%	33	%
54	130	%	35	%
49	124	%	32	%
52	126	%	30	%
44	113	%	26	%
43	130	%	34	%
53	120	%	29	%

33	134	%	40	%
10	126	%	40	%
10	82	%	40	%
57	122	%	22	%
		%		%
		%		%
		%		%

Reference MSREC - Recovery Low	Reference MSREC - Recovery High	Reference MSREC - Units	Reference MSRPD - Precision	Reference MSRPD - Units
75	125	%	20	%
75	125	%	20	%
75	125	%	20	%
75	125	%	20	%
75	125	%	20	%
75	125	%	20	%
75	125	%	20	%

Reference MSREC - Recovery Low	Reference MSREC - Recovery High	Reference MSREC - Units	Reference MSRPD - Precision	Reference MSRPD - Units
75	125	%	20	%

Appendix B

Nevada Division of Environmental Protection
- Draft Guidelines for Discovery Events, Version: 01/28/2009
Reportable Concentrations for Soil

NDEP Draft Guidelines for Discovery Events (Soil RCs)

Appendix A2--Full list of Reportable Concentrations in soil Version: 01/28/2009

Analyte	CAS No.	Reportable Concentration (mg/kg)	Source
Acephate	30560-19-1	5.6E+01	EPA Regional Screening Level, Residential Soil
Acetaldehyde	75-07-0	1.1E+01	EPA Regional Screening Level, Residential Soil
Acetochlor	34256-82-1	1.2E+03	EPA Regional Screening Level, Residential Soil
Acetone	67-64-1	1.6E+01	Soil Screening Level, DAF 20
Acetone Cyanohydrin	75-86-5	2.0E+02	EPA Regional Screening Level, Residential Soil
Acetonitrile	75-05-8	8.7E+02	EPA Regional Screening Level, Residential Soil
Acetophenone	98-86-2	7.8E+03	EPA Regional Screening Level, Residential Soil
Acrolein	107-02-8	1.6E-01	EPA Regional Screening Level, Residential Soil
Acrylamide	79-06-1	1.1E-01	EPA Regional Screening Level, Residential Soil
Acrylic Acid	79-10-7	3.0E+04	EPA Regional Screening Level, Residential Soil
Acrylonitrile	107-13-1	2.4E-01	EPA Regional Screening Level, Residential Soil
Adiponitrile	111-69-3	8.5E+06	EPA Regional Screening Level, Residential Soil
Alachlor	15972-60-8	8.7E+00	EPA Regional Screening Level, Residential Soil
ALAR	1596-84-5	9.2E+03	EPA Regional Screening Level, Residential Soil
Aldicarb	116-06-3	6.1E+01	EPA Regional Screening Level, Residential Soil
Aldicarb Sulfone	1646-88-4	6.1E+01	EPA Regional Screening Level, Residential Soil
Aldrin	309-00-2	2.9E-02	EPA Regional Screening Level, Residential Soil
Ally	74223-64-6	1.5E+04	EPA Regional Screening Level, Residential Soil
Allyl Alcohol	107-18-6	3.1E+02	EPA Regional Screening Level, Residential Soil
Allyl Chloride	107-05-1	1.8E+00	EPA Regional Screening Level, Residential Soil
Aluminum	7429-90-5	7.7E+04	EPA Regional Screening Level, Residential Soil
Aluminum Phosphide	20859-73-8	3.1E+01	EPA Regional Screening Level, Residential Soil
Amdro	67485-29-4	1.8E+01	EPA Regional Screening Level, Residential Soil
Ametryn	834-12-8	5.5E+02	EPA Regional Screening Level, Residential Soil
Aminophenol, m-	591-27-5	4.9E+03	EPA Regional Screening Level, Residential Soil
Aminophenol, p-	123-30-8	1.2E+03	EPA Regional Screening Level, Residential Soil
Amitraz	33089-61-1	1.5E+02	EPA Regional Screening Level, Residential Soil
Ammonia	7664-41-7	1.4E+08	EPA Regional Screening Level, Residential Soil
Ammonium Perchlorate	7790-98-9	5.5E+01	EPA Regional Screening Level, Residential Soil
Ammonium Sulfamate	7773-06-0	1.6E+04	EPA Regional Screening Level, Residential Soil
Aniline	62-53-3	8.5E+01	EPA Regional Screening Level, Residential Soil
Antimony (metallic)	7440-36-0	5.0E+00	Soil Screening Level, DAF 20
Antimony Pentoxide	1314-60-9	3.9E+01	EPA Regional Screening Level, Residential Soil
Antimony Potassium Tartrate	11071-15-1	7.0E+01	EPA Regional Screening Level, Residential Soil
Antimony Tetroxide	1332-81-6	3.1E+01	EPA Regional Screening Level, Residential Soil
Antimony Trioxide	1309-64-4	3.1E+01	EPA Regional Screening Level, Residential Soil
Apollo	74115-24-5	7.9E+02	EPA Regional Screening Level, Residential Soil
Aramite	140-57-8	1.9E+01	EPA Regional Screening Level, Residential Soil
Arsenic, Inorganic	7440-38-2	3.9E-01	EPA Regional Screening Level, Residential Soil
Arsine	7784-42-1	7.1E+04	EPA Regional Screening Level, Residential Soil
Assure	76578-14-8	5.5E+02	EPA Regional Screening Level, Residential Soil
Asulam	3337-71-1	3.1E+03	EPA Regional Screening Level, Residential Soil
Atrazine	1912-24-9	2.1E+00	EPA Regional Screening Level, Residential Soil
Avermectin B1	65195-55-3	2.4E+01	EPA Regional Screening Level, Residential Soil
Azobenzene	103-33-3	4.9E+00	EPA Regional Screening Level, Residential Soil
Barium	7440-39-3	1.6E+03	Soil Screening Level, DAF 20
Baygon	114-26-1	2.4E+02	EPA Regional Screening Level, Residential Soil
Bayleton	43121-43-3	1.8E+03	EPA Regional Screening Level, Residential Soil
Baythroid	68359-37-5	1.5E+03	EPA Regional Screening Level, Residential Soil
Benefin	1861-40-1	1.8E+04	EPA Regional Screening Level, Residential Soil
Benomyl	17804-35-2	3.1E+03	EPA Regional Screening Level, Residential Soil
Bentazon	25057-89-0	1.8E+03	EPA Regional Screening Level, Residential Soil
Benzaldehyde	100-52-7	7.8E+03	EPA Regional Screening Level, Residential Soil
Benzene	71-43-2	3.0E-02	Soil Screening Level, DAF 20
Benzenethiol	108-98-5	7.8E-01	EPA Regional Screening Level, Residential Soil
Benzidine	92-87-5	5.0E-04	EPA Regional Screening Level, Residential Soil
Benzoic Acid	65-85-0	4.0E+02	Soil Screening Level, DAF 20
Benzotrichloride	98-07-7	4.9E-02	EPA Regional Screening Level, Residential Soil
Benzyl Alcohol	100-51-6	3.1E+04	EPA Regional Screening Level, Residential Soil
Benzyl Chloride	100-44-7	3.8E+00	EPA Regional Screening Level, Residential Soil

NDEP Draft Guidelines for Discovery Events (Soil RCs)

Appendix A2--Full list of Reportable Concentrations in soil Version: 01/28/2009

Analyte	CAS No.	Reportable Concentration (mg/kg)	Source
Beryllium and compounds	7440-41-7	6.3E+01	Soil Screening Level, DAF 20
Bidrin	141-66-2	6.1E+00	EPA Regional Screening Level, Residential Soil
Bifenox	42576-02-3	5.5E+02	EPA Regional Screening Level, Residential Soil
Biphenthrin	82657-04-3	9.2E+02	EPA Regional Screening Level, Residential Soil
Biphenyl, 1,1'-	92-52-4	3.9E+03	EPA Regional Screening Level, Residential Soil
Bis(2-chloroethoxy)methane	111-91-1	1.8E+02	EPA Regional Screening Level, Residential Soil
Bis(2-chloroethyl)ether	111-44-4	4.0E-04	Soil Screening Level, DAF 20
Bis(2-chloro-1-methylethyl) ether	108-60-1	3.5E+00	EPA Regional Screening Level, Residential Soil
Bis(2-ethylhexyl)phthalate	117-81-7	3.5E+01	EPA Regional Screening Level, Residential Soil
Bis(chloromethyl)ether	542-88-1	2.7E-04	EPA Regional Screening Level, Residential Soil
Bisphenol A	80-05-7	3.1E+03	EPA Regional Screening Level, Residential Soil
Boron And Borates Only	7440-42-8	1.6E+04	EPA Regional Screening Level, Residential Soil
Boron Trifluoride	7637-07-2	9.9E+05	EPA Regional Screening Level, Residential Soil
Bromate	15541-45-4	9.1E-01	EPA Regional Screening Level, Residential Soil
Bromobenzene	108-86-1	9.4E+01	EPA Regional Screening Level, Residential Soil
Bromodichloromethane	75-27-4	6.0E-01	Soil Screening Level, DAF 20
Bromoform	75-25-2	8.0E-01	Soil Screening Level, DAF 20
Bromomethane	74-83-9	2.0E-01	Soil Screening Level, DAF 20
Bromophos	2104-96-3	3.1E+02	EPA Regional Screening Level, Residential Soil
Bromoxynil	1689-84-5	1.2E+03	EPA Regional Screening Level, Residential Soil
Bromoxynil Octanoate	1689-99-2	1.2E+03	EPA Regional Screening Level, Residential Soil
Butadiene, 1,3-	106-99-0	7.7E-02	EPA Regional Screening Level, Residential Soil
Butanol, N-	71-36-3	1.7E+01	Soil Screening Level, DAF 20
Butyl Benzyl Phthlate	85-68-7	2.6E+02	EPA Regional Screening Level, Residential Soil
Butylate	2008-41-5	3.1E+03	EPA Regional Screening Level, Residential Soil
Butylphthalyl Butylglycolate	85-70-1	6.1E+04	EPA Regional Screening Level, Residential Soil
Cacodylic Acid	75-60-5	1.2E+03	EPA Regional Screening Level, Residential Soil
Cadmium (Diet)	7440-43-9	8.0E+00	Soil Screening Level, DAF 20
Caprolactam	105-60-2	3.1E+04	EPA Regional Screening Level, Residential Soil
Captafol	2425-06-1	3.2E+00	EPA Regional Screening Level, Residential Soil
Captan	133-06-2	2.1E+02	EPA Regional Screening Level, Residential Soil
Carbaryl	63-25-2	6.1E+03	EPA Regional Screening Level, Residential Soil
Carbofuran	1563-66-2	3.1E+02	EPA Regional Screening Level, Residential Soil
Carbon Disulfide	75-15-0	3.2E+01	Soil Screening Level, DAF 20
Carbon Tetrachloride	56-23-5	7.0E-02	Soil Screening Level, DAF 20
Carbosulfan	55285-14-8	6.1E+02	EPA Regional Screening Level, Residential Soil
Carboxin	5234-68-4	6.1E+03	EPA Regional Screening Level, Residential Soil
Chloral Hydrate	302-17-0	6.1E+03	EPA Regional Screening Level, Residential Soil
Chloramben	133-90-4	9.2E+02	EPA Regional Screening Level, Residential Soil
Chloranil	118-75-2	1.2E+00	EPA Regional Screening Level, Residential Soil
Chlordane	12789-03-6	1.6E+00	EPA Regional Screening Level, Residential Soil
Chlordecone (Kepone)	143-50-0	3.0E-02	EPA Regional Screening Level, Residential Soil
Chlorimuron, Ethyl-	90982-32-4	1.2E+03	EPA Regional Screening Level, Residential Soil
Chlorine	7782-50-5	7.5E+03	EPA Regional Screening Level, Residential Soil
Chlorine Dioxide	10049-04-4	2.3E+03	EPA Regional Screening Level, Residential Soil
Chlorite (Sodium Salt)	7758-19-2	2.3E+03	EPA Regional Screening Level, Residential Soil
Chloro-1,1-difluoroethane, 1-	75-68-3	5.9E+04	EPA Regional Screening Level, Residential Soil
Chloro-1,3-butadiene, 2-	126-99-8	8.6E+00	EPA Regional Screening Level, Residential Soil
Chloro-2-methylaniline HCl, 4-	3165-93-3	1.1E+00	EPA Regional Screening Level, Residential Soil
Chloro-2-methylaniline, 4-	95-69-2	1.8E+00	EPA Regional Screening Level, Residential Soil
Chloroacetic Acid	79-11-8	1.2E+02	EPA Regional Screening Level, Residential Soil
Chloroacetophenone, 2-	532-27-4	4.3E+04	EPA Regional Screening Level, Residential Soil
Chloroaniline, p-	106-47-8	7.0E-01	Soil Screening Level, DAF 20
Chlorobenzene	108-90-7	1.0E+00	Soil Screening Level, DAF 20
Chlorobenzilate	510-15-6	4.4E+00	EPA Regional Screening Level, Residential Soil
Chlorobenzotrifluoride, 4-	98-56-6	2.1E+02	EPA Regional Screening Level, Residential Soil
Chlorobutane, 1-	109-69-3	3.1E+03	EPA Regional Screening Level, Residential Soil
Chlorodifluoromethane	75-45-6	5.3E+04	EPA Regional Screening Level, Residential Soil
Chloroform	67-66-3	3.0E-01	EPA Regional Screening Level, Residential Soil
Chloromethane	74-87-3	1.7E+00	EPA Regional Screening Level, Residential Soil

NDEP Draft Guidelines for Discovery Events (Soil RCs)

Appendix A2--Full list of Reportable Concentrations in soil Version: 01/28/2009

Analyte	CAS No.	Reportable Concentration (mg/kg)	Source
Chloronaphthalene, Beta-	91-58-7	6.3E+03	EPA Regional Screening Level, Residential Soil
Chloronitrobenzene, o-	88-73-3	5.0E+01	EPA Regional Screening Level, Residential Soil
Chloronitrobenzene, p-	100-00-5	6.1E+01	EPA Regional Screening Level, Residential Soil
Chlorophenol, 2-	95-57-8	4.0E+00	Soil Screening Level, DAF 20
Chlorothalonil	1897-45-6	1.6E+02	EPA Regional Screening Level, Residential Soil
Chlorotoluene, o-	95-49-8	1.6E+03	EPA Regional Screening Level, Residential Soil
Chlorotoluene, p-	106-43-4	5.5E+03	EPA Regional Screening Level, Residential Soil
Chlorpropham	101-21-3	1.2E+04	EPA Regional Screening Level, Residential Soil
Chlorpyrifos	2921-88-2	1.8E+02	EPA Regional Screening Level, Residential Soil
Chlorpyrifos Methyl	5598-13-0	6.1E+02	EPA Regional Screening Level, Residential Soil
Chlorsulfuron	64902-72-3	3.1E+03	EPA Regional Screening Level, Residential Soil
Chlorthiophos	60238-56-4	4.9E+01	EPA Regional Screening Level, Residential Soil
Chromium (III) (Insoluble Salts)	16065-83-1	1.2E+05	EPA Regional Screening Level, Residential Soil
Chromium VI (particulates)	18540-29-9	3.8E+01	Soil Screening Level, DAF 20
Chromium, Total (1:6 ratio Cr VI : Cr III)	7440-47-3	3.8E+01	Soil Screening Level, DAF 20
Cobalt	7440-48-4	2.3E+01	EPA Regional Screening Level, Residential Soil
Coke Oven Emissions	8007-45-2		EPA Regional Screening Level, Residential Soil
Copper	7440-50-8	3.1E+03	EPA Regional Screening Level, Residential Soil
Cresol, m-	108-39-4	3.1E+03	EPA Regional Screening Level, Residential Soil
Cresol, o-	95-48-7	3.1E+03	EPA Regional Screening Level, Residential Soil
Cresol, p-	106-44-5	3.1E+02	EPA Regional Screening Level, Residential Soil
Crotonaldehyde, trans-	123-73-9	3.4E-01	EPA Regional Screening Level, Residential Soil
Cumene	98-82-8	2.2E+03	EPA Regional Screening Level, Residential Soil
Cyanazine	21725-46-2	5.8E-01	EPA Regional Screening Level, Residential Soil
Cyclohexane	110-82-7	7.2E+03	EPA Regional Screening Level, Residential Soil
Cyclohexane, 1,2,3,4,5-pentabromo-6-chloro-	87-84-3	2.1E+01	EPA Regional Screening Level, Residential Soil
Cyclohexanone	108-94-1	3.1E+05	EPA Regional Screening Level, Residential Soil
Cyclohexylamine	108-91-8	1.2E+04	EPA Regional Screening Level, Residential Soil
Cyhalothrin/karate	68085-85-8	3.1E+02	EPA Regional Screening Level, Residential Soil
Cypermethrin	52315-07-8	6.1E+02	EPA Regional Screening Level, Residential Soil
Cyromazine	66215-27-8	4.6E+02	EPA Regional Screening Level, Residential Soil
Cyanides			
Calcium Cyanide	592-01-8	3.1E+03	EPA Regional Screening Level, Residential Soil
Copper Cyanide	544-92-3	3.9E+02	EPA Regional Screening Level, Residential Soil
Cyanide (CN-)	57-12-5	1.6E+03	EPA Regional Screening Level, Residential Soil
Cyanogen	460-19-5	3.1E+03	EPA Regional Screening Level, Residential Soil
Cyanogen Bromide	506-68-3	7.0E+03	EPA Regional Screening Level, Residential Soil
Cyanogen Chloride	506-77-4	3.9E+03	EPA Regional Screening Level, Residential Soil
Hydrogen Cyanide	74-90-8	1.6E+03	EPA Regional Screening Level, Residential Soil
Potassium Cyanide	151-50-8	3.9E+03	EPA Regional Screening Level, Residential Soil
Potassium Silver Cyanide	506-61-6	1.6E+04	EPA Regional Screening Level, Residential Soil
Silver Cyanide	506-64-9	7.8E+03	EPA Regional Screening Level, Residential Soil
Sodium Cyanide	143-33-9	3.1E+03	EPA Regional Screening Level, Residential Soil
Thiocyanate	463-56-9	1.6E+01	EPA Regional Screening Level, Residential Soil
Zinc Cyanide	557-21-1	3.9E+03	EPA Regional Screening Level, Residential Soil
Dacthal	1861-32-1	6.1E+02	EPA Regional Screening Level, Residential Soil
Dalapon	75-99-0	1.8E+03	EPA Regional Screening Level, Residential Soil
DDD	72-54-8	2.0E+00	EPA Regional Screening Level, Residential Soil
DDE, p,p'-	72-55-9	1.4E+00	EPA Regional Screening Level, Residential Soil
DDT	50-29-3	1.7E+00	EPA Regional Screening Level, Residential Soil
Decabromodiphenyl ether, 2,2',3,3',4,4',5,5',6,6'- (BDE-209)	1163-19-5	4.3E+02	EPA Regional Screening Level, Residential Soil
Demeton	8065-48-3	2.4E+00	EPA Regional Screening Level, Residential Soil
Di(2-ethylhexyl)adipate	103-23-1	4.0E+02	EPA Regional Screening Level, Residential Soil
Diallate	2303-16-4	8.0E+00	EPA Regional Screening Level, Residential Soil
Diazinon	333-41-5	5.5E+01	EPA Regional Screening Level, Residential Soil
Dibromo-3-chloropropane, 1,2-	96-12-8	5.6E-03	EPA Regional Screening Level, Residential Soil
Dibromobenzene, 1,4-	106-37-6	6.1E+02	EPA Regional Screening Level, Residential Soil
Dibromochloromethane	124-48-1	4.0E-01	Soil Screening Level, DAF 20
Dibromoethane, 1,2- (EDB)	106-93-4	3.4E-02	EPA Regional Screening Level, Residential Soil
Dibromomethane (Methylene Bromide)	74-95-3	7.8E+02	EPA Regional Screening Level, Residential Soil

NDEP Draft Guidelines for Discovery Events (Soil RCs)

Appendix A2--Full list of Reportable Concentrations in soil Version: 01/28/2009

Analyte	CAS No.	Reportable Concentration (mg/kg)	Source
Dibutyl Phthalate	84-74-2	2.3E+03	Soil Screening Level, DAF 20
Dibutyltin Compounds	NA	1.8E+01	EPA Regional Screening Level, Residential Soil
Dicamba	1918-00-9	1.8E+03	EPA Regional Screening Level, Residential Soil
Dichloro-2-butene, 1,4-	764-41-0	3.2E-03	EPA Regional Screening Level, Residential Soil
Dichloroacetic Acid	79-43-6	9.7E+00	EPA Regional Screening Level, Residential Soil
Dichlorobenzene, 1,2-	95-50-1	1.7E+01	Soil Screening Level, DAF 20
Dichlorobenzene, 1,4-	106-46-7	2.0E+00	Soil Screening Level, DAF 20
Dichlorobenzidine, 3,3'-	91-94-1	7.0E-03	Soil Screening Level, DAF 20
Dichlorodifluoromethane	75-71-8	1.9E+02	EPA Regional Screening Level, Residential Soil
Dichloroethane, 1,1-	75-34-3	3.4E+00	EPA Regional Screening Level, Residential Soil
Dichloroethane, 1,2- (EDC)	107-06-2	2.0E-02	Soil Screening Level, DAF 20
Dichloroethylene, 1,1-	75-35-4	6.0E-02	Soil Screening Level, DAF 20
Dichloroethylene, 1,2- (Mixed Isomers)	540-59-0	7.0E+02	EPA Regional Screening Level, Residential Soil
Dichloroethylene, 1,2-cis-	156-59-2	4.0E-01	Soil Screening Level, DAF 20
Dichloroethylene, 1,2-trans-	156-60-5	7.0E-01	Soil Screening Level, DAF 20
Dichlorophenol, 2,4-	120-83-2	1.0E+00	Soil Screening Level, DAF 20
Dichlorophenoxy Acetic Acid, 2,4-	94-75-7	6.9E+02	EPA Regional Screening Level, Residential Soil
Dichlorophenoxy)butyric Acid, 4-(2,4-	94-82-6	4.9E+02	EPA Regional Screening Level, Residential Soil
Dichloropropane, 1,2-	78-87-5	3.0E-02	Soil Screening Level, DAF 20
Dichloropropane, 1,3-	142-28-9	1.6E+03	EPA Regional Screening Level, Residential Soil
Dichloropropanol, 2,3-	616-23-9	1.8E+02	EPA Regional Screening Level, Residential Soil
Dichloropropene, 1,3-	542-75-6	4.0E-03	Soil Screening Level, DAF 20
Dichlorvos	62-73-7	1.7E+00	EPA Regional Screening Level, Residential Soil
Dicyclopentadiene	77-73-6	2.9E+01	EPA Regional Screening Level, Residential Soil
Dieldrin	60-57-1	4.0E-03	Soil Screening Level, DAF 20
Diethyl Phthalate	84-66-2	4.9E+04	EPA Regional Screening Level, Residential Soil
Diethylene Glycol Monobutyl Ether	112-34-5	6.1E+02	EPA Regional Screening Level, Residential Soil
Diethylene Glycol Monoethyl Ether	111-90-0	3.7E+03	EPA Regional Screening Level, Residential Soil
Diethylformamide	617-84-5	6.1E+01	EPA Regional Screening Level, Residential Soil
Diethylstilbestrol	56-53-1	1.4E-03	EPA Regional Screening Level, Residential Soil
Difenzoquat	43222-48-6	4.9E+03	EPA Regional Screening Level, Residential Soil
Diflubenzuron	35367-38-5	1.2E+03	EPA Regional Screening Level, Residential Soil
Difluoroethane, 1,1-	75-37-6	5.3E+04	EPA Regional Screening Level, Residential Soil
Diisopropyl Ether (DIPE)	108-20-3	1.2E+03	EPA Regional Screening Level, Residential Soil
Diisopropyl Methylphosphonate	1445-75-6	6.3E+03	EPA Regional Screening Level, Residential Soil
Dimethipin	55290-64-7	1.2E+03	EPA Regional Screening Level, Residential Soil
Dimethoate	60-51-5	1.2E+01	EPA Regional Screening Level, Residential Soil
Dimethoxybenzidine, 3,3'-	119-90-4	3.5E+01	EPA Regional Screening Level, Residential Soil
Dimethyl methylphosphonate	756-79-6	2.9E+02	EPA Regional Screening Level, Residential Soil
Dimethylaniline HCl, 2,4-	21436-96-4	8.4E-01	EPA Regional Screening Level, Residential Soil
Dimethylaniline, 2,4-	95-68-1	6.5E-01	EPA Regional Screening Level, Residential Soil
Dimethylaniline, N,N-	121-69-7	1.6E+02	EPA Regional Screening Level, Residential Soil
Dimethylbenzidine, 3,3'-	119-93-7	4.4E-02	EPA Regional Screening Level, Residential Soil
Dimethylformamide	68-12-2	6.1E+03	EPA Regional Screening Level, Residential Soil
Dimethylphenol, 2,4-	105-67-9	9.0E+00	Soil Screening Level, DAF 20
Dimethylphenol, 2,6-	576-26-1	3.7E+01	EPA Regional Screening Level, Residential Soil
Dimethylphenol, 3,4-	95-65-8	6.1E+01	EPA Regional Screening Level, Residential Soil
Dimethylterephthalate	120-61-6	7.8E+03	EPA Regional Screening Level, Residential Soil
Dinitro-o-cresol, 4,6-	534-52-1	6.1E+00	EPA Regional Screening Level, Residential Soil
Dinitro-o-cyclohexyl Phenol, 4,6-	131-89-5	1.2E+02	EPA Regional Screening Level, Residential Soil
Dinitrobenzene, 1,2-	528-29-0	6.1E+00	EPA Regional Screening Level, Residential Soil
Dinitrobenzene, 1,3-	99-65-0	6.1E+00	EPA Regional Screening Level, Residential Soil
Dinitrobenzene, 1,4-	100-25-4	6.1E+00	EPA Regional Screening Level, Residential Soil
Dinitrophenol, 2,4-	51-28-5	3.0E-01	Soil Screening Level, DAF 20
Dinitrotoluene Mixture, 2,4/2,6-	25321-14-6	8.0E-04	Soil Screening Level, DAF 20
Dinitrotoluene, 2,4-	121-14-2	8.0E-04	Soil Screening Level, DAF 20
Dinitrotoluene, 2,6-	606-20-2	7.0E-04	Soil Screening Level, DAF 20
Dinitrotoluene, 2-Amino-4,6-	35572-78-2	1.5E+02	EPA Regional Screening Level, Residential Soil
Dinitrotoluene, 4-Amino-2,6-	19406-51-0	1.5E+02	EPA Regional Screening Level, Residential Soil
Dinoseb	88-85-7	6.1E+01	EPA Regional Screening Level, Residential Soil

NDEP Draft Guidelines for Discovery Events (Soil RCs)

Appendix A2--Full list of Reportable Concentrations in soil Version: 01/28/2009

Analyte	CAS No.	Reportable Concentration (mg/kg)	Source
Dioxane, 1,4-	123-91-1	4.4E+01	EPA Regional Screening Level, Residential Soil
Diphenamid	957-51-7	1.8E+03	EPA Regional Screening Level, Residential Soil
Diphenyl Sulfone	127-63-9	1.8E+02	EPA Regional Screening Level, Residential Soil
Diphenylamine	122-39-4	1.5E+03	EPA Regional Screening Level, Residential Soil
Diphenylhydrazine, 1,2-	122-66-7	6.1E-01	EPA Regional Screening Level, Residential Soil
Diquat	85-00-7	1.3E+02	EPA Regional Screening Level, Residential Soil
Direct Black 38	1937-37-7	6.6E-02	EPA Regional Screening Level, Residential Soil
Direct Blue 6	2602-46-2	6.6E-02	EPA Regional Screening Level, Residential Soil
Direct Brown 95	16071-86-6	7.2E-02	EPA Regional Screening Level, Residential Soil
Disulfoton	298-04-4	2.4E+00	EPA Regional Screening Level, Residential Soil
Dithiane, 1,4-	505-29-3	6.1E+02	EPA Regional Screening Level, Residential Soil
Diuron	330-54-1	1.2E+02	EPA Regional Screening Level, Residential Soil
Dodine	2439-10-3	2.4E+02	EPA Regional Screening Level, Residential Soil
Dioxins			
Hexachlorodibenzo-p-dioxin	34465-46-8	4.5E-05	EPA Regional Screening Level, Residential Soil
Hexachlorodibenzo-p-dioxin, Mixture	19408-74-3	9.4E-05	EPA Regional Screening Level, Residential Soil
HpCDD, 2,3,7,8-	37871-00-4	4.5E-04	EPA Regional Screening Level, Residential Soil
OCDD	3268-87-9	1.5E-02	EPA Regional Screening Level, Residential Soil
PeCDD, 2,3,7,8-	36088-22-9	4.5E-06	EPA Regional Screening Level, Residential Soil
TCDD, 2,3,7,8-	1746-01-6	4.5E-06	EPA Regional Screening Level, Residential Soil
Endosulfan	115-29-7	1.8E+01	Soil Screening Level, DAF 20
Endothall	145-73-3	1.2E+03	EPA Regional Screening Level, Residential Soil
Endrin	72-20-8	1.0E+00	Soil Screening Level, DAF 20
Epichlorohydrin	106-89-8	1.8E+01	EPA Regional Screening Level, Residential Soil
Epoxybutane, 1,2-	106-88-7	1.5E+02	EPA Regional Screening Level, Residential Soil
EPTC	759-94-4	2.0E+03	EPA Regional Screening Level, Residential Soil
Ethephon	16672-87-0	3.1E+02	EPA Regional Screening Level, Residential Soil
Ethion	563-12-2	3.1E+01	EPA Regional Screening Level, Residential Soil
Ethoxyethanol Acetate, 2-	111-15-9	1.8E+04	EPA Regional Screening Level, Residential Soil
Ethoxyethanol, 2-	110-80-5	2.4E+04	EPA Regional Screening Level, Residential Soil
Ethyl Acetate	141-78-6	7.0E+04	EPA Regional Screening Level, Residential Soil
Ethyl Acrylate	140-88-5	1.3E+01	EPA Regional Screening Level, Residential Soil
Ethyl Chloride	75-00-3	1.5E+04	EPA Regional Screening Level, Residential Soil
Ethyl Ether	60-29-7	1.6E+04	EPA Regional Screening Level, Residential Soil
Ethyl Methacrylate	97-63-2	7.0E+03	EPA Regional Screening Level, Residential Soil
Ethyl-p-nitrophenyl Phosphonate	2104-64-5	6.1E-01	EPA Regional Screening Level, Residential Soil
Ethylbenzene	100-41-4	5.7E+00	EPA Regional Screening Level, Residential Soil
Ethylene Cyanohydrin	109-78-4	1.8E+03	EPA Regional Screening Level, Residential Soil
Ethylene Diamine	107-15-3	5.5E+03	EPA Regional Screening Level, Residential Soil
Ethylene Glycol	107-21-1	1.2E+05	EPA Regional Screening Level, Residential Soil
Ethylene Glycol Monobutyl Ether	111-76-2	3.1E+04	EPA Regional Screening Level, Residential Soil
Ethylene Oxide	75-21-8	1.6E-01	EPA Regional Screening Level, Residential Soil
Ethylene Thiourea	96-45-7	4.9E+00	EPA Regional Screening Level, Residential Soil
Ethylphthalyl Ethyl Glycolate	84-72-0	1.8E+05	EPA Regional Screening Level, Residential Soil
Express	101200-48-0	4.9E+02	EPA Regional Screening Level, Residential Soil
Fenamiphos	22224-92-6	1.5E+01	EPA Regional Screening Level, Residential Soil
Fenpropathrin	39515-41-8	1.5E+03	EPA Regional Screening Level, Residential Soil
Fluometuron	2164-17-2	7.9E+02	EPA Regional Screening Level, Residential Soil
Fluorine (Soluble Fluoride)	7782-41-4	4.7E+03	EPA Regional Screening Level, Residential Soil
Fluridone	59756-60-4	4.9E+03	EPA Regional Screening Level, Residential Soil
Flurprimidol	56425-91-3	1.2E+03	EPA Regional Screening Level, Residential Soil
Flutolanil	66332-96-5	3.7E+03	EPA Regional Screening Level, Residential Soil
Fluvalinate	69409-94-5	6.1E+02	EPA Regional Screening Level, Residential Soil
Folpet	133-07-3	1.4E+02	EPA Regional Screening Level, Residential Soil
Fomesafen	72178-02-0	2.6E+00	EPA Regional Screening Level, Residential Soil
Fonofos	944-22-9	1.2E+02	EPA Regional Screening Level, Residential Soil
Formaldehyde	50-00-0	1.2E+04	EPA Regional Screening Level, Residential Soil
Formic Acid	64-18-6	1.2E+05	EPA Regional Screening Level, Residential Soil
Fosetyl-AL	39148-24-8	1.8E+05	EPA Regional Screening Level, Residential Soil
Furazolidone	67-45-8	1.3E-01	EPA Regional Screening Level, Residential Soil

NDEP Draft Guidelines for Discovery Events (Soil RCs)

Appendix A2--Full list of Reportable Concentrations in soil Version: 01/28/2009

Analyte	CAS No.	Reportable Concentration (mg/kg)	Source
Furfural	98-01-1	1.8E+02	EPA Regional Screening Level, Residential Soil
Furium	531-82-8	3.2E-01	EPA Regional Screening Level, Residential Soil
Furmecyclox	60568-05-0	1.6E+01	EPA Regional Screening Level, Residential Soil
Furans			
Furan	110-00-9	7.8E+01	EPA Regional Screening Level, Residential Soil
HpCDF, 2,3,7,8-	38998-75-3	3.7E-04	EPA Regional Screening Level, Residential Soil
HxCDF, 2,3,7,8-	55684-94-1	3.7E-05	EPA Regional Screening Level, Residential Soil
OCDF	39001-02-0	1.2E-02	EPA Regional Screening Level, Residential Soil
PeCDF, 1,2,3,7,8-	57117-41-6	1.2E-04	EPA Regional Screening Level, Residential Soil
PeCDF, 2,3,4,7,8-	57117-31-4	1.2E-05	EPA Regional Screening Level, Residential Soil
TCDF, 2,3,7,8-	51207-31-9	3.7E-05	EPA Regional Screening Level, Residential Soil
Glufosinate, Ammonium	77182-82-2	2.4E+01	EPA Regional Screening Level, Residential Soil
Glycidyl	765-34-4	2.4E+01	EPA Regional Screening Level, Residential Soil
Glyphosate	1071-83-6	6.1E+03	EPA Regional Screening Level, Residential Soil
Goal	42874-03-3	1.8E+02	EPA Regional Screening Level, Residential Soil
Haloxyfop, Methyl	69806-40-2	3.1E+00	EPA Regional Screening Level, Residential Soil
Harmony	79277-27-3	7.9E+02	EPA Regional Screening Level, Residential Soil
Heptachlor	76-44-8	1.1E-01	EPA Regional Screening Level, Residential Soil
Heptachlor Epoxide	1024-57-3	5.3E-02	EPA Regional Screening Level, Residential Soil
Hexabromobenzene	87-82-1	1.2E+02	EPA Regional Screening Level, Residential Soil
Hexachlorobenzene	118-74-1	3.0E-01	EPA Regional Screening Level, Residential Soil
Hexachlorobutadiene	87-68-3	2.0E+00	Soil Screening Level, DAF 20
Hexachlorocyclohexane, Alpha-	319-84-6	5.0E-04	Soil Screening Level, DAF 20
Hexachlorocyclohexane, Beta-	319-85-7	3.0E-03	Soil Screening Level, DAF 20
Hexachlorocyclohexane, Gamma- (Lindane)	58-89-9	9.0E-03	Soil Screening Level, DAF 20
Hexachlorocyclohexane, Technical	608-73-1	3.0E-03	Soil Screening Level, DAF 20
Hexachlorocyclopentadiene	77-47-4	3.7E+02	EPA Regional Screening Level, Residential Soil
Hexachloroethane	67-72-1	5.0E-01	Soil Screening Level, DAF 20
Hexachlorophene	70-30-4	1.8E+01	EPA Regional Screening Level, Residential Soil
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121-82-4	5.5E+00	EPA Regional Screening Level, Residential Soil
Hexamethylene Diisocyanate, 1,6-	822-06-0	3.7E+00	EPA Regional Screening Level, Residential Soil
Hexane, N-	110-54-3	5.7E+02	EPA Regional Screening Level, Residential Soil
Hexanedioic Acid	124-04-9	1.2E+05	EPA Regional Screening Level, Residential Soil
Hexazinone	51235-04-2	2.0E+03	EPA Regional Screening Level, Residential Soil
Hydrazine	302-01-2	2.1E-01	EPA Regional Screening Level, Residential Soil
Hydrazine Sulfate	10034-93-2	2.1E-01	EPA Regional Screening Level, Residential Soil
Hydrogen Chloride	7647-01-0	2.8E+07	EPA Regional Screening Level, Residential Soil
Hydrogen Sulfide	7783-06-4	2.8E+06	EPA Regional Screening Level, Residential Soil
Hydroquinone	123-31-9	8.7E+00	EPA Regional Screening Level, Residential Soil
Hexabromodiphenyl ether, 2,2',4,4',5,5'- (BDE-153)	68631-49-2	1.6E+01	EPA Regional Screening Level, Residential Soil
Imazalil	35554-44-0	7.9E+02	EPA Regional Screening Level, Residential Soil
Imazaquin	81335-37-7	1.5E+04	EPA Regional Screening Level, Residential Soil
Iprodione	36734-19-7	2.4E+03	EPA Regional Screening Level, Residential Soil
Iron	7439-89-6	5.5E+04	EPA Regional Screening Level, Residential Soil
Isobutyl Alcohol	78-83-1	2.3E+04	EPA Regional Screening Level, Residential Soil
Isophorone	78-59-1	5.0E-01	Soil Screening Level, DAF 20
Isopropalin	33820-53-0	9.2E+02	EPA Regional Screening Level, Residential Soil
Isopropyl Methyl Phosphonic Acid	1832-54-8	6.1E+03	EPA Regional Screening Level, Residential Soil
Isoxaben	82558-50-7	3.1E+03	EPA Regional Screening Level, Residential Soil
Kerb	23950-58-5	4.6E+03	EPA Regional Screening Level, Residential Soil
Lactofen	77501-63-4	1.2E+02	EPA Regional Screening Level, Residential Soil
Linuron	330-55-2	1.2E+02	EPA Regional Screening Level, Residential Soil
Lithium	7439-93-2	1.6E+02	EPA Regional Screening Level, Residential Soil
Lithium Perchlorate	7791-03-9	5.5E+01	EPA Regional Screening Level, Residential Soil
Londax	83055-99-6	1.2E+04	EPA Regional Screening Level, Residential Soil
Lead Compounds			
Lead and Compounds	7439-92-1	4.0E+02	EPA Regional Screening Level, Residential Soil
Tetraethyl Lead	78-00-2	6.1E-03	EPA Regional Screening Level, Residential Soil
Malathion	121-75-5	1.2E+03	EPA Regional Screening Level, Residential Soil
Maleic Anhydride	108-31-6	6.1E+03	EPA Regional Screening Level, Residential Soil

NDEP Draft Guidelines for Discovery Events (Soil RCs)

Appendix A2--Full list of Reportable Concentrations in soil Version: 01/28/2009

Analyte	CAS No.	Reportable Concentration (mg/kg)	Source
Maleic Hydrazide	123-33-1	3.1E+04	EPA Regional Screening Level, Residential Soil
Malononitrile	109-77-3	6.1E+00	EPA Regional Screening Level, Residential Soil
Mancozeb	8018-01-7	1.8E+03	EPA Regional Screening Level, Residential Soil
Maneb	12427-38-2	3.1E+02	EPA Regional Screening Level, Residential Soil
Manganese (Water)	7439-96-5	1.8E+03	EPA Regional Screening Level, Residential Soil
MCPA	94-74-6	3.1E+01	EPA Regional Screening Level, Residential Soil
MCPB	94-81-5	6.1E+02	EPA Regional Screening Level, Residential Soil
MCPP	93-65-2	6.1E+01	EPA Regional Screening Level, Residential Soil
Mephosfolan	950-10-7	5.5E+00	EPA Regional Screening Level, Residential Soil
Mepiquat Chloride	24307-26-4	1.8E+03	EPA Regional Screening Level, Residential Soil
Merphos	150-50-5	1.8E+00	EPA Regional Screening Level, Residential Soil
Merphos Oxide	78-48-8	1.8E+00	EPA Regional Screening Level, Residential Soil
Metalaxyl	57837-19-1	3.7E+03	EPA Regional Screening Level, Residential Soil
Methacrylonitrile	126-98-7	3.2E+00	EPA Regional Screening Level, Residential Soil
Methamidophos	10265-92-6	3.1E+00	EPA Regional Screening Level, Residential Soil
Methanol	67-56-1	3.1E+04	EPA Regional Screening Level, Residential Soil
Methidathion	950-37-8	6.1E+01	EPA Regional Screening Level, Residential Soil
Methomyl	16752-77-5	1.5E+03	EPA Regional Screening Level, Residential Soil
Methoxy-5-nitroaniline, 2-	99-59-2	9.9E+00	EPA Regional Screening Level, Residential Soil
Methoxychlor	72-43-5	1.6E+02	Soil Screening Level, DAF 20
Methoxyethanol Acetate, 2-	110-49-6	1.2E+02	EPA Regional Screening Level, Residential Soil
Methoxyethanol, 2-	109-86-4	1.8E+02	EPA Regional Screening Level, Residential Soil
Methyl Acetate	79-20-9	7.8E+04	EPA Regional Screening Level, Residential Soil
Methyl Acrylate	96-33-3	2.3E+03	EPA Regional Screening Level, Residential Soil
Methyl Ethyl Ketone (2-Butanone)	78-93-3	2.8E+04	EPA Regional Screening Level, Residential Soil
Methyl Isobutyl Ketone (4-methyl-2-pentanone)	108-10-1	5.3E+03	EPA Regional Screening Level, Residential Soil
Methyl Methacrylate	80-62-6	4.7E+03	EPA Regional Screening Level, Residential Soil
Methyl Parathion	298-00-0	1.5E+01	EPA Regional Screening Level, Residential Soil
Methyl Styrene (Mixed Isomers)	25013-15-4	1.9E+02	EPA Regional Screening Level, Residential Soil
Methyl tert-Butyl Ether (MTBE)	1634-04-4	3.9E+01	NDEP calculated SSL, DAF 20
Methyl-5-Nitroaniline, 2-	99-55-8	1.5E+01	EPA Regional Screening Level, Residential Soil
Methylaniline Hydrochloride, 2-	636-21-5	3.7E+00	EPA Regional Screening Level, Residential Soil
Methylarsonic acid	124-58-3	6.1E+02	EPA Regional Screening Level, Residential Soil
Methylene Chloride	75-09-2	2.0E-02	Soil Screening Level, DAF 20
Methylene-bis(2-chloroaniline), 4,4'-	101-14-4	1.2E+00	EPA Regional Screening Level, Residential Soil
Methylene-bis(N,N-dimethyl) Aniline, 4,4'-	101-61-1	1.1E+01	EPA Regional Screening Level, Residential Soil
Methylenebisbenzenamine, 4,4'-	101-77-9	3.0E-01	EPA Regional Screening Level, Residential Soil
Methylenediphenyl Diisocyanate	101-68-8	8.5E+05	EPA Regional Screening Level, Residential Soil
Methylstyrene, Alpha-	98-83-9	5.5E+03	EPA Regional Screening Level, Residential Soil
Metolachlor	51218-45-2	9.2E+03	EPA Regional Screening Level, Residential Soil
Metribuzin	21087-64-9	1.5E+03	EPA Regional Screening Level, Residential Soil
Mirex	2385-85-5	2.7E-02	EPA Regional Screening Level, Residential Soil
Molinate	2212-67-1	1.2E+02	EPA Regional Screening Level, Residential Soil
Molybdenum	7439-98-7	3.9E+02	EPA Regional Screening Level, Residential Soil
Monochloramine	10599-90-3	7.8E+03	EPA Regional Screening Level, Residential Soil
Monomethylaniline	100-61-8	1.2E+02	EPA Regional Screening Level, Residential Soil
Mercury Compounds			
Mercuric Chloride	7487-94-7	2.3E+01	EPA Regional Screening Level, Residential Soil
Mercuric Sulfide	1344-48-5	2.3E+01	EPA Regional Screening Level, Residential Soil
Mercury (elemental)	7439-97-6	6.7E+00	EPA Regional Screening Level, Residential Soil
Mercury, Inorganic Salts	NA	2.3E+01	EPA Regional Screening Level, Residential Soil
Methyl Mercury	22967-92-6	7.8E+00	EPA Regional Screening Level, Residential Soil
Phenylmercuric Acetate	62-38-4	4.9E+00	EPA Regional Screening Level, Residential Soil
N,N'-Diphenyl-1,4-benzenediamine	74-31-7	1.8E+01	EPA Regional Screening Level, Residential Soil
Naled	300-76-5	1.2E+02	EPA Regional Screening Level, Residential Soil
Napropamide	15299-99-7	6.1E+03	EPA Regional Screening Level, Residential Soil
Nickel Refinery Dust	NA	1.4E+04	EPA Regional Screening Level, Residential Soil
Nickel Soluble Salts	7440-02-0	1.3E+02	Soil Screening Level, DAF 20
Nickel Subsulfide	12035-72-2	6.9E+03	EPA Regional Screening Level, Residential Soil
Nitrate	14797-55-8	1.3E+05	EPA Regional Screening Level, Residential Soil

NDEP Draft Guidelines for Discovery Events (Soil RCs)

Appendix A2--Full list of Reportable Concentrations in soil Version: 01/28/2009

Analyte	CAS No.	Reportable Concentration (mg/kg)	Source
Nitrite	14797-65-0	7.8E+03	EPA Regional Screening Level, Residential Soil
Nitroaniline, 3-	99-09-2	1.8E+01	EPA Regional Screening Level, Residential Soil
Nitroaniline, 4-	100-01-6	2.3E+01	EPA Regional Screening Level, Residential Soil
Nitrobenzene	98-95-3	1.0E-01	Soil Screening Level, DAF 20
Nitrofurantoin	67-20-9	4.3E+03	EPA Regional Screening Level, Residential Soil
Nitrofurazone	59-87-0	3.7E-01	EPA Regional Screening Level, Residential Soil
Nitroglycerin	55-63-0	6.1E+00	EPA Regional Screening Level, Residential Soil
Nitroguanidine	556-88-7	6.1E+03	EPA Regional Screening Level, Residential Soil
Nitromethane	75-52-5	4.7E+00	EPA Regional Screening Level, Residential Soil
Nitropropane, 2-	79-46-9	1.2E-02	EPA Regional Screening Level, Residential Soil
Nitroso-di-N-butylamine, N-	924-16-3	9.3E-02	EPA Regional Screening Level, Residential Soil
Nitroso-di-N-propylamine, N-	621-64-7	5.0E-05	Soil Screening Level, DAF 20
Nitroso-N-ethylurea, N-	759-73-9	4.3E-03	EPA Regional Screening Level, Residential Soil
Nitrosodiethanolamine, N-	1116-54-7	1.7E-01	EPA Regional Screening Level, Residential Soil
Nitrosodiethylamine, N-	55-18-5	7.7E-04	EPA Regional Screening Level, Residential Soil
Nitrosodimethylamine, N-	62-75-9	2.3E-03	EPA Regional Screening Level, Residential Soil
Nitrosodiphenylamine, N-	86-30-6	1.0E+00	Soil Screening Level, DAF 20
Nitrosomethylethylamine, N-	10595-95-6	2.2E-02	EPA Regional Screening Level, Residential Soil
Nitrosopyrrolidine, N-	930-55-2	2.3E-01	EPA Regional Screening Level, Residential Soil
Nitrotoluene, m-	99-08-1	1.2E+03	EPA Regional Screening Level, Residential Soil
Nitrotoluene, o-	88-72-2	2.9E+00	EPA Regional Screening Level, Residential Soil
Nitrotoluene, p-	99-99-0	3.0E+01	EPA Regional Screening Level, Residential Soil
Norflurazon	27314-13-2	2.4E+03	EPA Regional Screening Level, Residential Soil
Nustar	85509-19-9	4.3E+01	EPA Regional Screening Level, Residential Soil
Octabromodiphenyl Ether	32536-52-0	1.8E+02	EPA Regional Screening Level, Residential Soil
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetra (HMX)	2691-41-0	3.8E+03	EPA Regional Screening Level, Residential Soil
Octamethylpyrophosphoramide	152-16-9	1.2E+02	EPA Regional Screening Level, Residential Soil
Oryzalin	19044-88-3	3.1E+03	EPA Regional Screening Level, Residential Soil
Oxadiazon	19666-30-9	3.1E+02	EPA Regional Screening Level, Residential Soil
Oxamyl	23135-22-0	1.5E+03	EPA Regional Screening Level, Residential Soil
Paclobutrazol	76738-62-0	7.9E+02	EPA Regional Screening Level, Residential Soil
Paraquat Dichloride	1910-42-5	2.7E+02	EPA Regional Screening Level, Residential Soil
Parathion	56-38-2	3.7E+02	EPA Regional Screening Level, Residential Soil
Pebulate	1114-71-2	3.1E+03	EPA Regional Screening Level, Residential Soil
Pendimethalin	40487-42-1	2.4E+03	EPA Regional Screening Level, Residential Soil
Pentabromodiphenyl Ether	32534-81-9	1.2E+02	EPA Regional Screening Level, Residential Soil
Pentabromodiphenyl ether, 2,2',4,4',5- (BDE-99)	60348-60-9	7.8E+00	EPA Regional Screening Level, Residential Soil
Pentachlorobenzene	608-93-5	4.9E+01	EPA Regional Screening Level, Residential Soil
Pentachloroethane	76-01-7	5.4E+00	EPA Regional Screening Level, Residential Soil
Pentachloronitrobenzene	82-68-8	1.9E+00	EPA Regional Screening Level, Residential Soil
Pentachlorophenol	87-86-5	3.0E-02	Soil Screening Level, DAF 20
Perchlorate and Perchlorate Salts	14797-73-0	5.5E+01	EPA Regional Screening Level, Residential Soil
Permethrin	52645-53-1	3.1E+03	EPA Regional Screening Level, Residential Soil
Phenmedipham	13684-63-4	1.5E+04	EPA Regional Screening Level, Residential Soil
Phenol	108-95-2	1.0E+02	Soil Screening Level, DAF 20
Phenylenediamine, m-	108-45-2	3.7E+02	EPA Regional Screening Level, Residential Soil
Phenylenediamine, o-	95-54-5	1.0E+01	EPA Regional Screening Level, Residential Soil
Phenylenediamine, p-	106-50-3	1.2E+04	EPA Regional Screening Level, Residential Soil
Phenylphenol, 2-	90-43-7	2.5E+02	EPA Regional Screening Level, Residential Soil
Phorate	298-02-2	1.2E+01	EPA Regional Screening Level, Residential Soil
Phosgene	75-44-5	4.0E-01	EPA Regional Screening Level, Residential Soil
Phosmet	732-11-6	1.2E+03	EPA Regional Screening Level, Residential Soil
Phosphine	7803-51-2	2.3E+01	EPA Regional Screening Level, Residential Soil
Phosphoric Acid	7664-38-2	1.4E+07	EPA Regional Screening Level, Residential Soil
Phosphorus, White	7723-14-0	1.6E+00	EPA Regional Screening Level, Residential Soil
Phthalic Acid, P-	100-21-0	6.1E+04	EPA Regional Screening Level, Residential Soil
Phthalic Anhydride	85-44-9	1.2E+05	EPA Regional Screening Level, Residential Soil
Picloram	1918-02-1	4.3E+03	EPA Regional Screening Level, Residential Soil
Picramic Acid (2-Amino-4,6-dinitrophenol)	96-91-3	1.2E+02	EPA Regional Screening Level, Residential Soil
Pirimiphos, Methyl	29232-93-7	6.1E+02	EPA Regional Screening Level, Residential Soil

NDEP Draft Guidelines for Discovery Events (Soil RCs)

Appendix A2--Full list of Reportable Concentrations in soil Version: 01/28/2009

Analyte	CAS No.	Reportable Concentration (mg/kg)	Source
Polybrominated Biphenyls	59536-65-1	1.6E-02	EPA Regional Screening Level, Residential Soil
Polymeric Methylene Diphenyl Diisocyanate (PMDI)	9016-87-9	8.5E+05	EPA Regional Screening Level, Residential Soil
Potassium Perchlorate	7778-74-7	5.5E+01	EPA Regional Screening Level, Residential Soil
Prochloraz	67747-09-5	3.2E+00	EPA Regional Screening Level, Residential Soil
Profluralin	26399-36-0	3.7E+02	EPA Regional Screening Level, Residential Soil
Prometon	1610-18-0	9.2E+02	EPA Regional Screening Level, Residential Soil
Prometryn	7287-19-6	2.4E+02	EPA Regional Screening Level, Residential Soil
Propachlor	1918-16-7	7.9E+02	EPA Regional Screening Level, Residential Soil
Propanil	709-98-8	3.1E+02	EPA Regional Screening Level, Residential Soil
Propargite	2312-35-8	1.2E+03	EPA Regional Screening Level, Residential Soil
Propargyl Alcohol	107-19-7	1.2E+02	EPA Regional Screening Level, Residential Soil
Propazine	139-40-2	1.2E+03	EPA Regional Screening Level, Residential Soil
Propham	122-42-9	1.2E+03	EPA Regional Screening Level, Residential Soil
Propiconazole	60207-90-1	7.9E+02	EPA Regional Screening Level, Residential Soil
Propylene Glycol	57-55-6	1.2E+06	EPA Regional Screening Level, Residential Soil
Propylene Glycol Dinitrate	6423-43-4	6.0E+01	EPA Regional Screening Level, Residential Soil
Propylene Glycol Monoethyl Ether	1569-02-4	4.3E+04	EPA Regional Screening Level, Residential Soil
Propylene Glycol Monomethyl Ether	107-98-2	4.3E+04	EPA Regional Screening Level, Residential Soil
Propylene Oxide	75-56-9	1.9E+00	EPA Regional Screening Level, Residential Soil
Pursuit	81335-77-5	1.5E+04	EPA Regional Screening Level, Residential Soil
Pydrin	51630-58-1	1.5E+03	EPA Regional Screening Level, Residential Soil
Pyridine	110-86-1	7.8E+01	EPA Regional Screening Level, Residential Soil
Polychlorinated Biphenyls (PCBs)			
Aroclor 1016	12674-11-2	3.9E+00	EPA Regional Screening Level, Residential Soil
Aroclor 1221	11104-28-2	1.7E-01	EPA Regional Screening Level, Residential Soil
Aroclor 1232	11141-16-5	1.7E-01	EPA Regional Screening Level, Residential Soil
Aroclor 1242	53469-21-9	2.2E-01	EPA Regional Screening Level, Residential Soil
Aroclor 1248	12672-29-6	2.2E-01	EPA Regional Screening Level, Residential Soil
Aroclor 1254	11097-69-1	2.2E-01	EPA Regional Screening Level, Residential Soil
Aroclor 1260	11096-82-5	2.2E-01	EPA Regional Screening Level, Residential Soil
Heptachlorobiphenyl, 2,2',3,3',4,4',5- (PCB 170)	35065-30-6	3.4E-02	EPA Regional Screening Level, Residential Soil
Heptachlorobiphenyl, 2,2',3,4,4',5,5'- (PCB 180)	35065-29-3	3.4E-01	EPA Regional Screening Level, Residential Soil
Heptachlorobiphenyl, 2,3,3',4,4',5,5'- (PCB 189)	39635-31-9	1.1E-01	EPA Regional Screening Level, Residential Soil
Hexachlorobiphenyl, 2,3',4,4',5,5'- (PCB 167)	52663-72-6	1.1E-01	EPA Regional Screening Level, Residential Soil
Hexachlorobiphenyl, 2,3,3',4,4',5'- (PCB 157)	69782-90-7	1.1E-01	EPA Regional Screening Level, Residential Soil
Hexachlorobiphenyl, 2,3,3',4,4',5- (PCB 156)	38380-08-4	1.1E-01	EPA Regional Screening Level, Residential Soil
Hexachlorobiphenyl, 3,3',4,4',5,5'- (PCB 169)	32774-16-6	1.1E-04	EPA Regional Screening Level, Residential Soil
Pentachlorobiphenyl, 2',3,4,4',5- (PCB 123)	65510-44-3	1.1E-01	EPA Regional Screening Level, Residential Soil
Pentachlorobiphenyl, 2,3',4,4',5- (PCB 118)	31508-00-6	1.1E-01	EPA Regional Screening Level, Residential Soil
Pentachlorobiphenyl, 2,3,3',4,4'- (PCB 105)	32598-14-4	1.1E-01	EPA Regional Screening Level, Residential Soil
Pentachlorobiphenyl, 2,3,4,4',5- (PCB 114)	74472-37-0	1.1E-01	EPA Regional Screening Level, Residential Soil
Pentachlorobiphenyl, 3,3',4,4',5- (PCB 126)	57465-28-8	3.4E-05	EPA Regional Screening Level, Residential Soil
Polychlorinated Biphenyls (high risk)	1336-36-3	2.4E-01	EPA Regional Screening Level, Residential Soil
Tetrachlorobiphenyl, 3,3',4,4'- (PCB 77)	32598-13-3	3.4E-02	EPA Regional Screening Level, Residential Soil
Tetrachlorobiphenyl, 3,4,4',5- (PCB 81)	70362-50-4	1.1E-02	EPA Regional Screening Level, Residential Soil
Polynuclear Aromatic Hydrocarbons (PAHs)			
Acenaphthene	83-32-9	5.7E+02	Soil Screening Level, DAF 20
Anthracene	120-12-7	1.2E+04	Soil Screening Level, DAF 20
Benz[a]anthracene	56-55-3	1.5E-01	EPA Regional Screening Level, Residential Soil
Benzo[a]pyrene	50-32-8	1.5E-02	EPA Regional Screening Level, Residential Soil
Benzo[b]fluoranthene	205-99-2	1.5E-01	EPA Regional Screening Level, Residential Soil
Benzo[k]fluoranthene	207-08-9	1.5E+00	EPA Regional Screening Level, Residential Soil
Chrysene	218-01-9	1.5E+01	EPA Regional Screening Level, Residential Soil
Dibenz[a,h]anthracene	53-70-3	1.5E-02	EPA Regional Screening Level, Residential Soil
Fluoranthene	206-44-0	2.3E+03	EPA Regional Screening Level, Residential Soil
Fluorene	86-73-7	5.6E+02	Soil Screening Level, DAF 20
Indeno[1,2,3-cd]pyrene	193-39-5	1.5E-01	EPA Regional Screening Level, Residential Soil
Methylnaphthalene, 1-	90-12-0	2.2E+01	EPA Regional Screening Level, Residential Soil
Methylnaphthalene, 2-	91-57-6	3.1E+02	EPA Regional Screening Level, Residential Soil
Naphthalene	91-20-3	3.9E+00	EPA Regional Screening Level, Residential Soil

NDEP Draft Guidelines for Discovery Events (Soil RCs)

Appendix A2--Full list of Reportable Concentrations in soil Version: 01/28/2009

Analyte	CAS No.	Reportable Concentration (mg/kg)	Source
Pyrene	129-00-0	1.7E+03	EPA Regional Screening Level, Residential Soil
Quinalphos	13593-03-8	3.1E+01	EPA Regional Screening Level, Residential Soil
Quinoline	91-22-5	1.6E-01	EPA Regional Screening Level, Residential Soil
Refractory Ceramic Fibers	NA	4.3E+07	EPA Regional Screening Level, Residential Soil
Resmethrin	10453-86-8	1.8E+03	EPA Regional Screening Level, Residential Soil
Ronnel	299-84-3	3.1E+03	EPA Regional Screening Level, Residential Soil
Rotenone	83-79-4	2.4E+02	EPA Regional Screening Level, Residential Soil
Savey	78587-05-0	1.5E+03	EPA Regional Screening Level, Residential Soil
Selenious Acid	7783-00-8	3.9E+02	EPA Regional Screening Level, Residential Soil
Selenium	7782-49-2	5.0E+00	Soil Screening Level, DAF 20
Selenourea	630-10-4	3.1E+02	EPA Regional Screening Level, Residential Soil
Sethoxydim	74051-80-2	5.5E+03	EPA Regional Screening Level, Residential Soil
Silver	7440-22-4	3.4E+01	Soil Screening Level, DAF 20
Simazine	122-34-9	4.0E+00	EPA Regional Screening Level, Residential Soil
Sodium Acifluorfen	62476-59-9	7.9E+02	EPA Regional Screening Level, Residential Soil
Sodium Azide	26628-22-8	3.1E+02	EPA Regional Screening Level, Residential Soil
Sodium Diethyldithiocarbamate	148-18-5	1.8E+00	EPA Regional Screening Level, Residential Soil
Sodium Fluoroacetate	62-74-8	1.2E+00	EPA Regional Screening Level, Residential Soil
Sodium Metavanadate	13718-26-8	7.8E+01	EPA Regional Screening Level, Residential Soil
Sodium Perchlorate	7601-89-0	5.5E+01	EPA Regional Screening Level, Residential Soil
Stirofos (Tetrachlorovinphos)	961-11-5	2.0E+01	EPA Regional Screening Level, Residential Soil
Strontium, Stable	7440-24-6	4.7E+04	EPA Regional Screening Level, Residential Soil
Strychnine	57-24-9	1.8E+01	EPA Regional Screening Level, Residential Soil
Styrene	100-42-5	4.0E+00	Soil Screening Level, DAF 20
Sulfonylbis(4-chlorobenzene), 1,1'-	80-07-9	3.1E+02	EPA Regional Screening Level, Residential Soil
Systhane	88671-89-0	1.5E+03	EPA Regional Screening Level, Residential Soil
TCMTB	21564-17-0	1.8E+03	EPA Regional Screening Level, Residential Soil
Tebuthiuron	34014-18-1	4.3E+03	EPA Regional Screening Level, Residential Soil
Temephos	3383-96-8	1.2E+03	EPA Regional Screening Level, Residential Soil
Terbacil	5902-51-2	7.9E+02	EPA Regional Screening Level, Residential Soil
Terbufos	13071-79-9	1.5E+00	EPA Regional Screening Level, Residential Soil
Terbutryn	886-50-0	6.1E+01	EPA Regional Screening Level, Residential Soil
Tetrachlorobenzene, 1,2,4,5-	95-94-3	1.8E+01	EPA Regional Screening Level, Residential Soil
Tetrachloroethane, 1,1,1,2-	630-20-6	2.0E+00	EPA Regional Screening Level, Residential Soil
Tetrachloroethane, 1,1,2,2-	79-34-5	3.0E-03	Soil Screening Level, DAF 20
Tetrachloroethylene (PCE)	127-18-4	6.0E-02	Soil Screening Level, DAF 20
Tetrachlorophenol, 2,3,4,6-	58-90-2	1.8E+03	EPA Regional Screening Level, Residential Soil
Tetrachlorotoluene, p- alpha, alpha, alpha-	5216-25-1	2.4E-02	EPA Regional Screening Level, Residential Soil
Tetraethyl Dithiopyrophosphate	3689-24-5	3.1E+01	EPA Regional Screening Level, Residential Soil
Tetrafluoroethane, 1,1,1,2-	811-97-2	1.1E+05	EPA Regional Screening Level, Residential Soil
Tetryl (Trinitrophenylmethylnitramine)	479-45-8	2.4E+02	EPA Regional Screening Level, Residential Soil
Thallium (I) Nitrate	10102-45-1	7.0E+00	EPA Regional Screening Level, Residential Soil
Thallium (Soluble Salts)	7440-28-0	5.1E+00	EPA Regional Screening Level, Residential Soil
Thallium Acetate	563-68-8	7.0E+00	EPA Regional Screening Level, Residential Soil
Thallium Carbonate	6533-73-9	6.3E+00	EPA Regional Screening Level, Residential Soil
Thallium Chloride	7791-12-0	6.3E+00	EPA Regional Screening Level, Residential Soil
Thallium Sulfate	7446-18-6	6.3E+00	EPA Regional Screening Level, Residential Soil
Thiobencarb	28249-77-6	6.1E+02	EPA Regional Screening Level, Residential Soil
Thiofanox	39196-18-4	1.8E+01	EPA Regional Screening Level, Residential Soil
Thiophanate, Methyl	23564-05-8	4.9E+03	EPA Regional Screening Level, Residential Soil
Thiram	137-26-8	3.1E+02	EPA Regional Screening Level, Residential Soil
Tin	7440-31-5	4.7E+04	EPA Regional Screening Level, Residential Soil
Toluene	108-88-3	1.2E+01	Soil Screening Level, DAF 20
Toluene diisocyanate mixture (TDI)	26471-62-5	5.4E+01	EPA Regional Screening Level, Residential Soil
Toluene-2,4-diamine	95-80-7	1.3E-01	EPA Regional Screening Level, Residential Soil
Toluene-2,5-diamine	95-70-5	3.7E+04	EPA Regional Screening Level, Residential Soil
Toluene-2,6-diamine	823-40-5	1.8E+03	EPA Regional Screening Level, Residential Soil
Toluidine, o- (Methylaniline, 2-)	95-53-4	2.7E+00	EPA Regional Screening Level, Residential Soil
Toluidine, p-	106-49-0	2.6E+00	EPA Regional Screening Level, Residential Soil
Total Petroleum Hydrocarbons		1.0E+02	NDEP derived concentration

NDEP Draft Guidelines for Discovery Events (Soil RCs)

Appendix A2--Full list of Reportable Concentrations in soil Version: 01/28/2009

Analyte	CAS No.	Reportable Concentration (mg/kg)	Source
Toxaphene	8001-35-2	4.4E-01	EPA Regional Screening Level, Residential Soil
Tralomethrin	66841-25-6	4.6E+02	EPA Regional Screening Level, Residential Soil
Triallate	2303-17-5	7.9E+02	EPA Regional Screening Level, Residential Soil
Triasulfuron	82097-50-5	6.1E+02	EPA Regional Screening Level, Residential Soil
Tribromobenzene, 1,2,4-	615-54-3	3.1E+02	EPA Regional Screening Level, Residential Soil
Tributyl Phosphate	126-73-8	5.3E+01	EPA Regional Screening Level, Residential Soil
Tributyltin Compounds	NA	1.8E+01	EPA Regional Screening Level, Residential Soil
Tributyltin Oxide	56-35-9	1.8E+01	EPA Regional Screening Level, Residential Soil
Trichloro-1,2,2-trifluoroethane, 1,1,2-	76-13-1	4.3E+04	EPA Regional Screening Level, Residential Soil
Trichloroaniline HCl, 2,4,6-	33663-50-2	1.7E+01	EPA Regional Screening Level, Residential Soil
Trichloroaniline, 2,4,6-	634-93-5	1.4E+01	EPA Regional Screening Level, Residential Soil
Trichlorobenzene, 1,2,4-	120-82-1	5.0E+00	Soil Screening Level, DAF 20
Trichloroethane, 1,1,1-	71-55-6	2.0E+00	Soil Screening Level, DAF 20
Trichloroethane, 1,1,2-	79-00-5	2.0E-02	Soil Screening Level, DAF 20
Trichloroethylene (TCE)	79-01-6	6.0E-02	Soil Screening Level, DAF 20
Trichlorofluoromethane	75-69-4	8.0E+02	EPA Regional Screening Level, Residential Soil
Trichlorophenol, 2,4,5-	95-95-4	2.7E+02	Soil Screening Level, DAF 20
Trichlorophenol, 2,4,6-	88-06-2	2.0E-01	Soil Screening Level, DAF 20
Trichlorophenoxy) Propionic Acid, 2(2,4,5-	93-72-1	4.9E+02	EPA Regional Screening Level, Residential Soil
Trichlorophenoxyacetic Acid, 2,4,5-	93-76-5	6.1E+02	EPA Regional Screening Level, Residential Soil
Trichloropropane, 1,1,2-	598-77-6	3.9E+02	EPA Regional Screening Level, Residential Soil
Trichloropropane, 1,2,3-	96-18-4	9.1E-02	EPA Regional Screening Level, Residential Soil
Trichloropropene, 1,2,3-	96-19-5	2.7E+00	EPA Regional Screening Level, Residential Soil
Tridiphane	58138-08-2	1.8E+02	EPA Regional Screening Level, Residential Soil
Triethylamine	121-44-8	1.7E+02	EPA Regional Screening Level, Residential Soil
Trifluralin	1582-09-8	6.3E+01	EPA Regional Screening Level, Residential Soil
Trimethyl Phosphate	512-56-1	1.3E+01	EPA Regional Screening Level, Residential Soil
Trimethylbenzene, 1,2,4-	95-63-6	6.7E+01	EPA Regional Screening Level, Residential Soil
Trimethylbenzene, 1,3,5-	108-67-8	4.7E+01	EPA Regional Screening Level, Residential Soil
Trinitrobenzene, 1,3,5-	99-35-4	2.2E+03	EPA Regional Screening Level, Residential Soil
Trinitrotoluene, 2,4,6-	118-96-7	1.9E+01	EPA Regional Screening Level, Residential Soil
Triphenylphosphine Oxide	791-28-6	1.2E+03	EPA Regional Screening Level, Residential Soil
Tris(2-chloroethyl)phosphate	115-96-8	3.5E+01	EPA Regional Screening Level, Residential Soil
Tris(2-ethylhexyl)phosphate	78-42-2	1.5E+02	EPA Regional Screening Level, Residential Soil
Tetrabromodiphenyl ether, 2,2',4,4'- (BDE-47)	5436-43-1	7.8E+00	EPA Regional Screening Level, Residential Soil
Tri-n-butyltin	688-73-3	1.8E+01	EPA Regional Screening Level, Residential Soil
Uranium (Soluble Salts)	NA	2.3E+02	EPA Regional Screening Level, Residential Soil
Vanadium Pentoxide	1314-62-1	4.0E+02	EPA Regional Screening Level, Residential Soil
Vanadium Sulfate	36907-42-3	1.6E+03	EPA Regional Screening Level, Residential Soil
Vanadium and Compounds	NA	3.9E+02	EPA Regional Screening Level, Residential Soil
Vanadium, Metallic	7440-62-2	5.5E+02	EPA Regional Screening Level, Residential Soil
Vernolate	1929-77-7	6.1E+01	EPA Regional Screening Level, Residential Soil
Vinclozolin	50471-44-8	1.5E+03	EPA Regional Screening Level, Residential Soil
Vinyl Acetate	108-05-4	1.7E+02	Soil Screening Level, DAF 20
Vinyl Bromide	593-60-2	1.1E-01	EPA Regional Screening Level, Residential Soil
Vinyl Chloride	75-01-4	1.0E-02	Soil Screening Level, DAF 20
Warfarin	81-81-2	1.8E+01	EPA Regional Screening Level, Residential Soil
Xylene, Mixture	1330-20-7	2.1E+02	Soil Screening Level, DAF 20
Xylene, P-	106-42-3	2.1E+02	Soil Screening Level, DAF 20
Xylene, m-	108-38-3	2.1E+02	Soil Screening Level, DAF 20
Xylene, o-	95-47-6	2.1E+02	Soil Screening Level, DAF 20
Zinc (Metallic)	7440-66-6	1.2E+04	Soil Screening Level, DAF 20
Zinc Phosphide	1314-84-7	2.3E+01	EPA Regional Screening Level, Residential Soil
Zineb	12122-67-7	3.1E+03	EPA Regional Screening Level, Residential Soil

Appendix C

Statement of Procedures

Appendix C-1

Guidance Document - EPA Method 5035

GUIDANCE DOCUMENT FOR THE IMPLEMENTATION OF UNITED STATES ENVIRONMENTAL PROTECTION AGENCY METHOD 5035: METHODOLOGIES FOR COLLECTION, PRESERVATION, STORAGE, AND PREPARATION OF SOILS TO BE ANALYZED FOR VOLATILE ORGANIC COMPOUNDS

Department of Toxic Substances Control
California Environmental Protection Agency

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1.0 INTRODUCTION

The United States Environmental Protection Agency (USEPA) Office of Solid Waste promulgated Method 5035, *Closed-System Purge-and-Trap Extraction for Volatile Organics in Soil and Waste Samples* in June 1997 in SW-846*, Test Methods for Evaluating Solid Waste, Physical / Chemical Methods, Update III* (Method 5035). More recently, in July 2002, USEPA updated the Method within SW-846 as Method 5035A[1]. Method 5035 describes procedures and protocols for the collection of three types of solid samples contaminated with volatile organic compounds (VOCs)[2]: low-concentration solids (i.e., soil, sludge and sediment), high-concentration solids, and solid samples with oily waste. For low-concentration samples, Method 5035 describes a "closed-system purge-and-trap" process to minimize the loss of VOCs due to sample collection and handling. For high-concentration samples, Method 5035 describes procedures for the collection and preservation of samples, but references Method 5030 (Revision 2, December 1996) for the actual analysis of the prepared sample extracts. Method 5030 remains as a part of Method 5035 and is applicable to the analysis of high-concentration soil and solid waste extracts prepared with Method 5035, as well as aqueous samples. As such, when USEPA promulgated Method 5035, there was no intention to make Method 5030 obsolete.

The procedures in Method 5035 should be used for the collection of soil samples at all sites in California contaminated with VOCs in order to comply with USEPA Region IX's Interim Policy and the California Code of Regulations. USEPA Region IX issued their Regional Interim Policy concerning Method 5035 on June 23, 1999. The Region IX Interim Policy requires the use of Method 5035, or an equally or more effective method, for the collection of VOC data for soil in California. The Region IX Interim Policy is included in this Guidance Document as Appendix D. The objective of the Interim Policy is to minimize VOC loss from volatilization and biodegradation during sample collection and handling. By minimizing soil sample transfer steps from sampling to analysis, VOC loss due to atmospheric volatilization is reduced. The use of chemical preservatives further minimizes microbial action, yielding soil samples that are more representative of site conditions. Likewise, the protocols of SW-846 are referenced within the California Code of Regulations as a mechanism to achieve representative samples of waste materials (Title 22, Chapter 11, Article 5, Appendix I).

2.0 PURPOSE

The Department of Toxic Substances Control (DTSC) has compiled this Guidance Document in order to provide assistance in the implementation of Method 5035 at sites regulated by the DTSC where VOCs are chemicals-of-concern. This Guidance Document is meant to supplement USEPA Method 5035 by summarizing the sampling options for the collection of soil samples for VOC analysis. It is DTSC's intent to provide the minimum requirements and minimum standards to prevent loss of VOCs during sample collection and handling. Thus**,** DTSC encourages all parties involved in site cleanup to read and understand SW-846 in conjunction with the use of this Guidance Document. This Guidance Document, along with SW-846 and the Region IX Regional Interim Policy, will provide technically defensible and consistent approaches for sampling VOCs in soils. However, while Method 5035 should always be implemented at sites in California

[1] Method 5035 and the associated 2002 update in SW-846 are collectively referred to as "5035" in this Guidance Document.

[2] The term "volatile organic compounds" refers to low molecular weight compounds which possess boiling points below 200°C, are insoluble or slightly soluble in water, and have been traditionally analyzed by purge-and-trap methods.

contaminated with VOCs, the procedures within this Guidance Document are recommendations only. Other technically equivalent procedures may exist that minimize VOC loss during soil sample collection, storage, preservation, and preparation, and the intent of this Guidance Document is not to exclude alternative sampling approaches as long as the alternative procedures are functionally equivalent to Method 5035. This Guidance Document addresses the collection and handling of soil samples. Sludge samples and sediment samples are not specifically addressed, although some of the procedures herein may apply. Likewise, this Guidance Document does not address the collection of solid samples contaminated with oily waste.

This Guidance Document does not address all aspects of VOC soil sampling and analysis. The focus of this Guidance Document is the field procedures associated with soil sample collection, storage, preservation, and preparation for VOC analysis, since most VOC loss during soil sampling occurs before the samples arrive at the laboratory. It is not the intent of this Guidance Document to provide specific instructions to stationary and mobile laboratories on how to perform the analysis of VOCs in soil samples, but rather to provide guidance on the collection of soil samples in the field.

3.0 SCOPE

The implementation of Method 5035 impacts multiple technical disciplines. Therefore, successful implementation of Method 5035 in the field will require increased communication, planning, and coordination among the project team responsible for site characterization. Method 5035 is more complex than previous soil sample preparation methods because it involves multiple soil preservation options for the project team, each suited for specific project objectives depending upon the action levels for the chemicals-of-concern and prior knowledge of the soil VOC concentrations. The final selection of sampling procedures will require input from all data users, such as project managers, geologists, chemists, risk assessors, and engineers. Items to consider before selecting the VOC sampling and analysis methods at a site are as follows:

- Compounds of interest
- Concentration range of the VOCs
- Potential compound interferences
- Data quality objectives
- Physical character of the soil
- Reactive character of the soil
- Chemical preservation techniques
- Laboratory equipment specifications

Accordingly, a high degree of coordination and planning is required between field and laboratory personnel before the start of field activities.

USEPA Method 5035 arranges the soil sampling options into three groups: low-concentration soil, high-concentration soil, and soil with oily waste. Sample preservation is then given within each group as a sub-option, followed by the appropriate type of sample container to use. This arrangement by USEPA emphasizes the systematic steps that are needed to determine the proper choice of VOC sampling methods, as follows: 1) determine target compounds and their concentration to select low concentration or high concentration methods; 2) select the preservation options that are best suited for the VOC target compounds and data quality objectives; and 3) determine the appropriate container or sampler for the sample collection.

In contrast, this Guidance Document does not emphasize a systematic approach for selecting a soil sampling technique within Method 5035. Rather, the Guidance Document groups the sampling options according to the sampling devices, followed with sub-options for low-concentration and high-concentration methods. The intent of this Guidance Document is to summarize the options available for the sampling of soils contaminated with VOCs and provide detailed field procedures for the use of each sampling approach. Nonetheless, the selection of a field sampling technique must be technically justifiable pursuant to the systematic steps within Method 5035. The technical justification for the selection of a particular sampling technique must be provided to DTSC for our approval within appropriate workplans. A sampling technique should not be selected based upon the availability of sample containers and convenience of use. Instead, the sampling and preservation options must meet the scientific requirements of the data quality objectives.

4.0 APPLICATION

This Guidance Document describes the field sampling and preservation procedures for soil samples subject to VOC analysis. The applicable analytical methods described in SW-846 to be used in conjunction with Method 5035 are as follows:

Method 8015A:	Non-halogenated Organics
Method 8021B:	Aromatic and Halogenated Volatiles
Method 8260B:	Volatile Organic Compounds

Accordingly, all soil samples collected at sites regulated by DTSC that are analyzed using the above methods should also be handled pursuant to the Method 5035 procedures described in this Guidance Document.

5.0 SUMMARY OF METHOD

Method 5035 soil sample collection and preparation procedures are dependent on the desired detection limits needed for the project. For the low VOC concentration method, the available options are summarized in Table 1. For the high VOC concentration method, the available options are summarized in Table 2. The selection of a preservation option must be a function of the data quality objectives as outlined above in Section 3.0. Soil samples with VOC concentrations below 200 micrograms per kilogram (μg/kg) are generally considered as "Low Level Analysis" and have a method detection limit of approximately 0.5 μg/kg. Soil samples with VOC concentrations above 200 μg/kg are generally considered as "High Level Analysis" and have a method detection limit of approximately 200 μg/kg.

The procedures for a Low Level Analysis utilize a hermetically-sealed sampling container and analysis of the sample by a closed-system purge-and-trap process. The Low Level Analysis method uses a direct purging of the VOCs from an aqueous medium. The aqueous medium can be either sodium bisulfate solution or reagent water. The sodium bisulfate solution acts both as a preservative and extractant medium whereas reagent water is strictly an extractant medium with minimal preservation benefit. The aqueous medium is introduced into the sampling container either in the field or at the laboratory. No sample dilution is involved, yielding detection limits of approximately 0.5 μg/kg.

The procedures for a High Level Analysis utilize a hermetically-sealed sampling container and analysis of the sample at the laboratory by Method 5030. The High Level Analysis method uses a

methanol solvent extraction technique. The methanol is introduced into the sampling container either in the field or at the laboratory. Detection limits of greater than 200 μg/kg occur due to dilution of the sample with methanol.

When designing and implementing a sampling program for VOC contaminated soil, the project team must consider the appropriate analytical detection limits needed for the site characterization. Ultimately, the detection limits should be a function of the end-use of the data. For example, if the objective of the sampling is to quantify the human health risk to exposure to VOCs where the action levels are very low, then nothing less than Low Level Analysis is acceptable for the project. Conversely, if the objective is waste classification where the regulatory concentration thresholds are relatively high, then High Level Analysis is warranted. Another case where High Level Analysis is appropriate is the delineation of non-aqueous phase liquid (NAPL) in soil for remedial system design.

5.1 Number of Samples Needed for Analysis

In contrast with past soil sampling practices, Method 5035 now requires, if necessary, that multiple soil samples be collected from each sampling location. If needed, both Low Level Analysis and High Level Analysis sample sets are collected with proper preservation at each sampling point. The need for multiple samples is pertinent to sites with unknown VOC concentrations and for the need to have the lowest possible detection limits.

If detection limits of approximately 0.5 μg/kg are needed for the soil at a site, three samples are collected pursuant to Method 5035. One sample is collected for High Level Analysis and two samples are collected for Low Level Analysis. First, the High Level Analysis sample is analyzed by the laboratory to determine if VOCs exist at the site in high concentrations. If this first sample yields VOC concentrations below the detection limit (<200 μg/kg), then a Low Level Analysis sample is analyzed. The second Low Level Analysis sample is available as a backup if the first Low Level Analysis run is unacceptable or re-analysis is warranted.

If detection limits of greater than 200 μg/kg are acceptable at a site, then only one sample is collected for High Level Analysis pursuant to Method 5035. As necessary, the laboratory can perform multiple dilutions on the methanol extract to meet the instrument's calibration range. However, under this scenario, Low Level Analysis cannot be performed after the High Level Analysis due to the lack of available soil. To assist in the determination of the number of samples needed for Method 5035, a soil sampling decision flowchart is provided in Figure 1.

A general overview of the sampling options with Method 5035 is summarized below. A more detailed description of the options is provided within the Appendices[3].

5.2 Option 1: Preserved VOA Vials (Field Chemical Preservation)

Tared and labeled VOA vials with polytetrafluoroethylene (PTFE)-lined septum caps are provided by the laboratory or a vendor with appropriate chemical preservatives. Typically, the VOA vials are

[3] The Appendices were written as stand-alone documents which could be detached from this Guidance Document and taken into the field as a resource for Method 5035 sampling; hence, the Appendices reiterates numerous procedures presented within the text of this Guidance Document. Likewise, the individual Appendices are repetitious due to the numerous commonalities of the sampling procedures.

40 milliliters in size. The preservation fluid is either methanol or another water-miscible solvent such as polyethylene glycol[4] (High Level Analysis), or sodium bisulfate solution[5] (Low Level Analysis). Also, for Low Level Analysis, the VOA vials can contain reagent-grade extractant water[6]. Magnetic stir bars should be added to the VOA vials for Low Level Analysis pursuant to the laboratory's requirements. The selection of the preservation fluid is based on the chemistry of the target compounds and the type of soil, along with the desired method detection limits. In the field, the pre-preserved VOA vials for High Level Analysis are re-weighed before use to verify no evaporative loss of methanol since last tared. Re-weighing of the VOA vials before use for Low Level Analysis is not necessary because sodium bisulfate solution and reagent water have no affect on the dilution calculation. The soil subcores are obtained from appropriate sample locations using a field coring device. Then the soil subcores of appropriate mass are placed into the VOA vials in the field and are capped, forming an airtight seal.

To avoid VOC loss, Low Level Analysis samples preserved with sodium bisulfate solution or placed into reagent-grade extractant water are never again opened throughout the entire storage, preparation, and analysis process. Thus, the physical dimensions of the VOA vials must be compatible with the laboratory's autosampler instrumentation since sample re-handling is not possible. At the laboratory, the capped VOA vials are re-weighed to obtain the weight of the soil samples. For Low Level Analysis samples preserved with sodium bisulfate solution or placed into reagent-grade extractant water, the samples are prepared and analyzed with the caps in-place. All surrogates, internal standards, and matrix spikes are introduced through the PTFE-lined septum caps either manually or mechanically. For samples preserved with methanol, the VOA vials may be opened pursuant to the procedures of Method 5030 but only after the soil subcore is completely immersed in methanol and shaken gently to completely capture the VOCs in the headspace.

There are five options available for sample collection, preservation, and analysis for preserved VOA vials, as follows.

Option 1A: Field Preservation with Methanol. After collecting the soil samples in tared VOA vials preserved with methanol, the vials are re-weighed in the field, and then are chilled at 4 ± 2°C in a cooler and shipped with adequate ice to ensure that 4 ± 2°C is maintained during transport to the laboratory. The samples must arrive at the laboratory within 48 hours of the sample collection time. The VOA vials are weighed again at the stationary laboratory to verify no methanol loss during transport. The laboratory must prepare and analyze the samples by Method 5030 within 14 days of the sample collection date. This technique applies only to High Level Analysis so it should be used if detection limits of greater than 200 μg/kg are warranted.

Option 1B: Field Preservation with Sodium Bisulfate Solution. After collecting the soil samples in tared VOA vials preserved with sodium bisulfate solution, the samples are kept chilled at 4 ± 2°C in a cooler and shipped with adequate ice to ensure that 4 ± 2°C is maintained during transport to the laboratory. The samples must arrive at the laboratory within 48 hours of the sample collection

[4] Ten milliliters of methanol or another water-miscible solvent is added to each VOA vial.

[5] A twenty percent sodium bisulfate solution is generally used for preservation. The solution is usually produced by adding one gram of sodium bisulfate to five grams of reagent water, thus producing a solution with a pH of less than two.

[6] Five milliliters of reagent-grade extractant water is added to each VOA vial.

time. The laboratory must prepare and analyze the samples within 14 days of the sample collection date. This preservation technique provides detection limits to approximately 0.5 μg/kg (Low Level Analysis). However, sample preservation with sodium bisulfate solution presents four potential problems. One, acid preservation may cause the chemical breakdown of certain reactive VOC compounds in the soil sample, specifically styrene, acrylonitrile, vinyl chloride, and 2-chloroethylvinyl ether. Two, in soil samples with a high proportion of organic material, acid preservation may generate acetone as a byproduct. Three, calcareous soil samples may effervesce upon contact with sodium bisulfate solution and cause VOC loss. Four, calcareous soil samples may increase the pH of the preservation fluid above 2.0, producing a sample in an unpreserved state. Accordingly, the soils at the site should be evaluated for potential problems prior to sampling activities. In cases where preservation by acid is a potential problem, an alternate sample collection method should be utilized.

Option 1C: Field Extraction into Reagent Water (Laboratory Freezing). After collecting the soil samples in tared VOA vials containing reagent-grade extractant water, the samples are kept chilled at 4 ± 2°C in a cooler and shipped with adequate ice to ensure that 4 ± 2°C is maintained during transport to the laboratory. The laboratory must receive and immediately freeze the sample vials to <-7°C within 48 hours of the sample collection time. During the freezing process, the VOA vials should be stored in a 45° angle to prevent water expansion from shattering the vials. The samples may be held at <-7°C for up to seven days prior to analysis from the sample collection date. The sample vials should not be frozen below -20°C due to potential problems with the vial seals. This technique applies to samples for Low and High Level Analysis.

Option 1D: Field Extraction into Reagent Water (Field Freezing). After collecting the soil samples in tared VOA vials containing reagent-grade extractant water, the samples are frozen to <-7°C in a cooler in the field and shipped with adequate dry ice[7] to ensure that <-7°C is maintained during transport to the laboratory. The sample vials should not be frozen below -20°C due to potential problems with the vial seals. A temperature blank should be included with the samples so that the laboratory can verify the temperature upon receipt and the arrival temperature of the samples should be annotated on the chain-of-custody form. During the freezing process, the VOA vials should be stored in a 45° angle to prevent water expansion from shattering the vials. To avoid potential rupture of the PTFE-lined septum caps, the dry ice should not directly contact the top of the VOA vials. The laboratory must immediately freeze the sample vials to <-7°C upon receipt. The samples may be held at <-7°C for up to seven days prior to analysis from the sample collection date. This technique applies to samples for Low and High Level Analysis. This option is used in the situations where it is difficult or impossible to deliver the samples to the laboratory within 48 hours of the sample collection time.

Option 1E: Field Extraction into Reagent Water; Analysis within 48 Hours. After collecting the soil samples in tared VOA vials containing reagent-grade extractant water, the samples are kept chilled at 4 ± 2°C in a cooler and shipped with adequate ice to ensure that 4 ± 2°C is maintained during transport to the laboratory. Upon receipt of the samples, the laboratory chills the tared VOA vials to 4 ± 2°C and analyzes the samples within 48 hours of the sample collection time. This technique applies to samples for Low and High Level Analysis.

[7] There two potential difficulties in using dry ice to achieve <-7°C in the field; 1) dry ice will only last about eight hours within a field cooler, and 2) dry ice may contain low concentrations of VOCs, such as acetone. Hence, care must be taken in overnight shipment of field coolers to insure proper freezing and trip blanks should always accompany coolers containing dry ice.

It should be noted that extruding soil samples into vials containing reagent-grade extractant water may have an adverse effect on sample results in that water may actually promote bacterial degradation of certain VOCs (See Section 6.3.1). Likewise, some VOCs may be unstable in reagent water, such as 1,1,2,2-tetrachloroethane. Accordingly, reagent water-filled VOA vials should only be used for chemicals that do not readily biodegrade or breakdown.

The field procedures for Options 1A, 1B, 1C, 1D and 1E are furthered discussed in Appendix A.

5.3 Option 2: Multi-Functional Sampling Devices (No Field Chemical Preservation)

Multi-functional sampling devices (MFSDs) act as both a coring tool and airtight storage container. Examples of MFSDs are the EnCore™ Sampler and the Core N' One™ Sampler[8]. In MFSDs, a small subcore of soil is collected directly into the volumetric storage chamber of the MFSD from a soil core or soil surface, filling it completely with zero headspace. The storage chamber is then capped to form an airtight seal. The intact MFSDs are placed into a plastic bag for transport to the laboratory at 4 ± 2°C. At the stationary laboratory, the soil content of the MFSD is extruded into a prepared VOA vial for analysis. The opening of the VOA vial must be sufficiently large to accept the soil content from the MFSD without obstruction. Since the VOA vial may be used directly for analysis, it must be compatible with the stationary laboratory's purge and trap apparatus to avoid further sample handling which might promote VOC loss. Field personnel should contact the laboratory for the required dimensions.

There are three options available for sample collection, preservation, and analysis for MFSDs, as follows.

Option 2A: The Subcore is Extruded into a VOA Vial Containing Chemical Preservative at the Laboratory. The field cooler is kept chilled at 4 ± 2°C and shipped with adequate ice to ensure that 4 ± 2°C is maintained during transport to the laboratory. The laboratory must receive the MFSDs and extrude the samples into VOA vials that contain appropriate extraction fluid within 48 hours of the sample collection time. For MFSDs for Low Level Analysis, the soil can be extruded, weighed, and preserved with sodium bisulfate solution. Also, for Low Level Analysis, the soil can be extruded into reagent-grade extractant water. For MFSDs for High Level Analysis, the soil must be extruded, weighed, and preserved with methanol. After extrusion of the soil into an appropriate extraction fluid, the sample may be held up to 14 days prior to analysis from the sample collection date.

Option 2B: The Subcore is Extruded into an Empty VOA Vial at the Laboratory. The field cooler is kept chilled at 4 ± 2°C and shipped with adequate ice to ensure that 4 ± 2°C is maintained during transport to the laboratory. The laboratory must receive the MFSDs and extrude the samples within 48 hours of the sample collection time. Upon receipt of the samples, the laboratory extrudes the subcores into empty VOA vials and then freezes the unpreserved VOA vials at <-7°C. The samples may be held at <-7°C for up to seven days[9] prior to analysis from the sample collection

[8] The mention of trade names or commercial products in this Guidance Document is for illustrative purposes only, and does not constitute an endorsement or exclusive recommendation for use at DTSC sites. Equipment other than that listed may be used provided that the resulting performance meets the project data quality objectives.

[9] The holding time of seven days from the sample collection date is consistent with guidance from the Los Angeles Regional Water Quality Control Board (General Laboratory Testing Requirements for Petroleum Hydrocarbon Impacted Sites, June 5, 2000)

date. For Low Level Analysis, the samples are prepared and analyzed with the VOA vial caps in-place. For High Level Analysis, the samples are handled pursuant to Method 5030.

Option 2C: The MFSD is Analyzed within 48 Hours. The field cooler is kept chilled at 4 ± 2°C and shipped with adequate ice to ensure that 4 ± 2°C is maintained during transport to the laboratory. Upon receipt of the samples, the laboratory chills the MFSDs to 4 ± 2°C until analysis. The laboratory must extrude and analyze the samples within 48 hours of the sample collection time. The samples may be subject to either High or Low Level Analysis.

The field procedures for Options 2A, 2B, and 2C are furthered discussed in Appendix B.

5.4 Option 3: Non-Preserved VOA Vials (Empty Vial Technique)

Empty, tared and labeled VOA vials with a PTFE-lined septum caps are taken into the field as provided by the laboratory. Likewise, these vials may be purchased as specially prepared vials from scientific suppliers or can be prepared by the field staff using empty VOA vials, certified clean to USEPA specifications. The VOA vials do not contain chemical preservatives, water-miscible solvents, or reagent water but may contain small magnetic stir bars as required by the laboratory. Soil cores of appropriate mass are placed into the VOA vials in the field and are capped, forming an airtight seal. For Low Level Analysis, the VOA vials are never again opened throughout the entire storage, preparation, and analysis process. Thus, the physical dimensions of the VOA vials must be compatible with the laboratory's autosampler instrumentation since sample re-handling is not possible. At the laboratory, the capped VOA vials are re-weighed to obtain the weight of the soil samples. For Low Level Analysis, the samples are prepared and analyzed with the caps in-place. All preservatives, surrogates, internal standards, and matrix spikes are introduced through the PTFE-lined septum caps either manually or mechanically and analyzed with a closed-system purge-and-trap process. For High Level Analysis, methanol is introduced through the septum and the resulting extract is analyzed with Method 5030.

There are three options available for sample collection, preservation, and analysis for non-preserved VOA vials, as follows.

Option 3A: Laboratory Freezing. After collecting the soil samples in tared VOA vials, the samples are kept chilled at 4 ± 2°C in a cooler and shipped with adequate ice to ensure that 4 ± 2°C is maintained during transport to the laboratory. The laboratory must receive the samples within 48 hours of the sample collection time and immediately freeze the sample vials to <-7°C upon receipt. The samples may be held at <-7°C for up to seven days prior to analysis from the sample collection date. The sample vials should not be frozen below -20°C due to potential problems with the vial seals and the samples may be subject to either High or Low Level Analysis.

Option 3B: Field Freezing. After collecting the soil samples in tared VOA vials, the samples are frozen to <-7°C in a cooler in the field and shipped with adequate dry ice[10] to ensure that <-7°C is maintained during transport to the laboratory. The sample vials should not be frozen below -20°C due to potential problems with the vial seals. A temperature blank should be included with the samples so that the laboratory can verify the temperature upon receipt and the arrival temperature

[10] There two potential difficulties in using dry ice to achieve <-7°C in the field; 1) dry ice will only last about eight hours within a field cooler, and 2) dry ice may contain low concentrations of VOCs, such as acetone. Hence, care must be taken in overnight shipment of field coolers to insure proper freezing and trip blanks should always accompany coolers containing dry ice.

of the samples should be annotated on the chain-of-custody form. During the freezing process, the VOA vials should be stored in a 45° angle to prevent sample expansion from shattering the vials. To avoid potential rupture of the PTFE-lined septum caps, the dry ice should not directly contact the top of the VOA vials. Upon receipt, the laboratory must commence with analysis. Otherwise, the laboratory must immediately freeze the sample vials to <-7°C upon receipt. The samples may be held at <-7°C for up to seven days prior to analysis from the sample collection date. The samples may be subject to either High or Low Level Analysis. This option is used in the situations where it is difficult or impossible to deliver the samples to the laboratory within 48 hours of the sample collection time.

Option 3C: Analysis within 48 Hours. After collecting the soil samples in tared VOA vials, the samples are kept chilled at 4 ± 2°C in a cooler and shipped with adequate ice to ensure that 4 ± 2°C is maintained during transport to the laboratory. Upon receipt of the samples, the laboratory chills the tared VOA vials to 4 ± 2°C and analyzes the samples within 48 hours of the sample collection time. The samples may be subject to either High or Low Level Analysis.

The field procedures for Options 3A, 3B, and 3C are furthered discussed in Appendix C.

6.0 CONDITIONS OF THE METHOD

6.1 Limitation of Methanol Preservation

The preservation and extraction of samples with methanol is not appropriate for soils with low VOC concentrations. The use of methanol as a preservative introduces a significant dilution factor that will raise the method detection limit beyond the operating range of the Low Level Analysis procedure. For gas chromatography, depending on the analytical method, methanol may also mask the elution of some VOCs. Accordingly, the potential for coelution should be discussed with the laboratory prior to sample collection. Potentially, these limitations could render the soil analytical results useless in evaluating sites for risk assessment purposes.

6.2 Subcoring Devices

With most standard drilling techniques, soil cores are retrieved from the subsurface during site characterization with a core barrel. When analyzing soil samples pursuant to Method 5035, the soil from the core barrels must be subcored and then these subcore samples must be placed into airtight containers. With Option 2, the MFSD acts as both a subcoring tool and airtight storage container. The MFSD is designed to collect, transport, and deliver intact soil sample subcores to the stationary laboratory. The coring body of the MFSD is pushed into a freshly exposed soil surface, obtaining a headspace-free subcore. The sample chamber is then sealed with the cap, becoming airtight. Once back at the laboratory, the sample subcore is extruded into a tared empty or preserved VOA vial, as appropriate. To aid in the extrusion of the subcore from the MFSD into the VOA vial, the opening of the VOA vial must be larger than the diameter of the subcore. Accordingly, the project planning team must contact the stationary laboratory to ensure that the MFSDs are compatible with the VOA vials used in the laboratory's autosampler instrumentation to avoid further sample handling which might promote VOC loss.

For Options 1 and 3, a subcoring device must be used to obtain the subcore soil samples. The subcoring device must have a diameter smaller than the opening of the VOA vial into which the subcore is extruded. Additionally, the project planning team must contact the stationary laboratory to ensure that the VOA vials used in the field are compatible with the laboratory's autosampler

instrumentation. The subcoring devices are used to obtain either five or ten grams of soil, as appropriate. Five grams is the preferred weight to minimize sample handling by the laboratory. Numerous subcoring devices are available for the collection of the soil subcores. The following list contains a description of three subcoring devices. However, any equivalent device may also be used.

- Disposable Plastic Syringe. A disposable plastic syringe can be easily converted to an inexpensive subcoring device. The "needle end" of the syringe barrel can be cut off, thus creating a blunt, even coring end. The end of the syringe should be cut with a knife or scissors rather than a saw so that the blunt end is smooth to prevent soil disaggregation upon collection. Prior to use, the plunger of the syringe must be in the “down position” so that its end directly contacts the soil, not allowing for any trapped air. The soil subcore is collected by pushing the cut end of the syringe into the freshly exposed soil surface until the soil column fills the inside of the syringe with five grams of soil, or as needed. The soil subcore is then removed from the syringe and extruded into the VOA vial using the syringe's plunger.

- EasyDraw Syringe™ and PowerStop Handle™. The soil subcore is obtained with the sampling device and transferred into a VOA vial in the field. The PowerStop Handle™ is reusable but a new syringe must be used for each sampling location. There are three 5 gram positions and three 10 gram positions on the PowerStop Handle™. The three positions are labeled light, medium, and heavy to correspond to low, medium and high soil densities. There is also one 13 gram position. In general, one of the 5 gram positions will be used to collect the soil subcores. The soil subcore is collected by pushing the EasyDraw Syringe™ into the freshly exposed soil surface until the soil column inside the syringe has forced the plunger to the stopping point.

- Lock N’ Load™ Soil Sampling Tool. The soil subcore is obtained with the sampling device and transferred into a VOA vial in the field. There are two settings, a 5 gram position and a 10 gram position, on the Lock N’ Load™ Soil Sampling Tool. In general, the 5 gram position will be used to collect the soil subcores. The Lock N’ Load™ Soil Sampling Tool is reusable but a new syringe must be used for each sampling location. The Lock N' Load syringe fits securely into the neck of a 40 milliliter glass vial and by turning the Lock N' Load handle, one can dispense the soil into a VOA vial without removing the syringe.

Section 6.10 provides guidance on the collection of samples from consolidated soil, such cemented soil, dense sand, stiff clay, or bedrock, where subcores cannot be obtained with a MFSD, disposable plastic syringe, EasyDraw Syringe™, Lock N’ Load™ Soil Sampling Tool, or other appropriate subcoring device.

6.3 Procedural Incompatibilities

6.3.1 Aromatic Hydrocarbons

Chemicals, such as aromatic hydrocarbons (AH), are subject to VOC loss by biodegradation under certain Method 5035 sampling procedures. Accordingly, to obtain AH soil concentrations that are representative of site conditions, only a subset of the available Method 5035 options are available for use. To reduce the biological activity in soil contaminated with AH, soil samples should be preserved with methanol or sodium bisulfate solution in the field, collected with MFSDs, or frozen in the field at <-7°C in non-preserved VOA vials. Under no circumstances should soil samples contaminated with AH be collected in the field with VOA vials containing reagent-grade extractant

water. The introduction of unpreserved water to the soil sample may enhance the biodegradation of the AH.

6.3.2 Chemical Reactions

Acid preservation of soil by sodium bisulfate solution, whether done in the field or in the stationary laboratory, may cause the chemical breakdown of certain compounds. Some olefins, ketones, esters, ethers, and sulfides may react under low pH conditions, yielding analytical results that are not representative of soil conditions. Hence, precaution should be taken when preserving soil samples with sodium bisulfate solution when these compounds are present. If the degree of potential chemical reaction is unknown, an alternative Method 5035 procedure should be used.

6.3.3 Calcareous Soil

Calcareous soil samples may react upon contact with sodium bisulfate solution, causing VOC loss through effervescence and potentially cause failure of the VOA vial septum through pressure build-up. Additionally, when soil samples are highly calcareous in nature, the sodium bisulfate preservative solution may not be strong enough to reduce the pH of the aqueous solution to below 2.0, potentially rendering the preservative useless. If carbon dioxide is generated due to carbonate reaction with the acid, the carbon dioxide in the VOA vial may interfere with the detector of the analytical equipment. Hence, precaution should be taken when preserving soil samples with sodium bisulfate solution when carbonates are present.

6.4 Selection of Appropriate Sampling Procedures

The selection of a Method 5035 sampling technique for a site should not be based upon on the availability of sample containers and convenience of use. Instead, the sampling and preservation options should be selected based upon the requirements of the data quality objectives for the project. Accordingly, this hierarchy of techniques is offered as a guide for users when evaluating the data quality needs for a project.

1) Option 1: Field Chemical Preservation. Chemical preservation of VOA vials in the field with sodium bisulfate solution (Low Level Analysis) or methanol (High Level Analysis) yields the best possible data quality for VOC analysis of soil. The introduction of these chemical preservatives in the field inhibits VOC loss by biodegradation. Also, VOC loss due to sample handling is minimized.

2) Option 2: Multi-Functional Sampling Devices. When the MFSDs are received by the stationary laboratory, the soil subcores within the MFSDs are extruded into VOA vials for analysis. As the soil subcores pass from the MFSDs to the VOA vials during the extrusion process, the soil subcores are open to ambient air and VOC loss could occur. This VOC loss could yield analytical results that are potentially biased low. Users of MFSDs must recognize this limitation when evaluating the data quality objectives for their project.

3) Option 3: Empty Vial Technique. The extractant fluid, whether methanol, sodium bisulfate solution, or reagent water, must be added by the stationary laboratory to the VOA vials after the soil has been sealed into the vials in the field. To do this, the PTFE-lined septum caps must be pierced for the introduction of the extraction fluid into the VOA vials. After the introduction of the extraction fluid, the vials must be stirred or sonicated to promote the partitioning of the VOCs into the extraction fluid. Upon completion of the stirring or sonication, the sample is then

analyzed for VOC concentration. During the stirring or sonication, VOCs can escape from the VOA vial through the pierced septum. Hence, the Empty Vial Technique may potentially yield analytical results that are biased low. Users of the Empty Vial Technique must recognize this limitation when evaluating the data quality objectives for their project.

Thus, the sampling options within Method 5035 do not potentially yield similar data quality results. Accordingly, for sites that require the highest quality analytical results, the soil subcores should be field preserved with methanol or sodium bisulfate solution.

For sites where the contaminants may react with the sodium bisulfate solution or where the soils may react with the sodium bisulfate solution due to high carbonate content, water may be substituted for the sodium bisulfate solution in the field in cases where chemical biodegradation is not a concern.

6.5 Field Screening

Not all soil samples collected from a borehole during site characterization are submitted to a stationary laboratory for analysis. Usually, the soil samples exhibiting the highest concentrations of VOCs through field screening techniques are submitted for analysis. Accordingly, to comply with the intent of Method 5035, care must be taken in the field to minimize VOC loss during the field screening process. Typically, during split-spoon sampling, cores are obtained within brass sleeves and one brass sleeve is field screened for VOC concentration. Meanwhile, another brass sleeve from the same depth interval is placed on ice in a sample cooler for possible laboratory analysis. Upon completion of the drilling, the soil samples for laboratory analysis are then selected. To comply with Method 5035, DTSC allows this style of procedure to continue but with minor modification. Brass sleeves can be held in a cooler filled with ice onsite awaiting subcoring for Method 5035 upon completion of borehole drilling if the following conditions are met:

1) The ends of the brass sleeve are covered with teflon sheeting, capped with tight-fitting plastic end-caps, and then placed into a resealable plastic (Ziploc™ type) bag.

2) No headspace exists within the brass sleeve.

3) The resealable plastic bag containing the brass sleeve is placed directly on ice within the shipping cooler.

4) No more than two hours transpire between core retrieval from the subsurface and the collection of the Method 5035 subcores from the brass sleeve.

5) The field log or boring log must reflect the time of core retrieval and the time of subcoring.

If the conditions listed-above are met, the brass sleeves can be held and subcored upon completion of the drilling of the borehole or within two hours of core retrieval, which ever is less. For Method 5035 sampling upon completion of borehole drilling, the brass sleeve is uncapped and the first inch of soil is removed from the brass sleeve with an appropriate instrument. The subcoring then takes place on the newly exposed surface as quickly as possible and as deep as possible within the brass sleeve. However, if the above conditions are not achieved in the field, all brass sleeves that might be subject to VOC analysis must be subcored immediately pursuant to Method 5035.

In some situations, acetate-lined core barrels are used rather than brass sleeves during the collection of subsurface soil samples. The above-mentioned approach applies to acetate-lined core samples where the cores would be manually sliced with a knife for field screening and subcoring.

Under no circumstances should brass sleeves or acetate-lined cores be submitted to a stationary laboratory for Method 5035 analysis. However, brass sleeves and acetate-lined cores can be hand-carried to an onsite mobile laboratory pursuant to the conditions referenced in Section 6.9 in this Guidance Document.

6.6 Dry Weight Determination

If the soil analytical results for a project must be reported on a dry weight basis, an additional soil sample must be collected from the sampling location in order to determine the dry weight of the soil. The soil sample submitted to the stationary laboratory specifically for dry weight determination does not need chemical preservation in the field and may be collected by conventional methods, such as in glass jars, brass sleeves, or acetate liners. However, the collection method should minimize sample handling, sample disaggregation, and moisture loss. As such, the sample containers used for the collection of these samples should have appropriate seals to prevent moisture loss and be clearly labeled to avoid confusion at the laboratory. Also, this sample for dry weight determination can be used by the laboratory to evaluate soil reactivity to sodium bisulfate solution.

6.7 Quality Assurance / Quality Control Samples

6.7.1 Trip Blanks

Soil samples can be contaminated by diffusion of VOCs through the septum on VOA vials or through the seal on MFSDs during shipment and storage. A trip blank prepared with laboratory-grade methanol, sodium bisulfate solution, or reagent water, dependent on the field methods, can be carried through sampling and handling protocols as a check on such contamination. DTSC recommends that, ideally, one trip blank should be used for each field sample cooler, but, at a minimum, one trip blank should be used per day.

6.7.2 Temperature Blanks

Temperature blanks should be used so that the laboratory can verify the temperature upon receipt of the samples. In the case of field freezing, the temperature blanks should be frozen upon arrival at the laboratory. The temperature of the samples upon arrival should be annotated on the chain-of-custody form and also mentioned in the laboratory narrative that accompanies the analytical results.

6.7.3 Matrix Spike and Matrix Spike Duplicate Samples

An important measure of the performance of an analytical method relative to the specific sample matrix of interest is the matrix spike and matrix spike duplicate (MS/MSD). The MS/MSD is an important aspect of an overall quality assurance program for a project. When soil sampling, a MS/MSD sample should be collected for each analytical method at a frequency of five percent of the field samples. The MS/MSD sample should be prepared in a fashion similar to the other samples pursuant to Method 5035. Samples taken for MS/MSD should be labeled as such and

specified on the chain-of-custody form. The primary purpose of MS/MSD analyses is to establish the applicability of the overall analytical approach to the specific sample matrix from the site.

6.7.4 Other Field Quality Control Samples

Field quality control samples to demonstrate the integrity of the field samples should also be collected. Field duplicates, field blanks, and equipment rinsate blanks should be collected at a frequency of five percent of the samples, or, at a minimum, one should be collected each day.

6.8 Bulk Soil Sampling

The collection of soil samples in bulk containers that would require laboratory subcoring is *not* an option pursuant to Method 5035. Large bottles, wide-mouthed jars, acetate liners, or brass sleeves from split-spoon samplers are not appropriate sample containers under Method 5035 for VOC analysis. However, with DTSC prior approval, these traditional, non-Method 5035 approaches can be used at sites for characterization purposes only, but VOC concentrations from these soil samples should never be used in fate and transport modeling or to quantify the risk associated with human and ecological exposure.

6.9 Mobile Laboratories

VOC analysis may be performed by a certified mobile field laboratory as long as their procedures and analytical equipment meet the performance standards of Method 5035. Tables 1 and 2 summarize the options available for sample preservation for both Low Level Analysis and High Level Analysis, respectively. Obviously, sample preservation for long holding times is not warranted with use of an onsite mobile laboratory. Accordingly, DTSC anticipates that soil samples for analysis by a mobile laboratory will be collected in a non-preserved manner. There are two options available for mobile laboratories for the analysis of soil samples pursuant to Method 5035, as follows:

1) Laboratory Subcoring. After the acquisition of soil cores from the subsurface, which are usually obtained within brass sleeves, the field geologist or technician covers the ends of one of the sleeves with teflon sheeting, caps the ends with tight-fitting plastic end-caps, and then places the sleeve into a resealable plastic bag. No headspace should exist within the brass sleeve. The brass sleeve is quickly brought to the mobile laboratory where the chemist can either carefully perform the subcoring of the brass sleeve and then immediately analyze the sample or the brass sleeve is placed into the mobile laboratory's freezer for later subcoring. A brass sleeve placed into the laboratory's freezer should only be held for two hours prior to analysis. Otherwise, the sample should be preserved pursuant to Method 5035 and then analyzed later as appropriate.

   At the mobile laboratory, the chemist performing the subcoring of the soil from the brass sleeve has two options for sample preparation and analysis. The soil subcore can be placed into either a VOA vial or a test tube for preparation and analysis. Prior to sample collection, the mobile laboratory chemist prepares pre-tared test tubes or VOA vials, with magnetic stir bars as needed. A subcoring device, such as a disposable plastic syringe, is used to remove a five gram sample plug from a newly exposed surface of the soil core. The barrel diameter of the disposable plastic syringe should be smaller than that of the test tube or VOA vial. The sample plug is immediately transferred to the test tube or VOA vial, which is then hermetically sealed. The test tube or VOA vial is then weighed to obtain the actual sample weight and the

test tube or VOA vial is loaded immediately on the closed system purge-and-trap for analysis. The time between removal of the sample plug from the soil core and the sealing of the test tube or VOA vial should be no more than two minutes. All surrogates, internal standards, and matrix spikes are introduced either through the PTFE-lined septum cap of the VOA vial or through the sampling value on the test tube cap.

2) Field Subcoring. Pre-tared, labeled VOA vials with PTFE-lined septum caps are taken into the field. The analytical instrumentation of the mobile laboratory should be capable of mechanically accepting the VOA vials. Magnetic stir bars are added to the VOA vials as necessary. Once a soil core is available from the drilling or sampling activities, a subcoring device, such as plastic syringe, is used to remove a five gram sample plug from a fresh surface of the soil core. The plastic syringe should be disposable with a barrel diameter that is smaller than the diameter of the VOA vial. Each sample subcore is immediately transferred to the VOA vial, which is then hermetically sealed. The time between removal of the soil core from the subsurface and hermetically sealing the VOA vial should be no more than two minutes. The sample is quickly brought to the mobile laboratory where the chemist immediately analyzes the sample. If the sample cannot be analyzed immediately, the sample is placed into the mobile laboratory's freezer for later analysis. The sample in the laboratory's freezer should only be held for two hours prior to analysis, otherwise the sample should be preserved pursuant to Method 5035 and then analyzed later as appropriate, either at the mobile laboratory or at a stationary laboratory.

The onsite mobile laboratory should process the samples immediately upon receipt. The chain-of-custody form should be checked and signed, the samples logged-in, and the samples should then be weighed as appropriate. For Low Level Analysis samples, the samples are prepared and analyzed with the caps in-place. All surrogates, internal standards, and matrix spikes are introduced through the septum, either manually or mechanically. For High Level Analysis, the VOA vials may be opened but only after the soil subcore is completely immersed in methanol, as introduced through the septum, and shaken gently to completely capture the VOCs in the headspace. All samples, while in the custody of either the field investigator or the mobile laboratory, should be chilled to 4 ± 2°C.

6.10 Sampling of Consolidated Soil

Some materials that require sampling may be too cohesive for subcoring tools to penetrate. Examples of such materials include cemented soil, dense sand, stiff clay, or bedrock. Samples of these materials can be collected by exposing a fresh surface and using an appropriate tool such as a clean chisel or spatula to generate aggregates of a size that can be placed into a VOA vial. When transferring the aggregates, care must be taken to prevent compromise of the sealing surfaces and threads of the VOA vials. The VOA vial should be handled and preserved pursuant to the data quality objectives for the site. When sampling under these conditions, field personnel should note the occurrence in their field logs. Although the inevitable disaggregation of the sample increases the possibility of VOC losses, there may be no alternative under these conditions. Therefore, caution should be used in the interpretation of the data obtained from this type of material.

TABLE 1: METHOD 5035 LOW LEVEL ANALYSIS
Low Concentrations of VOCs Are Anticipated in the Soil Samples
Sample Detection Limits are Approximately 0.5 μg/kg

Option	Sample Container	Field Preservation	Laboratory Activity	Holding Time [2]
1B	VOA Vial [1, 3]	Sodium bisulfate solution and cool to 4 ± 2°C	Cool to 4 ± 2°C until analysis	14 days
1C	VOA Vial [1, 5]	Water and cool to 4 ± 2°C	Freeze to <-7°C within 48 hours from sample collection	7 days
1D	VOA Vial [1, 5]	Water and freeze to <-7°C [4]	Freeze to <-7°C	7 days
1E	VOA Vial [1, 5]	Water and cool to 4 ± 2°C	Cool to 4 ± 2°C until analysis	48 hours
2A	Multi-Functional Sampling Device [3]	Cool to 4 ± 2°C	Extrude into sodium bisulfate solution within 48 hours of sample collection and cool to 4± 2°C	14 days
2B	Multi-Functional Sampling Device	Cool to 4 ± 2°C	Extrude into VOA vial within 48 hours of sample collection and freeze to <-7°C	7 days
2C	Multi-Functional Sampling Device [3]	Cool to 4 ± 2°C	Cool to 4 ± 2°C until analysis	48 hours
3A	VOA Vial [1]	Cool to 4 ± 2°C	Freeze to <-7°C within 48 hours from sample collection	7 days
3B	VOA Vial [1]	Freeze to <-7°C [4]	Freeze to <-7°C	7 days
3C	VOA Vial [1, 3]	Cool to 4 ± 2°C	Cool to 4 ± 2°C until analysis	48 hours

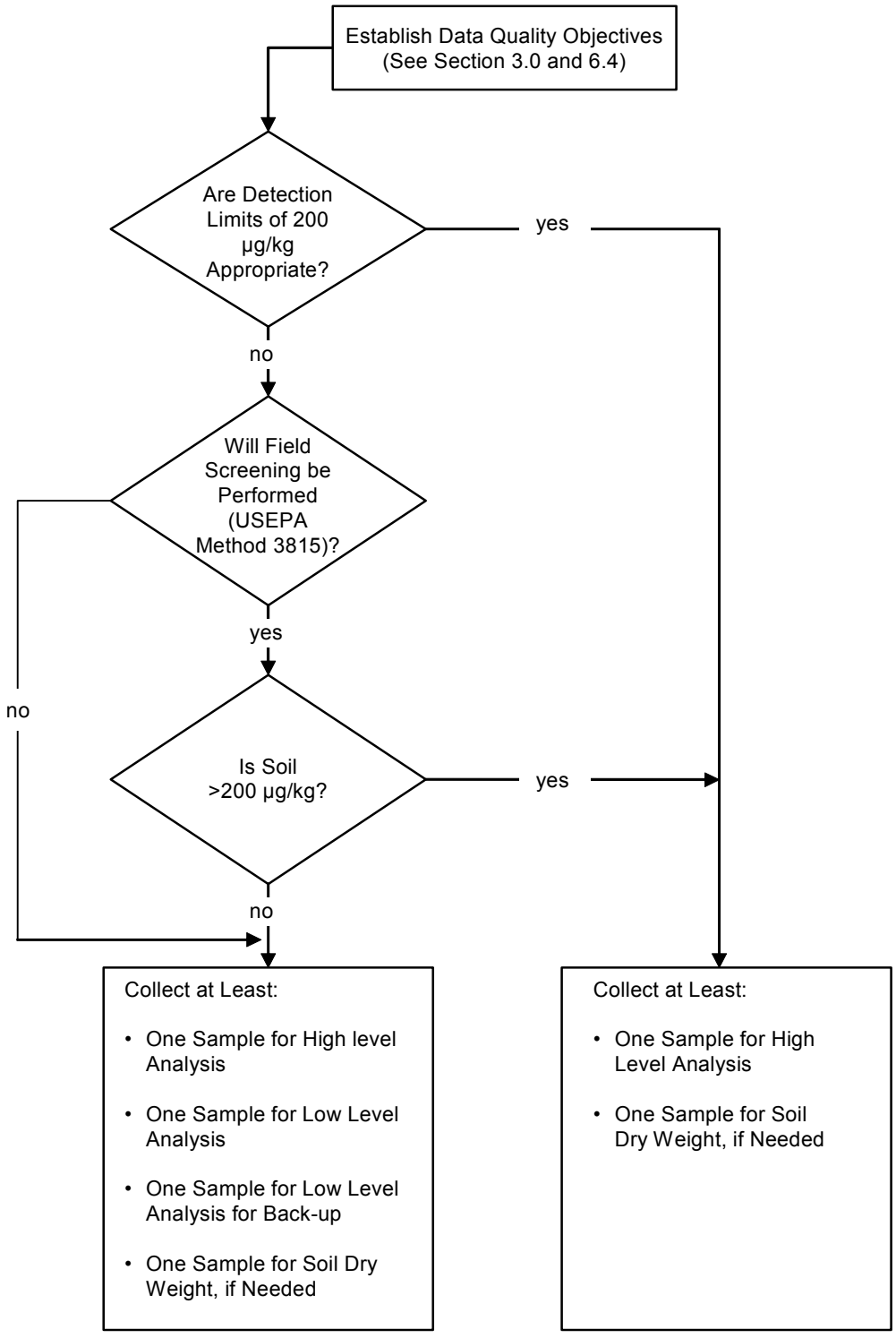
[1] VOA vials are never opened after being sealed in the field.
[2] Holding time is measured from the time of sample collection.
[3] Preferred method for aromatic hydrocarbons due to potential biodegradation.
[4] Field freezing is needed when the samples cannot be transported to the stationary laboratory within 48 hours of the sampling time.
[5] Water should be used as a replacement for sodium bisulfate solution when soils and contaminants are incompatible with low pH conditions.

TABLE 2: METHOD 5035 HIGH LEVEL ANALYSIS
High Concentrations of VOCs are Anticipated in the Soil Samples
Sample Detection Limits are Approximately 200 μg/kg

Option	Sample Container	Field Preservation	Laboratory Activity	Holding Time [2]
1A	VOA Vial [1, 3]	Methanol and cool to 4 ± 2°C	Cool to 4°C until analysis	14 days
1C	VOA Vial [1]	Water and cool to 4 ± 2°C	Freeze to <-7°C within 48 hours from sample collection	7 days
1D	VOA Vial [1]	Water and freeze to <-7°C [4]	Freeze to <-7°C	7 days
1E	VOA Vial [1]	Water and cool to 4 ± 2°C	Cool to 4 ± 2°C until analysis	48 hours
2A	Multi-Functional Sampling Device [3]	Cool to 4 ± 2°C	Extrude into methanol within 48 hours of sample collection and cool to 4 ± 2°C	14 days
2B	Multi-Functional Sampling Device	Cool to 4 ± 2°C	Extrude into VOA vial within 48 hours of sample collection and freeze to <-7°C	7 days
2C	Multi-Functional Sampling Device [3]	Cool to 4 ± 2°C	Cool to 4 ± 2°C until analysis	48 hours
3A	VOA Vial [1]	Cool to 4 ± 2°C	Freeze to <-7°C within 48 hours of sample collection	7 days
3B	VOA Vial [1]	Freeze to <-7°C [4]	Freeze to <-7°C	7 days
3C	VOA Vial [1, 3]	Cool to 4 ± 2°C	Cool to 4 ± 2°C until analysis	48 hours

[1] VOA vials are never opened after being sealed in the field.
[2] Holding time is measured from the time of sample collection.
[3] Preferred method for aromatic hydrocarbons due to potential biodegradation.
[4] Field freezing is needed when the samples cannot be transported to the stationary laboratory within 48 hours of the sampling time.

FIGURE 3: SOIL SAMPLING DECISION MATRIX
Selection of the Number of Soil Samples at a Sample Location Point



Note: The options for Low Level Analysis and High Level Analysis are shown in Tables 1 and 2.

Appendix A: Sampling Option 1

Sampling Options 1A, 1B, 1C, 1D, and 1E
Preserved VOA Vials

The stationary laboratory that will perform the soil analysis will provide preserved, tared, and labeled VOA vials that have PTFE-lined septum caps. Alternatively, VOA vials can be purchased from scientific suppliers that are certified clean to USEPA specifications. Typically, the VOA vials are 40 milliliters in size. The preservation fluid is either methanol or sodium bisulfate solution. Also, the VOA vials may contain reagent-grade extraction water. The methanol, sodium bisulfate solution, and reagent water must be laboratory-grade fluids. The fluids must be purge-and-trap grade, certified to be free of VOCs. The selection of the preservation fluid is based upon the desired method detection limits (Low Level Analysis or High Level Analysis) and the data quality objectives. In the field, the methanol-preserved VOA vials are re-weighed to verify no preservative loss due to volatilization. Re-weighing the VOA vials containing reagent water or sodium bisulfate solution is not necessary because these fluids have no affect on the dilution calculation. However, magnetic stir bars may be needed in VOA vials containing reagent water or sodium bisulfate solution pursuant to the laboratory's requirements. Soil subcores of appropriate mass are placed into the VOA vials in the field and are capped, forming an airtight seal. The soil samples preserved with methanol are re-weighed in the field to determine the soil sample weight. The soil samples in reagent water or sodium bisulfate solution are not reweighed in the field because the stationary laboratory determines the sample weight.

Usually, three co-located samples are taken and placed into their individual vials so that the laboratory has an appropriate sample volume. At the laboratory, the capped vials containing reagent water or sodium bisulfate solution are weighed to obtain the weight of the soil. The methanol-preserved samples are re-weighed to verify any preservative loss due to volatilization. For Low Level Analysis, the samples containing reagent water or sodium bisulfate solution are prepared and analyzed with the caps in-place. The vial caps are not removed throughout the entire storage, preparation, and analysis procedure. Hence, the VOA vials must be compatible with the laboratory's autosampler instrumentation to avoid further sample handling which might promote VOC loss. All surrogates, internal standards, extract aliquots and matrix spikes are introduced and removed through the septums, either manually or mechanically. For High Level Analysis, the methanol-preserved samples are analyzed by Method 5030.

Several coring devices are available for the collection of soil subcores, which can readily transfer the soil subcores into the relatively narrow opening of a VOA vial. These devices include the EasyDraw Syringe™ and PowerStop Handle™, the Purge-and-Trap Soil Sampler™, the Lock N' Load™ Soil Sampling Tool, and a cut plastic syringe. Any equivalent device may also be used after consultation with DTSC prior to sampling. The coring devices are usually disposable and should not be re-used. To expedite the soil sampling, numerous coring devices should be taken into the field.

A.1 Field Procedures at a Sample Location Point

1) On the day of the field activities, weigh the pre-tared methanol-preserved VOA vials to verify that no preservative has evaporated. All weights must be recorded to within 0.05 grams[11]. To the extent possible, field personnel should weigh the VOA vials in a protected environment to permit accurate weighing. The VOA vials containing reagent water or sodium bisulfate solution do not require weighing prior to sample collection.

2) Discard all methanol-preserved VOA vials with unacceptable preservative loss of greater than 0.05 grams.

3) Record the weight of the methanol-preserved VOA vials in the field log book.

4) Construct or assemble the subcoring device pursuant to the manufacturer's instructions.

5) Push the coring device into a freshly exposed soil surface. Continue pushing until the soil column inside the coring device has forced the device's plunger to the stopping point or until the appropriate amount of soil has been collected, usually five grams (two to three cubic centimeters).

6) Use a paper towel to quickly wipe the exterior of the coring device to remove excess soil.

7) Insert the end of the coring device into the pre-tared VOA vial and eject the soil sample into the vial by pushing on the plunger of the coring device. Avoid splashing the preservative out of the VOA vial by holding the VOA vial at an angle. The mouth of the coring device should not contact the preservative.

8) Use a paper towel to quickly wipe the VOA vial threads to remove excess soil and cap, hermetically sealing the vial. Note: Steps 5 – 8 should be done as quickly as possible, usually within two minutes, to prevent VOC loss.

9) Gently swirl the soil sample in the VOA vial to mix and break up the soil aggregate until the soil is covered with the preservative. The swirling of the VOA vial should not allow the soil to contact the PTFE septum. The PTFE septum must remain free of soil to allow for the analysis of the sample through the septum. Hence, do not vigorously shake the vial.

10) Re-weigh the methanol-preserved VOA vials to determine the weight of the soil sample. The VOA vials containing reagent water or sodium bisulfate solution do not require weighing after sample collection.

11) Using the pre-adhered label on the VOA vial, complete the label information as needed. The VOA vials as supplied from the laboratory or a certified vendor will be pre-labeled. Hence, no additional labeling of the VOA vials in the field should be done that might alter the weight of the sample container. If it is necessary to include another label, a label can be applied to the exterior of the plastic bag containing the vial.

[11] USEPA Method 5035 specifies that all weights should be recorded within 0.01 grams but most commercially available electronic balances only have the capacity to accurately measure within 0.05 grams; hence, 0.05 is used within this Guidance Document as the accuracy threshold.

12) Place the VOA vial into a resealable plastic bag and place the package into a cooler chilled to 4 ± 2°C or <-7°C, as needed. The VOA vials should be transported to the laboratory in an upright position whenever possible. However, VOA vials subject to freezing at <-7°C should be transported to the laboratory at a 45° angle to prevent vial breakage due to preservative expansion.

13) Repeat the procedure as necessary to obtain the required number of Method 5035 soil samples.

14) As needed, collect a soil sample for the measurement of the dry weight of the soil. The sample does not need chemical preservation and can be collected in either a sealable glass jar or empty VOA vial.

A.2 Field Considerations

a) Disposable plastic syringes can be easily converted into an inexpensive coring device. The "needle end" of the syringe barrel is cut-off with a sharp knife or scissors, creating a blunt, even coring end. The barrel diameter of the plastic syringe must be narrower than the diameter of the VOA vial for soil extrusion. Prior to field activities, the approximate volume associated with five grams of soil must be determined. Hence, it may be necessary to calibrate the syringe by collecting and weighing trial soil quantities with the plastic syringe to determine the length of soil in the syringe barrel that corresponds to 5.0 ± 0.5 grams.

b) Do not use or submit samples for analysis if the preservative has spilled or splashed from the VOA vial. Extra tared and preserved VOA vials should be taken into the field anticipating potential preservative loss due to evaporation or spillage. Methanol-preserved VOA vials should be weighed in the field prior to soil sample collection. A significant change in weight of the VOA vial indicates preservative loss and the VOA vial should not be used. Unacceptable preservative loss is 0.05 grams. After sample collection and before transport to the laboratory, the samples are reweighed to determine the weight of the samples.

c) Rough trimming of a sampling location's surface layer should be considered if the soil has been exposed to ambient air for more than two minutes. Removal of the surface layer can be accomplished by scraping the soil surface with a clean spatula, scoop, trowel, or knife.

d) The collection of numerous co-located subcores from a core sample may be difficult due to the small diameter of the core. Accordingly, care should be taken in obtaining all the necessary subcores. All subcores should be taken from a fresh surface. If a fresh surface is not available after the first or second co-located sample, the core sample should be slowly extruded from the core barrel and cut to expose additional subcore sampling areas.

e) Many core barrels are not entirely full upon retrieval from the subsurface. Hence, upon subcoring, these partially full core barrels will require bracing or support so that subcoring can occur without pushing the soil core into the interior of the barrel.

f) The collection of subsequent co-located subcores should not begin until the previous subcore is sealed in its vial.

g) Field personnel should wear powderless gloves during sample collection to avoid VOC exposure.

h) The threads of the VOA vials must be free of soil; otherwise the cap will not seal properly, compromising the integrity of the sample.

i) To maintain sample integrity, only two minutes should ideally transpire between core retrieval from the subsurface and subcoring by the coring device.

j) Soil samples with known high concentrations of VOCs should be separated from soil samples with low concentrations to prevent cross contamination. Ideally, the soil samples of differing VOC concentrations should be placed into different shipping bags and, if possible, placed into separate field coolers.

k) Calcareous soil samples may effervesce upon contact with sodium bisulfate solution and compromise the integrity of the sample. Off-gassing could result in VOC loss as the soil contacts the effervescing acid. Pressure build-up after sealing the VOA vial could cause the vial to shatter or the carbonates in the soil could buffer the acid, rendering sodium bisulfate solution ineffective as a preservative. Accordingly, the soils at the site should be evaluated for potential effervescence prior to sampling activities and the occurrence of effervescence should be reported to the laboratory. In cases where effervescence is a potential problem, an alternative sample collection method should be utilized.

l) Methanol is a toxic and flammable liquid, and must be handled with appropriate safety precautions. Inhalation of methanol vapors should be avoided. It should be handled in well ventilated areas and stored away from open flames and other ignition sources as well as extremely hot areas. Sodium bisulfate solution is a mineral acid and must be handled with appropriate safety precautions. Contact with skin and eyes should be avoided. Protective gloves and eye protection should be worn when handling vials containing sodium bisulfate solution.

m) Depending on the quantity and method of packaging, methanol and sodium bisulfate solution may be considered Department of Transportation (DOT) Hazardous Materials and subject to DOT hazardous materials regulations.

n) Consult the laboratory to determine if magnetic stir bars should be added to the VOA vials prior to hermetic sealing in the field. Soil samples subject to Low Level Analysis must be agitated during analysis to assist the VOC purge process. Agitation can be accomplished by either sonication or stirring with magnetic bars. Hence, if the stationary laboratory does not have the ability to sonicate the soil sample with their instrumentation, magnetic stir bars must be added to the VOA vials subject to Low Level Analysis.

A.3 Potential Field Equipment

- VOA Vials – Extra preserved VOA vials should be taken into the field due to potential breakage or expansion of the sampling program due to unanticipated field conditions. Typically, the VOA vials are 40 milliliters in size.

- Digital Field Scale – Used to weigh VOA vials to verify no methanol loss prior to sampling; if the field scale is a balance-type, calibrated weights must also be taken into the field. All

scales must have an accuracy of 0.05 grams. The field scale is also used to determine the volumetric amount of soil needed for five grams of sample.

- Coring Devices – Used to obtain the soil subcores; must have a diameter that is slightly smaller than the VOA vials.

- Gloves – Used for health and safety protection; powderless preferable.

- Paper Towels – Used to clean VOA vial threads for proper cap attachment.

- pH Test Strips – Used to verify that soil subcores are preserved to a pH of less than 2.0 in the VOA vials.

- Acid Preservative – Used as needed to reduce the pH in the VOA vials to less than 2 before adding the soil subcore to the vial; the addition of acid should only be done if the VOA vials were incorrectly preserved by the laboratory or vendor.

- Field Cooler – Insulated ice chest for sample storage and shipment; must be capable of cooling and maintaining the soil samples to 4 ± 2°C or <-7°C, as needed.

- Ice – Used to chill field cooler and samples to 4 ± 2°C. Wet ice preferred over blue ice for chilling to 4 ± 2°C. The wet ice should be double bagged to prevent filling the field coolers with water which may damage the labels on the samples. Dry ice, as needed, for chilling the field cooler to <-7°C.

- Field Blades – Clean spatula, scoop, trowel or knife used for exposing fresh soil surfaces before subcoring.

- Indelible Ink Pens – Labeling of the soil sample containers; pens that use VOCs, such as markers, are not recommended due to potential cross-contamination.

- Resealable Plastic Bags – Used as a secondary container to prevent moisture infiltration during sample transport.

- Glass Containers – Used to collect soil samples for dry weight determination. Samples for dry weight determination can also be collected in brass sleeves or acetate liners. These samples do not need preservation. However, the collection method should minimize sample handling, sample disaggregation, and moisture loss.

- Decontamination Equipment – Used to decontaminate the field blades and coring devices, for repeated use, as needed.

Appendix B: Sampling Option 2

Sampling Options 2A, 2B, and 2C
Multi-Functional Sampling Devices

Multi-functional sampling devices (MFSDs) are used which act as both a coring tool and airtight storage container. Examples of MFSDs are the EnCore™ Sampler and the Core N' One™ Sampler. The MFSDs collect a small sample subcore directly into a volumetric storage chamber, filling it completely with zero headspace. The soil sample size can be either five grams or 25 grams, dependent on the MFSD size[12]. MFSDs are to be used on cohesive but uncemented soils that will form a cohesive plug when sampled. The storage containers are then capped, forming an airtight seal. The intact samples are transported to the laboratory in the sealed device at 4 ± 2°C. Usually, three co-located samples are taken with the MFSDs so that the stationary laboratory has an appropriate sample volume; however, fewer number of samples may be taken pursuant to Figure 1 if the VOC concentrations can be quantified with high detection limits (200 μg/kg). At the stationary laboratory, the soil sample within the MFSD is transferred to a VOA vial. The diameter of the VOA vial must be sufficiently large to accept the soil sample from the MFSD without alteration and the VOA vial must be compatible with the laboratory's autosampler instrumentation.

B.1 Field Procedures at a Sample Location Point

1) Enter the preliminary sample identification information on the label of the MFSD package. Usually, each sampler is individually packaged in a resealable plastic bag with usage instructions attached. No pre-sampling container preparation is required.

2) Remove the sampler and cap from the package and assemble the MFSD pursuant to its instructions.

3) Push the coring body of the MFSD into a freshly exposed soil surface, filling the sampling chamber. The MFSD should be visually checked to verify that a headspace-free subcore has filled the chamber. Any excess soil extruding from the sample chamber should be carefully removed by trimming away the excess with a clean field blade.

4) Use a paper towel to quickly wipe the sampler head to remove excess soil from the exterior so that the cap can be tightly attached.

5) For an Encore™ Sampler, carefully push the cap on with a gentle twisting motion to firmly attach the cap to the chamber, taking care not to damage the o-ring seal on the sampler. For a Core N' One™ Sampler, the cap is gently treaded onto place on the sampling chamber, taking care to properly seat the sealing gasket on the chamber. Note: Steps 3 – 5 should be done as quickly as possible, usually within two minutes, to prevent VOC loss.

6) Complete the label information and attach label as needed or required. The label should be placed only on the exterior bag containing the MFSD and not on the MFSD itself.

[12] Generally, the 5 gram MFSDs are used for the determination of VOC concentrations in soil and the 25 gram MFSDs are used for Toxicity Characteristic Leaching Procedure (TCLP) testing. When conducting TCLP testing, usually two 25 gram samples are taken and submitted to the laboratory.

7) Place the MFSD back into its original package and place the package into a cooler chilled to 4 ± 2°C.

8) Repeat the procedure as necessary to obtain the required number of Method 5035 soil samples.

9) As needed, collect a soil sample for the measurement of the dry weight of the soil. The sample does not need to be collected within a MFSD and can be collected in either a sealable glass jar or empty VOA vial.

B.2 Field Considerations

a) The exterior surface of the MFSD must be free of soil; otherwise the cap will not seal properly, compromising the integrity of the sample.

b) Rough trimming of a sampling location's surface layer should be considered if the soil has been exposed to ambient air for more than two minutes. Removal of the surface layer can be accomplished by scraping the soil surface with a clean spatula, scoop, trowel, or knife.

c) The collection of numerous co-located subcores from a core sample may be difficult due to the small diameter of the core. Accordingly, care should be taken in obtaining all the necessary subcores. All subcores should be taken from a fresh surface. If a fresh surface is not available after the first or second co-located sample, the core sample should be slowly extruded from the core barrel and cut to expose additional subcore sampling areas.

d) Many core barrels are not entirely full upon retrieval from the subsurface. Hence, upon subcoring, these partially full core barrels will require bracing or support so that subcoring can occur without pushing the soil core into the interior of the barrel.

e) To maintain sample integrity, only two minutes should ideally transpire between core retrieval from the subsurface and subcoring by the MFSD.

f) The collection of subsequent co-located subcores should not begin until the previous subcore is sealed in its MFSD.

g) Soil samples with known high concentrations of VOCs should be separated from soil samples with low concentrations to prevent cross contamination. Ideally, the soil samples of differing VOC concentrations should be placed into different shipping bags and, if possible, placed into separate field coolers.

h) Field personnel must communicate the required detection limits of the soil samples to the stationary laboratory so that the proper extraction procedures can be followed.

i) A 25 gram MFSD is used to collect, store, and transfer soils for Toxicity Characteristic Leaching Procedure (TCLP) testing, and must not be subsampled by the laboratory into five gram aliquots for VOC analysis per Method 5035.

j) Field personnel should wear powderless gloves during sample collection to avoid VOC exposure.

k) The soil sample collected for measurement of dry weight will also be used by the laboratory to evaluate the soil for reactivity with sodium bisulfate solution prior to Low Level Analysis.

B.3 Potential Field Equipment

- Multi-Functional Sampling Devices – Extra MFSDs should be taken into the field due to potential MFSD breakage or expansion of the sampling program due to unanticipated field conditions.

- Gloves – Used for health and safety protection; powderless preferable.

- Paper Towels – Used to clean sampler head of the MFSD for proper cap attachment.

- Field Cooler – Insulated ice chest for sample storage and shipment; must be capable of cooling and maintaining the soil samples to 4 ± 2°C.

- Ice – Used to chill field cooler and samples to 4 ± 2°C. Wet ice preferred over blue ice for chilling to 4 ± 2°C. The wet ice should be double bagged to prevent filling the field coolers with water which may damage the labels on the samples.

- Field Blades – Clean spatula, scoop, trowel or knife used for exposing fresh soil surfaces before subcoring.

- Indelible Ink Pens – Labeling of the soil sample containers; pens that use VOCs, such as markers, are not recommended due to potential cross-contamination.

- Resealable Plastic Bags – Used as a secondary container to prevent moisture infiltration during sample transport.

- Glass Containers – Used to collect soil samples for dry weight determination. Samples for dry weight determination can also be collected in brass sleeves or acetate liners. These samples do not need preservation. However, the collection method should minimize sample handling, sample disaggregation, and moisture loss.

- Decontamination Equipment – Used to decontaminate the field blades, for repeated use, as needed.

Appendix C: Sampling Option 3

Sampling Options 3A, 3B, and 3C
Non-Preserved VOA Vials

Tared and labeled VOA vials with a PTFE-lined septum caps are taken into the field as supplied by the laboratory or certified vendor, cleaned to USEPA specifications. Typically, the VOA vials are 40 milliliters in size. The VOA vials do not contain chemical preservatives, water-miscible solvents, or reagent water. Soil cores of appropriate mass are placed into the VOA vials in the field and are capped, forming an airtight seal. However, magnetic stir bars may be needed in the VOA vials pursuant to the laboratory's requirements.

Usually, three co-located samples are taken and placed into their individual vials so that the laboratory has an appropriate sample volume. At the laboratory, the capped vials are weighed to obtain the weight of the soil. For Low Level Analysis, the samples are prepared and analyzed with the caps in-place. The vial caps are not removed throughout the entire storage, preparation, and analysis procedure. Hence, the VOA vials must be compatible with the laboratory's autosampler instrumentation to avoid further sample handling which might promote VOC loss. All surrogates, internal standards, extract aliquots and matrix spikes are introduced and removed through the septums, either manually or mechanically. For High Level Analysis, the samples are analyzed by Method 5030.

Several coring devices are available for the collection of soil subcores, which can readily transfer the soil subcores into the relatively narrow opening of a VOA vial. These devices include the EasyDraw Syringe™ and PowerStop Handle™, the Purge-and-Trap Soil Sampler™, the Lock N' Load™ Soil Sampling Tool, and a cut plastic syringe. Any equivalent device may also be used after consultation with DTSC prior to sampling. The coring devices are usually disposable and should not be re-used. To expedite the soil sampling, numerous coring devices should be taken into the field.

C.1 Field Procedures at a Sample Location Point

1) Obtain tared and labeled VOA vials from the laboratory or certified vendor.

2) Construct or assemble the subcoring device pursuant to the manufacturer's instructions.

3) Push the coring device into a freshly exposed soil surface. Continue pushing until the soil column inside the coring device has forced the device's plunger to the stopping point or until the appropriate amount of soil has been collected, usually five grams (two to three cubic centimeters).

4) Use a paper towel to quickly wipe the exterior of the coring device to remove excess soil.

5) Insert the end of the coring device into the pre-tared VOA vial and eject the soil sample into the vial by pushing on the plunger of the coring device.

6) Use a paper towel to quickly wipe the VOA vial threads to remove excess soil and cap, hermetically sealing the vial. Note: Steps 2 - 5 should be done as quickly as possible, usually within two minutes, to prevent VOC loss. Also, care should be taken so that the PTFE

septum remains free of soil to allow for the analysis of the sample through the septum. Hence, do not shake the vial.

7) Using the pre-adhered label on the VOA vial, complete the label information as needed. The VOA vials as supplied from the laboratory or a certified vendor will be pre-labeled. Hence, no additional labeling of the VOA vials in the field should be done that might alter the weight of the sample container. If it is necessary to include another label, a label can be applied to the exterior of the plastic bag containing the vial.

8) Place the VOA vial into a resealable plastic bag and place the package into a cooler chilled to 4 ± 2°C or <-7°C, as needed. The VOA vials should be transported to the laboratory in an upright position whenever possible. However, VOA vials subject to freezing at <-7°C should be transported to the laboratory at a 45° angle to prevent vial breakage due to sample expansion.

9) Repeat the procedure as necessary to obtain the required number of Method 5035 soil samples.

10) As needed, collect a soil sample for the measurement of the dry weight of the soil. The sample can be collected in a sealable glass jar or empty VOA vial.

C.2 Field Considerations

a) Disposable plastic syringes can be easily converted into an inexpensive coring device. The "needle end" of the syringe barrel is cut-off with a sharp knife or scissors, creating a blunt, even coring end. The barrel diameter of the plastic syringe must be narrower than the diameter of the VOA vial for soil extrusion. Prior to field activities, the approximate volume associated with five grams of soil must be determined. Hence, it may be necessary to calibrate the syringe by collecting and weighing trial soil quantities with the plastic syringe to determine the length of soil in the syringe barrel that corresponds to 5.0 ± 0.5 grams.

b) Rough trimming of a sampling location's surface layer should be considered if the soil has been exposed to ambient air for more than two minutes. Removal of the surface layer can be accomplished by scraping the soil surface with a clean spatula, scoop, trowel, or knife.

c) The collection of numerous co-located subcores from a core sample may be difficult due to the small diameter of the core. Accordingly, care should be taken in obtaining all the necessary subcores. All subcores should be taken from a fresh surface. If a fresh surface is not available after the first or second co-located sample, the core sample should be slowly extruded from the core barrel and cut to expose additional subcore sampling areas.

d) Many core barrels are not entirely full upon retrieval from the subsurface. Hence, upon subcoring, these partially full core barrels will require bracing or support so that subcoring can occur without pushing the soil core into the interior of the barrel.

e) The collection of subsequent co-located subcores should not begin until the previous subcore is sealed in its vial.

f) Field personnel should wear powderless gloves during sample collection to avoid VOC exposure.

g) The threads of the VOA vials must be free of soil; otherwise the cap will not seal properly, compromising the integrity of the sample.

h) To maintain sample integrity, only two minutes should ideally transpire between core retrieval from the subsurface and subcoring by the coring device.

i) Soil samples with known high concentrations of VOCs should be separated from soil samples with low concentrations to prevent cross contamination. Ideally, the soil samples of differing VOC concentrations should be placed into different shipping bags and, if possible, placed into separate field coolers.

j) Field personnel must communicate the required detection limits of the soil samples to the stationary laboratory so that the proper extraction procedures can be followed.

k) Consult the laboratory to determine if magnetic stir bars should be added to the VOA vials prior to hermetic sealing in the field. Soil samples subject to Low Level Analysis must be agitated during analysis to assist the VOC purge process. Agitation can be accomplished by either sonication or stirring with magnetic bars. Hence, if the stationary laboratory does not have the ability to sonicate the soil sample with their instrumentation, magnetic stir bars must be added to the VOA vials subject to Low Level Analysis.

l) The soil sample collected for the measurement of dry weight can also be used by the laboratory to evaluate the soil for reactivity with sodium bisulfate solution prior to Low Level Analysis.

C.3 Potential Field Equipment

- VOA Vials – Extra VOA vials should be taken into the field due to potential breakage or expansion of the sampling program due to unanticipated field conditions. Typically, the VOA vials are 40 milliliters in size.

- Coring Devices – Used to obtain the soil subcores; must have a diameter that is slightly smaller than the VOA vials.

- Gloves – Used for health and safety protection; powderless preferable.

- Paper Towels – Used to clean VOA vial threads for proper cap attachment.

- Digital Field Scale – Used to determine the volumetric amount of soil needed for five grams of sample.

- Field Cooler – Insulated ice chest for sample storage and shipment; must be capable of cooling and maintaining the soil samples to 4 ± 2°C or <-7°C, as needed.

- Ice – Used to chill field cooler and samples to 4 ± 2°C. Wet ice preferred over blue ice for chilling to 4 ± 2°C. The wet ice should be double bagged to prevent filling the field coolers with water which may damage the labels on the samples. Dry ice, as needed, for chilling to <-7°C.

- Field Blades – Clean spatula, scoop, trowel or knife used for exposing fresh soil surfaces before subcoring.

- Indelible Ink Pens – Labeling of the soil sample containers; pens that use VOCs, such as markers, are not recommended due to potential cross-contamination.

- Resealable Plastic Bags – Used as a secondary container to prevent moisture infiltration during sample transport.

- Glass Containers – Used to collect soil samples for dry weight determination. Samples for dry weight determination can also be collected in brass sleeves or acetate liners. These samples do not need preservation. However, the collection method should minimize sample handling, sample disaggregation, and moisture loss.

- Decontamination Equipment – Used to decontaminate the field blades and coring devices, for repeated use, as needed.

Appendix D: USEPA Interim Policy

United States Environmental Protection Agency
Region IX

Regional Interim Policy for Determination of Volatile Organic Compound (VOC) Concentrations in Soil and Solid Matrices

June 23, 1999

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105-3901

June 23, 1999

MEMORANDUM

SUBJECT: Regional Interim Policy for Determination of Volatile Organic Compound (VOC) Concentrations in Soil and Solid Matrices.

FROM: Nora McGee, Assistant Regional Administrator
USEPA Region 9

TO: USEPA Region 9 Personnel and Parties Collecting Environmental Measurements Under Regional Programs.

Purpose

Appropriate methodologies to minimize volatilization and biodegradation losses in solid matrices have not been consistently implemented throughout Region 9. This memorandum articulates the Region's policy on the adoption of sampling and laboratory methodologies for the collection of volatile organic compound (VOC) data from soil or solid matrices. USEPA SW-846, Update III, Method 5035, "Closed-System Purge-and-Trap and Extraction for Volatile Organics in Soil and Waste Samples," incorporating procedures to minimize VOC losses was finalized by USEPA in June 1997. This Region 9 policy requires the use of Method 5035, or an equally or more effective method, for the collection of representative and precise data for VOCs in soil and solid matrices. Additionally, this policy was developed to be consistent with the Agency's Data Quality Objectives (DQO) Process (outlined in "Guidance for the Data Quality Objectives Process," USEPA QA/G-4, September 1994) by allowing for a graded approach through the collection of representative data that meets project data quality needs.

Policy

Scope and Applicability

Environmental data collection activities performed under USEPA Region 9 programs for the determination of VOC concentrations in soil and solid matrices.

This policy is applicable to data collection activities conducted by USEPA staff and contractors, USEPA grantees, Federal Facilities, entities complying with USEPA regulatory requirements and/or other entities producing data for USEPA decision making. This includes data being collected under ongoing quality assurance plans and sampling plans.

Time Frame for Implementation

This policy should be adopted quickly and to the maximum practicable extent. Cases where it is not practicable to implement this policy should be brought to the attention of the USEPA Region 9 QA Office. This is being put forth as an interim policy, as USEPA is still evaluating technical information to further refine procedures for minimization of VOC losses. Please note, an amendment to this policy may be required.

Statement of Policy

Methods for the collection and analysis of VOCs in soil or other solid matrices must minimize volatile losses. Because USEPA SW-846 Method 5035 does not rigorously dictate specifics of field sample collection[1] and laboratory sample handling protocols, project specific procedures to minimize volatile losses must be developed and be included in the site/program quality assurance project plan (QAPP) or sampling and analysis plan (SAP). USEPA SW-846 Method 5021 "Volatile Organic Compounds in Soils and Other Solid Matrices Using Equilibrium Headspace Analysis," also incorporates procedures to minimize volatile losses. However, Method 5021 should be used with caution, as it can be reasonably interpreted and performed in a way which does not prevent loss of VOCs. USEPA Region 9 considers the following practices as minimum requirements to reduce volatile losses in soil samples:

1. Samples are handled as intact[2] soil cores in the field and laboratory.

2. Samples are stored in containers which can be reliably sealed to prevent volatilization losses[3] over the project specified analytical holding time.

3. Samples are analyzed or chemically, acid or methanol, preserved within 48 hours of collection, if any contaminant may undergo biodegradation.

4. Exposure of the sample core to the atmosphere in the field and laboratory should be minimized[4].

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1 ASTM Method D4547-98 "Standard Guide for Sampling Waste and Soils for VOCs," is a good reference for VOC sampling protocols.

2 Soils should always be collected and transferred using a coring device, such as a metal sleeve or cut off syringe. Use of transfer devices, such as spatulas, is not acceptable either in the field or laboratory.

3 Volatilization losses from sampling/storage containers must be less than what would be expected from a volatile organic analysis vial with a Teflon/silicon septa stored for 14 days, unless project DQOs require more stringent requirements.

4 Field sub-cores should be taken immediately upon exposing the soil core to ambient conditions. Sub samples should be directly extruded into the analysis containers. Total exposure of samples to ambient conditions should not be more than 15 seconds.

USEPA Region 9 will consider exceptions to this policy on a case-by-case basis. All deviations from procedures outlined in Method 5035 should be documented in a QAPP or a SAP which must be submitted to, and approved by, the Region 9 QA Office. Additionally, the party responsible for data collection must demonstrate that the methodologies proposed will result in data that meet project/program data quality objectives (DQOs).

Additional Considerations

Field Laboratories: The use of field laboratories, that analyze samples within several hours of collection, is an excellent choice to prevent loss of volatiles in transit and storage. However, the sample collection and analysis procedures used must prevent volatilization losses and comply with requirements 1 and 4 articulated in the Statement of Policy. Additionally, the quality control criteria and quality assurance system used by a field laboratory must be adequate for generation of data which will meet project DQOs.

Addition of Surrogates and Matrix Spiking Compounds in the Field: The most appropriate time for addition of analytical surrogate and matrix spiking compounds into soils is prior to sample extraction, by water or a solvent. Method 5035 does not incorporate the addition of the compounds prior to extraction in the field. Because this is an important control check on the analytical process, which begins at extraction, for some project/program DQOs it may be appropriate to incorporate a procedure which adds surrogate and/or matrix spiking compounds prior to extraction.

Holding Times: The holding time for preserved soil samples should be interpreted as 14 days from the time of sample collection(stored at $4\pm2^{o}C$). Due to potential biodegradation losses, samples stored in sealed containers, but not chemically preserved, should not be stored for more than 48 hours. On a project/program specific basis, USEPA Region 9 will consider other alternatives to extend the holding time of soils that have not been chemically preserved (see Attachment A). Holding time will be considered as cumulative (see Attachment B for holding time examples). Exceptions should be documented in a QAPP or a SAP submitted to and approved by the Region 9 QA Office.

Unconsolidated Solid Matrices: Solid Matrices that are not amenable to the use of a coring technique should be collected in such a way as to preserve the integrity of the sample matrix. Transferring of these soils with spatulas or similar devices into sampling containers is discouraged as this disrupts the sample pore spaces and greatly increases the sample surface area available for volatilization. For soil piles, fresh soil at an adequate depth should be sampled.

Calcareous Soils: Method 5035 notes that, "Soil samples that contain carbonate minerals (either from natural sources or applied as an amendment) may effervesce upon contact with the acidic preservative solution in the low concentration sample vial." Calcareous soils that effervesce on contact with the low-level preservative solution should be collected using an alternative preservation technique (see Attachment A).

Soil Gas: This policy is not intended to address the role of soil gas in the environmental decision making process. The Region recognizes that soil gas data is used extensively, in USEPA Region 9, for site decision making and in some cases soil gas is the preferred tool for gathering data on subsurface conditions. However, there are also scenarios where soil gas data are unacceptable for agency decision making (e.g., in excavated soils and when determining disposal options).

Drilling Techniques: This policy does not address the impact of drilling techniques on the collection of a representative VOC sample. Site/program QAPPs and SAPs should address the impact of all collection techniques on sample integrity and select those appropriate for the DQOs. Potential VOC losses due to drilling techniques include, but are not limited to: sample compression and loss of pore space; air introduction into the sample matrix; heat introduced in the drilling process; and volatilization from prolonged periods in a non-hermetically sealed sampling apparatus.

Background

Traditional practices for the sampling and analysis of volatile organic compounds (VOCs) in soil have been shown to have a significantly low bias of inconsistent magnitude (Grant, 1996) from volatilization (Hewitt, 1996) and biodegradation (Hewitt, 1994). Based on this and other research, the USEPA modified the methodology in SW846 for collection and analysis of volatiles in soil. Soil was deleted as an option from Method 5030 and Method 5035 and Method 5021 were added. These methods provide for handling of samples as intact soil cores, chemical preservation techniques, storage of samples in hermetically sealed containers and minimization of analyte losses due to direct volatilization (both in the field and the laboratory) and biodegradation.

"Traditional" collection techniques, such as transferring soils to a glass jar with minimal head space and collecting samples directly into a brass sleeve (e.g., CA Split Spoon) do not yield accurate or consistent results. It has been specifically demonstrated that capped brass sleeves show significant losses. Hewitt and Lukash (Hewitt, 1996) demonstrated capped sleeves can show substantial losses in less than one day. Hewitt and Lukash also demonstrated volatile losses in uncapped core liners of up to 90% in less than 40 minutes for trichloroethene (TCE). Because other analytes and matrix types can have higher mobility than those tested, substantial losses may occur in an even shorter period of time. Grant, Jenkins and Mudambi (Grant, 1996) examined split sampling results from a cross section of laboratories. For VOCs in soil they noted that, "The magnitude of this scatter [for a typical data comparison] is so large that it is

impossible to recommend effective limits of acceptability. Instead, we believe that steps are urgently needed to improve data quality." Hewitt noted (Hewitt, 1994) that biodegradation of Benzene and Toluene in soil samples stored in sealed glass ampules at 4 C for 14 days could be substantial, demonstrating a need for chemical preservatives. Turriff and Reitmeyer (Turriff, 1998) demonstrated that a variety of soil matrices could be held for 48 hours at 4 C, in sealed zero headspace containers, without substantial VOC losses. Additionally, Turriff and Reitmeyer demonstrated that freezing was an option to extend holding times of En Core™ sampling devices. Because volatile losses have been linked to disturbance of the soil matrix and exposure to the atmosphere, samples should be handled in intact soil cores and stored in hermetically sealed vessels in both the field and the laboratory.

This USEPA Region 9 policy is based on the best scientific information available at this time and is subject to further clarifications and additions as other research becomes available. If you have any questions please call Vance Fong at 415 744-1492 or Mathew Plate at 415 744-1493.

References

Hewitt, A.D. (1994) Concentration Stability of Four Volatile Organic Compounds in Soil Subsamples. US Army Cold Regions Research and Engineering Laboratory, Special Report 94-6.

Grant, C.L., T.F. Jenkins and A.R. Mudambi (1996) Comparison Criteria for Environmental Chemical Analyses of Split Samples Sent to Different Laboratories, Corps of Engineers Archived Data. US Army Cold Regions Research and Engineering Laboratory, Special Report 96-9.

Hewitt, A.D. and J.E. Lukash (1996) Obtaining and Transferring Soils for In-Vial Analysis of Volatile Organic Compounds. US Army Cold Regions Research and Engineering Laboratory, Special Report 96-5.

Turriff, D. Ph.D. and C. Reitmeyer (1998) Validation of Holding Times for the EnCore™ Sampler. En Novative Technologies, Inc.

Attachment A

Preservation Alternatives: The following are preservation alternatives that may be appropriate for some projects/programs and are subject to project/program specific approval by the USEPA Region 9 QA Office.

> **Freezing of unpreserved samples:** It has been shown in several studies that freezing of unpreserved soils is an effective means of slowing the biodegradation process. At this time, USEPA Region 9 will accept freezing of unpreserved soils as a method to extend holding times up to seven days on a project specific basis. While there is some evidence that freezing for longer periods may also be acceptable for some data needs, USEPA Region 9 does not believe that the current scientific evidence supports a longer holding time for frozen samples in most cases. Samples should be frozen in containers that have an air tight seal and can maintain this seal while frozen. Because water expands in the freezing process, VOA vials with water or samples with extremely high moisture contents may rupture the storage container.
>
> **Preservatives**: Acids other than sodium bisulfate may be used to preserve low level samples. The choice of an alternative acid should be made in consultation with the USEPA Region 9 QA Office. In all cases the preserved sample pH should be 2.

Sampling Containers: Currently the Region recognizes three sample collection/storage alternatives which can be used (other than acid/water or methanol, as specified in Method 5035).

> 1. A VOA vial with 5 mL of water without preservative and approximately 5 g of sample. Which must be analyzed within 48 hours of collection by closed system purge and trap.
>
> 2. A VOA vial with approximately 5 g of sample. Water must be introduced through the septa at time of analysis by closed system purge and trap. Sample must be analyzed within 48 hours of collection if stored at 4±2°C or 7 days if frozen. (This alternative must be approved on a project specific basis.)
>
> 3. An En Core™ sampler which is analyzed or preserved within 48 hours of collection if stored at 4±2°C or analyzed within 7 days if frozen. (Freezing of En Core™ samplers must be approved on a project specific basis.)

If requested, USEPA Region 9 QA Office will consider the applicability of other sampling containers/devices that have been demonstrated, with appropriate supporting documentation, to be adequate for collection and storage of VOCs.

Attachment B Examples of Holding Time Policy

Example 1 Sample is placed into a vial without chemical preservative in the field (due to effervescence) and stored at 4±2°C.

Sample must be analyzed within 48 hours of collection.

Example 2 Sample is collected into a hermetically sealed sub-coring and storage device in the field, stored at 4±2°C and transferred into a vial without chemical preservative in the laboratory.

Sample must be analyzed within 48 hours of collection.

Example 3 Sample is collected into a hermetically sealed sub-coring and storage device, transported/stored at 4±2°C, frozen at the laboratory 28 hours after collection, defrosted after 2 days and transferred into a vial without chemical preservative in the laboratory.

Sample must be analyzed within 20 hours from the time the sample is defrosted to 4±2°C.
48 (hours allowed) - 28 (hours before freezing) = 20 (hours allowed from defrosting to analysis)

COMMENT SHEET
Method 5035 Guidance Document

As a user of this guidance document, your comments are important to the Department of Toxic Substances Control. Please use this sheet to inform us of any errors, deficiencies, or suggestions that may improvement this document. If you identify errors or technical deficiencies, please provide suggestions for their rectification.

Please send comments to:

Department of Toxic Substances Control
8800 Cal Center Drive
Sacramento, California 95826-3200
Attention: Geological Services Unit

Your name and address are optional, but if included, a written response will be provided.

Appendix C-2

Superfund Program Representative Sampling Guidance for Soil

U.S.EPA REGION 9 LABORATORY

RICHMOND, CALIFORNIA

FIELD SAMPLING GUIDANCE DOCUMENT #1205

SOIL SAMPLING

TABLE OF CONTENTS

1.0 SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) is applicable to the collection of representative soil samples. Analysis of soil may determine whether concentrations of specific contaminants exceed established threshold action levels, or if the concentrations present a risk to public health, welfare, or the environment.

The methodologies discussed in this procedure are applicable to the sampling of (dry) soil. Typically this term "soil" refers to samples which are not covered with an aqueous layer for more than 30% of the time. The descriptions and procedures are generic in nature and may be modified in whole or part to meet the handling and analytical requirements of the contaminants of concern, as well as the constraints presented by the sampling area. However, if modifications occur, they should be documented in the site logbook or report summarizing field activities.

2.0 METHOD SUMMARY

Soil samples may be recovered using a variety of methods and equipment, depending on the portion of the soil profile required (surface versus subsurface), and the type of sample required (disturbed versus undisturbed) and the soil type.

Soil is collected directly, using a hand-held device such as hand scoop, auger or a post hole digger, or indirectly using a power activated device such as power augers, back hoes, or drill rigs. Following collection, the soil can be homogenized in a container constructed of inert material and transferred to the appropriate sample containers.

NOTE: This SOP does not provide sufficient detail to describe the essential details for collecting samples for volatile organic compounds; e.g., total petroleum hydrocarbons-gasoline, BTEX, etc. There are many nuances for sampling soil VOCs, thus a separate SOP(#1210) is being drafted to explain specific sampling, sub-sampling, preservation and analytical preparations. The reader may also refer to EPA Method 5035, "Closed-System Purge-and-Trap and Extraction for Volatile Organics in Soil and Waste Samples" (1996).

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

- Chemical preservation of solids is generally not recommended. Cooling is usually the best approach, supplemented by the appropriate holding time.

- Wide-mouth glass containers with Teflon-lined caps are utilized for soil samples. The sample volume is a function of the analytical requirements and will be specified in the work plan.

- Transfer soil from the sample collection device to an appropriate sample container using a stainless steel or plastic scoop or equivalent. If composite samples are collected, place the soil sample in a stainless steel, plastic or other appropriate composition (e.g.: Teflon) bucket, and mix

thoroughly to obtain a homogeneous sample representative of the entire sampling interval. Then aliquot the soil sample into labeled containers.

- Samples for volatile organic analysis must be collected directly from the bucket, before mixing the sample, to minimize loss due to volatilization of contaminants.

- All sampling devices should be decontaminated, then wrapped in aluminum foil. The sampler should remain in this wrapping until it is needed. Each sampler should be used for only one sample. Dedicated samplers for soil samples may be impractical due to the large number of soil samples which may be required and the cost of the sampler. In this case, samplers should be cleaned in the field using the decontamination procedure described in SOP #1230, *Sampling Equipment Decontamination*.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

Substrate particle size and organic content are directly related to water velocity and flow characteristics of a body of water. Contaminants are more likely to be concentrated in soils typified by fine particle size and a high organic content. This type of soil is most likely to be collected from depositional zones. In contrast, coarse soils with low organic content do not typically concentrate pollutants and are found in erosional zones. The selection of a sampling location can, therefore, greatly influence the analytical results.

5.0 EQUIPMENT/APPARATUS

Equipment needed for collection of soil samples includes:

- maps/plot plan
- safety equipment--photoinjection detector, OVM
- compass
- tape measure
- survey stakes, flags, or buoys and anchors
- camera and film
- stainless steel, plastic, or other appropriate composition bucket
- 4-oz, 8-oz, and one-quart, wide-mouth jars w/Teflon-lined lids
- Ziploc plastic bags
- logbook
- sample jar labels
- chain of custody forms
- custody seals
- field data sheets
- cooler(s)
- ice
- decontamination supplies/equipment
- spade or shovel
- scoop

- bucket auger
- hand auger
- extension rods
- T-handle
- power augers
- backhoes
- drill rigs

6.0 REAGENTS

Reagents are not used for preservation of soil samples. Decontamination solutions are specified in SOP #1230, *Sampling Equipment Decontamination*.

7.0 PROCEDURES

7.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and required equipment and supplies according to the sampling QA plans for the site.
2. Obtain necessary sampling and monitoring equipment.
3. Decontaminate or preclean equipment, and ensure that it is in working order.
4. Prepare schedules, and coordinate with staff, client, and regulatory agencies, 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, flags, or buoys to identify and mark all sampling locations. Specific site characteristics, including flow regime, basin morphometry, soil characteristics, depth of overlying aqueous layer, and 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.

7.2 Sample Collection

Selection of a sampling device is most often contingent upon: (1) depth of water at the sampling location, and (2) the physical characteristics of the medium to be sampled.

7.2.1 <u>Sampling Surface Soils with a Trowel or Hand Scoop</u>

Collection of surface soil can be accomplished with tools such as spades, shovels, and scoops. Surface soil can be removed to the required depth with a garden spade, then use a stainless steel or plastic scoop to collect the sample.

Accurate, representative samples can be collected with this procedure depending on the care and precision demonstrated by the sample team member. A stainless steel or plastic scoop or lab spoon 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.

Follow these procedures to collect soil samples with a scoop or trowel:

1. Using a precleaned stainless steel scoop or trowel remove vegetation and top layer of soil, then loosen the desired volume of soil from the sampling area.
2. Transfer the discrete grab sample into an appropriate samples container.
3. For composite sample, homogenize grab samples in a stainless steel or glass mixing container using the appropriate tool (stainless steel spoon, trowel, or pestle).
4. Secure the cap tightly. Chemical preservation of solids is generally not recommended.
5. Label and tag sample containers, and record appropriate data on soil sample data sheets (depth, location, color, other observations).
6. Place glass sample containers in sealable plastic bags, if required, and place containers into an iced shipping container. Samples should be cooled to 4°C as soon as possible.
7. Complete chain of custody forms and ship as soon as possible to minimize sample holding time. Scheduled arrival time at the analytical laboratory should give as much much of a holding time as possible for scheduling of sample analysis.
8. Follow required decontamination and disposal procedures (see SOP #1230).

7.2.2 Sampling Surface Soils with a Hand Auger

This system uses an auger, a series of extension rods, a "T" handle, and a thin-wall tube sampler. The auger bores a hole to a desired sampling depth and then is withdrawn. The auger tip is then replaced with a tube core sampler, lowered down the borehole, and driven into the soil at the completion depth. The core is then withdrawn and the sample collected. Posthole augers have limited utility for sample collection, as they are designed more for their ability to cut through fibrous, rooted areas. Bucket augers are better for direct sample recovery, are fast, and provide a large volume of sample.

Use the following procedure to collect soil samples with a hand auger:

1. Insert the auger into the material to be sampled at a 0^{o} to 45^{o} angle from vertical. This orientation minimizes spillage of the sample from the sampler. Extraction of samples may require tilting of the sampler.
2. Rotate the auger once or twice to cut a core of material.
3. Slowly withdraw the auger, making sure that the slot is facing upward.
4. An acetate core may be inserted into the auger prior to sampling, if characteristics of the soils or body of water warrant. By using this technique, an intact core can be extracted.
5. Transfer the sample into an appropriate sample or homogenization container.

OR

Follow these procedures to collect soil samples with a hand auger:

1. Attach the auger bit to a drill extension rod, then attach the "T" handle to the drill extension rod.

2. Clear the area to be sampled of any surface debris.
3. Begin augering, periodically removing any accumulated soil from the auger bucket.
4. After reaching the desired depth, slowly and carefully remove the auger from boring. (When sampling directly from the auger, collect sample after the auger is removed from boring and proceed to Step 10.)
5. Remove auger tip from drill rods and replace with a precleaned thin-wall tube sampler. Install proper cutting tip.
6. Carefully lower tube sampler down borehole. Gradually force tube sampler into soil. Care should be taken to avoid scraping the borehole sides. Also **avoid hammering** of the drill rods to facilitate coring, since the vibrations may cause the boring walls to collapse.
7. Remove tube sampler and unscrew drill rods.
8. Remove cutting tip and remove core from device.
9. Discard top of core (approximately 1 inch), as this represents material collected by the tube sampler before penetration of the layer of concern.
10. Transfer sample into an appropriate sample or homogenization container.

7.2.4 Sampling Surface Soils From Power augers etc.

Samples for volatile organic analysis must be collected by sub-sampling directly from the bucket before mixing the sample to minimize volatilization of contaminants.

7.2.5 Sampling Subsurface Soils with a drill rig

Follow these procedures when using a sample coring device to collect subsurface soils. It consists of a coring device, handle, and acetate core utilized in the following procedure:

1. Assemble the coring device by inserting the acetate core into the sampling tube.This sampling device works best in medium to fine-grained cohesive sediments.
2. For loose sandy materials place an “eggshell” check valve mechanisms into the tip of the sampling tube with the convex surface positioned inside the acetate core.
3. Screw the coring point onto the tip of the sampling tube.
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 material to be sampled.
6. This sampler may be used with either a drive hammer for firm consolidated soils, or a “T” handle for soft soils. If the “T” handle is used, place downward pressure on the device until the desired depth is reached. Rotate the sample to shear off the core of the bottom, retrieve the device 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. With left hand holding the tube, drive the sampler into the material to the desired depth. Do not drive the tube further than the tip of the hammer’s guide.
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 at least two revolutions to shear off the sample 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 90º
13. Withdraw the sampler by puling the handle (hammer) upwards and dislodging the hammer from the sampler.
14. Unscrew the coring point and remove the "eggshell" check valve.
15. Slide the acetate core out of the sampler tube. The acetate core may be capped at both ends. The sample may be used in this fashion, or the contents transferred to a stainless steel or plastic bucket and mixed thoroughly to obtain a homogeneous sample representative of the entire sampling interval.
16. Samples for volatile organic analysis must be collected directly from the bucket before mixing the sample to minimize volatilization of contaminants.

8.0 CALCULATIONS

This section is not applicable to this SOP.

9.0 QUALITY ASSURANCE/QUALITY CONTROL

There are no specific quality assurance activities which apply to the implementation of these procedures. However, the following QA/QC procedures apply:

1. All data must be documented on field data sheets or within site logbooks.

2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation, and they must be documented.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OSHA and specific health and safety procedures.

More specifically, when sampling soil from areas containing known or suspected hazardous substances, adequate precautions must be taken to ensure the sampler's safety. The team member collecting the sample should not climb into trenches where bank failure may cause him or her to lose their balance. To prevent this, the person performing the sampling should be completed via augers with extensions or from directly from the backhoe immediately after removal from the ambient ground area.

OSWER Directive 9360.4-10
EPA 540/R-95/141
PB96-963207
December 1995

SUPERFUND PROGRAM

REPRESENTATIVE SAMPLING GUIDANCE

VOLUME 1: SOIL

Interim Final

Environmental Response Team

Office of Emergency and Remedial Response
Office of Solid Waste and Emergency Response
U.S. Environmental Protection Agency
Washington, DC 20460

Notice

This document has been reviewed in accordance with U.S. Environmental Protection Agency policy and approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

The policies and procedures established in this document are intended solely for the guidance of government personnel, for use in the Superfund Program. They are not intended, and cannot be relied upon, to create any rights, substantive or procedural, enforceable by any party in litigation with the United States. The Agency reserves the right to act at variance with these policies and procedures and to change them at any time without public notice.

For more information on Soil Sampling and Surface Geophysics procedures, refer to the *Compendium of ERT Soil Sampling and Surface Geophysics Procedures*, OSWER directive 9360.4-02, EPA/540/P-91/006. Topics covered in this compendium include Sampling Equipment Decontamination, Soil Sampling, Soil Gas Sampling, and General Surface Geophysics. The compendium describes procedures for collecting representative soil samples and provides a quick means of waste site evaluation. It also addresses the general procedures used to acquire surface geophysical data.

Questions, comments, and recommendations are welcomed regarding the *Superfund Program Representative Sampling Guidance, Volume 1 -- Soil*. Send remarks to:

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1.0 INTRODUCTION

1.1 OBJECTIVE AND SCOPE

This is the first volume in a series of guidance documents that assist Superfund Program Site Managers, On-Scene Coordinators (OSCs), Remedial Project Managers (RPMs), and other field staff in obtaining representative samples at Superfund sites. The objective of representative sampling is to ensure that a sample or a group of samples accurately characterizes site conditions. This document specifically addresses representative sampling for soil. The information presented here is valid throughout the Superfund program, but focuses on the objectives of early action activities and emergency responses. Topics covered in the document include: assessing available information; selecting an appropriate sampling approach; selecting and utilizing geophysical, analytical screening, and sampling equipment; utilizing proper sample preparation techniques; incorporating suitable types and numbers of Quality Assurance/Quality Control (QA/QC) samples; and interpreting and presenting the analytical and geophysical data.

In the Superfund program, representative sample data collected during emergency responses or early actions may form the basis of remedial response. Longer, more complex responses require a variety of sampling objectives, including identifying threat, delineating sources and extent of contamination, and confirming the achievement of clean-up standards. Many important and potentially costly decisions are based on the sampling data, making it very important that OSCs and field personnel understand how accurately the sampling data characterize the actual site conditions. In keeping with this strategy, this document emphasizes analytical screening and geophysical techniques as cost effective approaches to characterize the site and to select sampling locations.

1.2 Conceptual Site Model

A conceptual site model is a useful tool for selecting sampling locations. It helps ensure that sources, pathways, and receptors throughout the site have been considered before sampling locations are chosen. The conceptual model assists the Site Manager in evaluating the interaction of different site features. Risk assessors use conceptual models to help plan for risk assessment activities. Frequently, a conceptual model is created as a site map (see Figure 1) or it may be developed as a flow diagram which describes potential migration of contaminants to site receptors (see Appendix A).

A conceptual model follows contaminants from their sources, to pathways (e.g., air, surface water), and eventually to the assessment endpoints. Consider the following when creating a conceptual model:

- The state(s) of each contaminant and its potential mobility
- Site topographical features
- Meteorological conditions (e.g., wind direction/speed, average precipitation, temperature, humidity)
- Human/wildlife activities on or near the site

The conceptual site model on the next page is an example created for this document. The model assists in identifying the following site characteristics:

Potential Sources:

Site (waste pile); drum dump; agricultural activities

Potential Exposure Pathway (Soil):

Leachate from the waste pile or drum dump; contaminated soil from direct contact with the waste pile or drum dump; agricultural activities such as pesticide application onto cropland

NOTE: Soil is described as an *exposure* pathway rather than a *migration* pathway because, unlike other media (e.g., air), contact between contaminated soil and a receptor is initiated by the receptor.

Potential Exposure Routes:

Ingestion -- Soil particles from the waste pile, drum dump or area of agricultural activity

Absorption/direct contact -- Soil near the waste pile, drum dump or area of agricultural activity

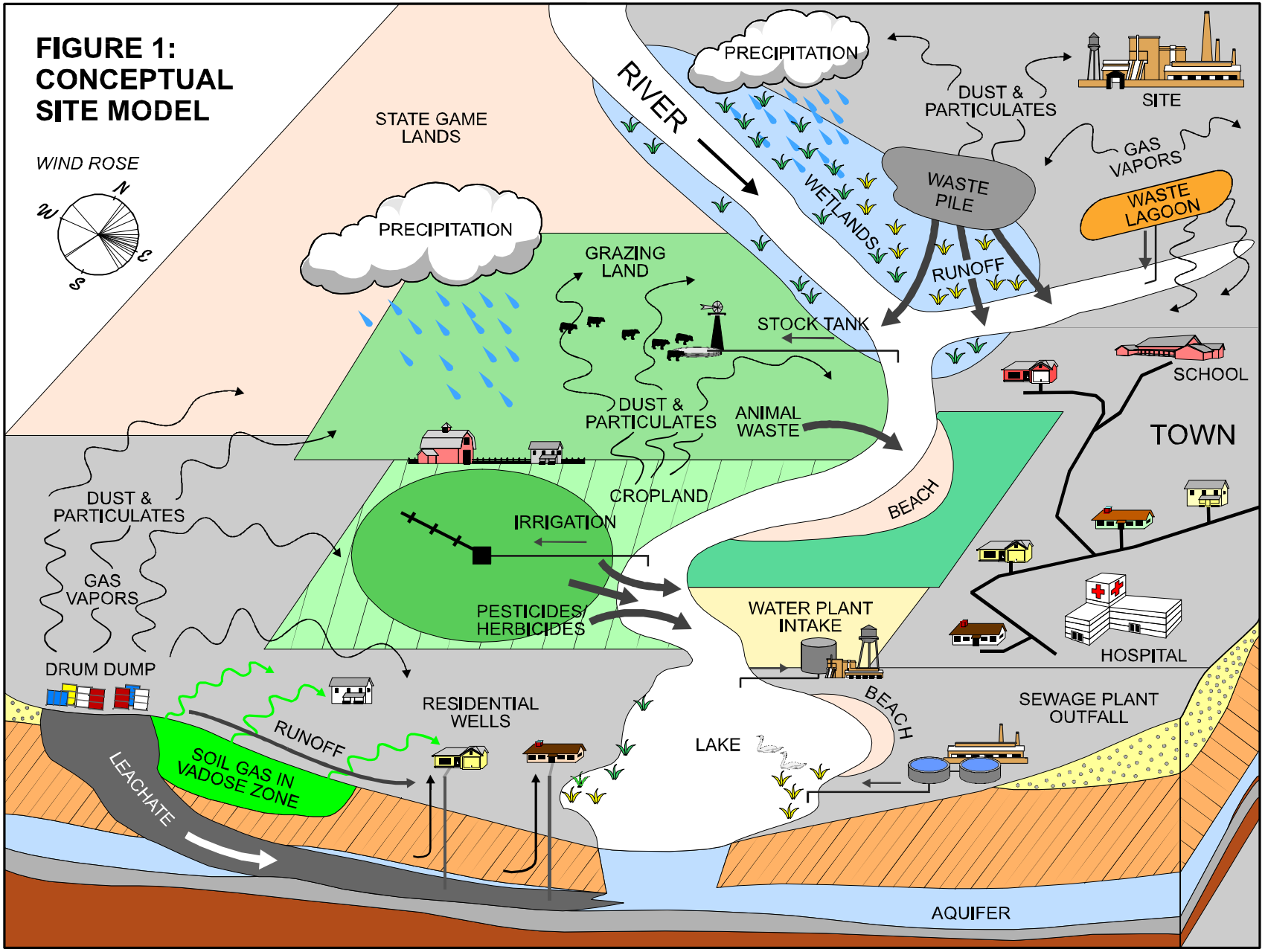


FIGURE 1:
CONCEPTUAL
SITE MODEL
WIND ROSE
N
E
S
W
STATE GAME
LANDS
RIVER
PRECIPITATION
DUST &
PARTICULATES
SITE
GAS
VAPORS
WASTE
PILE
WASTE
LAGOON
WETLANDS
RUNOFF
PRECIPITATION
GRAZING
LAND
STOCK TANK
SCHOOL
TOWN
DUST &
PARTICULATES
ANIMAL
WASTE
CROPLAND
BEACH
DUST &
PARTICULATES
IRRIGATION
GAS
VAPORS
PESTICIDES/
HERBICIDES
WATER PLANT
INTAKE
HOSPITAL
DRUM DUMP
RESIDENTIAL
WELLS
BEACH
SEWAGE PLANT
OUTFALL
RUNOFF
SOIL GAS IN
VADOSE ZONE
LEACHATE
LAKE
AQUIFER

Potential Receptors of Concern (and associated potential exposure routes):

Human Population

Residents/Trespassers:

Leachate into soil from the drum dump; direct contact with soil contaminated by pesticides or other agricultural activities in the cropland

Workers/Trespassers:

Leachate into soil from the waste pile; contaminated soil associated with the waste pile or agricultural activities in the cropland

Biota

Endangered/threatened species or human food chain organisms, if suspected to be in contact with an area of potentially contaminated soil

Preliminary site information may provide the identification of the contaminant(s) of concern and the level(s) of the contamination. A sampling plan should be developed based upon the selected receptors of concern and the suspected sources and pathways. The model may assist in the selection of on-site and off-site sampling locations.

1.3 REPRESENTATIVE SAMPLING OBJECTIVES

Representative sampling applies to all phases of a Superfund response action. Representative sampling objectives for soil include:

1. Establishing threat to public health or welfare or to the environment;

2. Locating and identifying potential sources of contamination;

3. Defining the extent of contamination;

4. Determining treatment and disposal options; and

5. Documenting the attainment of clean-up goals.

These objectives are discussed in detail in Section 2.5.

1.4 REPRESENTATIVE SAMPLING

Representative soil sampling ensures that a sample or group of samples accurately reflects the concentration of the contaminant(s) of concern at a given time and location. Analytical results from representative samples reflect the variation in pollutant presence and concentration throughout a site.

This document concentrates on the variables that are introduced in the field -- namely, those that relate to the site-specific conditions, the sampling design approach, and the techniques for collection and preparation of samples. The following variables affect the representativeness of samples and subsequent measurements:

- Geological variability -- Regional and local variability in the mineralogy of rocks and soils, the buffering capacity of soils, lithologic permeability, and in the sorptive capacity of the vadose zone.

- Contaminant concentration variability -- Variations in the contaminant concentrations throughout the site.

- Collection and preparation variability -- Deviations in analytical results attributable to bias introduced during sample collection, preparation, and transportation (for analysis).

- Analytical variability -- Deviations in analytical results attributable to the manner in which the sample was stored, prepared, and analyzed by the on-site or off-site laboratory. Although analytical variability cannot be corrected through representative sampling, it can falsely lead to the conclusion that error is due to sample collection and handling procedures.

1.5 EXAMPLE SITE

An example site, presented at the end of each chapter, illustrates the development of a representative soil sampling plan that meets Superfund Program objectives for early actions or emergency responses.

2.0 SAMPLING DESIGN

2.1 INTRODUCTION

The following procedures are recommended for developing a sound sampling design. Many steps can be performed simultaneously, and the sequence is not rigid.

- Review existing historical site information;
- Perform a site reconnaissance;
- Evaluate potential migration pathways and receptors;
- Determine the sampling objectives;
- Establish the data quality objectives;
- Utilize screening techniques;
- Select parameters for which to be analyzed;
- Select an appropriate sampling approach; and
- Determine the locations to be sampled.

Real-time analytical screening techniques can be used throughout the removal action. The results can be used to modify the site sampling plan as the extent of contamination becomes known.

2.2 HISTORICAL DATA REVIEW

Unless the site is considered a classic emergency, every effort should be made to first thoroughly review relevant site information. An historical data review examines past and present site operations and disposal practices, providing an overview of known and potential site contamination and other site hazards. Sources of information include federal, state and local officials and files (e.g., site inspection reports and legal actions), deed or title records, current and former facility employees, potentially responsible parties, local residents, and facility records or files. For any previous sampling efforts, obtain information regarding sample locations (on maps, if possible), matrices, methods of collection and analysis, and relevant contaminant concentrations. Assess the reliability and usefulness of existing analytical data. Even data which are not substantiated by documentation or QA/QC controls may still be useful.

Collect information that describes any specific chemical processes used on site, as well as descriptions of raw materials used, products and wastes, and waste storage and disposal practices. Whenever possible, obtain site maps, facility blueprints, and historical aerial photographs, detailing past and present storage, process, and waste disposal locations. The local Agricultural Extension Agent, a Soil Conservation Service (SCS) representative, has information on soil types and drainage patterns. County property and tax records, and United States Geological Survey (USGS) topographic maps are also useful sources of site and regional information.

2.3 SITE RECONNAISSANCE

A site reconnaissance, conducted either prior to or in conjunction with sampling, is invaluable to assess site conditions, to evaluate areas of potential contamination, to evaluate potential hazards associated with sampling, and to develop a sampling plan. During the reconnaissance, fill data gaps left from the historical review by:

- Interviewing local residents, and present or past employees about site-related activities;
- Researching facility files or records (where records are made accessible by owner/operator);
- Performing a site entry, utilizing appropriate personal protective equipment and instrumentation. Observe and photo-document the site; note site access routes; map process and waste disposal areas such as landfills, lagoons, and effluent pipes; inventory site wastes; and map potential transport routes such as ponds, streams, and irrigation ditches. Note topographic and structural features, dead animals and dead or stressed vegetation, potential safety hazards, and visible label information from drums, tanks, or other containers found on the site.

2.4 MIGRATION PATHWAYS AND RECEPTORS

The historical review and site visit are the initial steps in defining the source areas of contamination which could pose a threat to human health and the environment. This section addresses how to delineate the spread of contamination away from the source areas. Included are pollutant migration pathways and

the routes by which persons or the environment may be exposed to the on-site chemical wastes.

2.4.1 Migration Pathways and Transport Mechanisms

Migration pathways are routes by which contaminants have moved or may be moved away from a contamination source. Pollutant migration pathways may include man-made pathways, surface drainage, vadose zone transport, and wind dispersion. Human activity (such as foot or vehicular traffic) also transports contaminants away from a source area. These five transport mechanisms are described below.

- Man-made pathways -- A site located in an urban setting has the following man-made pathways which can aid contaminant migration: storm and sanitary sewers, drainage culverts, sumps and sedimentation basins, French drain systems, and underground utility lines.

- Surface drainage -- Contaminants can be adsorbed onto sediments, suspended independently in the water column, or dissolved in surface water runoff and be rapidly carried into drainage ditches, streams, rivers, ponds, lakes, and wetlands. Consider prior surface drainage routes; historical aerial photographs can be invaluable for delineation of past surface drainage patterns. An historical aerial photograph search can be requested through the EPA Regional Remote Sensing Coordinator.

- Vadose zone transport -- Vadose zone transport is the vertical or horizontal movement of water and of soluble and insoluble contaminants within the unsaturated zone of the soil profile. Contaminants from a surface source or a leaking underground storage tank can percolate through the vadose zone and be adsorbed onto subsurface soil or reach groundwater.

- Wind dispersion -- Contaminants deposited over or adsorbed onto soil may migrate from a waste site as airborne particulates. Depending on the particle-size distribution and associated settling rates, these particulates may be deposited downwind or remain suspended, resulting in contamination of surface soils and/or exposure of nearby populations.

- Human and animal activity -- Foot and vehicular traffic of facility workers, response personnel, and trespassers can move contaminants away from a source. Animal burrowing, grazing, and migration can also contribute to contaminant migration.

2.4.2 Receptors

Once the migration pathways have been determined, identify all receptors (i.e., potentially affected human and environmental populations) along these pathways. Human receptors include on-site and nearby residents and workers. Note the attractiveness and accessibility of site wastes (including contaminated soil) to children and other nearby residents. Environmental receptors include Federal- or state-designated endangered or threatened species, habitats for these species, wetlands, and other Federal- and state-designated wilderness, critical, and natural areas.

2.5 SOIL REPRESENTATIVE SAMPLING OBJECTIVES

Collect samples if any of the following sampling objectives in the scope of the project are not fulfilled by existing data.

1. Establishing Threat to Public Health or Welfare or to the Environment -- The Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) and the National Contingency Plan (NCP) establish the funding mechanism and authority which allow the OSC to activate a Federal removal action. The OSC must establish (often with sampling) that the site poses a threat to public health or welfare or to the environment.

2. Locating and Identifying Potential Sources of Contamination -- Sample to identify the locations and sources of contamination. Use the results to formulate removal priorities, containment and clean-up strategies, and cost projections.

3. Defining the Extent of Contamination -- Where appropriate, sample to assess horizontal and vertical extent of contaminant concentrations. Use the results to determine the site boundaries (i.e., extent of contamination), define clean areas, estimate volume of contaminated soil, establish a clearly defined removal approach, and assess removal costs and timeframe.

4. Determining Treatment and Disposal Options -- Sample to characterize soil for in situ or other on-site treatment, or excavation and off-site treatment or disposal.

5. Documenting the Attainment of Clean-up Goals -- During or following a site cleanup, sample to determine whether the goals were achieved, and to delineate areas requiring further treatment or excavation when appropriate.

2.6 DATA QUALITY OBJECTIVES

Data quality objectives (DQOs) state the level of uncertainty that is acceptable from data collection activities. DQOs also define the data quality necessary to make a certain decision. Consider the following when establishing DQOs for a particular project:

- Decision(s) to be made or question(s) to be answered;
- Why environmental data are needed and how the results will be used;
- Time and resource constraints on data collection;
- Descriptions of the environmental data to be collected;
- Applicable model or data interpretation method used to arrive at a conclusion;
- Detection limits for analytes of concern; and
- Sampling and analytical error.

In addition to these considerations, the quality assurance components of precision, accuracy (bias), completeness, representativeness, and comparability should also be considered. Quality assurance components are defined as follows:

- Precision -- measurement of variability in the data collection process.
- Accuracy (bias) -- measurement of bias in the analytical process. The term "bias" throughout this document refers to the QA/QC accuracy component.
- Completeness -- percentage of sampling measurements which are judged to be valid.
- Representativeness -- degree to which sample data accurately and precisely represent the characteristics of the site contaminants and their concentrations.
- Comparability -- evaluation of the similarity of conditions (e.g., sample depth, sample homogeneity) under which separate sets of data are produced.

Quality assurance/quality control (QA/QC) objectives are discussed further in Chapter 5.

2.7 ANALYTICAL SCREENING AND GEOPHYSICAL TECHNIQUES

There are two primary types of analytical data which can be generated during sampling: laboratory analytical data and analytical screening data. Analytical screening techniques (e.g., using a photoionization detector (PID), portable X-ray fluorescence (XRF) unit, and hazard categorization kits) provide real-time or direct reading capabilities. These screening methods can narrow the possible groups or classes of chemicals for laboratory analysis and are effective and economical for gathering large amounts of site data. Once an area is identified using screening techniques, a subset of samples can be sent for laboratory analysis to substantiate the screening results. Under a limited sampling budget, analytical screening (with laboratory confirmation) will generally result in more analytical data from a site than will sampling for off-site laboratory analysis alone. To minimize the potential for false negatives (not detecting on-site contamination), use only those analytical screening methods which provide detection limits below applicable action levels. It should be noted, that some analytical screening methods which do not achieve detection limits below site action levels can still detect grossly contaminated areas, and can be useful for some sampling events.

Geophysical techniques may also be utilized during a removal action to help depict locations of any potential buried drums or tanks, buried waste, and disturbed areas. Geophysical techniques include ground penetrating radar (GPR), magnetometry, electromagnetic conductivity (EM) and resistivity surveys.

2.8 PARAMETERS FOR ANALYSIS

If the historical data review yields little information about the types of waste on site, use applicable screening methods to narrow the parameters for analysis by ruling out the presence of high concentrations of certain contaminants. If the screening results are inconclusive, send a subset of samples from the areas of concern for a full chemical

characterization by an off-site laboratory. It is advised that samples from known or suspected source areas be sent to the laboratory for a full chemical characterization so that all contaminants of concern can be identified (even at low detection levels), and future sampling and analysis can then focus on those substances.

Away from source areas, select a limited number of indicator parameters (e.g., lead, PAHs) for analysis based on the suspected contaminants of concern. This will result in significant cost savings over a full chemical characterization of each sample. Utilize EPA-approved methodologies and sample preparation, where possible, for all requested off-site laboratory analyses.

2.9 SAMPLING APPROACHES

Selecting sampling locations for screening or laboratory analysis entails choosing the most appropriate sampling approach. Representative sampling approaches include **judgmental, random, stratified random, systematic grid, systematic random, search, and transect sampling**. A representative sampling plan may combine two or more of these approaches. Each approach is defined below.

2.9.1 Judgmental Sampling

Judgmental sampling is the subjective selection of sampling locations at a site, based on historical information, visual inspection, and on best professional judgment of the sampling team. Use judgmental sampling to identify the contaminants present at areas having the highest concentrations (i.e., worst-case conditions). Judgmental sampling has no randomization associated with the sampling strategy, precluding any statistical interpretation of the sampling results.

2.9.2 Random Sampling

Random sampling is the arbitrary collection of samples within defined boundaries of the area of concern. Choose random sample locations using a random selection procedure (e.g., using a random number table). Refer to U.S. EPA, 1984a, for a random number table. The arbitrary selection of sampling points requires each sampling point to be selected independent of the location of all other points, and results in all locations within the area of concern having an equal chance of being selected. Randomization is necessary in order to make probability or confidence statements about the sampling results. The key to interpreting these probability statements is the assumption that the site is homogeneous with respect to the parameters being monitored. The higher the degree of heterogeneity, the less the random sampling approach will adequately characterize true conditions at the site. Because hazardous waste sites are very rarely homogeneous, other statistical sampling approaches (discussed below) provide ways to subdivide the site into more homogeneous areas. These sampling approaches may be more appropriate for removal activities than random sampling. Refer to U.S. EPA, February 1989, pages 5-3 to 5-5 for guidelines on selecting sample coordinates for random sampling. Figure 2 illustrates a random sampling approach.

2.9.3 Stratified Random Sampling

Stratified random sampling often relies on historical information and prior analytical results (or screening data) to divide the sampling area into smaller areas called strata. Each strata is more homogeneous than the site is as a whole. Strata can be defined based on various factors, including: sampling depth, contaminant concentration levels, and contaminant source areas. Place sample locations within each of these strata using random selection procedures. Stratified random sampling imparts some control upon the sampling scheme but still allows for random sampling within each stratum. Different sampling approaches may also be selected to address the different strata at the site. Stratified random sampling is a useful and flexible design for estimating the pollutant concentration within each depth interval or area of concern. Figure 3 illustrates a stratified random sampling approach where strata are defined based on depth. In this example, soil coring devices are used to collect samples from given depths at randomly selected locations within the strata.

Figure 2: Random Sampling

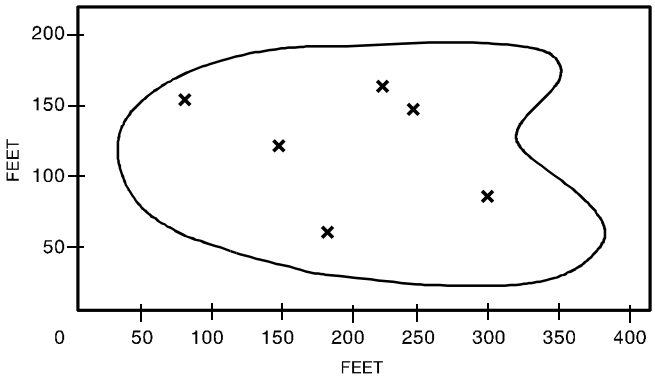


Figure 3: Stratified Random Sampling

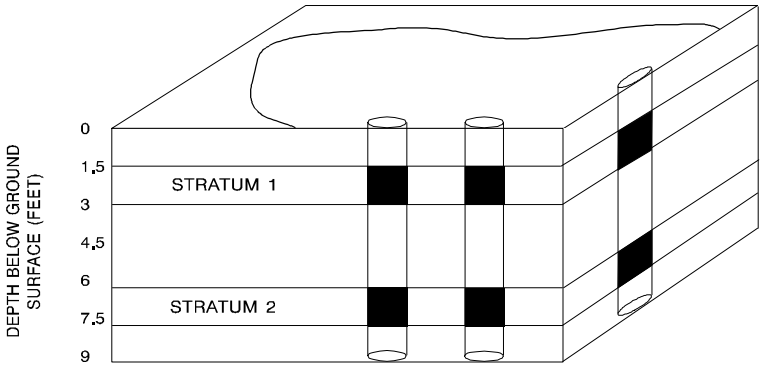
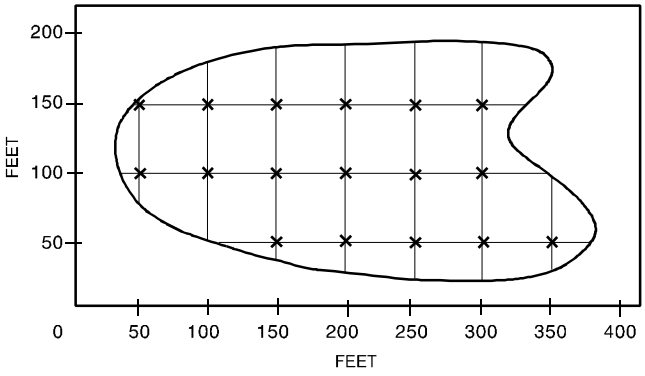


Figure 4: Systematic Grid Sampling



KEY

× SELECTED SAMPLE LOCATION

After U.S. EPA, February 1989

2.9.4 Systematic Grid Sampling

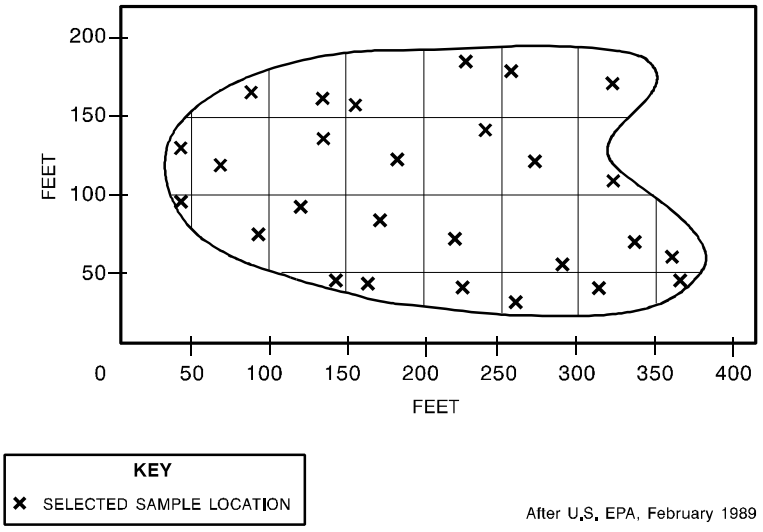
Systematic grid sampling involves subdividing the area of concern by using a square or triangular grid and collecting samples from the nodes (intersections of the grid lines). Select the origin and direction for placement of the grid using an initial random point. From that point, construct a coordinate axis and grid over the whole site. The distance between sampling locations in the systematic grid is determined by the size of the area to be sampled and the number of samples to be collected.

Systematic grid sampling is often used to delineate the extent of contamination and to define contaminant concentration gradients. Refer to U.S. EPA February 1989, pages 5-5 to 5-12, for guidelines on selection of sample coordinates for systematic grid sampling. Figure 4 illustrates a systematic grid sampling approach.

2.9.5 Systematic Random Sampling

Systematic random sampling is a useful and flexible design for estimating the average pollutant concentration within grid cells. Subdivide the area of concern using a square or triangular grid (as described in Section 2.9.4) then collect samples from within each cell using random selection procedures. Systematic random sampling allows for the isolation of cells that may require additional sampling and analysis. Figure 5 illustrates a systematic random sampling approach.

Figure 5: Systematic Random Sampling



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2.9.6 Search Sampling

Search sampling utilizes either a systematic grid or systematic random sampling approach to search for areas where contaminants exceed applicable clean-up standards **(hot spots)**. The number of samples and the grid spacing are determined on the basis of the acceptable level of error (i.e., the chance of missing a hot spot). Search sampling requires that assumptions be made about the size, shape, and depth of the hot spots. As illustrated in Figure 6, the smaller and/or narrower the hot spots are, the smaller the grid spacing must be in order to locate them. Also, the smaller the acceptable error of missing hot spots is, the smaller the grid spacing must be. This, in effect, means collecting more samples.

Once grid spacing has been selected, the probability of locating a hot spot can be determined. Using a systematic grid approach, Table 1 lists approximate probabilities of missing an elliptical hot spot based on the grid method chosen as well as the dimensions of the hot spot. The lengths of the long and short axes (L and S) are represented as a percentage of the grid spacing chosen. The triangular grid method consistently shows lower probabilities of missing a hot spot in comparison to the block grid method. Table 1 can be used in two ways. If the acceptable probability of missing a hot spot is known, then the size of the hot spot which can be located at that probability level can be determined. Conversely, if the approximate size of the hot spot is known, the probability of locating it can be determined.

For example, suppose the block grid method is chosen with a grid spacing of 25 feet. The OSC is willing to accept a 10% chance of missing an elliptical hot spot. Using Table 1, there would be a 90% probability of locating an elliptical hot spot with L equal to 90% of the grid spacing chosen and S equal to 40% of the grid spacing chosen. Therefore the smallest elliptical hot spot which can be located would have a long axis L = 0.90 × 25ft. = 22.5 ft. and a short axis S = 0.40 × 25ft. = 10 ft.

Similarly, if the approximate size of the hot spot being searched for is known, then the probability of missing that hot spot can be determined. For example, if a triangular grid method was chosen with a 25 foot grid spacing and the approximate shape of the hot spot is known, and L is approximately 15 feet or 60% of the grid spacing, and S is approximately 10 feet or 40% of the grid spacing, then there is approximately a 15% chance of missing a hot spot of this size and shape.

2.9.7 Transect Sampling

Transect sampling involves establishing one or more transect lines across the surface of a site. Collect samples at regular intervals along the transect lines at the surface and/or at one or more given depths. The length of the transect line and the number of samples to be collected determine the spacing between sampling points along the transect. Multiple transect lines may be parallel or non-parallel to one another. If the lines are parallel, the sampling objective is sim-

Figure 6: Search Sampling

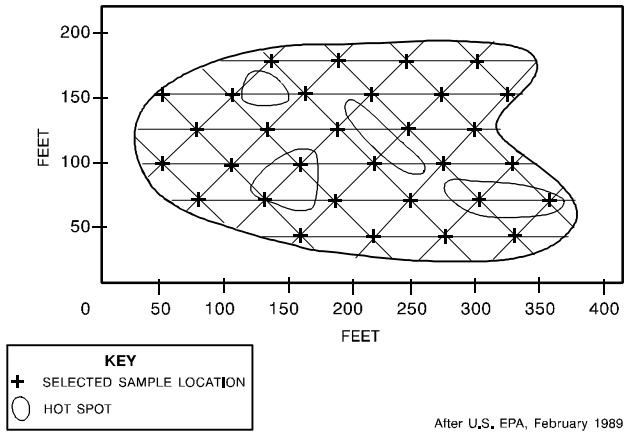

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Table 1: Probability of Missing an Elliptical Hot Spot

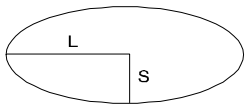
LENGTH OF SHORT AXIS AS A PERCENTAGE OF GRID SPACING

LENGTH OF LONG AXIS AS A PERCENTAGE OF GRID SPACING

	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
10%	0.97 / 0.95									
20%	0.95 / 0.92	0.88 / 0.85								
30%	0.92 / 0.87	0.83 / 0.78	0.72 / 0.66							
40%	0.88 / 0.85	0.75 / 0.71	0.65 / 0.55	0.50 / 0.41						
50%	0.85 / 0.82	0.69 / 0.63	0.54 / 0.44	0.38 / 0.27	0.21 / 0.08					
60%	0.80 / 0.80	0.62 / 0.58	0.45 / 0.35	0.27 / 0.15	0.12 / 0.03	0.06 / 0.0				
70%	0.77 / 0.77	0.56 / 0.54	0.38 / 0.29	0.18 / 0.12	0.07 / 0.01	0.03 / 0.0	0.0 / 0.0			
80%	0.75 / 0.75	0.54 / 0.50	0.32 / 0.23	0.12 / 0.08	0.05 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0		
90%	0.72 / 0.72	0.51 / 0.45	0.30 / 0.21	0.10 / 0.06	0.03 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	
100%	0.70 / 0.66	0.45 / 0.37	0.24 / 0.18	0.08 / 0.04	0.01 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0

From tables In Gilbert, 1987

L=length of long side
S=length of short side



BLOCK GRID 0.97 / 0.95 TRIANGULAR GRID

ilar to systematic grid sampling. A primary benefit of transect sampling over systematic grid sampling is the ease of establishing and relocating individual transect lines versus an entire grid. Transect sampling is often used to delineate the extent of contamination and to define contaminant concentration gradients. It is also used, to a lesser extent, in compositing sampling schemes. For example, a transect sampling approach might be used to characterize a linear feature such as a drainage ditch. A transect line is run down the center of the ditch, along its full length. Sample aliquots are collected at regular intervals along the transect line and are then composited. Figure 7 illustrates transect sampling.

Table 2 summarizes the various representative sampling approaches and ranks the approaches from most to least suitable, based on the sampling objective. Table 2 is intended to provide general guidelines, but it cannot cover all site-specific conditions encountered.

2.10 SAMPLING LOCATIONS

Once a sampling approach has been selected, the next step is to select sampling locations. For statistical (non-judgmental) sampling, careful placement of each sampling point is important to achieve representativeness.

Factors such as the difficulty in collecting a sample at a given point, the presence of vegetation, or discoloration of the soil could bias a statistical sampling plan.

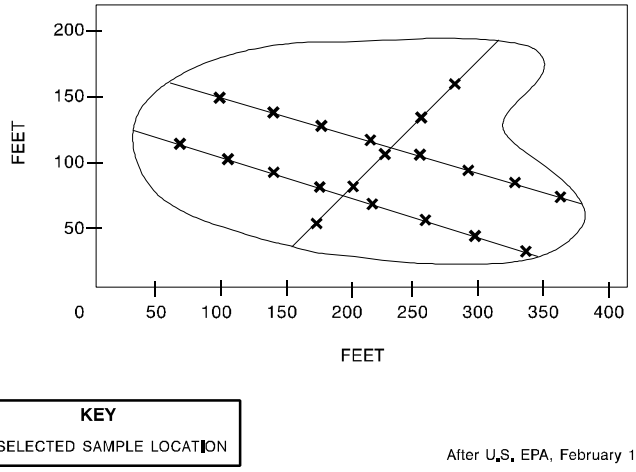
Sampling points may be located with a variety of methods. A relatively simple method for locating random points consists of using either a compass and a measuring tape, or pacing, to locate samplingpoints with respect to a permanent landmark, such as a survey marker. Then plot sampling coordinates on a map and mark the actual sampling points for future reference. Where the sampling design demands a greater degree of precision, locate each sample point by means of a survey. After sample collection, mark each sample point with a permanent stake so that the survey team can identify all the locations.

2.11 EXAMPLE SITE

2.11.1 Background Information

The ABC Plating Site is located in Carroll County, Pennsylvania, approximately 1.5 miles north of the town of Jonesville (Figure 8). The site covers approximately 4 acres, and operated as an electroplating facility from 1947 to 1982. During its years of operation, the company plated automobile and airplane parts with chromium, nickel, and copper. Cyanide solutions were used in the plating process. ABC Plating deposited electroplating wastes into two shallow surface settling lagoons in the northwest sector of the site. The county environmental health department was attempting to enforce cleanup by the site owner, when, in early 1982, a fire on site destroyed most of the process building. The owner then abandoned the facility and could not be located by enforcement and legal authorities. The county contacted EPA for an assessment of the site for a possible response.

Figure 7: Transect Sampling



After U.S. EPA, February 1989

Table 2: Representative Sampling Approach Comparison

SAMPLING OBJECTIVE	SAMPLING APPROACH: JUDGEMENTAL	RANDOM	STRATIFIED RANDOM	SYSTEMATIC GRID	SYSTEMATIC RANDOM	SEARCH	TRANSECT
ESTABLISH THREAT	1	4	3	2 [a]	3	3	2
IDENTIFY SOURCES	1	4	2	2 [a]	3	2	3
DELINEATE EXTENT OF CONTAMINATION	4	3	3	1 [b]	1	1	1
EVALUATE TREATMENT & DISPOSAL OPTIONS	3	3	1	2	2	4	2
CONFIRM CLEANUP	4	1 [c]	3	1 [b]	1	1	1 [d]

1 - PREFERRED APPROACH
2 - ACCEPTABLE APPROACH
3 - MODERATELY ACCEPTABLE APPROACH
4 - LEAST ACCEPTABLE APPROACH
a - SHOULD BE USED WITH FIELD ANALYTICAL SCREENING
b - PREFERRED ONLY WHERE KNOWN TRENDS ARE PRESENT
c - ALLOWS FOR STATISTICAL SUPPOFT OF CLEANUP VERIFICATION IF SAMPLING OVER ENTIRE SITE
d - MAY BE EFFECTIVE WITH COMPOSTING TECHNIQUE IF SITE IS PRESUMED TO BE CLEAN

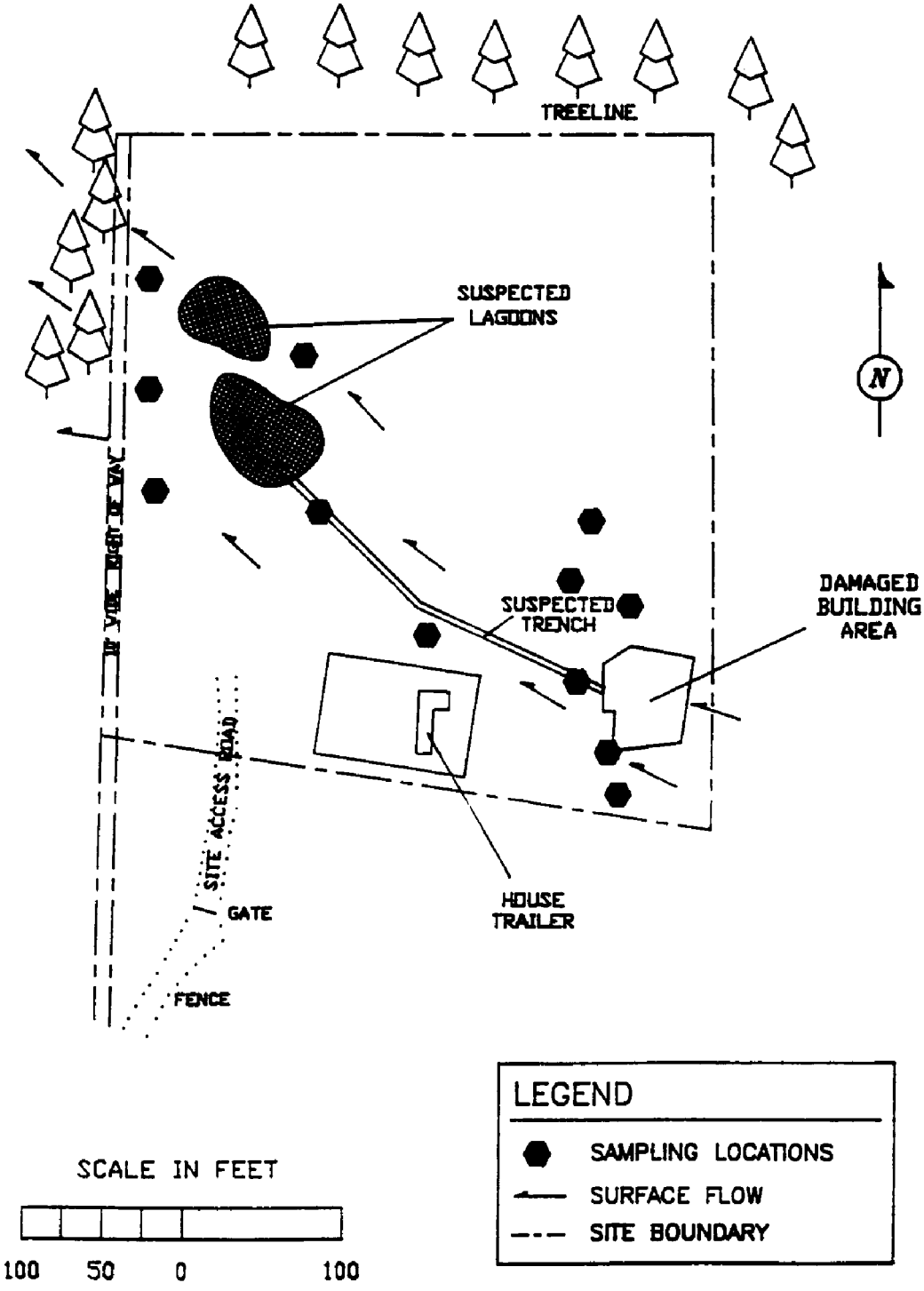
2.11.2 Historical Data Review and Site Reconnaissance

The EPA On-Scene Coordinator (OSC) reviewed the county site file, finding that in 1974, the owner was cited for violating the Clean Streams Act and for storing and treating industrial waste without a permit. The owner was ordered to file a site closure plan and to remediate the storage lagoons. The owner, however, continued operations and was then ordered to begin remediation in 90 days or be issued a cease and desist order. Soon after, a follow-up inspection revealed that the lagoons had been backfilled without removing the waste.

The OSC and response contractor arrived on site to interview local officials, fire department officers, neighboring residents (including a past facility employee), and county representatives, regarding site operating practices and other site details. A past employee sketched facility process features on a map which was obtained from the county (Figure 8). The features included two settling lagoons and a feeder trench which transported plating wastes from the process building to the lagoons. The OSC obtained copies of aerial photographs of the site area from the district office of the U.S. Soil Conservation Service. The county also provided the OSC with copies of all historical site and violation reports.

The OSC and response contractor made a site entry utilizing appropriate personal protective equipment and instrumentation. They observed 12 vats, likely containing plating solutions, on a concrete pad where the original facility building once stood.

Figure 8: Site Sketch and Phase I Soil Sampling Locations
ABC Plating Site



Measurements of pH ranged from 1 to 11. In addition, 50 drums and numerous smaller containers (some on the concrete pad, others sitting directly on the ground) were leaking and bulging, due to the fire. The response contractor noted many areas of stained soil, which indicated container leakage, poor waste handling practices, and possible illegal dumping of wastes.

2.11.3 Identification of Migration Pathways, Transport Mechanisms and Receptors

During the site entry, the OSC noted that several areas were devoid of vegetation, threatening wind erosion which could transport heavy metal- and cyanide-contaminated soil particulates off site. These particulates could be deposited on residential property downwind or be inhaled by nearby residents.

Erosion gullies located on site indicated soil erosion and fluvial transport due to storms. Surface drainage sloped towards the northwest. The response contractor observed stressed and discolored vegetation immediately off site, along the surface drainage route. Surface drainage of heavy metals and cyanide was a direct contact hazard to local residents. Further downgradient, runoff enters an intermittent tributary of Little Creek. Little Creek in turn feeds Barker Reservoir, the primary water supply for the City of Jonesville and neighboring communities, which are located 2.5 miles downgradient of the site. The site entry team observed that the site was not secure and there were signs of trespass (confirming a neighbor's claim that children play at the facility). These activities could lead to direct contact with cyanide and heavy metal contaminants, in addition to the potential for chemical burns from direct contact with strong acids and bases.

Information obtained from the historical data review and site reconnaissance was used to create a site-specific conceptual model. Sources (e.g., vats, drums), pathways (e.g., gullies) and potential receptors (e.g., local residents) were detailed on a map to assist the selection of sampling approaches, objectives, and locations.

2.11.4 Sampling Objectives

The OSC selected three specific sampling objectives, as follows:

- Phase 1 -- Determine whether a threat to public health, welfare, and the environment exists. Identify sources of contamination to support an immediate CERCLA-funded activation for containment of contaminants and security fencing.

- Phase 2 -- Define the extent of contamination at the site and adjacent residential properties. Estimate the volume of contaminated soil and the associated removal costs.

- Phase 3 -- After excavation (or treatment), document the attainment of clean-up goals. Assess that cleanup was completed to the selected level.

2.11.5 Selection of Sampling Approaches

The OSC selected a judgmental sampling approach for Phase 1. Judgmental sampling supports the Action Memorandum process by best defining on site contaminants in the worst-case scenario in order to evaluate the threat to human health, welfare, and the environment. Threat is typically established using a relatively small number of samples (less than 20) collected from source areas, or suspected contaminated areas based on the historical data review and site reconnaissance. For this site, containerized wastes were screened to categorize the contents and to establish a worst- case waste volume, while soil samples were collected to demonstrate whether a release had already occurred.

For Phase 2, a stratified systematic grid design was selected to define the extent of contamination. The grid can accommodate analytical screening and geophysical surveys and allow for contaminated soil excavation on a cell-by-cell basis. Based on search sampling conducted at similar sites, the hot spots being searched for were assumed to be elliptical in shape and 45 feet by 20 feet in size. Under these assumptions, a block grid, with a 50 foot grid spacing, was selected. This grid size ensured a no more than 10% probability of missing a hot spot (see Table 1). The grid was extended to adjacent residential properties when contaminated soil was identified at grid points near the boundary of the site.

Phase 3 utilized a systematic grid sampling approach to confirm the attainment of clean-up goals. Following cleanup, analytical screening was conducted on excavated soil areas using a

transportable X-ray fluorescence (XRF) unit mounted in a trailer (mobile laboratory instrument). Based on the results, each area was documented as clean, or was excavated to additional depth, as necessary.

2.11.6 Analytical Screening, Geophysical Techniques, and Sampling Locations

During Phase 1 operations, containerized wastes were screened using hazard categorization techniques to identify the presence of acids, bases, oxidizers, and flammable substances. Following this procedure, photoionization detector (PID) and flame ionization detector (FID) instruments, a radiation meter, and a cyanide monitor were used to detect the presence of volatile organic compounds, radioactive substances, and cyanide, respectively, in the containerized wastes. Phase 1 screening indicated the presence of strong acids and bases and the absence of volatile organic compounds. The response contractor collected a total of 12 surface soil samples (0-3 inches) during this phase and sent them to a laboratory for analysis. The soil sampling locations included stained soil areas, erosion channels and soil adjacent to leaking containers. Background samples were not collected during Phase 1 because they were unnecessary for activating funding. Phase 1 sampling locations are shown in Figure 8. Based on Phase 1 analytical results, consultation with a Regional EPA toxicologist and with the Agency for Toxic Substances and Disease Registry (ATSDR), an action level of 100 ppm for chromium was selected for cleanup.

During Phase 2 sampling activities, the OSC used a transportable XRF unit installed in an on-site trailer to screen samples for total chromium in order to limit the number of samples to be sent for off-site laboratory analysis. The transportable XRF (rather than a portable unit) was selected for analytical screening to accommodate the 100 ppm action level for chromium. Sampling was performed at all grid nodes at the surface (0-4 inches) and subsurface (36-40 inches) (Figure 9). The 36-40 inch depth was selected based on information obtained from county reports and local interviews which indicated the lagoon wastes were approximately 3 feet below ground surface. The samples were homogenized and sieved (discussed in Chapter 4), then screened for chromium using the XRF. The surface and subsurface samples from areas downgradient of the original facility (21 grid nodes) and three upgradient (background) locations were sent for off-site laboratory analysis following XRF screening. The analytical results from these samples allowed for site-specific calibration of the XRF unit. Once grid nodes with a contamination level greater than the selected action level were located, composite samples were collected from each adjoining cell. Surface aliquots were collected and then composited, sieved, thoroughly homogenized, and screened using the XRF to pinpoint contaminated cells. Additionally, four subsurface aliquots were collected at the same locations as the surface aliquots. They were also composited, sieved, thoroughly homogenized, and screened using the XRF. Figure 10 illustrates a Phase 2 sampling grid cell diagram. Based on the XRF data, each adjoining cell was either identified as clean (below action level), or designated for excavation (at or above action level).

For Phase 3 sampling, cleanup was confirmed by collecting and compositing four aliquots from the surface of each grid cell excavated during Phase 2. The surface composites were then screened (as in Phase 2), using the transportable XRF. Ten percent of the screened samples were also sent to an off-site laboratory for confirmatory sampling. Based on the Phase 3 screening and sampling results, each cell was documented as clean, or, excavated to additional depth, as necessary.

During Phase 2, the OSC conducted ground penetrating radar (GPR) and electromagnetic conductivity (EM) geophysical surveys to help delineate the buried trench and lagoon areas along with any other waste burial areas. The GPR survey was run along the north-south grid axis across the suspected locations of the trench and lagoons. Several structural discontinuities, defining possible disturbed areas, were detected. One anomaly corresponded with the suspected location and orientation of the feeder trench. Several discontinuities were identified in the suspected lagoon areas; however, the data did not conclusively pinpoint precise locations. This could be due to a disturbance of that area during the backfilling process by the PRP. The GPR survey is illustrated in Figure 11.

Figure 9: Soil Sampling and SRF Screening Locations
ABC Plating Site

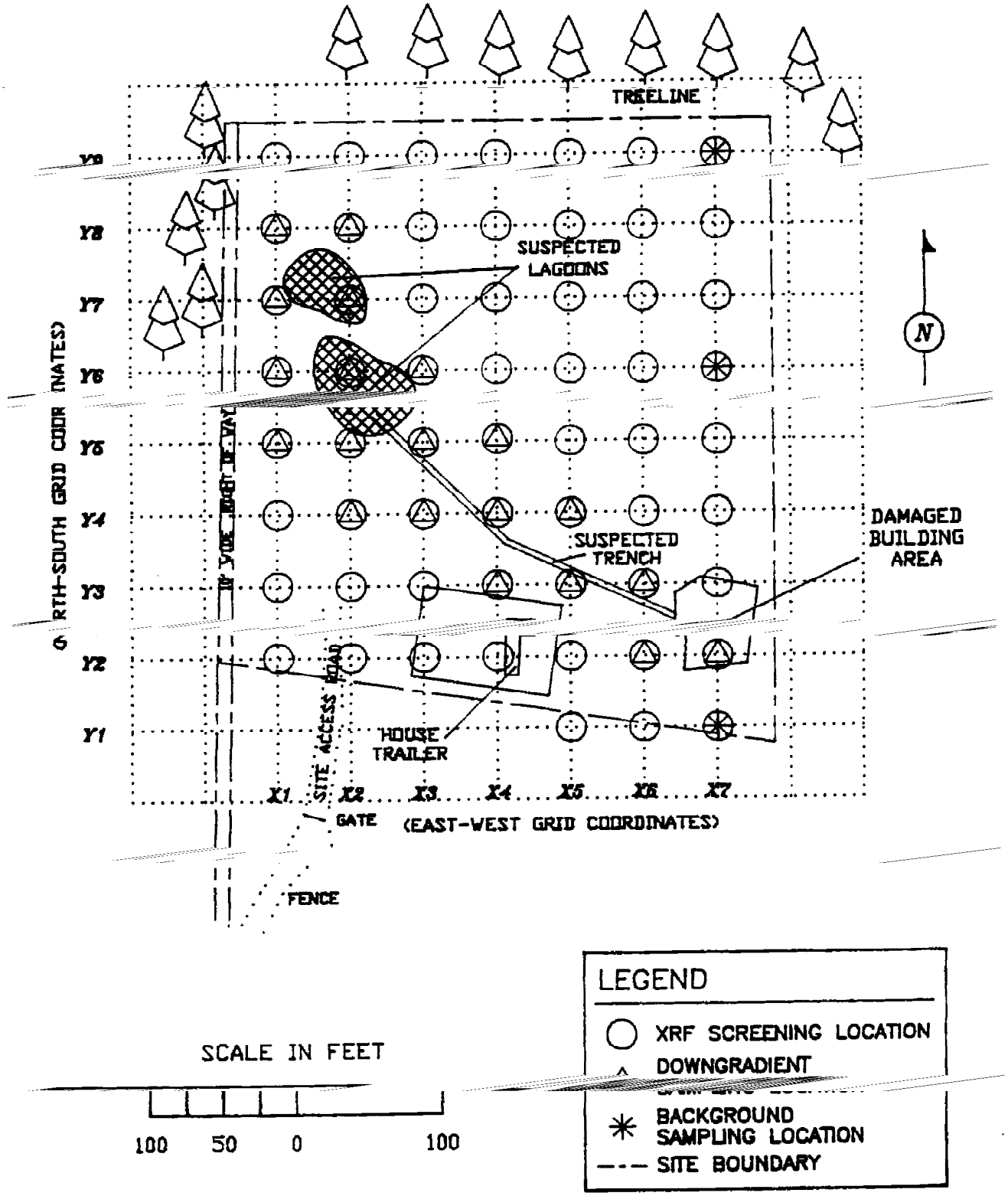
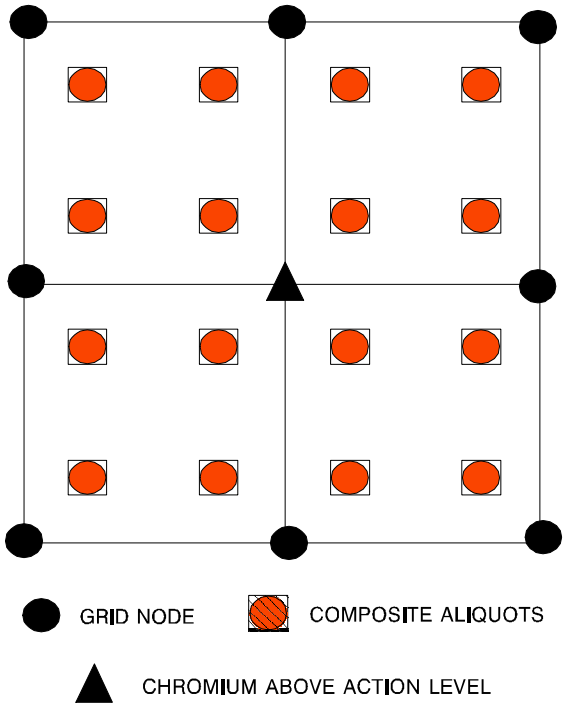


Figure 10: Phase 2 Sampling Grid Cell Diagram*



* Surface samples should be taken over a minimum area of one square foot. Sampling areas for depth sampling are limited by the diameter of the sampling equipment (e.g., auger, split spoon, or coring devices).

For the comprehensive EM survey, the original 50 foot grid spacing was decreased to 25 feet along the north-south grid axis. The EM survey was run along the north-south axes and readings were obtained at the established grid nodes. The EM survey was utilized throughout the site to detect the presence of buried metal objects (e.g., buried pipe leading to the lagoons), and potential subsurface contaminant plumes. The EM survey identified several high conductivity anomalies: the suspected feeder trench location, part of the lagoon area, and a small area west of the process building (Figure 12), which could have been an illegal waste dumping area. Several areas of interference were encountered due to the presence of large metal objects at the surface (a dumpster, surface vats and a junk car).

2.11.7 Parameters for Analysis

During Phase 1 sampling activities, full priority pollutant metals and total cyanide analyses were conducted on all samples. Since Phase 1 samples were collected from the areas of highest suspected contaminant concentration (i.e., sources and drainage pathways), Phase 2 samples were run for total chromium and cyanide, the only analytes detected during the Phase 1 analyses. During Phase 3, the samples sent to the laboratory for definitive analysis were analyzed for total chromium and cyanide. Throughout the removal, it was not possible to screen soils on site for cyanide, therefore the OSC requested laboratory cyanide analysis on the 10% confirmatory samples.

Figure 11: GPR Survey Results
ABC Plating Site

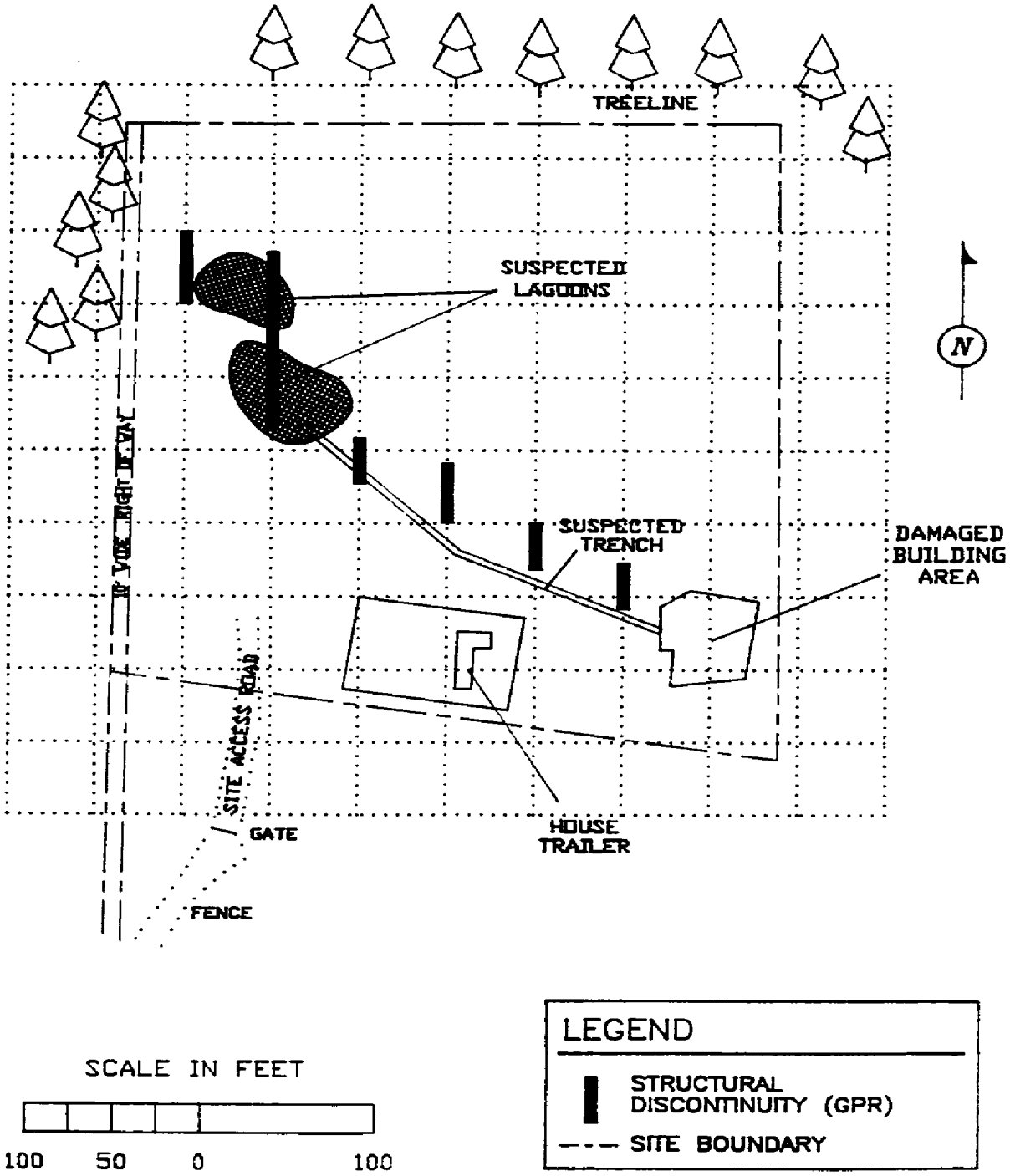
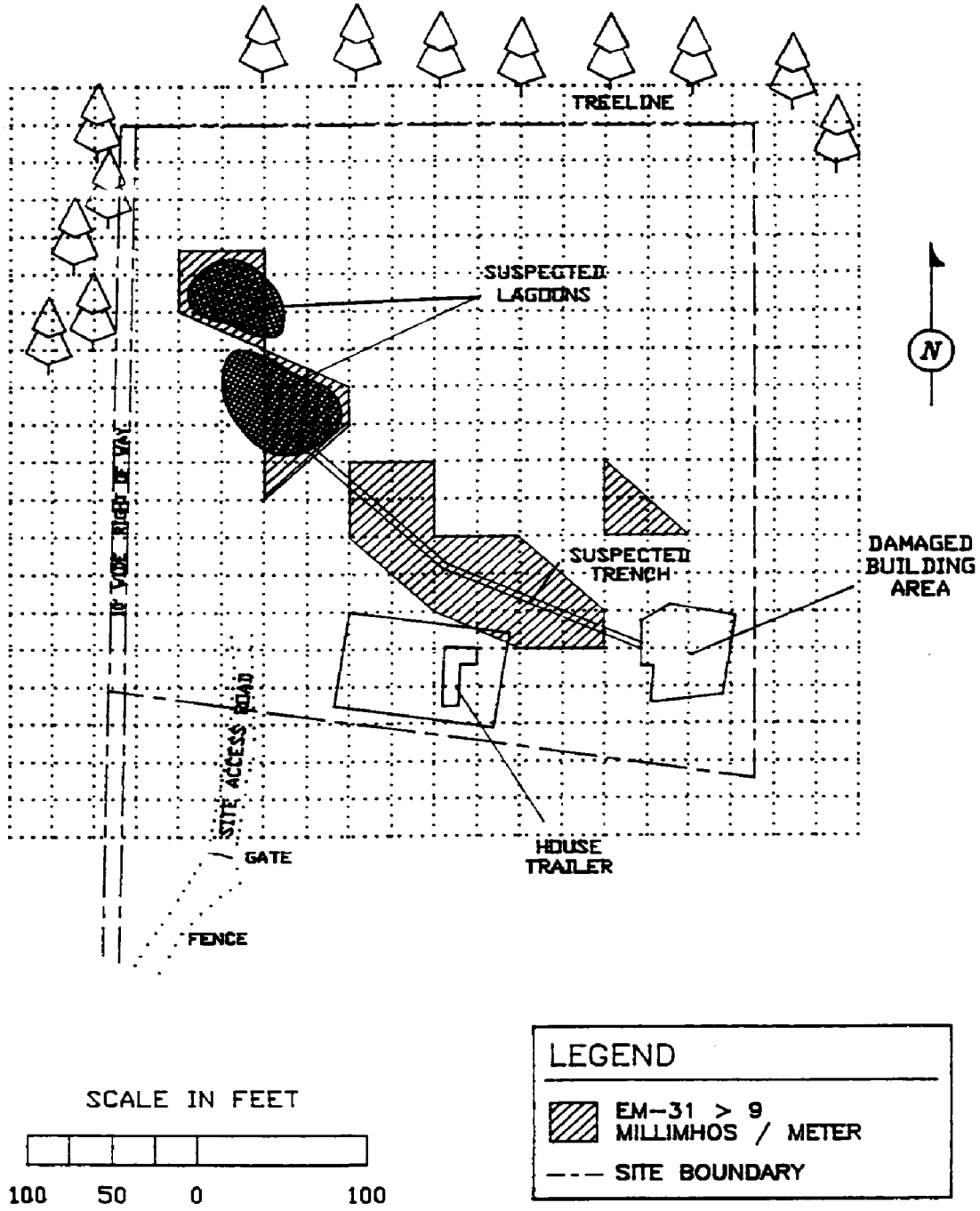


Figure 12: EM-31 Survey Results
ABC Plating Site



3.0 EQUIPMENT

3.1 INTRODUCTION

Sample collection requires an understanding of the capabilities of the sampling equipment, since using inappropriate equipment may result in biased samples. This chapter provides information for selecting sampling and screening equipment.

3.2 ANALYTICAL SCREENING EQUIPMENT

Analytical screening methods provide on-site measurements of contaminants of concern, limiting the number of samples which need to be sent to an off-site laboratory for time-consuming and often costly analysis. Screening techniques can also evaluate soil samples for indications that soil contamination exists (e.g., X-ray fluorescence (XRF) for target metals or soil gas survey for identification of buried wastes or other subsurface contamination). All screening equipment and methods described in this section are **portable** (the equipment is hand-held, and generally no external power is necessary). Examples are photoionization detectors (PID), flame ionization detectors (FID), and some XRF devices.

Screening generally provides analytical data of suitable quality for site characterization, monitoring during response activities, and on-site health and safety decisions. The methods presented here can provide rapid, cost-effective, real-time data; however, results are often not compound-specific and not quantitative.

When selecting one screening method over another, consider relative cost, sample analysis time, potential interferences or instrument limitations, detection limit, QA/QC requirements, level of training required for operation, equipment availability, and data bias. Also consider which elements, compounds, or classes of compounds the screening instrument is designed to analyze. As discussed in Section 2.7, the screening method selected should be sensitive enough to minimize the potential for false negatives. When collecting samples for on-site analysis (e.g., XRF), evaluate the detection limits and bias of the screening method by sending a minimum of 10% of the samples to an off-site laboratory for confirmation. Table 3 summarizes the advantages and disadvantages of selected portable screening equipment.

3.3 GEOPHYSICAL EQUIPMENT

Geophysical techniques can be used in conjunction with analytical screening to help delineate areas of subsurface contamination, including buried drums and tanks. Geophysical data can be obtained relatively rapidly, often without disturbing the site. Geophysical techniques suitable for emergency or removal activities include: ground penetrating radar (GPR), magnetometry, electromagnetic conductivity (EM) and resistivity. Specific advantages and disadvantages associated with geophysical equipment are summarized in Table 4. See also EPA ERT Standard Operating Procedure (SOP) #2159, General Surface Geophysics (U.S. EPA, January 1991).

3.4 SELECTING SAMPLING EQUIPMENT

The mechanical method by which a sampling tool collects the sample may impact representativeness. For example, if the sampling objective is to determine the concentrations of contaminants at each soil horizon interface, using a hand auger would be inappropriate: the augering technique would disrupt and mix soil horizons, making the precise horizon interface difficult to determine. Depth of sampling is another factor to consider in the proper selection of sampling equipment. A trowel, for example, is suitable for unconsolidated surface soils, but may be a poor choice for sampling at 12 inches, due to changes in soil consistency with depth.

All sampling devices should be of sufficient quality not to contribute contamination to samples (e.g., painted surfaces which could chip off into the sample). In addition, the sampling equipment should be either easily decontaminated, or cost-effective if considered to be expendable. Consider ease of use when selecting sampling equipment.

Table 3: Portable Field Analytical Screening Equipment

Equipment	Application to Sampling Design	Advantages and Disadvantages
X-ray fluorescence (portable)	Detects heavy metals in soils	Rapid sample analysis; may be used in situ; requires trained operator; potential matrix interferences; may be used with a generic or site-specific calibration model; detection limit may exceed action level; detects to ppm level; detection limit should be calculated on a site-specific basis.
Flame ionization detector (FID)	Semi-quantitatively detects VOCs in soils	Immediate results; can be used in GC mode to identity specific organic compounds; detects VOCs only; detects to ppm level.
Photoionization detector (PID)	Detects total concentration of VOCs and some non-volativle organics and inorganics in soils	Immediate results; easy to use; non-compound specific; results affected by high ambient humidity and electrical sources such as radios; does not respond to methane; detects to ppm level.
Field test kits	Detects specific elements, compounds, or compound classes in soils	Rapid results; easy to use; low cost; limited number of kit types available; kits may be customized to user needs; semi-quantitative; interferences by other analytes is common; colorimetric interpretation is needed; detection level dependent upon type of kit used; can be prone to error.
Radiation detector	Detects the presence of selected forms of radiation in soils or other waste materials	Easy to use; low cost; probes for one or a combination of alpha, beta or gamma forms of radiation; unit and detection limits vary greatly; detailed site surveys are time intensive and require experienced personnel to interpret results.

Sources: U.S. EPA, September 1988a; U.S. EPA, December 1987; U.S. EPA 1987.

Table 4: Geophysical Equipment

Equipment	Application to Sampling Design	Advantages and Disadvantages
Ground penetrating radar (GPR)	Detects reflection anomalies caused by lithology changes buried objects; varying depths of investigation, 15 to 30 feet, are possible.	Capable of high resolution; generates continuous measurement profile; can survey large area quickly; site specific; best results are achieved in dry, sandy soils; clay-rich and water saturated soils produce poor reflections and limit depth of penetration; data interpretation requires a trained geophysicist.
Magnetometer	Detects presence and areal extent of ferromagnetic material in subsurface soils, including buried metal containers. Single 55-gallon drums can be identified at depths up to 10 feet and large massed of drums up to 30 feet or more.	Quick and easy to operate; good initial survey instrument; readings are often affected by nearby man-made steel structures (including above-ground fences, buildings, and vehicles); data interpretation may require geophysicist.
Electromagnetic conductivity meter (EM)	Detects electrical conductivity changes in subsurface geologic lithology, pore fluids, and buried objects. Depth of investigation varies from 9 feet to 180 feet depending on instrument used, coil spacing, and coil configuration.	Rapid data collection; can delineate inorganic and large-scale organic contamination in subsurface fluids; sensitive to man-made structures (including buried cables, above-ground steel structures and electrical power lines); survey planning and data interpretation may require geophysicist.
Wadi	Detects electrical conductivity changes in surface and sub-surface materials utilizing existing very low frequency (VLF) radio waves.	Utilizes existing long-distance communication VLF radio waves (10-30 Khz range); no need to induce electrical field; directional problems can be overcome with portable transmitters.
Resistivity meter	Detects electrical resistivity variations in subsurface materials (e.g., lithology, pore fluids, buried pipelines and drums). Vertical resolution to depths of 100 feet are possible.	Detects lateral and vertical variations; instrument requires direct ground contact, making it relatively labor intensive; sensitive to outside interference; data interpretation requires a trained geophysicist.

Sources: Benson, et. al. 1988; NJDEP, 1988.

Complicated sampling procedures usually require increased training and introduce a greater likelihood of procedural errors. Standard operating procedures help to avoid such errors. Sample volume is another selection concern. Specific advantages and disadvantages of soil sampling equipment are given in Table 5. Refer also to EPA ERT SOP #2012, Soil Sampling (in U.S. EPA, January 1991) for guidance on using various types of soil sampling equipment.

3.5 EXAMPLE SITE

3.5.1 Selection of Sampling Equipment

Dedicated plastic scoops were used for Phase 1 soil sampling. For Phase 2, the OSC used bucket augers for both surface and subsurface soil sampling because of their ease of use, good vertical depth range, and uniform surface sampling volume. Standard operating procedures were followed to promote proper sample collection, handling, and decontamination. From the bucket auger, each sample was placed into a dedicated plastic pan and mixed using a dedicated plastic scoop. Samples were further prepared for XRF screening and laboratory analysis (Section 4.8).

3.5.2 Selection of Analytical Screening Equipment

Phase 1 sampling identified the sources and types of on-site contaminants in order to establish a threat. Hazard categorization techniques, organic vapor detecting instruments, and radiation and cyanide monitors were utilized to tentatively identify containerized liquid wastestreams in order to select initial judgmental soil sampling locations. During Phase 2 sampling, a portable XRF unit was used to determine the extent of contamination and to identify additional hot spots. Samples to be sent for laboratory analysis were then placed into sampling jars (as discussed in Section 4.8). Samples collected from upgradient grid nodes for XRF screening only were stored on site for later treatment/disposal. For Phase 3, the XRF was used to confirm whether contaminated areas identified during Phase 2 were sufficiently excavated.

3.5.3 Selection of Geophysical Equipment

The GPR instrument delineated buried trench and lagoon boundaries. The EM meter detected subsurface conductivity changes due to buried metal containers and contaminants. The EM-31 (a shallower-surveying instrument than the EM-34) was selected because expected contaminant depth was less than 10 feet and because of the instrument's maneuverability and ease of use.

Table 5: Soil Sampling Equipment

Equipment	Applicability	Advantages and Disadvantages
Trier	Soft surface soil	Inexpensive; easy to use and decontaminate; difficult to use in stony, dry, or sandy soil.
Scoop or trowel	Soft surface soil	Inexpensive, easy to use and decontaminate; trowels with painted surfaces should be avoided.
Tulip bulb planter	Soft soil, 0-6 in.	Easy to use and decontaminate; uniform diameter and sample volume; preserves soil core (suitable for VOA and undisturbed sample collection); limited depth capability; not useful for hard soils.
Soil coring device	Soft soil, 0-24 in.	Relatively easy to use; preserves soil core (suitable for VOA and undisturbed sample collection); limited depth capability; can be difficult to decontaminate.
Thin-wall tube sampler	Soft soil, 0-10 ft.	Easy to use; preserves soil core (suitable for VOA and undisturbed sample collection); may be used in conjunction with bucket auger; acetate sleeve may be used to help maintain integrity of VOA samples, easy to decontaminate; can be difficult to remove cores from sampler.
Split spoon sampler	Soil, 0 in.-bedrock	Excellent depth range; preserves soil core (suitable for VOA and undisturbed sample collection); acetate sleeve may be used to help maintain integrity of VOA samples; useful for hard soils; often used in conjunction with drill rig for obtaining deep cores.
Shelby tube sampler	Soft soil, 0 in.-bedrock	Excellent depth range; preserves soil core (suitable for VOA and undisturbed sample collection); tube may be used to ship sample to lab undisturbed; may be used in conjunction with drill rig for obtaining deep cores and for permeability testing; not durable in rocky soils.
Bucket auger	Soft soil, 3 in.-10 ft.	Easy to use; good depth range; uniform diameter and sample volume; acetate sleeve may be used to help maintain integrity of VOA samples; may disrupt and mix soil horizons greater than 6 inches in thickness.
Hand-operated power auger	Soil, 6 in.-15 ft.	Good depth range; generally used in conjunction with bucket auger for sample collection; destroys soil core (unsuitable for VOA and undisturbed sample collection); requires 2 or more equipment operators; can be difficult to decontaminate; requires gasoline-powered engine (potential for cross-contamination).

Sources: NJDEP, 1988; U.S. EPA, January 1991.

4.0 SAMPLE COLLECTION AND PREPARATION

4.1 INTRODUCTION

In addition to sampling equipment, sample collection includes sample quantity and sample volume. Sample preparation refers to all aspects of sample handling after collection, until the sample is received by the laboratory. Sample preparation for soils may include, but is not limited to:

- removing extraneous material;
- sieving samples;
- homogenizing samples;
- splitting samples;
- compositing samples; and
- final preparation.

Sample preparation depends on the sampling objectives and analyses to be performed. Proper sample preparation and handling help to maintain sample integrity. Improper handling can result in a sample becoming unsuitable for the type of analysis required. For example, homogenizing, sieving, and compositing samples all result in a loss of volatile constituents and are therefore inappropriate when volatile contaminants are the concern.

4.2 SAMPLE COLLECTION

How a sample is collected can affect its representativeness. The greater the number of samples collected from a site and the larger the volume of each sample, the more representative the analytical results will be. However, sampling activities are often limited by sampling budgets and project schedules. The following sections provide guidelines on appropriate sample numbers and volumes.

4.2.1 Sample Number

The number of samples needed will vary according to the particular sampling approach that is being used. For example, in grid sampling, one sample is generally collected at each grid node, regardless of grid size. As discussed in Section 2.11.6, once contaminated grid node samples are located, adjoining grid cells can be sampled more thoroughly to define areas of contamination. Four aliquots from each grid cell, situated equidistant from the sides of each cell and each other (as illustrated in Figure 10), are recommended for grid cells measuring up to 100 x 100 feet. One additional aliquot may be collected from the center of each cell, making a total of five aliquots per cell. For grid sizes greater than 100 feet x 100 feet, nine aliquots, situated equidistant from the sides of each cell and each other (as illustrated in Figure 13), are recommended. Depending on budget and other considerations, grid cell aliquots can be analyzed as separate samples or composited into one or more samples per cell.

4.2.2 Sample Volume

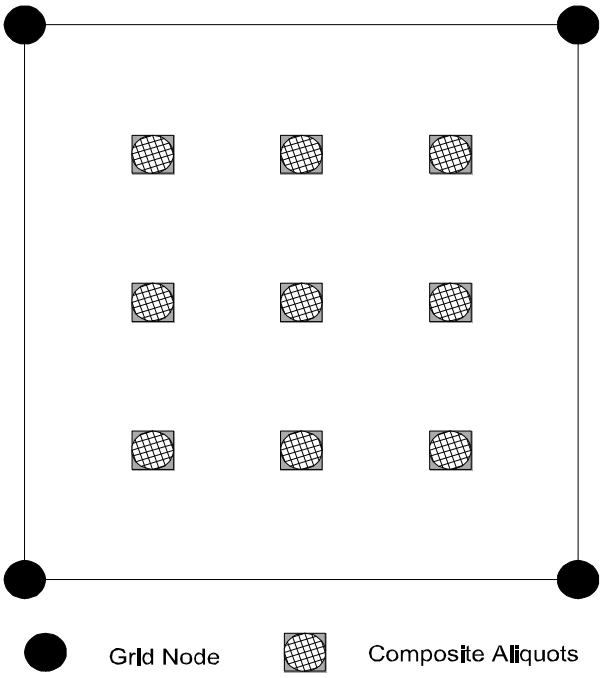
Both sample depth and area are considerations in determining appropriate sample volume. Depending on the analytes being investigated, samples are collected at the surface (0-3 in.), extended surface (0-6 in.), and/or at one-foot depth intervals. Non-water soluble contaminants such as dioxin and PCBs are often encountered within the first six inches of soil. Water-soluble contaminants such as metals, acids, ketones, and alcohols will be encountered at deeper depths in most soils except clays. Contaminants in solution, such as PCPs in diesel fuel and pesticides in solvents, can penetrate to great depths (e.g., down to bedrock), depending on soil type.

For surface samples, collect soil over a surface area of one square foot per sample. A square cardboard template measuring 12 in. x 12 in., or a round template with a 12 in. diameter can be used to mark sampling areas. For subsurface samples, one of several coring devices may be used (see Table 5). Using a coring device results in a smaller diameter sampling area than a surface template, and therefore somewhat lessens the representativeness of the sample.

4.3 REMOVING EXTRANEOUS MATERIAL

Identify and discard materials in a sample which are not relevant or vital for characterizing the sample or the site, since their presence may introduce an error in the sampling or analytical procedures. Examples of extraneous material in soil samples include pieces glass, twigs or leaves. However, not all non-soil material is extraneous. For example, when sampling at a junkyard, lead-contaminated battery casing pieces should not be removed from a sample if the casing composes more than 10% of the sample composition. For a sample to be representative, it must also incorporate the lead from the casing. Collect samples

Figure 13: Phase 2 Sampling Grid Cell Diagram (Grid Sizes > 100 x 100 ft.)



of any material thought to be a potential source of contamination for a laboratory extraction procedure. Discuss any special analytical requirements for extraneous materials with project management, geologists, and chemists and notify the laboratory of any special sample handling requirements.

4.4 SIEVING SAMPLES

Sieving is the process of physically sorting a sample to obtain uniform particle sizes, using sieve screens of predetermined size. For example, the sampler may wish to sieve a certain number of samples to determine if particle size is related to contaminant distribution. Sieving is generally only conducted when preparing soil samples for XRF screening. For this purpose, a 20-mesh screen size is recommended.

Be aware of the intent of the sampling episode, when deciding whether to sieve a sample prior to analysis. Prior to sieving, samples may need to be oven-dried. Discarding non-soil or non-sieved materials, as well as the sieving process itself, can result in physical and chemical losses. Sieving is not recommended where volatile compounds are of concern. Analyze the discarded materials, or a fraction thereof, to determine their contribution to the contamination of the site being investigated.

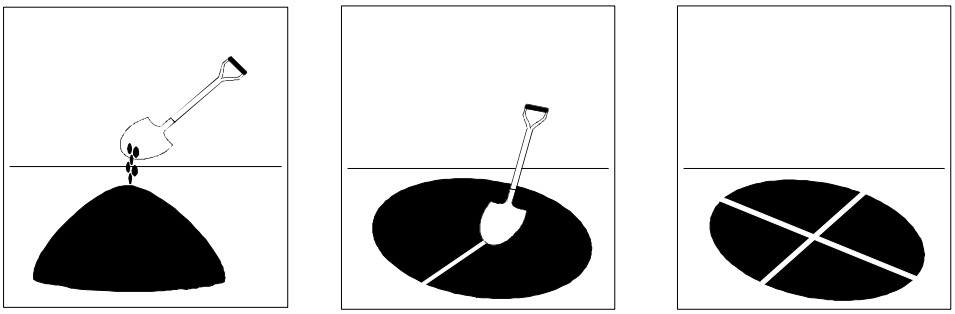
4.5 HOMOGENIZING SAMPLES

Homogenization is the mixing or blending of a soil sample in an attempt to provide uniform distribution of contaminants. (Do not homogenize samples for volatile compound analysis). Ideally, proper homogenization ensures that portions of the containerized samples are equal or identical in composition and are representative of the total soil sample collected. Incomplete homogenization will increase sampling error. All samples to be composited or split should be homogenized after all aliquots have been combined. Manually homogenize samples using a stainless steel spoon or scoop and a stainless steel bucket, or use a disposable scoop and pan. Quarter and split the sample as illustrated in Figure 14, repeating each step a minimum of 5 times until the sample is visually homogenized. Samples can also be homogenized using a mechanically-operated stirring device as depicted in ASTM standard D422-63.

4.6 SPLITTING SAMPLES

Splitting samples after collection and field preparation into two or more equivalent parts is performed when two or more portions of the same sample need to be analyzed separately. Split samples are most often collected in enforcement actions to compare sample results obtained by EPA with those obtained by the potentially responsible party (PRP). Split samples also provide a measure of the sample variability, and a measure of the analytical and extraction errors. Before splitting, follow homogenization techniques outlined above. Fill two sample collection jars simultaneously with alternate spoonfuls (or scoopfuls) of homogenized sample. To simultaneously homogenize and split a sample, **quarter** (as illustrated in Figure 14) or **mechanically** split the sample using a riffle sample splitter. The latter two techniques are described in detail in ASTM Standard C702-87.

Figure 14: Quartering to Homogenize and Split Samples



Step 1:

- Cone sample on hard, clean surface
- Mix by forming new cone

Step 2:

- Flatten cone
- Divide sample into quarters

Step 3: (not shown)

- Remix opposite quarters
- Reform cone
- Repeat a minimum of 5 times

4.7 COMPOSITING SAMPLES

Compositing is the process of physically combining and homogenizing several individual soil aliquots. Compositing samples provides an average concentration of contaminants over a certain number of sampling points, which reduces both the number of required lab analyses and the sample variability. Compositing can be a useful technique, but must always be implemented with caution. Compositing is not recommended where volatile compounds are of concern.

Specify the method of selecting the aliquots that are composited and the compositing factor in the sampling plan. The compositing factor is the number of aliquots to be composited into one sample (e.g., 3 to 1; 10 to 1). Determine this factor by evaluating detection limits for parameters of interest and comparing them with the selected action level for that parameter. Compositing also requires that each discrete aliquot be the same in terms of volume or weight, and that the aliquots be thoroughly homogenized. Since compositing dilutes high concentration aliquots, the applicable detection limits should be reduced accordingly. If the composite value is to be compared to a selected action level, then the action level must be divided by the number of aliquots that make up the composite in order to determine the appropriate detection limit (e.g., if the action level for a particular substance is 50 ppb, an action level of 10 ppb should be used when analyzing a 5-aliquot composite). The detection level need not be reduced if the composite area is assumed to be homogeneous in concentration (for example, stack emission plume deposits of particulate contamination across an area, or roadside spraying of waste oils).

4.8 FINAL PREPARATION

Select sample containers on the basis of compatibility with the material being sampled, resistance to breakage, and volume. For soil sampling, use wide-mouth glass containers with Teflon-lined lids. Appropriate sample volumes and containers will vary according to the parameter being analyzed. Keep low and medium concentration soil samples to be analyzed for organic constituents at 4EC. Actual sample volumes, appropriate containers, and holding times are specified in the *QA/QC Guidance for Removal Activities* (U.S. EPA, April 1990), in 40 CFR 136, and in the Compendium of ERT Soil Sampling and Surface Geophysics (U.S. EPA, January 1991). Package all samples in compliance with Department of Transportation (DOT) or International Air Transport Association (IATA) requirements.

It is sometimes possible to ship samples to the laboratory directly in the sampling equipment. For example, the ends of a Shelby tube can be sealed with caps, taped, and sent to the laboratory for analysis. To help maintain the integrity of VOA samples, collect soil cores using acetate sleeves and send the sleeves to the laboratory. To ensure the integrity of the sample after delivery to the laboratory, make laboratory sample preparation procedures part of all laboratory bid contracts.

4.9 EXAMPLE SITE

After placing each sample in a dedicated pan and mixing (as discussed in Section 3.5.1), plant matter, stones, and broken glass were removed. Soil samples were oven-dried (at 104E C) and sieved using a 20-mesh screen in preparation for XRF analysis. Samples were then homogenized and split using the quartering technique. Opposite quarters were remixed and quartering was repeated five times to ensure thorough homogenization. A portion of each sample was placed into XRF analysis cups for screening. The remainder of each sample was placed into 8-ounce, wide-mouth glass jars with Teflon-lined lids and sent to a laboratory for inorganic analysis. The samples were packaged in compliance with IATA requirements. Chain-of-custody paperwork was prepared for the samples. Laboratory paperwork was completed as appropriate and the samples were shipped to the predesignated laboratories for analysis.

5.0 QUALITY ASSURANCE/QUALITY CONTROL EVALUATION

5.1 INTRODUCTION

The goal of representative sampling is to collect samples which yield analytical results that accurately depict site conditions during a given time frame. The goal of quality assurance/quality control (QA/QC) is to identify and implement correct methodologies which limit the introduction of error into the sampling and analytical procedures, ultimately affecting the analytical data.

QA/QC samples evaluate the degree of site variation, whether samples were cross-contaminated during sampling and sample handling procedures, or if a discrepancy in sample results is due to laboratory handling and analysis procedures. The QA/QC sample results are used to assess the quality of the analytical results of waste and environmental samples collected from a site.

5.2 DATA CATEGORIES

EPA has established a process of data quality objectives (DQOs) which ensure that the precision, accuracy, representativeness, and quality of environmental data are appropriate for their intended application. Superfund DQO guidance defines two broad categories of analytical data: *screening* and *definitive*.

Screening data are generated by rapid, less precise methods of analysis with less rigorous sample preparation. Sample preparation steps may be restricted to simple procedures such as dilution with a solvent, rather than elaborate extraction/digestion and cleanup. At least 10 percent of the screening data are confirmed using the analytical methods and QA/QC procedures and criteria associated with definitive data. Screening data without associated confirmation data are not considered to be data of known quality. To be acceptable, screening data must include the following: chain of custody, initial and continuing calibration, analyte identification, and analyte quantification. Streamlined QC requirements are the defining characteristic of screening data.

Definitive data are generated using rigorous analytical methods (e.g., approved EPA reference methods). These data are analyte-specific, with confirmation of analyte identity and concentration. Methods produce tangible raw data (e.g., chromatograms, spectra, digital values) in the form of paper printouts or computer-generated electronic files. Data may be generated at the site or at an off-site location, as long as the QA/QC requirements are satisfied. For the data to be definitive, either analytical or total measurement error must be determined. QC measures for definitive data contain all of the elements associated with screening data, but also may include trip, method, and rinsate blanks; matrix spikes; performance evaluation samples; and replicate analyses for error determination.

For further information on these QA/QC objectives, please refer to EPA's *Quality Assurance/Quality Control Guidance for Removal Activities* or EPA's *Data Quality Objectives Process for Superfund*.

5.3 SOURCES OF ERROR

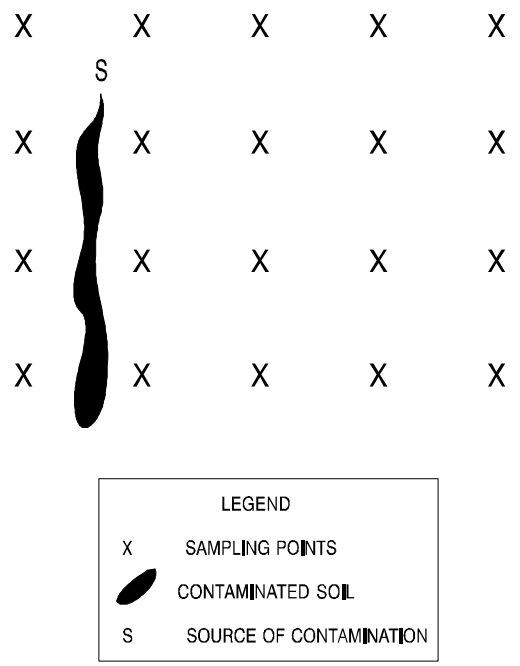
Identifying and quantifying the error or variation in sampling and laboratory analysis can be difficult. However, it is important to limit their effect(s) on the data. Four potential sources of error are:

- sampling design;
- sampling methodology;
- sample heterogeneity; and
- analytical procedures.

5.3.1 Sampling Design

Site variation includes the variation both in the types and in the concentration levels of contaminants throughout a site. Representative sampling should accurately identify and define this variation. However, error can be introduced by the selection of a sampling design which "misses" site variation. For example, a sampling grid with relatively large distances between sampling points or a biased sampling approach (i.e., judgmental sampling) may allow significant contaminant trends to go unidentified, as illustrated in Figure 15.

Figure 15: Sampling Error Due to Sampling Design



5.3.2 Sampling Methodology

Error can be introduced by the sampling methodology and sample handling procedures, as in cross-contamination from inappropriate use of sample collection equipment, unclean sample containers, improper sampling equipment decontamination and shipment procedures, and other factors. Standardized procedures for collecting, handling, and shipping samples allow for easier identification of the source(s) of error, and can limit error associated with sampling methodology. The use of standard operating procedures ensures that all sampling tasks for a given matrix and analyte will be performed in the same manner, regardless of the individual sampling team, date, or location of sampling activity. Trip blanks, field blanks, replicate samples, and rinsate blanks are used to identify error due to sampling methodology and sample handling procedures.

5.3.3 Sample Heterogeneity

Sample heterogeneity is a potential source of error. Unlike water, soil is rarely a homogeneous medium and it exhibits variable properties with lateral distance and with depth. This heterogeneity may also be present in the sample container unless the sample was homogenized in the field or in the laboratory. The laboratory uses only a small aliquot of the sample for analysis; if the sample is not properly homogenized, the analysis may not be truly representative of the sample and of the corresponding site. Thoroughly homogenizing samples, therefore, can limit error associated with sample heterogeneity.

5.3.4 Analytical Procedures

Error which may originate in analytical procedures includes cross-contamination, inefficient extraction, and inappropriate methodology. Matrix spike samples, replicate samples, performance evaluation samples, and associated quality assurance evaluation of recovery, precision, and bias, can be used to distinguish analytical error from error introduced during sampling activities.

5.4 QA/QC SAMPLES

This section briefly describes the types and uses of QA/QC samples that are collected in the field, or prepared for or by the laboratory. QA/QC samples are analyzed in addition to field samples and provide information on the variability and usability of environmental sample results. They assist in identifying the origin of analytical discrepancies to help determine how the analytical results should be used. They are used mostly to validate analytical results. Field replicate, collocated, background, and rinsate blank samples are the most commonly collected field QA/QC samples. Performance evaluation, matrix spike, and matrix spike duplicate samples, either prepared for or by the laboratory, provide additional measures of control for the data generated. QA/QC results may suggest the need for modifying sample collection, preparation, handling, or analytical procedures if the resultant data do not meet site-specific quality assurance objectives. Refer to data validation procedures in U.S. EPA, April 1990, for guidelines on utilizing QA/QC analytical results. The following paragraphs briefly describe each type of QA/QC sample.

5.4.1 Field Replicates

Field replicates are field samples obtained from one location, homogenized, divided into separate containers and treated as separate samples throughout the remaining sample handling and analytical processes. These samples are used to assess error associated with sample heterogeneity, sample methodology and analytical procedures. Use field replicates when determining total error for critical samples with contamination concentrations near the action level. For statistical analysis to be valid in such a case, a minimum of eight replicate samples would be required.

5.4.2 Collocated Samples

Collocated samples are collected adjacent to the routine field sample to determine local variability of the soil and contamination at the site. Typically, collocated samples are collected about one-half to three feet away from the selected sample location. Analytical results from collocated samples can be used to assess site variation, but only in the immediate sampling area. Due to the non-homogeneous nature of soil at sites, collocated samples should not be used to assess variability across a site and are not recommended for assessing error. Determine the applicability of collocated samples on a site-by-site basis. Collecting many samples (more than 50 samples/acre), is sufficient to demonstrate site variation.

5.4.3 Background Samples

Background samples are collected upgradient of the area(s) of contamination (either on or off site) where there is little or no chance of migration of the contaminants of concern. Background samples determine the natural composition of the soil (especially important in areas with high concentrations of naturally-occurring metals) and are considered "clean" samples. They provide a basis for comparison of contaminant concentration levels with samples collected on site. At least one background soil sample should be collected; however, more are warranted when site-specific factors such as natural variability of local soil, multiple on-site contaminant source areas, and presence of off-site facilities potentially contributing to soil contamination exist. Background samples may be collected for all QA objectives, in order to evaluate potential error associated with sampling design, sampling methodology, and analytical procedures.

5.4.4 Rinsate Blanks

Rinsate blanks are samples obtained by running analyte-free water over decontaminated sampling equipment to test for residual contamination. The blank is placed in sample containers for handling, shipment, and analysis identical to the samples collected that day. A rinsate blank is used to assess cross-contamination brought about by improper decontamination procedures. Where dedicated sampling equipment is not utilized, collect one rinsate blank, per type of sampling device, per day.

5.4.5 Performance Evaluation Samples

Performance evaluation (PE) samples evaluate the overall bias of the analytical laboratory and detect any error in the analytical method used. These samples are usually prepared by a third party, using a quantity of analyte(s) which is known to the preparer but unknown to the laboratory, and always undergo certification analysis. The analyte(s) used to prepare the PE sample is the same as the analyte(s) of concern. Laboratory procedural error is evaluated by the percentage of analyte identified in the PE sample (percent recovery). Even though they are not available for every single analyte, analysis of PE samples is required to obtain definitive data.

5.4.6 Matrix Spike Samples

Matrix spike and matrix spike duplicate samples (MS/MSDs) are environmental samples that are spiked in the laboratory with a known concentration of a target analyte(s) to verify percent recoveries. MS/MSDs are primarily used to check sample matrix interferences. They can also be used to monitor laboratory performance. However, a dataset of at least three or more results is necessary to distinguish between laboratory performance and matrix interference.

MS/MSDs can also monitor method performance. Again, a dataset is helpful to assess whether a method is performing properly. Generally, interference and poor method performance go together.

MS/MSDs can also evaluate error due to laboratory bias and precision (when four or more pairs are analyzed). Analyze one MS/MSD pair to assess bias for every 20 soil samples. Use the average percent recovery for the pair. To assess precision, analyze at least 8 matrix spike replicates from the same sample, determine the standard deviation and the coefficient of variation. See pages 9 - 10 of the *QA/QC Guidance*

for Removal Activities (U.S. EPA, April 1990) for procedures on calculating analytical error. MS/MSDs are optional when the goal is to obtain screening data and required to obtain definitive data as one of several methods to determine analytical error.

5.4.7 Field Blanks

Field blanks are samples prepared in the field using certified clean sand or soil and are then submitted to the laboratory for analysis. A field blank is used to evaluate contamination error associated with sampling methodology and laboratory procedures. If available, submit field blanks at a rate of one per day.

5.4.8 Trip Blanks

Trip blanks are samples prepared prior to going into the field. Trip blanks consist of certified clean sand or soil and are handled, transported, and analyzed in the same manner as the other volatile organic samples acquired that day. Trip blanks are used to evaluate error associated with sampling methodology and analytical procedures by determining if any contamination was introduced into samples during sampling, sample handling and shipment, and/or during laboratory handling and analysis. If available, utilize trip blanks for volatile organic analyses.

5.5 EVALUATION OF ANALYTICAL ERROR

The percentage and types of QA/QC samples needed to help identify the error and confidence in the data is based on the sampling objectives and the corresponding QA/QC objectives. The acceptable level of error is determined by the intended use of the data and the sampling objectives, including such factors as: the degree of threat to public health, welfare, or the environment; selected action levels; litigation concerns; and budgetary constraints.

The use of replicate samples is one method to evaluate error. To evaluate the total error of samples with contaminant concentrations near the selected action level, prepare and analyze a minimum of eight replicates of the same sample. Analytical data from replicate samples can also be used for a quick check on errors associated with sample heterogeneity, sample methodology and analytical procedures. Differing analytical results from two or more replicate samples could indicate improper sample preparation (e.g., incomplete homogenization), or that contamination was introduced during sample collection, preparation, handling, shipment, or analysis.

It may be desirable to try to quantify confidence; however, quantification or analytical data correction is not always possible. A 95% confidence level (i.e., 5% acceptable error) should be adequate for most sampling activities. Experience will provide the best determination of whether to use a higher (e.g., 99%) or lower (e.g., 90%) level of confidence. It must be recognized that the use of confidence levels is based on the assumption that a sample is homogeneous. See also Section 6.8 for information on total error.

5.6 CORRELATION BETWEEN SCREENING RESULTS AND DEFINITIVE RESULTS

One cost-effective approach for delineating the extent of site contamination is to correlate inexpensive screening data and other field measurements (e.g., XRF, soil-gas measurements) with laboratory results. The relationship between the two methods can then be described by a regression analysis and used to predict laboratory results based on screening measurements. In this manner, cost-effective screening results may be used in addition to, or in lieu of, off-site laboratory sample analysis.

Statistical regression involves developing a model (equation) that relates two or more variables at an acceptable level of correlation. When screening techniques, such as XRF, are used along with laboratory methods (e.g., atomic absorption (AA)), a regression equation can be used to predict a laboratory value based on the results of the screening device. The model can also be used to place confidence limits around predictions. Additional discussion of correlation and regression can be found in most introductory statistics textbooks. A simple regression equation (e.g., linear) can be developed on many calculators or computer databases; however, a statistician should be consulted to check the accuracy of more complex models.

Evaluation of the accuracy of a model in part relies on statistical correlation. Statistical correlation involves computing an index called the correlation coefficient (r) that indicates the degree and nature of the relationship between two or more sets of values. The correlation coefficient ranges from !1.0 (a perfect inverse or negative relationship), through 0 (no relationship), to +1.0 (a perfect direct, or positive, relationship). The square of the correlation coefficient, called the coefficient of determination, or simply R^2, is an estimate of the proportion of variance

in one variable (the dependent variable) that can be accounted for by the independent variables. The R^2 value that is acceptable depends on the sampling objectives and intended data uses. As a rule of thumb, statistical relationships should have an R^2 value of at least 0.6 to determine a reliable model; however, for health or risk assessment purposes, the acceptable R^2 value may be made more stringent (e.g., 0.8). Analytical calibration regressions have an R^2 value of 0.98 or better.

Once a reliable regression equation has been derived, the screening data can be used to predict laboratory results. These predicted values can then be located on a base map and contoured (mapping methods are described in Chapter 6). These maps can be examined to evaluate the estimated extent of contamination and the adequacy of the sampling program.

5.7 EXAMPLE SITE

The screening of containerized liquid wastes was performed to quickly obtain data indicating general chemical class. Definitive analysis was run on 10% of the samples in order to verify screening results. The definitive analyses provided were analyte and concentration specific. Recoveries of matrix spike and matrix spike duplicate samples indicated no matrix interferences. Dedicated equipment was used during Phase 1 sampling, making rinsate blanks unnecessary. Phase 2 screening was performed using XRF. During Phase 2, samples were collected at 30% of the nodes screened with the XRF. These samples were sent for laboratory AA analysis. A correlation was established by plotting the Phase 2 AA and XRF data. This allowed the XRF data from the other 70% of the nodes to be used to evaluate the chromium levels across the site.

For Phase 2 and 3 sampling, 10% of the data were confirmed by running replicate analyses to obtain an estimate of precision. The results indicated good correlation. Matrix spikes and matrix spike duplicate samples indicated no matrix interferences. During Phase 2, the OSC included performance evaluation (PE) samples for metals to evaluate the overall laboratory bias. The laboratory achieved 92% recovery, which was within the acceptable control limits.

During Phases 2 and 3, a rinsate blank was collected each day. Following the decontamination of the bucket augers, analyte-free water was poured over the augers and the rinsate was placed into 1-liter polyethylene bottles and preserved. The rinsate blanks were analyzed for total metals and cyanide to determine the effectiveness of the decontamination procedures and the potential for cross-contamination. All rinsate blank samples were "clean", indicating sufficient decontamination procedures.

The correlation analysis run on Phase 2 laboratory (AA) data and corresponding XRF values resulted in r values of 0.97 for both surface and subsurface data, which indicated a strong relationship between the AA and XRF data. Following the correlation analyses, regression analyses were run and equations to predict laboratory values based on the XRF data were developed. The resulting equation for the surface data was: AA = 0.87 (XRF) + 10.16. The resulting regression equation for the subsurface data was: AA = 0.94 (XRF) + 0.30.

6.0 DATA PRESENTATION AND ANALYSIS

6.1 INTRODUCTION

Data presentation and analysis techniques are performed with analytical, geophysical, or screening results. The techniques discussed below can be used to compare analytical values, to evaluate numerical distribution of data, to determine and illustrate the location of hot spots and the extent of contamination across a site, and to assess the need for removal of contaminated soil with concentrations at or near the action level. The appropriate methods to present and analyze sample data depend on the sampling objectives, the number of samples collected, the sampling approaches used, and a variety of other considerations.

6.2 DATA POSTING

Data posting involves placement of sample values on a site basemap. Data posting is useful for displaying the spatial distribution of sample values to visually depict extent of contamination and to locate hot spots. Data posting requires each sample to have a specific location (e.g., X and Y coordinates). Ideally, the sample coordinates would be surveyed values to facilitate placement on a scaled map.

6.3 GEOLOGIC GRAPHICS

Geologic graphics include cross-sections and fence diagrams, which are two- and three-dimensional depictions, respectively, of soils and strata to a given depth beneath the site. These types of graphics are useful for posting subsurface analytical data as well as for interpreting subsurface geology and contaminant migration.

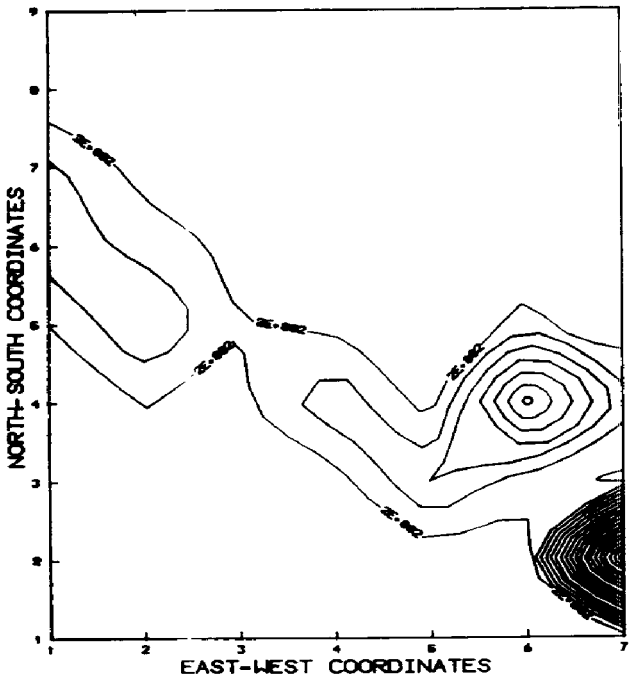
6.4 CONTOUR MAPPING

Contour maps are useful for depicting contaminant concentration values throughout a site. Contour mapping requires an accurate, to-scale basemap of the site. After data posting sample values on the basemap, insert contour lines (or isopleths) at a specified contour interval, interpolating values between sample points. Contour lines can be drawn manually or be generated by computer using contouring software. Although the software makes the contouring process easier, computer programs have a limitation: they may interpolate between all data points, attempting to fit a contour interval to the full range of data values. This can result in a contour map that does not accurately represent general site contaminant trends. Typical emergency or early action sites have low concentration/non-detect areas and hot spots. Computer contouring programs may represent these features as in Figure 16 which illustrates a site that has a 4000 mg/kg hot spot. Because there is a large difference in concentration between the hot spot and the surrounding area, the computer contouring program used a contour interval that eliminated most of the subtle site features and general trends. However, if that same hot spot concentration value is posted at a reduced value, then the contouring program can select a more appropriate contour interval to better illustrate the general site trends. Figure 17 depicts the same site as in Figure 16, but the hot spot concentration value has been arbitrarily posted at 1400 mg/kg. The map was recontoured and the contouring program selected a contour interval that resulted in a map which enhanced the subtle detail and general site contaminant trends.

6.5 STATISTICAL GRAPHICS

The distribution or spread of the data set is important in determining which statistical techniques to use. Common statistical analyses such as the t-test relies on normally distributed data. The histogram is a statistical bar graph which displays the distribution of a data set. A normally distributed data set takes the shape of a bell curve, with the mean and median close together about halfway between the maximum and minimum values. A probability plot depicts cumulative percent against the concentration of the contaminant of concern. A normally distributed data set, when plotted as a probability plot, would appear as a straight line. Use a histogram or probability plot to see trends and anomalies in the data prior to conducting more rigorous forms of statistical analysis.

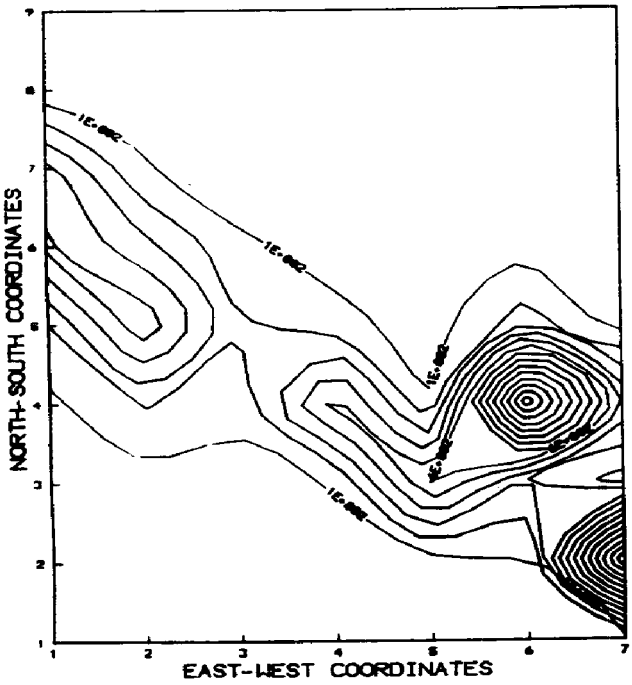
Figure 16: Computer-Generated Contour Map (4000 mg/kg Hot Spot)
ABC Plating Site



Total Chromium Concentration
Units = mg/kg
Contour Interval = 100 mg/kg

Includes 4000 mg/kg Hot Spot

Figure 17: Computer-Generated Contour Map (1400 mg/kg Hot Spot)
ABC Plating Site



Total Chromium Concentration
Units = mg/kg
Contour Interval = 100 mg/kg

Includes 1400 mg/kg Hot Spot*

* 1400 mg/kg hot spot is substituted for 4000 mg/kg hot spot

6.6 GEOSTATISTICS

Geostatistical methods are useful for data analysis and presentation. The characteristic feature of geostatistics is the use of variograms to quantify and model the spatial relationship between values at different sampling locations and for interpolating (e.g., kriging) estimated values across a site. The geostatistical analysis can be broken down into two phases. First, a model is developed that describes the spatial relationship between sample locations on the basis of a plot of spatial variance versus the distance between pairs of samples. This plot is called a variogram. Second, the spatial relationship modeled by the variogram is used to compute a weighted-average interpolation of the data. The result of geostatistical mapping by data interpolation is a contour map that represents estimates of values across a site, and maps depicting potential error in the estimates. The error maps are useful for deciding if additional samples are needed and for calculating best or worst-case scenarios for site cleanup. More information on geostatistics can be found in U.S. EPA, September 1988b and U.S. EPA, 1990. Geo-EAS and GEOPACK, geostatistical environmental assessment software packages developed by U.S. EPA, can greatly assist with geostatistical analysis methods.

6.7 RECOMMENDED DATA INTERPRETATION METHODS

The data interpretation method chosen depends on project-specific considerations, such as the number of sampling locations and their associated range in values. A site depicting extremely low data values (e.g., non-detects) with significantly higher values (e.g., 5,000 ppm) from neighboring hot spots, with little or no concentration gradient in-between, does not lend itself to contouring and geostatistics, specifically the development of variograms. However, data posting would be useful at such a site to illustrate hot spot and clean areas. Conversely, geostatistics and contour mapping, as well as data posting, can be applied to site data with a wide distribution of values (i.e., depicting a "bell shaped" curve) with beneficial results.

6.8 UTILIZATION OF DATA

When conducting search sampling to determine the locations of hot spots (as discussed in Section 2.9), analyze the data using one of the methods discussed in this chapter. For each node that is determined to be close to or above the action level, the following procedure is recommended.

Investigate all neighboring grid cells to determine which areas must be excavated and/or treated. From each grid cell, take a composite sample consisting of four or more aliquots, using the procedure described in Section 2.11.6. Grid cells with contaminant concentrations significantly above the action level (e.g., 20%) should be marked for removal. Grid cells with contaminant concentrations significantly less than the action level should be designated as clean. For grid cells with contaminant concentrations close to the action level, it is recommended that additional sampling be done within that grid cell to determine whether it is truly a hot spot, or whether the analytical result is due to sampling and/or analytical procedural error. If additional sampling is to be performed, one of the following methods should be considered:

- Collect a minimum of four grab samples within the grid cell in question. Use these samples to develop a 95% confidence interval around the mean concentration. If the action level falls within or below this confidence interval, then consider removal/treatment of the soil within that grid cell. More information on confidence intervals and standard deviation can be found in Gilbert, 1987.

- Collect additional composite samples from the grid cells in question using the technique discussed in Section 2.11.6. From these additional samples, determine the need for removal/treatment.

These two practical approaches help to determine the total error associated with collecting a sample from a non-homogeneous site. Total error includes design error, sampling error, non-homogeneous sampling error, and analytical error.

If additional sampling is being considered, weigh the cost-effectiveness of collecting the additional samples versus removing the soil from the areas in question. This decision must be made on a site-by-site basis.

After removal/treatment of the contaminated soil, re-investigate the grid cells to verify cleanup below the action level. Each grid cell that had soil removed must either be composite sampled again, or have multiple grab samples collected with a 95% confidence interval set up again. Again, this decision must be made on a site-by-site basis. The methodology should be repeated until all grid cells are determined to have soil concentrations below the action level.

6.9 EXAMPLE SITE

The Phase 2 XRF/atomic absorption (AA) data were examined to determine the appropriate data interpretation method to use. A histogram was generated to illustrate the distribution of the data as depicted in Figure 18. The histogram showed an uneven distribution of the data with most values less than 50 (approximately 4 on the LN scale of the histogram). Also, the presence of a single data point of 4000 (8 on the LN scale) was shown on the histogram. The data were initially posted as illustrated in Figures 19 and 20. Data posting was performed manually to give the OSC a quick depiction of the general site contamination trends. A contour mapping program was used to generate contours based on the posted data. Figure 16 illustrates the results of contouring with the 4000 mg/kg hot spot included. This contour map exaggerated the hot spot while eliminating the subtle site features and contaminant trends. Figure 17 depicts the same site data with the hot spot arbitrarily reduced to 1400 mg/kg. The resulting contour map enhanced more of the subtle site features and trends while reducing the effects of the hot spot.

AA concentrations predicted by the regression equations were kriged and contoured using Geo-EAS (Figures 21 and 22). Both the kriged contours and the data posting showed the same general site contaminant trends. However, data posting gave a more representative depiction of actual levels of contamination and the OSC used data posting for decision-making.

For each node with chromium concentrations close to or above the 100 ppm action level, the adjacent grid cells were further investigated. Composite samples consisting of four aliquots of soil were taken from within each grid cell in question and analyzed. If the soil concentration level was significantly below 100 ppm of chromium, the cell was designated as clean. Each cell that had a soil concentration level well above the action level was marked for removal/treatment. Any cells having soil concentrations close to the action level were sampled further using the compositing method to better quantify the actual contaminant concentration. Since the surrounding area is residential, on-site landfilling was not considered a viable treatment option. To expedite treatment/disposal, all excavated soil from contaminated cells was stockpiled on site until treatment/disposal could be accomplished under a fixed-price contract. The stockpile, placed in the area of the most highly contaminated grid cells (where the lagoons were located), was covered until treatment/disposal could be arranged. Cleanup was verified with composite sampling in the excavated cells. Results of the composite sampling were compared with the action level to verify cleanup. All action levels were met. The excavation pits were filled with stone and clean soil, covered with topsoil, graded and seeded.

Figure 18: Histogram of Surface Chromium Concentrations
ABC Plating Site

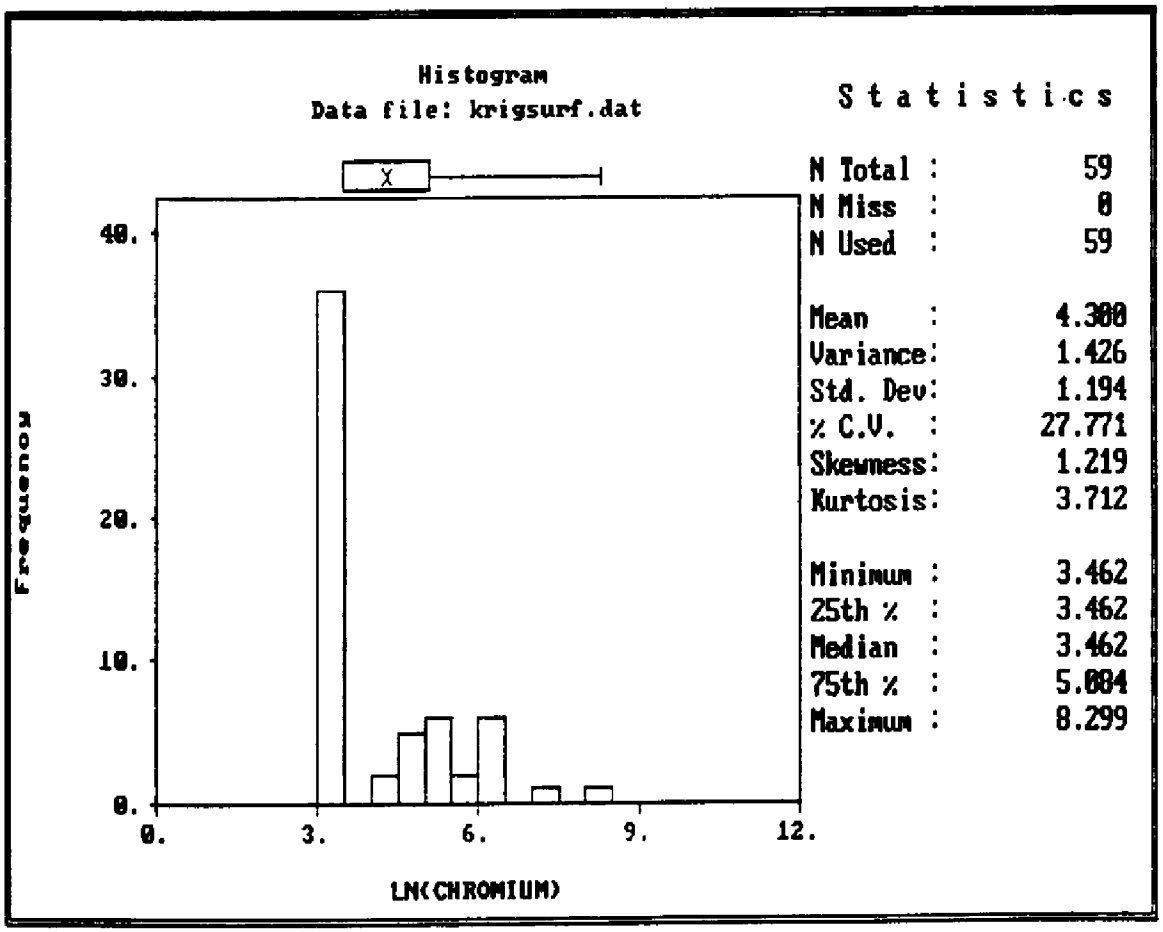


Figure 19: Phase 2 Surface Data Posting for Chromium
ABC Plating Site

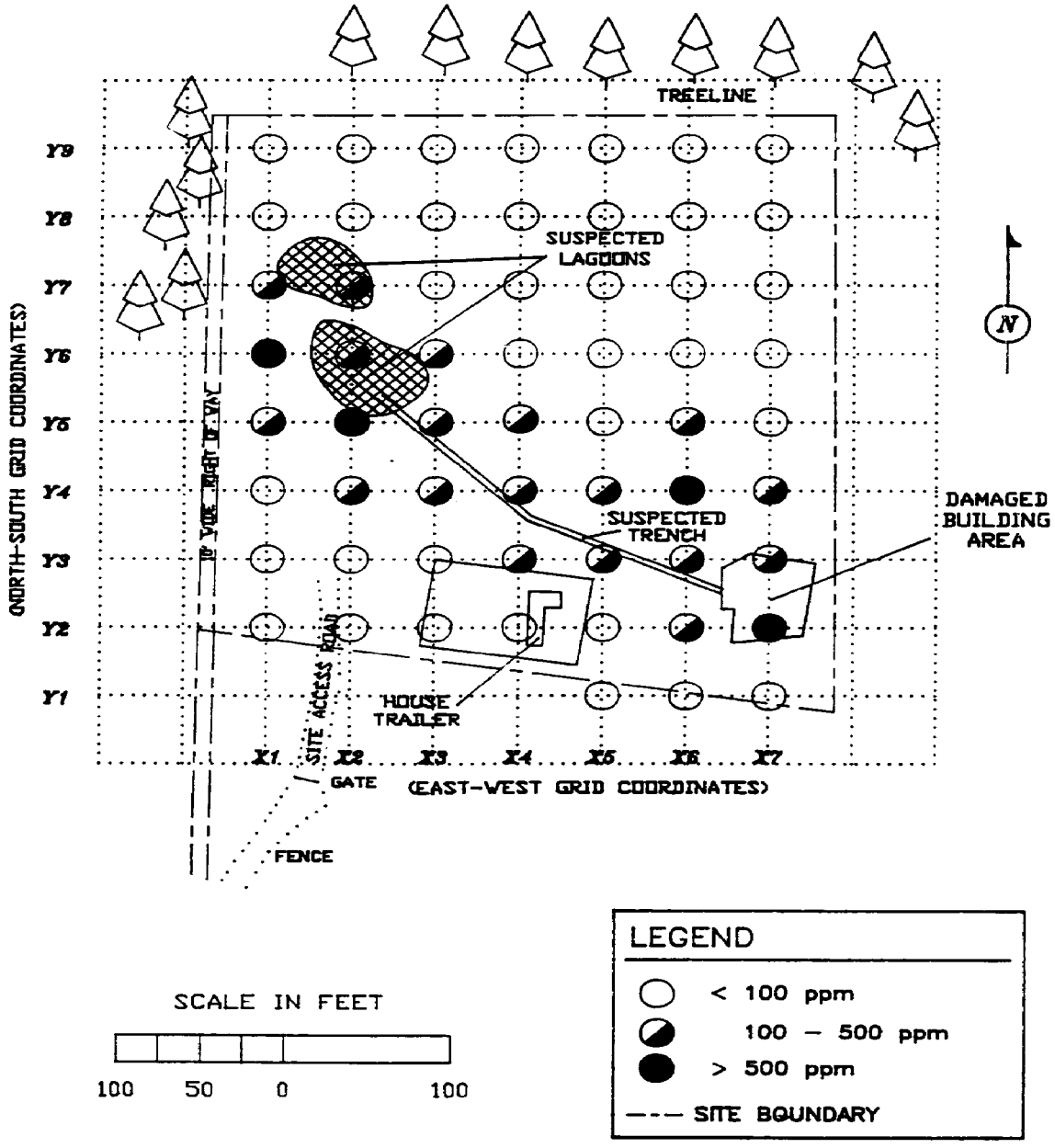


Figure 20: Phase 2 Subsurface Data Posting for Chromium
ABC Plating Site

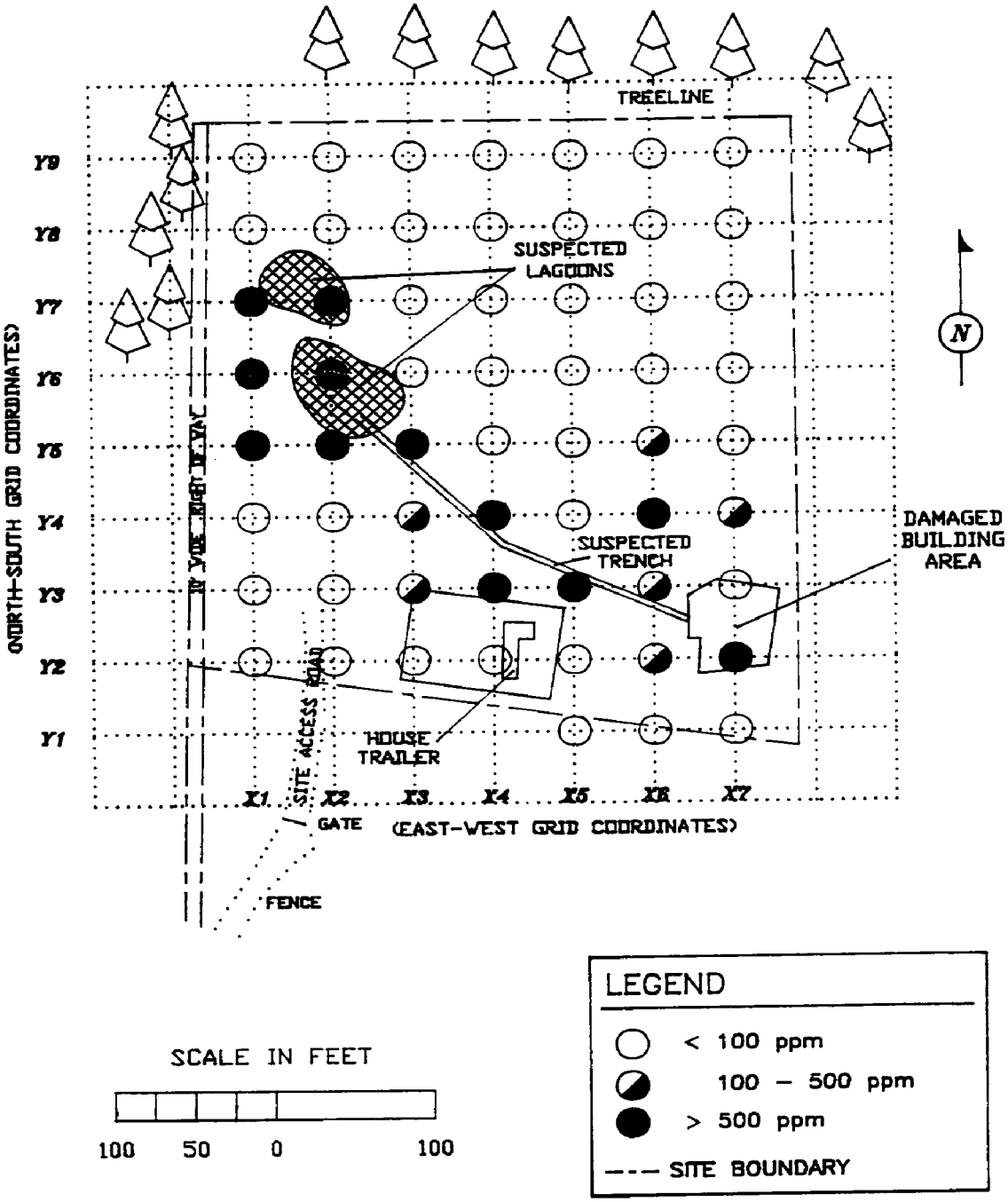


Figure 21: Contour Map of Surface Chromium Data (ppm)
ABC Plating Site

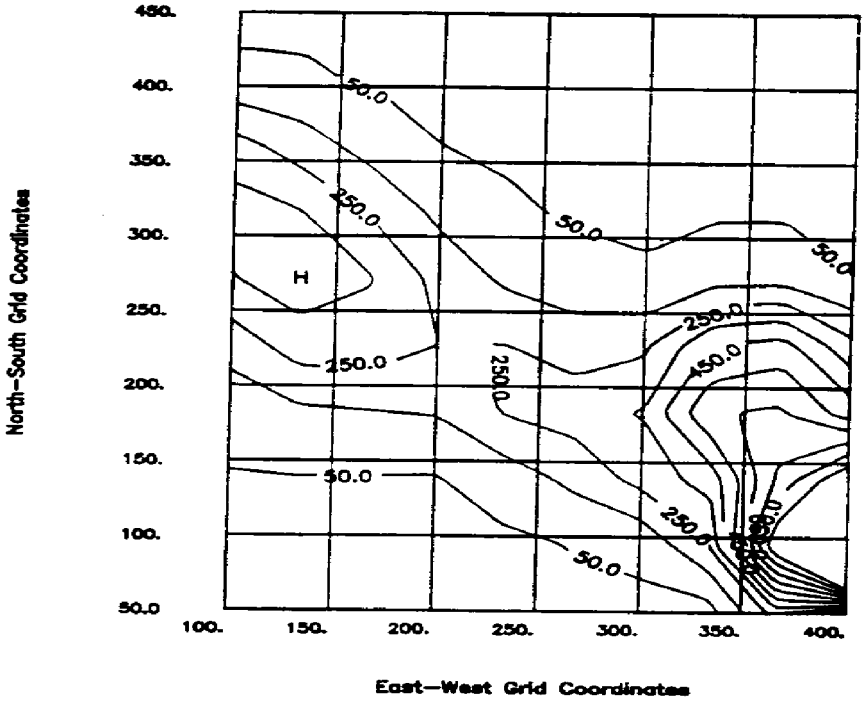
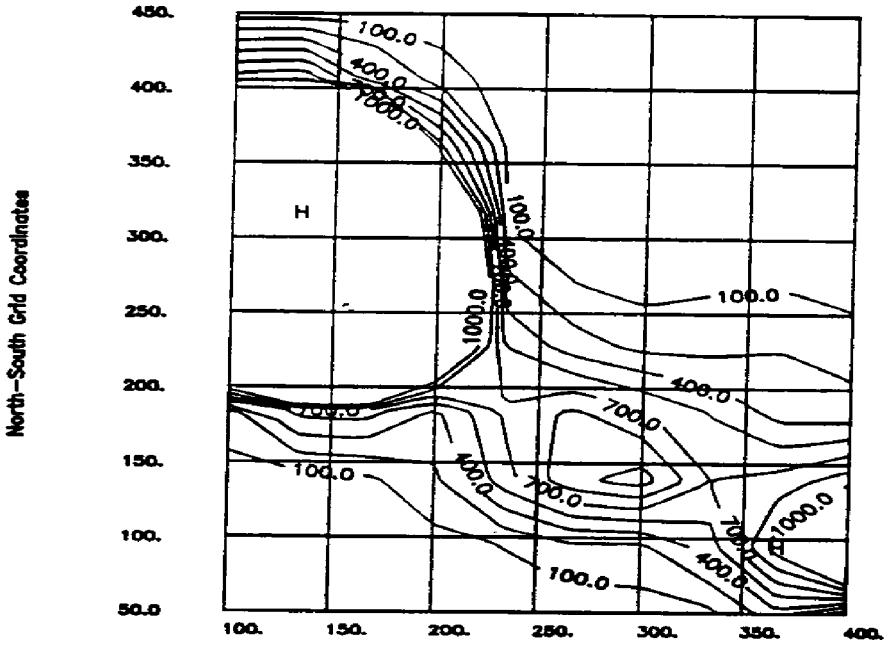
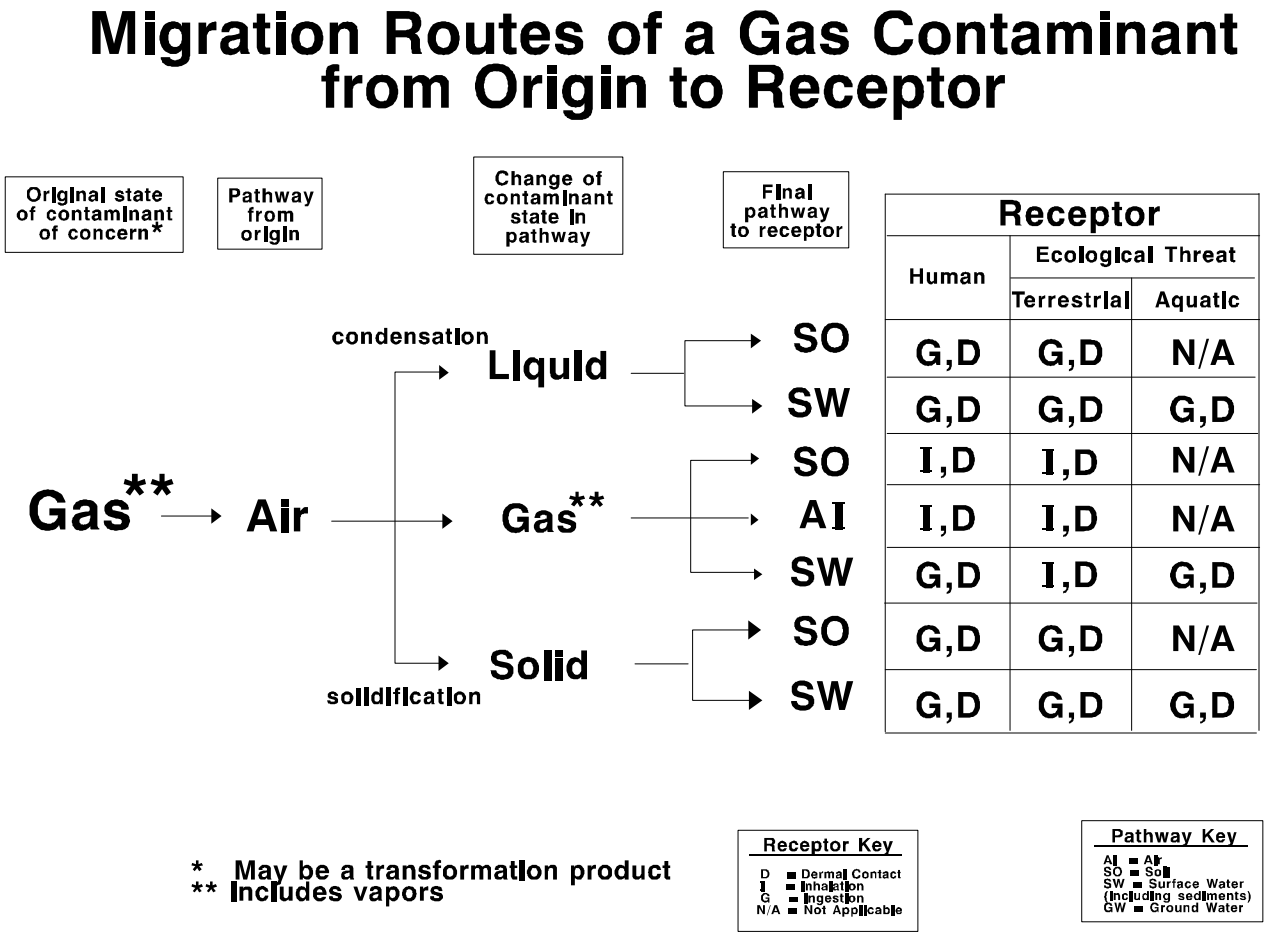


Figure 22: Contour Map of Subsurface Chromium Data (ppm)
ABC Plating Site



APPENDIX A -- EXAMPLE OF FLOW DIAGRAM FOR CONCEPTUAL SITE MODEL

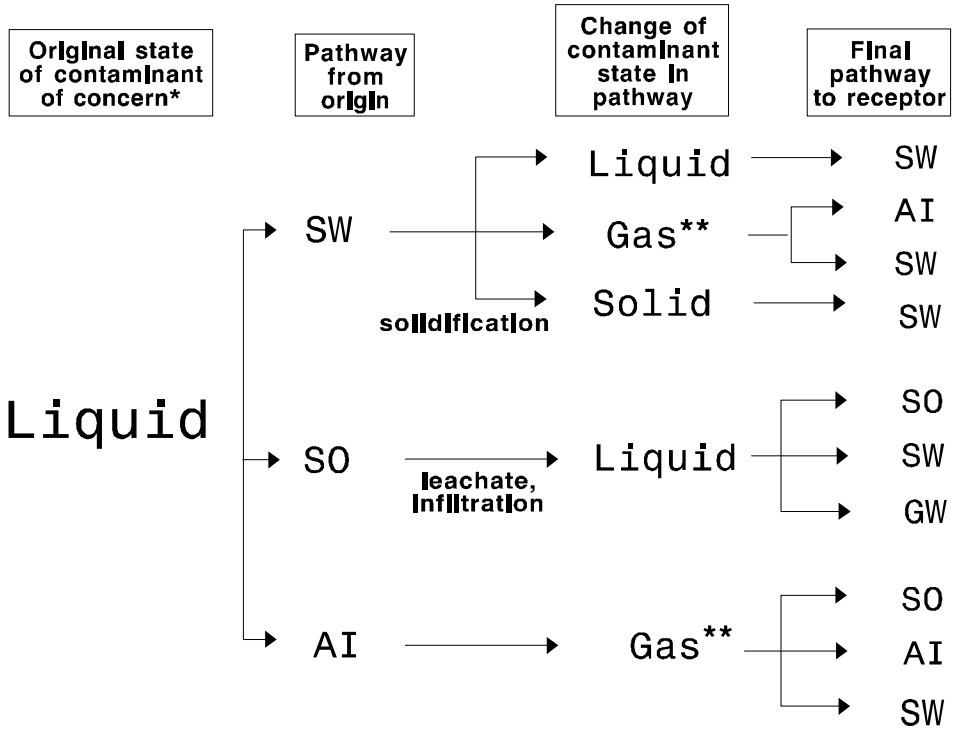
Figure A-1



Receptor		
Human	Ecological Threat	
	Terrestrial	Aquatic
G,D	G,D	N/A
G,D	G,D	G,D
I,D	I,D	N/A
I,D	I,D	N/A
G,D	I,D	G,D
G,D	G,D	N/A
G,D	G,D	G,D

Figure A-2

Migration Routes of a Liquid Contaminant from Origin to Receptor



Original state of contaminant of concern*	Pathway from origin	Change of contaminant state in pathway	Final pathway to receptor	Receptor: Human	Receptor: Ecological Threat: Terrestrial	Receptor: Ecological Threat: Aquatic
Liquid	SW	Liquid	SW	G,D	G,D	G,D
		Gas**	AI	I,D	I,D	N/A
			SW	G,D	G,D	G,A
		Solid (solidification)	SW	G,D	G,D	G,D
	SO	Liquid (leachate, infiltration)	SO	G,D	G,D	N/A
			SW	G,D	G,D	G,D
			GW	G,D	N/A	N/A
	AI	Gas**	SO	G,D	G,D	N/A
			AI	I,D	I,D	N/A
			SW	G,D	G,D	G,D

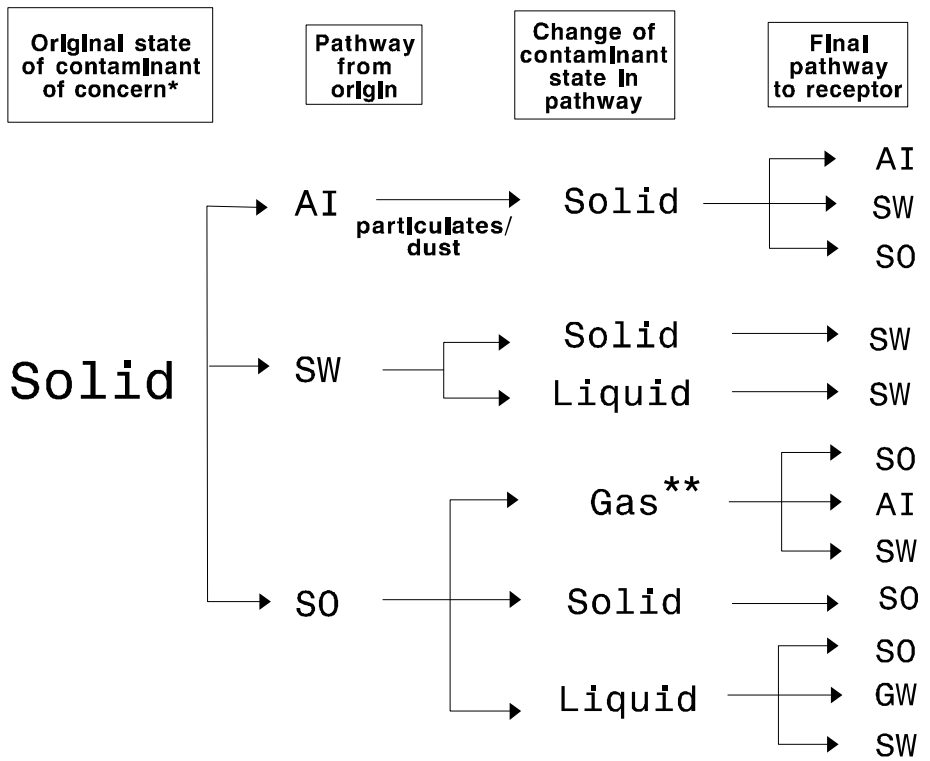
* May be a transformation product
** Includes vapors

Receptor Key
D = Dermal Contact
I = Inhalation
G = Ingestion
N/A = Not Applicable

Pathway Key
AI = Air
SO = Soil
SW = Surface Water (including sediments)
GW = Ground Water

Figure A-3

Migration Routes of a Solid Contaminant from Origin to Receptor



Receptor		
Human	Ecological Threat	
	Terrestrial	Aquatic
I,D	I,D	N/A
G,D	G,D	G,D
G,D	G,D	N/A
G,D	G,D	G,D
G,D	G,D	G,D
G,D	G,D	N/A
I,D	I,D	N/A
G,D	G,D	G,D
G,D	G,D	N/A
G,D	G,D	N/A
G,D	N/A	N/A
G,D	G,D	G,D

* May be a transformation product
** Includes vapors

Receptor Key
D = Dermal Contact
I = Inhalation
G = Ingestion
N/A = Not Applicable

Pathway Key
AI = Air
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Appendix D

Field Forms

bec environmental, inc.

Environmental Consulting

Date:_____

Time:_____

Site Conditions/Weather:_____

_____

Team Member(s): _____

_____

SAMPLE NUMBER:_____

SAMPLE LOCATION:_____

ANALYSIS:

- ☐ Total Arsenic
- ☐ TPH
- ☐ Total Lead
- ☐ Asbestos
- ☐ Other:_____

Stored by Lab: Y N

SAMPLE DESCRIPTION:_____

_____

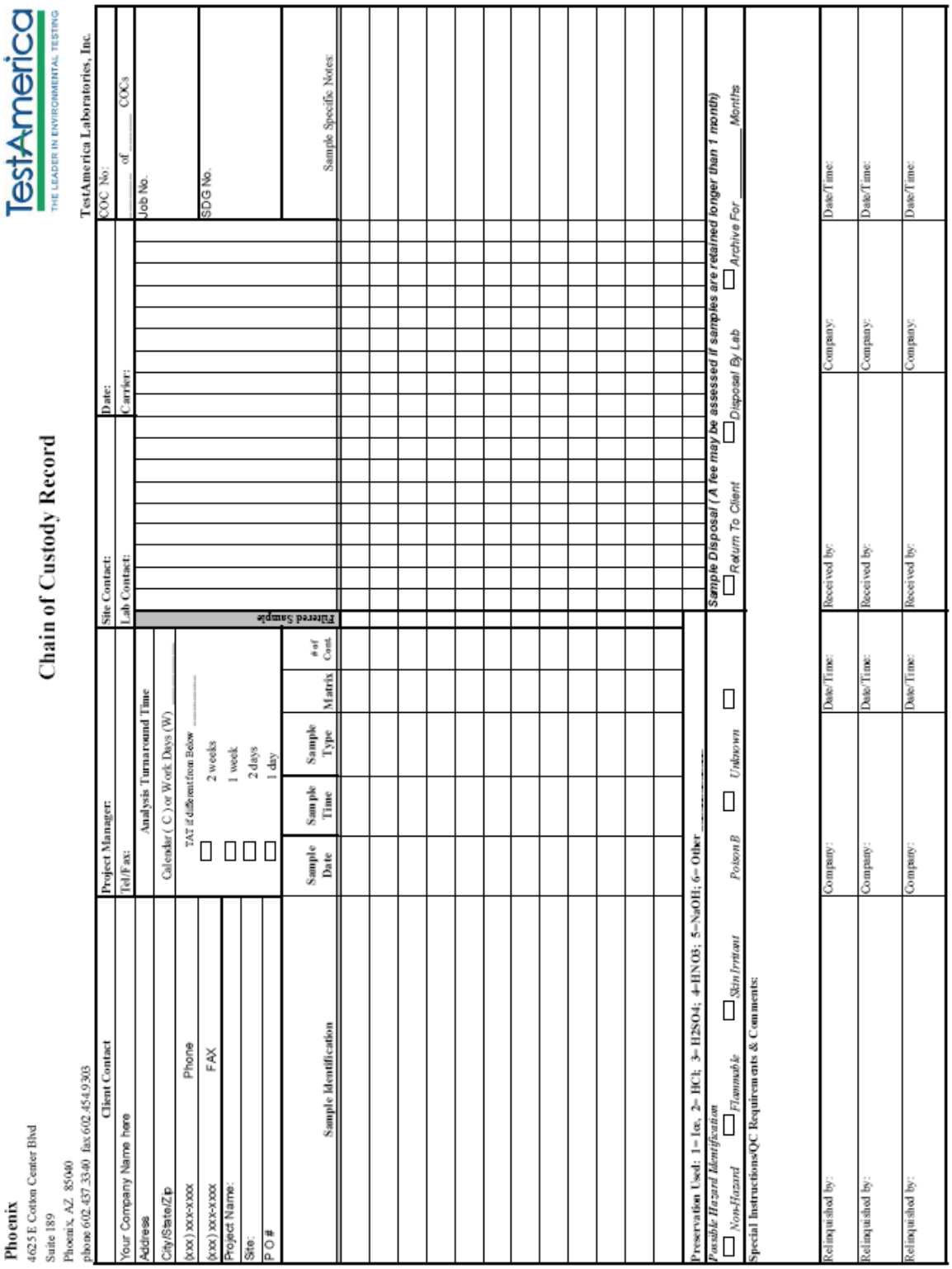
NOTES/SITE SKETCH:

7660 West Sahara Avenue · Suite 150 · Las Vegas · Nevada · 89117 · phone 702.304.9830 · fax 702.304.9839

Appendix E

Chain-of-Custody Form

Figure 23-1. Example: Chain of Custody (COC)



Appendix F

Site Health and Safety Plan

HEALTH AND SAFETY PLAN

TONOPAH AIRPORT FBO BUILDING

1 AIRPORT ROAD

TONOPAH, NEVADA 89049

NYE APN: 012-471-13

NYE COUNTY, NEVADA

Asbestos Survey, Lead-Based Paint Survey
&
Phase II Surface Investigation
Soil

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FIGURES

APPENDICES

1.0 INTRODUCTION

This Site Specific Health and Safety Plan (SSHASP) provides site specific information, safety responsibilities, and field mitigation measures to be employed by individuals taking part in field work activities. Elements of this program may include, but are not limited to the following activities: long distance travel to isolated areas; travel on dirt, gravel, and unimproved roads; mechanical issues with vehicles; adverse encounters with desert flora and fauna; encounters with unknown individuals; difficulties locating work sites.

An SSHASP will be completed prior to the implementation of each major field project.

2.0 ORGANIZATIONAL STRUCTURE

This section of the SSHASP identifies key employees on and off site, site contractors and subcontractors, and State and Federal agency representatives and discusses: primary personnel on site, their roles, and their responsibilities; and contact personnel off site, their roles and responsibilities.

2.1 Primary Site Staff

Field Safety Supervisor (FSS): On site project lead.
The FSS has full responsibility and authority to develop and implement this SSHASP, and to verify compliance. The FSS has overall responsibility for all field activities during work operations and has the authority to halt site work if unsafe conditions are encountered. The specific responsibilities of the FSS are:

- performing a hazard assessment prior to project implementation;
- managing the safety and health functions on the site;
- serving as the site's point of contact for safety and health matters;
- ensuring site monitoring, worker training, and effective selection and use of Personal Protective Equipment;
- assessing site conditions for unsafe acts and conditions and providing corrective action;
- assisting in the preparation and review of the SSHASP; and
- coordinating with others as necessary for safety and health efforts.

The FSS is also responsible for ensuring any necessary safety equipment is in proper working order and is used correctly; safety meetings are conducted prior to each survey; and steps are taken immediately to effect remediation of health and safety issues. The FSS will retain the authority to stop work on-site in the event unsafe work practices or conditions are observed, e.g., lightning storms, hazardous materials spill, wildlife encounters, etc. The FSS may delegate authority for Health and Safety oversight to other appropriately trained Field Personnel.

Field Personnel: On site field workers or assistants.
Field Personnel on the site may include employees, contractors, and/or subcontractors. Field Personnel are responsible for:

- complying with this SSHASP;
- using the proper Personal Protective Equipment (PPE);
- reporting unsafe acts and conditions to the FSS; and
- following the work, safety, and health instructions of the FSS.

It is the responsibility of all field personnel to be aware of safety requirements necessary for the work being performed. All workers will be aware of the requirements set forth in this SSHASP, and will acknowledge this fact in writing, by signing the Acknowledgement Sheet provided in Appendix A before being allowed access to the site.

Off-Site Contacts: Offsite contacts not involved in the field work.
Upon completion of the day's field work, a personnel not located in the field will be notified of the field crew's safe return from the field. This contact will have knowledge of the individuals in the field that day, and the location (including a map) of the field work site(s).

2.2 Occasional Field Staff

Occasional Site Workers are other personnel, contractors and subcontractors who work on site infrequently on an as needed basis and will also be identified in the SSHASP for each project for which work was performed.

3.0 HAZARD ANALYSIS

This section of the SSHASP describes the safety and health hazards associated with site work and the control measures selected to protect workers. The purpose of a hazard analysis is to identify and quantify the health and safety hazards associated with each site, and to evaluate the risks to workers. Using this information, appropriate control methods are selected to reduce or eliminate the identified risks if possible, or to effectively control them.

3.1 Hazard Analyses

The FSS will be responsible for conducting a project specific hazard analysis by completing a Hazardous Analysis Worksheet and a Medical Needs Analysis Worksheet (as appropriate) for each task of each major field project. These worksheets and appropriate supporting material are in Appendix B.

3.2 Process for Project Specific Hazard Analysis

The hazard analysis is performed for specific tasks and/or operations necessary for on-site project completion. Each hazard analysis identifies anticipated physical and biological hazards and the likelihood and level of exposure. The final section of each hazard analysis lists the control measures implemented to protect employees from exposure to the identified hazards. The information provided here is designed to satisfy the hazard analysis requirements of Nye County. Documentation of this assessment process, including potential risks and control measures for each identified task, is included as Appendix B.

Tools, vehicles, electronics, and other equipment shall be visually inspected and calibrated as necessary prior to departure. This includes, but is not limited to, the condition of field vehicles, including the spare tire, all electronic equipment planned to be utilized on site, ensuring extra batteries are available, associated maps are correctly marked with locations to be accessed, and any paperwork associated with the sites (locations, descriptions, permissions, site conditions, etc.) is on hand and up to date, including contact information. The Field Work Check Sheet is included as Appendix C.

Travel to and from site: Hazards associated with travel over unimproved, dirt, or gravel road surfaces shall be considered. Safe driving practices, including the observation of speed limits and the utilization of an out of the vehicle spotter for backing and uncertain or confined road conditions shall be utilized. As necessary, rotation of drivers will be used to avoid driver fatigue and maximize off road driving skill.

Vehicle issues: The vehicle to be used for the field work shall be inspected for pre-existing damage and the location and condition of the spare tire. If site work is expected to involve travel on other than paved road surfaces, a four wheel drive vehicle is highly recommended. If a four wheel drive vehicle is not available, common sense should be used in determining if the vehicle being used is able to travel the roads necessary to access the site. If successful access to the site is questionable, it should not be attempted. The staff should return to the site when road conditions have improved (i.e. no snow or mud), or when a four wheel drive vehicle is available. A vehicle safety kit, including safety equipment such as a collapsible shovel and basic tools, should be kept in the vehicle during the extent of the field work.

Desert conditions: Field work, by its nature, involves contact, both purposeful and inadvertent, with desert flora and fauna, and environmental conditions. Because of this, all personnel in the field shall maintain certification in first aid and CPR, and be familiar with common desert issues such as, snake and spider bites, cactus encounters, skin irritants, heat stress/stroke, and abandoned mine hazards and procedures.

Site conditions: Before beginning any field work, site procedures will be reviewed to cover contingencies such as the inability to locate the field site, inability to reach the field site, needed clarification of site descriptions or locations, or encounters with individuals not associated with the project. A Site Condition Procedures Check Sheet is included as Appendix D.

4.0 TRAINING PROGRAM AND MEDICAL CERTIFICATION

The field work training program is designed to ensure that workers receive the training they need to work safely in the field.

4.1 General Training Requirements

All site workers will be trained and current in First Aid and CPR certifications. Documentation of this training will be maintained on-site and in the Office. Personnel who have not been trained to a level required by their job function and responsibility are permitted to participate in

field activities with appropriate supervision and must obtain the required training as soon as feasible.

Upon project implementation, daily "tailgate" training is required to discuss topical subjects including, but not limited to, site specific hazards, general safety practices, site conditions (weather, terrain, new/additional personnel or equipment on site), work schedule/plan, and other safety directives considered appropriate by the FSS. Tailgate safety meetings will provide an additional venue for field personnel to actively participate in the health and safety program. Field personnel are expected to provide feedback, make recommendations, and express concerns that will ultimately improve the program. Tailgate safety meetings will be documented on a daily worksheet which is found in Appendix E of the SSHASP. The worksheet will include the date, topic(s) for discussion, FSS or designated tailgate meeting leader, and a signature list of attendees. The completed forms will be maintained throughout the life of the project.

During field activities, workers will be monitored for any indications of heat or cold induced stress and fatigue. Appropriate environmental monitoring, a work/rest regimen, and physiological response (pulse, temperature, skin temperature, and respiration) monitoring will be performed if conditions warrant. Adequate drinking water shall be on hand at all times during site operations.

4.2 Site Personnel Training and Notification Requirements

Field personnel are required to call (or otherwise provide notification if no phone coverage is available) into the their office, or to a designated contact, at the beginning of the day before departing for the field, and after completing work in the field to inform work has been completed and the personnel are inbound. If field work is expected to occur in areas with no or limited cell phone coverage, a SPOT device, or something similar, should be set up prior to the beginning of field work so it can notify the designated off-site contacts of field staff location. For multi-day field visits, contact should be made at least twice daily, more often if field personnel will be working in multiple locations.

5.0 GENERAL SAFETY PRACTICES

During the performance of all work, field personnel should keep safety in mind, both for themselves and their fellow workers. Any safety hazards which are observed, or which a worker feels may reasonably occur, should be brought to the attention of the FSS and field crew immediately. The incidence of accidents or injury is a measure of the SSHASP's effectiveness and as such, a "Zero Accident" philosophy should be followed. Any employee and/or contractor who discovers a condition or practice that creates or, if allowed to persist, would create any imminent danger to workers, the public, or the environment, has the authority to stop work.

5.1 Personal Protective Equipment

Personal protection equipment (PPE) will be used by all on-site personnel in accordance with the findings of the hazard analyses. The FSS is responsible for ensuring that all site personnel and

visitors are equipped with, use, and maintain appropriate PPE. All personnel will wear designated approved protective clothing and devices as instructed by the FSS. This may include the use of boots with ankle support, clothing for a variety of environmental conditions, sunscreen, head protection, ear protection, and water.

5.2 Safety and Communications Equipment

The following safety equipment and information should be available on site at all times during field operations. All equipment must meet federal and state OSHA requirements and shall be checked prior to departing for the field by the FSS, or their designated assistant, to ensure that the equipment is in proper operating condition and instructions regarding its use are current.

- Fire extinguisher
- First aid kit
- Portable Eye-Wash Kit
- Vehicle safety kit
- Cellular phone
- GPS unit (extra batteries)
- Digital camera
- SPOT satellite locator device
- Two-way radios (extra batteries)
- Topographic maps
- Site Specific Health and Safety Plan
- Additional equipment and supplies as required to provide adequate safety at the site.

5.3 FIELD CREW SAFETY PRACTICES

Should members of a field crew become separated and outside of contact range during field activities, they are to return to the vehicle and remain there until all personnel are accounted for before continuing with any field activities.

6.0 EMERGENCY RESPONSE PROCEDURES

Emergency response procedures are to protect the health and safety of personnel working at remote field sites. These procedures are designed to take all reasonable precautions to avoid any emergency situation and to detail the appropriate response in the event of such a situation.

All accidents or emergencies will be reported to the FSS and the designated off-site contact, and will be followed as immediately as practicable (but no later than 24 hours after incident) with an Emergency Event Report (Appendix F). These reports will be prepared by the FSS for submittal to the appropriate supervisor. **A map depicting the safest route from the project site to the nearest medical facility is included in the Figures section.**

6.1 Definition of Emergency Conditions

The FSS will determine what conditions constitute an emergency. These conditions may include, but are not limited to:

- Death;
- Employee injury or illness (OSHA recordable cases);
- On-site accident or equipment failure that poses an immediate danger to life, health, or the environment;
- Property damage or loss; and
- Vehicle accidents en route to or from field sites.

6.2 Emergency-Related Responsibilities

The FSS will have overall responsibility for the coordination of emergency response activities. Specific activities may include, but are not limited to, one or more of the following:

- First aid to injured;
- Repair/replacement of failed equipment; and
- Request for Emergency Services.

In the event of an emergency, all personnel shall assist the FSS as required until the response has been completed.

6.3 Emergency Contact Information

Site-specific emergency contact information shall be included for each SSHASP. The FSS will review and update this information as the information changes to ensure the information is current and accurate.

7.0 SITE SPECIFIC DETAILS

7.1 Project Information

Project Name: _____

Date: _____

Site Location/Name _____

Site Description (Reference Figures 1and 3: Site and Vicinity Maps):
_____

Project Objective(s) (Include project phases, scope of work, and anticipated tasks):_____
_____
_____

Project Start Date: _____ ***Anticipated Completion Date:***_____

7.2 Site Information

Primary Site Personnel

FSS:_____ Phone: _____(cell)
(office)

Site Worker: _____ Phone: _____(cell)

Site Worker: _____ Phone: _____

7.3 Hazard Analysis

This section of the SSHASP describes the site-specific safety and health hazards associated with specific tasks and operations performed as part of this project, and the specific control measures selected to protect workers. Documentation of this assessment process, including potential risks and control measures for each identified task, is included as Appendix D. Detailed hazard description reference sheets and control measures (if necessary) for each hazard analysis are included behind the applicable worksheet.

Hazard Analysis Summary:

Appendix A

Acknowledgement Sheet

I have read and understand the Field Site Specific Health and Safety Plan.

Name: Date:

Appendix B

Hazard Analysis and Medical Needs Assessment

MATERIAL SAFETY DATA SHEET

MSDS DATE: 03/14/12

ABC® ASBESTOS BINDING COMPOUND

Per OSHA-recommended ANSI Z400.1-2004 standard format & in accordance with European standard format

SECTION 1: PRODUCT AND COMPANY IDENTIFICATION

Product Name: ABC® Asbestos Binding Compound
Product Description: Asbestos Binding Compound - Off-White
Product Code: 6421

Manufacturer: Fiberlock Technologies, Inc.
Address:
Fiberlock Technologies
150 Dascomb Road
Andover MA, 01810

Contact Info:
Tel: (800) 342-3755
Fax: (978) 475-6205

Emergency Phone: 24 Hour Contact: CHEM-TEL: (800) 255-3924 (Contract Number: MIS0001450)
INTERNATIONAL 24 HOUR EMERGENCY Phone: 813-248-0585

SECTION 2: COMPOSITION/INFORMATION ON INGREDIENTS

Non-hazardous:
Pigmented Latex emulsion coating comprised of water, pigments, fillers, additives, and latex emulsion resin.

Hazardous:

Chemical Name	CAS#	Percent	Exposure Limits
1 - Titanium dioxide	13463-67-7	< 25.0	ACGIH TLV 10 mg/m³ as Dust OSHA PEL 10 mg/m³ as Total Dust 5 mg/m³ Respirable Fraction

Note: Normal application procedures pose no hazard since titanium dioxide is wetted and encapsulated, but grinding or sanding dried films of this product may yield respirable titanium dioxide dust. Control exposures to less than 0.1 mg/m3 using NIOSH-approved dust filter respirators.

Note: Per 29CFR 1910.1200 (g) (2) (1) (C) (2), only hazardous substances present in excess of 1.0% by weight (or 0.1% for carcinogens) must be listed on an MSDS.

SECTION 3: HAZARDS IDENTIFICATION

Emergency Overview:

Product Description: This product is a pigmented liquid.

Health Hazards:
Eyes: May cause slight irritation.
Skin: Substance may cause slight skin irritation.
Inhalation: May cause irritation of respiratory tract.
Ingestion: Ingestion may cause gastrointestinal irritation, nausea, and vomitting.

Flammability Hazards: This product is not flammable. If this product is involved in a fire, the decomposition products generated will include irritating vapors and gases and some carbon monoxide.

Reactivity Hazards: This product is not reactive.

Environmental Hazards: Although release of this product to the environment is not expected to cause significant adverse effect, all releases should be avoided.

SECTION 4: FIRST AID MEASURES

Eyes: Immediately flush eyes with plenty of water for at least 15 minutes and consult physician.

Skin: Wash skin thoroughly with soap and water. If drenched with product, remove and wash clothing before reuse.

Ingestion: Ingestion If victim is conscious give 2 glasses of water. Call a physician.

Inhalation: N/A

SECTION 5: FIRE-FIGHTING MEASURES

Product is non-combustible.

Flash point:
F: Not flammable
C: Not flammable

Autoignition Temperature:
F: Not Established
C: Not Established

Extinguishing Media:

Use extinguishing media appropriate for surrounding fire

Water Spray	OK
Carbon Dioxide	OK
Foam	OK
Dry Chemical	OK
Halon	OK
Other	Any "ABC" Class

SECTION 6: ACCIDENTAL RELEASE MEASURES

Accidental Release Measures:

Personal Precautions: Do not get in eyes. Do not take internally. Avoid skin contact. Prevent prolonged or repeated breathing of vapor or spray mists. Keep unnecessary people away. Floor may be slippery, use care to avoid falling. Ventilate the area. Remove with inert absorbent.

Environmental Precautions: Keep spills and cleaning run-offs out of municipal sewers and open bodies of water. Comply with local, state and national regulations.

SECTION 7: HANDLING AND STORAGE

Handling and Storage:

Storage: Store in a cool, dry place
Keep closure tight and containers upright to prevent leakage.

Precautionary labeling: "KEEP FROM FREEZING".

SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

Precautions:
Use only with adequate ventilation.
Avoid contact with skin and eyes. Avoid breathing vapor and spray mist.
Wash hands after using.

This coating may contain materials classified as nuisance particulates (listed "as Dust" in Section 2) which may be present at hazardous levels only during the sanding or abrading of the dried film. If no specific dusts are listed in Section 2, the applicable limits for nuisance dusts are ACGIH TLV 10 mg/m3 (total dust), 3 mg/m3 (respirable fraction), OSHA PEL 10 mg/m3 (total dust), 5 mg/m3 (respirable fraction).

Work Hygienic Practices: Avoid contact with skin. Do not get in eyes. Do not take internally. Avoid breathing vapors or spray mists.

Ventilation: Use in well-ventilated areas. General exhaust acceptable if the exposure to materials in Section 2 is maintained below applicable exposure limits. Refer to OSHA Standards 1910.94, 1910.107, 1910.108.

Respiratory Protection: If personal exposure cannot be controlled below applicable limits by ventilation, wear a properly fitted organic vapor/particulate respirator approved by NIOSH/MSHA for protection against materials in Section 2. When sanding or abrading the dried film, wear a dust/mist respirator approved by NIOSH/MSHA for dust which may be generated from this product, underlying paint, or the abrasive.

Eye Protection: Use approved safety eyewear including side shields, chemical goggles or face shields.

Skin Protection: Wear neoprene or rubber gloves to prevent skin contact if prolonged skin contact is likely. Wash hands before eating, smoking or using the wash room.

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

Appearance:	Viscous liquid	**Viscosity @ 77°F:**	60-75 Kreb Units ± 5.0 ± 5.0
Odor:	Slight odor	**Percent Solids By Weight:**	51.4% ± 2.0.0
Boiling Point:	212°F	**Solubility in Water:**	Total
Freezing Point:	32°F	**Vapor Density @ 68°F:**	Heavier than air
Vapor Pressure (mmHg) @ 68°F:	17	**Specific Gravity (H2O = 1) @ 68°F:**	1.1 ± 0.1
Weight Per Gallon:	9.6 lbs/gal ± 0.5	**Evaporation Rate:**	Slower than ether

SECTION 10: STABILITY AND REACTIVITY

Stability: Stable

Incompatibility: (Material to Avoid): Avoid contact with strong oxidizing agents (e.g. nitric acid, permanganates), etc.

Hazardous Decomposition or By-Products: Some carbon monoxide.

Hazardous Polymerization: Will not occur.

SECTION 11: TOXICOLOGICAL INFORMATION

Toxicological Information:

Chronic Health Hazards

IARC's Monograph No. 93 reports there is sufficient evidence of carcinogenicity in experimental rats exposed to titanium dioxide but inadequate evidence for carcinogenicity in humans and has assigned a Group 2B rating. In addition, the IARC summary concludes, "No significant exposure to titanium dioxide is thought to occur during the use of products in which titanium is bound to other materials, such as paint."

Toxicology Data

Chemical Name	CAS No.	LD50
Titanium dioxide	13463-67-7	Oral: >24000 mg/kg (Rat) Dermal: >10000 mg/m^3 (rabbit) Inhalation (Dust): >6.82 mg/L (Rat, 4hr.)

SECTION 12: ECOLOGICAL INFORMATION

Ecological Information:

No Data Available

SECTION 13: DISPOSAL CONSIDERATIONS

Waste Disposal Method:

Waste from this product is not hazardous as defined under the Resource Conservation and Recovery Act (RCRA) 40 CFR 261. If incinerating, do so in an approved facility, and do not incinerate closed container. Dispose of in accordance with Federal, State/Provincial, and Local regulations regarding pollution.

SECTION 14: TRANSPORT INFORMATION

U.S. Department of Transportation

Proper Shipping Name: Non-Hazardous Water-Based Paint
Hazard Class: "Not Regulated"
Label Statement: "Keep From Freezing"
Class 55 Non-Hazardous Water-Based Paint

Canada (TDG)
Not Regulated for Transportation.

IMO
Not Regulated for Transportation.

SECTION 15: REGULATORY INFORMATION

U.S. Federal Regulations:

TSCA (TOXIC SUBSTANCE CONTROL ACT): All components of this product are in compliance with the inventory listing requirements of the U.S. Toxic Substances Control Act (TSCA) Chemical Substance Inventory.

CERCLA (COMPREHENSIVE RESPONSE COMPENSATION, AND LIABILITY ACT): Releases of this material to air, land, or water are not reportable to the National Response Center under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) or to state and local emergency planning committees under the Superfund Amendments and Reauthorization Act (SARA) Title III Section 304.

SARA TITLE III: No ingredients in this product are subject to SARA 313 (40 CFR 372.65C) Supplier Notification.

CALIFORNIA SAFE DRINKING WATER AND TOXIC ENFORCEMENT ACT (PROPOSITION 65): Components of this product are on the California Proposition 65 lists.

Titanium Dioxide is subject to the reporting requirements of Section 313 of the Emergency Planning and Community-Right-To-Know Act of 1986 and of 40 CFR 372.

CANADA DSL: All components are listed or exempt.

SECTION 16: OTHER INFORMATION

This product has been classified in accordance with the hazard criteria of the Canadian Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

To comply with New Jersey DOH Right-To-Know labeling law (NJAC 8:59 – 5.1 & 5.2)

CAS. No.:	CHEMICAL INGREDIENTS
7732-18-5	Water
13463-67-7	Titanium dioxide
25265-77-4	2, 2, 4-Trimethyl-1-3, pentanediol monoisobutyrate
Not Available +	Proprietary surfactant
Not Available +	Latex resin solids
(+) Contents Partially Unknown	

HMIS HAZARD RATING			
Health 1	Flammability 0	Physical Hazard 0	Personal Protection A
HAZARD INDEX: 0=Minimal, 1=Slight, 2=Moderate, 3=Serious, 4=Severe			
PERSONAL PROTECTION CODE:			
A=Safety glasses			

Warning! If you scrape, sand or remove old paint, you may release lead dust. LEAD IS TOXIC. EXPOSURE TO LEAD DUST CAN CAUSE SERIOUS ILLNESS, SUCH AS BRAIN DAMAGE, ESPECIALLY IN CHILDREN. PREGNANT WOMEN SHOULD ALSO AVOID EXPOSURE. Wear a NIOSH-approved respirator to control lead exposure. Clean up carefully with a HEPA vacuum and wet mop. Before you start, find out how to protect yourself and your family by contacting the National Lead Information Hot line at 1-800-424-LEAD (5323) or log on to: www.epa.gov/lead

IDAHO DEPARTMENT OF HEALTH & WELFARE

Bureau of Community and Environmental Health

Facts About Lead-Based Paint

This fact sheet includes:

- Health Effects of Lead
- Having Your Children Tested for Lead Poisoning
- Lead-Based Paint in Homes Built Before 1978
- Reducing Your Risks
- Lead Disclosure Laws
- Precautions When Remodeling
- Some Other Sources of Lead Exposure

Lead-based paint can be found in buildings in the city, country, apartments or single-family homes, and inside or outside of homes. Lead-based paint was heavily used in homes built before 1960, but was phased out of paint in 1978. In general, the older the home or structure, the more likely it is to have lead-based paint. It is most commonly found on windows, trim, doors, railings, columns, porches and exterior walls.

There are two ways lead can get into your body, through breathing or swallowing lead dust particles, and by eating chips, dust or soil containing lead based-paint.

Health Effects of Lead

Lead is most harmful to children six-years-old or younger because children often put their hands and other objects in to their mouth which may have lead dust on them. Growing bodies absorb more lead, and their brains and nervous systems are more sensitive to the damaging effects of lead.

Health effects of lead in children can include behavioral and learning problems (hyperactivity), slowed growth, hearing problems, headaches and damage to the brain and central nervous system.

Adults exposed to lead can suffer from reproductive problems, high blood pressure, digestive disorders, muscle and joint pain, memory and concentration problems, and nerve disorders.

Having Your Children Tested for Lead Poisoning

If you live in a home built prior to 1978 and the paint is in poor condition, or you have been or are remodeling, you should talk to your physician about having your children tested. A simple blood test by a physician is the only way to know if a child has lead poisoning. Blood lead tests are especially important for babies and toddlers since their blood levels tend to increase rapidly from 6 to 12 months and peak at 18 to 24 months of age. Children older than one year should have a blood test every couple of years or every year if the house or apartment contains lead paint or if you use lead in your job or hobby.

Lead-Based Paint in Homes Built Before 1978

A paint inspection will determine if there is lead content in the paint. A risk assessment will determine if there are any sources of lead exposure which may be hazardous and what actions you need to take.

Testing and assessments should be done by qualified individuals who are certified lead-based paint professionals. For a list of certified professionals, visit EPA's website at www.epa.gov/r10earth/lead.htm, or call the Idaho Indoor Environment Program at 1-800-445-8647.

Reducing Your Risks

There are simple steps that can be taken to reduce exposure to lead:

- Keep the areas your children play in as dust-free and clean as possible.
- Ensure that your children have a nutritious diet strong in iron and calcium. This will reduce the amount of lead their body takes in.
- Keep children from chewing on window sills or other painted surfaces.
- Wash children's hands often throughout the day, especially before meals and bedtime.
- Wash bottles, pacifiers, toys, and stuffed animals regularly.
- Clean-up paint chips immediately.
- Notify your landlord of peeling or chipping paint.
- Clean floors, window frames, window sills, and other surfaces *weekly* using warm water and a general all-purpose cleaner. NEVER MIX AMMONIA AND BLEACH AS THEY CAN FORM A DANGEROUS GAS.
- Clean or remove shoes before entering your home to avoid tracking in lead from soil.
- Bath pets on a regular basis to reduce the amount of dirt they bring in from the outside.

Precautions When Remodeling

Certain renovations can release lead from paint and dust into the air. Take the following precautions before you or a contractor disturb painted surfaces:

- Have the area tested for lead-based paint.
- Temporarily remove your family when the remodeling is being done, especially children and pregnant women. Seal off the area from the rest of the house.
- Do not use a belt-sander, propane torch, heat gun, dry scraper or dry sander. These can produce large amounts of lead dust and fumes.
- Follow other safety measures as outlined in the EPA document, "Reducing Lead Hazards When Remodeling Your Home" available by calling 1-800-424-LEAD or through their website at www.epa.gov/lead.

Lead Disclosure Laws

Federal law requires that individuals receive certain information regarding lead before renting, buying, or renovating pre 1978 housing.

- Landlords have to disclose known information on lead-based paint and lead-based paint hazards before leases are signed. Leases must include a lead-based paint disclosure form.
- Home sales contracts must include a lead-based paint disclosure form. Buyers have up to 10 days to check for lead hazards.
- Renovators are required to provide occupants with a copy of the EPA booklet, "Protect Your Family From Lead In Your Home".

Some Other Sources of Lead Exposure

- Drinking water - older homes may have lead plumbing pipes or lead solder. If you think your home plumbing has lead, use only cold water for drinking and cooking and run the water for 30 seconds before drinking it.
- Occupations - Some jobs may leave lead dust on clothing such as construction, demolition, painting, working with batteries or in a radiator repair shop. If you work with lead in your job, change your clothes before going home. Wash your hands well before eating, drinking, or smoking.
- Hobbies - some hobbies use lead such as making pottery, stained glass, sinkers, bullets, or refinishing furniture. If you have hobbies involving lead, change your clothes before going home. Wash your hands well before eating, drinking, or smoking.
- Soil - Lead from paint can peel off the outside of the house and get into the soil. Encourage your children to play in sand or grassy areas and try to keep them from eating dirt. Make sure they wash their hands when they come inside.
- Pottery - avoid eating or storing foods in lead crystal or lead-blazed pottery or porcelain.
- Lead Smelters - release lead into the air.
- Folk Remedies - some remedies contain lead, such as "greta" and "azarcon" which are used to treat an upset stomach.

For more information contact the **Idaho Indoor Environment Program** at:
Phone: 800-445-8647
Email: bceh@dhw.idaho.gov

EPA Region 10 website: www.epa.gov/r10earth/lead.htm

PropEx .com

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Graduate Study
Mortgage 101
Investments 101

Propex has it all.

Lead Paint

Lead is an element found in nature that can be highly toxic to the human body. Until its harmful properties were discovered, lead was widely used in many everyday products such as paint, plumbing pipe, gasoline, pottery glaze, and furniture finish. The use of lead-based paint was banned from housing by the federal government in 1978 and other products containing harmful levels of lead were phased out or eliminated during the 1970's and 1980's.

Common Sources

Lead was historically used as an additive to primers and paints. It was applied to steel structures as it would increase the durability of the paint while reducing the corrosion of the steel. However, the use of lead-based paint was not restricted to steel buildings and it became common in homes, apartments, and public housing buildings constructed before 1978.

Before tests proved high levels of lead to be harmful, it could be found commercially in two common forms:

• Organic

Organic lead was primarily used in products like gasoline. It is not encountered commonly, but harmful levels of this form of lead can be found in soil where gasoline containing lead additives was deposited. Organic lead may be absorbed through the skin.

• Inorganic

Inorganic lead is the form of lead used in lead-based paints. It is commonly encountered in harmful levels in and around houses that were painted with lead-based paints. Unlike organic lead, it may not be absorbed through the skin, but can enter the body in high amounts through ingestion or inhalation.

Health Effects

Inorganic lead (such as is found in lead-based paint) is directly absorbed and distributed into the body in three primary areas:

• Blood

• Soft tissue (such as the kidneys, bone marrow, brain, and liver)

• Bones and teeth

Exposure to lead can have serious health effects for both children and adults.

Children are most susceptible to damage from lead exposure, and high blood-lead levels can cause some of the following conditions:

- Damage to the brain and nervous system
- Behavior and learning problems
- Slowed growth

- Hearing problems
- Headaches

Adults can also be affected by high levels of lead in the blood and can suffer from:

- Ill effects during pregnancy
- Reproductive problems (men and women)
- High blood pressure
- Digestive difficulties
- Nerve disorders
- Memory and concentration problems
- Muscle and joint pain

Lead-based paint in the home is most dangerous when it begins to deteriorate. If the paint begins to crack or chip, lead dust forms and disperses into the air; the dust cannot be smelled, seen or tasted, and can be found both inside the home in the air and in or on surfaces, or outside in the soil. Lead dust can enter the body through:

- Consumption
  - Eating lead-saturated soil or paint chips containing lead
  - Inserting hands or objects covered in lead dust into mouth
- Inhalation

Breathing in lead dust

Young children are especially prone to encounter lead by touching or chewing on surfaces coated in lead-based paint.

If not detected and controlled, lead-based paint may also form harmful levels of dust during construction or renovation. Some of the processes that increase the risk of elevated dust levels include dry scraping, dry sanding, and the use of a heat gun or propane torch.

Testing

There are two ways in which your home can be checked for lead:

- **Paint Inspection**

  Indicates the lead content of each type of painted surface in the home but does not tell whether the paint is a hazard, or how it should be dealt with.

- **Risk Assessment**

  Indicates if there are hazardous sources of lead in the home and details what actions to take to deal with the risk.

There are home lead test kits available if you are concerned about your home but their reliability is not always assured and these tests should not be trusted for accurate information. Instead, a trained, certified professional should do the testing work in your home. The government certifies all testers and holds them to the same level of competency in lead testing.

Certified lead testers will use several methods of inspection to check your home for lead, including:

- Visual inspection
- XRF (X-ray fluorescence) scans
- Lab test of the paint samples
- Surface dust tests

Federal law requires that individuals such as landlords and real estate personnel notify you if there is lead-based paint in an apartment or home that you may be renting or buying, and must provide you with a period of time in which to check for lead hazards. Contractors are also required by law to provide lead information before beginning renovation on a building constructed before 1978.

Control/Remediation

Since lead-based paints are usually not a danger if they are in good condition, keeping your home in good repair can reduce your risk of contamination from any lead-based paint product. If you know your home is at risk from lead-based paint dust – for instance, in areas where the paint is peeling, chipping, cracking, or chalking - repairing the damaged areas can temporarily reduce the hazard. However, this is only a temporary solution, since the areas will need constant upkeep.

Before repairing or otherwise changing the state of any lead-based paint in your home, you should consult an authority such as the National Lead Information Center (NLIC) or a licensed lead-control professional.

Encapsulation or Abatement

To permanently remove the hazard of lead-based paint from a building, **you must hire a certified lead abatement contractor.** The work required to encapsulate (contain) or abate (remove) lead can only be done safely by a licensed contractor who knows the safe procedures and will follow the rules mandated by the federal government or the state. The contractor may use methods which will remove, seal, or enclose lead-based paint in a safe manner, and will follow strict procedures to thoroughly clean up any remaining lead after the job is complete. Some procedures currently used include:

- **Pelletized/Granulated CO2 blasting (interior)**

  Freezes and fractures the paint, causing it to fracture into chips which can then be removed by the contractor

- **Chemical Stripping (interior)**

  Works much like paint remover, weakening the bonds within the paint so that it can be safely removed in large portions

- **Torbo Wet Abrasive Blasting (exterior)**

  Blasts the paint from the surface while minimizing heat from friction and forming cohesive bonds with the dust, reducing the risk of its release as the paint is removed

Exposure Guidelines

Lead dust levels that test above the following are considered extremely hazardous and fall above the acceptable federally-mandated "safe" ranges:

- 40 micrograms per square foot (µg/ft2) for floors, including carpeted floors
- 250 µg/ft2 for interior windowsills
- 400 µg/ft2 for window troughs

Any surfaces covered in lead-based paint that deteriorate in your home should be considered hazardous and treated appropriately.

More information on lead testing, a list of certified contacts, and other relevant information can be obtained from the National Lead Information Center (NLIC). The Department of Housing and Urban Development can also be contacted for information on lead regulations, outreach efforts, and lead hazard control and research grant programs.

1-800-424-LEAD

www.epa.gov/lead

Home | Why List? | Search | Classroom | Opportunities | Business Services

Appendix C

Field Work Items Checklist

Field Work Items Checklist

- ☐ Vehicle Safety Kit
- ☐ 2-way Radios (extra batteries)
- ☐ Digital Camera (extra batteries)
- ☐ Cell Phone with Car Charger
- ☐ GPS Units (extra batteries)
- ☐ Binoculars
- ☐ Topographic Map
- ☐ First Aid Kit
- ☐ Fire Extinguisher
- ☐ Portable Eye-Wash Kit
- ☐ Copy of the HASP
- ☐ Vehicle Tracking Clipboard

Other Items:

_____

_____

_____

_____

Appendix D

Adverse Site Condition Procedures Checklist

Adverse Site Condition Procedures Checklist

☐ Ambiguous site description or location (determine prior to leaving for the field)
- o Verify all sources of information have been rechecked – maps, scope of work, notes, etc.
- o Contact governing agency, designated off site contact, or the project manager for further clarification

☐ Unable to locate site
- o Consult the topographic map (other maps if available)
  - ▪ Find current location (elevation)
  - ▪ Verify location of survey site (and elevation)
- o Verify the GPS has the correct coordinates entered.
  - ▪ UTM vs. Lat. Long.
  - ▪ UTM Zone 11 (Nevada)
  - ▪ NAD27, NAD83, WGS
- o Call offsite contact and/or the governing agency

☐ Site inaccessible
- o Use steps above to verify the correct area
- o Research other possible access routes
- o If feasible, return to site at a later date
- o Notify off site contact and governing agency of difficulty
- o Do not attempt to access if conditions do not allow it to be done safely

☐ Unknown individuals at or around site
- o Try to determine professional association either at a distance, or during conversation through the vehicle window
- o Determine current activities of individual(s)
- o If uncomfortable about the individual(s) activity, return at a later time or date
- o Notify offsite contact of the presence of individuals in the area and of determinations made of whether or not to proceed with work at the site

☐ Vehicle problems
- o Troubleshoot mechanical problems
  - ▪ Verify battery cables are secure
  - ▪ Verify the vehicle is in park
  - ▪ Check fuel level
  - ▪ Contact off site contact and/or the vehicle rental company
- o If vehicle is stuck, determine action necessary to free the vehicle
  - ▪ If possible, use the shovel to dig the tires out
  - ▪ If unable to free the vehicle, call the offsite contact for assistance and direction

- If there is an accident with another vehicle, get all of the pertinent information from the other driver, take photos, write down a description of the events that happened and notify the offsite contact and the appropriate legal authority with jurisdiction over the area

☐ Injury
- Attend to the injured individual immediately
- Call for an ambulance if necessary
- Notify offsite contact
- Take notes on incident that led to the injury and the action taken to assist the individual
- Upon return to the home office, restock any supplies used in the field

Appendix E

Tailgate Meeting/Safety Briefing Worksheet

Date: _____

Person Responsible for Briefing: _____

Topic(s) for Discussion: _____

_____

_____

_____

Personnel in Attendance:

Printed Name	Organization	Signature

Appendix F

Emergency Event Report

Complete only applicable items.

Complete and return this checklist to the home office no later than three days following the emergency event.

Report Date:	Date and Time of Event::	Sites:
Type of Emergency Event: ☐ Accident (H & S) ☐ Spill/Release (Environmental) ☐ Other		
Description of Event:		

Action	Yes	No	Comments
EMERGENCY RESPONSE TEAM			
1. Did the Site Supervisor call 911 or verify the notification was made?			
2. Did the Site Supervisor call the offsite contact, or verify the notification was made?			
3. Did the Site Supervisor use verbal or radio communication to notify on site personnel of the nature and extent of the emergency?			
4. Did the Site Supervisor direct all personnel to remain calm and proceed to an applicable assembly area?			
5. Did the Site Supervisor take action to mitigate the emergency; if so, what actions?			
6. Did the Site Supervisor ensure personnel needing assistance were aided in reaching an applicable assembly area?			
7. Did the Site Supervisor perform head counts and on-site personnel safety checks at the assembly area?			
8. Were all personnel accounted for at the assembly area, and accounted for in a timely manner?			
9. Did the Site Supervisor call the offsite contact with accountability? (Information from 7, above.)			
ON-SITE PERSONNEL			
10. Did on-site personnel display knowledge of emergency procedures?			
11. Did on-site personnel proceed to the designated assembly area in a calm, orderly, timely, and professional manner?			
12. Did on-site personnel remain at the designated assembly area until dismissed?			
13. Did on-site personnel display the appropriate attitude during the event?			
14. How was the FSS notified of the nature and extent of the emergency?			
15. Did the FSS communicate the nature and extent of the emergency with the appropriate offsite contacts?			
16. If the emergency entailed an injury, were the appropriate contacts notified? Who?			
17. Did the FSS debrief site personnel regarding the event within three days of that event, and write up a summary of the event and "Lessons Learned" for incorporation into later versions of the HASP?			

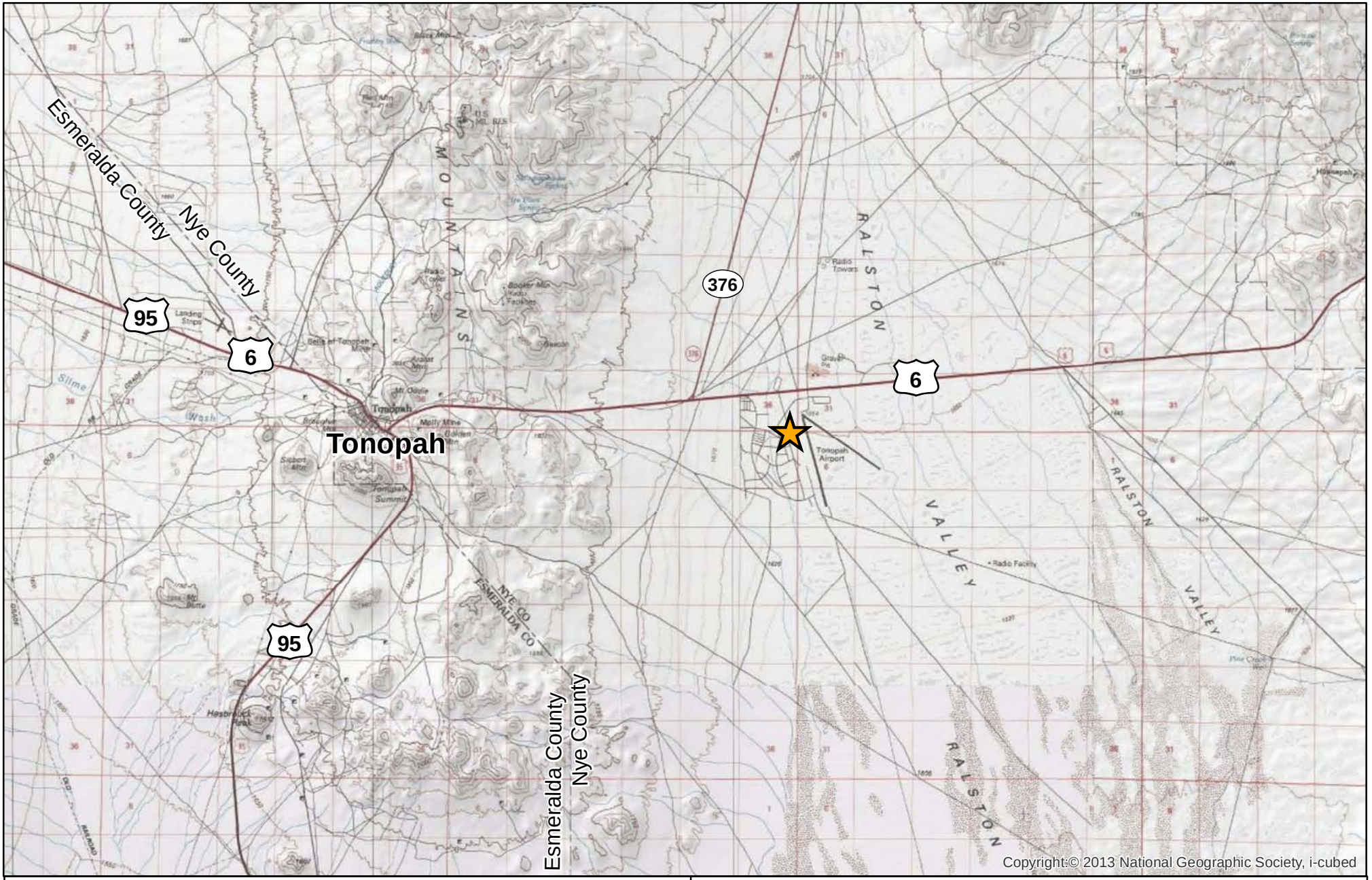


Figure 1 - Vicinity Map

Tonopah FBO Building
Tonopah, Nye County, Nevada

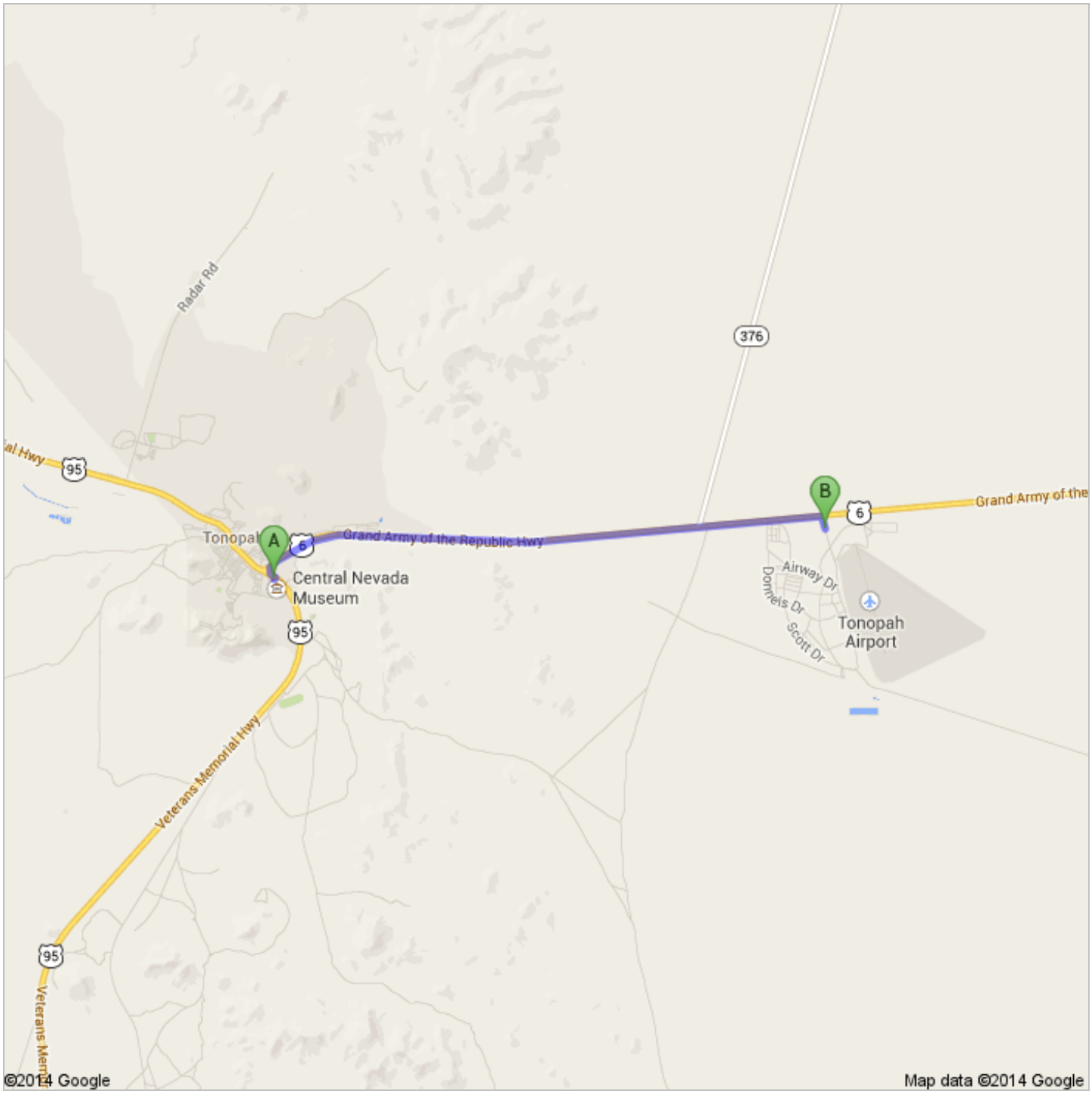
0 1.25 2.5 5 7.5 10
Miles

N

bec environmental, inc.

Google

Directions to Airport Rd, Tonopah, NV 89049
7.1 mi – about **9 mins**



Nye Regional Medical Center
825 S Main St, Tonopah, NV 89049

	1. Head **northeast** toward **Erie St** About 1 min	go 128 ft total 128 ft
	2. Turn left onto **Erie St**	go 249 ft total 377 ft
	3. Take the 1st right onto **US-6 E/Grand Army of the Republic Hwy** (signs for **Ely**) About 7 mins	go 6.9 mi total 7.0 mi
	4. Turn right onto **Airport Rd**	go 0.2 mi total 7.1 mi

Airport Rd, Tonopah, NV 89049

These directions are for planning purposes only. You may find that construction projects, traffic, weather, or other events may cause conditions to differ from the map results, and you should plan your route accordingly. You must obey all signs or notices regarding your route.

Directions weren't right? Please find your route on maps.google.com and click "Report a problem" at the bottom left.

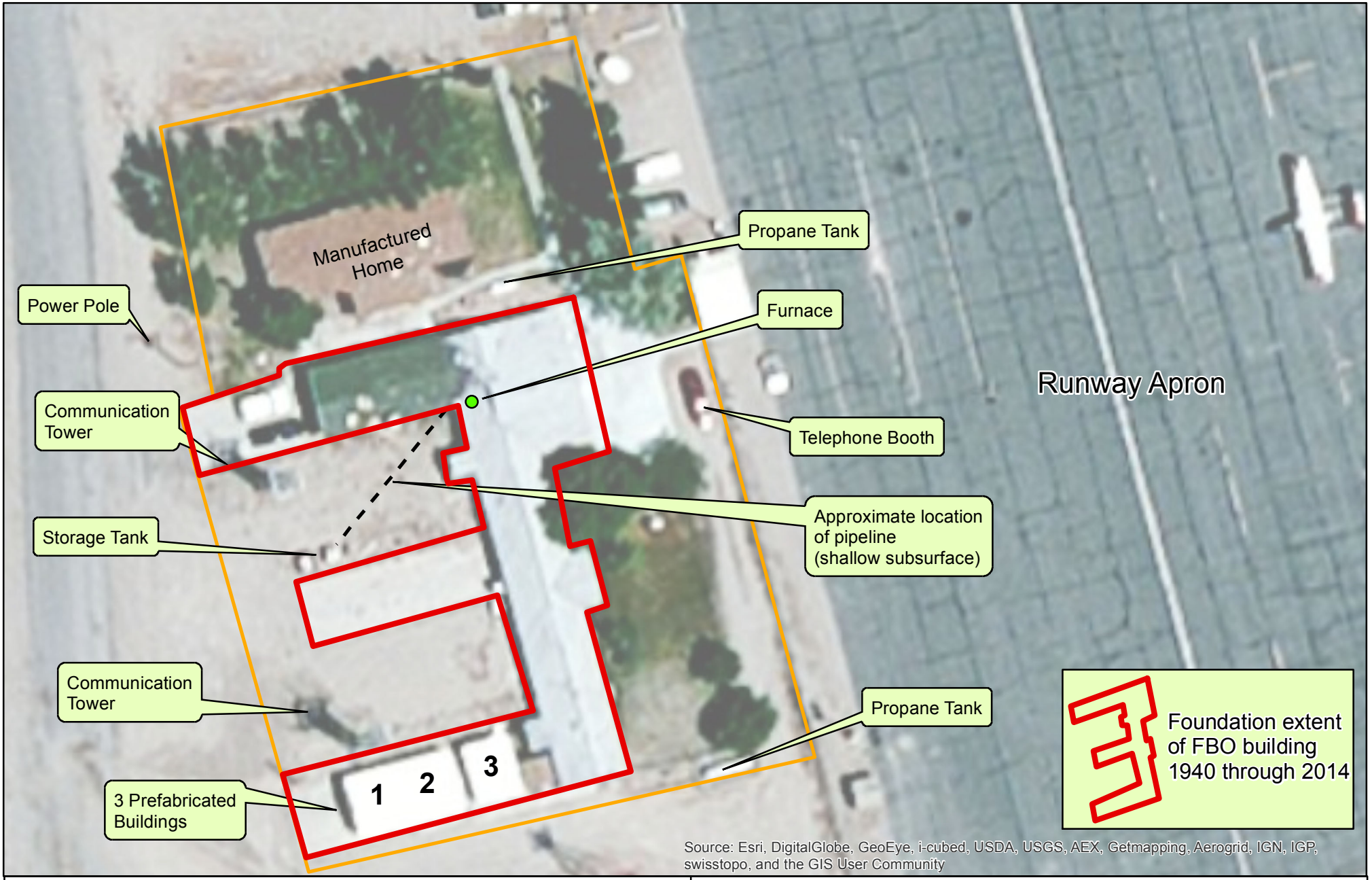


Figure 3 - Site Reconnaissance Map

Tonopah FBO Building
Tonopah, Nye County, Nevada

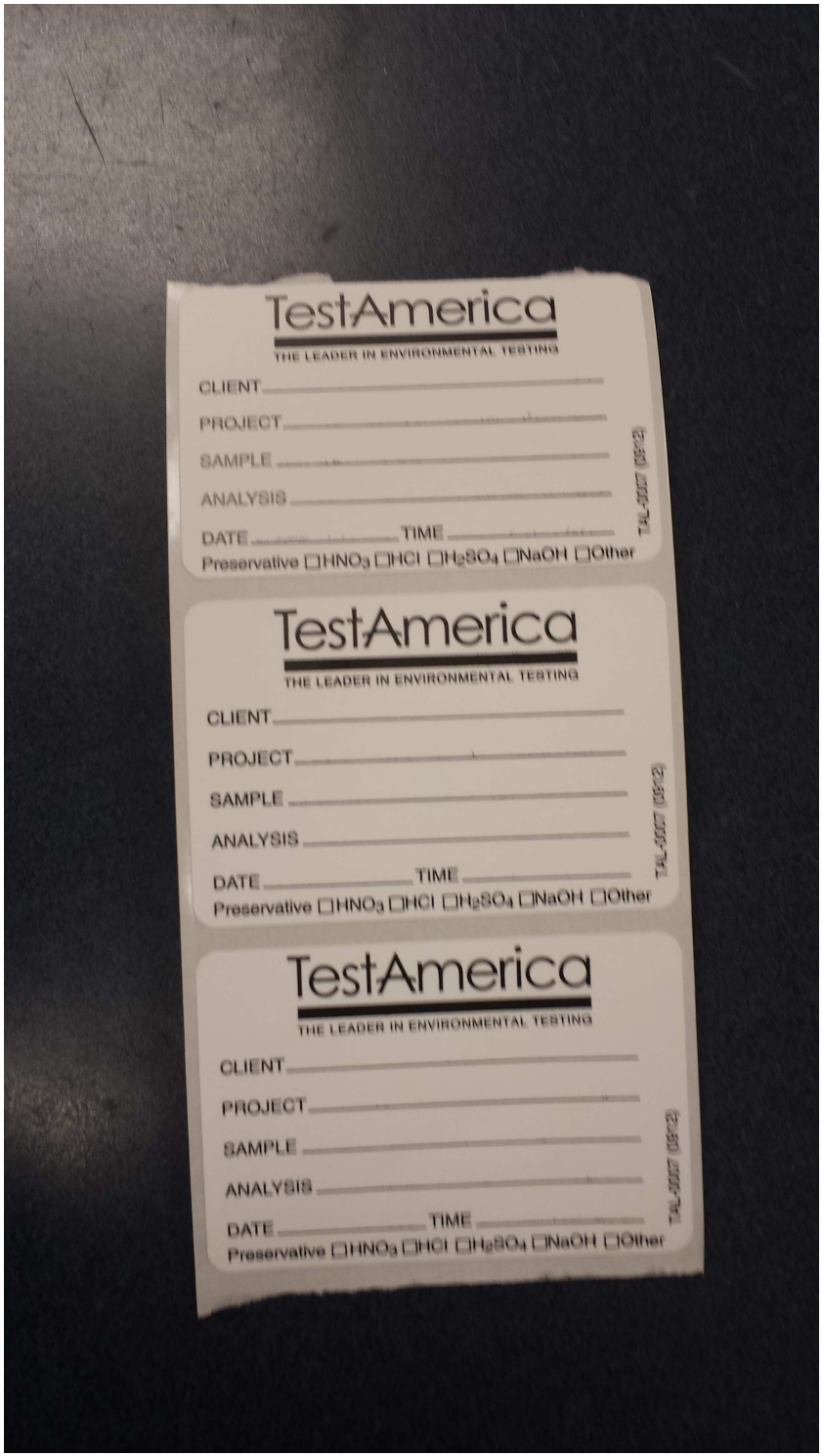
0 37.5 75 150
Feet

N

bec environmental, inc.

Appendix G

Sample Labels and Container Information


TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING
CLIENT
PROJECT
SAMPLE
ANALYSIS
DATE
TIME
Preservative ☐HNO3 ☐HCl ☐H2SO4 ☐NaOH ☐Other
TAL-5000 (0512)
TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING
CLIENT
PROJECT
SAMPLE
ANALYSIS
DATE
TIME
Preservative ☐HNO3 ☐HCl ☐H2SO4 ☐NaOH ☐Other
TAL-5000 (0512)
TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING
CLIENT
PROJECT
SAMPLE
ANALYSIS
DATE
TIME
Preservative ☐HNO3 ☐HCl ☐H2SO4 ☐NaOH ☐Other
TAL-5000 (0512)

Certificate of Compliance

The enclosed containers have been chemically cleaned by using the specified USEPA cleaning procedures for low level chemical analysis. Representative containers have been tested by independent certified laboratories for their appropriate use. ESS containers meet and exceed the required detection limits established by the USEPA in SPECIFICATIONS AND GUIDANCE FOR CONTAMINANT-FREE SAMPLE CONTAINERS (OSWER Directive #9240.0-05A).

EXTRACTABLE ORGANIC COMPOUNDS (PROCEDURE 1)

Analyte	Quantitation Limit (ug/L)
PESTICIDES/PCB'S	
Alpha-BHC	<0.005
Beta-BHC	<0.005
Delta-BHC	<0.005
Gamma-BHC (Lindane)	<0.005
Heptachlor	<0.005
Aldrin	<0.005
Heptachlor Epoxide	<0.005
Endosulfan I	<0.005
Dieldrin	<0.005
4,4'-DDE	<0.005
Endrin	<0.005
Endosulfan II	<0.005
4,4'-DDD	<0.005
Endosulfan Sulfate	<0.005
4,4'-DDT	<0.005
Methoxychlor	<0.005
Endrin Ketone	<0.005
Endrin Aldehyde	<0.005
Alpha-Chlordane	<0.005
Gamma-Chlordane	<0.005
Toxaphene	<0.005
Aroclor-1016	<0.2
Aroclor-1221	<0.2
Aroclor-1232	<0.2
Aroclor-1242	<0.2
Aroclor-1248	<0.2
Aroclor-1254	<0.2
Aroclor-1260	<0.2
Aroclor-1262	<0.2
Aroclor-1268	<0.2
SEMIVOLATILES	
Phenol	<1
bis-(2-Chloroethyl) ether	<1
bis-(2-Chloroisopropyl) ether	<1
2-Chlorophenol	<1
2-Methylphenol	<1
2,2'-Oxybis-(1-Chloropropane)	<1
4-Methylphenol	<1
N-Nitroso-di-n-propylamine	<1
Hexachloroethane	<1
Nitrobenzene	<1
Isophorone	<1
2-Nitrophenol	<1
2,4-Dimethylphenol	<1
bis-(2-Chloroethoxy) methane	<1
2,4-Dichlorophenol	<1
1,2,4-Trichlorobenzene	<1
Naphthalene	<0.2
4-Chloroaniline	<1
Hexachlorobutadiene	<1
4-Chloro-3-Methylphenol	<1
2-Methylnaphthalene	<0.2
Hexachlorocyclopentadiene	<1
2,4,6-Tricholrophenol	<1
2,4,5-Tricholrophenol	<1
1,2-Diphenylhydrazene	<1
Carbazole	<1
2-Chloronaphthalene	<0.15
2-Nitroaniline	<1
Dimethylphthalate	<1
Acenaphthylene	<0.2
2,6-Dinitrotoluene	<1
3-Nitroaniline	<1
Acenaphthene	<0.2
2,4-Dinitrophenol	<5
4-Nitrophenol	<5
Dibenzofuran	<1
2,4-Dinitrotoluene	<1
Diethylphthalate	<1
4-Chlorophenyl-Phenylether	<1
Flourene	<0.15
4-Nitroaniline	<1.5
4,6-Dinitro-2-Methyphenol	<1
N-Nitrosodiphenylamine	<1
N-Nitrosodimethylamine	<1
4-Bromophenyl-Phenylether	<1
Hexachlorobenzene	<1
Pentachlorophenol	<1
Phenanthrene	<0.2
Anthracene	<0.1
Di-n-Butylphthalate	<0.2
Fluoroanthene	<0.1
Pyrene	<0.15
Butylbenzylphthalate	<1
1,2'-Dichlorobenzene	<1
1,3'-Dichlorobenzene	<1
1,4'-Dichlorobenzene	<1
3,3'-Dichlorobenzidine	<1
Benzo[a]anthracene	<0.15
Chyrsene	<0.1
bis-(2-Ethylhexyl) Phthalate	<1
Di-n-Octylphthalate	<1
Benzo[b]flouranthene	<0.2
Benzo[k]flouranthene	<0.15
Benzo[a]pyrene	<0.15
Indeno(1,2,3-cd)pyrene	<0.2
Dibenzo[a,h]anthracene	<0.15
Benzo[g,h,i]perylene	<0.15
Benzoic Acid	<5
Benzyl Alcohol	<1

PURGEABLE VOLATILE ORGANIC COMPOUNDS (PROCEDURE 2)

Analyte	Quantitation Limit (ug/L)
Acetone	<2.0
Benzene	<0.1
Bromoform	<0.1
Bromobenzene	<0.1
Bromochloromethane	<0.1
Bromodichloromethane	<0.1
Bromomethane	<0.1
z-Butylbenzene	<0.1
n-Butylbenzene	<0.1
sec-Butylbenzene	<0.1
tert-Butylbenzene	<0.1
Carbon Tetrachloride	<0.1
Carbon Disulfide	<0.1
Chlorobenzene	<0.1
Chloroethane	<0.1
Chloromethane	<0.1
2-Chlorotoluene	<0.1
4-Chlorotoluene	<0.1
2,4-Chlorotoluene	<0.2
Chloroform	<0.1
Dibromomethane	<0.1
1,2-Dibro 3-Chloropropane	<0.1
Dibromochloromethane	<0.1
1,2-Dibromoethane (EDB)	<0.1
1,2-Dichlorobenzene	<0.1
1,3-Dichlorobenzene	<0.1
1,4-Dichlorobenzene	<0.1
Dichlorodifluoromethane	<0.1
1,1-Dichloroethane	<0.1
1,2-Dichloroethane	<0.1
1,1-Dichloroethene	<0.1
cis-1,2-Dichloroethene	<0.1
trans-1,2-Dichloroethene	<0.1
1,2-Dichloropropane	<0.1
1,3-Dichloropropane	<0.1
2,2-Dichloropropane	<0.1
1,1-Dichloropropene	<0.1
cis-1,3-Dichloropropene	<0.1
trans-1,3-Dichloropropene	<0.1
Ethylbenzene	<0.1
2-Hexanone	<0.5
Hexachlorobutadiene	<0.1
Isopropylbenzene	<0.1
4-Isopropyltoluene	<0.1
Methylene Chloride	<0.5
Napthalene	<0.5
Propylbenzene	<0.1
Styrene	<0.1
1,1,1,2-Tetrachloroethane	<0.1
1,1,2,2-Tetrachloroethane	<0.1
Tetrachloroethene	<0.1
Toluene	<0.1
1,2,3-Trichlorobenzene	<0.1
1,2,4-Trichlorobenzene	<0.1
1,1,1-Trichloroethane	<0.1
1,1,2-Trichloroethane	<0.1
Trichloroethene	<0.1
Trichlorofluoromethane	<0.1
Trichlorotrifluoroethane	<0.1
1,2,3-Trichloropropane	<0.1
1,2,3-Trimethylbenzene	<0.1
1,2,4-Trimethylbenzene	<0.1
1,3,5-Trimethylbenzene	<0.1
Vinyl Acetate	<0.5
Vinyl Chloride	<0.1
Methyl-Tert-Butyl-Ether	<0.1
4-Methyl-2-pentanone	<0.5
ethyl-tert-butylether	<0.1
tert-amylmethylether	<0.1
diisopropylether	<0.1
tert-butanol	<0.1
o-xylene	<0.1
m-xylene(1)	<0.2
p-xylene(1)	<0.2

METALS, CYANIDE & SULFIDE COMPOUNDS (PROCEDURE 3)

Analyte	Detection Limit (ug/L)
Aluminum	<0.5
Antimony	<0.03
Arsenic	<0.01
Barium	<0.03
Beryllium	<0.01
Cadmium	<0.03
Calcium	<50
Chromium	<0.06
Cobalt	<0.25
Copper	<0.08
Iron	<3
Lead	<0.05
Magnesium	<4
Manganese	<0.1
Mercury	<0.2
Molybdenum	<0.5
Nickel	<0.05
Potassium	<50
Selenium	<0.5
Silver	<0.02
Sodium	<6
Thallium	<0.09
Vanadium	<1
Zinc	<0.3
Cyanide	<5
Flouride	<100
Nitrate + Nitrite	<50

ENVIRONMENTAL SAMPLING SUPPLY

www.essvial.com

ON-TIME PRODUCTS FOR ENVIRONMENTAL SAMPLING & ANALYSIS

For more information on our cleaning & monitoring procedures, please call

1-800-233-8425

Matthew Macy, Vice President ESS Inc

032812

ENVIRONMENTAL SAMPLING SUPPLY

LOT#

SAMPLE ID

SAMPLED BY	DATE
	TIME
LOCATION	PRESERVATIVE
ANALYSIS	CLIENT

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5/08/04
PRECLEANED
Lot #: 8-274-005
Container No: 2213

5/08/04
PRECLEANED
Lot #: 8-274-005
Container No: 2212

5/08/04
PRECLEANED
Lot #: 8-274-005
Container No: 2211

5/08/04
PRECLEANED
Lot #: 8-274-005
Container No: 2210

5/08/04
PRECLEANED
Lot #: 8-274-005
Container No: 2209

8 OZ GLASS CLEAR JAR N/A PRESV.

PRECLEANED CERTIFIED

Certificate of Compliance

The enclosed containers have been chemically cleaned by using the specified USEPA cleaning procedures for low level chemical analysis. Representative containers have been tested by independent certified laboratories for their appropriate use. ESS containers meet and exceed the required detection limits established by the USEPA in SPECIFICATIONS AND GUIDANCE FOR CONTAMINANT-FREE SAMPLE CONTAINERS (OSWER Directive #9240.0-05A).

EXTRACTABLE ORGANIC COMPOUNDS (PROCEDURE 1)

Analyte	Quantitation Limit (ug/L)
PESTICIDES/PCB'S	
Alpha-BHC	<0.005
Beta-BHC	<0.005
Delta-BHC	<0.005
Gamma-BHC (Lindane)	<0.005
Heptachlor	<0.005
Aldrin	<0.005
Heptachlor Epoxide	<0.005
Endosulfan I	<0.005
Dieldrin	<0.005
4,4'-DDE	<0.005
Endrin	<0.005
Endosulfan II	<0.005
4,4'-DDD	<0.005
Endosulfan Sulfate	<0.005
4,4'-DDT	<0.005
Methoxychlor	<0.005
Endrin Ketone	<0.005
Endrin Aldehyde	<0.005
Alpha-Chlordane	<0.005
Gamma-Chlordane	<0.005
Toxaphene	<0.005
Aroclor-1016	<0.2
Aroclor-1221	<0.2
Aroclor-1232	<0.2
Aroclor-1242	<0.2
Aroclor-1248	<0.2
Aroclor-1254	<0.2
Aroclor-1260	<0.2
Aroclor-1262	<0.2
Aroclor-1268	<0.2
SEMIVOLATILES	
Phenol	<1
bis-(2-Chloroethyl) ether	<1
bis-(2-Chloroisopropyl) ether	<1
2-Chlorophenol	<1
2-Methylphenol	<1
2,2'-Oxybis-(1-Chloropropane)	<1
4-Methylphenol	<1
N-Nitroso-di-n-propylamine	<1
Hexachloroethane	<1
Nitrobenzene	<1
Isophorone	<1
2-Nitrophenol	<1
2,4-Dimethylphenol	<1
bis-(2-Chloroethoxy) methane	<1
2,4-Dichlorophenol	<1
1,2,4-Trichlorobenzene	<1
Naphthalene	<0.2
4-Chloroaniline	<1
Hexachlorobutadiene	<1
4-Chloro-3-Methylphenol	<1
2-Methylnaphthalene	<0.2
Hexachlorocyclopentadiene	<1
2,4,6-Tricholrophenol	<1
2,4,5-Tricholrophenol	<1
1,2-Diphenylhydrazene	<1
Carbazole	<1
2-Chloronaphthalene	<0.15
2-Nitroaniline	<1
Dimethylphthalate	<1
Acenaphthylene	<0.2
2,6-Dinitrotoluene	<1
3-Nitroaniline	<1
Acenaphthene	<0.2
2,4-Dinitrophenol	<5
4-Nitrophenol	<5
Dibenzofuran	<1
2,4-Dinitrotoluene	<1
Diethylphthalate	<1
4-Chlorophenyl-Phenylether	<1
Flourene	<0.15
4-Nitroaniline	<1.5
4,6-Dinitro-2-Methyphenol	<1
N-Nitrosodiphenylamine	<1
N-Nitrosodimethylamine	<1
4-Bromophenyl-Phenylether	<1
Hexachlorobenzene	<1
Pentachlorophenol	<1
Phenanthrene	<0.2
Anthracene	<0.1
Di-n-Butylphthalate	<0.2
Fluoroanthene	<0.1
Pyrene	<0.15
Butylbenzylphthalate	<1
1,2'-Dichlorobenzene	<1
1,3'-Dichlorobenzene	<1
1,4'-Dichlorobenzene	<1
3,3'-Dichlorobenzidine	<1
Benzo[a]anthracene	<0.15
Chyrsene	<0.1
bis-(2-Ethylhexyl) Phthalate	<1
Di-n-Octylphthalate	<1
Benzo[b]flouranthene	<0.2
Benzo[k]flouranthene	<0.15
Benzo[a]pyrene	<0.15
Indeno(1,2,3-cd)pyrene	<0.2
Dibenzo[a,h]anthracene	<0.15
Benzo[g,h,i]perylene	<0.15
Benzoic Acid	<5
Benzyl Alcohol	<1
TPH Diesel	**<50.00**

PURGEABLE VOLATILE ORGANIC COMPOUNDS (PROCEDURE 2)

Analyte	Quantitation Limit (ug/L)
Acetone	<2.0
Benzene	<0.1
Bromoform	<0.1
Bromobenzene	<0.1
Bromochloromethane	<0.1
Bromodichloromethane	<0.1
Bromomethane	<0.1
z-Butylbenzene	<0.1
n-Butylbenzene	<0.1
sec-Butylbenzene	<0.1
tert-Butylbenzene	<0.1
Carbon Tetrachloride	<0.1
Carbon Disulfide	<0.1
Chlorobenzene	<0.1
Chloroethane	<0.1
Chloromethane	<0.1
2-Chlorotoluene	<0.1
4-Chlorotoluene	<0.1
2,4-Chlorotoluene	<0.2
Chloroform	<0.1
Dibromomethane	<0.1
1,2-Dibro 3-Chloropropane	<0.1
Dibromochloromethane	<0.1
1,2-Dibromoethane (EDB)	<0.1
1,2-Dichlorobenzene	<0.1
1,3-Dichlorobenzene	<0.1
1,4-Dichlorobenzene	<0.1
Dichlorodifluoromethane	<0.1
1,1-Dichloroethane	<0.1
1,2-Dichloroethane	<0.1
1,1-Dichloroethene	<0.1
cis-1,2-Dichloroethene	<0.1
trans-1,2-Dichloroethene	<0.1
1,2-Dichloropropane	<0.1
1,3-Dichloropropane	<0.1
2,2-Dichloropropane	<0.1
1,1-Dichloropropene	<0.1
cis-1,3-Dichloropropene	<0.1
trans-1,3-Dichloropropene	<0.1
Ethylbenzene	<0.1
2-Hexanone	<0.5
Hexachlorobutadiene	<0.1
Isopropylbenzene	<0.1
4-Isopropyltoluene	<0.1
Methylene Chloride	<0.5
Napthalene	<0.5
Propylbenzene	<0.1
Styrene	<0.1
1,1,1,2-Tetrachloroethane	<0.1
1,1,2,2-Tetrachloroethane	<0.1
Tetrachloroethene	<0.1
Toluene	<0.1
1,2,3-Trichlorobenzene	<0.1
1,2,4-Trichlorobenzene	<0.1
1,1,1-Trichloroethane	<0.1
1,1,2-Trichloroethane	<0.1
Trichloroethene	<0.1
Trichlorofluoromethane	<0.1
Trichlorotrifluoroethane	<0.1
1,2,3-Trichloropropane	<0.1
1,2,3-Trimethylbenzene	<0.1
1,2,4-Trimethylbenzene	<0.1
1,3,5-Trimethylbenzene	<0.1
Vinyl Acetate	<0.5
Vinyl Chloride	<0.1
Methyl-Tert-Butyl-Ether	<0.1
4-Methyl-2-pentanone	<0.5
ethyl-tert-butylether	<0.1
tert-amylmethylether	<0.1
diisopropylether	<0.1
tert-butanol	<0.1
o-xylene	<0.1
m-xylene(1)	<0.2
p-xylene(1)	<0.2
TPH as Gasoline	**<50.00**

METALS, CYANIDE & SULFIDE COMPOUNDS (PROCEDURE 3)

Analyte	Detection Limit (ug/L)
Aluminum	<0.5
Antimony	<0.03
Arsenic	<0.01
Barium	<0.03
Beryllium	<0.01
Cadmium	<0.03
Chromium	<0.06
Copper	<0.08
Iron	<3
Lead	<0.05
Magnesium	<4
Mangonese	<0.1
Mercury	<0.2
Molybdenum	<0.5
Nickel	<0.05
Potassium	<50
Selenium	<0.5
Silver	<0.02
Sodium	<6
Thallium	<0.09
Zinc	<0.3
Flouride	<100
Nitrate + Nitrite	<50

This certificate only applies to the enclosed containers and not to any added preservative (except HCL vials). ESS uses only Analytical Grade chemicals. All ESS PrePreserved® containers include a case label with the reagent manufacturer and their lot number. Chemical C of A's can be found online using their lot number. For additional assistance or questions, call 800 233-8424 or email at: essorders@essvial.com.

ON-TIME PRODUCTS FOR ENVIRONMENTAL SAMPLING & ANALYSIS

ENVIRONMENTAL SAMPLING SUPPLY

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