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Infrastructure, environment, buildings

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Transmittal Letter

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Copies:
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Dale Truskett, Lockheed Martin
File

From:
Lisa Collins

Date:
October 14, 2009

Subject:
Quality Assurance Project Plan

ARCADIS Project No.:
NJ000643.0001

We are sending you:

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LOCKHEED MARTIN

Quality Assurance Project Plan

Solvent Dock Area
Former French Road Facility
Utica, New York

October 2009

ARCADIS

Quality Assurance Project Plan

Solvent Dock Area
Former French Road Facility
Utica, New York

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Our Ref.:
NJ000643.0001

Date:
October 2009

Table of Contents

Figures

Tables

Appendix

Attachment

Acronyms

AOC	area(s) of concern
ASP	analytical services protocol
BBL	Blasland, Bouck, & Lee, Inc.
CB	catch basin
CLP	Contract-Laboratory Procedure
COC	constituent(s) of concern
COCs	chain-of-custody forms
DQOs	data quality objective(s)
EB	equipment blank
EDD	electronic data deliverable
FSP	*Field Sampling Plan*
GC/MS	gas chromatography/mass spectrometry
GCTS	groundwater collection and treatment system
GE	General Electric Company
GIS	Geographic Information System
IA	indoor air
MMC	Martin Marietta Corporation
MNA	monitored natural attenuation
MS	matrix spike
MSD	matrix-spike duplicate
µg/L	micrograms per liter
MW	monitoring well sample
NEIC	National Enforcement Investigations Center
NYSDEC	New York State Department of Environmental Conservation
O&M	operation and maintenance

OCIDA	Oneida County Industrial Development Agency
OMM	*Operation & Maintenance Manual*
OM&M	*Operation, Maintenance & Monitoring Plan*
ppbv	parts per billion by volume
QA/QC	quality assurance/quality control
QAC	quality assurance coordinator
QAPP	Quality Assurance Project Plan
RB	rinse blank
SDG	sample delivery group
SPDES	State Pollutant Discharge Elimination System
SSDS	sub-slab depressurization system
SV	soil-vapor sample
TB	trip blank
USEPA	United States Environmental Protection Agency
VMP	vapor monitoring point
VOCs	volatile organic compounds

Preface

This *Quality Assurance Project Plan* (QAPP) was prepared for the former Lockheed Martin Corporation French Road Facility in Utica, New York. It supplements the appropriate work plans, operation & maintenance manuals (OMM), and required regulatory procedures. The QAPP presents the sampling and analytical methods and procedures that will be used during the implementation of all on-site project activities. This QAPP was prepared in a manner consistent with the following reference and guidance documents:

- United States Environmental Protection Agency (USEPA) *EPA Requirements for Quality Assurance Project Plans for Environmental Operations*, EPA-QA/R-5 (USEPA, 2001), which replaces QAMS-005/80, *Interim Guidance and Specifications for Preparing Quality Assurance Project Plans* (USEPA, 1980)

- USEPA *Guidance for Quality-Assurance Project Plans* (USEPA, 2002b)

- USEPA National Enforcement-Investigations Center (NEIC) *Policies and Procedures Manual* (USEPA, 1991)

This QAPP is organized as follows:

Section	Content
Project Management	
1	Project Organization
2	Project Background
3	Project Description
4	Quality Objectives and Criteria for Measurement Data
5	Special Training Requirements/Certification
6	Documentation and Records
Measurement/Data Acquisition	
7	Sampling Process Design
8	Sampling Method Requirements
9	Sample Handling and Custody Requirements
10	Analytical Method Requirements
11	Quality Control Requirements
12	Instrument/Equipment Testing, Inspection, and Maintenance Requirements
13	Instrument Calibration and Frequency
14	Inspection/Acceptance Requirements for Supplies and Consumables
15	Data Acquisition Requirements for Non-Direct Measurements
16	Data Management

Section	Content
Assessment/Oversight	
17	Assessment and Response Actions
18	Reports to Management
Data Validation and Usability	
19	Data Reduction and Review
20	Data Validation and Verification
21	Reconciliation with User Requirements

Subsequent sections detail each of the subjects listed above.

1. Project Organization

1.1 Project Organization

All sampling detailed in documents for the Solvent Dock Area site ("the site") at the former Lockheed Martin Corporation French Road Facility in Utica, New York will require integrating personnel from the organizations identified below, collectively referred to as the "project team." These documents include, but are not limited to, the *Groundwater Collection and Treatment System Operation, Maintenance and Monitoring Manual* (ARCADIS 2009a), *Monitored Natural Attenuation Plan* (ARCADIS 2009b), *Sub-Slab Depressurization System Operation, Maintenance and Monitoring Plan* (ARCADIS 2009c), and *Work Plan for Supplemental Investigation* (2009d). The responsibilities of each project-team member are described in detail below.

1.1.1 Overall Project Management

ARCADIS has overall responsibility for operation and maintenance (O&M) activities at the site on behalf of Lockheed Martin Corporation (Lockheed Martin), including routine and periodic sampling of environmental media. ARCADIS personnel will perform related sampling activities, evaluate data, and prepare the deliverables, as specified in the *Work Plan*. Lockheed Martin Corporation will direct the project, with oversight by the New York State Department of Environmental Conservation (NYSDEC). A list of key project management personnel is provided below.

Company/ Organization	Title	Name	Phone Number
NYSDEC	Project Manager	Larry A. Rosenmann	518.402.8594
	Quality Assurance Manager	Edwin Perkins	518.402.8594
Lockheed Martin	Project Manager	Tom Blackman	301.548.2209
ARCADIS	Project Officer	Jeffrey Bonsteel	518.452.7826
	Project Manager	Christopher Motta	201.236.2233
	Field Manager	Jeffrey Bonsteel	518 452 7826
	Quality Assurance Coordinator	Dennis K. Capria	315.671.9299
TestAmerica Laboratories, Inc.	Project Manager	Candace Fox	716.691.2600
Centek Laboratories	Project Manager	Russell Pellegrino	315.431.9730

1.1.2 Task Managers

Representatives of the project team will direct staff performing the investigations and site activities. Personnel responsible for each site activity are listed below.

Company/Organization	Title	Name	Phone Number
ARCADIS	Field Task Manager	Katie Arnold	518.248.5001
	Survey Task Manager	Jeff Bonsteel	518.452.7826
	Health and Safety Officer	Greg Ertel	315.671.9297
	Database Administrator	John Garrett	315.671.9642
	Data Validator	Mary Ann Doyle	518.452.7826

1.2 Team Member Responsibilities

Various team members' responsibilities are summarized below, by organization.

1.2.1 Lockheed Martin Corporation

Project Manager: Responsibilities and duties include:

- overall direction of site actions
- directing ARCADIS personnel
- reviewing ARCADIS work products, including data, memoranda, letters, reports, and all other documents transmitted to the NYSDEC

1.2.2 ARCADIS

Project Officer: Responsibilities and duties include:

- overseeing ARCADIS work products
- providing ARCADIS approval for major project deliverables

Project Manager: Responsibilities and duties include:

- managing and coordinating the project, as defined in the appropriate work plans, OMM, or required regulatory procedures, with an emphasis on adhering to the objectives of the site activities
- reviewing documents prepared by ARCADIS
- confirming that corrective actions are taken for deficiencies cited during any audits of site activities

Task Managers

Various task managers will supervise the deliverable as detailed in the appropriate work plans, OMM, and required regulatory procedures, as set forth in Section 1.1.2. Task managers' duties include, as appropriate:

- managing relevant day-to-day activities
- developing, establishing, and maintaining files on relevant site activities
- reviewing data reductions from the relevant site activities
- performing final data review of field data reductions and reports on relevant site activities
- confirming that corrective actions are taken for deficiencies cited during audits of relevant site activities
- performing overall quality assurance/quality control (QA/QC) of the relevant portions of the site activities
- reviewing relevant field records and logs
- instructing personnel working on relevant site activities
- coordinating field and laboratory schedules pertaining to relevant site activities
- requesting sample bottles from the laboratory

- reviewing field instrumentation, maintenance, and calibration to meet quality objectives
- preparing reports pertaining to relevant site activities
- maintaining field and laboratory files of notebooks/logs, data reductions and calculations, and transmit originals to the project manager

Field Personnel: Responsibilities and duties include:

- performing field procedures associated with the final deliverable as set forth in the appropriate work plan
- performing field analyses and collect QA samples
- calibrating, operating, and maintaining field equipment
- reducing field data
- maintaining sample custody
- preparing field records and logs

Quality Assurance Coordinator: Responsibilities and duties include:

- reviewing laboratory data packages
- overseeing and interfacing with the analytical laboratory
- coordinating field QA/QC procedures with task managers (including audits of field activities), concentrating on field analytical measurements and practices to meet data quality objectives (DQOs)
- reviewing field reports
- performing and reviewing audit reports
- preparing a QA/QC report in accordance with NYSDEC guidelines, including an evaluation of field and laboratory data and data-usability reports

1.2.3 Analytical Laboratories

Analytical laboratories' general responsibilities and duties include:

- sample analyses and associated laboratory QA/QC procedures
- supplying sampling containers and shipping cartons
- maintaining laboratory custody of sample
- strictly adhering to all protocols in this QAPP

Project Manager: Responsibilities and duties include:

- serving as the primary communication link between ARCADIS and laboratory technical staff
- monitoring workloads and confirming resource availability
- overseeing preparation of analytical reports
- supervising in-house chain-of-custody forms (COCs)

Quality Assurance Manager: Responsibilities and duties include:

- supervising personnel reviewing and inspecting all project-related laboratory activities
- conducting audits of all laboratory activities

1.2.4 New York State Department of Environmental Conservation

Project Manager: Responsibilities and duties include:

- providing NYSDEC with review and approval of the appropriate work plans, OMM, or required regulatory procedures supporting documents, and future deliverables
- monitoring progress of site activities

Quality Assurance Manager: Responsibilities and duties include:

- review and approval of this QAPP
- review of the QA/QC portion of any submitted report
- monitoring progress of the deliverable
- confirming that all activities are performed in compliance with applicable federal, state, and regional requirements
- performing field and laboratory audits, as necessary

1.2.5 Project Organization Chart

Figure 1 is a project-organization chart. The project's end data-users, as indicated in the organization chart, include NYSDEC and Lockheed Martin.

2. Project Background

2.1 Site Location and Description

The site is located at 525 French Road in Utica, New York, and is currently occupied by the ConMed Corporation (ConMed). The site consists of a main manufacturing building, several outbuildings (maintenance building, boiler house, guard house, etc.), and parking lots, roadways, and landscaped areas.

2.2 Site History and Summary of Activities

In the early 1950s, General Electric Company (GE) acquired approximately 55 acres of undeveloped land on French Road and constructed a 500,000-square-foot manufacturing facility. Figure 2 is a site location map. GE operations included manufacturing, assembly, and testing of electrical components for the defense and aerospace industries. GE operations continued until April 1993, when the facility was acquired by Martin Marietta Corporation (MMC). In March 1995, MMC merged with Lockheed Corporation to form Lockheed Martin Corporation. In March 1996, Lockheed Martin sold the property to Pinnacle Park, Inc., which subsequently transferred the property to and leased it back from the Oneida County Industrial Development Agency (OCIDA). ConMed, a medical supplies manufacturer and distributor, now occupies the facility under a lease with OCIDA. Lockheed Martin retains responsibility for environmental cleanup activities related to past releases at the Solvent Dock Area even though they no longer own the property.

Groundwater in the northeast portion of the main manufacturing building in an area known as the Solvent Dock and an area along the northern-perimeter ditch has been adversely affected by volatile organic compounds (VOCs). The Solvent Dock and immediate vicinity (referred to as the Solvent Dock Area) included a 275-gallon fiberglass overflow-retention tank. This tank was used to store spent waste solvents, which were periodically sampled, pumped from the tank, and disposed of by waste haulers. The tank was removed in June 1990, and was observed to be dented and leaking fluid. The northern-perimeter ditch (along the northern property boundary) was an open drainage swale, which received stormwater from the area north of the manufacturing building and conveyed the water, along with stormwater from the western portion of the property, to a manhole before eventually discharging to the municipal storm sewer.

Since 1991, GE, MMC, and Lockheed Martin have completed groundwater investigations in these areas. In November 1994, Blasland, Bouck, & Lee, Inc. (BBL) completed an investigation of the facility storm sewer in the Solvent Dock Area. The investigation determined that VOCs detected in the storm sewer were attributable to the discharge of VOC-contaminated groundwater into the northern-perimeter ditch and infiltration of VOC-contaminated groundwater from the Solvent Dock Area into the storm sewer beneath the building.

In May 1995, BBL completed a *Storm Sewer Investigation Report*, which recommended that the contaminated portion of the storm sewer flow be collected, treated, and discharged to meet proposed State Pollutant Discharge Elimination System (SPDES) VOC-effluent limitations. To address the source of VOCs entering the storm sewer, BBL evaluated remedial design alternatives that would remediate the contaminated groundwater (in accordance with NYSDEC recommendations). Results of this evaluation were presented in the *Storm Sewer Basis of Design Report* (BBL 1995).

Based on this report, BBL completed the final design of the *French Road Facility Ground-Water Collection and Treatment System* in October 1995. Construction of the system was completed in June 1996. The system collects groundwater from the Solvent Dock Area and the northern-perimeter ditch area, conveys the collected groundwater to a treatment building where VOCs are removed by a low-profile air stripper, and discharges the treated effluent to the municipal stormwater system. A hydraulic and chemical groundwater-monitoring program was developed to evaluate the effectiveness of the GCTS for the Solvent Dock Area. This program, as presented in the *Ground-Water Sampling and Analysis Work Plan* (BBL 1998), has been modified through monthly and quarterly correspondence with the NYSDEC to accommodate the changing conditions over the life of the project.

In response to observed groundwater contamination at the site (as described above), Lockheed Martin voluntarily installed and operated the GCTS and initiated an investigation of soil vapor and indoor-air quality. Beginning in 2007, Lockheed Martin and NYSDEC began developing an Order for the site, which became effective on October 3, 2008 (CO 6-20080321-5). The Order identified five areas of concern (AOC) and required further investigation and identification of corrective actions for each area. These investigations were completed in 2008, and the results are presented in the *CMS Report*. Supplemental investigations to the CMS are ongoing, and as new data are developed, data quality objectives may change. Updates to this QAPP will be provided if warranted by the findings of these investigations. At a minimum, the QAPP will be reviewed and updated as appropriate every five years.

3. Project Description

This section presents a general description of the activities to be conducted in accordance with this QAPP. Sampling activities will include:

- GCTS monitoring activities (SPDES-permit sampling, stormwater sampling)
- Periodic groundwater sampling
- Periodic soil gas and indoor air sampling
- SSDS-performance sampling (influent and effluent soil vapor sampling)
- Site investigation sampling (non-routine groundwater and soil gas sampling)

Sampling protocols are detailed in this QAPP, as well as protocols set forth in the *Monitored Natural Attenuation Plan* (MNA Plan), *Groundwater Collection and Treatment System Operation, Maintenance and Monitoring Manual* (GCTS OM&M), *Sub-Slab Depressurization System Operation, Maintenance, and Monitoring Plan* (SSDS OM&M Plan), and other site-related investigative work plans. Samples collected during the above activities will be analyzed in accordance with the methods and protocols described in these plans and defined within this QAPP. Table 1 lists the constituents that will be analyzed for in the samples collected. Health and safety protocols to be followed by field personnel during investigation activities are discussed in the *Site-Specific Health and Safety Plan* (ARCADIS 2008). A brief description of each task's objectives is presented below. More detailed descriptions appear in the associated plans, manuals and work plans.

3.1 GCTS Monitoring Activities

The objective of GCTS monitoring is to collect and analyze treated groundwater and stormwater samples from the site to confirm the effectiveness of this corrective action and to comply with the existing SPDES permit.

3.2 Periodic Groundwater Sampling

The objective of periodic groundwater sampling (associated with the *MNA Plan*) is to collect and analyze groundwater samples to evaluate VOC concentrations at the site.

3.3 Periodic Soil Gas and Indoor Air Sampling

The objective of periodic soil-gas and indoor-air sampling is to collect and analyze sub-slab soil-gas and indoor-air samples to quantify VOC concentrations at the site, as part of an evaluation of the performance and effectiveness of the existing SSDS.

3.4 SSDS Performance Sampling

The objective of SSDS-performance sampling is to collect and analyze influent soil-vapor and effluent (treated) system-stream for the presence of VOC contaminants, as part of system-performance evaluations.

3.5 Site Investigation Sampling

The objective of non-routine groundwater and soil-gas sampling is to collect and analyze media for VOCs, as part of further definition and evaluation of site impacts.

3.6 Approach

Turnaround time for analytical results will vary based on the need for analytical data and the status of sampling activities. All samples collected will be analyzed in accordance with the methods presented in this QAPP.

3.7 Project Schedule

The project is ongoing, and routine sampling activities are scheduled monthly, quarterly, semi-annually, or annually. Specific sampling schedules can be found in the associated plans and manuals.

4. Quality Objectives and Criteria for Measurement Data

The DQO process, as described in the USEPA *QA/G-5 QAPP* instructions document (USEPA, 2002b), provides a "logical framework" for planning field investigations. The following section addresses, in turn, each of the seven sequential steps in the USEPA QA/G-5 QAPP DQO process.

Step 1: State the Problem: Sampling activities will be conducted at the site to evaluate, investigate and confirm the presence or absence of VOCs in groundwater, stormwater and soil gas.

Step 2: Identify the Goal of the Study: The initial use of the data is descriptive (distribution and concentration); no decision point is associated with this descriptive application. Subsequent to review of the descriptive information, an exposure evaluation will be performed based on the findings of the site investigation. The decision in this case is to determine the potential presence and significance of complete exposure pathways based on the distribution and concentrations of constituents of concern present at the site.

Step 3: Identify Information Inputs: Decision inputs incorporate both concentration and distribution of constituents of concern in site media. A fundamental basis for decision-making is that a sufficient number of data points of acceptable quality must be available from the investigation to support the decision. Thus, the necessary inputs for the decision are: 1) the proportion of non-rejected (usable) data points and 2) the quantity of data needed to evaluate whether regulatory unacceptable risks to human health and the environment exist at the site. The data will be evaluated for completeness, consistency among data sets, and general conformance with requirements of this QAPP and with historical data, as appropriate.

Step 4: Define the Study Boundaries: The site includes the area within the former Lockheed Martin facility in Utica, New York exhibiting groundwater that has been adversely affected by VOCs (primarily in the northeast portion of the main manufacturing building, in an area known as the Solvent Dock, and an area along the northern-perimeter ditch).

Step 5: Develop the Analytical Approach: Samples will typically be analyzed for the constituents of concern (COC) identified from the assessment of site history and previous sampling analytical results. VOCs are the primary site COC. Validation of the

analytical results will determine whether data can be used for the project. Following validation, the data will be flagged, as appropriate, and any use restrictions noted.

Step 6: Specify Performance or Acceptance Criteria: Specifications for this step call for: 1) giving forethought to corrective actions to improve data usability and 2) understanding the representative nature of the sampling design. This QAPP is designed to meet both specifications for this step. The sampling and analysis program has been developed based on a review of previous site data and knowledge of present site conditions. The laboratory detection-levels and planned data-quality reviews presented within the QAPP have been determined appropriate and adequate for the project. Corrective actions are described elsewhere in this QAPP and in the appended documents. The representative nature of the sampling design has been determined by discussions among professionals familiar with the site and with the appropriate government agencies.

Step 7: Develop the Plan for Obtaining Data: The overall QA objective is to develop and implement procedures for field sampling, chain-of-custody forms, laboratory analysis, and reporting that will provide results to support the evaluation of site data consistent with USEPA *National Contingency Plan* requirements. Specific procedures for sampling, chain-of-custody, laboratory instrument calibration, laboratory analysis, data reporting, internal QC, audits, preventive maintenance of field equipment, and corrective action are described in other sections of this QAPP. Work plans and required regulatory procedures involve a phased approach to both sampling and analysis. This provides the opportunity to evaluate and focus each data collection step to optimize overall data collection. A DQO summary for the sampling investigation is presented in the subsequent section. The summary consists of stated DQOs relative to data uses, data types, data quantity, sampling and analytical methods, and data measurement performance criteria.

4.1 Data Categories

Three data categories have been defined to address various analytical data uses and the associated QA/QC effort and methods required to achieve the desired levels of quality:

- *Screening Data*— Screening data affords a quick assessment of site characteristics or conditions. This DQO applies to data collection involving rapid, non-rigorous analytical methods and QA. This objective is generally applied to physical and/or chemical properties of samples, degree of

contamination relative to concentration differences, and preliminary health and safety assessment.

- *Screening Data with Definitive Confirmation*— Screening data allows rapid identification and quantitation, although the quantitation can be relatively imprecise. This DQO is available for data collection requiring qualitative and/or quantitative verification of a select portion of sample findings (10 percent or more). This objective can also be used to verify less rigorous laboratory-based methods.

- *Definitive Data*— Definitive data are generated using analytical methods, such as approved USEPA reference methods. Data are analyte-specific, with confirmation of analyte identity and concentration. Methods produce raw data (e.g., chromatograms, spectra, digital values) in the form of paper printouts or computer-generated electronic files.

For this project, three levels of data reporting have been defined:

- *Level 1: Minimal Reporting*— Minimal or "results only" reporting is used for analyses that, either due to their nature (i.e., field monitoring) or the intended data use (i.e., preliminary screening), do not generate or require extensive supporting documentation.

- *Level 2: Modified Reporting*— Modified reporting is used for analyses performed according to standard USEPA-approved methods and QA/QC protocols and that, based on the intended data use, require some supporting documentation but not full "Contract Laboratory Procedure"-type ("CLP-type") reporting.

- *Level 3: Full Reporting*— Full "CLP-type" reporting is used for analyses that, based on intended data use, require full documentation. This reporting level would include Analytical Services Protocol (ASP) Superfund and Category B reporting.

The analytical methods to be implemented, as described in the appropriate work plans, OMM, or required regulatory procedures, will be USEPA SW-846 Methods and USEPA *Compendium of Methods for the Determination of Volatile Organic Compounds in Ambient Air*. Volatile organic compounds in water will be analyzed in accordance with

NYSDEC ASP Revision 2005, QA/QC requirement, and Category B reporting deliverables.

4.2 Field Investigations

Field sampling will be conducted to support the DQOs. Details of field sampling investigations are described in the appropriate work plans, OMM, or required regulatory procedures. Standard operating procedures (SOPs) for field sampling are included as Attachment 2.

5. Special Training Requirements/Certification

In compliance with the Occupational Safety and Health Administration's (OSHA) final rule "Hazardous Waste Operations and Emergency Response," 29 *Code of Federal Regulations* 1910.120(e), all personnel working at the site will have completed the requirements for OSHA "40-Hour Hazardous Waste Operations and Emergency Response" training. Field supervisors will have also completed the additional OSHA "8-Hour Supervisory Training."

6. Documentation and Records

6.1 General

Samples of various environmental media will be collected as described in the appropriate work plans, OMM, or required regulatory procedures. Detailed descriptions of the documentation and reporting requirements are presented below.

6.2 Sample Designation System

6.2.1 Sample Codes

During sampling, samples will be identified with a unique designation system that will facilitate sample tracking. The sample-designation system will be consistent, yet flexible enough to accommodate unforeseen events and conditions. An alphanumeric system is appropriate and will be used by field personnel to assign to each sample a unique sample identification number. This number will begin with the historical sample identification number proximal to the sampling location, followed by letters indicating the sample type and a single digit indicating the sequential sample number collected from the location (for instance, MW-1-GW-1). The samples types may be designated using the following codes:

- Monitoring Well Sample— “MW”
- Soil-Vapor Sample— “SV”
- Vapor Monitoring Point— “VMP”
- Indoor Air— “IA”
- SSDS system— “SDS”
- Catch Basin— “CB”
- Trip Blank— “TB”
- Equipment Blank— “EB”

Additional codes may be used pending the location and type of sample collected. The double-digit sample number beginning with "01" will be assigned in the field and incremented by one as samples are collected from one to the next. Where necessary, the code system will be supplemented to accommodate additional sample identification information. For example, the code for soil samples will include a qualifier to identify the section increment (e.g., 0–0.5 feet).

Additional sample volumes collected for matrix spike (MS) and matrix-spike duplicate (MSD) analysis will be noted on the COCs, and the associated additional sample containers will be labeled with the appropriate suffix (MS or MSD). Rinse blanks will use the same coding scheme described above, substituting the location code with the prefix "RB" (e.g., the first rinse blank associated with backfill collection would be named RB-BF-01). Field duplicates will be labeled as ordinary field samples with a unique identification number (e.g., the first field duplicate associated with confirmation sample collection would be named DUP-01). Duplicate samples will not be identified and the laboratory will analyze them as "blind" QC samples.

6.2.2 Field Documentation

Field personnel will provide comprehensive documentation covering all aspects of field sampling, field analysis, and sample chain-of-custody. This documentation constitutes a record that allows reconstruction of all field events to aid in data review and interpretation. All documents, records, and information relating to fieldwork will be retained in the project file. The various forms of documentation to be maintained throughout the action include:

- *Daily Production Documentation*— A field notebook consisting of a waterproof, bound notebook that will contain a record of all site activities.

- *Sampling Information*— Detailed notes as to the exact sampling location, physical observations, and weather conditions (as appropriate).

- *Sample COCs*— Chain-of-custody forms record the party(ies) responsible for sample collection, transport, and submittal to the laboratory. COCs will be filled out at each sampling site, at a group of sampling sites, or at the end of each day of sampling by ARCADIS field personnel designated responsible for sample custody. If the designated sampling person relinquishes the samples to other sampling or field personnel, the chain-of-custody form will be signed and dated by the appropriate personnel to document the sample transfer. The

original chain-of-custody form will accompany the samples to the laboratory, and copies will be forwarded to the project files. A sample chain-of-custody form is included in Appendix A. Individuals will be deemed as having custody of samples when the samples are in their physical possession, in their view after being in their possession, or in their physical possession and secured so they cannot be tampered with. In addition, when samples are secured in a restricted area accessible only to authorized personnel, they will be deemed to be in the custody of such authorized personnel.

- *Field Equipment, Calibration, and Maintenance Logs*— To document the calibration and maintenance of field instrumentation, calibration and maintenance logs will be maintained for each piece of field equipment that is not factory-calibrated.

6.3 Laboratory Documentation Files

6.3.1 Laboratory Project Files

The laboratory will establish a file for all pertinent data. The file will include all correspondence, faxed information, phone logs, and COCs. The laboratory will retain all project files and data packages for a period of five years.

6.3.2 Laboratory Logbooks

Workbooks, bench sheets, instrument logbooks, and instrument printouts will be used to trace the history of samples through the analytical process and to document important aspects of the work, including the associated QC steps. As such, logbooks, bench sheets, instrument logs, and instrument printouts will be part of the permanent laboratory record. Each page or entry will be dated and initialed by the analyst at the time of entry. Errors in entry will be crossed out in indelible ink with a single stroke, corrected without the use of White-out® or by obliterating or writing directly over the erroneous entry, and initialed and dated by the individual making the correction. Unused logbook pages will be completed by lining out unused portions. Information on the sample, analytical procedures performed, and results of testing will be recorded by the analyst on laboratory forms or personal notebook pages. These notes will be dated and will also identify the analyst, the instrument used, and the instrument conditions.

Laboratory group leaders will periodically review laboratory notebooks for accuracy, completeness, and compliance with this QAPP. The laboratory group leader will verify

all entries and calculations. If all entries are correct, then the laboratory group leader will initial and date the pages. Corrective action for incorrect entries will be taken before the laboratory group leader signs.

6.3.3 Computer Tape and Hard-Copy Storage

All electronic files and deliverables will be retained by the laboratory for not less than five years; hard-copy data packages (or electronic copies) will also be retained for not less than five years.

6.4 Data Reporting Requirements

Data will be reported both in the field and by the analytical laboratory, as described below.

6.4.1 Field Data Reporting

Visual observations, manual measurements, and/or instrumentation in the field will be recorded in field notebooks or data sheets and/or on forms. Such data will be reviewed by the appropriate task manager for adherence to the appropriate work plans, OMM, or required regulatory procedures for consistency. Concerns identified through this review will be discussed with field personnel, corrected if possible, and, as necessary, incorporated into the data evaluation. If applicable, field data forms and calculations will be processed and included in appendices to the appropriate reports. The original field logs, documents, and data reductions will be kept in the project file at the ARCADIS office in Albany, New York.

6.4.2 Laboratory Data Reporting

The laboratory is responsible for preparing ASP Category B data packages for all data packages and case narratives for all other analyses. All data reports for all parameters will include, at a minimum:

Narrative— Summary of sample analysis activities, including:

- laboratory name and address
- date of sample receipt

- cross-reference of laboratory identification number to contractor sample-identification
- analytical methods used
- deviations from specified protocol
- corrective actions taken

Included with the narrative will be any sample-handling documents, including field and internal COCs, air bills, and shipping tags.

Analytical Results— Reported according to analysis type, including the following, as acceptable:

- sample ID
- laboratory ID
- date of collection
- date of receipt
- date of extraction
- date of analysis
- detection limits

Sample results on the report forms will be collected for dilutions. Unless otherwise specified, results will be reported uncorrected for blank contamination.

Data for VOCs and TO-15 analyses will be expanded to include all supporting documentation necessary to provide a Category B package, with the exception of SPDES-related analysis. This additional documentation will include, but is not limited to, all raw data required to recalculate any result, including printouts, chromatograms, and quantitation reports. The report will also include standards used in calibration and calculation of analytical results; sample extraction, digestion, and other preparation logs; standard preparation logs; instrument run logs; and moisture content calculations.

6.5 Project File

Project documentation will be placed in project files according to ARCADIS file-retention protocols and Lockheed Martin requirements. Project files typically consist of the following components:

- Agreements/Proposals (filed chronologically)
- Change Orders/Purchase Orders (filed chronologically)
- Invoices (filed chronologically)
- Project Management (filed by topic)
- Correspondence (filed chronologically)
- Notes and Data (filed by topic)
- Public Relations Information (filed by topic)
- Regulatory Documents (filed chronologically)
- Final Reports/Presentations (filed chronologically)
- Draft Reports/Presentations (filed chronologically)
- Documents Prepared by Others (filed chronologically)

Final reports (including QAPPs and QA reports) are filed in a designated folder within the project file. Analytical laboratory documentation (when received) and field data will also be filed in a designated folder within the project file. Filed materials may be removed and signed out by authorized personnel, and only temporarily.

6.6 Sampling Process Design

Information regarding the sampling design and rationale and associated sampling locations can be found in the appropriate work plan, OMM, or required regulatory procedures.

7. Sampling Method Requirements

Soil and sediment samples will be collected as described in the appropriate work plan, OMM, or required regulatory procedures. All required plans will also contain procedures to be followed to decontaminate and clean sampling equipment and to handle, package, and ship collected samples.

7.1 Sample Containers and Preservation

Appropriate sample containers, preservation methods, and laboratory holding times are provided in the appropriate work plan, OMM, or required regulatory procedures. Sampling descriptions are included in Table 2. The analytical laboratory will supply appropriate sample containers and preservatives, as necessary. The bottles will be purchased pre-cleaned according to the USEPA Office of Solid Waste and Emergency Response Directive 9240.05A requirements. Field personnel will be responsible for properly labeling containers and preserving samples (as appropriate). Sample labeling procedures are discussed in Section 9.2.2.

7.2 Field Custody Procedures

The objective of these field-sample custody-procedures is to confirm that samples are not tampered with from the time of sample collection through transport to the analytical laboratory. Individuals will have “custody of samples” when the samples are in their physical possession, in their view after being in their possession, or in their physical possession and secured so they cannot be tampered with. In addition, when samples are secured in a restricted area accessible only to authorized personnel, they will be deemed to be in the custody of such authorized personnel. Field custody documentation consists of both field logbooks and field chain-of-custody forms.

7.2.1 Field Logbooks

Field logbooks will provide the means to record the data-collection activities performed. Entries will provide as much detail as possible so that future site visitors can reconstruct a particular situation without reliance on memory. Field logbooks will be bound field-survey books or notebooks. Logbooks will be assigned to field personnel, but will be stored in a secure location when not in use. Each logbook will be identified by the project-specific document number. The title page of each logbook will contain the following:

- individual to whom the logbook is assigned
- logbook number
- project name
- project start date
- end date

Logbook entries will contain a variety of information. At the beginning of each entry, the date, start time, weather, names of all sampling team members present, level of personal protection being used, and the signature of the person making the entry will be entered. The names of visitors to the site, field sampling or investigation team personnel, and the purpose of their visit will also be recorded in the field logbook.

Measurements made and samples collected will be recorded. Entries will be made in ink, and no erasures will be made. If an incorrect entry is made, the information will be crossed out with a single strike mark. Whenever a sample is collected or a measurement is made, a detailed description of the station location shall be recorded. The number of photographs taken of the station, if any, will also be noted. All equipment used to make measurements will be identified, as well as the date of calibration.

Samples will be collected following the procedures documented in the appropriate work plan, OMMs, or required regulatory procedures. The equipment used to collect samples will be noted, as well as the time of sampling, sample description, depth at which the sample was collected, volume, and number of containers. Sample-identification numbers will be assigned before sample collection. Field duplicate samples, which will receive an entirely separate sample identification number, will be noted under sample description.

7.2.2 Sample Labeling

Preprinted sample labels will be affixed to sample bottles before delivery to the sampling site. Each sample label must have the following information:

- project

- date collected
- time collected
- location
- sampler
- analysis to be performed
- preservative
- sample number

7.2.3 Field Chain-of-Custody Forms

Completed chain-of-custody forms will be required for all samples to be analyzed. COCs will be initiated by the sampling crew in the field and filled out as samples are collected. The COCs will contain the unique sample identification number, sample date and time, sample description, sample type, preservation (if any), and analyses required. The original COCs will accompany the samples to the laboratory. Copies of the COCs will be made before shipment (or multiple-copy forms used) for field documentation. The COCs will remain with the samples at all times. The samples and signed COCs will remain in the possession of the sampling crew until the samples are delivered to the express carrier (e.g., FedEx) or hand delivered to a mobile or permanent laboratory or placed in secure storage.

Sample labels will be completed for each sample using waterproof ink. The labels will include sample information, such as sample number and location, type of sample, date and time of sampling, sampler's name or initials, preservation, and analyses to be performed. The completed sample labels will be affixed to each sample bottle and covered with clear tape.

Whenever samples are split with a government agency or other party, a separate chain-of-custody form will be prepared for those samples and marked to indicate with whom the samples are being split. The individual relinquishing the samples to the facility or agency should request the representative’s signature acknowledging sample receipt. If the representative is unavailable or refuses, this shall be noted in the

"Received By" space. All split-sample data are intended to be managed by the third party and will not be under the requirements of this QAPP.

7.3 Management of Investigation-Derived Materials and Wastes

Management of investigation-derived materials and wastes will be performed consistent with the USEPA guidance *Guide to Management of Investigation-Derived Wastes,* 9345.3-03FS, January 1992. Disposable equipment (including personal protective equipment) and debris will be containerized and appropriately labeled during sampling events and disposed of accordingly. Equipment will be decontaminated, as appropriate, as discussed in the appropriate work plan, OMMs, or required regulatory procedures.

7.4 Packing, Handling, and Shipping Requirements

Sample packaging and shipment procedures are designed to confirm that the samples and their COCs will arrive at the laboratory intact. Samples will be packaged for shipment as outlined below:

- Confirm that sample containers have the sample labels securely affixed to the container with clear packing tape.
- Check the caps on the sample containers to confirm that they are properly sealed.
- Wrap the sample container cap with clear packing tape to prevent it from becoming loose.
- At time of collection, complete the COCs with the required sampling information and confirm that the recorded information matches the sample labels. ***Note*****:** If the designated sampler relinquishes the samples to other sampling or field personnel for packing or other purposes, the sampler will complete the COCs before this transfer. The appropriate personnel will sign and date the COCs to document the sample-custody transfer.
- Using duct tape, secure the outside drain-plug at the bottom of the cooler.
- Wrap sample containers in bubble wrap or other cushioning material.

- Place 1–2 inches of cushioning material in the bottom of the cooler.
- Place the sealed sample containers into the cooler. A final cross-check of sample containers and the COCs will be completed at this time.
- Place ice in plastic bags and seal. Place loosely in the cooler.
- Fill the remaining space in the cooler with cushioning material.
- Place COCs in a plastic bag and seal. Tape the forms to the inside of the cooler lid.
- Close the lid of the cooler, lock, and secure with duct tape.
- Wrap strapping tape around both ends of the cooler at least twice.
- Mark the cooler on the outside with the following information: shipping address, return address, “Fragile” labels, and arrows indicating “this side up.” Cover the labels with clear plastic tape. Place a signed custody seal over the sample cooler lid.

For air samples, each sample will be packaged for shipment as outlined below:

- Confirm that the brass plug is installed and snug on the canister.
- Package the canister and flow controller in the shipping container supplied by the laboratory. The canister does not require preservation with ice or refrigeration.
- Complete the appropriate forms and sample labels as required by the laboratory (i.e., affix card with a string).
- Complete the COCs and place the requisite copies in the shipping container. Close the shipping container and affix a custody seal to the container closure.

Samples will be hand delivered or delivered by an express carrier within 48 hours of the time of collection. Shipments will be accompanied by the COCs identifying the contents. The original chain-of-custody form will accompany the shipment and the sampler will retain copies for the sampling office records. If the samples are sent by

common carrier, a bill of lading will be used. Receipts or bills of lading will be retained as part of the permanent project documentation. Commercial carriers are not required to sign off on the COCs as long as the forms are sealed inside the sample cooler and the custody seals remain intact.

The analytical laboratory will provide sample-custody seals and packing materials for filled sample containers. The filled, labeled, and sealed containers will be placed on ice in a cooler and carefully packed to eliminate the possibility of container breakage. All samples will be properly chilled in accordance with the laboratory-specific SOP (Appendix A). Additional procedures for packing, handling, and shipping environmental samples are presented in the *Field Sampling Plan* (FSP).

7.5 Laboratory Custody Procedures

7.5.1 General

Laboratory personnel will be responsible for sample custody upon sample receipt. The original field COCs will accompany all samples requiring laboratory analysis. The laboratory will use chain-of-custody guidelines described in USEPA guidance documents. Samples will be kept secured in the laboratory until all stages of analysis are complete. All laboratory personnel having samples in their custody will be responsible for documenting and maintaining sample integrity.

7.5.2 Sample Receipt and Storage

Immediately upon sample receipt, the laboratory sample-custodian will verify the cooler seal, open the cooler, and compare the contents against the field COCs. If a sample container is missing, a sample container is received broken, the sample is in an inappropriate container, or has not been preserved by appropriate means, ARCADIS will be notified immediately. The laboratory sample-custodian will be responsible for logging in the samples, assigning a unique laboratory identification number to each sample, labeling the sample bottle with the laboratory identification number, and moving the sample to an appropriate storage location to await analysis. The project name, field sample code, date sampled, date received, analysis required, storage location, and date and action for final disposition will be recorded in the laboratory tracking system. Relevant custody documentation will be placed in the project file.

7.5.3 Sample Analysis

Analysis of an acceptable sample will be initiated by worksheets that contain all pertinent information for analysis. The analyst will sign and date the laboratory COCs when removing samples from storage. The laboratory will organize samples into sample-delivery groups (SDGs). An SDG may contain up to 20 field samples (field duplicates, trip blanks, and rinse blanks are considered field samples for the purposes of SDG assignment). All field samples assigned to a single SDG shall be received by the laboratory over a maximum of seven calendar days and must be processed through the laboratory (preparation, analysis, and reporting) as a group. Every SDG must include a minimum of one site-specific MS/MSD pair, which shall be received by the laboratory at the start of the SDG assignment.

7.5.4 Sample Storage Following Analysis

The laboratory will maintain samples for at least one month after the final report is delivered to ARCADIS. The laboratory will be responsible for the eventual and appropriate disposal of the samples. The analytical laboratory will inform ARCADIS before any samples are disposed of. Unused portions of the samples, sample extracts, and associated wastes will be disposed of by the laboratory in accordance with applicable rules and regulations as specified in their SOP for waste disposal (included in Attachment 1).

8. Analytical-Method Requirements

8.1 Field Parameters and Methods

Any specific field-measurement protocols are provided in the appropriate work plan, OMM, or required regulatory procedures.

8.2 Laboratory Parameters and Methods

The methods listed below include the range of analyses likely to be performed. The associated laboratory SOPs can be found in Attachment 1. Laboratory analytical requirements presented in the subsections below include a general summary of requirements, specifics related to each sample medium to be analyzed, and details of the methods to be used for this project. SW-846 methods with NYSDEC ASP 2005 Revision, QA/QC, and reporting deliverables requirements will be used for all analytes.

8.2.1 General

The following tables summarize general analytical requirements:

Table	Title
Table 2	Sample Containers, Preservation Methods, and Holding Time Requirements
Table 3	Environmental and Quality-Control Analyses
Table 4	Parameters, Methods, and Target Reporting-Limits

8.2.2 Supplemental Remedial Design Sample Matrices

This QAPP covers the groundwater, treated groundwater, stormwater, soil gas, treated soil-vapor, and indoor air to be completed for the final deliverable. Analyses will be performed following the methods listed in Table 3. Results will be reported as micrograms per liter (µg/L) or parts per billion by volume (ppbv), as presented in Table 4.

8.2.3 Analytical Requirements

The primary sources describing the analytical methods to be used during the investigation are provided in USEPA *Methods for Chemical Analysis of Water and Waste* and USEPA *Compendium of Methods for the Determination of Organic Compounds in Ambient Air* with NYSDEC ASP 2005 Revision, QA/QC, and reporting deliverables requirements.

9. Quality Control Requirements

9.1 Quality Assurance Indictors

The overall QA objective for this QAPP is to develop and implement procedures for sampling, chain-of-custody, laboratory analysis, instrument calibration, data reduction and reporting, internal QC, audits, preventive maintenance, and corrective action, such that valid data will be generated. These procedures are presented or referenced in the following sections of this QAPP. Specific QC checks are discussed in Section 11.2. QA indicators are generally defined in terms of five parameters:

1. Representativeness
2. Comparability
3. Completeness
4. Precision
5. Accuracy

Each parameter is defined below. Specific objectives for the site actions are set forth in other sections of this QAPP, as referenced below.

9.1.1 Representativeness

Representativeness is the degree to which sampling data accurately and precisely represent site conditions, and depends on sampling and analytical variability and the variability of environmental media at the site. Field activities have been designed to assess the presence of the chemical constituents at the time of sampling. The appropriate work plans, OMM, and required regulatory procedures present the rationale for sample quantities and location. This QAPP presents field sampling and laboratory analytical methodologies. Using the prescribed field and laboratory analytical methods in concert with the associated holding times and preservation requirements is intended to ensure representative data.

9.1.2 Comparability

Comparability is the degree of confidence with which one data set can be compared to another. Comparability between this investigation, and to the extent possible, with existing data will be maintained through consistent sampling and analytical methodology as set forth in the appropriate work plans, OMM, and required regulatory procedures, as well as this QAPP, SW-846, and USEPA *Compendium Organic Compounds in Ambient Air* analytical methods with NYSDEC ASP Revision 2005, QA/QC requirements, Category B reporting deliverables, and through the use of QA/QC procedures and appropriately-trained personnel.

9.1.3 Completeness

Completeness is defined as a measure of the amount of valid data obtained from an event and/or investigation compared to the total amount that was obtained. This will be determined upon final assessment of the analytical results, as discussed in Section 11.6.

9.1.4 Precision

Precision is the measure of reproducibility of sample results. The goal is to maintain a level of analytical precision consistent with the project objectives. Sampling and analytical procedures will be followed to maximize precision. All work for this investigation will adhere to established protocols presented in the appropriate work plans, OMM. Required regulatory procedures-checks for analytical precision will include analysis of MSDs, laboratory duplicates, and field duplicates. Checks for field-measurement precision will include obtaining duplicate field measurements. Further discussion of precision QC checks is provided in Section 11.4.

9.1.5 Accuracy

Accuracy is the deviation of a measurement from the true value of a known standard. Both field and analytical accuracy will be monitored through initial and continuing calibration of instruments. In addition, internal standards, MSs, blank spikes, and surrogates (system-monitoring compounds) will be used to assess the accuracy of the laboratory analytical data. Further discussion of these QC samples is provided in Section 11.5.

9.2 Field Quality Control Checks

9.2.1 Field Measurements

To verify the quality of data using field instrumentation, duplicate measurements will be obtained and periodically reported for field measurements. A duplicate measurement will involve obtaining measurements a second time at the same sampling location. Duplicate measurements will be collected at least once per day during a sampling event.

9.2.2 Sample Containers

Certified, clean sample containers in accordance with Exhibit I of the NYSDEC ASP Revision 2005 (Eagle Picher pre-cleaned containers or equivalent) will be supplied by the laboratory.

9.2.3 Field Duplicates

Field duplicates will be collected from the different site materials to verify the reproducibility of the sampling methods. Field duplicates will be prepared by placing well homogenized aliquots (except samples for VOC analysis) from the same sampling location into individual sample containers, which are submitted blind to the laboratory. Field-duplicate water samples and soil samples for VOC analysis will constitute collocated samples rather than homogenized aliquots. In general, field duplicates will be analyzed at a 5 percent frequency (every 20 samples) for the chemical constituents. Table 3 provides an estimated number of field duplicates to be prepared for each applicable parameter and matrix.

9.2.4 Rinse Blanks

Rinse blanks are used to monitor the cleanliness of the sampling equipment and the effectiveness of the cleaning procedures. Rinse blanks will be prepared and submitted for analysis once per day per matrix. Rinse blanks will be prepared by filling sample containers with analyte-free water (supplied by the laboratory) that has been routed through a cleaned sampling device. When dedicated sampling devices or sample containers are used to collect the samples, rinse blanks will not be necessary. Table 3 estimates the number of rinse blanks for environmental media samples to be collected.

9.2.5 Trip Blanks

Trip blanks will be used to assess whether site samples have been exposed to non-site-related volatile constituents during storage and transport. Trip blanks will be analyzed at a frequency of once per day per cooler containing samples to be analyzed for VOCs. A trip blank will consist of a container filled with analyte-free water (supplied by the laboratory) that will remain unopened by the field sampling team and accompany the field samples throughout the sampling event. Trip blanks will only be analyzed for VOCs. Table 3 estimates the number of trip blanks to be collected for each matrix and parameter.

9.3 Analytical Laboratory Quality Control Checks

9.3.1 General

Internal laboratory QC-checks will be used to monitor data integrity. These checks will include method blanks, MS/MSDs, spike blanks, internal standards, surrogate samples, calibration standards, and reference standards. Project QC limits for duplicates and MSs are identified in Table 1. Laboratory control charts will be used to determine long-term instrument trends.

9.3.2 Method Blanks

Sources of contamination in the analytical process, whether specific analyses or interferences, need to be identified, isolated, and corrected. A method blank is useful in identifying possible sources of contamination within the analytical process. The method blank must be initiated at the beginning of the analytical process and encompass all aspects of the analysis. The method blank helps account for any potential contamination attributable to glassware, reagents, instrumentation, or other sources that could affect sample analysis. One method blank will be analyzed with each analytical series associated with no more than 20 samples.

9.3.3 Matrix Spike/Matrix Spike Duplicates

MS/MSDs will be site-specific and used to measure the accuracy of analyte recovery from the sample matrices. MS/MSD pairs will be analyzed at a 5 percent frequency (every 20 samples or once every week, whichever comes first). When MS recoveries are outside QC limits, associated control samples and surrogate-spike recoveries will be evaluated, as applicable, to attempt to verify the reason for the deviation and

determine its effect on the reported sample results. Table 3 estimates the number of MS and MSD analyses to be performed for each applicable parameter.

9.3.4 Surrogate Spikes

Surrogates are compounds unlikely to occur under natural conditions that have properties similar to the analytes of interest. This type of control is primarily used for organic samples analyzed by gas chromatography/mass spectrometry (GC/MS) methods, and is added to the samples before purging or extraction. The surrogate spike is used to provide broader insight into the proficiency and efficiency of an analytical method on a sample-specific basis. This control reflects analytical conditions that may not be attributable to the sample matrix.

If surrogate-spike recoveries exceed specified QC limits, the analytical results need to be evaluated thoroughly in conjunction with other control measures. In the absence of other control measures, the integrity of the data may not be verifiable and re-analysis of the samples with additional control may be necessary. Surrogate-spike compounds will be selected using the guidance provided in the analytical methods.

9.3.5 Laboratory Duplicates

For inorganics, laboratory duplicates will be analyzed to assess laboratory precision. Laboratory duplicates are defined as a separate aliquot of an individual sample that is analyzed as a separate sample. Table 3 estimates the number of laboratory duplicates needed for each applicable parameter.

9.3.6 Calibration Standards

Calibration-check standards analyzed within a particular analytical series provide insight regarding instrument stability. A calibration-check standard will be analyzed at the beginning and end of an analytical series or periodically throughout a series containing a large number of samples. In general, calibration-check standards will be analyzed after every 12 hours, or more frequently, as specified in the applicable analytical method. In analyses where internal standards are used, a calibration-check standard will only be analyzed in the beginning of an analytical series. If results of the calibration-check standard exceed specified tolerances, then all samples analyzed since the last acceptable calibration check standard will be re-analyzed. Laboratory-instrument calibration-standards will be selected using the guidance provided in the analytical methods, as summarized in Section 13.

9.3.7 Internal Standards

Internal-standard areas and retention times will be monitored for organic analyses performed by GC/MS methods. Method-specified internal-standard-compounds will be spiked into all field samples, calibration standards, and QC samples after preparation and before analysis. If internal-standard areas in one or more samples exceed the specified tolerances, the cause will be investigated, the instrument will be recalibrated, if necessary, and all affected samples will be re-analyzed. Acceptability of internal-standard performance will be determined using the guidance provided in the analytical methods.

9.3.8 Reference Standards/Control Samples

Reference standards are standards of known concentration and independent in origin from the calibration standards. The intent of reference-standard analysis is to provide insight into the analytical proficiency within an analytical series. This includes preparation of calibration standards, validity of calibration, sample preparation, instrument setup, and the premises inherent in quantitation. Reference standards will be analyzed at the frequencies specified within the analytical methods.

9.4 Data Precision Assessment Procedures

Field precision is difficult to measure because of temporal variations in field parameters. Precision will be controlled through the use of experienced field personnel, properly calibrated meters, and duplicate field measurements. Field duplicates will be used to assess precision for the entire measurement system, including sampling, handling, shipping, storage, preparation, and analysis. Laboratory data precision for organic analyses will be monitored through the use of MS/MSD and laboratory duplicates as identified in Table 3.

Data precision will be measured by calculating the relative percent-difference (RPD) by the following equation:

$$RPD = \frac{(A-B)}{(A+B)/2} \times 100$$

Where:

A = analytical result from one of two duplicate measurements

B = analytical result from the second measurement

Precision objectives for MSD and laboratory duplicate analyses are identified in the NYSDEC ASP Revision 2005 and contained in Table 1.

9.5 Data Accuracy Assessment Procedures

The accuracy of field measurements will be controlled by experienced field personnel, properly calibrated field meters, and adherence to established protocols. The accuracy of field meters will be assessed by review of calibration and maintenance logs. Laboratory accuracy will be assessed via the use of MSs, surrogate spikes, internal standards, and reference standards. Where available and appropriate, QA performance standards will be analyzed periodically to assess laboratory accuracy. Accuracy will be calculated in terms of percent recovery as follows:

$$\text{Percent Recovery} = \frac{A-X}{B} \times 100$$

Where:

A = value measured in spiked sample or standard

X = value measured in original sample

B = true value of amount added to sample or true value of standard

This formula is derived under the assumption of constant accuracy over the original and spiked measurements. If any accuracy calculated by this formula is outside of the acceptable levels, data will be evaluated to determine whether the deviation represents unacceptable accuracy, or variable, but acceptable accuracy. Accuracy objectives for MS recoveries and surrogate recovery objectives are identified in the NYSDEC ASP 2005 Revision and contained in Table 1.

9.6 Data Completeness Assessment Procedures

Completeness of a field or laboratory data set will be calculated by comparing the number of valid sample results generated to the total number of results generated.

$$\text{Completeness} = \frac{\text{Number valid results}}{\text{Total number of results generated}} \times 100$$

As a general guideline, overall project completeness is expected to be at least 90 percent. The assessment of completeness will require professional judgment to determine data usability for intended purposes.

10. Instrument/Equipment Testing, Inspection, and Maintenance Requirements

10.1 General

Testing and maintenance schedules have been developed for both field and laboratory instruments. A summary of testing and maintenance to be performed is presented below.

10.2 Field Instruments and Equipment

Each piece of field equipment will be inspected before field sampling to confirm that it is operational. If the equipment is not operational, it will be serviced before its use. All equipment will be fully charged and/or have fresh batteries, as appropriate. If instrument service is required, the appropriate task manager or field worker is responsible for following the maintenance schedule and arranging for timely service. Field instruments will be maintained according to their respective manufacturer's instructions.

10.2.1 Equipment Maintenance

All measuring and test equipment to be used in support of Site activities that directly affects the quality of the analytical data shall be subject to preventive maintenance measures that minimize equipment downtime. Equipment will be examined to certify that it is in operating condition, including checking the manufacturer's operating manual to confirm that all maintenance requirements are being observed. Field notes from previous sampling events will be reviewed to confirm that any earlier equipment problems have not been overlooked and that any necessary repairs to equipment have been carried out.

Field equipment returned from a site will be inspected to confirm that it is in working order. The inspection will be recorded in the logbook or field notebooks, as appropriate. The last user is obligated to record any equipment problems in the logbook. Non-operational field equipment will either be repaired or replaced. Appropriate spare parts will be made available for field meters. Maintenance of consultant- or subcontractor-owned or leased equipment shall be in accordance with the manufacturer's instructions, and all maintenance records shall be requested from the equipment owner/leasing company and reviewed before mobilizing any equipment to the site. No equipment shall be allowed on site if proper maintenance for that piece of equipment has not been performed and recorded.

10.3 Laboratory Instruments and Equipment

10.3.1 General

Laboratory-instrument and equipment-documentation procedures include details of any observed problems, corrective measure(s), routine maintenance, and instrument repair (including information regarding the repair and the individual who performed the repair). Preventive maintenance of laboratory equipment generally will follow the guidelines recommended by the manufacturer. A malfunctioning instrument will be repaired immediately by in-house staff or through a service call from the manufacturer.

10.3.2 Instrument Maintenance

Maintenance schedules for laboratory equipment adhere to the manufacturer's recommendations. Records reflect the complete history of each instrument and specify the timeframe for future maintenance. Major repairs or maintenance procedures are performed through service contracts with manufacturer or qualified contractors. Paperwork associated with service calls and preventative maintenance calls will be kept on file by the laboratory.

Laboratory-systems managers are responsible for routine maintenance of instruments used in a particular laboratory. Any routine preventive maintenance performed is logged into the appropriate logbooks. The frequency of routine maintenance is dictated by the nature of samples being analyzed, the requirements of the method used, and/or the judgment of the laboratory-systems manager. All major instruments are backed up by comparable (if not equivalent) instrument systems in the event of unscheduled downtime. An inventory of spare parts is also available to minimize equipment/instrument downtime.

10.3.3 Equipment Monitoring

The operation of balances, incubators, ovens, refrigerators, and water purification systems will be checked and documented daily. Any discrepancies will be immediately reported to the appropriate laboratory personnel for resolution.

11. Instrument Calibration and Frequency

11.1 Field Instruments and Equipment

Calibration of field instruments is documented in the FSP for the applicable field analysis method, and such procedures take precedence over the following discussion. Field personnel are responsible for confirming that a master calibration/maintenance log is maintained following the procedures specified for each measuring device. Where applicable, each log will include, at a minimum, the following information:

- name of device and/or instrument calibrated
- device/instrument serial/identification numbers
- calibration method
- tolerance
- calibration standard used
- frequency of calibration
- date(s) of calibration(s)
- name of person(s) performing calibration(s)

Instruments and equipment used to gather, generate, or measure environmental data will be calibrated at the intervals specified by the manufacturer or more frequently, and in such a manner that accuracy and reproducibility of results are consistent with the manufacturer's specifications. In the event that an internally calibrated field instrument fails to meet calibration/checkout procedures, it will be returned to the manufacturer for service. Equipment found out of tolerance during the period of use shall be removed from the field, and measuring and testing done with the equipment shall be addressed via the corrective-action system described in Section 17.4 of this QAPP.

11.2 Laboratory Instrument and Equipment

Instrument calibration will follow the specifications provided by the instrument manufacturer or specific analytical method used. Equipment calibration procedures for

detecting VOCs will follow guidelines presented in NYSDEC ASP 2005 Revision, Exhibit E, Part II Section 2. When analyses are conducted according to the USEPA SW-846 Methods and USEPA *Compendium Organic Compounds in Ambient Air*, the calibration procedures and frequencies specified in the applicable method will be followed, as noted in the attached SOPs (Attachment 1). For analyses governed by SOPs, see the appropriate SOP for the required calibration procedures and frequencies. Records of calibrations will be filed and maintained by the laboratory. These records will be subject to QA audits. For all instruments, the laboratory will maintain trained repair staff with in-house spare parts or will maintain service contracts with vendors.

All equipment-calibration standards are traceable, directly or indirectly, to the National Institute of Standards and Technology. All standards received shall be logged into standard-receipt logs maintained by the individual analytical groups. Each group shall maintain a standards-log that tracks the preparation of standards used for calibration and QC purposes.

12. Inspection/Acceptance Requirements for Supplies and Consumables

All supplies to be used in the field and laboratory will be available when needed. They will be free of target chemicals and interferences. All reagents will be tested before use with site samples. All standards will be verified against a second source standard. The laboratory will follow a “first in/first out” procedure for the storage and use of all consumables to minimize the risk of contamination and degradation. The various supplies and consumables required on site are noted in the various field SOPs included in the appropriate work plans and OMM.

13. Data Acquisition Requirements for Non-Direct Measurements

At present, direct use of historical data generated by outside parties is not anticipated in completing the final deliverable. Historical data will guide the determination of sampling locations for the deliverable. Before use, historic data sets will be reviewed according to the procedures identified in subsequent sections of this QAPP to determine appropriate uses of such data. The extent to which these data can be validated will be determined by the analytical level and QC data available. Evaluation of historic data for deliverable purposes requires:

- identification of analytical levels
- evaluation of QC data, when available
- development of conclusions regarding the acceptability of the data for intended uses

Acceptability of historic data for its intended uses will be determined by applying these procedures and professional judgment. If the quality of historic data cannot be determined, its use will be limited to general trend evaluations.

14. Data Management

The purpose of data management is to confirm that all necessary data are accurate and readily accessible to meet the project's analytical and reporting objectives. Field investigations will include a relatively large number of samples. Thus, a structured, comprehensive, and efficient program for data management will be necessary due to the large amount of data that will be produced.

The project's data-management program includes field documentation and sample QA/QC procedures, methods for tracking and managing the data, and a system for filing all site-related information. More specifically, data management procedures will be used to efficiently process the information collected, such that data are readily accessible and accurate. These procedures are detailed in the following section. The data management plan has five elements: 1) sample-designation system, 2) field activities, 3) sample tracking and management, 4) data-management system, and 5) document control and inventory.

14.1 Sample Designation System

A concise and easily understandable sample-designation system is an important part of project sampling-activities. It provides a unique sample number that will facilitate both sample tracking and easy re-sampling of select locations to evaluate data gaps, if necessary. The sample-designation system to be used during sampling will be consistent, yet flexible enough to accommodate unforeseen sampling events or conditions. A combination of letters and numbers will be used to yield a unique sample number for each field sampled collected, as outlined in Section 6.2.1.

14.2 Field Activities

Field activities designed to gather information necessary to make decisions during deliverable creation require consistent documentation and accurate recordkeeping. During site activities, standardized procedures will be used to document field activities, data security, and QA. Specific field activities are detailed as part of the project's SOPs (included as Attachment 2). General procedures are described in further detail in the following subsections.

14.2.1 Field Documentation

Complete and accurate recordkeeping is a critical component of the field investigation. When interpreting analytical results and identifying data trends, investigators realize that field notes are an important part of the review and validation process. To confirm that the field investigation is thoroughly documented, several different records, each with its own specific reporting requirements, will be maintained, including:

- field logs
- COCs
- instrument-calibration records

Each of these types of field documentation is described below.

Field Logs: Personnel performing field activities will keep field logs detailing all observations and measurements made. Data will be recorded directly into site-dedicated bound notebooks, with each entry dated and signed. To determine at any future date that notebook pages are not missing, each page will be sequentially numbered. Erroneous entries will be corrected by crossing out the original entry, initialing it, and then documenting the proper information. In addition, certain media-sampling locations will be surveyed to accurately record their locations. The survey crew will use their own field logs and supply the sampling-location coordinates to the database administrator.

Chain-of-Custody Forms: COCs are used to document and track sample possession from time of collection to the time of disposal. A chain-of-custody form will accompany each field sample collected, and one copy of the form will be filed in the field office. All field personnel will be briefed on the proper use of the chain-of-custody procedure. Chain-of-custody procedures and a sample form are included in all appropriate work plans, the OMM, and required regulatory procedures.

Instrument Calibration Records: As part of data QA procedures, field monitoring and detection equipment will be routinely calibrated. Instrument calibration confirms that equipment used is of the proper type, range, accuracy, and precision to provide data compatible with the specified requirements and desired results. Calibration procedures for the various types of field instrumentation are described in Section 13.1. To

demonstrate that established calibration procedures have been followed, calibration records will be prepared and maintained to include, as appropriate:

- calibration date and time
- equipment type and identification number
- calibration frequency and acceptable tolerances
- identification of individual(s) performing calibration
- reference standards used
- calibration data
- information on calibration success or failure

The calibration record will serve as a written account of monitoring or detection equipment QA. All erratic behavior or failures of field equipment will be subsequently recorded in the calibration log.

14.2.2 Data Security

Measures will be taken during the field investigation to confirm that samples and records are not lost, damaged, or altered. When not in use, all field notebooks will be stored at the field office or locked in the field vehicle. Access to these files will be limited to the field personnel who use them.

14.3 Sample Management and Tracking

A record of all field documentation will be maintained to confirm the validity of data used in the site analysis. To effectively execute such documentation, specific sample tracking and data management procedures will be used throughout the sampling program. Sample tracking will begin with the completion of COCs, as summarized in Section 9.2.3. The completed COCs associated with collected samples will be faxed to the quality assurance coordinator (QAC). Copies of all completed COCs will be maintained in the field office. The laboratory shall verify receipt of the samples electronically (via e-mail) on the following day. When analytical data are received from the laboratory, the QAC will review the incoming analytical data packages against the

information on the COCs to confirm that the correct analyses were performed for each sample and that results for all samples submitted for analysis were received. Any discrepancies noted will be promptly followed up by the QAC.

14.4 Data-Management System

In addition to the sample-tracking system, a data-management system will be implemented. The central focus of the data-management system will be to develop a personal-computer-based project database. The project database, to be maintained by the database administrator, will combine pertinent geographical, field, and analytical data. Information that will populate the database will be derived from three primary sources: surveying of sampling locations, field observations, and analytical results. Each of these sources is discussed in the following sections.

14.4.1 Computer Hardware

The database will be constructed on Pentium®-based personal-computer workstations connected through a network server. The network will provide access to various hardware peripherals, such as, laser printers, backup storage devices, image scanners, and modems. Computer hardware will be upgraded to industrial and corporate standards, as necessary, in the future.

14.4.2 Computer Software

The database will be written in Microsoft *Access*®, running under the *Windows*® operating system. Custom applets, such as diskette-importing programs, will be written in either Microsoft *VBA*® or Microsoft *Visual Basic*®. Geographic Information System (GIS) applications will be developed in ESRI *ArcGIS*®, with additional customization performed with *Visual Basic*®. Tables and other database reports will be generated through Microsoft Access in conjunction with Microsoft *Excel*®, Microsoft *Word*®, and/or Seagate *Crystal Reports*®. These software products will be upgraded to current industrial standards, as necessary.

14.4.3 Survey Information

In general, each location sampled as part of the deliverable will be surveyed to confirm accurate documentation of sample locations for mapping and GIS purposes (if appropriate), to facilitate the re-sampling of select sampling locations during future monitoring programs, if needed, and for any potential remediation activities. Surveying

activities in the field will consist of collecting information that will be used to compute northing and easting in-state plane-coordinates for each sampling location and the collection of information to compute elevations relative to the National Geodetic Vertical Datum of 1988 for select sampling locations, as appropriate. All field books associated with surveying will be stored as a project record.

14.4.4 Field Observations

An important part of the information that will ultimately reside in the project's data-management system will originate in field observations. Following each sampling event, the field personnel who performed the sampling may prepare a status memorandum to summarize and document the event. Topics to be discussed include the locations sampled, the sampling methodologies used, QA/QC procedures, blind duplicate and MS/MSD sample-identification numbers, equipment-decontamination procedures, personnel involved in the activity, and any other noteworthy aspects.

Tables are typically attached to the memorandum to summarize measurements recorded in the field books. These tables will be developed using a personal-computer spreadsheet program to reduce possible transcription error and facilitate transferring information to the data-management system. For example, for sediment samples, the table would present the sampling date and time, water depth, sediment depth, depth of sediment recovered in a given core, the depth increment submitted for analysis, and a description of the lithology.

Status memos are valuable tools to keep project personnel informed of the details of field activities and are invaluable during development of the final report. Each status memo will be reviewed for accuracy and completeness by the respective sampling-activity manager. Following approval and finalization of each memo, the status memo will be used to transfer field observations into the data-management system. All pertinent field data will be manually entered into the appropriate database tables from the COCs and field notebooks.

14.4.5 Analytical Results

The laboratory will provide analytical results both in digital and hard-copy formats. Data packages will be examined to confirm that the correct analyses were performed for each sample submitted and that all of the analyses requested on the chain-of-custody form were performed. If discrepancies are noted, the QAC will be notified and will promptly follow up with the laboratory to resolve any issues.

Each data package will be validated in accordance with the procedures presented in Section 20. Data not meeting the specified standards will be flagged pending resolution of the issue. The flag will not be removed until the issue associated with the sample results is resolved. Although flags may remain for certain data, the use of that data may not necessarily be restricted.

After data validation, the digital files will be used to populate the appropriate database tables. An example of the format of the electronic data-deliverable (EDD) is included in Table 5. This format specifies one data record for each constituent for each sample analyzed. Specific fields include:

- sample identification number
- date sampled
- date analyzed
- parameter name
- analytical result
- units
- detection limit
- qualifier(s)

The individual EDDs, supplied by the laboratory in either an ASCII comma-separated-value format or in a Microsoft *Excel* ® worksheet, will be loaded into the appropriate database table via a custom-designed user-interface *Visual Basic*® program. Any analytical data the laboratory cannot provide in electronic format will be entered manually. After database entry, EDD data will be compared to field information previously entered into the database to confirm that all requested analytical data have been received.

14.4.6 Data Analysis and Reporting

The database-management system will have several functions to facilitate review and analysis of the SRD data. Data-entry screens will be developed to assist in

keypunching field observations. Routines will also be developed to allow the user to scan analytical data from a given site for a given environmental medium. Several output functions developed by ARCADIS will be modified appropriately for use in the data-management system.

A valuable function of the data-management system will be the capability to generate analytical-results tables from the project databases. The system's capacity to directly produce tables reduces redundant manual entry of analytical results during report preparation and precludes transcription errors. This function of the data-management system creates a digital comma-delimited ASCII file of analytical results and qualifiers for a given medium. The ASCII file is then processed through a spreadsheet, which transforms the comma-delimited file into a table of rows and columns. Tables of analytical data will be produced as part of data-interpretation tasks, data reporting, and production of the deliverable report.

Another function of the data-management system will be to create digital files of analytical results and qualifiers suitable for transfer to mapping/presentation software. ARCADIS has developed a function that creates a digital file consisting of sample-location number, state-plane coordinates, sampling date, detected constituents, and associated concentrations and analytical qualifiers. The file is then transferred to an *AutoCAD*® workstation, where another program has been developed to plot a location's analytical data in a "box" format at the sampling location (represented by the state-plane coordinates). This routine greatly reduces redundant keypunching of analytical results and facilitates efficient production of interpretative and presentation graphics. The data-management system can also produce a digital file of select parameters that exists in one or more of the databases. This type of custom function is accomplished interactively and is best used to transfer select information into a number of analytical tools, such as statistical or graphing programs.

14.5 Document Control and Inventory

ARCADIS maintains project files for this site at its Albany, New York office. Each client project is assigned a file/job number. Each file is broken down into the following sub-files:

- Agreements/Proposals (filed chronologically)
- Change Orders/Purchase Orders (filed chronologically)
- Invoices (filed chronologically)

- Project Management (filed by topic)
- Correspondence (filed chronologically)
- Notes and Data (filed by topic)
- Public Relations Information (filed by topic)
- Regulatory Documents (filed chronologically)
- Final Reports/Presentations (filed chronologically)
- Draft Reports/Presentations (filed chronologically)
- Documents Prepared by Others (filed chronologically)

Whenever possible, originals are placed in these files. These are the central files and will serve as the site-specific files for the deliverable.

15. Assessment and Response Actions

15.1 General

Performance- and systems-audits will be completed in the field and laboratory during creation of the deliverable, as described below.

15.2 Field Audits

The following field-performance- and systems-audits will be completed during this project. The appropriate task manager will monitor field performance. Field-performance-audit summaries will evaluate field activities to verify that they are performed according to established protocols. The ARCADIS QAC will review field reports and communicate concerns to the ARCADIS project manager and/or task managers, as appropriate. In addition, the ARCADIS QAC will review the rinse and trip-blank data to identify potential deficiencies in field sampling and cleaning procedures. Systems audits comparing scheduled QA/QC activities associated with this document with actual QA/QC activities completed will also be performed. The appropriate task manager and QAC will periodically confirm that work is being performed consistent with this QAPP, the appropriate work plan, OMM, or required regulatory procedures.

15.3 Laboratory Audits

The laboratory will perform internal audits consistent with NYSDEC ASP 2005 Revision, Exhibit E. Internal laboratory-audits are conducted by the laboratory QAC. As part of the audit, the overall performance of laboratory staff is evaluated and compared to performance criteria outlined in the laboratory QA manual and SOPs. Results of these audits are summarized and issued to each department supervisor, the laboratory manager, and the laboratory director. Each laboratory QAC will also perform a systems audit to determine if the procedures implemented by their laboratory comply with the QA manual and SOPs.

In addition to each laboratory's internal audits, each laboratory (as a participant in state and federal certification programs) is audited by representatives of the certifying regulatory agency. Audits are usually conducted annually and focus on laboratory conformance to the specific program-protocols for which the laboratory seeks certification. The auditor reviews sample-handling and tracking documentation, analytical methodologies, analytical support documentation, and final reports. The audit findings are formally documented and submitted to the laboratory for corrective action,

if necessary. ARCADIS reserves the right to conduct an on-site audit of any laboratory before the start of project analyses. Additional audits may be performed during the course of the project, as necessary.

15.4 Corrective Action

Corrective actions are required when field or analytical data are not within the objectives specified in this QAPP, the appropriate work plan, OMM, or required regulatory procedures. Corrective actions include procedures to promptly investigate, document, evaluate, and correct data collection and/or analytical procedures. Field and laboratory corrective action procedures for the actions are described below.

15.4.1 Field Procedures

If a condition is noted in the field that could adversely affect data quality, corrective action will be taken to prevent or mitigate this condition. Condition identification, cause, and corrective action implemented by the field manager or their designee will be documented on a “Corrective Action Form” and reported to the appropriate ARCADIS task manager, QAC, and project manager. Examples of such situations include:

- Protocols as defined by the QAPP, appropriate work plan, OMM, or required regulatory procedures have not been followed
- Equipment not in proper working order or is not properly calibrated
- QC requirements not met
- Unresolved issues resulting from performance or systems audits

Project personnel will continuously monitor ongoing work performance in the course of normal daily responsibilities.

15.4.2 Laboratory Procedures

In the laboratory, when a condition is noted to adversely affect data quality, corrective action will be taken to prevent or mitigate this condition. Condition identification, cause, and corrective action taken will be documented and reported to the appropriate project manager and QAC. Corrective action may be initiated, at a minimum, under the following conditions:

- Specific laboratory analytical protocols have not been followed
- Protocols as defined by this QAPP have not been followed
- Pre-determined data-acceptance standards are not obtained
- Equipment is not in proper working order or calibrated
- Sample and test results are not completely traceable
- QC requirements have not been met
- Unresolved issues resulting from performance or systems audits

Laboratory personnel will continuously monitor ongoing work performance in the normal course of daily responsibilities. Corrective action begins when the problem is identified. At whatever level this occurs (analyst, supervisor, data review, or QC), the issue is brought to the attention of the laboratory QAC and, ultimately, the laboratory director. Final approval of any action deemed necessary is subject to the approval of the laboratory director. Any corrective action deemed necessary would be implemented, based on system or performance audits or the results of data review. The corrective action may include sample re-extraction, re-preparation, re-analysis, cleanup, dilutions, matrix modifications, or other activities.

16. Reports to Management

16.1 Internal Reporting

The analytical laboratory will submit analytical reports to ARCADIS for review. If required, ARCADIS will, in turn, submit the reports to the data validator for review. Supporting data (i.e., historic data, related field or laboratory data) will also be reviewed to evaluate data quality, as appropriate. The ARCADIS QA manager will incorporate results of data validation reports and assessments of data usability into a summary report (if required) that will be submitted to the ARCADIS project manager and appropriate task managers. If required, this report will be filed in the project file at ARCADIS' Albany, New York office and will include the following:

- Assessment of data accuracy, precision, and completeness for both field and laboratory data

- Results of the performance and systems audits
- Significant QA/QC problems, solutions, corrections, and potential consequences
- Analytical data validation report

16.2 Supplemental Remedial Design Reporting

As samples are transported to the laboratory, a copy of the chain-of-custody form will be forwarded to the ARCADIS project manager. Upon receipt of the "ASP— Category B Data Package" from the laboratory, the ARCADIS QA manager will determine if the data package has met the required DQOs. The analytical data package will be submitted to the ARCADIS project manager and the analytical data will be incorporated into the final deliverable report in a tabulated format.

17. Data Reduction and Review

17.1 General

After field and laboratory data are obtained, the data will be subjected to the following:

- reduction, or manipulation mathematically, or otherwise into meaningful and useful forms
- review
- organization, interpretation, and reporting
- data validation

17.2 Field Data Reduction and Review

17.2.1 Field Data Reduction

Information collected in the field through visual observation, manual measurement, and/or field instrumentation will be recorded in field notebooks or data sheets, and/or on forms. Such data will be reviewed by the appropriate task manager for adherence to the appropriate work plan, OMM, or required regulatory procedures and this QAPP for consistency. Concerns identified through this review will be discussed with the field personnel, corrected if possible, and, as necessary, incorporated into data evaluation.

17.2.2 Field Data Review

Field-data calculations, transfers, and interpretations will be conducted by field personnel and reviewed for accuracy by the appropriate task manager and the QAC. Logs and documents will be checked for:

- general completeness
- readability
- usage of appropriate procedures
- appropriate instrument calibration and maintenance

- reasonableness in comparison to present and past data collected
- correct sample locations
- correct calculations and interpretations

17.3 Laboratory Data-Reduction and Review

17.3.1 Laboratory Data-Reduction

Data-reduction calculations will be specified in each of the analytical methods referenced previously. Whenever possible, analytical data will be transferred directly from the instrument to a computerized data-system. Raw data will be entered into permanently bound laboratory notebooks. The data entered must be sufficient to document all factors used to arrive at the reported value. Concentration calculations for chromatographic analyses will be based on response factors. Quantitation will be performed using either internal or external standards.

Inorganic analyses will be based on regression analysis. Regression analysis is used to fit a curve through the calibration-standard data. Sample concentrations will be calculated using the resulting regression-equations. Nonaqueous values will be reported on a dry-weight basis. Unless otherwise specified, all values will be reported uncorrected for blank contamination.

17.3.2 Laboratory Data Review

Data will be subjected to multi-level review by the laboratory. The group leader will review all data reports before release for the final data report and signature by the laboratory project manager. The laboratory QAC will review a cross-section of the final data reports before shipment to ARCADIS.

Corrective action will be taken if discrepancies or deficiencies exist in the analytical results, as discussed in Section 17.4. Deficiencies discovered as a result of internal data-review, as well as the corrective actions to be used to rectify the situation, will be documented on a “Corrective Action Form.” This form will be submitted to the ARCADIS project manager.

17.4 Data Validation and Verification

All data generated for health and safety and engineering/design-control purposes will be subjected to the data validation and verification procedures outlined in Section 18. Data generated for disposal purposes will not be reviewed.

18. Data Validation and Verification

Data validation entails a review of the QC data and the raw data to verify that the laboratory was operating within required limits, the analytical results were correctly transcribed from the instrument read-outs, and which, if any, environmental samples were related to any out-of-control QC samples. The objective of data validation is to identify any questionable or invalid laboratory measurements. ARCADIS will validate all data generated producing a NYSDEC *Data Usability Summary Report* for each individual SDG using the most recent versions of the USEPA's *Function Guidelines* (USEPA, 1999b) and USEPA Region II SOPs for data validation available when the project began, where appropriate. These procedures and criteria may be modified, as necessary, to address project-specific and method-specific criteria, control limits, and procedures. Data validation will consist of data screening, checking, reviewing, editing, and interpretation to document analytical data quality and to determine whether the quality is sufficient to meet the DQOs.

The data validator will verify that reduction of laboratory measurements and laboratory reporting of analytical parameters is in accordance with the procedures specified for each analytical method and/or as specified in this QAPP. Any deviations from the analytical method or any special reporting requirements apart from what is specified in this QAPP will be detailed on COCs. Upon receipt of laboratory data, the data validator will execute the following procedures:

- Evaluate completeness of the data package
- Verify that field COCs were completed and that samples were handled properly
- Verify that holding times were met for each parameter. Holding-time exceedences, should they occur, will be documented. Data for all samples exceeding holding time requirements will be flagged as either estimated or rejected. The decision as to which qualifier is more appropriate will be made on a case-by-case basis
- Verify that parameters were analyzed according to the methods specified
- Review QA/QC data (i.e., make sure duplicates, blanks, and spikes were analyzed on the required number of samples, as specified in the method; verify that duplicate and MS recoveries are acceptable)

- Investigate anomalies identified during review. When anomalies are identified, they will be discussed with the project manager and/or laboratory manager, as appropriate

- If data appear suspect, investigate the specific data of concern. Calculations will be traced back to raw data; if calculations do not agree, the cause will be determined and corrected

Deficiencies discovered through the data review, as well as corrective actions implemented in response, will be documented and submitted as a written report addressing the following topics (as applicable to each method):

- data-package assessment

- description of any protocol deviations

- failures to reconcile reported and/or raw data

- assessment of any compromised data

- overall appraisal of the analytical data

- table of site name, sample quantities, matrix, and fractions analyzed

Note that qualified results do not necessarily invalidate data. The goal to produce the best possible data does not necessarily mean producing data without QC qualifiers. Qualified data can provide useful information. Resolution of any issues regarding laboratory performance or deliverables will be handled between the laboratory and the data validator. The ARCADIS QAC may make suggestions for re-analysis at this point. Data validation reports will be kept in the project file at the ARCADIS office in Albany, New York.

19. Reconciliation with User Requirements

Data results will be examined to determine the performance achieved for each data-usability criterion. Performance will then be compared with project objectives and DQOs. Deviations from objectives will be noted. Additional action may be warranted when performance does not meet objectives for critical data. Options for corrective action relating to incomplete information, questionable results, or inconsistent data may include any or all of the following:

- retrieval of missing information
- request for additional explanation or clarification
- re-analysis of sample from extract (when appropriate)
- re-calculation or re-interpretation of results by the laboratory

These actions may improve data quality, reduce uncertainty, and may eliminate the need to qualify or reject data. If these actions do not improve data quality to an acceptable level, the following additional actions may be taken:

- extrapolation of missing data from existing data points
- use of historical data
- evaluation of the critical/non-critical nature of the sample

If the data gap cannot be resolved by these actions, an evaluation of the data bias and potential for false negatives and positives can be performed. If the resultant uncertainty level is unacceptable, additional samples must be collected and analyzed.

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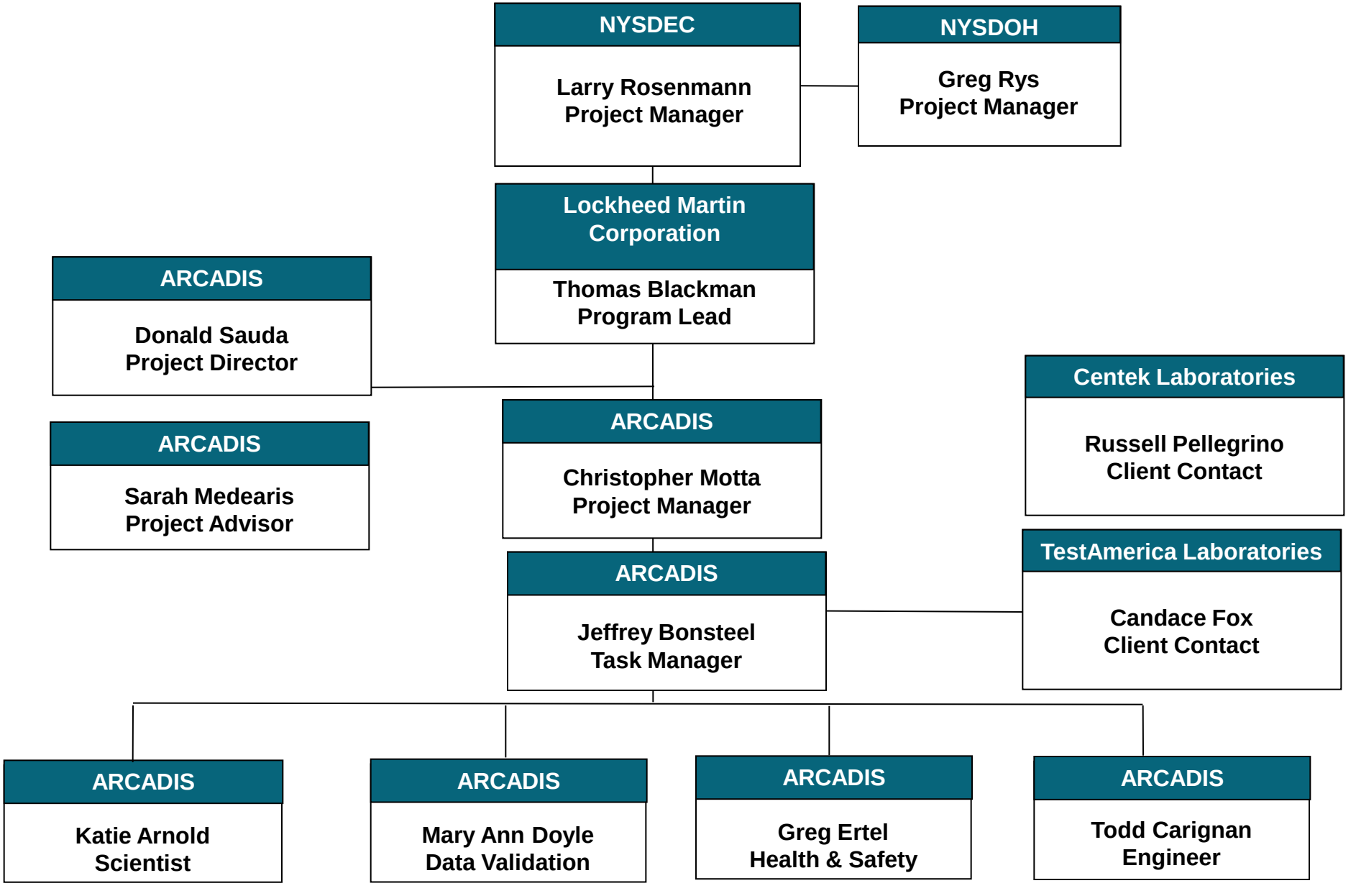
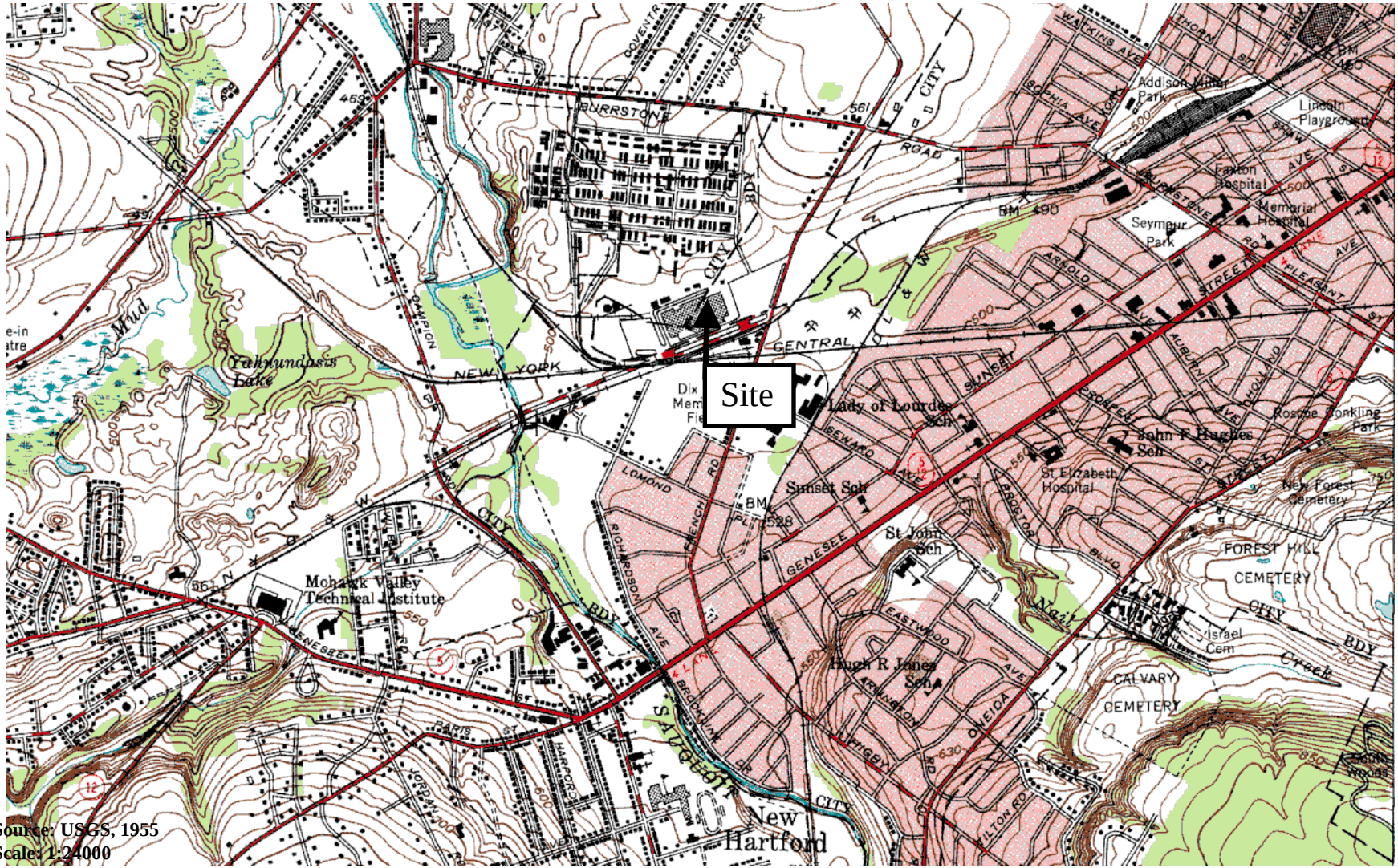
Figures

Figure 1. Utica Organizational Chart





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Site Location Map

Solvent Dock Area

UTICA, NEW YORK

PROJECT MANAGER	DRAWING NUMBER
C. Motta	
CHECKED BY	PROJECT NUMBER
J. Bonsteel	NJ000630.0001
DATE DRAWN	FIGURE NUMBER
April 5, 2005	2

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Tables

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Table 1. Analytical Quality Control Limits, Quality Assurance Project Plan, Lockheed Martin Corporation, Utica, New York

Parameter	Accuracy - % Recovery			Precision - RPD		
	Surrogate	MS/MSD	LCS	MS/MSD	Lab Duplicate	Field Duplicate
Water						
Volatile Organics	60-140	60-140	70-140	25	--	50
Soil						
Volatile Organics	60-140	60-140	70-140	25	--	100
Air						
VOCs TO-15	--	--	70-130	--	20	100

Notes:

[1] The listed QC limits are based on SW-846 guidance and are advisory. The actual limits are determined based on laboratory performance. Frequent failure to meet the QC limits; however, warrant investigation of the laboratory.

QC - quality control

MS/MSD - matrix spike/matrix spike duplicate

RPD - relative percent difference

LCS - laboratory control sample

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Table 2. Sample Containers, Preservation, and Holding Times, Quality Assurance Project Plan, Lockheed Martin Corporation, Utica, New York

Parameter	Method[1]	Bottle Type	Preservation	Holding Time[2]
Water / Soil				
Volatile Organic Compounds	8260	Two 40 mL glass vials with Teflon®-lined lid	Cool to 4°C pH<2	48 hours to preservation
Air				
Volatile Organic Compounds	TO-15	1 - Canister	None	10 days to analysis

Notes:

[1] USEPA. Office of Solid Waste and Emergency Response. *Test Methods for Evaluating Solid Waste. SW-846 3rd ed. Washington, D.C. 1996.*

[2] All holding times are calculated from verified time of sample receipt and will be consistent with Exhibit I of the NYSDEC Analytical Services Protocol

mL - milliliters

oz - ounce

^{o}C - degrees Celsius

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Table 3. Environmental and Quality Control Analyses, Quality Assurance Project Plan, Lockheed Martin Corporation, Utica, New York

Parameter	Estimated Environmental Sample Quantity	Field QC Analyses						Laboratory QC Sample						Total
		Trip Blank		Rinse Blank		Field Duplicate		Matrix Spike		Matrix Spike Duplicate		Lab Duplicate		
		Freq.	No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.	No.	
Groundwater Sampling														
Volatile Organic Compounds (SW-846 8260)	1	1/cooler	1	1/20	1	1/20	1	1/20	1	1/20	1	NA	--	6
Vapor Sampling														
Volatile Organic Compounds (TO-15)	1	NA	--	NA	--	1/20	1	NA	--	NA	--	NA	--	2
Soil Sampling														
Volatile Organic Compounds (SW-846 8260)	1	1/cooler	1	1/20	1	1/20	1	1/20	1	1/20	1	NA	--	6

Sample counts are an approximation of the estimated minimal quantity. Additional samples may be obtained based on analytical data and result in increased QC samples.

[1] -

[2] -

1/day - One rinse blank per day or one per 20 samples, whichever is more frequent. Rinse blanks not required when dedicated sampling equipment or new, clean, unused disposable sampling equipment is used.
Freq. - frequency
NA - not applicable
No. - number
QC - quality control
TBD - to be determined
TCL - Target Compound List
TAL - Target Analyte List

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Table 4. Parameters, Methods, and Target Reporting Limits, Quality Assurance Project Plan, Lockheed Martin Corporation, Utica, New York

Analyte	Water (µg/L)		
	NYS GW STD./G.V.[3]	Laboratory MDL	Laboratory RL
Volatile Organic Compounds 8260 [1]			
Dichlorodifluoromethane	5	0.29	1.0
Chloromethane	5	0.35	1.0
Bromomethane	5	0.28	1.0
Vinyl chloride	2	0.24	1.0
Chloroethane	5	0.32	1.0
Trichlorofluoromethane	5	0.15	1.0
Methylene chloride	5	0.44	1.0
1,1,2-Trichloro-1,2,2-trifluoroethane	5	0.21	1.0
Acetone	50	1.30	5
Carbon disulfide	60	0.19	1.0
Methyl acetate	NA	0.50	1.0
1,1-Dichloroethene	5	0.29	1.0
1,1-Dichloroethane	5	0.38	1.0
trans-1,2-Dichloroethene	5	0.42	1.0
Chloroform	7	0.34	1.0
1,2-Dichloroethane	0.6	0.21	1.0
cis-1,2-Dichloroethene	5	0.38	1.0
2-Butanone	50	1.30	5
1,1,1-Trichloroethane	5	0.26	1.0
Cyclohexane	NA	0.53	1.0
Carbon tetrachloride	5	0.27	1.0
Bromodichloromethane	50	0.39	1.0
1,2-Dichloropropane	1	0.32	1.0
cis-1,3-Dichloropropene	0.4	0.36	1.0
Trichloroethene	5	0.46	1.0
Methylcyclohexane	NA	0.50	1.0
Dibromochloromethane	50	0.39	1.0
1,2-Dibromoethane	0.0006	0.17	1.0
1,1,2-Trichloroethane	1	0.21	1.0
Benzene	1	0.41	1.0
trans-1,3-Dichloropropene	0.4	0.37	1.0
Bromoform	50	0.26	1.0
Isopropylbenzene	5	0.19	1.0
4-Methyl-2-pentanone	NA	0.91	5.0
2-Hexanone	50	1.20	5.0
Tetrachloroethene	5	0.36	1.0
Toluene	5	0.51	1.0
1,1,2,2-Tetrachloroethane	5	0.21	1.0
Chlorobenzene	5	0.32	1.0

Table 4. Parameters, Methods, and Target Reporting Limits, Quality Assurance Project Plan, Lockheed Martin Corporation, Utica, New York

Analyte	Water (µg/L)		
	NYS GW STD./G.V.[3]	Laboratory MDL	Laboratory RL
Volatile Organic Compounds 8260 [1]			
Ethylbenzene	5	0.18	1.0
Styrene	5	0.18	1.0
Xylenes (total)	5	0.66	2.0
1,3-Dichlorobenzene	3	0.36	1.0
1,4-Dichlorobenzene	3	0.39	1.0
1,2-Dichlorobenzene	3	0.36	1.0
1,2-Dibromo-3-chloropropane	0.04	0.39	1.0
1,2,4-Trichlorobenzene	5	0.41	1.0
Methyl t-butyl ether (MTBE)	10	0.16	1.0

Notes:

[1] USEPA. Office of Solid Waste and Emergency Response. *Test Methods for* Evaluating Solid Waste SW-846 3rd ed.*Washington, D.C. 1996.*

[2] The target reporting limits are based on wet weight. The actual reporting limits will vary based on sample weight and moisture content.

[3] Water guidance values (GV) are as presented in the NYSDEC, Division of Water, Technical and Operation Guidance Series (TOGS) document etitled, *Ambient Water* Quality Standards and Guidance Values and Groundwater Effluent Limitations (TOGS 1.1.1), dated June 1998, last revised April 2000.

[4] Soil guidance values (GV) are as presented in the NYSDEC Technical and Administrative Guidance Memorandum (TAGM) etitled, *Determination of Soil* Cleanup Objectives and Cleanup Levels, HWR-94-4046 (TAGM 4046) dated January 24, 1994.

µg/L - micrograms per liter

µg/kg - micrograms per kilogram

MDL - method detection limit

Table 4. Parameters, Methods, and Target Reporting Limits, Quality Assurance Project Plan, Lockheed Martin Corporation, Utica, New York

Analyte	Air (ppbv)		
	Guidance Criteria[1]	Laboratory MDL	Laboratory RL
Volatile Organic Compounds TO-15			
1,1,1-Trichloroethane	-	0.013	0.50
1,1,2,2-Tetrachloroethane	-	0.023	0.50
Freon-113	-	0.015	0.50
1,1,2-Trichloroethane	-	0.017	0.50
1,1-Dichloroethane	-	0.026	0.50
1,1-Dichloroethene	-	0.028	0.50
1,2,4-Trichlorobenzene	-	0.046	0.50
1,2,4-Trimethylbenzene	-	0.013	0.50
1,2-Dibromoethane	-	0.024	0.50
1,2-Dichlorobenzene	-	0.025	0.50
Dichlorodifluoromethane	-	0.015	0.50
1,2-Dichloroethane	-	0.021	0.50
1,2-Dichloropropane	-	0.019	0.50
1,3,S-Trimethylbenzene	-	0.015	0.50
1,3-Butadiene	-	0.029	0.50
1,3-Dichlorobenzene	-	0.03	0.50
1,4-Dichlorobenzene	-	0.024	0.50
4-Ethyltoluene	-	0.021	0.50
Acetone	-	0.5	1.00
Benzene	-	0.013	0.50
Benzyl Chloride	-	0.031	0.50
Bromodichloromethane	-	0.015	0.50
Bromoform	-	0.021	0.50
Bromomethane	-	0.025	0.50
Carbon Disulfide	-	0.01	0.50
Carbon Tetrachloride	-	0.017	0.50
Chlorobenzene	-	0.013	0.50
Chloroethane	-	0.032	0.50
Chloroform	-	0.025	0.50
Chloromethane	-	0.015	0.50
CIS-1,2-Dichloroethene	-	0.0	0.50
CIS-1,3-Dichloropropene	-	0.015	0.50
Cyclohexane	-	0.028	0.50
Dibromochloromethane	-	0.015	0.50
Freon-114	-	0.013	0.50
Ethyl Acetate	-	0.057	0.50
Ethylbenzene	-	0.0	0.50

Table 4. Parameters, Methods, and Target Reporting Limits, Quality Assurance Project Plan, Lockheed Martin Corporation, Utica, New York

Analyte	Air (ppbv)		
	Guidance Criteria[1]	Laboratory MDL	Laboratory RL
Heptane	-	0.015	0.50
Hexachlorobutadiene	-	0.029	0.50
Hexane	-	0.021	0.50
M+P-Xylene	-	0.01	1.00
2-Hexanone	-	0.061	0.50
2-Butanone	-	0.06	0.50
4-Methyl-2-Pentanone	-	0.056	0.50
Methyl Tert-Butyl Ether	-	0.015	0.50
Methylene Chloride	-	0.024	0.50
O-Xylene	-	0.01	0.50
Propylene	-	0.027	0.50
Styrene	-	0.017	0.50
Tetrachloroethene	-	0.019	0.50
Tetrahydrofuran	-	0.033	0.50
Toluene	-	0.01	0.50
Trans-1,2-Dichloroethene	-	0.01	0.50
Trans-1,3-Dichloropropene	-	0.015	0.50
Trichloroethene	-	0.028	0.50
Trichlorofluoromethane	-	0.01	0.50
Vinyl Acetate	-	0.15	0.50
Vinyl Chloride	-	0.03	0.50

Notes:
[1] NYSDOH Guidance for Soil Vapor Intrusion will be used for evaluation of all soil
NA - not applicable
ppbv - parts per billion by volume.

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Table 5. Electronic Data Deliverable (EDD) Format, Quality Assurance Project Plan, Lockheed Martin Corporation, Utica, New York

Field Name [1]	Data Type [2]	Notes
Sample Name	Text-50	Sample ID as it appears on Laboratory Form 1 for analysis (e.g., MW-1 reported as MW-1RE for re-analysis).
COC Sample Name	Text-50	Sample ID as it appears on the chain of custody.
SDG	Text-50	Sample Delivery Group
Lab Sample ID	Text-50	
Matrix	Text-25	e.g., Soil, Water, Sediment
Sample Type	Text-10	e.g., FB, RB, FD , FS, TB, MS, MSD -- for Field Blank, Rinse Blank, Field Duplicate, Field Sample, Trip Blank, Matrix spike, Matrix Spike Duplicate respectively. MS and MSD sample results are optional.
Date Collected	Date/Time	
Time Collected	Date/Time	
Depth Start	Number	
Depth End	Number	
Depth Units	Text-25	
Method	Text-50	Analytical method used by laboratory. Include "-TCLP" or "-Filtered" as appropriate (e.g., Soil-1 reported as Soil-1-TCLP for TCLP samples).
CAS Number	Text-25	Chemical Abstracts Service Registry Number
Analyte	Text-100	
Result Value	Number	For non-detected results a "U" must be present in Lab Qualifiers field.
Lab Qualifiers	Text-10	"U" for not detected, others as defined by the lab.
Reporting Limit	Number	PQL
Result Units	Text-25	
Dilution Factor	Number	
Reportable Result	Yes/No	If the field is not included, default on import will be "Yes". If the field is included it must be populated. Used where re-analyses or dilutions are present to determine proper result to report.
Filtered	Yes/No	
MDL	Number	Method Detection Limit
Date Analyzed	Date/Time	
Time Analyzed	Date/Time	
Date Received	Date/Time	Date Received by Lab
Laboratory	Text-50	
Lab Certification Number	Text-50	
Result Type	Text-10	e.g., IS, SC, SUR, TIC or TRG -- for Internal Standard, Spiked Compound, Surrogate, Tentatively Identified Compound, Target (regular) result, respectively. IS, SC and SUR results are optional.
Basis	Text-10	e.g., Wet, Dry or NA -- for wet weight, dry weight, not applicable, respectively.
Test Type	Text-10	e.g., Initial, DL, DL1…DLn, RE, RE1…Ren, REX, REX1…REXn; where Initial = Initial Analysis, DL = Dilution, RE = Re-analysis, REX = Re-extraction, n = the nth analysis of the test type.
Time Received	Date/Time	Time Received by Lab

Notes:
1. Fields highlighted in pink are not required. They may be left empty or the field can be eliminated from the EDD if the lab is not providing that data.
2. Number after "Text-" indicates the maximum number of characters allowed.
3. If lab is providing Matrix or Sample Types, they can use codes different from the examples above but will need to provide definitions for them.
4. Depth related fields can be left blank for samples where they are not applicable.

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Appendix A

Sample Chain-of-Custody Form

ARCADIS
Infrastructure, environment, facilities

ID#:

CHAIN OF CUSTODY & LABORATORY ANALYSIS REQUEST FORM

Page ___ of ___

Lab Work Order #

Send Results to:

Contact & Company Name:	Telephone:
Address:	Fax:
City State Zip	E-mail Address:
Project Name/Location (City, State):	Project #:
Sampler's Printed Name:	Sampler's Signature:

Preservative								
Filtered (✓)								
# of Containers								
Container Information								

PARAMETER ANALYSIS & METHOD

Keys

Preservation Key:
A. H_2SO_4
B. HCL
C. HNO_3
D. NaOH
E. None
F. Other: _____
G. Other: _____
H. Other: _____

Container Information Key:
1. 40 ml Vial
2. 1 L Amber
3. 250 ml Plastic
4. 500 ml Plastic
5. Encore
6. 2 oz. Glass
7. 4 oz. Glass
8. 8 oz. Glass
9. Other: _____
10. Other: _____

Matrix Key:
SO - Soil | SE - Sediment | NL - NAPL/Oil
W - Water | SL - Sludge | SW - Sample Wipe
T - Tissue | A - Air | Other: _____

Sample ID	Collection Date	Collection Time	Type (✓) Comp	Type (✓) Grab	Matrix								**REMARKS**

Special Instructions/Comments:

☐ **Special QA/QC Instructions(✓):**

Laboratory Information and Receipt		**Relinquished By**	**Received By**	**Relinquished By**	**Laboratory Received By**
Lab Name:	Cooler Custody Seal (✓)	Printed Name:	Printed Name:	Printed Name:	Printed Name:
☐ Cooler packed with ice (✓)	☐ Intact ☐ Not Intact	Signature:	Signature:	Signature:	Signature:
Specify Turnaround Requirements:	Sample Receipt:	Firm:	Firm/Courier:	Firm/Courier:	Firm:
Shipping Tracking #:	Condition/Cooler Temp: _____	Date/Time:	Date/Time:	Date/Time:	Date/Time:

Distribution: **WHITE – Laboratory returns with results** **YELLOW – Lab copy** **PINK – Retained by ARCADIS**

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Attachment 1

Laboratory Standard Operating Procedures

CORPORATE QUALITY MANAGEMENT PLAN

Analytical Laboratories

Revision: 0

January 2009

Controlled Source: Intranet **Facility Distribution No.** _____

Corporate Quality Management Plan

Approval Signatures

Rachel Brydon Jannetta

Rachel Brydon Jannetta
President & Chief Executive Officer (CEO)

1/6/2009
Date

Dr. Keith Wheatstone
Chief Operating Officer (COO)

1/5/2009
Date

Dr. Charles W. Carter
Vice President of Quality & Technical Services (QTS)

12/16/2008
Date

Raymond. J. Frederici
Director of Quality & Client Advocacy

12/15/2008
Date

Table of Contents

Tables & Figures

Appendix

3.0 Introduction

3.1 Overview

TestAmerica is the leading environmental testing firm in the United States, including 38 laboratories and 27 service centers. TestAmerica provides innovative technical expertise and comprehensive analytical testing services. Specialty analyses include source and ambient air, aquatic toxicity, explosives, specialty organics, dioxins, drinking water, sediments and tissues, emerging contaminants, radiochemistry and mixed waste testing. TestAmerica is well positioned to support a variety of clients including commercial, governmental and chemical industries.

TestAmerica offers a broad range of environmental testing services. TestAmerica's testing capabilities include chemical, physical, and biological analyses of a variety of matrices, including aqueous, solid, drinking water, waste, tissue, air, mold and fungus (Mycology) and saline/estuarine samples. Specialty capabilities include air toxics testing, radiological, mixed waste testing, geotechnical testing, tissue preparation and analysis, aquatic toxicology, dioxin/furan testing, indoor air quality and microscopy services, asbestos analysis, High Resolution Mass Spectrometry (HRMS), Inductively Coupled Plasma/MS (ICP/MS), Liquid Chromatography/MS (LC/MS), PCR microbiology and on-site technologies including mobile laboratories. TestAmerica laboratory locations are as follows:

Table 3-1. TestAmerica Analytical Facility Locations

TestAmerica Anchorage	TestAmerica North Canton
TestAmerica Austin	TestAmerica Ontario
TestAmerica Buffalo	TestAmerica Pensacola
TestAmerica Burlington	TestAmerica Phoenix
TestAmerica Cedar Falls	TestAmerica Pittsburgh
TestAmerica Chicago	TestAmerica Portland
TestAmerica Connecticut	TestAmerica Richland
TestAmerica Corpus Christi	TestAmerica San Francisco
TestAmerica Dayton	TestAmerica Savannah
TestAmerica Denver	TestAmerica Seattle
TestAmerica Edison	TestAmerica Spokane
TestAmerica Honolulu	TestAmerica St. Louis
TestAmerica Houston	TestAmerica Tacoma
TestAmerica Irvine	TestAmerica Tallahassee
TestAmerica King of Prussia	TestAmerica Tampa
TestAmerica Knoxville	TestAmerica Valparaiso
TestAmerica Los Angeles	TestAmerica Watertown
TestAmerica Mobile	TestAmerica West Sacramento
TestAmerica Nashville	TestAmerica Westfield

3.2 Purpose

The purpose of TestAmerica's Corporate Quality Management Plan (CQMP) is to describe the TestAmerica quality system and to outline how that system enables all employees of TestAmerica to meet the Quality Assurance (QA) Policy. This document also describes specific QA activities and requirements and prescribes their frequencies. Roles and responsibilities of TestAmerica Senior Management in support of the quality system are also defined.

3.3 References

The following references were used in preparation of this document and as the basis of the TestAmerica Quality System:

- National Environmental Laboratory Accreditation Conference (NELAC) Standard, 2003
- 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.
- EPA SW-846, *Test Methods for the Evaluation of Solid Waste, 3rd Edition,* September 1986; Update I, July 1992; Update II, September 1994; Update III, December 1996; and Update IV, February 2007.
- Federal Register, 40 CFR Parts 136, 141, 172, 173, 178, 179 and 261.
- USEPA Contract Laboratory Program. *Statement of Work for Inorganics Analysis. Multi-Media, Multi-Concentration.* Document ILM04.0.
- USEPA Contract Laboratory Program. *Statement of Work for Organics Analysis. Multi-Media, Multi-Concentration.* Document Number OLMO3.1, August 1994.
- APHA, *Standard Methods for the Examination of Water and Wastewater,* 18th Edition, 19th, 20th and 21st Edition.
- *U.S. Department of Energy* Order 414.1B, *Quality Assurance*, April 29, 2004.
- *U.S. Department of Energy* Order 414.1C, *Quality Assurance*, June 17, 2005.
- *U.S. Department of Energy*, *Quality Systems for Analytical Services*, Revision 2.4, October 28, 2008.
- U.S. Department of Defense, *Quality Systems Manual for Environmental Laboratories*, Final Version 3, January 2006.
- U.S. Department of Defense, *Air Force Center for Environmental Excellence Quality Assurance Project Plan (QAPP),* Version 4.0.02, May 2006.
- Nuclear Regulatory Commission (NRC) quality assurance requirements.
- Marine Protection, Research, and Sanctuaries Act (MPRSA).
- Toxic Substances Control Act (TSCA).

3.4 Scope

The requirements set forth in this document are applicable to all TestAmerica laboratories. Where this document uses the terms "must" and "shall", this denotes required activities. Practices described in this CQMP denote how those activities are performed in general; and each laboratory may have a more detailed description of that activity.

Each laboratory has the responsibility and authority to operate in compliance with regulatory requirements of the jurisdiction in which the work is performed. Where this CQMP conflicts with those regulatory requirements, the regulatory requirements of the jurisdiction shall hold primacy. Each laboratory's Quality Assurance Manual (QAM) shall take precedence over the CQMP in those cases. Secondarily, each TestAmerica laboratory has the responsibility and authority to operate in compliance with documented client requirements, where they do not conflict with regulatory requirements or TestAmerica's Ethics Policy (Document No. CA-L-P-001). TestAmerica shall not enter any client agreements that conflict with regulatory requirements in the jurisdiction in which the work is performed. Where documented client agreements conflict with this document, but meet the regulatory requirements of the jurisdiction in which the work is performed, the client agreements shall supersede requirements in this CQMP.

TestAmerica Policies, as directed in the CQMP, are documented & adhered to by each analytical testing facility. The Quality Assurance (QA) Manager at each facility is responsible to ensure that their QAM remains in the Corporate-approved format and that all updates are in accordance to the CQMP and their operational processes.

TestAmerica operates under the regulations and guidelines of the following federal programs:

- Air Force Center for Environmental Excellence (AFCEE)
- US Army Corp of Engineers, Hazardous, Toxic and Radioactive Waste (USACE HTRW)
- Clean Air Act (CAA)
- Clean Water Act (CWA)
- Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)
- Department of Energy (DOE)
- Marine Protection, Research, and Sanctuaries Act (MPRSA)
- Navy Facilities Engineering Service Center (NFESC)
- National Pollutant, Discharge, and Elimination System (NPDES)
- Nuclear Regulatory Commission (NRC)
- Occupational Safety and Health Administration (OSHA)
- Resource Conservation and Recovery Act (RCRA)
- Safe Drinking Water Act (SDWA)
- Toxic Substances Control Act (TSCA)

TestAmerica also provides services under various state and local municipal guidelines. A listing of each laboratory's service offerings and certifications is presented on TestAmerica's website or available from the laboratory.

This CQMP was written to comply with the National Environmental Laboratory Accreditation Conference (NELAC) standards.

3.5 Terms and Definitions

A Quality Assurance Program is a company-wide system designed to ensure that data produced by our laboratories conform 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.

4.0 Organization and Management

4.1 Roles and Responsibilities

TestAmerica's organizational structure is presented in Figure 4-1. Corporate employees are located at various TestAmerica facilities as outlined in the organizational structure. A QA Manager shall be designated at each TestAmerica laboratory.

President / CEO
The President / CEO is a member of the Board of Directors and is ultimately responsible for the quality and performance of all TestAmerica facilities. The President/CEO establishes the overall quality standard and data integrity program for the Analytical Division, providing the necessary leadership and resources to assure that the standard and integrity program are met. The President authorizes the CQMP and as such, sets the standards for the quality system.

Chief Operating Officer (COO)
The COO serves as the ranking executive for all respective analytical laboratory operational functions and reports to the President/CEO of the Analytical Division. The COO is responsible for the daily management of all analytical laboratories, long-term planning and development of technical policies and management plans. The COO ensures the attainment of corporate objectives through the selection, development, motivation, and evaluation of top management personnel. The COO approves all operating budgets and capital expenditures. The COO authorizes the CQMP and is responsible for ensuring that business and technical operations are conducted in accordance with its requirements.

Vice President of Quality and Technical Services (QTS)
The Vice President (VP) of Quality and Technical Services is responsible for offerings to clients including risk management, technical assistance, legal compliance and contract administration. The VP of Quality and Technical Services provides support and direction to the Managers of these areas, and supports the COO in decisions regarding long term planning, resource allocation and capital expenditures. The VP QTS authorizes the CQMP and responsibilities include authorization of Manuals, Policies and Procedures, providing support and direction to the Managers of these areas, and supporting the COO in decisions regarding long term planning, resource allocation, and capital expenditures.

Director of Quality & Client Advocacy
The Director of Quality & Client Advocacy reports directly to the VP of Quality & Technical Services. With the aid of the Senior Management Team, Laboratory Directors, Quality Directors, EHS Director, QA Managers and EHS Coordinators, the Director of Quality & Client Advocacy has the responsibility for the establishment, general overview and Corporate maintenance of the Quality Assurance and Environmental, Health and Safety Program within TestAmerica. Additional responsibilities include:

- Review of QA/QC aspects of Corporate SOPs & Policies, national projects and expansions or changes in services.
- Work with various organizations outside of TestAmerica to further the development of quality standards and represent TestAmerica at various trade meetings.
- With the assistance of the EHS Director, development and implementation of the TestAmerica Environmental, Health and Safety Program.

Director of Technical Services
The Director of Technical Services is responsible for establishing, implementing and communicating TestAmerica's Analytical Division's Technical Policies, SOPs, and Manuals. Other responsibilities include conducting technical assessments as required, acting as a technical resource in national contracts review, coordinating new technologies, establishing best practices, advising staff on technology advances, innovations, and applications.

General Manager (GM)
Each GM reports directly to the COO. Each GM has full responsibility for the overall administrative and operational management of their respective laboratories. The GM's responsibilities include allocation of personnel and resources, long-term planning, setting goals, and achieving the financial, business, and quality objectives of TestAmerica. The GM ensures timely compliance with corporate management directives, policies, and management systems reviews. The GM is also responsible for restricting any laboratory from performing analyses that cannot be consistently and successfully performed to meet the standards set forth in this manual.

Quality Directors
The Quality Directors report to the Director of Quality & Client Advocacy. Together with the Director of Quality & Client Advocacy, the Quality Directors have the responsibility for the establishment, general overview and maintenance of the Analytical Division's Quality Assurance Program within TestAmerica. The Quality Directors are responsible for:

- Oversight of the QA/QC programs within each laboratory. This includes a review of each laboratory-specific QAM and receipt of each laboratory's QA monthly report.
- Review of QA/QC aspects of national projects.
- Assistance with certification & accreditation activities.
- Preparation of a monthly report that includes quality metrics across the Analytical Division and a summary of any quality related initiatives and issues.

Ethics and Compliance Officers (ECOs)
TestAmerica has designated two senior members of the Corporate staff to fulfill the role of Ethics and Compliance Officer (ECO) – VP of Quality & Technical Services and the Director of Quality & Client Advocacy. Each ECO acts as a back-up to the other ECO and both are involved when data investigations occur. Each ECO has a direct line of communication to the entire senior Corporate and lab management staff.

The ECOs ensure that the organization distributes the data integrity and ethical practices policies to all employees and ensures annual trainings and orientation of new hires to the ethics program and its policies. The ECOs are responsible for establishing a mechanism to foster employee reporting of incidents of illegal, unethical, or improper practices in a safe and confidential environment.

The ECOs monitor and audit procedures to determine compliance with policies and to make recommendations for policy enhancements to the CEO, COO, GMs, Laboratory Directors or other appropriate individuals within the laboratory. The ECOs will assist the laboratory QA Manager in the coordination of internal auditing of ethical policy related activities and processes within the laboratory, in conjunction with the laboratories regular internal auditing function.

The ECOs will also participate in investigations of alleged violations of policies and work with the appropriate internal departments to investigate misconduct, remedy the situation, and prevent recurrence of any such activity.

Chief Information Officer (CIO)
The CIO is responsible for establishing, implementing and communicating TestAmerica's Information Technology (IT) Policies, SOPs and Manuals. Other responsibilities include coordinating new technologies, development of electronic communication tools such as TestAmerica's intranet and internet sites, ensuring data security and documentation of software, ensuring compliance with the NELAC standard, and assistance in establishing, updating, and maintaining Laboratory Information Management Systems (LIMS) at the various TestAmerica facilities.

Environmental Health and Safety Director (EHS)
The EHS Director reports directly to the Director of Quality & Client Advocacy. The EHS Director is responsible for the development and implementation of the TestAmerica Environmental, Health and Safety program. Responsibilities include:

- Consolidation and tracking all safety and health-related information and reports for the company, and managing compliance activities for TestAmerica locations.
- Coordination/preparation of the Corporate Environmental Health and Safety Manual that is used by each laboratory to prepare its own laboratory-specific Safety Manual.
- Preparation of information and training materials for laboratory EHS Coordinators.
- Assistance in the internal and external coordination of employee exposure and medical monitoring programs to insure compliance with applicable safety and health regulations.
- Serving as Department of Transportation (D.O.T.) focal point and providing technical assistance to location management.
- Serving as Hazardous Waste Management main contact and providing technical assistance to location management.

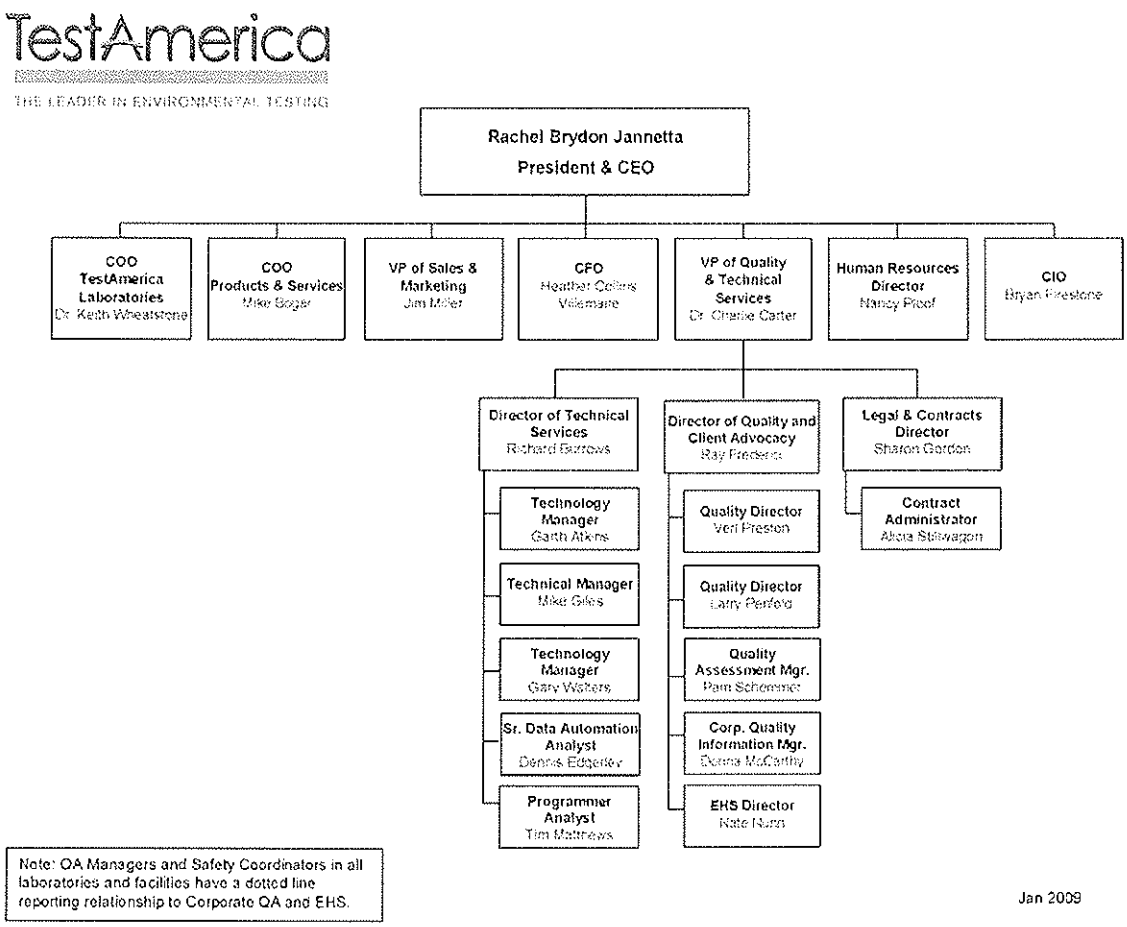
Laboratory Director
The Laboratory Director oversees the daily operations of the laboratory. The Laboratory Director's responsibilities include supervision of staff, setting goals and objectives for both the business and the employees, and achieving the financial, business, technical and quality objectives of the facility. The Laboratory Director ensures timely compliance with audits and corrective actions, and is responsible for maintaining a working environment which encourages open, constructive problem solving and continuous improvement.

QA Manager
The QA Manager is responsible for ensuring that the laboratory's quality system and QAM meet the requirements set forth in the CQMP, providing quality systems training to all new personnel, maintaining a QAM, and performing or overseeing systems, data, special, and external audits. The QA Manager performs, or supervises, the maintenance of QA records, the maintenance of certifications and accreditations, the submission of monthly QA Reports, and assists in reviewing new work as needed. The QA Manager shall have the final authority to accept or reject data, and to stop work in progress in the event that procedures or practices compromise the validity and integrity of analytical data. The QA Manager is available to any employee at the facility to resolve data quality or ethical issues. The QA Manager shall be independent of laboratory operations. The facility QA Manager has an indirect reporting relationship to the Quality Director. Each laboratory's QAM has further descriptions of roles and responsibilities at the facility level.

Technical Director
The Technical Director(s) of a laboratory has overall responsibility for a defined portion of the technical operations of the laboratory, and may or may not be the Laboratory Director. The Technical Director solves day to day technical issues, provides technical training and guidance to staff, project managers, and clients, investigates technical issues identified by QA, and directs evaluation of new methods.

Figure 4-1.

TestAmerica Organizational Chart



5.0 Quality System

5.1 Quality Assurance Policy

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.

5.2 Management Commitment to Quality Assurance and Data Integrity

TestAmerica management is committed to providing data of known and documented quality and the best service in the environmental testing industry. To ensure that the data produced and reported by TestAmerica meet the requirements of its clients and comply with the letter and spirit of municipal, state and federal regulations, TestAmerica maintains quality and data integrity systems that are clear, effective, well communicated, and supported at all levels in the company.

5.3 Objectives of the Quality System

The goal of the TestAmerica quality system is to ensure that business and technical operations are conducted with the highest standards of professionalism and ethics in the industry.

To achieve this goal, it is necessary to provide TestAmerica clients with not only scientifically sound, well-documented, and regulatory-compliant data, but also to ensure that TestAmerica provides the highest quality service available in the industry with uncompromising data integrity. A well-structured and well-communicated quality system is essential in meeting this goal. TestAmerica's quality system is designed to minimize systematic error, encourage constructive, documented problem solving, and provide a framework for continuous improvement within the organization.

This CQMP is the basis for TestAmerica's quality and data integrity system. It contains requirements and general guidelines under which all TestAmerica analytical facilities shall conduct their operations.

5.3.1 Laboratory Quality Assurance Manual (QAM)

Each TestAmerica analytical facility shall have a Quality Assurance Manual that further describes the specific QA program at the laboratory.

The Quality Assurance Manual shall address the following:

Section No.	Title
-	Cover Page
1.0	Title Page
2.0	Table of Contents
3.0	Introduction
4.0	Organization & Management (NELAC 5.4.1)
5.0	Quality Systems (NELAC 5.4.2)
6.0	Document Control (NELAC 5.4.3)
7.0	Service to the Client (NELAC 5.4.7)
8.0	Subcontracting of Tests (NELAC 5.4.5)
9.0	Purchasing Services & Supplies (NELAC 5.4.6)
10.0	Complaints (NELAC 5.4.8)
11.0	Control of Non-Conforming Work (NELAC 5.4.9)
12.0	Corrective Action (NELAC 5.4.10)
13.0	Preventive Action (NELAC 5.4.11)
14.0	Control of Records (NELAC 5.4.12)
15.0	Audits (NELAC 5.4.13)
16.0	Management Reviews (NELAC 5.4.14)
17.0	Personnel (NELAC 5.5.2)
18.0	Accommodations & Environmental Conditions (NELAC 5.5.3)
19.0	Test Methods & Method Validation (NELAC 5.5.4)
20.0	Equipment (and Calibration) (NELAC 5.5.5)
21.0	Measurement Traceability (NELAC 5.5.6)
22.0	Sampling (NELAC 5.5.7)
23.0	Handling of Samples (NELAC 5.5.8)
24.0	Assuring the Quality of Test Results (NELAC 5.5.9)
25.0	Reporting Results (NELAC 5.5.10)

5.3.2 Data Quality Objectives

The Data Quality Objectives (DQO) process is a methodology used by project planners to define the environmental question to be answered and the processes needed to ensure the generation of the type, quantity, and quality of environmental data that will be needed for the intended application. The process results in a series of qualitative and quantitative statements termed Data Quality Objectives (DQOs). DQOs are identified before project initiation, and are the basis of laboratory quality control limits in project documents, such as Quality Assurance Program Plans (QAPPs) and Sampling & Analysis Plans (SAPs). QC samples routinely used by TestAmerica are described in Section 24.

Data quality indicators often defined as DQOs include precision, accuracy, representativeness, completeness, and comparability:

Precision is the degree to which a set of observations or measurements of the same property, obtained under similar conditions, agree with each other. At the client project level, precision is

usually expressed as standard deviation, variance or range, in either absolute or relative terms. In laboratory reports, batch precision is commonly expressed in terms of relative percent difference (RPD) for replicate pairs of measurements (e.g., matrix spike / matrix spike duplicates) or relative standard deviation (RSD) for more than two replicates.

Accuracy is 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 that are due to sampling and analytical operations; a data quality indicator. Accuracy is commonly expressed by the laboratory as the percent recovery of analytical spikes. However, project teams typically consider bias and precision separately when assessing data quality.

Representativeness is the degree to which data characterizes a population being studied, such as a sampling point or an environmental decision unit. Data representativeness is primarily a function of sampling strategy (e.g., the sampling scheme must be designed to maximize representativeness). The portion of the sample used for analysis must also be representative of the entire sample delivered to the laboratory. However, due to the lack of industry-wide agreement on a more quantifiable definition, this term is going out of favor.

Completeness is defined as the percentage of measurements that are judged valid or useable. Factors negatively affecting completeness include the following: sample leakage or breakage in transit or during handling, loss of sample during laboratory analysis through accident or improper handling, improper documentation such that traceability is compromised, or sample result is rejected due to failure to conform to QC specifications. A completeness objective of greater than 90% of the data specified by the statement of work is the goal established for most projects.

Comparability is a measure of the confidence with which one data set can be compared to another. To ensure comparability, project plans typically require the use of methods approved by EPA or other standards setting bodies. Within the laboratory, analysts are required to use uniform procedures (e.g., SOPs) and a uniform set of units and calculations for analyzing and reporting environmental data.

What is most important for the laboratory is that the components of analytical variability (uncertainty) can be estimated when QC samples of the right types and at the appropriate frequency are incorporated into measurement process at the analytical laboratory. With these QC results, the laboratory's client can assess whether or not the DQOs were met. With data of known and documented quality, the laboratory data and ultimately the environmental decision made using the data can withstand scientific and legal scrutiny.

6.0 Document Control

6.1 Document Type

The following documents, at a minimum, must be controlled at each TestAmerica laboratory:

- Laboratory Quality Assurance Manual (QAM)
- Standard Operating Procedures (SOPs)
- Corporate Quality Management Plan (CQMP)
- Corporate Policies and Procedures

- Corporate Quality Policy Memorandums

6.2 Document Control Procedure

Security and control of documents are necessary to ensure that confidential information is not distributed and that all current copies of a given document are from the latest applicable revision. Unambiguous identification of a controlled document is maintained by identification of the following items in the document header: Document Number, Revision Number, Revision Date, Effective Date, and Number of Pages. Controlled documents are authorized by Management and/or the QA Department. Controlled documents are marked as such and records of their distribution are kept by the QA Department. Document control maybe achieved by either electronic or hardcopy distribution.

Controlled documents shall be available at all locations where the operational activity described in the document is performed.

6.3 Document Revision

Quality system policies and procedures will be reviewed at a minimum of every two years[1] and revised as appropriate. Changes to documents occur when a procedural change warrants a revision of the document. When an approved revision of a controlled document is ready for distribution, obsolete copies of the document shall be replaced with the current version of the document. The previous revision of the controlled document must be archived by the QA Department.

[1] Laboratory's participating in the Department of Defense (DoD) programs will update their documents every calendar year. Corporate quality documents that support the DoD programs will be reviewed annually by Corporate staff members.

6.4 Official Documents

The TestAmerica Corporate Operations staff posts Corporate Manuals, Standard Operating Procedures, Policies, Quality Policy Memorandums, Work Instructions, White Papers and Training Materials on TestAmerica's intranet site. These are collectively termed "Official Documents" and encompass the Policies and Procedures that all testing facilities are required to employ. Corporate Quality Policy Memorandums are employed to notify personnel of required changes and subsequent implementation to both administrative and technical issues. By reference, these memorandums can be attached to Official Documents but do not need to be included in these documents. A detailed description of the procedure for issuing, authorizing, controlling, distributing, and archiving Corporate Documents is found in the Corporate SOP No. CW-Q-S-001, Corporate Document Control and Archive.

7.0 Service to the Client

7.1 Contract Review

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 TestAmerica's intent to provide both standard and customized environmental testing services to

our clients. To ensure project success, technical staff shall perform a thorough review of technical and QC requirements contained in contracts. Contracts are reviewed for adequately defined requirements and TestAmerica's capability to meet those requirements.

Contract review shall include a review of the client's requirements in terms of compound lists, test methodology requested, sensitivity, accuracy, and precision requirements. The TestAmerica representative ensures that the laboratory's test methods are suitable to achieve these requirements and must ensure that the laboratory holds the appropriate certifications and approvals to perform the work. The review also includes the laboratory's capabilities in terms of turnaround time, capacity, and resources to provide the services requested, as well the laboratory's ability to provide the documentation, whether hardcopy or electronic. If the laboratory cannot provide all services but intends to subcontract such services, whether to another TestAmerica laboratory or to an outside firm, this must be documented and discussed with the client prior to contract approval (refer to Section 8, Subcontracting).

All contracts entered into by TestAmerica shall be reviewed and approved by the appropriate personnel at the facility or facilities performing the work. Any contract requirement or amendment to a contract communicated to TestAmerica verbally must be documented and confirmed with the client in writing. Any discrepancy between the client's requirements and TestAmerica's capability to meet those requirements is resolved in writing before acceptance of the contract. Contract amendments, initiated by the client and/or TestAmerica, are documented in writing for the benefit of both the client and TestA merica.

All contracts, Quality Assurance Program Plans (QAPPs), Sampling & Analysis Plans (SAPs), contract amendments, and documented communications become part of the permanent project record as defined in Section 14.

7.2 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, TestAmerica assigns a Project Manager (PM) to each client. The PM is the primary point of contact for the client. It is the PM's responsibility to ensure that project-specific technical and QC requirements are effectively communicated to the laboratory personnel before and during the project.

Each TestAmerica laboratory shall have established project planning procedures in order to ensure that communication is inclusive and effective. These include project memos, designation and meetings of project teams, and meetings between the laboratory staff and the client. TestAmerica has found it very effective to invite the client into this process. TestAmerica strongly encourages our clients to visit the laboratories and hold formal or informal sessions with employees in order to effectively communicate ongoing client needs as well as project-specific details for customized testing programs.

7.3 Client Confidentiality

Data and sample materials provided by the client or at the client's request, and the results obtained by TestAmerica, shall be held in confidence (unless such information is generally available to the public or is in the public domain or client has failed to pay TestAmerica for all services rendered or is otherwise in breach of the terms and conditions set forth in the TestAmerica and client contract) subject to any disclosure required by law or legal process.

TestAmerica's reports, and the data and information provided therein, are for the exclusive use and benefit of the client, and are not released to a third party without written consent from the client

7.4 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 develop lab and client specific surveys to assess client satisfaction.

8.0 Subcontracting

Subcontracting must be arranged with the documented consent of the client, in a timely response which shall not be unreasonably refused. 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. The originating laboratory shall obtain proof of certification from the subcontract facility, and retain this information in TestAmerica records. Where applicable, specific QC guidelines, QAPPs, and/or SAPs are transmitted to the subcontract laboratory. Samples are subcontracted under formal Chain of Custody (COC). It is not acceptable to subcontract work outside of TestAmerica without attempting to negotiate alternative requirements with the client and/or the proposed TestAmerica subcontract lab.

Non-TestAmerica subcontract laboratories may receive an on-site audit by a representative of TestAmerica's QA staff if it is deemed appropriate by the QA Manager. The audit involves a measure of compliance with the required test method, QC requirements, as well as any special client requirements. The originating laboratory may also perform a paper audit of the subcontractor, which could entail reviewing the QAM, the last two PT studies, and a copy of any recent regulatory audits with the laboratory's responses. Complete details on TestAmerica's Subcontracting Procedure are available in Corporate SOP No. CA-L-S-002.

Intra-company subcontracting within TestAmerica must be arranged with the documented consent of the client, in a timely response which shall not be unreasonably refused. The originating laboratory is responsible for communicating all technical, quality, and deliverable requirements as well as other contract needs.

Project reports from both TestAmerica and external subcontractors are discussed in Section 25.

9.0 Purchasing Services and Supplies

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, all purchases from specific vendors are approved by a member of the supervisory or management staff.

Chemical reagents, solvents, glassware, and general supplies are ordered as needed to maintain sufficient quantities on hand. Purchasing guidelines for equipment and reagents meet with the requirements of the specific method and testing procedures for which they are being purchased. Solvents and acids are pre-tested in accordance with the Corporate SOP No. CA-Q-S-001, Solvent & Acid Lot Testing & Approval.

10.0 Complaints

TestAmerica believes that an effective client complaint handling process has important business and strategic value. Listening to and documenting client's concerns captures "client knowledge" that helps to continually improve the process and outpace the competition. Implementing a client complaint handling process also provides assurance to the data user that the laboratory will stand behind its data, service obligations and products.

Client complaints shall be documented, communicated to management, and addressed promptly and thoroughly. Client complaints are documented by the employee receiving the complaint. The documentation can take the form of a corrective action report (as described in Section 12) or in a format specifically designed for that purpose.

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 is notified and may conduct a special audit to assist in resolving the issue. A written confirmation, or letter to the client, outlining the issue and response taken is strongly recommended as part of the overall action taken.

The number of client complaints shall be reported to the Quality Directors in the QA monthly report submitted by each laboratory. The overall number of complaints received per facility is tracked and the appropriateness of the response to client complaints is assessed. Monitoring and addressing the overall level and nature of client complaints and the effectiveness of the solutions is part of the Management Systems Review. Most client feedback comes either verbally or in writing to TestAmerica employees. However, TestAmerica also uses a number of additional mechanisms to obtain client feedback including a customer satisfaction survey and a response card system. Each of these is monitored for trends and opportunities for improvement.

11.0 Control of Non-Conforming Work

Each laboratory shall have a procedure to control and document non-conformances. Non-conformances broadly include any QC result outside of established control limits or actions outside of established processes. Non-conformances may relate to client specific requirements, procedural requirements, or equipment issues. All non-conformances in the laboratory are documented at the time of their occurrence.

All non-conformances that affect a sample and/or sample data become part of the affected project's permanent record. When appropriate, reanalysis is performed where QC data falls outside of specifications, or where data appears anomalous. If the reanalysis is within established tolerances, the results are approved. If the reanalysis is still outside tolerances, further reanalysis or consultation with the Supervisor, Manager, PM, Laboratory Director, or QA Manager for direction may be required. All records of reanalysis are kept with the data files.

Where non-conformances specifically affect a client's sample and/or data, the client shall be informed and action must be taken. Action can take the form of reporting and flagging the data, and including a description of the non-conformance in the project narrative or cover letter.

12.0 Corrective Action

12.1 General

Each TestAmerica laboratory shall maintain an established, documented corrective action process. Each corrective action is thoroughly investigated. The outcome of the investigation, actions taken, and follow-up is documented. The more significant the issue to be corrected, the more formal the investigation into root cause and the more detailed the documentation that is required.

12.2 Initiation

Any employee in TestAmerica shall be authorized to initiate a corrective action. The initial source of corrective action can also be external to TestAmerica (e.g., corrective action due to client complaint, regulatory audit, or proficiency test). When a problem that requires corrective action is identified, the following items are identified by the initiator on the corrective action report (or however named): the nature of the problem, the name of the initiator, and the date. If the problem relates to a specific client project, the name of the client and laboratory project number is recorded, and the PM is informed immediately.

12.3 Cause Analysis

The corrective action process must be embarked upon as a joint, problem solving, and constructive effort. Identification of systematic errors, or errors that are likely to occur repetitively due to a defect or weakness in a system, is particularly valuable in maintaining an environment of continuous improvement in laboratory operations.

When a corrective action report (or however named) is initiated, the initiator works with the affected employee(s) and/or department(s) to identify the root cause of the problem. An essential part of the corrective action process is to identify whether the problem occurred due to a systematic or isolated error.

If the initiator of the corrective action report (or however named) is uncertain as to what would constitute appropriate corrective action or is unable to resolve the situation, the problem is identified to the Supervisor, Manager, Laboratory Director or the QA Manager who provides assistance in the corrective action process. The root cause of the problem and associated cause analysis is documented.

12.4 Corrective Action

Once the root cause of a problem is identified, the initiator and affected employee(s) and/or department(s) examine potential actions that will rectify the present problem to the extent possible, and prevent recurrence of future, similar occurrences. An appropriate corrective action is then recommended. The corrective action must be appropriate for the size and nature of the issue.

If the corrective action concerns a specific project related issue, the PM or Customer Service Manager approves the corrective action before its implementation.

Implementation of the corrective action and the date of implementation are documented on the corrective action report (or however named).

If a corrective action is related to a specific project report, it is included in the project file. An essential part of the corrective action process is communication and awareness of the problem, the cause, and the action taken to prevent future occurrences and/or rectify the immediate problem.

12.5 Monitoring Corrective Action

The QA department reviews corrective action reports and selects one or more of the more significant corrective actions for inclusion in the annual systems audit. The QA Department also may implement a special audit. The purpose of inclusion of the corrective action process in both routine and special audits is to monitor the implementation of the corrective action and to determine whether the action taken has been effective in overcoming the issue identified.

13.0 Preventative Action

Each laboratory shall maintain an established, documented preventative action process. Preventative action is identifying process weaknesses which have the potential to lead to failure(s). Preventative action includes analysis of the quality system to detect, analyze, and eliminate potential causes of non-conformances. It may include trend analysis using control charts to detect chemical analysis problems before QC results exceed control limits at a high frequency. When potential problems are identified, preventative action is initiated to effectively address the problem to eliminate or reduce the risk identified.

13.1 Management of Change

A Management of Change System is a documentation system designed to manage significant events and changes that occur within the laboratory. The types of changes include, but are not limited to: facility changes, major accreditation & approval changes, addition or deletion to laboratory capabilities, key personnel changes and the addition of a new type of instrumentation. Through a documentation system (however named by the laboratories), the potential risks inherent with a new event or change are identified and evaluated. The risks are minimized or eliminated through pre-planning and the development of preventive measures.

A Management of Change System can apply to all areas except in the application of: maintenance, repairs and activities which are "repair or replacement in-kind", and other changes at the discretion of the Laboratory Director. A laboratory may expand on this process for internal changes as long as the basic framework of documentation & communication is followed.

14.0 Control of Records

14.1 Record Types & Record Retention

Table 14-1 outlines TestAmerica's standard record retention time. 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 14.2.

Table 14-1. Example of TestAmerica Record Types[1]

	Record Types [1]:	Retention Time:
Technical Records	- Raw Data - Logbooks[2] - Standards - Certificates - Analytical Records - Lab Reports	5 Years from analytical report issue*
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, Disposal Records	7 years
	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 are listed in each facility QAM.

Table 14-2. Example: Special Record Retention Requirements

Program	Retention Requirement [1]
Drinking Water – All States	10 years (project records)
Drinking Water Lead and Copper Rule	12 years (project records)
Commonwealth of MA – All environmental data 310 CMR 42.14	10 years
FIFRA – 40 CFR Part 160	Retain for life of research or marketing permit for pesticides regulated by EPA
Housing and Urban Development (HUD) Environmental Lead Testing	10 years
Alaska	10 years
Louisiana – All	10 years
Michigan Department of Environmental Quality – all environmental data	10 years
Navy Facilities Engineering Service Center (NFESC)	10 years
NY Potable Water NYCRR Part 55-2	10 years
Ohio VAP	10 years and State contacted prior to disposal
TSCA - 40 CFR Part 792	10 years after publication of final test rule or negotiated test agreement

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

14.2 Programs with Longer Retention Requirements

Some regulatory programs have longer record retention requirements than the TestAmerica standard record retention time. These are detailed in Table 14-2 with their retention requirements. In these cases, the longer retention requirement must be implemented and noted in the archive or addressed in a facility-specific records retention procedure. If special instructions exist such that client data cannot be destroyed prior to notification of the client, the record retention management system provides information as to who to contact for authorization prior to destroying the data.

14.3 Archives and Record Transfer

Archives must be indexed such that records are accessible on either a project or temporal basis. Archives are protected against fire, theft, loss, deterioration, and vermin. Electronic records are protected from deterioration caused by magnetic fields and/or electronic deterioration. Access to archives is controlled and documented. On-site and/or off-site facilities may be used.

TestAmerica ensures that all records are maintained as required by the regulatory guidelines and per the CQMP upon facility location change or ownership transfer. Upon a laboratory location change, all archives are retained by TestAmerica in accordance with the CQMP. Upon ownership transfer, record retention requirements shall be addressed in the ownership transfer agreement and the responsibility for maintaining archives is clearly established.

15.0 Audits

15.1 Internal Audits - Audit Types and Frequency

A number of types of audits shall be performed at TestAmerica. Audit type and frequency are categorized in Table 15-1.

Table 15-1. Types of Internal Audits and Frequency

Description	Performed by	Frequency
Quality Systems	QA Department or Designee	All areas of the laboratory annually
QA Technical Audits - Evaluate raw data versus final reports - Analyst integrity - Data authenticity	QA Department or Designee	All methods within a 2-year period, with at least 15% of methods every quarter
SOP Method Compliance	Technical Director	- All SOPs within a 2-year period - All new analysts or new analyst/methods within 3 months of IDOC
Special	QA Department or Designee	Surveillance or spot checks performed as needed
Performance Testing	Analysts with QA oversight	Two successful per year for each NELAC 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, the laboratory's Data Integrity and Ethics Policies, NELAC 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. The audit is divided into modules for each operating or support area of the lab, and each module is comprehensive for a given area. The area audits may be done 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, MintMiner is 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 Director at least every two years. 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 (PT)

The laboratory participates semi-annually (NELAC) or annually (Non-NELAC) 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: Drinking Water, Nonpotable Water, Soil, Air.

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

TestAmerica facilities are routinely audited by clients and external regulatory authorities. TestAmerica is available for these audits and makes every effort to provide the auditors with the personnel, documentation, and assistance required by the auditors. TestAmerica recommends that the audits be scheduled with the QA Department so that all necessary personnel are available on the day of the audit.

15.3 Audit Findings

Audit findings are documented using the corrective action process. 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 laboratory management personnel where the finding originated. Findings that are not corrected by specified due dates are reported monthly to management in the QA monthly report. 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.

16.0 Management Reviews

16.1 QA Reports to Management

A monthly QA report shall be prepared by the QA Manager or their designee and forwarded to their Laboratory Director, GM and Quality Director. The report includes statistical results that are used to assess the effectiveness of the quality system.

A Corporate QA Monthly Report containing a compilation of the Facility QA reports statistics, information on progress of the Corporate QA program, and a narrative outlining significant occurrences and/or concerns shall be compiled by the Quality Directors and forwarded to the Director of Quality & Client Advocacy who, after preparing comments, forwards the report to the COO, VP of QTS, GMs and the entire Senior Management Team.

16.1.1 Monthly QA Report and Metrics

The QA Manager's monthly QA report is due by the fifth day of the month. The report will contain a narrative summary and metrics spreadsheet. At a minimum, the report content will contain the laboratory's status for defined quality metrics and a discussion of both improvements and weaknesses in the quality system. During the course of the year, the Laboratory Director, General Manager, Director of Quality & Client Advocacy or the Quality Director may request that additional information be added to the report.

16.2 Management Systems Review

Each laboratory shall perform a management quality system review annually in accordance with the Corporate SOP No. CA-Q-S-008, Quality Systems Management Review. This will synchronize quality planning with fiscal year planning. The management quality system review will assess the adequacy of the laboratory's quality system and plan any changes in laboratory organization, policies, practices, certifications, accreditations in order to achieve operational efficiencies, meet regulatory requirements and client expectations.

17.0 Personnel

17.1 General

TestAmerica management believes that its highly qualified, ethical and professional staff is the single most important aspect in assuring the highest level of data quality and service in the industry.

TestAmerica staff consists of over two thousand professionals and support personnel that include, but not limited to, the following positions:

- General Manager
- Customer Service Manager
- Quality Assurance (QA) Manager
- Laboratory Director
- Technical Director
- Department Supervisor
- Information Technology Manager
- Human Resources Manager
- Project Manager
- Department Manager
- Analyst
- Sample Custodian
- Technician
- Quality Assurance Specialist
- Data Review Specialist
- Information Technology Specialist

17.1.1 Training

TestAmerica is committed to furthering the professional and technical development of employees at all levels. Minimum training requirements for TestAmerica employees are outlined in Table 17-1.

Table 17-1. TestAmerica Employee Minimum Training Requirements

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
Ethics – Refresher	Annually	All
Initial Demonstration of Capability (DOC)	Prior to unsupervised method performance	Technical

**From date of initial employment unless otherwise indicated.*

Technical training is accomplished within each laboratory by management to ensure method comprehension. All new personnel shall be required to demonstrate competency in performing a particular method by successfully completing an Initial Demonstration of Capability (DOC) before conducting analysis independently on client samples.

DOCs are performed by analysis of four replicate QC samples. Results of successive LCS analyses can be used to fulfill the DOC requirement. The accuracy and precision, measured as average recovery and standard deviation (using n-1 as the population), of the 4 replicate results are calculated and compared to those in the test method (where available). If the test method does not include accuracy and precision requirements, the results are compared to target criteria set by the laboratory. The laboratory sets the target criteria such that they reflect the DQOs of the specific test method or project. A DOC Certification Statement is recorded and maintained in the employee's training or personnel file. Figure 17-1 shows an example of a DOC Certification Statement.

The following evidence must be on file at the laboratory for each technical employee. Additional items may be kept on file based on the laboratory-specific QAM.

- DOC.
- The employee has read and understood the latest version of the laboratory's quality documentation.
- The employee has read and understood the latest, approved version of all test methods and/or SOPs for which the employee is responsible.
- Annual evidence of continued DOC that may include successful analysis of a blind QC sample on the specific test method, or a similar test method, or an annual DOC, or four successive & successful LCSs.
- An Ethics Agreement signed by each staff member (renewed each year).

Figure 17-1. Example Demonstration of Capability Certification Statement

Laboratory Name:_____
Laboratory Address:_____
Method:_____ Matrix:_____
Date:_____ Analyst(s):_____
Source of Analyte(s):_____

		Analytical Results					
Analyst	Conc. (Units)	Rep 1	Rep 2	Rep 3	Rep 4	Avg. % Recovery	% RSD

% RSD = Percent relative standard deviation = standard deviation divided by average % Recovery

Raw data reference: _____

Certification Statement:

We, the undersigned, certify that:
1. The cited test method has met Demonstration of Capability requirements.
2. The test method was performed by the analyst(s) identified on this certification.
3. A copy of the test method and the laboratory-specific SOPs are available for all personnel on site.
4. The data associated with the method demonstration of capability are true, accurate, complete, and self-explanatory.
5. All raw data necessary to reconstruct and validate these analyses have been retained at the facility, and the associated information is well organized and available for review.

_____ _____
Analyst Signature Date

_____ _____
Technical Director Signature Date

_____ _____
Quality Assurance Manager Signature Date

17.1.2 Ethics Policy

Establishing and maintaining a high ethical standard is an important element of a quality system. In order to ensure that all personnel understand the importance the company places on maintaining high ethical standards at all times, TestAmerica has established an *Ethics Policy*, Policy No. CA-L-P-001, and an Ethics Agreement. Each employee shall sign the Ethics Agreement, signifying agreed compliance with its stated purpose. The ethics agreement is required to be re-signed on an annual basis.

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 the Company's ability to do work on Government contracts, and for that reason, the Company has a Zero Tolerance approach to such violations.

Ethics is also a major component of TestAmerica's quality and data integrity systems. Each employee must be introduced to TestAmerica's Ethics Policy within 1 week of hire; and receive the Comprehensive Ethics training and Quality Training within 90 days of hire. Technical employees shall also receive Data Integrity Training within 30 days of hire. Annually, Ethics Refresher Training will be provided. Employees must be trained as to the legal and

environmental repercussions that result from data misrepresentation. A data integrity hotline is maintained by TestAmerica and administered by the Corporate Quality Department.

18.0 Accommodations & Environmental Conditions

Each laboratory must be secure and access must be controlled and documented. Access is controlled by various measures including locked doors, passwords, electronic access cards, security codes, and staffed reception areas. All visitors sign in and are escorted by TestAmerica personnel while at a laboratory.

TestAmerica's facilities are designed for efficient, automated high-quality operations. All laboratories are equipped with Heating, Ventilation, and Air Conditioning (HVAC) systems appropriate to the needs of environmental testing laboratories. Environmental conditions in the facilities, such as hood flow, are routinely monitored and documented.

All TestAmerica facilities are 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. TestAmerica also provides and requires the use of protective equipment including safety glasses, protective clothing, gloves, respirators, etc..

19.0 Test Methods and Method Validation

19.1 Test Methods

Most of the test methods performed at TestAmerica originate from test methods published by a regulatory agency such as the U.S. EPA and other state and federal regulatory agencies. These include, but are not limited to, the following published compendiums of test methods:

- *Prescribed Procedures for Measurement of Radioactivity in Drinking Water, EPA-600/4-80-032, August 1980.*
- *Eastern Environmental Radiation Facility Radiochemistry Procedures Manual, EPA, PB84-215581, June 1984.*
- *HASL-300 28th Edition, Environmental Measurements Laboratory (EML), 1997.*
- *Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms, Fourth Edition, EPA/600/4-90/027F, August 1993.*
- *Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms, Fifth Edition, EPA-821-R-02-012, October 2002.*
- *Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms, Fourth Edition, EPA-821-R-02-013, October 2002.*
- *Analytical Method for Determination of Asbestos Fibers in Water, EPA-600/4-83, September 1983.*
- *Determination of Asbestos Structures Over 10-mm in Length in Drinking Water, EPA-600/R-94-134, June 1994.*
- *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, US EPA, January 1996.*

- *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 March 12, 2007, 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)*
- *Technical Notes on Drinking Water Methods, EPA-600/R94-173, October 1994*
- *NIOSH Manual of Analytical Methods, 4th ed., August 1994.*
- *Statement of Work for Inorganics Analysis, ILM04.1, USEPA Contract Laboratory Program Multi-media, Multi-concentration.*
- *Statement of Work for Inorganics Analysis, ILM05.2,5.3 & 5.4 USEPA Contract Laboratory Program Multi-media, Multi-concentration*
- *Statement of Work for Organics Analysis, OLM04.1, 4.2 & 4.3 USEPA Contract Laboratory Program, Multi-media, Multi-concentration.*
- *Statement of Work for Organics Analysis, SOM01.1 & 1.2, USEPA Contract Laboratory Program, Multi-media, Multi-concentration*
- *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.*
- *National Status and Trends Program, National Oceanographic and Atmospheric Administration, Volume I-IV, 1985-1994.*
- *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*

19.2 Standard Operating Procedures

Each laboratory shall maintain a Standard Operating Procedure (SOP) Index for both Method and Process SOPs. Method SOPs are maintained to describe a specific test method. Process SOPs are maintained to describe functions and processes not related to a specific test method.

Technical SOPs may contain the following information (in any particular order):

Title Page with Document Name, Document Number, Revision Number, Effective Date, Page Numbers and Total # of Pages, Authorized Signatures, Dates and Proprietary Information Statement (Figure 19-1).

Identification of Test Method
Applicable Matrix
Reporting Limit
Scope and Application, including test analytes
Summary of the Test Method
Definitions
Interferences
Safety
Equipment and Supplies
Reagents and Standards
Sample Collection, Preservation, Shipment and Storage
Quality Control

Calibration and Standardization
Procedure
Calculations
Method Performance
Pollution Prevention
Data Assessment and Acceptance Criteria for Quality Control Measures
Corrective Actions for Out-of-Control Data
Contingencies for Handling Out-of-Control or Unacceptable Data
Waste Management
References
Tables, Diagrams, Flowcharts and Validation Data
Method Modifications
SOP Revision History

Non-Technical SOPs may contain the following information (in any particular order):

Title Page with Document Name, Document Number, Revision Number, Effective Date, Page Numbers and Total # of Pages, Authorized Signatures, Dates and Proprietary Information Statement (Figure 19-1).

Scope
Summary
Definitions
Responsibilities

Safety
Procedure
References
Tables, Diagrams and Flowcharts
SOP Revision History

The QA Department is responsible for maintenance of SOPs, archival of SOP historical revisions, maintenance of an SOP index, and records of controlled distribution. SOPs, at a minimum, must undergo periodic review as described the each facility's QAM or SOP. Where an SOP is based on a published method, the laboratory must maintain a copy of the reference method.

Figure 19-1. Proprietary Information Statement

SOP Appendix
In some cases, a standard laboratory procedure is modified slightly for a specific client or project at the client or regulatory agency's request. In these cases, an Appendix to the SOP may be attached that indicates the modifications to the SOP which are specific to that project. SOP appendices shall not be used to alter test methods required by regulation such that the modifications would result in non-compliance with the regulation. All client- or project-specific modifications must be approved by laboratory management.

19.3 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.

Determination of Method Selectivity and Interferences
If the new method is based on a published consensus method or an EPA method, then analysis of blanks and spikes as described in the source method is sufficient. If the laboratory is developing a method without a published source method, then more extensive validation is required. The laboratory must perform analysis of spikes in each sample matrix of interest. In some cases to achieve the required selectivity for an analyte, a confirmation analysis may be required

Determination of Method Sensitivity
The sensitivity of new methods is normally demonstrated using the procedure described in the Corporate SOP No. CA-Q-S-006, Detection Limits. Sensitivity can also be estimated for short-term projects using other techniques (e.g., signal-to-noise ratio of low concentration standards), but only with client agreement.

Limit of Quantitation (LOQ) and Reporting Limit (RL)
The LOQ is the minimum level at which the concentration of an analyte can be determined within limits of confidence required by the data user. The lowest calibration standard must be at

or below the LOQ. The LOQ cannot be at or below the detection limit concentration. Confirmed results between the method detection limit and the LOQ, if reported at all, must be qualified as estimated concentrations. The laboratory's routine reporting limit (RL) is equal to the LOQ, and higher reporting limits may be used to satisfy special project requirements.

Special project RLs can be lower than the lab's standard LOQ if there is a written agreement with the client that poorer precision and bias are acceptable. The client must be informed in writing (e.g., confirmation of communication, letter of agreement, QAPP or report narrative) of the likelihood of less accurate quantitation, increased probability of false positive and false negative results, potential method compliance problems, and/or potential misidentification at the lower concentration. The RL can never be below the method detection limit.

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.

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. If the laboratory is developing a method without a published source method, then more extensive validation is required. The laboratory must establish the bias and precision in each sample matrix of interest throughout the working range.

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.

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.

19.4 Permitting Departures from Documented Procedure

Each laboratory must have a procedure that defines the process, documentation, and level of authorization required to permit departures from documented procedures.

Where a departure from a documented SOP, test method, or policy is determined to be necessary, or unavoidable, the departure shall be documented and be authorized by the appropriate level of management, which is defined in the policy. In some instances, it is appropriate to inform the client before permitting a departure. Any such occurrence is documented in the cover letter and/or project narrative.

20.0 Equipment (and Calibration)

20.1 Equipment Operation

TestAmerica is committed to routinely updating and automating instrumentation. TestAmerica facilities maintain state of the art instrumentation to perform the analyses within the QC specifications of the test methods. Each laboratory shall maintain an equipment list that must include the following information:

- Date Installed or year placed in service
- Manufacturer's Name, Model Number, Serial Number
- Condition when Received

All equipment is subject to rigorous checks upon its receipt, upgrade, or modification to establish that the equipment meets with the selectivity, accuracy, and precision required by the test method for which it is to be used. All manufacturer's operations and maintenance manuals are kept up to date and accessible for the use of the equipment operator. Documentation of equipment usage is maintained using analytical run and maintenance logbooks or the electronic versions of said documents.

20.2 Equipment Maintenance

Each laboratory must employ a system of preventative maintenance in order to ensure system up time, minimize corrective maintenance costs and ensure data validity. All routine maintenance is performed as recommended by the manufacturer and may be performed by an analyst, instrument specialist or outside technician. Maintenance logbooks or electronic records are kept on all major pieces of equipment in which both routine and non-routine maintenance is recorded. Notation of the date and maintenance activity is recorded each time service procedures are performed. The return to analytical control following instrument repair is documented. Maintenance logbooks or electronic records are retained as QA records.

Maintenance contracts are held on specific pieces of equipment where outside service is efficient, cost-effective, and necessary for effective operation of the laboratory.

20.3 Equipment Verification and Calibration

All equipment shall be tested upon receipt to establish its ability to meet the QC guidelines contained in the test method for which the instrumentation is to be used. This testing shall be documented. Once an instrument is placed in routine service, ongoing instrument calibration is demonstrated at the appropriate frequency as defined in the test method. Refer to the Corporate Policy CA-T-P-002, *Selection of Calibration Points*, for guidance on using calibration data. Any instrument that is deemed to be malfunctioning is clearly marked and taken out of service. When the instrument is brought back into control, acceptable performance is documented.

20.4 Calibration

Each laboratory must define calibration protocols in their facility-specific SOPs. Refer to the Corporate SOP CA-Q-S-005, *Calibration Curves*, for guidance on the calibration curve models used at TestAmerica and the basic formulae and calculations associated with them.

20.5 Glassware Cleaning

Each laboratory must define glassware cleaning procedures in their facility SOPs.

20.6 Data Integrity and Security

This section details those procedures that are relevant to computer systems that collect, analyze, and process raw instrumental data, and those that manage and report data.

Security and Traceability
Access to computer systems that collect, analyze, and process raw instrumental data, and those that manage and report data must be both controlled and recorded. There are various systems at TestAmerica to which this applies, which include the Laboratory Information Management System (LIMS), as well as specific systems such as chromatography data systems.

Control of the system is accomplished through limitation of access to the system by users with the education, training and experience to perform the task knowledgeably and accurately. System users are granted privileges that are commensurate with their experience and responsibilities.

Computer access is tracked by using unique login names and passwords for all employees that have access to the computer system. "General" or "multi-user" account access to computer systems that collect, analyze and process raw instrumental data, and those that manage and report data shall not be permitted unless approved by laboratory management. Entries and changes are documented with the identity of the individual making the entry, and the time and date. Where a computer system is processing raw instrumental data, the instrument identification number is recorded. Many of these systems have the capability of maintaining audit trails to track entries and changes to the data. This function is activated on any computer system that has that capability.

TestAmerica requires that all sensitive computer systems, defined as LIMS servers and other servers of critical importance, be locked in a secured room. Access must be limited only to employees who need physical access to those systems. This room must also provide climate control within the parameters provided by the vendor of the secured equipment.

Verification
All commercially obtained software shall be verified prior to use and after version upgrade. Verification involves assessing whether the computer system accurately performs its intended function. Verification generally is accomplished by comparing the output of the program with the output of the raw data manually processed, or processed by the software being replaced. The records of the verification are required to contain the following information: software vendor, name of product, version, comparison of program output and manual output, raw data used to verify the program, date, and name of the individual performing the verification. Records of verification are retained as records with IT personnel.

Validation
Software validation involves documentation of specifications and coding as well as verification of results. Software validation is performed on all in-house programs. Records of validation include original specifications, identity of code, printout of code, software name, software

version, name of individual writing the code, comparison of program output with specifications, and verification records as specified above. Records of validation are retained as records with IT personnel.

Auditing
The QA Departments system audits may include review of the control, security, and tracking of IT systems and software.

Version Control
The laboratory shall maintain copies of outdated versions of software and associated manuals for all software in use at the laboratory for a period of five years from its retirement date. The associated hardware, required to operate the software, must also be retained for the same time period.

21.0 Measurement Traceability

21.1 General

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. With the exception of Class A Glassware (including glass microliter syringes that have a certificate of accuracy), 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.

An external certified service engineer services laboratory balances on an annual basis. This service is documented on each balance with a signed and dated certification sticker. Balance calibrations are checked each day of use. All mercury thermometers are calibrated annually against a traceable reference thermometer. Temperature readings of ovens, refrigerators, and incubators are checked on each day of use.

Laboratory DI and RO water systems have documented preventative maintenance schedules and the conductivity of the water is recorded on each day of use.

21.2 Reference Standards Traceability

The receipt of all reference standards must be documented. References standards are labeled with a unique Standard Identification Number and expiration date. All documentation received with the reference standard is retained as a QC record and references the Standard Identification Number.

All standards should be purchased 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 documentation of standard purity is archived, and references the Standard Identification Number.

All efforts are made to purchase standards that are ≥97.0% purity or as prescribed by the methods. If this is not possible, the purity is used in performing standards calculations.

The accuracy of calibration standards is checked by comparison with a standard from a second source. In cases where a second standard manufacturer is not available, a different lot is acceptable for use as a second source. The appropriate Quality Control (QC) criteria for specific standards are defined in laboratory SOPs. In most cases, the analysis of an Initial Calibration Verification (ICV) or LCS is used as the second source confirmation.

21.3 Reagents

Reagents are, in general, required to be analytical reagent grade unless otherwise specified in method SOPs. Reagents must be at a minimum the purity required in the test method. The date of reagent receipt and the expiration date are documented.

22.0 Sampling

22.1 Sampling Plans

Sample representativeness and integrity are the foundations upon which meaningful analytical results rely. Where documented and approved SAPs and/or QAPPs are in place, they must be made available to the laboratory before sample receipt, and approved by laboratory management before sample receipt.

23.0 Handling of Samples

23.1 General

Chain of Custody (COC) can be established either when bottles are sent to the field, or at the time of sampling. TestAmerica can provide all of the necessary coolers, reagent water, sample containers, preservatives, sample labels, custody seals, COC forms, ice, and packing materials required to properly preserve, pack, and ship samples to the laboratory.

Samples are received at the laboratory by a designated sample custodian and a unique Laboratory Project Identification Number is assigned. The following information is recorded for each sample shipment: Client/Project Name, Date and Time of Laboratory Receipt, Laboratory Project Number, and Signature or Initials of the personnel receiving the cooler and making the entries.

Upon inspection of the cooler and custody seals, the sample custodian opens and inspects the contents of the cooler, and records the cooler temperature. If the cooler arrival temperature exceeds the required or method specified temperature range; sample receipt is considered "compromised" and the procedure described in Section 23.2 is followed. All documents are immediately inspected to assure agreement between the test samples received and the COC.

Any non-conformance, irregularity, or compromised sample receipt as described in Section 23.2 must be documented 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 permanent project record.

Samples that are being tested at another TestAmerica laboratory or by an external subcontractor shall be appropriately packaged and sent out under COC.

Following sample labeling as described in Section 23.3, the sample is placed in storage. Sample storage is required to be access-controlled. All samples are stored according to the requirements outlined in the test method and in a manner such that they are not subject to cross contamination or contamination from their environment. Unless specified by method or state regulation, a tolerance range of 0-6°C is used. Sample storage temperatures are monitored daily.

23.2 Sample Acceptance Policy

Each laboratory shall maintain a sample acceptance policy that describes compromised sample receipt. Samples shall be considered "compromised" if the following conditions are observed upon sample receipt:

- Cooler and/or samples are received outside of temperature specification.
- Samples are received broken or leaking.
- Samples are received beyond holding time.
- Samples are received without appropriate preservative.
- Samples are received in inappropriate containers.
- COC does not match samples received.
- COC is not properly completed or not received.
- Breakage of any Custody Seal.
- Apparent tampering with cooler and/or samples.
- Headspace in volatiles samples.
- Seepage of extraneous water or materials into samples.
- Inadequate sample volume.
- Illegible, impermanent, or non-unique sample labeling.

When "compromised" samples are received, it must be documented by the laboratory and the client must be contacted for instructions. If the client decides to proceed with the analysis, the project report shall clearly indicate any of the above conditions and the resolution.

23.3 Sample Identification and Traceability

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 sample identification label.

All unused portions of samples are returned to the secure sample control area. Where required by the project, empty sample containers are also retained.

23.4 Sub-sampling

Sub-sampling procedures must be referenced in each facility's QAM and documented in their SOPs.

23.5 Sample Preparation

Sample preparation procedures must be referenced in each facility's QAM and documented in their SOPs.

23.6 Sample Disposal

Each facility shall have an SOP describing sample retention and disposal procedures. Samples should be retained in TestAmerica storage facilities 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. Samples may be returned to the client per written request. 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.

Samples shall be disposed of in accordance with federal, state and local regulations. Each facility must have an SOP detailing the disposal of samples, digestates, and extracts. All laboratories shall remove or deface sample labels prior to disposal unless this is accomplished through the disposal method (e.g., samples are incinerated).

24.0 Assuring the Quality of Test Results

24.1 Control Samples

Control samples are analyzed with each batch of samples to monitor laboratory performance in terms of accuracy, precision, sensitivity, selectivity, and interferences. Each regulatory program and each method within those programs specify the control samples that are prepared and/or analyzed with a specific batch. Control samples must be uniquely identified and correlated to unique batches. There are also a number of QC sample types that monitor field sampling accuracy, precision, representativeness, interferences, and the effect of the matrix on the method performed. Control sample types and typical frequency of their application are outlined in Table 24-1. Note that frequency and use of control samples vary with specific regulatory, methodology and project specific criteria. Table 24-1 does not define TestAmerica's approach to the application of QC samples for each regulatory program or test method.

Table 24-1. Example of Control Samples

Laboratory QC Sample Type	Use	Required Frequency
Laboratory Control Sample (LCS) (Laboratory Fortified Blank)	Measures accuracy of the method in a blank matrix	Generally 1 for each batch of samples; not to exceed 20 environmental samples.
Method Blank (MB)	Measures method contribution to any source of contamination	Generally it is 1 for each batch of samples; not to exceed 20 environmental samples.
Instrument Blank	Measures instrumental contribution to any source of contamination	As specified in test method
Reference Toxicant	Measure sensitivity of test organisms (Aquatic toxicology)	Annually
Field QC Sample Type	**Use**	**Typical Frequency**
Matrix Duplicate	Measures the effect of the site matrix on the precision of the method	Per 20 samples per matrix or per SAP/QAPP[1]
Matrix Spike	Measures the effect of the site matrix on the accuracy of the method	Per 20 samples per matrix or per SAP/QAPP
Matrix Spike Duplicate	Measures the effect of the site matrix on the precision of method	Per 20 samples per matrix or per SAP/QAPP[1]
Equipment Blank (Equipment Rinsate)	Measures field equipment contribution to any source of contamination	Per SAP/QAPP
Trip Blank	Measures shipping contribution to any source of contamination (Volatiles only)	Per Cooler
Field Blank	Measures the field environment contribution to any source of contamination	Per SAP/QAPP
Field Duplicate	Measures representativeness of the sampling and the effect of the site matrix on precision	Per SAP/QAPP

[1] Either an MSD or an MD is required per 20 samples per matrix or per SAP/QAPP.

24.2 Review / Verification Procedures

The data review process at the laboratory starts at the Sample Control level. Sample Control personnel review COC forms and input the sample information and required analyses into a computer LIMS. A secondary review of the transaction of the chain-of-custody forms and the inputted information is also performed by sample control personnel. The PMs perform final review of the COC forms and inputted information.

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 EPA 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, continuing calibration results, laboratory control samples, sample data, qualifiers and spike information are evaluated. Approximately 15% of all sample data from manual methods and from automated methods, all GC/MS spectra and all manual integrations are reviewed. 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

Unacceptable analytical results may require reanalysis of the samples. Any problems are brought to the attention of the Laboratory Director, PM, QA Manager, Technical Manager, or Supervisor for further investigation. Corrective action is initiated whenever necessary.

Any project that requires a data package is subject to a tertiary data review for transcription errors and acceptable quality control requirements.

All data, regardless of regulatory program or level of reporting, shall be subject to a thorough review which involves a primary, secondary, and completeness review process. All levels of the review must be documented.

Any anomalous results and/or non-conformances noted during the Primary Review are documented on a data review checklist (defined by each facility) communicated to the Supervisor and the PM for resolution. Resolution can require sample reanalysis, or it may require that data be reported with a qualification. Non-conformances are documented per Section 12.

24.2.1 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 must train all analytical staff on proper manual integration techniques using TestAmerica's Corporate SOP (CA-Q-S-002) as the guideline.

24.3 Development of QC Criteria, Non-Specified in Method/Regulation

Where a method or regulation does not specify acceptance and/or rejection criteria, the laboratory must develop a policy for doing so. The policy must address how the laboratory examines the data user's needs and the demonstrated sensitivity, accuracy and precision of the available test methods in determining appropriate QC criteria.

Data users often need the laboratory's best possible sensitivity, accuracy, and precision using a routinely offered test method, or are unsure of their objectives for the data. For routine test methods that are offered as part of TestAmerica's standard services, the laboratory bases the QC criteria on statistical information such as determination of sensitivity, historical accuracy and precision data, and method verification data. The method SOP includes QC criteria for ongoing demonstration that the established criteria are met (e.g., acceptable LCS accuracy ranges, precision requirements, method blank requirements, initial and continuing calibration criteria, etc.).

In some cases, a routine test method may be far more stringent than a specific data user's needs for a project. The laboratory may either use the routinely offered test method, or may opt to develop an alternate test method based on the data user's objectives for sensitivity, accuracy, and precision. In this case, it can be appropriate to base the QC criteria on the data user's objectives, and demonstrate through method verification and ongoing QC samples that these objectives are met.

For example, a client may require that the laboratory test for a single analyte with specific DQOs for sensitivity, accuracy, and precision as follows: Reporting Limit of 10 ppm, accuracy $\pm$25%, and RSD of less than 30%. The laboratory may opt to develop a method that meets these criteria and document the results of the Method Blanks, MDL study, and LCSs that the method satisfies those objectives. In this case, both the method and the embedded QC criteria have been based on the client's DQOs.

In some cases, the data user needs more stringent sensitivity, accuracy, and/or precision than the laboratory can provide using a routine test method. In this case, it is appropriate that the laboratory provide documentation of the sensitivity, accuracy, and precision obtainable to the data user and let the data user determine whether to use the best available method offered by the laboratory, or determine whether method development or further research is required.

25.0 Reporting Results

25.1 Project Reports

All TestAmerica Project Reports that are generated under NELAC requirements must contain the content as described below. This criteria applies to all Project Reports.

25.2 Project Report Content

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. At a minimum, the standard laboratory report shall contain the following information:

- A report title (e.g. Analytical Report for Samples) with a "sample results" column header.
- Each report cover page printed on company letterhead, which includes the laboratory name, address and telephone number.
- A unique identification of the report (e.g., work order 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.
- A copy of the chain of custody (COC).
- The name and address of client and a project name/number, if applicable.
- Client project manager or other contact
- Description and unambiguous identification of the tested sample(s) including the client identification code.
- 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.
- Date reported or date of revision, if applicable.
- Method of analysis including method code (EPA, Standard Methods, etc).
- Practical quantitation limits or reporting limit.
- Method detection limits (if requested)
- Definition of Data qualifiers and reporting acronyms (e.g., ND).
- Sample results.
- QC data consisting of method blank, surrogate, LCS, and MS/MSD recoveries and control limits (if requested)
- Condition of samples at receipt including temperature. This may be accomplished in a narrative or by attaching sample login sheets.
- A statement expressing the validity of the results, that the source methodology was followed and all results were reviewed for error.
- A statement to the effect that the results relate only to the items tested and the sample as received by the laboratory.
- A statement that the report shall not be reproduced except in full, without prior express written approval by the Laboratory Director or PM.
- 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 Laboratory Director.
- When NELAC accreditation is required, the lab shall certify that the test results meet all requirements of NELAC or provide reasons and/or justification if they do not.
- The laboratory includes a cover letter.
- 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.
- When soil samples are analyzed, a specific identification as to whether soils are reported on a "wet weight" or "dry weight" basis.
- Appropriate laboratory certification number for the state of origin of the sample, if applicable.

- 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 how your lab identifies it). A complete report must be sent once all of the work has been completed.
- 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.

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 Electronic Data Deliverables

Electronic Data Deliverables (EDD) are routinely offered as part of TestAmerica's services. TestAmerica offers a variety of EDD formats including Environmental Restoration Information Management System (ERPIMS), New Agency Standard (NAS), SEDD, Format A, Excel, Dbase, GISKEY, and Text Files.

EDD specifications are submitted to the IT department by the PM for review and undergo the contract review process outlined in Section 7. Once the facility has committed to providing diskettes in a specific format, the coding of the format may need to be performed. This coding is documented and validated. The validation of the code is retained as a QC record.

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 Project Report Format

TestAmerica offers a wide range of project reporting formats, including EDDs, short report formats, and complete data deliverable packages modeled on the Contract Laboratory Protocol (CLP) guidelines. More information on the range of project reports available can be obtained by contacting any TestAmerica laboratory. Regardless of the level of reporting, all projects must undergo the levels of review as described in Section 24.2.

Appendix 1. List of TestAmerica Corporate Policies & SOPs

Document No.	Title
CA-Q-S-005	Calibration Curves (General)
CW-Q-S-001	Corporate Document Control and Archives
CA-Q-S-006	Detection Limits
CA-I-P-002	Electronic Reporting and Signature Policy
CA-L-P-001	Ethics Policy
CA-Q-S-002	Manual Integrations
CA-Q-S-008	Quality Systems Management Review
CA-T-P-002	Selection of Calibration Points
CA-Q-S-001	Solvent & Acid Lot Testing & Approval
CA-L-S-002	Subcontracting Procedures

NY Laboratory ID #11830

Laboratory Quality Manual

Russell J. Pellegrino, Jr.
(315) 431-9730

Approved : _____
Laboratory Director Name

Approved : _____
Quality Assurance Officer Name

Distribution List:

Russell Pellegrino, Laboratory Director
Russell J. Pellegrino, Jr., Laboratory Manager
Michael S. Palmer, QA Deputy Officer

Organics Office

Revision Record

Revision Number	Date	Person Responsible	Description of Change
1	9/28/03	MA Winslow	Initial Release
1A	11/25/03	MA Winslow	Director/Manager Change
2	5/5/2004	MA Winslow	Director/Manager Change/NYDOH ID#
3	3/17/06	M. Palmer	QC Officer/Annual /Audit Updates
4	4/22/09	M. Palmer	QC Deputy Officer/Annual /Audit Updates

The following laboratory staff members have read this manual.
A copy of this page will be distributed to the employee training record file.

Name	Title	Date

Table of Contents

1. Quality Policy

It is the laboratory's objective to provide technically valid laboratory test results that accurately and precisely represent the quality of a client's sample being analyzed. The laboratory management is committed to comply with ISO 17025,NELAP and AIHA's International Standard and to continually improve the effectiveness of the management system. Top management shall provide evidence of commitment to the development and implementation of the management system and continually improving its effectiveness. The Laboratory Quality Manual shall be updated whenever necessary and shall be reviewed and approved by management at least annually. All Documents issued to personnel in the laboratory as part of the management system shall be reviewed and approved use by authorized personnel prior to issue. A master list or an equivalent document control procedure identifying the current revision status and the distribution of documents in the management system shall be established and be readily available to preclude the use of invalid and/or obsolete documents. The procedure(s) adopted shall ensure that: documents are periodically reviewed and, where necessary, revised to ensure continuing suitability and compliance with applicable requirements. Management system documents generated by the laboratory shall be uniquely identified. Such identification shall include the date of issue and/or revision identification, page numbering, the total number of pages or a mark to signify the end of the document and the issuing authority(ies). Centek will always strive to perform laboratory work that is in conformance to the NELAC, ISO/IEC 17025 AND AIHA LABORATORY QUALITY ASSURANCE PRGRAM POLICY DOCUMENT standards, resulting in the overall improvement of the laboratory's quality over time. Demonstration of the laboratory's commitment to reach its goal will result in the following:

- Adequately staffed and equipped facility
- Successful participation when available in the proficiency testing programs operated by the New York State Environmental Laboratory Approval Program, AIAH, the National Institute for Occupational Safety and Health and the US Environmental Protection Agency.
- Successful implementation of a NELAC, ISO/IEC 17025 AND AIHA LABORATORY QUALITY ASSURANCE PRGRAM POLICY DOCUMENT compliant quality system
- Annual internal audits (using both the NELAC and AIHA Checklists – 2 individual audits) with management review and yearly review for updating and maintenance of the/this Laboratory Quality Manual and all SOPs
- Successful biennial assessments by the New York State Environmental Laboratory Approval Program
- Timely reporting of laboratory test results to the regulating authorities
- Laboratory test results that are supported by quality control data and documented laboratory testing procedures

A copy of the quality policy is given to employees during the training of new hires. It is understood, implemented and maintained by employees at all levels. This is documented by management through the employee evaluation process, the training procedure, the internal audit process and the document control process.

2. Accredited Test Methods

Test	Method	Reference
Volatile Organic Compounds by GC/MS:		
EPA Method TO-14A	TO-14A	1
Volatile Organic Compounds by GC/MS:		
EPA Method TO-15	TO-15	1

References:

1) "Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air," USEPA, Center for Environmental Research Information, Office of Research and Development, Cincinnati, EPA 625/R-96/010B, revised January 1999.

3. Organization Chart

4. Relationship Between Management, Technical Operations, Support Services and the Quality System

A. The lab director has the overall responsibility for the technical operation of the lab. The lab director is also responsible for arranging and overseeing all support services including instrument service contracts, subcontracting sample analysis and physical maintenance of the laboratory.

B. The lab manager is responsible for providing supervision to all laboratory personnel to ensure adherence to documented laboratory procedures. When the director is not present in the lab, one operator from each area is appointed that is familiar with the calibration and test procedures, the objective of the calibration or test and the assessment of test results. The lab manager reports directly to the lab director.

C. The lab manager shall certify that personnel with the appropriate educational and/or technical background perform all tests for which the lab is accredited. Documentation includes college transcripts, past work experience, and on-site and off-site training certificates.

D. The quality assurance officer shall ensure that the lab's policies and objectives for quality of testing services are documented in the Quality Manual. The QA officer shall also ensure that the Quality Manual is communicated to, understood and implemented by all personnel concerned. Documentation includes signed statements in each analyst's training file.

E. The quality assurance officer is responsible for the quality system and its implementation. The QA officer has direct access to the highest level of management at which decisions are taken on lab policy and/or resources, and to the lab director. When the QA officer is not present, a deputy shall be appointed.

5. Job Descriptions of Staff

Laboratory Director – The technical director has overall responsibility for the technica operation of the lab. The technical director is also responsible for arranging and overseeing all support services including instrument service contracts, subcontracting sample analyses, and physical maintenance of the laboratory. The technical director also interacts with departmental, interdepartmental and appointed/elected officials to participate in coordination of lab participation in departmental/ interdepartmental projects. The technical director reports directly to the department head.

The technical director is responsible for providing supervision to all laboratory personnel to ensure adherence to lab documented procedures. When the technical director is not present in the lab, an employee who is familiar with test procedures,

the objective of the testing and the assessment of results will be appointed by the technical director to supervise.

The technical director shall certify that personnel with appropriate educational and/or technical background perform all tests for which the lab is accredited.

5. Job Descriptions of Staff (continued)

Laboratory Manager – Responsible for providing supervision to all laboratory personnel to ensure adherence to documented policies and procedures. The lab manager is also in charge of hiring laboratory technicians and certifying that all personnel performing accredited tests have the appropriate educational and/or technical background.

Quality Assurance Officer – The quality assurance officer has responsibility for the quality system and its implementation. This includes, but is not limited to, the writing and revising of Standard Operating Procedures (SOPs), semi-annual internal audits, annual quality review meeting with management and preparation of laboratory control charts. The QA officer has direct access to the highest level of management at which decisions are taken on lab policy and/or resources, and to the technical director. (For a small lab, the QA officer may also be the technical director.) When the QA officer is not present, a deputy shall be appointed.

Environmental Project Coordinator (EPC) – Responsible for acting as a liaison between laboratory and clients. Duties include, but are not limited to, organizing sampling schedules and sample pick-up, writing work orders, writing price quotations, using data request forms to retrieve test results from the laboratory and verifying test results.

Administrative Project Coordinator (APC) – Responsible for compiling result data into final reports for clients, invoicing for projects completed, first draft reviews and secretarial work.

Laboratory Technician – Responsible for performing day to day tests on samples in accordance with the laboratory's quality system and method SOPs.

Sample Custodian – Responsible for properly accepting samples, assigning each sample a unique CLL sample number, storing samples in a secure area under conditions that ensure regulatory compliance, logging samples into database according to the chain of custody, and disposing of samples in an environmentally sound manner.

5. A Deputy List

In the absence of key personnel, the following substitutions will occur:

Laboratory Director –Russell J. Pellegrino, Jr. (Laboratory Manager)
Laboratory Manager – Russell J. Pellegrino, Jr.
Deputy replacement (Laboratory) – Leo S. Lucisano
Deputy replacement (Administrative) – Nick Scala
Deputy replacement (Marketing) – Michael Palmer

Quality Systems Manager – Michael Palmer
Environmental Project Coordinator Manager – Michael Palmer
Deputy replacement (s) – Russell J. Pellegrino, Jr. (EPCs)
Sample Custody Manager – Russell J. Pellegrino, Jr.
Deputy replacement – Michael Palmer (Quality Systems Manager)
Administrative Office Manager – Michael Palmer
Deputy replacement – Janice Scala (Owner)
Director of Operations – Nick Scala
Deputy replacement – Russell J. Pellegrino, Jr.
Maintenance Engineer – Floyd Mulholland
Deputy replacement – Assistant

6. Document Control

All operating procedures, manuals (including this quality manual), and documents are subject to document control. Distribution of controlled documents is limited to those indicated on the document distribution list. Controlled documents are indicated by the paper color located in the footer of each page. Uncontrolled copies are indicated by reproduction on any other type paper. The Quality Assurance Officer controls the supply of paper used to produce controlled copies.

The purpose of the document control system is to ensure that only the most recent revisions are available to the appropriate personnel, revisions are made on a timely basis, and revisions receive the required approvals. All internal regulatory documentation, standard operating procedures, work instructions, service manuals and product instructions are under document control. The QA Officer is responsible for the document control system and keeps a master list of the current revision and location of all controlled documents in the laboratory. The Laboratory Director and the Quality Assurance Officer approve all newly released documents and revised documents. Any employee can request to change a document or policy. Where necessary, the Quality Assurance Officer may store retained obsolete documents, which may be kept for legal reasons or knowledge preservation. Each page of documents produced by the laboratory will contain the effective date, revision number, document number and document title. Controlled documents will have an approval signature page, a revision history page and a distribution page.

7. Traceability of Measurements

Verification and/or validation of equipment, such as balances, thermometers and spectrophotometers, shall be performed with the National Institute of Standards and Technology (NIST) traceable standards. Calibration certificates must indicate NIST Traceability along with measured results and the associated uncertainty. Reference standards, such as Class S weights and NIST traceable thermometers are used for calibration only and are calibrated by a company that can provide traceability to NIST.

8. Review of All New Work

All new work is initiated by the Laboratory Director, who delegates responsibilities for the new work to his supporting staff members. Affected staff meets prior to initiation of new work in order to determine if the appropriate facilities, manpower and time for analysis are available. The plan for any new projects shall be reviewed and approved by the Laboratory Director before starting such work. For any new testing method, the designated employee shall write a standard operating procedure and demonstrate capability to perform those tests prior to reporting results. The SOP(s) shall be under document control and a Demonstration of Capability Statement(s) must be on file.

9. Calibration/Verification of Test Procedures

A. Calibration and/or verification procedures are designed to ensure that the data will be of known quality and be appropriate for a given regulation or decision. Details of instrument calibration and/or test verification procedures including calibration range, standardizations, calculations and acceptance criteria are included or referenced in each test method SOP.
B. Sufficient raw data are retained to reconstruct the calibration used to calculate the sample results.
C. All calibrations are verified with a second source standard which is traceable to a national standard, when available.
D. Calibration standards include a concentration at or below the regulatory/decision level but above the laboratory's detection limit.
E. Results of samples must be within the calibration range (bracketed by standards) or the results must be flagged as having less certainty.
F. No data associated with a calibration that is out-of-control will be reported.
G. Method Detection Limits (MDL) – The MDL has been determined by the laboratory and documented for each analyte where spiking solutions are available. MDL can be determined by the procedure presented in 40 CFR Part 136, Appendix B. All sample processing steps of the analytical methods are included in the determination of the MDL. The standard deviation of the analysis of seven portions of spiked ultra high purity Nitrogen is calculated. The spiked Nitrogen is at an estimated concentration between the actual MDL and 5 times the actual MDL. The MDL is the product of 3.14 times the calculated standard deviation. The MDL should be about one fifth of the practical and routinely achievable

detection level that can be reported with relatively good certainty that any reported value is reliable.

10. Sample Handling

A. Sample Acceptance Policy – The sample custodian is responsible for the receipt of all samples collected by the outer offices, field technicians and the clients themselves. All samples are checked to see that they arrive accompanied by a complete chain of custody form, are received intact and are sampled in the correct container with the proper volume for the parameter(s) requested. A sample receipt checklist is completed for all projects, and any problems with the samples is documented and brought to the attention of the Environmental Project Coordinator (EPC). The EPC then contacts the client to determine if the samples need to be re-collected or if the laboratory should continue with the analysis. Each sample container is uniquely identified with a durable label. The sample collection policy is available to all sample collectors.

Obtaining sample aliquots from a submitted sample as part of the test methods is carried out using procedures as written in each method SOP. Appropriate techniques to obtain representative subsamples are employed and documented in the method SOP.

The samples must be submitted to the laboratory with records of field ID, location, date and time of collection, collector's name, preservation, sample type and remarks. Complete handling instructions are furnished to the sample collectors.

Summary of Sampling and Handling Requirements

Analyte	Container	Preservation	Max. Holding Time
ENVIRONMENTAL ANALYSES/AIR REQUIREMENTS:			
Organic Tests:			
Polar and Non Polar Organics	Summa - Mini Can	None	14 days
Polar and Non Polar Organics	Tedlar Bag	None	72 hours until transfer,14 days from sample collection

B. Sample Receipt Protocol – Upon receipt, the condition of the samples, including all items specified in the sample acceptance policy, are checked and recorded.

Sample records are linked to the sample ID and include all required information specified by the sample acceptance policy. Samples are stored according to conditions specified in each test SOP. The laboratory has documented procedures and appropriate facilities to avoid deterioration, contamination, or damage to samples during storage, handling, preparation and testing. Storage conditions are maintained, monitored, and recorded.

C. Procedures for handling submitted samples –

1. Obtaining sample aliquots from a submitted sample as part of the test method is carried out using procedures as written in each method SOP. Appropriate techniques to obtain representative subsamples are employed.
2. Each sample container is uniquely identified using a durable label. For this laboratory, the month of the year, the last two digits of the year, and the sample ID number (also written on the Chain of Custody) is used to identify all samples submitted. For example, a sample that was received on December 1, 2003, and was the 65th sample numbered for that day would have the sample ID of C0312065-XXX.
3. The sample acceptance policy is documented and available to the sample collectors. If any samples do not meet any of the requirements of the acceptance policy, the data is flagged in a clear manner, which defines the nature of the problem.
4. The sample receipt protocol is documented. The condition of the sample, including any abnormalities or departures from standard condition as described in the relevant test method is recorded.
5. Receipt of all samples is recorded on the accompanying Chain of Custody form. This form contains the project name, date and time of collection and laboratory receipt, client ID, laboratory ID, and sample custodians' signatures.
6. Sample records, which are also available and linked to the sample ID, include all required information specified by the sample acceptance policy. These records are kept in the project draft folder with the Chain of Custody.
7. Samples are stored according to conditions specified in each test SOP. The laboratory has documented procedures and appropriate facilities to avoid deterioration, contamination or damage to samples during storage, handling, preparation and testing. Storage conditions are maintained, monitored and recorded where necessary. Sample canisters are recycled/cleaned after use and are not stored for possible subsequent reanalysis.

11. Laboratory Environment

A. Calibration and testing occur only within the laboratory, designed, built and maintained as laboratory space. The laboratory space is maintained

by the operations staff to the specifications required for laboratory space. Neighboring test areas of incompatible activities are effectively separated. Specific work areas are defined and access to these areas is controlled. (Only authorized laboratory personnel and escorted signed-in visitors may enter the work area.) Smoking is prohibited throughout the entire building. Work areas include: entries to the laboratory, sample custody area, sample storage area, laboratory analysis area, chemical and waste storage area, data handling and storage area.

B. All equipment and reference materials required for the accredited tests are available in the laboratory. Records are maintained for all equipment, reference measurement materials, and services used by the laboratory.
C. Reference materials traceable to national standards of measurement or to national standard reference materials are stored away from heavy use areas or major equipment that may effect the proper operation of the materials. Certificates of Traceability are available for the reference thermometer and the Class S weights. The reference materials are used only for calibration to maintain the validity of performance.

12. Procedures for Calibration, Verification and Maintenance of Equipment

A. Equipment is maintained, inspected and cleaned according to the written Equipment Maintenance Procedures. Any defective item of equipment is clearly marked and taken out of service until it has been shown to perform satisfactorily.
B. Each item of equipment or reference material is labeled to show its calibration status.
C. Equipment and reference material records include:
    1. Name of item of equipment or reference material
    2. Manufacturer, identification, serial number
    3. Date received and placed in service
    4. Current location
    5. Condition when received
    6. Copy of manufacturer's instructions or manuals
    7. Dates and results of calibrations/verifications and date of next calibration/verification
    8. Details of maintenance carried out to date and planned for the future
    9. History of any damage, malfunction, modification or repair
D. Service of equipment is performed by qualified service organizations. All records and certificates from service calls are retained.
E. Support equipment is calibrated/verified annually using NIST traceable references over the range of use. Balances, ovens, refrigerators, freezers, incubators, and water baths are checked with NIST traceable references (where possible) daily and recorded. Mechanical volumetric dispensing devices are checked for accuracy quarterly and recorded.

13. Use of Reference Materials and Proficiency Testing Participation

A. The laboratory purchases external reference samples. All reference samples are certified. The laboratory retains the manufacturer's Certificate of Analysis.
B. The laboratory when a source is available will participate in a 3rd party proficiency testing or in a round robin program to demonstrate competency. In the meantime the laboratory will implement an internal QC program. The lab shall prepare and collect data from quality control samples or the laboratory control sample (LCS) . The data points will be charted to determine upper and lower control limits at two standard deviations, 2*sd.* A minimum of twenty data points shall be required.

14. Internal Quality Control Procedures

The data acquired from quality control (QC) procedures are used to estimate the quality of analytical data, to determine the need for corrective action, and to interpret results after corrective actions are implemented. QC procedures and QC limits are clearly defined in each method SOP. QC limits are generated when no method limits exist. The QC limits for laboratory control samples (LCS) and matrix spikes (MS) are based on the historical mean recovery plus or minus three standard deviation units. Duplicate limits for precision range from zero to 3.27 times the mean of the historical differences or relative percent differences.

All quality control measures are assessed and evaluated on a continuous basis. The laboratory presents summaries of LCS and MS recoveries on control charts to monitor laboratory quality and map trends in results.

Method blanks are performed at a frequency of one per batch of twenty or fewer samples. The results are used to determine batch acceptance. When blanks exceed the method criteria, steps are taken to determine the source of contamination, and measures are made to minimize or eliminate the problem.

Laboratory control samples (LCS) are performed at a frequency of one per batch of twenty samples or less. The results are used to determine batch acceptance.

Matrix spikes are performed whenever they are requested by the client. The results are used to identify matrix interferences in the spike sample. Matrix interference is indicated when the LCS data is within limits, but the matrix spike data exceed QC criteria.

Laboratory duplicates and matrix spike duplicates (MSD) are performed at a frequency of one per twenty samples or less. MSDs are run for organic parameters. Both are a measure of precision. If a duplicate result falls outside QC limits, the original sample and the duplicate sample is regarded as unreliable.

RPD Replicate Precision: The measure of Replicate Precision used for this program is the absolute value of the difference between replicate measurements of the sample, divided by the average value expressed as a %, as follows: Replicate Precision = $\frac{X_1 - X_2}{\bar{X}} \times 100$.

15. Testing Discrepancies

Specific corrective action procedures for handling QC limit exceedances are detailed in each method SOP. In addition, general procedures are followed to determine when departures from quality control have occurred. Protocol for documentation of such deviations is determined by the Corrective Action Procedure. Due to sample scheduling times and sample holding times, it is not always possible to repeat the analysis if all quality control measures are not found to be acceptable. Therefore, when data must be reported, the laboratory uses data qualifiers (in the form of flags on the final report) to notify clients when their samples are associated with outlying QC measures.

16. Preventative/Corrective Action Procedure

Preventative/Corrective action is the process of identifying, recommending, approving and implementing measures to counter unacceptable departures from policies and procedures or out of control QC performance prior to and after an issue which can affect data quality.

Each method SOP details QC acceptance criteria and specific protocols for corrective actions. Any QC measure that falls outside of acceptable limits needs a corrective action. This corrective action may be performed by the laboratory technician (as defined in the method SOP), and/or by the QA Officer. All discrepancies will be identified and the associated sample data will be flagged. The QA Officer will conduct an investigation into the cause of the discrepancy, and will help to implement the corrective action. Each corrective action will be documented in a log, and each log entry must be reviewed, signed and dated by the QA Officer. Corrective actions should be performed prior to the reporting of the effected data. However, in cases where the discrepancy is discovered after the results are released, an amended report may be sent to the client with the reanalysis results (if applicable).

17. Permitted Departures from Standard Specifications or Documented Policies and Procedures

The laboratory manager has responsibility for ensuring the lab's policies and procedures are adhered to. Arrangements for known and controlled departures from documented policies and procedures are allowed. Planned departures do not require audits, however, the departure must be fully

documented and include the reason for the departure, the effected SOP(s), the intended results of the departure and the actual results. If the data reported to the client is effected adversely, it will be notified in writing. The procedures used to document any specific departure are the same as the corrective action procedure.

18. Complaints

All complaints about the laboratory's activities received from clients or other parties will be documented in a complaint file (contained in the Corrective Action Log) maintained by the laboratory. The file will contain the date and person filing the complaint, a description of the complaint, source of the complaint, the resolution, and any written material accompanying the complaint.

The QA Officer is responsible for investigating all complaints by conducting an internal audit. All areas of the laboratory that are associated with the complaint are checked, and the written results of the investigation, including actions taken by the laboratory, are reviewed by the Laboratory Director and Laboratory Manager. The results of the investigation are signed and dated by the QA Officer.

19. Internal Audit and Data Review

A. Data Review – All data, including original observations, calculations, derived data, calibration records, QC records and a copy of the test report are kept for five years (ten years for drinking water) to allow historical reconstruction of the final result. All original observations and calculations are reviewed by the second analyst, Environmental Project Coordinator or QA Officer before the data are reported. The data is reviewed to ensure that all calculations are correct and to detect transcription errors. The second analyst (laboratory section supervisor or laboratory manager) must sign and date all reviewed data packages. The QA Officer evaluates the sample results and QC data for approximately 15 to 20% of the results that are reported due the large volume of samples this laboratory handles. Errors detected in the review process are referred to the analyst for corrective action. The QA Officer documents all corrective actions taken.

B. Internal Quality System Audits – The QA Officer will conduct semi-annual internal audits on the laboratory's quality system. The QA Officer, who is independent of the activities being audited, will carry out these audits. The QA Officer will use the requirements of the ELAP manual as a guideline to evaluate the laboratory procedures and SOPs. All audit results will be documented, along with any corrective actions. The Laboratory Manager will ensure that all corrective actions are implemented immediately.

C. Managerial Review – The Laboratory Director and Laboratory Manager shall review the laboratory quality system and its testing and calibration activities annually to introduce any changes or improvements. The review will incorporate outcomes of recent internal audits, assessments by external bodies (NYSDOH, USEPA, NYSDEC), the results of proficiency tests, any changes in the volume or type of work performed, client feedback, corrective actions, suitability of policies and procedures, reports from managerial and supervisory personnel, outcome of the recent internal audits and assessments by external bodies, and Other relevant factors, such as quality control activities, resources and staff training.

20.0 Training and Review of Personnel Qualifications

Laboratory management reviews an applicant's level of qualification, experience and skills against the laboratory's job description requirements before assigning an employee to the laboratory. Each analyst must possess adequate experience and education in the appropriate field. All laboratory technicians must possess a minimum of a two-year degree in chemistry or a related field, with some general knowledge of laboratory operations, test methods, QC procedures and records management. The QA Officer will keep the following personnel records:

A. The laboratory will maintain a training file which contains:
   1. A statement from each employee that they have read, understood, and are using the latest version of the Quality Manual and SOPs. The statement will be signed and dated.
   2. A statement from each employee that they have read, acknowledged and understood their personal ethical and legal responsibilities including the potential punishments and penalties for improper, unethical or illegal actions. The statement will be signed and dated.
   3. A Demonstration of Capability (DOC) for each employee for each accredited method that they perform.
   4. Documentation of any training courses, seminars and/or workshops.
   5. Documentation of each employee's continued proficiency to perform each test method by one of the following annually:
      i. acceptable performance of a blind sample for each accredited method;
      ii. another Demonstration of Capability;
      iii. at least four consecutive Laboratory Control Samples with acceptable levels of precision and accuracy.
      iv. if i-iii cannot be performed, analysis of authentic samples that have been analyzed by another trained analyst with statistically precise results.

B. Demonstration of Capability (DOC) – A DOC must be performed prior to using any test method, and any time there is a change in instrument type. The procedure will follow ISO/IEC 17025, AIHA LQAP, ELAP Certification Manual, and the DOC Certificate included in this procedure is completed for each analyst for each test method and a DOC must be completed every six months.

21.0 Education and Training in Ethical and Legal Responsibilities Including the Potential Punishments and Penalties for Improper, Unethical or Illegal Actions

All new employees that will be performing laboratory testing shall be given training from the QA Officer within the first two weeks of employment. A copy of the laboratory's Code of Ethical Conduct will be given to each employee (see Appendix A for the Code of Ethics). A record of training will be signed, indicating the employee read and understood the material presented to them. These signed records will be kept in the employee's training file.

22.0 Reporting Analytical Results

The results of each test carried out by the laboratory will be reported to the client and/or regulatory agency in an accurate, clear and unambiguous manner. Administrative Project Coordinators are responsible for compiling sample results into reports for review by client and/or validators.

All employees are informed that all knowledge of client results and private information is the sole property of Centek Laboratories, LLC and its client. No information can be shared without prior written approval by Centek Laboratories, LLC and/or the client.

23.0 Reagents and Standards

All reagents and standards are only to be purchased by an employee that is qualified to know proper handling and disposal requirements. All reagents and standards must be accepted by the technical director.

If the reagent or standard is a compound that the laboratory has not received than the MSDS's sheets need to be filed. All reagents and

standards are to be stored in a cabinet certified to meet the requirements of the MSDS's. All standards Certificate of Analysis (CoA) must be filed away in the CoA book in the laboratory.

End of Procedure

Appendix A
Code of Ethics

1. No employee should have any interest, financial or otherwise, direct or indirect, or engage in any business or transaction or professional activity or incur any obligation of any nature, which is in substantial conflict with the proper discharge of hid duties in the public interest.
2. No employee should accept other employment that will impair his/her independence of judgement in the exercise of his duties.
3. No employee should disclose confidential information acquired by him/her in the course of his/her official duties nor use such information to further his personal interests.
4. No employee should accept employment or engage in any business or professional activity that will require him/her to disclose confidential information that he/she has gained by reason of his/her official position or authority.
5. No employee should use or attempt to use his/her official position to secure unwarranted privileges or exemptions for him/herself or others.
6. No employee should engage in any transaction as representative or agent of the laboratory with any business entity in which he/she has a direct or indirect financial interest that might reasonably tend to conflict with the proper discharge of his/her official duties.
7. An employee should not by his/her conduct give reasonable basis for the impression that any person can improperly influence him.
8. Violations:
   In addition to any penalty contained in any other provision of law, such as fine and imprisonment, any such employee who shall knowingly and intentionally violate any of the provisions of this Code of Ethics may be fined, suspended or removed from employment in the manner provided by law.

By signing below, I certify that I have read and understood the Center Laboratories, LLC. **Code of Ethics**, and possible penalties for violations.

_____ _____ _____
Name Title Date

Quality Manual
Employee Training File
File: LQM-3
Last Revision: 3/17/2006

By signing below, I certify that I have read and understood the latest version of the Laboratory Quality Manual.

_____	_____	_____
Signature	Quality Manual Revision No.	Date

Demonstration of Capability
Certification Statement

Date:_____

Analyst Name:_____

Matrix:_____

Parameter and Method Number:_____

We, the undersigned, CERTIFY that:

1. The analyst identified above, using the cited test method, which is in use at this facility for the analyses of samples under the National Environmental Laboratory Accreditation Program, have met the Demonstration of Capability.
2. The test method was performed by the analyst identified on this certification.
3. A copy of the test method and the laboratory-specific SOPs are available for all personnel on-site.
4. The data associated with the demonstration capability are true, accurate, complete and self-explanatory (1).
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.

_____	_____	_____
Laboratory Director	Signature	Date
_____	_____	_____
Quality Assurance Officer	Signature	Date

This certification form must be completed each time a demonstration of capability is completed.

(1) Definitions

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

Self-explanatory: Data properly labeled and stored so that the results are clear and require no additional explanation.

Technically Acceptable Analyst Documentation

All analysts must show technical competence for each test they conduct. This document, when signed by the analyst, Laboratory Manager and Quality Assurance Officer, is certification of their capability to perform the indicated test according to Centek guidelines and method SOPs. The analyst must show demonstration of capability by independently performing five acceptable analyses of the test method Reference Standard.

Test:_____ Matrix:_____

Method:_____

Analyst:_____

Batch/File Number	Date Performed	True Value	Actual Value	Percent Recovery	Control Limits

Average: _____ _____

_____ _____
Analyst Date

_____ _____
Laboratory Manager Date

_____ _____
Quality Assurance Officer Date

The following people have read and understand the "Laboratory Quality Manual" Standard Operating Procedure, (Revision 4, 4/22/09):

Name	Signature	Date

CENTEK LABS, LLC

Mini-Can Air Sampling Operating Instructions

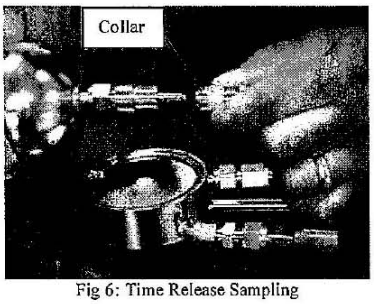


Fig 6: Time Release Sampling

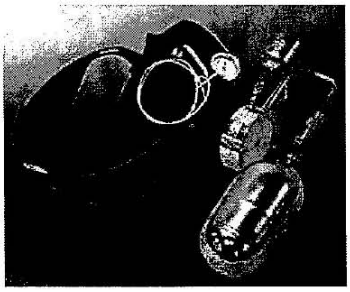


Fig 7: Personal sampling belt

Time Released Sampling

Equipment: 1) 400cc can (figure 1)
2) Time released regulator (figure 3)
3) Sampling unit belt if being used as a personal sampler (figure 7)

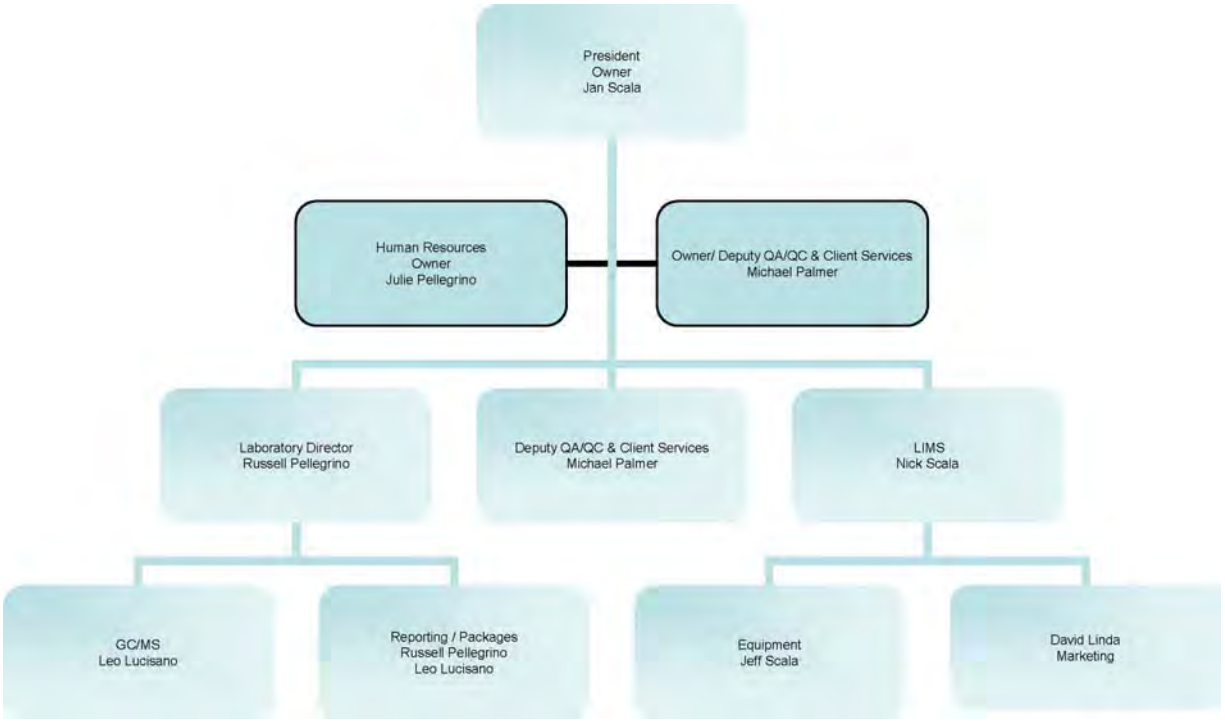
- Remove protective cap from the can
- Hold the CS1200P regulator in one hand and slide back collar (figure 3)
- Hold can in other and face sampler tip into regulator (figure 6)
- Insert sampler tip into regulator and release collar. There should be **no gap** between the regulator and the can. (figure 5)
- Sampler will automatically start without power. You will see a decrease in vacuum located on vacuum gauge of the regulator over a period of time.

- **If using sampler as a stationary unit:**
  1. Place unit on its side
  2. Check vacuum gauge periodically for loss in vacuum (starts @ -30'Hg / ends @ approx -1-5"Hg)

- **If using sampler as a personal unit:**
  1. Place sampler in holster belt.(figure 7)
  2. Clip belt around waste
  3. Pin sampling tube to your collar (**remember no perfume or colognes should be worn)
  4. Check vacuum gauge periodically for loss in vacuum (starts @ -30'Hg / ends @ approx -1-5"Hg)

- When done pull back on the collar of the regulator and slide the can out.
- Put protective cap back on sampler tip.
- Ship back to Centek Laboratories, LLC.

Organizational Chart



Title: Analytical Methods for the Analysis of GC/MS Volatiles [SW-846 Method 8260B]

Once printed, this is considered an uncontrolled document

Approvals (Signature/Date):

07/24/2008
James J. Lis Date
Department Manager

07/25/2008
Kene Kasperek Date
Health & Safety Manager / Coordinator

07/24/08
Peggy Gray-Erdmann Date
Quality Assurance Manager

07/25/2008
Chris Spencer Date
Laboratory Director

Facility Distribution No. _____ **Distributed To:_____**

1.0 Scope and Application

1.1 Analytes, Matrix(s), and Reporting Limits

1.1.1 Methods 8260B -5 mL aqueous purge, 8260B - 25mL aqueous purge, 8260B – 5gr soil and 8260B – medium level soil.

1.1.2 Applicable matrices include all aqueous samples, sediment, and soil.

1.1.3 The standard reporting limit (RL) is established at or above the low-level standard in the calibration curve. For a 5-ml purge volume, the RL for the majority of compounds is 1 ug/l.

On occasion clients may request modifications to this SOP. These modifications are handled following the procedures outlined in Section xx in the Quality Assurance Manual.

2.0 Summary of Method

2.1 This analytical method is utilized for the analysis of water, sediment and soil from hazardous waste sites for the organic compounds listed in table 1.

2.2 The method includes sample preparation and analyses by purge and trap gas chromatograph/mass spectrometer (GC/MS). Method can be used for 5mL purge or 25mL purge (concentrations adjusted accordingly).

2.3 Volatile compounds are extracted from sample matrix by the purge and trap method. Analytes are desorbed onto a capillary column. An appropriate ramping temperature program is applied to maximize separation and achieve the correct resolution between the analytes. A mass spectrometer detector (MSD) interfaced to the gas chromatograph (GC) is utilized to detect analytes of interest.

2.4 Analytes eluted from the capillary column are introduced into the mass spectrometer via a direct connection. Identification of target analytes is accomplished by comparing their mass spectra with the electron impact spectra of authentic standards. Quantitation is accomplished by comparing the response of a major (quantitation) ion relative to an internal standard using a minimum of a five-point calibration curve.

3.0 Definitions

3.1 **VBLK - Volatile blank**: VBLK's are made from laboratory produced volatile free water. They are analyzed before samples to ensure a clean laboratory environment and analytical system.

3.2 **IBLK – Instrument Blank:** IBLK's are made from laboratory produced volatile free water. They are analyzed after high level samples to verify that the system is clean and demonstrate the absence of carryover.

4.0 Interferences

4.1 Airborne contamination may result from solvent vapors. VBLKs and IBLKs will be utilized to demonstrate a clean system and laboratory environment.

4.2 Some volatile compounds can permeate through a sample septum seal during storage or shipment. A weekly volatile holding blank is stored in all sample incubators to monitor contamination.

4.3 Contamination by carryover can occur whenever a sample with high concentrations of target compounds precedes a sample with low levels. The purging device, syringe and lines are flushed between every analysis to reduce carry over contamination. The trap is baked at 260^0 C between each analysis.

5.0 Safety

Employees must abide by the policies and procedures in the Corporate Environmental Health and Safety Manual (CW-E-M-001) and this document. This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.

5.1 Specific Safety Concerns or Requirements

5.1.1 The gas chromatograph and mass spectrometer contain zones that have elevated temperatures. The analyst needs to be aware of the locations of those zones, and must cool them to room temperature prior to working on them.

5.1.2 The mass spectrometer is under deep vacuum. The mass spectrometer must be brought to atmospheric pressure prior to working on the source.

5.1.3 There are areas of high voltage in both the gas chromatograph and the mass spectrometer. Depending on the type of work involved, either turn the power to the instrument off, or disconnect it from its source of power.

5.2 Primary Materials Used

The following is a list of the materials used in this method, which have a serious or significant hazard rating. **Note: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table.** A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

Material	Hazards	Exposure Limit (1)	Signs and symptoms of exposure
Methanol	Flammable Poison Irritant	200 ppm-TWA	A slight irritant to the mucous membranes. Toxic effects exerted upon nervous system, particularly the optic nerve. Symptoms of overexposure may include headache, drowsiness and dizziness. Methyl alcohol is a defatting agent and may cause skin to become dry and cracked. Skin absorption can occur; symptoms may parallel inhalation exposure. Irritant to the eyes.
1 – Exposure limit refers to the OSHA regulatory exposure limit.			

6.0 Equipment and Supplies

6.1 Instrumentation

6.1.1 Purge and trap devices

- Varian Archon Auto sampler
- Encon Concentrator
- O/I Analytical Auto sampler and Concentrator
- Centurion Auto sampler

6.1.2 Trap Packing - Supelco Vocarb 3000

- Packing Material:
- 10cm Carbpack B
- 6cm Carboxen 1000
- 1cm Carboxen 1001

6.1.3 Gas Chromatograph/Mass Spectrometer (GC/MS) - GC: HP5890, MS:

- Gas chromatograph Column - J&W Scientific DB-624 or Phenomenex ZB-624
- Internal diameter: 0.25mm or 0.18mm
- Length: 20m, 30m or 60m.
- Coating: Cyanopropylphenyl Methyl Silicone
- Film thickness: 1.0um or 3.0μm

6.1.4 Data System

- Dell computer with Chemstation enviroquant software
- Gas Chromatograph/Mass Spectrometer (GC/MS)-GC: HP6890 or HP7890, MS: Hewlett-Packard/Agilent 5973N or 5975.
- ProLab Resources software

6.1.5 Analytical Balance Mettler - Toledo Inc. Mettler AE160

6.2 Supplies

- Syringes - Hamilton Syringes size, 10ul, 25ul, 50ul, 100ul, 500ul, 1ml, 5ml, 10ml, 25ml
- Pasteur Pipettes – disposable
- Vials and caps - 2ml disposable
- Vials and caps - 40ml disposable
- Volumetric flasks - Pyrex 2ml, Pyrex 10ml, Pyrex 50ml, Pyrex 100ml
- pH paper - wide range -.EM Science

7.0 Reagents and Standards

7.1 **Reagent Water** - For volatile analysis, the reagent water is volatile free and is prepared by passing water through a carbon trap.

7.2 **Methanol** - Burdick & Jackson, purge and trap grade

7.3 **Stock Standards** - Are purchased as certified standard mixtures. Traceability is documented following the procedures in the "Standards Traceability and Preparation Logbooks" SOP# AGP-STD-14. Individual compounds are prepared using reagent grade chemicals following the "Primary Standards Preparation" SOP# AMV-STD-25.

7.3.1 **Stock Target Compound Mix** – Is composed of three different mixtures.

7.3.1.1 **The Gas Mix** (See Table 6 for component list) is purchased from Supelco (or equivalent vendor) at a concentration of 2000ug/ml.

7.3.1.2 **The 54 Component** Mix (See Table 7 for component list) is purchased from Supelco (or equivalent vendor) at a concentration of 2000ug/ml.

7.3.1.3 **The 8260+ Mix** (See Table 8 for component list) is purchased from Restek (or equivalent vendor) and is composed of four separate mixtures.

- 8260+ Mix #1 is purchased at a concentration of 1000ug/ml.
- 8260+ Mix #2 is purchased at a concentration of 5000ug/ml.
- 8260+ Mix #3 is purchased at a concentration of 20000ug/ml.
- 8260+ Mix #4 is purchased at a concentration of 5000ug/ml.

7.3.2 **Stock Calibration Verification Mix** – Is composed of two different mixtures.

7.3.2.1 The Second Source Mix (See Table 9 for component list) is purchased from Ultra (or equivalent vendor) at a concentration of 2000ug/ml.

7.3.2.2 The 8260+ Second Source Mix (See Table 10 for component list) is purchased from Supelco (or equivalent vendor) and is composed of two separate mixtures.

- 8260+ Second Source Mix #1 is purchased at a concentration of 1000ug/ml.
- 8260+ Second Source Mix #2 is purchased at a concentration of 5000ug/ml.

7.3.3 **Stock Internal Standard Solution** – A mixture of 1,4-Dichlorobenzene-d4, Chlorobenzene-d5 and 1,4-Difluorobenzene in Methanol is purchased from Restek (or equivalent vendor) at a concentration of 2500ug/ml.

7.3.4 **Stock System Monitoring Solution** – A mixture of Dibromofluoromethane, Toluene-D8, 4-Bromofluorobenzene and 1,2-Dichloroethane-d4 in Methanol is purchased from Ultra (or equivalent vendor) at a concentration of 2500ug/ml.

7.3.5 **Stock Matrix Spike Solution** – A 5 component mixture of 1,1-dichloroethene, trichloroethene, chlorobenzene, toluene, and benzene in Methanol is purchased from Restek (or equivalent vendor) at a concentration of 2500ug/ml.

7.3.6 **Stock BFB Solution** – A solution of 4-Bromofluorobenzene in Methanol is purchased from Supelco (or equivalent vendor) at a concentration of 25000ug/ml.

7.4 **Secondary IS and System Monitoring Calibration Dilution Standards** – these solutions are used for the manual injections required to prepare the initial calibration.

7.4.1 **Internal Standard Solution** - 80ul of stock standard IS solution (2500ug/ml) is added to approximately 1 ml of purge and trap grade methanol in a 2 ml Class A volumetric, and then brought up to final volume of 2 ml with additional purge and trap grade methanol for a final concentration of 100ng/ul.

7.4.2 **System Monitoring Compound Solution** - 80ul of stock standard Surrogate solution (2500ug/ml) is added to approximately 1 ml of purge and trap methanol in a 2 ml Class A volumetric, and then brought up a final volume of 2ml with additional purge and trap grade methanol for a final concentration of 100ng/ml.

7.4.3 To calculate appropriate expiration dates, refer to “Standards Traceability and Preparation Logbooks”.

7.5 **Working Standards**

7.5.1 **Intermediate Calibration Solution** (Three individual mixtures)

7.5.1.1 250ul of stock standard Gas Mix solution (2000ug/ml) is added to approximately 4 ml of purge and trap methanol in a 5ml Class A volumetric, and then brought up a final volume of 5ml with additional purge and trap grade methanol for a final concentration of 100ng/ul.

7.5.1.2 500ul of stock standard 54 Component Mix solution (2000ug/ml) is added to approximately 9ml of purge and trap methanol in a 10ml Class A volumetric, and then brought up a final volume of 10ml with additional purge and trap grade methanol for a final concentration of 100ng/ul.

7.5.1.3 1000ul of each of the four stock standard 8260+ Mixes are added to approximately 9ml of purge and trap methanol in a 10ml Class A volumetric, and then brought up a final volume of 10ml with additional purge and trap grade methanol.

7.5.2 **Matrix Spike Solution** - 100ul of stock standard 5 component solution (2500ug/ml) is added to approximately 4 ml of purge and trap methanol in a 5 ml Class A volumetric, and then brought up a final volume of 5ml with additional purge and trap grade methanol for a final concentration of 50ng/ul.

7.5.3 **A Full List Matrix Spike Standard** is made from stock Calibration Verification Standards and is composed of two mixes.

7.5.3.1 250ul of stock standard Gas Mix solution (2000ug/ml) is added to approximately 4 ml

of purge and trap methanol in a 5ml Class A volumetric, and then brought up a final volume of 5ml with additional purge and trap grade methanol for a final concentration of 100ng/ul.

7.5.3.2 200ul of each of the two stock standard 8260+ Second Source Mixes are added to approximately 1ml of purge and trap methanol in a 2ml Class A volumetric, and then brought up a final volume of 2ml with additional purge and trap grade methanol.

7.5.4 **Working Internal Standard and System Monitoring Compound Solutions** – for auto injection by instrument.

7.5.4.1 **Working Internal Standard Solution** - An Internal Standard Mixture is made from IS stock standard (2500ug/ml) at 140ng/ul to 175ng/ul, depending on sample loop size, for the auto sampler and is made at 220ng/ul to 280ng/ul, depending on sample loop size, for the auto sampler.

7.5.4.2 **Working System Monitoring Calibration Solution** - A System Monitoring Compounds Mixture is made from Surrogate stock standard (2500ug/ml) at 140 ng/ul to 175 ng/ul depending on sample loop size, for the auto sampler and is made at 220ng/ul to 280ng/ul, , depending on sample loop size, for the auto sampler.

7.5.5 **Tuning Mixture** - 4ul of stock solution 4-Bomofluorobenzene (BFB) tuning mixture is added to approximately 1 ml of purge and trap grade methanol in a 2 ml Class A volumetric, and then brought up to final volume of 2 ml with additional purge and trap grade methanol for a final concentration of 50ng/ul.

7.5.6 **Working Initial Calibration Standards**

7.5.6.1 **Water: 25 mL**

7.5.6.1.1 20ul, 10ul and 5ul each of Intermediate Calibration Solution (10.5.1) is added to reagent water in each of three 50ml volumetric flasks. 20ul, 10ul and 5ul each of the Secondary IS Calibration Dilution Solution and also the Secondary System Monitoring Calibration Dilution Solution are added to the respective 50 ml volumetric flasks. The flasks are brought to volume with reagent water to prepare the 40, 20 and 10 ug/L standards respectively.

7.5.6.1.2 4ul and 1ul each of Intermediate Calibration Solution ((10.5.1) plus 4ul and 1ul each of the Secondary IS Calibration Dilution Solution and also the Secondary System Monitoring Calibration Dilution Solution are added to reagent water in 100 ml volumetric flasks. The flasks are brought to volume with reagent water to prepare the 4ug/L and 1 ug/L standards respectively.

7.5.6.1.3 Each standard is then transferred into a 40ml vial and loaded onto the auto sampler.

7.5.6.2 **Water: 5 mL**

7.5.6.2.1 50ul, 25ul, 12.5ul, 5ul into 50 ml and 1ul into 100ml each of Intermediate Calibration Solution (10.5.1) plus the same amounts of Secondary IS

Calibration Solution and Secondary System Monitoring Calibration Solution are (100ng/ml) are added to five individual 50ml volumetric flasks continuing reagent water to prepare 100, 50, 25, 10 and 1ug/L standards respectively.

7.5.6.2.2 Each standard is then transferred into a 40ml vial and loaded onto the auto sampler.

7.5.6.3 Soil:

7.5.6.3.1 100ul, 50ul, 25ul, 10ul and 2.5ul of Intermediate Calibration Solution (10.5.1) plus the same amounts of Secondary IS Calibration Solution and Secondary System Monitoring Calibration Solution (at 100ng/ml) are added to five individual 50ml volumetric flasks containing reagent water. The final concentration of each standard is 200, 100, 50, 20 and 5 ug/kg, respectively.

7.5.6.3.2 5 ml of each standard is then transferred into five individual 40ml vials and loaded onto the auto sampler.

7.5.7 Continuing Calibration Standard

7.5.7.1 Water: 25 ml

7.5.7.1.1 5ul of stock target compound mix is added to 50ml of DI water to make a final concentration of 10ppb. Pour standard into 40ml vial; working standard internal standard and system monitoring compounds are added by auto sampler.

7.5.7.2 Water: 5 ml

7.5.7.2.1 12.5ul of stock target compound mix is added to 50ml of DI water to make a final concentration of 25ppb. Pour standard into 40ml vial; working standard internal standard and system monitoring compounds are added by the auto sampler.

7.5.7.3 Soil: 25ul of stock target compound is added to 50ml of DI water to make a final concentration of 50ppb. Take 5ml and transfer it into a 40ml; working standard internal standard and system monitoring compounds are added by the auto sampler.

7.6 Storage of Standards

7.6.1 Stock and secondary dilution standards are stored in Teflon-sealed crimp cap vials at -10^0 C to -20^0 C.

7.6.2 Aqueous standards are stored in Teflon-sealed crimp cap bottles at 4^0 C $\pm$ 2^o C.

8.0 Sample Collection, Preservation, Shipment and Storage

8.1 Samples are collected in 40 mL vials with caps and septa, preserved to a pH < 2 with Hydrochloric Acid and stored at 4±2 degrees C until time of analysis.

8.2 Holding time for unpreserved samples is 7 days from sample date. For preserved samples the holding time is 14 days from sample date.

8.3 For some clients, regulatory agencies or QAPPS, the specified holding times may be different than those described in 8.2. In those cases, consult the specific Protocol/Method/QAPP or Project Manager for holding time details.

8.4 Sample Storage

- Volatile samples are stored at 4 ± 2^0C from the time of collection until analysis.
- Volatile samples are stored together in refrigerators specifically designated for volatiles only.
- Storage blanks are stored with samples until analysis.
- Samples and extracts are stored separately.
- Volatile samples and standards are stored separately.

8.5 Preparation Of MS/MSD Samples

8.5.1 Water Samples: 40ml vial is spiked with 8ul of 50ng/ul matrix spike standard for 25ml purge and 40ul for the 5ml purge. This corresponds to a final concentration in the samples of 10 ug/L and 50 ug/L respectively. Analysis proceeds according to procedures described for water analysis.

8.5.2 Low Level Soil/Sediment Samples: 5ul of matrix spiking solution is added to a 5g aliquot of sample. This corresponds to a final concentration in the samples of 50 ug/kg. Analysis proceeds according to procedures described for low-level soil/sediment samples.

8.5.3 Medium Level Soil/Sediment Samples: 1ml of methanol containing the soil spiking solution is combined with 50 mL of water and 50 ul of spiking solution is added to the methanol extraction solution. Sample analysis proceeds according to procedures described for medium level soil/sediment samples.

9.0 Quality Control

9.1 Blank Analysis

9.1.1 Method Blank: A method blank consisting of a clean reference matrix (reagent water or purified quartz sand) must be analyzed prior to the analysis of samples but following any standard analysis.

- Target compounds detected in a method blank must fall below the reporting limit, unless specified in client QAPP.
- If internal standard or systems monitoring compound recoveries are not met, the method blank must be reanalyzed before the analysis of samples.

9.1.2 Storage (Holding) Blank: A weekly holding blank is analyzed to determine if cross contamination occurs within the volatile holding area. The results are reviewed by the quality assurance department and deemed acceptable or not acceptable. Corrective action, if necessary, will be taken.

9.1.3 **Instrument Blank:** An instrument blank consisting of a clean reference matrix analyzed after the analysis of samples containing target compounds which exceed the calibration range. Multiple instrument blanks are shot until the instrument blank meets the criteria for method blanks.

9.2 **Matrix Spike Blank (MSB/LCS)** An aliquot of clean reference material spiked with the matrix spiking solution is analyzed with each analytical batch. The standard from which the MSB/LCS is prepared is purchased from an alternate vender from the continuing (CCV) standard. The solution is spiked at a concentration of 10ug/L for 25ml analysis and 25ug/L for 5ml analysis. A matrix spike blank duplicate is performed when insufficient volume is available for sample specific MS/MSD quality control.

9.2.1 The MSB/LCS must fall within internally derived statistical control limits or where applicable the limits specified by a project QAPP.

9.2.2 Routine compounds included in the MSB/LCS are:

1,1-Dichloroethene; Chlorobenzene; Toluene; Benzene; Trichloroethene

9.2.3 When required, the MSB/LCS a 'full-compound' spike will be prepared and the MSB/LCS will be spiked with all compounds of interest. Due to the potentially large number of target compounds for method 8260B, it is possible that a few of the spiking compound could fall outside limits in the MSB/LCS. If a compound falls outside limits biased high and that compound is not found in the samples, a comment will be made in the case narrative and the data will be found to be acceptable.

9.2.4 If the results of sample matrix spikes fall outside of the quality control range due to matrix, the MSB is used to verify that the laboratory can perform a spike on a clean matrix.

9.3 **Matrix Spike And Matrix Spike Duplicate Analysis** A matrix spike and matrix spike duplicate consisting of an actual field sample which has been spiked with the matrix spiking solution.

9.3.1 Matrix spike and matrix spike duplicate analysis will not be performed on rinsates or field/trip blanks.

9.3.2 If a sample has not been designated for MS/MSD analysis by the client, a sample will be selected at the analyst's discretion. MS/MSD analysis will be performed at a minimum of every 20 samples.

9.3.3 If insufficient sample was received for a designated MS/MSD the client will be contacted with the laboratory's in-house designated sample for MS/MSD analysis. If no MS/MSD is required, the instance will be documented in the SDG narrative.

9.3.4 If medium level analysis is required on the client designated sample, the laboratory analyst will choose a low level sample on which to perform the quality control analysis. Medium level QC will also be performed.

9.4 **Data Assessment & Acceptance Criteria for QC Measures**

9.4.1 Technical Acceptance Criteria For Initial Calibration

9.4.1.1 **SPCCs** (System performance check compounds) are compounds used to check compound instability degradation. The following average minimum average response factors must be met before the curve can be used.

Chloromethane	0.10
1,1-Dichloroethane	0.10
Bromoform	0.10
Chlorobenzene	0.30
1,1,2,2-Tetrachloroethane	0.30

9.4.1.2 **CCCs** (Calibration Check Compounds) evaluate the calibration based on the integrity of the system. The % RSD for the CCCs MUST be equal or less than 30%. The CCCs are:

Vinyl chloride
1,1-Dichloroethene
Chloroform
1,2-Dichloropropane
Toluene
Ethyl benzene

If the % RSD of any of the target analytes is 15% or less, the average response factor is assumed constant and the average response factor may be used for quantitation.

OR

If the % RSD of a target analyte is greater than 15%, linear regression may be used providing the coefficient of determination is greater than or equal to 0.99.

9.4.2 Technical Acceptance Criteria For Continuing Calibration

9.4.2.1 **SPCCs** - A system performance check is made daily or during every 12 hour analytical shift. Each compound must meet its minimum response factor (see Initial Calibration Criteria).

9.4.2.2 **CCCs** - Used to check the validity of the initial calibration. The % Difference for each CCC shall be less than or equal to 20% from the initial calibration for the continuing calibration to be valid. All non-CCC target compounds must be less than 100% difference.

9.4.2.3 **Internal Standard Retention Time** – The retention times for all internal standards must be evaluated to make sure that they are no more than 30 seconds from that of the midpoint of the initial calibration. If the retention time shift is greater than 30 seconds, the system must be inspected for malfunctions and maintenance must be performed, as required.

9.4.2.4 **Internal Standard Response** – The EICP area for all internal standards must be evaluated to make sure that they have not change by a factor greater than two (-50% to +100%) from that of the midpoint of the initial calibration. If the response exceeds these limits, the system must be inspected for malfunctions and maintenance must be performed, as required.

9.4.3 Technical Acceptance Criteria of Quality Control Samples

Samples, blanks, matrix spikes, and matrix spike duplicates must meet internal standard and system monitoring compound recovery limits. Where the Internal Standard recovery limit equals sample internal standard characteristic ion area (EICP) divided by the CCV internal standard characteristic ion area (EICP), multiplied by 100.

9.5 Corrective Action for Out-of-Control Data

9.5.1 Corrective Actions For MS/MSD

9.5.1.1 If the recoveries of the internal standards and system monitoring compounds do not agree with the unspiked sample (i.e. the sample recoveries were within control limits and MS/MSD recoveries were outside of control limits) the MS/MSD will be evaluated. The analyst will use their technical judgment to determine if the non-conformance is due to sample matrix or laboratory error. If it is determined that the QC failure was due to laboratory error, then reanalysis will occur.

9.5.1.2 If the recoveries of the internal standards and system monitoring compounds agree with the unspiked sample (i.e. both the sample and MS/MSD recoveries were outside of control limits) re-analysis is not required. The instance will be documented in the SDG narrative.

9.5.1.3 Limits for the matrix spiking compounds are established by the laboratory on an annual basis. If the concentrations determined in the MS/MSD do not meet the control limits, no corrective action is necessary as long as the MSB/LCS was within control limits. The instance will be documented in the job narrative.

9.5.2 Corrective Actions For Initial Calibration

9.5.2.1 If technical acceptance criteria cannot be met, it may be necessary to re-analyze the initial calibration. If after re-analysis, the criteria have not been met, it may be necessary to inspect the GC/MS system for possible problems.

9.5.2.2 Corrective actions may require one or several of the following procedures:

- Open new/remake standard mixes
- The ion source may be cleaned
- The column may be cut at the injection port end
- Change the purge trap on the purge and trap unit
- Correct purge gas flow to optimize response

- The column may be baked out
- The purge trap may be baked out
- The column may be replaced

9.5.3 Corrective Actions for Failure to Meet the Continuing Calibration Acceptance Criteria

9.5.3.1 If the technical acceptance criteria given above are not met, it may be necessary to re-analyze the continuing calibration check. If, after re-analysis, the given criterion has not been met, it may be necessary to re-analyze the initial calibration.

9.5.3.2 Other Corrective actions may be taken. The following details possible corrective actions:

- Open new/remake standard mixes
- The ion source may be cleaned
- The column may be cut at the injection port end
- The trap on the purge and trap unit may be replaced
- The purge gas flow may be adjusted
- The column may be baked out
- The purge trap may be baked out
- The column may be replaced

9.5.4 Corrective Actions For Samples

9.5.4.1 If the internal standard or system monitoring criteria are not met, the sample must be re-analyzed to insure that it was not an internal problem that affected recoveries. If, after re-analysis, recoveries are outside of control limits, a matrix effect can be assumed.

9.5.4.2 When dilutions are performed, target compound concentration must fall within the upper range of the initial calibration. If any target compound exceeds the calibration range, the sample would require dilution. The sample immediately following a sample with target compounds above the calibration range must be monitored to insure that there is no carryover present. If there is a possibility of carryover, that sample must be re-analyzed.

9.5.4.3 If matrix effects exist, and both analyses exhibit recoveries outside of control limits, both analyses will be reported and documented in the job narrative.

9.5.4.4 If, after re-analysis, recovery criteria are met, only the second analyses will be reported. If the second analyses occur outside of the contract required holding time, both analyses will be reported in that instance.

9.5.4.5 In the case of a matrix spike or matrix spike duplicate, these samples should only be

reanalyzed if the recoveries do not agree with the unspiked sample. If recoveries agree, the unspiked sample will not require re-analysis. The instance will be documented in the SDG narrative.

9.5.5 Corrective Actions for Failure to Meet the Matrix Spike Blank Acceptance Criteria

9.5.5.1 Limits for the matrix spiking compounds are established by the laboratory on an annual basis. The MSB/LCS must fall within these control limits. When required, the MSB/LCS will be spiked with all compounds of interest, otherwise spiked to include a minimum of 1,1-dichloroethene, trichloroethene, chlorobenzene, toluene, and benzene. Due to the potentially large number of target compounds for method 8260B, it is possible that a few of the spiking compounds could fall outside limits in the MSB/LCS. If a compound falls outside limits biased high and that compound is not found in the samples, a comment will be made in the case narrative and the data will be found to be acceptable

9.5.5.2 If the technical acceptance criteria are not met, it may be necessary to re-analyze the matrix spike blank. If, after re-analysis, the given criterion has not been met, it may be necessary to re-analyze the initial calibration.

9.5.5.3 Other Corrective actions may be taken. The following details possible corrective actions:

- Open new/remake standard mixes
- The ion source may be cleaned
- The column may be cut at the injection port end
- The trap on the purge and trap unit may be replaced
- The purge gas flow may be adjusted
- The column may be baked out
- The purge trap may be baked out
- The column may be replaced

9.5.6 Contingencies for Handling Out-of-Control or Unacceptable Data

- Inform project manager for client input and fill out job exception report.
- Rerun samples to confirm results.
- Resample if client or project manager requests.

10.0 Procedure

10.1 Calibration & Standardization

10.1.1 Instrument Tuning and Performance Check:

The GC/MS system is calibrated using Perflurotributylamine (PFTBA) according to the

recommended tuning conditions suggested by the vendor.

An instrument performance check of Bromofluorobenzene (BFB) is analyzed at the beginning of each 12-hour analysis period.

The analysis of the instrument performance check is performed using the following procedure:

- 1ul of a 50ng/ul solution is directly injected, resulting in a 50ng injection of BFB into the GC/MS.
- A blank containing 50 ng BFB is purged.

10.1.2 The mass spectrum of BFB is acquired using the following procedure:

- A single scan on the peak.
- An average of the peak.
- The apex scan, one scan immediately preceding the apex and one scan immediately following the apex are averaged. The spectrum is background subtracted using a single scan no more than 20 scans prior to the elution of BFB.
- The mass spectrum of BFB must pass the technical acceptance criteria given in Table 2.

10.1.3 Initial Calibration (ICAL):

The instrument performance check must meet the technical acceptance criteria prior to the analysis of an initial curve or samples. The GC/MS system is calibrated using five levels of concentrations. All compounds of interest are included. (See section 9.4 for initial calibration acceptance criteria.)

Solutions containing target compounds and system monitoring compounds are analyzed at concentrations of 5, 20, 50, 100 and 200 ug/L. (1, 4, 10, 20 and 40 ug/L for 25 mL)

5 ml (aqueous) or 5 gram (soil) Purge Analysis

Standard	Solvent	Working Standard Conc.	Amount Added (ul)	Final Vol. (mL)	Final Conc. Water (ug/L)	Final Conc. Soil (ug/kg)
VSTD001	MeOH	100ng/ul	1	100	1	5
VSTD010	MeOH	100ng/ul	5	50	10	20
VSTD025	MeOH	100ng/ul	12.5	50	25	50
VSTD050	MeOH	100ng/ul	25	50	50	100
VSTD100	MeOH	100ng/ul	50	50	100	200

25 ml Purge Analysis

Standard	Solvent	Working Standard Conc.	Amount Added (ul)	Final Vol. (mL)	Final Conc. Water (ug/L)
VSTD001	MeOH	100ng/ul	1	100	1
VSTD004	MeOH	100ng/ul	4	100	4
VSTD010	MeOH	100ng/ul	5	50	10

VSTD020	MeOH	100ng/ul	10	50	20
VSTD040	MeOH	100ng/ul	20	50	40

10.1.4 Continuing Calibration Verification (CCV):

Every 12 hours of sample analysis the laboratory must demonstrate that the instrument has drifted or changed minimally by performing an instrument performance check and continuing calibration verification. (See section 9.4 for continuing calibration acceptance criteria.)

10.2 Before Analysis

10.2.1 Once initial calibration criteria has been met, and prior to analyzing samples and required blanks, Each GC/MS system must be routinely checked by analyzing a Continuing Calibration Verification (CCV) standard containing all compounds (including internal standards and system monitoring compounds) at a concentration of 25ug/L for 5ml or 10ug/L for 25ml analysis.

10.2.2 If time remains after initial calibration criteria have been met, it may not be necessary to perform a CCV. The 25 ug/L (10ug/L for 25ml) standard may be evaluated against the new initial curve and used as the CCV.

10.2.3 If there is no time remaining in the 12-hour period, the instrument performance check (BFB) must be analyzed along with a new CCV.

10.2.4 Procedure for Continuing Calibration: 12.5ul of internal standards, system monitoring compounds, and target compound mixture is added to a 50ml volumetric flask. A 5ml aliquot is analyzed. 25ml purge analysis requires 5ul into a 50 ml volumetric flask filled with volatile free water.

10.3 Sample Analysis

10.3.1 BFB tuning criteria and GC/MS calibration verification must be met before sample analysis begins.

10.3.2 The acquisition time of the BFB tune establishes a 12hr. batch. The CCV, MSB, and VBLK must be analyzed within 12hrs, unless specified by the client request. The remaining time in the 12hr batch is utilized to run samples of similar matrix. All aqueous samples are considered a water matrix. All solid samples, with the exception of sludges, are considered soil matrix. Sludges are run medium level.

10.3.3 Samples and standard solutions are brought to ambient temperature before analysis.

10.3.4 Prior to the analysis of samples, a method blank must be analyzed in accordance with the associated procedures for a given matrix. Technical criteria for method blanks must be met prior to sample analysis.

10.4 Water Sample Analysis

10.4.1 A 5ml sample aliquot is spiked with internal and system monitoring compounds to a final

concentration of 25 ug/L each. 25ml analysis requires a final concentration of 10ug/L. The spike may be performed manually with a Hamilton gas tight syringe or the auto sampler may be used. The sample is then loaded onto the auto sampler where it is in turn transferred to the purge chamber.

10.4.2 The sample is purged for 11.0 ± 1 minute at ambient temperature.

10.4.3 At the end of the purge time, the sample is desorbed onto the gas chromatograph column by rapidly heating the trap from 190C to 250^{0}C (depending on manufacturer specifications) while the trap is back flushed with Helium between 20 - 60 ml/minute for two minutes. The sample is desorbed onto the column and the gas chromatograph temperature ramping program is commenced.

10.4.4 While the trap is in the bake mode, the purge chamber is flushed with two 5ml aliquots of reagent water in order to avoid possible contamination from carryover of target compounds.

10.4.5 After the sample has desorbed, the trap is conditioned at 260^{0}C for 8 minutes. After baking, the trap is ready for the next sample.

10.4.6 Dilutions may be necessary if the concentration of any target compound exceeds the working range of the calibration.

10.4.7 In the event that a dilution is required, a measured volume of sample is added to a volumetric flask then to volume with reagent water and inverted 3 times. The sample in the neck portion is discarded and a 5ml volume is taken for analysis. Analysis may then proceed as described.

10.5 Low Level Soil/Sediment Sample Analysis

10.5.1 The low level soil method is based on a heated purge of a 5g sample mixed with reagent water containing a final concentration of 50 ug/L of internal and system monitoring compounds.

10.5.2 If a dilution of the soil/sediment is required, a smaller portion of soil may be used. The smallest amount of soil that may be used is 1g. If a higher dilution is required, the sample must be analyzed as a medium level soil/sediment.

10.5.3 Initial and continuing calibrations that are used for the quantitation of low soils/sediments are analyzed using the same purge and trap conditions as samples.

10.5.4 The sample consists of the entire contents of the sample container. The contents are mixed thoroughly with a narrow metal spatula or wooden tongue depressor. A 5g portion is taken for analysis. The weight is recorded to the nearest 0.01g.

10.5.5 A 5ml aliquot of reagent water containing internal standards and system monitoring compounds is added to the sample immediately prior to heating and purging.

10.5.6 After reagent water is added, the soil/sediment sample is heated to 40^{0}C ± 1^{0}C then purged for 11 ± 1 minutes.

10.5.7 After purging, the sample is subjected to desorbing as described for water analysis.

10.6 Medium Level Soil/Sediment Samples

10.6.1 The medium level soil/sediment method is based on an extraction of a portion of the sample with methanol. A portion of the extract is then added to a 5 ml aliquot of reagent water containing internal and system monitoring compounds at a final concentration of 25ug/L.

10.6.2 The sample consists of the entire contents of the sample container. The contents are thoroughly mixed with a thin metal spatula or wooden tongue depressor. A 4 g portion of the sample is weighed into a 20ml vial. The weight of the sample is recorded to the nearest 0.01g.

10.6.3 A 10ml aliquot of methanol is quickly added to the sample. The vial is capped and the sample is shaken for 2 minutes.

10.6.4 A determined amount of methanol extract is added to a 5ml aliquot of reagent water containing internal and system monitoring compounds at a final concentration of 50ug/L. Analysis may proceed according to procedures described for water samples.

10.6.5 Table 3 may be used to determine the volume of methanol extract required for a given dilution factor.

10.7 pH Determinations For Water Samples

10.7.1 After the sample aliquots are taken from the VOA vials, the pH of the sample is determined by placing several drops of sample, using a disposable pipette, onto pH paper. A checkmark will be entered in the injection logbook if the sample pH is <2, however if the sample demonstrates a pH>2, the actual pH will be noted in the injection logbook.

10.8 Percent Moisture Determinations

10.8.1 Immediately after weighing the sample for analysis, a 5-10g portion is weighed into a tarred aluminum weigh pan. The sample is then dried overnight at 105^0C. The sample is allowed to cool. The final weight is recorded. Using equation 4, the percentage moisture, which is used for reporting concentrations relative to the dry weight of the soil/sediment samples, may be determined. The following calculation is used to determine percent moisture:

$$\%\text{moisture} = \frac{\text{Wt. of sample (g)} - \text{wt. of dried sample (g)}}{\text{wt. of sample (g)}} \times 100$$

11.0 Calculations / Data Reduction

11.1 Calculations For MS/MSD Samples

11.1.1 The calculations to determine concentrations are the same equations described for sample analysis of a given matrix.

11.1.2 The percent recovery of the matrix spiking compounds is determined using equation:

$$\text{Matrix Spike Recovery} = \frac{SSR - SR}{SA} \times 100$$

Where: SSR = Spiked sample result
SR = Sample results
SA = Spike added

11.1.3 The relative percent difference (RPD) of the recoveries of each compound between the matrix spike and matrix spike duplicate is determined using equation:

$$RPD = \frac{|MSR - MSDR|}{\frac{1}{2}(MSR + MSDR)} \times 100$$

Where: MSR = Matrix spike recovery
MSDR = Matrix spike duplicate recovery

11.2 Calculations For Initial Calibration

11.2.1 The relative response factor (RRF) for each target compound and each system monitoring compound is calculated using equation.

$$RRF = \frac{Ax}{Ais} \times \frac{Cis}{Cx}$$

Where,
Ax = Area of the characteristic ion (EICP) for the compound to be measured (see Table 6)
Ais = Area of the characteristic ion (EICP for the specific internal standard (see Tables 5 and 6A)
Cis = Concentration of the internal standard
Cx = Concentration of the compound to be measured

11.2.2 The relative response factor of the Xylenes requires the use of the area response and the concentration of the peak that represents the single isomer.

11.2.3 The relative response factor of 1,2-dichloroethene is calculated using the sum of the areas of both isomers and the sum of the concentrations.

11.2.4 The average response factor (RRF) is calculated for all compounds of interest.

11.2.5 The relative standard deviation (% RSD) is calculated over the working range of the curve for all compounds using equation:

$$\%RSD = \frac{\text{Standard Deviation}}{\text{Mean}} \times 100$$

$$\text{Standard Deviation} = \sqrt{\frac{\sum_{i=1}^{n}(\chi i - \overline{\chi})2}{n-1}}$$

Where,
Xi = each individual value used to calculate the mean
X = the mean of n values
n = the total number of values

11.3 Calculations For Continuing Calibration

11.3.1 The relative response factor (RRF) for all target compounds and system monitoring compounds is calculated using equation 1.

11.3.2 The percent difference between the initial calibration and the continuing calibration is determined for all target compounds and system monitoring compound using equation:

$$\%Difference = \frac{RRFc - \overline{RRFi}}{\overline{RRFi}} \times 100$$

Where,
RRFc = Relative response factor from continuing calibration standard

$\overline{RRFi}$ = Mean relative response factor from the most recent initial calibration meeting technical acceptance criteria

11.4 Percent Moisture Determinations

11.4.1 Immediately after weighing the sample for analysis, a 5-10g portion is weighed into a tarred aluminum weigh pan. The sample is then dried overnight at 105^{0}C. The sample is allowed to cool. The final weight is recorded. Using the equation for % moisture, concentrations relative to the dry weight of the soil/sediment samples, may be determined.

$$\%moisture = \frac{\text{g of wet sample - g of dry sample}}{\text{g of wet sample}} \times 100$$

11.5 Quantitation of volatile target compounds is done using the internal standard method. The internal standards used for each compound are assigned those indicated in table 5. The Internal Standard RRF of the continuing calibration is used in the quantitation calculation.

11.5.1 Water Samples: The following equation is used to calculate water samples:

$$\text{Concentration ug/L} = \frac{(Ax)\,(Is)\,(DF)}{(Ais)\,(RRF)\,(Vo)}$$

Where,

Ax = Area of the characteristic ion (EICP) for the compound to be measured (see Table 2)

Ais = Area of the characteristic ion (EICP) for the specific internal standard (see Tables 5 and 6A)

Is = Amount of internal standard added in nanograms (ng)

RRF= Relative response factor from the ambient temperature purge of the calibration standard.

Vo = Volume of water purged in milliliters (mL)

Df = Dilution factor. The dilution factor for analysis of water samples for volatiles by this method is defined as the ratio of the number of milliliters (mL) of water purged (i.e., Vo above) to the number of mL of the original water sample used for purging. For example, if 2.0 mL of sample is diluted to 5 mL with reagent water and purged, Df = 5 mL/2.0 mL = 2.5. If no dilution is performed, Df = 1.

11.5.2 Low Level Soil/Sediment Samples - The following equation is used for low level soil/sediment samples:

$$\text{Concentration ug/Kg (dry weight basis)} = \frac{(Ax)\,(Is)}{(Ais)\,(RRF)\,(Ws)\,(D)}$$

Where,

Ax, Is, Ais are as given for water.

RRF = Relative response factor form the heated purge of the calibration standard.

$D = \frac{100 - \%\ \text{moisture}}{100}$

Ws = Weight of sample added to the purge tube, in grams (g).

11.5.3 Medium Level Soil/Sediment Samples

The following equation is used for quantitation of medium level soil/sediment samples:

$$\text{Concentration ug/Kg (Dry weight basis)} = \frac{(Ax)\,(Is)\,(Vt)\,(1000)\,(Df)}{(Ais)\,(RRF)\,(Va)\,(Ws)\,(D)}$$

Where,

Ax, Is, Ais are as given for water.

RRF = Relative response factor from the ambient temperature purge of the calibration standard.

Vt = Total volume of the methanol extract in milliliters (mL).

NOTE: This volume is typically 10 mL, even though only 1 mL is transferred to the vial.

Va = Volume of the aliquot of the sample methanol extract (i.e., sample extract not including the methanol added to equal 100 uL) in micro liters (ul) added to reagent water for purging.

Ws = Weight of soil/sediment extracted, in grams (g).

$$D = \frac{100 - \%\ \text{moisture}}{100}$$

Df = Dilution factor. The dilution factor for analysis of soil/sediment samples for volatiles by the medium level method is defined as:

$$\frac{\text{ul most conc. extract used to make dilution + ul clean solvent}}{\text{ul most conc. extract used to make dilution}}$$

(The dilution factor is equal to 1.0 in all cases other than those requiring dilution of the sample methanol extract (Vt). The factor of 1,000 in the numerator converts the value of Vt from mL to ul.)

11.6 When quantitating the sample concentration of Xylenes (total), the areas of both the m & p Xylene peak and the o-Xylene peak are summed and the RRF determined using equation 1 are used. The concentration of each peak may be determined separately and then summed to determine the concentration of Xylene (total).

11.7 When quantitating the concentration of 1,2-Dichloroethene (total), the concentrations of the two isomers (cis and trans) are summed.

11.8 Secondary ion quantitation may be used if interferences (such as matrix effects) may cause a bias in quantitation. If ions other then those listed in table 6 are used, the analyst will document the reason, and it will be noted in the job narrative.

11.9 If manual integration of any compound (including internal standards, system monitoring compounds, target or tentatively identified compounds) is required, the EICP of that compound will be provided. All manual integrations will be identified with an "m" and initialed and dated by the GC/MS analyst.

11.10 Tentatively Identified Compounds

11.10.1 An estimated concentration for tentatively identified compounds will be determined using the equations described above for a given matrix using the total area counts of both the tentatively identified compound and the nearest internal standard which is free of interferences.

11.10.2 The RRF used to determine all concentrations of tentatively identified compounds will be an assumed RRF of one (1).

11.10.3 All tentatively identified compounds will be qualified as "J" (estimated) and "N" (presumptive evidence).

11.11 System Monitoring Compounds

11.11.1 The recovery of all system monitoring compounds in samples, blanks matrix spikes and matrix spike duplicates, is calculated using equation:

$$\% \text{ Recovery} = \frac{\text{Concentration (amount) found}}{\text{Concentration (amount) spiked}} \times 100$$

11.11.2 The recovery limits for each system monitoring compound are laboratory established on an annual basis. The recoveries must be within the criteria limits. If they fall outside criteria limits, the results must be evaluated and the sample reanalyzed, if necessary.

11.11.3 The relative retention time (RRT) of each system monitoring compound must be within the acceptance windows of ±0.06 RRT.

11.12 Internal Standards

11.12.1 The internal standards of all samples, blanks, matrix spikes and matrix spike duplicates must be monitored. The EICP area of each internal standard must be within the range of -50.0 percent to 200.0 percent of those in the continuing calibration.

11.12.2 The relative retention time (RRT) of each internal standard must be within 0.5 minutes (30 seconds) of those in the continuing calibration.

11.13 Verification of Calculated Result

11.13.1 The laboratory analyst/data entry analyst will print out and review sample worksheets and hand calculate the result for positive hits, internal standards and surrogates for comparison to the AIMS calculated result. Corrective action will result, if needed.

12.0 Method Performance

Each analyst prior to sample analysis will perform 4 replicate second source QC check standards, at 25ug/L, as an Initial Demonstration of Capability. The average recovery and standard deviation are keep in AIMS and kept with each analyst's training file.

12.1 Method Detection Limit Study (MDL)

The method detection limit (MDL) is the lowest concentration that can be detected for a given analytical method and sample matrix with 99% confidence that the analyte is present. The MDL is determined according to the laboratory's MDL procedure in the QA Manual. MDLs reflect a calculated (statistical) value determined under ideal laboratory conditions in a clean matrix, and may not be achievable in all environmental matrices. The laboratory maintains MDL studies for analyses performed; these are verified at least annually unless method requirements require a greater frequency.

12.2 Demonstration of Capabilities

12.2.1 A one–time initial demonstration of performance for each individual method for both soils and water matrices must be generated.

12.2.2 This requires quadruplicate analysis of a mid–level check standard containing all of the standard analytes for the method using the same procedures used to analyze samples, including sample preparation.

12.2.3 Compare these results with the acceptance criteria given in the Method or to laboratory historical limits (if available).

12.2.4 Repeat the test for any analyte that does not meet the acceptance criteria. Repeated failure for any analyte indicates the need for the laboratory to evaluate the analytical procedure and take corrective action.

12.3 Training Requirements

12.3.1 The supervisor has the responsibility to ensure that this procedure is performed by an analyst who has been properly trained in its use and has the required experience.

12.3.2 The following analyst validation information is maintained for this method in the laboratory QA files.

12.3.3 The analyst must complete the laboratory safety orientation training that includes, but is not limited to, chemicals, PPE requirements, and electrical safety.

12.3.4 The analyst must read and understand this SOP.

12.3.5 The analyst must read and understand the Method used as reference for this SOP.

12.3.6 The analyst must complete a DOC or successfully analyze PT samples annually.

12.3.7 The analyst must complete the TestAmerica Quality Assurance Training.

13.0 Pollution Control

It is TestAmerica's policy to evaluate each method and look for opportunities to minimize waste generated (i.e., examine recycling options, ordering chemicals based on quantity needed, preparation of reagents based on anticipated usage and reagent stability). Employees must abide by the policies in Section 13 of the Corporate Environmental Health and Safety Manual (CW-E-M-001) for "Waste Management and Pollution Prevention."

14.0 Waste Management

Waste management practices are conducted consistent with all applicable rules and regulations. Excess reagents, samples and method process wastes are disposed of in an accepted manner.

Waste description rules and land disposal restrictions are followed. Waste disposal procedures are incorporated by reference to the Corporate Safety Manual. The following waste streams are produced when this method is carried out.

14.1 Waste Streams Produced by the Method

The following waste streams are produced when this method is carried out.

14.1.1 Spill Response: Any spills must be cleaned up immediately and handled correctly. Any wastes that have a pH < 7 must be disposed of in an "A" waste container. Any wastes having a pH > 7 must be disposed of in a "D" waste container.

14.1.2 Aqueous waste generated from analysis: Any wastes that have a pH < 7 must be disposed of in an "A" waste container. Any wastes having a pH > 7 must be disposed of in a "D" waste container.

14.1.3 Solvent waste generated from analysis: Solvent waste is stored in laboratory approved metal waste receptacle and labeled "C" waste. Waste receptacles are then taken to sample control where they are then properly disposed of.

14.1.4 Solid waste generated from analysis: Solid volatile analysis waste consists of soils and glass. The soil is wrapped in tin foil and placed in the solid waste receptacle. Soils used for dry weight measurements are also disposed of in this manner. Glass waste such as pipettes and vials are rinsed and disposed of in approved glass receptacles

14.1.5 Expired Standards: Expired and used standards are stored in a laboratory approved metal waste receptacle labeled “BV”. Waste receptacles are then taken to sample control where they are then properly disposed of.

15.0 References / Cross-References

- Method 8260B, “Test Methods for Evaluating Solid Waste”; SW846, Third Edition, December 1996.

16.0 Method Modifications:

Item	Method	Modification
		N/A

17.0 Attachments

Table 1. Compounds Determined by Method 8260B
Table 2. BFB Key Ions and Ion Abundance Criteria
Table 3. Volume of Medium Level Extracts for Dilution
Table 4. Characteristic Masses (m/z) for Purgeable Organic Compounds
Table 5. Job Summary Check List (Page 1 & 2)
Tables 6-12. Composition of Stock Standards

18.0 Revision History

- Revision 0, dated 18 July, 2008
  - Quality Director change, signature added
  - Section 6.0: Changed section to reflect current instrumentation and column specifications
  - Section 9: Added Trichloroethene to MSB list, took out duplicate Chlorobenzene
  - Minor grammatical changes

- Revision 01, dated -24 July, 2008
  - Sec 2.4- removed reference to jet separator and added clarification to 5 point curve reference
  - Section 7.5.5.2.1: Changed volumes used to make ICAL
  - Reduced throughout document volumes used from 25ul to 12.5ul. Also changed throughout final concentrations from 50ppb to 25ppb.
  - Sec 9.2.3 and 9.5.5.1- replaced couple with few
  - Sec 9.4.1.2- removed reference to use of mean RSD
  - Sec 9.5.1.1- added text to clarify lab practice
  - Sec 10.1.3- fixed table to reflect concentrations and volumes used.
  - Sec 10.4.3- added temperature range due to variances in instrumentation

Table 1: Compounds Determined by Method 8260B

Compound	CAS No.[b]	Appropriate Technique					
		5030/5035	5031	5032	5021	5041	Direct Injection
Acetone	67-64-1	pp	c	c	nd	c	c
Acetonitrile	75-05-8	pp	c	nd	nd	nd	c
Acrolein	107-02-8	pp	c	c	nd	nd	c
Acrylonitrile	107-13-1	pp	c	c	nd	c	c
Allyl alcohol	107-18-6	ht	c	nd	nd	nd	c
Allyl chloride	107-05-1	c	nd	nd	nd	nd	c
Benzene	71-43-2	c	nd	c	c	c	c
Benzyl chloride	100-44-7	c	nd	nd	nd	nd	c
Bis(2-chloroethyl)sulfide	505-60-2	pp	nd	nd	nd	nd	c
Bromoacetone	598-31-2	pp	nd	nd	nd	nd	c
Bromochloromethane	74-97-5	c	nd	c	c	c	c
Bromodichloromethane	75-27-4	c	nd	c	c	c	c
4-Bromofluorobenzene (surr)	460-00-4	c	nd	c	c	c	c
Bromoform	75-25-2	c	nd	c	c	c	c
Bromomethane	74-83-9	c	nd	c	c	c	c
n-Butanol	71-36-3	ht	c	nd	nd	nd	c
2-Butanone (MEK)	78-93-3	pp	c	c	nd	nd	c
t-Butyl alcohol	75-65-0	pp	c	nd	nd	nd	c
Carbon disulfide	75-15-0	pp	nd	c	nd	c	c
Carbon tetrachloride	56-23-5	c	nd	c	c	c	c
Chloral hydrate	302-17-0	pp	nd	nd	nd	nd	c
Chlorobenzene	108-90-7	c	nd	c	c	c	c
Chlorobenzene-d5 (IS)		c	nd	c	c	c	c
Chlorodibromomethane	124-48-1	c	nd	c	nd	c	c
Chloroethane	75-00-3	c	nd	c	c	c	c
2-Chloroethanol	107-03-3	pp	nd	nd	nd	nd	c
2-Chloroethyl vinyl ether	110-75-8	c	nd	c	nd	nd	c
Chloroform	67-66-3	c	nd	c	c	c	c
Chloromethane	74-87-3	c	nd	c	c	c	c
Chloroprene	126-99-8	c	nd	nd	nd	nd	c
3-Chloropropionitrile	542-76-7	l	nd	nd	nd	nd	pc
Crotonaldehyde	4170-30-3	pp	c	nd	nd	nd	c
1,2-Dibromo-3-chloropropane	96-12-8	pp	nd	nd	c	nd	c
1,2-Dibromoethane	106-93-4	c	nd	nd	c	nd	c
Dibromomethane	74-95-3	c	nd	c	c	c	c
1,2-Dichlorobenzene	95-50-1	c	nd	nd	c	nd	c

Compound	CAS No.[b]	Appropriate Technique					
		5030/5035	5031	5032	5021	5041	Direct Injection
1,3-Dichlorobenzene	541-73-1	c	nd	nd	c	nd	c
1,4-Dichlorobenzene	106-46-7	c	nd	nd	c	nd	c
1,4-Dichlorobenzene-d4 (IS)		c	nd	nd	c	nd	c
cis-1,4-Dichloro-2-butene	1476-11-5	c	nd	c	nd	nd	c
trans-1,4-Dichloro-2-butene	110-57-6	pp	nd	c	nd	nd	c
Dichlorodifluoromethane	75-71-8	c	nd	c	c	nd	c
1,1-Dichloroethane	75-34-3	c	nd	c	c	c	c
1,2-Dichloroethane	107-06-2	c	nd	c	c	c	c
1,2-Dichloroethane-d4 (surr)		c	nd	c	c	c	c
1,1-Dichloroethene	75-35-4	c	nd	c	c	c	c
trans-1,2-Dichloroethene	156-60-5	c	nd	c	c	c	c
1,2-Dichloropropane	78-87-5	c	nd	c	c	c	c
1,3-Dichloro-2-propanol	96-23-1	pp	nd	nd	nd	nd	c
cis-1,3-Dichloropropene	10061-01-5	c	nd	c	nd	c	c
trans-1,3-Dichloropropene	10061-02-6	c	nd	c	nd	c	c
1,2,3,4-Diepoxybutane	1464-53-5	c	nd	nd	nd	nd	c
Diethyl ether	60-29-7	c	nd	nd	nd	nd	c
1,4-Difluorobenzene (I.S.)	540-36-3	nd	nd	nd	nd	c	c
1,4-Dioxane	123-91-1	pp	c	c	nd	nd	c
Epichlorohydrin	106-89-8	l	nd	nd	nd	nd	c
Ethanol	64-17-5	l	c	c	nd	nd	c
Ethyl acetate	141-78-6	l	c	nd	nd	nd	c
Ethylbenzene	100-41-4	c	nd	c	c	c	c
Ethylene oxide	75-21-8	pp	c	nd	nd	nd	c
Ethyl methacrylate	97-63-2	c	nd	c	nd	nd	c
Fluorobenzene (IS)	462-06-6	c	nd	nd	nd	nd	nd
Hexachlorobutadiene	87-68-3	c	nd	nd	c	nd	c
Hexachloroethane	67-72-1	l	nd	nd	nd	nd	c
2-Hexanone	591-78-6	pp	nd	c	nd	nd	c
2-Hydroxypropionitrile	78-97-7	l	nd	nd	nd	nd	pc
Iodomethane	74-88-4	c	nd	c	nd	c	c
Isobutyl alcohol	78-83-1	pp	c	nd	nd	nd	c
Isopropylbenzene	98-82-8	c	nd	nd	c	nd	c
Malononitrile	109-77-3	pp	nd	nd	nd	nd	c
Methacrylonitrile	126-98-7	pp	l	nd	nd	nd	c
Methanol	67-56-1	l	c	nd	nd	nd	c
Methylene chloride	75-09-2	c	nd	c	c	c	c

Compound	CAS No.[b]	Appropriate Technique					
		5030/5035	5031	5032	5021	5041	Direct Injection
Methyl methacrylate	80-62-6	c	nd	nd	nd	nd	c
4-Methyl-2-pentanone (MIBK)	108-10-1	pp	c	c	nd	nd	c
Naphthalene	91-20-3	c	nd	nd	c	nd	c
Nitrobenzene	98-95-3	c	nd	nd	nd	nd	c
2-Nitropropane	79-46-9	c	nd	nd	nd	nd	c
N-Nitroso-di-n-butylamine	924-16-3	pp	c	nd	nd	nd	c
Paraldehyde	123-63-7	pp	c	nd	nd	nd	c
Pentachloroethane	76-01-7	l	nd	nd	nd	nd	c
2-Pentanone	107-87-9	pp	c	nd	nd	nd	c
2-Picoline	109-06-8	pp	c	nd	nd	nd	c
1-Propanol	71-23-8	pp	c	nd	nd	nd	c
2-Propanol	67-63-0	pp	c	nd	nd	nd	c
Propargyl alcohol	107-19-7	pp	l	nd	nd	nd	c
B-Propiolactone	57-57-8	pp	nd	nd	nd	nd	c
Propionitrile (ethyl cyanide)	107-12-0	ht	c	nd	nd	nd	c
n-Propylamine	107-10-8	c	nd	nd	nd	nd	c
Pyridine	110-86-1	l	c	nd	nd	nd	c
Styrene	100-42-5	c	nd	c	c	c	c
1,1,1,2-Tetrachloroethane	630-20-6	c	nd	nd	c	c	c
1,1,2,2-Tetrachloroethane	79-34-5	c	nd	c	c	c	c
Tetrachloroethene	127-18-4	c	nd	c	c	c	c
Toluene	108-88-33	c	nd	c	c	c	c
Toluene-d8 (surr)	2037-26-5	c	nd	c	c	c	c
o-Toluene	95-53-4	pp	c	nd	nd	nd	c
1,2,4-Trichlorobenzene	120-82-1	c	nd	nd	c	nd	c
1,1,1-Trichloroethane	71-55-6	c	nd	c	c	c	c
1,1,2-Trichloroethane	79-00-5	c	nd	c	c	c	c
Trichloroethane	79-01-6	c	nd	c	c	c	c
Trichlorofluoromethane	75-69-4	c	nd	c	c	c	c
1,2,3-Trichloropropane	96-18-4	c	nd	c	c	c	c
Vinyl acetate	108-05-4	c	nd	c	nd	nd	c
Vinyl chloride	75-01-4	c	nd	c	c	c	c
Xylene (Total)	1330-20-7	c	nd	c	c	c	c

c= Adequate response by this technique
b= Chemical Abstract Services Registry Number
pp= Poor purging efficiency resulting in high EQLs
l= Inappropriate technique for this analyte
nd= Not determined
surr= Surrogate
IS= Internal Standard
ht= Method analyte only when purged at 80 C

pc= Poor chromatographic behavior

The following compounds are also amenable to analysis by Method 8260:

Bromombenzene	1,3-Dichloropropane
n-Butylbenzene	2,2-Dichloropropane
sec-Butlybenzene	1,1-Dichloropropene
tert-Butylbenzene	p-Isopropyltoluene
Chloroacetonitrile	Methyl acrylate
1-Chlorobutane	Methyl-t-butyl ether
1-Chlorohexane	Pentafluorobenzene
2-Chlorotoluene	n-Propylbenzene
4-Chlorotoluene	1,2,3-Trichlorobenzene
Dibromofluoromethane	1,2,4-Trimethylbenzene
Cis-1,2-Dichloroethene	1,3,5-Trimethylbenzene

Table 2. BFB Key Ions and Ion Abundance Criteria

mz	Required Intensity (relative abundance)
50	15 to 40% of m/z 95
75	30 to 60% of m/z 95
95	Base peak, 100% relative abundance
96	5 to 9% of m/z 95
173	less than 2% of m/z 174
174	Greater than 50% of m/z 95
175	5 to 9% of m/z 174
176	Greater than 95% but less than 101% of m/z 174
177	5 to9% of m/z 176

*Alternate tuning criteria may be used, (e.g. CLP, Method 524.2, or manufacturers' instructions), provided that method performance is not adversely affected.

Table 3. Volume of Medium Level Extracts for Dilution

Dilution Factor	Volume of Extract
1	100ul
2	50ul
5	20ul
10	10ul
20	5ul
25	4ul
40	2.5ul
50	2ul
100	1ul
200	50ul of a 1/10 Dilution

Table 4. Characteristic Masses (m/z) for Purgeable Organic Compounds

Analyte	Primary Characteristic Ion	Secondary Characteristic Ion(s)
Acetone	58	43
Acetonitrile	41	40,39
Acrolein	56	55,58
Acrylonitrile	53	52,51
Allyl alcohol	57	58,39
Allyl chloride	76	41,39,78
Benzene	78	-
Benzyl chloride	91	126,65,128
Bromoacetone	136	43,138,93,95
Bromobenzene	156	77,158
Bromochloromethane	128	49,130
Bromodichloromethane	83	85,127
Bromoform	173	175,254
Bromomethane	94	96
iso-Butanol	74	43
n-Butanol	56	41
2-Butanone	72	43
n-Butylbenzene	91	92,134
sec-Butylbenzene	105	134
tert-Butylbenzene	119	91,134
Carbon disulfide	76	78
Carbon tetrachloride	117	119
Chloral hydrate	82	44,84,86,111
Chloroacetonitrile	48	75
Chlorobenzene	112	77,114
1-Chlorobutane	56	49
Chlorodibromomethane	129	208,206
Chloroethane	64 (49*)	66 (51*)
2-Chloroethanol	49	44,43,51,80
bis-(2-Chloroethyl) sulfide	109	111,158,160
2-Chloroethyl vinyl ether	63	65,106
Chloroform	83	85
Chloromethane	50 (49*)	52 (51*)
Chloroprene	53	88,90,51
3-Chloropropionitrile	54	49,89,91
3-Chlorotoluene	91	126
4-Chlorotoluene	91	126
1,2-Dibromo-3-chloropropane	75	155,157
Dibromochloromethane	129	127
1,2-Dibromoethane	107	109,188
Dibromomethane	93	95,174
1,2-Dichlorobenzene	146	111,148
1,2-Dichlorobenzene-d_4	152	115,150
1,3-Dichlorobenzene	146	111,148
1,4-Dichlorobenzene	146	111,148
cis-1,4-Dichloro-2-butene	75	53,77,124,89
trans-1,4-Dichloro-2-butene	53	88,75

Analyte	Primary Characteristic Ion	Secondary Characteristic Ion(s)
Dichlorodifluoromethane	85	87
1,1-Dichlorothane	63	65,83
1,2-Dichloroethane	62	98
1,1-Dichlorothene	96	61,63
cis-1,2-Dichloroethene	96	61,98
trans-1,2-Dichloroethene	96	61,98
1,2-Dichloropropane	63	112
1,3-Dichloropropane	76	78
2,2-Dichloropropane	77	97
1,3-Dichloro-2-propanol	79	43,81,49
1,1-Dichloropropene	75	110,77
cis-1,3-Dichloropropene	75	77,39
trans-1,3-Dichloropropene	75	77,39
1,2,3,4-Diepoxybutane	55	57,56
Diethyl ether	74	45,59
1,4-Dioxane	88	58,43,57
Epichlorohydrin	57	49,62,51
Ethanol	31	45,27,46
Ethyl acetate	88	43,45,61
Ethylbenzene	91	106
Ethylene oxide	44	43,42
Ethyl methacrylate	69	41,99,86,114
Hexachlorobutadiene	225	223,227
Hexachloroethane	201	166,199,203
2-Hexanone	43	58,57,100
2-Hydroxypropionitrile	44	43,42,53
Iodomethane	142	127,141
Isobutyl alcohol	43	41,42,74
Isopropylbenzene	105	120
p-Isopropyl toluene	119	134,91
Malonitrile	66	39,65,38
Methacrylonitrile	41	67,39,52,66
Methyl acrylate	55	85
Methyl-t-butyl ether	73	57
Methylene chloride	84	86,49
Methyl ethyl ketone	72	43
Methyl iodide	142	127,141
Methyl methacrylate	69	41,100,39
4-Methyl-2-pentanone	100	43,58,85
Naphthalene	128	-
Nitrobenzene	123	51,77
2-Nitropropane	46	-
2-Picoline	93	66,92,78
Pentachloroethane	167	130,132,165,169
Propargyl alcohol	55	39,38,53
B-Propiolactone	42	43,44
Propionitrile (ethyl cyanide)	54	52,55,40
n-Propylamine	59	41,39
n-Propylbenzene	91	120

Analyte	Primary Characteristic Ion	Secondary Characteristic Ion(s)
Pyridine	79	52
Styrene	104	78
1,2,3-Trichlorobenzene	180	182,145
1,2,4-Trichlorobenzene	180	182,145
1,1,1,2-Tetrachloroethane	131	133,119
1,1,2,2-Tetrachloroethane	83	131,85
Tetrachloroethene	164	129,131,166
Toluene	92	91
1,1,1-Trichloroethane	97	99,61
1,1,2-Trichloroethane	83	97,85
Trichloroethene	95	97,130,132
Trichlorofluoromethane	151	101,153
1,2,3-Trichloropropane	75	77
1,2,4-Trimethylbenzene	105	120
1,3,5-Trimethylbenzene	105	120
Vinyl acetate	43	86
Vinyl chloride	62	64
o-Xylene	106	91
m-Xylene	106	91
p-Xylene	106	91
INTERNAL STANDARDS/SURROGATES		
Benzene-d6	84	83
Bromobenzene-d5	82	162
Bromochloromethane-d2	51	131
1,4-Difluorobenzene	114	
Chlorobenzene-d5	117	
1,4-Dichlorobenzene-d4	152	115,150
1,1,2-Trichloroethane-d3	100	
4-Bromofluorobenzene	95	174,176
Chloroform-d1	84	
Dibromofluoromethane	113	

Table 5. Job Summary Check List (Page 1 & 2)

GCMS VOLATILE JOB SUMMARY

JOB No._____ METHOD_____
SOIL LEVEL_____
LAB DUE DATE_____ INSTRUMENT_____
PURGE VOLUME_____

TUNE

FILE#_____ FILE#_____ FILE#_____
PASSED? Y N PASSED? Y N PASSED? Y N

CONTINUING CALIBRATION VALUES CALCULATED FROM CCV ____ INIT ____

FILE#_____ FILE#_____ FILE#_____
PTS OUT?_____ PTS OUT_____ PTS OUT_____
ACCEPTABLE Y N ACCEPTABLE Y N ACCEPTABLE Y N

INITIAL CALIBRATION

REFERENCED CURVE ID_____ REFERENCED CURVE ID_____
PASSED? Y N PASSED? Y N

ADD STD REFERENCED CURVE ID_____

FILE#_____ FILE#_____ FILE#_____

MSB	FILE#_____	FILE#_____	FILE#_____
	PASSED? Y N	PASSED? Y N	PASSED? Y N
	CMPDS OUT_____	CMPDS OUT_____	CMPDS OUT_____
MSBD	FILE#_____	FILE#_____	FILE#_____
	PASSED? Y N	PASSED? Y N	PASSED? Y N
	CMPDS OUT_____	CMPDS OUT_____	CMPDS OUT_____
VBLK	FILE#_____	FILE#_____	FILE#_____
	VBLK____	VBLK____	VBLK____
	ACCEPTABLE? Y N	ACCEPTABLE Y N	ACCEPTABLE Y N

COMMENTS AND CORRECTIVE MEASURES (see reverse side for comment # explanations)

#_____ Sample(s)_____
#_____ Sample(s)_____
#_____ Sample(s)_____
#_____ Sample(s)_____
#_____ Sample(s)_____

Other Comments_____
_____
_____
_____

ANALYST_____ DATE_____
2ND REVIEW_____ DATE_____
AIMS ENTRY_____ DATE_____
VALIDATOR _____ DATE_____

Comment #	Comment
1	NA
2	NA
3	Sample(s) was diluted for excessive foaming.
4	Sample(s) was diluted for non-target compounds (TICS) exceeding 5X the total response of one of the Internal Standards.
5	Sample(s) was diluted for sample matrix which resulted in method non-compliance for an Internal standard.
6	Sample(s) was diluted for sample matrix which resulted in method non-compliance for a surrogate
7	Sample(s) was diluted for TCLP matrix
8	Sample(s) was diluted for high levels of target compound(s).
9	NA
10	NA
11	Sample(s) was diluted due to insufficient volume for a lower dilution.
12	Sample(s) was diluted for viscosity.
13	Sample(s) was diluted for other reason.
14	As a result of low volume, the sample was analyzed from a vial with headspace.
15	Sample(s) was re-analyzed for surrogate recoveries outside of limits.
16	Sample(s) was re-analyzed for Internal Standard recoveries outside of limits
17	Matrix effect on Surrogate was confirmed by the analysis of ms & sd
18	Sample contains compounds which saturated the detector.This will result in non-linear results between the sample and the "DL"
19	Samples were analyzed by method 8260B.
20	Sample pH was greater than 2.
21	There was insufficient volume for re-anaylsis of the sample(s).
22	There was insufficient volume for dilution of the sample(s).
23	The VBLK was contaminated with compounds below the reporting limit.
24	The VBLK was contaminated with compounds above the reporting limit.
25	The MSB had a compound(s) outside of the method limits.
26	Sample was re-run and confimed results not consistent with historical.
27	See accompaning Job Exception Report
28	
29	
30	

Table 6

Certificate of Composition

DESCRIPTION: Volatile Organic Compounds Mix 6

CATALOG NO.: 48799-U

MFG DATE: Nov-2005

LOT NO.: LB34727

EXPIRATION DATE: Feb-2007

SOLVENT: METHANOL

MVSC 72 8-20

MVSC 73 1-7

ANALYTE (1)	CAS NUMBER	PERCENT PURITY (2)	WEIGHT CONCENTRATION (3)	SUPELCO LOT NO
BROMOMETHANE	74-83-9	99.9 (a)	2000	LB22203
CHLOROETHANE	75-00-3	98.7 (a)	2000	LB29285
CHLOROMETHANE	74-87-3	99.9 (a)	2000	LA66620
DICHLORODIFLUOROMETHANE	75-71-8	99.9 (a)	2000	LB24923
TRICHLOROFLUOROMETHANE	75-69-4	99.9 (a)	2000	LA79530
VINYL CHLORIDE	75-01-4	99.9	2000	LB18727

(1) Listed in alphabetical order.
(2) Determined by capillary GC-FID, unless otherwise noted.
a) GC; detector HALL
(3) NIST traceable weights are used to verify balance calibration with the preparation of each lot. Concentration of analyte in solution is ug/ml +/- 0.5%, uncertainty based upon balance and Class A volumetric glassware. Weights are corrected for analytes less than 98% pure.

Elwood Doughty
QA Manager

Supelco warrants that its products conform to the information contained in this publication. Purchaser must determine the suitability of the product for its particular use. Please see the latest catalog or order invoice and packing slip for additional terms and conditions of sale.

SUPELCO
595 North Harrison Road • Bellefonte, PA
16823-0048 USA • Phone (814) 359-3441

Table 7 - 54 Component

Certificate of Analysis

MVSC 19 15-20
20 1-4

PAGE 1 OF 2

DESCRIPTION: 502/524 Volatile Organics Calibration Mix

CATALOG NO.: 502111 MFG DATE: Nov-2003

LOT NO.: LB16275 EXPIRATION DATE: Mar-2006

SOLVENT: METHANOL

ANALYTE (1)	CAS NUMBER	PERCENT PURITY(2)	WEIGHT(3) CONCENTRATION	ANALYTICAL(4) CONCENTRATION		STD DEV	SUPELCO LOT NO
BENZENE	71-43-2	99.9	2000	2000	+/-	15.1	LB03979
BROMOBENZENE	108-86-1	99.9	2000	2009	+/-	17.4	LA97903
BROMOCHLOROMETHANE	74-97-5	99.7	2000	1967	+/-	33.3	LA67395
BROMODICHLOROMETHANE	75-27-4	99.9	2000	2103	+/-	0.1	LB15447
BROMOFORM	75-25-2	99.9	2000	1974	+/-	38.7	LB15898
CARBON TETRACHLORIDE	56-23-5	99.9	2000	1960	+/-	32.4	LA55581
CHLOROBENZENE	108-90-7	99.9	2001	2029	+/-	14.3	LB09884
CHLOROFORM	67-66-3	99.9	2000	2000	+/-	18.8	LA55585
CIS 1,3-DICHLOROPROPENE (Z)	10061-01-5	96.1	2000	2036	+/-	12.1	LA60646
CIS-1,2-DICHLOROETHYLENE	156-59-2	97.6	2000	1947	+/-	26.7	LA97197
DIBROMOCHLOROMETHANE	124-48-1	99.9	2001	2022	+/-	11.2	LA87237
DIBROMOMETHANE	74-95-3	99.8	2000	2000	+/-	33.6	LA39031
ETHYLBENZENE	100-41-4	99.5	2000	2040	+/-	8.0	LA40866
HEXACHLOROBUTADIENE	87-68-3	98.2	2001	1946	+/-	45.0	LA95300
ISOPROPYLBENZENE (CUMENE)	98-82-8	99.0	2000	2012	+/-	17.3	LB01119
M-XYLENE (5)	108-38-3	99.8	2001	*****			LB15074
METHYLENE CHLORIDE	75-09-2	99.9	2000	1957	+/-	28.9	LA88418
N-BUTYLBENZENE	104-51-8	98.7	2000	1996	+/-	25.3	LB09309
N-PROPYLBENZENE	103-65-1	99.9	2001	2028	+/-	15.6	LA92696
NAPHTHALENE	91-20-3	99.9	2000	1950	+/-	39.5	LA97766
O-XYLENE	95-47-6	99.5	2000	2022	+/-	9.8	LB08117
P-ISOPROPYLTOLUENE	99-87-6	99.9	2000	1986	+/-	20.7	LA41611
P-XYLENE (5)	106-42-3	99.9	2000	*****			LB04801
SEC-BUTYLBENZENE	135-98-8	99.4	2000	1993	+/-	31.6	LA51283
STYRENE	100-42-5	99.9	2001	2012	+/-	11.8	LB09037
TERT-BUTYLBENZENE	98-06-6	99.9	2000	1981	+/-	21.8	LB09550
TETRACHLOROETHENE	127-18-4	99.9	2001	2029	+/-	29.4	LB05248

(1) Listed in alphabetical order.

(2) Determined by capillary GC-FID, unless otherwise noted.

(3) NIST traceable weights are used to verify balance calibration with the preparation of each lot. Concentration of analyte in solution is ug/ml +/- 0.5%, based upon balance and Class A volumetric glassware. Weights are corrected for analytes less than 98% pure.

(4) Determined by chromatographic analysis against an independently prepared reference lot. Mean of replicate injections.

(5) These products coelute and are not quantified in the final mix.

Elwood Doughty
Quality Control Supervisor

Supelco warrants that its products conform to the information contained in this publication. Purchaser must determine the suitability of the product for its particular use. Please see the latest catalog or order invoice and packing slip for additional terms and conditions of sale.

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SLCo

Certificate of Analysis

MVSCM 15-20
20 1-4

PAGE 2 of 2

DESCRIPTION: 502/524 Volatile Organics Calibration Mix

CATALOG NO.: 502111 MFG DATE: Nov-2003

LOT NO.: LB16275 EXPIRATION DATE: Mar-2006

SOLVENT: METHANOL

ANALYTE (1)	CAS NUMBER	PERCENT PURITY(2)	WEIGHT(3) CONCENTRATION	ANALYTICAL(4) CONCENTRATION		STD DEV	SUPELCO LOT NO
TOLUENE	108-88-3	99.7	2001	2020	+/-	15.8	LA90411
TRANS 1,3-DICHLOROPROPENE (E)	10061-02-6	98.5	2000	2052	+/-	12.9	LB06449
TRANS-1,2-DICHLOROETHYLENE	156-60-5	99.9	2000	1910	+/-	36.2	LB02428
TRICHLOROETHYLENE	79-01-6	98.5	2001	1980	+/-	20.2	LB04303
1,1-DICHLOROETHANE	75-34-3	97.0	2000	1968	+/-	32.1	LA54711
1,1-DICHLOROETHYLENE	75-35-4	99.9	2000	1980	+/-	46.1	LB04593
1,1-DICHLOROPROPENE	563-58-6	98.0	2000	1958	+/-	20.8	LB12558
1,1,1-TRICHLOROETHANE	71-55-6	99.9	2000	1973	+/-	26.8	LB14220
1,1,1,2-TETRACHLOROETHANE	630-20-6	99.1	2001	2000	+/-	16.1	LB01555
1,1,2-TRICHLOROETHANE	79-00-5	99.3	2000	2038	+/-	12.6	LB03464
1,1,2,2-TETRACHLOROETHANE	79-34-5	97.5	2000	1974	+/-	31.7	LA86969
1,2-DIBROMO-3-CHLOROPROPANE	96-12-8	97.9	2000	1978	+/-	43.5	LB06608
1,2-DIBROMOETHANE	106-93-4	99.6	2001	2029	+/-	0.1	LA87068
1,2-DICHLOROBENZENE	95-50-1	99.9	2000	2008	+/-	29.2	LA96474
1,2-DICHLOROETHANE	107-06-2	99.9	2000	1974	+/-	25.7	LA88777
1,2-DICHLOROPROPANE	78-87-5	99.9	2000	2019	+/-	9.6	LB08115
1,2,3-TRICHLOROBENZENE	87-61-6	99.75	2000	1962	+/-	18.9	LA50762
1,2,3-TRICHLOROPROPANE	96-18-4	99.1	2000	2006	+/-	17.8	LA39379
1,2,4-TRICHLOROBENZENE	120-82-1	98.6	2000	1957	+/-	52.1	LB12944
1,2,4-TRIMETHYLBENZENE	95-63-6	98.2	2000	2000	+/-	22.0	LA39081
1,3-DICHLOROBENZENE,	541-73-1	99.9	2001	2013	+/-	16.7	LA72024
1,3-DICHLOROPROPANE	142-28-9	99.9	2000	2024	+/-	11.8	LB00875
1,3,5-TRIMETHYLBENZENE	108-67-8	99.0	2000	2011	+/-	13.6	LA94493
1,4-DICHLOROBENZENE	106-46-7	99.9	2000	1992	+/-	16.2	LA50188
2-CHLOROTOLUENE	95-49-8	99.9	2000	2005	+/-	23.6	LA95842
2,2-DICHLOROPROPANE	594-20-7	98.3	2000	1968	+/-	19.4	LB01750
4-CHLOROTOLUENE	106-43-4	99.9	2001	1990	+/-	15.0	LB05252

(1) Listed in alphabetical order.
(2) Determined by capillary GC-FID, unless otherwise noted.
(3) NIST traceable weights are used to verify balance calibration with the preparation of each lot. Concentration of analyte in solution is ug/ml +/- 0.5%, based upon balance and Class A volumetric glassware. Weights are corrected for analytes less than 98% pure.
(4) Determined by chromatographic analysis against an independently prepared reference lot. Mean of replicate injections.
(5) These products coelute and are not quantified in the final mix.

Elwood Doughty
Quality Control Supervisor

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Table 8. 8260 + Mix

8260X #1A MIXL 5 1/7-20

Chemical Standard Batch Sheet
Lot #: A042263

Catalog #: 552504A	**Target:** 1000 - 40000 ug/ml	
Description: Custom Volatiles Standard Mix A		
Solvent: P&T Methanol	**Solvent Lot:** 44337	**Final Volume:** 100 ml

Made by: Joe Tallon	**Date:** 1/4/2006 8:09:50A	
Tested by:	**Date:**	
	By:	**Date:**
Packaged by: Jackie Glasgow / Staci Bodle	**Date:** 1/4/2006 10:49:12/	**No. Units:** 12
Balance Used: AT261	**Serial #:** 1119141429	

Compound	CAS	Storage Location	Lot #	Purity	Target Conc(ug/ml)	Target Weight	Actual Weight	Calc Conc(ug/ml)
Carbon disulfide	75-15-0	FA1A5D	J11J02	0.99	1,000.00	100.00	100.00	1,000.00
Methyl-tert-butyl ether (	1634-04-4	FA1B6C	10660BD	0.97	1,000.00	100.00	100.00	1,000.00
Iodomethane (methyl	74-88-4	FA1C2A	13906AB	0.99	1,000.00	100.00	100.00	1,000.00
Ethyl methacrylate	97-63-2	FA1C1D	09316HC	0.99	1,000.00	100.00	100.00	1,000.00
Tetrahydrofuran	109-99-9	FA1B8B	01057MC	0.99	5,000.00	500.00	500.00	5,000.00
trans-1,4-dichloro-2-butene	110-57-6	FA1C1C	160-22DD	0.99	5,000.00	500.00	500.00	5,000.00
Acetonitrile	75-05-8	FA1B13A	12067KC	0.99	40,000.00	4,000.00	4,000.00	40,000.00
1,1,2-Trichlorotrifluoroetha	76-13-1	FA1A11A	01404PV	0.99	1,000.00	100.00	100.00	1,000.00
Methyl acetate	79-20-9	FA1C11C	47640/1	0.99	1,000.00	100.00	100.00	1,000.00
Methylcyclohexane	108-87-2	FA1E4A	02759BC	0.99	1,000.00	100.00	100.00	1,000.00
Cyclohexane	110-82-7	FA1C7A	03145KB	0.99	1,000.00	100.00	100.00	1,000.00

8260+ #1B MVSC5 1-720

Chemical Standard Batch Sheet
Lot #: A042264

Catalog #: 552504B	**Target:** 5000 ug/ml	
Description: Custom Volatiles Standard Mix B		
Solvent: P&T Methanol	**Solvent Lot:** A041266	**Final Volume:** 50 ml

Made by: Joe Tallon	**Date:** 1/4/2006 8:30:59A	
Tested by:	**Date:**	
	By:	**Date:**
Packaged by: Jackie Glasgow / Staci Bodle	**Date:** 1/4/2006 10:54:16A	**No. Units:** 12
Balance Used: AT261	**Serial #:** 1119141429	

Compound	CAS	Storage Location	Lot #	Purity	Target Conc(ug/ml)	Target Weight	Actual Weight	Calc Conc(ug/ml)
2-Chloroethyl vinyl ether	110-75-8	FA1A11D	03206CI	0.99	5,000.00	250.00	250.00	5,000.00

Certificate of Composition

8260 + #3

MVSC 42 4 → 13

DESCRIPTION: SEVERN TRENT LABS

QUOTE 20460869 LOT NO.: LB25705 MFG DATE: Dec-2004

SOLVENT: DEIONIZED WATER

ANALYTE (1)	CAS NUMBER	PERCENT PURITY (2)	WEIGHT CONCENTRATION (3)	SUPELCO LOT NO
ACROLEIN	107-02-8	98.4	20008 +/- 100.0	LB21530
ACRYLONITRILE	107-13-1	99.9	20000 +/- 100.0	LB25800

(1) Listed in alphabetical order.
(2) Determined by capillary GC-FID, unless otherwise noted.
(3) NIST traceable weights are used to verify balance calibration with the preparation of each lot. Concentration of analyte in solution is ug/ml +/- 0.5%, uncertainty based upon balance and Class A volumetric glassware. Weights are corrected for analytes less than 98% pure.

Elwood Doughty
QA Manager

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8260 #4 MVSC 5 1→10

Chemical Standard Batch Sheet
Lot #: A042268

Catalog #: 556843	**Target:** 5000 ug/ml	
Description: Custom Vinyl Acetate Standard		
Solvent: P&T Methanol	**Solvent Lot:** A038421	**Final Volume:** 25 ml

Made by: Joe Tallon	**Date:** 1/4/2006 9:40:21A	
Tested by:	**Date:**	
	By:	**Date:**
Packaged by: Jackie Glasgow / Staci Bodle	**Date:** 1/4/2006 10:58:29A	**No. Units:** 12
Balance Used: AT261	**Serial #:** 1119141429	

Compound	CAS	Storage Location	Lot #	Purity	Target Conc(ug/ml)	Target Weight	Actual Weight	Calc Conc(ug/ml)
Vinyl acetate	108-05-4	FA1A9A	08831CW	0.99	5,000.00	125.00	125.00	5,000.00

MVSC 23 6→20
24 1→75

Gravimetric Certificate

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Fax: (814)353-1309

FOR LABORATORY USE ONLY-READ MSDS PRIOR TO USE.

Catalog No.: 552501 Lot No.: A044128
Description: Custom Ketones Standard
Expiration Date[1]: March 2008 Storage: Freezer

Component #	Compound	CAS#	Percent Purity[2]	Concentration (weight/volume)[3]	Percent Uncertainty[4]
1	2-Butanone (MEK)	78-93-3	99%	5,000.00 ug/ml	+/-0.08 %
2	2-Hexanone	591-78-6	99%	5,000.00 ug/ml	+/-0.08 %
3	4-Methyl-2-pentanone (MIBK)	108-10-1	99%	5,000.00 ug/ml	+/-0.08 %
4	Acetone	67-64-1	99%	5,000.00 ug/ml	+/-0.08 %

Solvent: P/T Methanol/Water (90:10)

F. Joseph Jaflon - Mix Technician Balance: 1119141429

[1] ...tion date of the unopened ampul stored at recommended temperature.
[2] ... was determined by one or more of the following techniques: GC/FID, HPLC, GC/ECD, GC/MS. Value rounded to the ...earest LOWER whole percentage. In addition to detectors listed above, chemical identity and purity are confirmed using 1 or more of the following: MS, DSC, solid probe MS, GC/FPD, GC/NPD, GC/TC, FTIR, melting point, refractive index, and Karl Fisher. See data pack or contact Restek for further details.
[3] Based upon gravimetric preperation with balance calibration verified using NISTraceable weights (seven mass levels).
[4] Percent Uncertainty based upon balance AND ASTM Class A volumetric glassware accuracy.

ISO 9001 REGISTERED
Manufactured under Restek's ISO 9001 Registered Quality System Certificate #FM80397

Table 9. Second Source

ULTRA SCIENTIFIC
Analytical Solutions

60 Comp S. Source

Certificate of Analysis MUSC 71

VOC Mixture

Product DWM-588 **Expiration Date:** Dec-2008
Lot Number: CB-2659 **Page:** 1 of 3

This Certified Reference Material (CRM) was manufactured and verified in accordance with ULTRA's ISO 9001:2000 registered quality system, and the analyte concentrations were verified by our ISO 17025 accredited laboratory. The true value and uncertainty value at the 95% confidence level for each analyte, determined gravimetrically, is listed below.

Analyte	CAS#	Analyte Lot	True Value
bromochloromethane	000074-97-5	JS-16015HS	2006 ± 10 µg/mL
bromodichloromethane	000075-27-4	DU-14522LS	2006 ± 10 µg/mL
bromoform	000075-25-2	DU-06126KS	2006 ± 10 µg/mL
carbon tetrachloride	000056-23-5	01704MF	2006 ± 10 µg/mL
chloroform	000067-66-3	BS-03041BS	2006 ± 10 µg/mL
dibromochloromethane	000124-48-1	DO-12622CI	2006 ± 10 µg/mL
dibromomethane	000074-95-3	EM-01514TJ	2006 ± 10 µg/mL
methylene chloride	000075-09-2	44267	2006 ± 10 µg/mL
trichlorofluoromethane	000075-69-4	DR-16417BR	2006 ± 10 µg/mL
1,2-dibromoethane	000106-93-4	TB-101777	2006 ± 10 µg/mL
1,1-dichloroethane	000075-34-3	64552/1	2006 ± 10 µg/mL
1,2-dichloroethane	000107-06-2	KN-09446KN	2006 ± 10 µg/mL
1,1-dichloroethene	000075-35-4	01218EC	2007 ± 10 µg/mL
cis-1,2-dichloroethene	000156-59-2	13707BO	2006 ± 10 µg/mL
trans-1,2-dichloroethene	000156-60-5	DO-07817JR	2006 ± 10 µg/mL
1,1,1,2-tetrachloroethane	000630-20-6	CO-12312LI	2006 ± 10 µg/mL
1,1,2,2-tetrachloroethane	000079-34-5	10917TB	2006 ± 10 µg/mL
tetrachloroethene	000127-18-4	PS-00344BR	2006 ± 10 µg/mL
1,1,1-trichloroethane	000071-55-6	LU-13149TR	2006 ± 10 µg/mL
1,1,2-trichloroethane	000079-00-5	JB-0701HH	2006 ± 10 µg/mL
trichloroethene	000079-01-6	KN-08846KN	2006 ± 10 µg/mL

Balances used in the manufacture of this standard are calibrated with weights traceable to NIST in compliance with ANSI/NCSL Z-540-1 and ISO 9001.

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Dr. Edward Fitzgerald,
Senior Scientist

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Analytical Solutions

Certificate of Analysis

VOC Mixture

Product DWM-588 **Expiration Date:** Dec-2008
Lot Number: CB-2659 **Page:** 2 of 3

Analyte	CAS#	Analyte Lot	True Value
1,2-dibromo-3-chloropropane	000096-12-8	OGF-01	2005 ± 10 µg/mL
1,2-dichloropropane	000078-87-5	DC-120777	2005 ± 10 µg/mL
1,3-dichloropropane	000142-28-9	PR-17916MR	2006 ± 10 µg/mL
2,2-dichloropropane	000594-20-7	CI-05304BI	2005 ± 10 µg/mL
1,1-dichloropropene	000563-58-6	34768-21	2006 ± 10 µg/mL
cis-1,3-dichloropropene	010061-01-5	35072-03	2006 ± 10 µg/mL
trans-1,3-dichloropropene	010061-02-6	34251-41	2005 ± 10 µg/mL
hexachlorobutadiene	000087-68-3	339923/1	2005 ± 10 µg/mL
1,2,3-trichloropropane	000096-18-4	12020TF	2006 ± 10 µg/mL
naphthalene	000091-20-3	14205KB	2005 ± 10 µg/mL
benzene	000071-43-2	31072	2006 ± 10 µg/mL
n-butylbenzene	000104-51-8	AA-28519CO	2005 ± 10 µg/mL
sec-butylbenzene	000135-98-8	MR-11305DN	2006 ± 10 µg/mL
tert-butylbenzene	000098-06-6	MQ-04010MQ	2006 ± 10 µg/mL
ethylbenzene	000100-41-4	033067	2005 ± 10 µg/mL
isopropylbenzene	000098-82-8	EN-00621TG	2006 ± 10 µg/mL
4-isopropyltoluene	000099-87-6	PP-05104CP	2006 ± 10 µg/mL
n-propylbenzene	000103-65-1	LO-14503MR	2006 ± 10 µg/mL
styrene	000100-42-5	MQ-11229MQ	2005 ± 10 µg/mL
toluene	000108-88-3	43045	2006 ± 10 µg/mL
1,2,4-trimethylbenzene	000095-63-6	BO-13528BI	2006 ± 10 µg/mL
1,3,5-trimethylbenzene	000108-67-8	KM-02011HM	2007 ± 10 µg/mL
o-xylene	000095-47-6	DO-06834CO	2006 ± 10 µg/mL
m-xylene	000108-38-3	DI-00459CJ	2006 ± 10 µg/mL

Balances used in the manufacture of this standard are calibrated with weights traceable to NIST in compliance with ANSI/NCSL Z-540-1 and ISO 9001.

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Dr. Edward Fitzgerald,
Senior Scientist

ULTRA SCIENTIFIC
Analytical Solutions

Certificate of Analysis

VOC Mixture

Product DWM-588 **Expiration Date:** Dec-2008
Lot Number: CB-2659 **Page:** 3 of 3

Analyte	CAS#	Analyte Lot	True Value
p-xylene	000106-42-3	03747LN	2005 ± 10 µg/mL
1,4-dichlorobenzene	000106-46-7	06205KA	2005 ± 10 µg/mL
bromobenzene	000108-86-1	CG-02513MF	2006 ± 10 µg/mL
chlorobenzene	000108-90-7	63148HZ	2006 ± 10 µg/mL
2-chlorotoluene	000095-49-8	KS-06506BN	2005 ± 10 µg/mL
4-chlorotoluene	000106-43-4	CR-14512LQ	2005 ± 10 µg/mL
1,2-dichlorobenzene	000095-50-1	08946KY	2005 ± 10 µg/mL
1,3-dichlorobenzene	000541-73-1	JN-05902LZ	2006 ± 10 µg/mL
1,2,3-trichlorobenzene	000087-61-6	LI-12912PF	2006 ± 10 µg/mL
1,2,4-trichlorobenzene	000120-82-1	00334TQ	2006 ± 10 µg/mL
bromomethane	000074-83-9	06623AQ	2008 ± 10 µg/mL
chloroethane	000075-00-3	00223KG	2009 ± 10 µg/mL
chloromethane	000074-87-3	07-44048	2009 ± 10 µg/mL
dichlorodifluoromethane	000075-71-8	N960053	2008 ± 10 µg/mL
vinyl chloride	000075-01-4	UN-1086	2009 ± 10 µg/mL

Matrix: methanol (methyl alcohol)

Balances used in the manufacture of this standard are calibrated with weights traceable to NIST in compliance with ANSI/NCSL Z-540-1 and ISO 9001.

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ISO 9001
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Cert. No. 0851- 01

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Dr. Edward Fitzgerald,
Senior Scientist

Table10. 8260+ Second Source

8260+#1 Sec Source MVSC61→10

Certificate of Composition

DESCRIPTION: SEVERN TRENT LABS

QUOTE 20687608 LOT NO.: LB35787 EXPIRATION DATE: Jan-2007

SOLVENT: METHANOL

ANALYTE (1)	CAS NUMBER	PERCENT PURITY (2)	WEIGHT CONCENTRATION (3)	SUPELCO LOT NO
ACETONITRILE	75-05-8	99.9	40001 +/- 200.0	LB34175
CARBON DISULFIDE	75-15-0	99.9 (a)	999 +/- 5.0	LB09107
CYCLOHEXANE	110-82-7	99.9	1000 +/- 5.0	LB18076
ETHYL METHACRYLATE	97-63-2	99.3	1002 +/- 5.0	LA29651
FREON 113	76-13-1	99.9 (b)	1001 +/- 5.0	LA33286
METHYL ACETATE	79-20-9	98.1	1001 +/- 5.0	LB32233
METHYL CYCLOHEXANE	108-87-2	99.8	1001 +/- 5.0	LB06982
METHYL TERT-BUTYL ETHER	1634-04-4	99.9	1002 +/- 5.0	LB34302
TETRAHYDROFURAN	109-99-9	97.4	4999 +/- 25.0	LA58136
TRANS-1,4-DICHLORO-2-BUTENE	110-57-6	98.2	5002 +/- 25.0	LB10202
1-CHLOROHEXANE	544-10-5	99.9	1000 +/- 5.0	LB18907

(1) Listed in alphabetical order.
(2) Determined by capillary GC-FID, unless otherwise noted.
a) GC; detector FPD
b) GC; detector HALL
(3) NIST traceable weights are used to verify balance calibration with the preparation of each lot. Concentration of analyte in solution is ug/ml +/- 0.5%, uncertainty based upon balance and Class A volumetric glassware. Weights are corrected for analytes less than 98% pure.

Elwood Doughty
QA Manager

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8260+#'s Sec Source MVSC6 11→20

Certificate of Composition

DESCRIPTION: SEVERN TRENT LABS

QUOTE 20687609 LOT NO.: LB35788 EXPIRATION DATE: Jan-2007

SOLVENT: DEIONIZED WATER 50 %
METHANOL 50 %

ANALYTE (1)	CAS NUMBER	PERCENT PURITY (2)	WEIGHT CONCENTRATION (3)	SUPELCO LOT NO
ACETONE	67-64-1	99.9	5004 +/- 25.0	LB31953
IODOMETHANE	74-88-4	99.9	1004 +/- 5.0	LA73149
VINYL ACETATE	108-05-4	99.9	5002 +/- 25.0	LB31606
2-BUTANONE	78-93-3	99.9	5004 +/- 25.0	LB19842
2-HEXANONE	591-78-6	99.9	5004 +/- 25.0	LB08447
4-METHYL-2-PENTANONE	108-10-1	99.9	5004 +/- 25.0	LA99226

(1) Listed in alphabetical order.
(2) Determined by capillary GC-FID, unless otherwise noted.
(3) NIST traceable weights are used to verify balance calibration with the preparation of each lot. Concentration of analyte in solution is ug/ml +/- 0.5%, uncertainty based upon balance and Class A volumetric glassware. Weights are corrected for analytes less than 98% pure.

Elwood Doughty
QA Manager

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Certificate of Analysis

MUSC 66 3-7

DESCRIPTION: 2-Chloroethyl vinyl ether

CATALOG NO.: 40017 MFG DATE: Feb-2005

LOT NO.: LB27794 EXPIRATION DATE: Feb-2008

SOLVENT: METHANOL

ANALYTE	CAS NUMBER	PERCENT PURITY(1)	WEIGHT(2) CONCENTRATION	ANALYTICAL(3) CONCENTRATION	STD DEV	SUPELCO LOT NO
2-CHLOROETHYL VINYL ETHER	110-75-8	99.9	5000	5000	+/- 55.9	LB01239

(1) Determined by capillary GC-FID, unless otherwise noted.
(2) NIST traceable weights are used to verify balance calibration with the preparation of each lot. Concentration of analyte in solution is ug/ml +/- 0.5%, uncertainty based upon balance and Class A volumetric glassware. Weights are corrected for analytes less than 98% pure.
(3) Determined by chromatographic analysis against an independently prepared reference lot. Mean of replicate injections.

Elwood Doughty
Quality Control Supervisor

SUPELCO
595 North Harrison Road
Bellefonte, PA 16823-0048 USA
Phone (814) 359-3441

Certificate of Composition

8260 #3 Sec. Source
MVSC 7
1-7/10

DESCRIPTION: SEVERN TRENT LABS

QUOTE 20687606 LOT NO.: LB35789 EXPIRATION DATE: Jul-2006

SOLVENT: DEIONIZED WATER

ANALYTE (1)	CAS NUMBER	PERCENT PURITY (2)	WEIGHT CONCENTRATION (3)	SUPELCO LOT NO
ACROLEIN	107-02-8	98.4	20012 +/- 100.1	LB21530
ACRYLONITRILE	107-13-1	99.9	20008 +/- 100.0	LB25800

(1) Listed in alphabetical order.
(2) Determined by capillary GC-FID, unless otherwise noted.
(3) NIST traceable weights are used to verify balance calibration with the preparation of each lot. Concentration of analyte in solution is ug/ml +/- 0.5%, uncertainty based upon balance and Class A volumetric glassware. Weights are corrected for analytes less than 98% pure.

Elwood Doughty
QA Manager

Supelco warrants that its products conform to the information contained in this publication. Purchaser must determine the suitability of the product for its particular use. Please see the latest catalog or order invoice and packing slip for additional terms and conditions of sale.

SUPELCO
595 North Harrison Road • Bellefonte, PA
16823-0048 USA • Phone (814) 359-3441

Table 11. 8260 Add

MVSC 71-18-20
72-01-07

Chemical Standard Batch Sheet
Lot #: A042005

Catalog #: 552546	Target: 2000-80000 ug/ml	
Description: Custom Volatiles Standard		
Solvent: P&T Methanol	Solvent Lot: 44337	Final Volume: 100 ml

Made by: Ryan Miller	Date: 12/19/2005 10:12:2
Tested by:	Date:
	By: Date:
Packaged by: / SLB / JG	Date: 12-20-05 No. Units: 12
Balance Used: AT400	Serial #: 1113372841

Compound	CAS	Storage Location	Lot #	Purity	Target Conc(ug/ml)	Target Weight	Actual Weight	Calc Conc(ug/ml)
Allyl chloride (	107-05-1	FA1B13D	00305HO	0.99	2,000.00	200.00	200.00	2,000.00
Chloroprene	126-99-8	FA1D8B	051215JLM	0.99	2,000.00	200.00		0.00
Pentachloroethane	76-01-7	FA1C3B	OGL01	0.98	2,000.00	200.00	200.00	2,000.00
1,1,2-Trichlorotrifluoroetha	76-13-1	FA1A11A	01404PV	0.99	2,000.00	200.00	200.00	2,000.00
Dichlorodifluoromethane	75-71-8	HOOD	A042007	0.99	2,000.00		4.20 (ml)	1,978.41
Dichlorofluoromethane	75-43-4	HOOD	A042008	0.99	2,000.00		3.10 (ml)	1,974.39
Chlorodifluoromethane	75-45-6	VOA Lab	A042009	0.99	2,000.00		2.40 (ml)	2,016.62
Ethyl acetate	141-78-6	FA1C5B	11073ED	0.99	2,000.00	200.00	200.00	2,000.00
Diisopropyl ether (DIPE)	108-20-3	FA1C2B	13450CB	0.99	2,000.00	200.00	200.00	2,000.00
Hexachloroethane	67-72-1	RA1B6D	12719A0	0.99	2,000.00	200.00	200.00	2,000.00
Methyl methacrylate	80-62-6	FA1C2D	09505TO	0.99	2,000.00	200.00	200.00	2,000.00
Methacrylonitrile	126-98-7	FA1C2C	04406MI	0.99	2,000.00	200.00	200.00	2,000.00
Diethyl ether (ethyl ether)	60-29-7	FA1C1A	17676TQ	0.99	2,000.00	200.00	200.00	2,000.00
2-Nitropropane	79-46-9	RA1C11C	04609PN	0.98	10,000.00	1,000.00	1,000.00	10,000.00
Pr nitrile	107-12-0	FA1C3D	10101EB	0.98	20,000.00	2,000.00	2,000.00	20,000.00
Cyclohexanone	108-94-1	RA1D2B	10513PA	0.99	20,000.00	2,000.00	2,000.00	20,000.00
ert-Butanol (TBA)	75-65-0	RA1H2D	06648PC	0.99	40,000.00	4,000.00	4,000.00	40,000.00
l-Butanol	71-36-3	FA1G1B	8238	0.99	80,000.00	8,000.00	8,000.00	80,000.00
sobutanol	78-83-1	FA1C3A	00439HD	0.99	80,000.00	8,000.00	8,000.00	80,000.00
l,4-Dioxane	123-91-1	RA1H3B	03053BD	0.99	80,000.00	8,000.00	8,000.00	80,000.00

Add + MVSC 74 18→20
L 75 1→7

CERTIFICATE OF COMPOSITION

FOR LABORATORY USE ONLY - READ MSDS PRIOR TO USE

110 Benner Circle
Bellefonte, PA 16823-8812
Tel: (800) 356-1688
Fax: (814) 353-1309

Catalog No.: 558661 Lot No.: A042271

Description: Custom Volatiles Standard

Expiration Date[1]: July 2007 Storage: Freezer

Elution Order	Compound	CAS#	Percent Purity[2]	Concentration[3]	Percent Uncertainty[4]
1	2-Propanol (isopropanol)	67-63-0	99%	20000 ug/mL	+/- 0.1
2	1-Propanol	71-23-8	99%	20000 ug/mL	+/- 0.1
3	n-Hexane (C6)	110-54-3	99%	1000 ug/mL	+/- 0.1
4	Acetaldehyde dimethyl acetal	534-15-6	99%	5000 ug/mL	+/- 0.1
5	Ethyl-tert-butyl ether (ETBE)	637-92-3	99%	1000 ug/mL	+/- 0.1
6	tert-Amyl methyl ether (TAME)	994-05-8	99%	1000 ug/mL	+/- 0.1
7	n-Heptane (C7)	142-82-5	99%	1000 ug/mL	+/- 0.1
8	2-Chlorobenzotrifluoride	88-16-4	99%	1000 ug/mL	+/- 0.1
9	3-Chlorobenzotrifluoride	98-15-7	99%	1000 ug/mL	+/- 0.1
10	4-Chlorobenzotrifluoride	98-56-6	98%	1000 ug/mL	+/- 0.1
11	3-Chlorotoluene	108-41-8	99%	1000 ug/mL	+/- 0.1
12	1,2,3-Trimethylbenzene	526-73-8	99%	1000 ug/mL	+/- 0.1
13	Dicyclopentadiene	77-73-6	98%	1000 ug/mL	+/- 0.1
14	1,3,5-Trichlorobenzene	108-70-3	99%	1000 ug/mL	+/- 0.1
	Solvent: P&T Methanol	67-56-1	99%		

Column:
105m x .32mm x 1.8um
Rtx-502.2 (cat #10921)

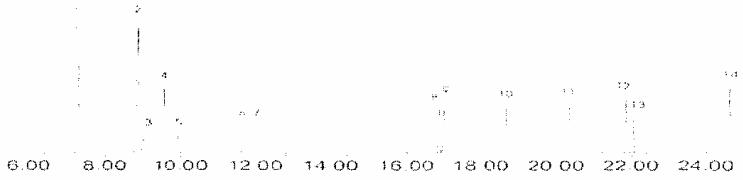
Carrier Gas:
helium @ 2.2 ml/min

Temp. Program:
40°C (hold 2 min.) to 240°C
@ 8°C/min (hold 10 min.)

Inj. Temp:
200°C

Det. Temp:
250°C

Det. Type:
MSD



Manufactured By: FJT
John Liggett - QA Analyst

1 Expiration date of the unopened ampul stored at recommended temperature
2 Purity was determined by one or more of the following techniques: GC/FID, HPLC, GC/ECD, GC/MS. Value rounded to the nearest LOWER whole percentage. In addition to detectors listed above, chemical identity and purity are confirmed using 1 or more of the following: MS, DSC, solid probe MS, GC/FPD, GC/NPD, GC/TC, FTIR, melting point, refractive index, and Karl Fisher. See data pack or contact Restek for further details.
3 Based upon gravimetric preperation with balance calibration verified using NISTtraceable weights (7 mass levels)
4 Percent Uncertainty based upon balance AND ASTM Class A volumetric glassware accuracy.

ISO 9001 REGISTERED
Manufactured Under Restek's ISO 9001 Registered Quality System
Certificate #FM80397

Table 12. BFB; IS & SS

MVSC 3 1-710

RESTEK

CERTIFICATE OF ANALYSIS

FOR LABORATORY USE ONLY - READ MSDS PRIOR TO USE

110 Benner Circle
Bellefonte, PA 16823-8812
Tel: (800) 356-1688
Fax: (814) 353-1309

Catalog No.: 30067 Lot No.: A038650

Description: 4-Bromofluorobenzene Standard

Expiration Date[1]: January 2010 Storage: Freezer

Elution Order	Compound	CAS#	Percent Purity[2]	Concentration[3]	Percent Uncertainty[4]
1	1-Bromo-4-fluorobenzene (BFB)	460-00-4	99%	2500 ug/mL	+/- 0.1
	Solvent: P&T Methanol	67-56-1	99%		

Column:
105m x .53mm x 3.0um
Rtx-502.2 (cat.#10910)

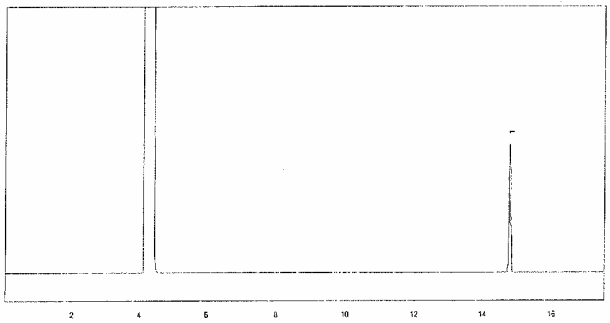
Carrier Gas:
hydrogen @ 40 cm/sec

Temp. Program:
50°C to 240°C @ 10°C/min.

Inj. Temp:
200°C

Det. Temp:
250°C

Det. Type:
FID



Manufactured By: MEW

John Lidgett - QA Analyst

1 Expiration date of the unopened ampul stored at recommended temperature.
2 Purity was determined by one or more of the following techniques: GC/FID, HPLC, GC/ECD, GC/MS. Value rounded to the nearest LOWER whole percentage. In addition to detectors listed above, chemical identity and purity are confirmed using 1 or more of the following: MS, DSC, solid probe MS, GC/FPD, GC/NPD, GC/TC, FTIR, melting point, refractive index, and Karl Fisher. See data pack or contact Restek for further details.
3 Based upon gravimetric preperation with balance calibration verified using NIST traceable weights (7 mass levels).
4 Percent Uncertainty based upon balance AND ASTM Class A volumetric glassware accuracy.

ISO 9001 REGISTERED
Manufactured Under Restek's ISO 9001 Registered Quality System
Certificate #FM80397

Page 1 1

MWSC08 (11-20)

CERTIFICATE OF ANALYSIS

FOR LABORATORY USE ONLY - READ MSDS PRIOR TO USE

110 Benner Circle
Bellefonte, PA 16823-8812
Tel: (800) 356-1688
Fax: (814) 353-1309

Catalog No.: 30091 Lot No.: A036981

Description: L/C VOA Internal Standard Mix

Expiration Date[1]: April 2010 Storage: Freezer

Elution Order	Compound	CAS#	Percent Purity[2]	Concentration[3]	Percent Uncertainty[4]
1	1,4-Difluorobenzene	540-36-3	99%	2500 ug/mL	+/- 0.1
2	Chlorobenzene-d5	3114-55-4	99%	2500 ug/mL	+/- 0.1
3	1,4-Dichlorobenzene-d4	3855-82-1	99%	2500 ug/mL	+/- 0.1
	Solvent: P&T Methanol	67-56-1	99%		

Column:
105m x .53mm x 3.0um
Rtx-502.2 (cat #10910)

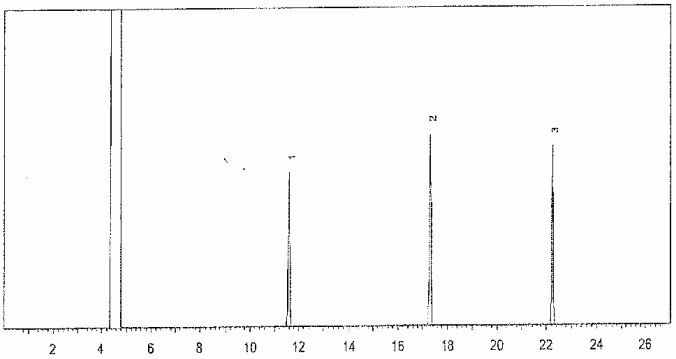
Carrier Gas:
hydrogen @ 40 cm/sec.

Temp. Program:
40°C (hold 2 min) to 240°C
@ 8°C/min.

Inj. Temp:
200°C

Det. Temp:
250°C

Det. Type:
FID



Manufactured By: n/a

John Lidgett - Q.A. Analyst

1 Expiration date of the unopened ampul stored at recommended temperature.
2 Purity was determined by one or more of the following techniques: GC/FID, HPLC, GC/ECD, GC/MS. Value rounded to the nearest LOWER whole percentage. In addtion to detectors listed above, chemical identity and purity are confirmed using 1 or more of the following: MS, DSC, solid probe MS, GC/FPD, GC/NPD, GC/TC, FTIR, melting point, refractive index, and Karl Fisher. See data pack or contact Restek for further details.
3 Based upon gravimetric preperation with balance calibration verified using NISTtraceable weights (7 mass levels).
4 Percent Uncertainty based upon balance AND ASTM Class A volumetric glassware accuracy.

ISO 9001 REGISTERED
Manufactured Under Restek's ISO 9001 Registered Quality System Certificate #FM80397

Page 1 1

ULTRA SCIENTIFIC
Analytical Solutions

Certificate of Analysis

MVSC { 73 18-20
74 1-17

Method 8260 Surrogate Standard Mixture

Product STM-530 (4) Comp 5.0r **Expiration Date:** Sep-2008
Lot Number: CB-1899 **Page:** 1 of 1

This Certified Reference Material (CRM) was manufactured and verified in accordance with ULTRA's ISO 9001:2000 registered quality system, and the analyte concentrations were verified by our ISO 17025 accredited laboratory. The true value and uncertainty value at the 95% confidence level for each analyte, determined gravimetrically, is listed below.

Analyte	CAS#	Analyte Lot	True Value
4-bromofluorobenzene	000460-00-4	12515BO	2512 ± 13 µg/mL
dibromofluoromethane	001868-53-7	90004843	2512 ± 13 µg/mL
1,2-dichloroethane-d4	017060-07-0	PSO 5A-048	2512 ± 13 µg/mL
toluene-d8	002037-26-5	PSO AG-433	2510 ± 13 µg/mL

Matrix: methanol (methyl alcohol)

Balances used in the manufacture of this standard are calibrated with weights traceable to NIST in compliance with ANSI/NCSL Z-540-1 and ISO 9001.

Quality System
Quality Endorsed Company ISO 9001 SAI Global Registered

ACCREDITED
ISO 17025 Cert. No. 0851- 01

250 Smith Street, North Kingstown, RI 02852 USA
401-294-9400 Fax: 401-295-2330
www.ultrasci.com

Edward Fitzgerald
Dr. Edward Fitzgerald, Senior Scientist

Centek Laboratories, LLC
Laboratory Division

Centek No.: TS-80
Regulation: EPA TO15

Laboratory SOP

Revision No. 1
Last Update: 02/2006

Volatile Organic Compounds By Gas Chromatography / Mass Spectroscopy and Cyro-focusing

Approved:

_____
Russell J Pellegrino,
Technical Director

_____
Nick Scala, Quality Assurance Officer

_____
Russ Pellegrino, VOC Manager

1.0 PURPOSE

1.1 This SOP describes the procedure to determine whole air samples that are collected in a canister. VOC's are cryofocused on a glass trap, then concentrated on a Tenax trap and finally refocused. The sample is then injected into a GC column, and passed to an MS detector for identification and quantification. The compounds determined by this method are listed in Table 1.

1.2 This procedure may be used for the following matrices and regulations:

Matrix	Regulation
Air	EPA

2.0 RESPONSIBILITIES

2.1 All GC/MS analysts performing this method are required to read and understand the method as written in the Compendium of methods for the Determination of Toxic Organic Compounds in Ambient Air TO-15 and are required to meet all QC requirements before attempting analysis of samples.

2.2 The section supervisor is required to read and understand the method as written but is also responsible for the training and continued education of technicians performing this method.

2.3 The section supervisor is required to review reports and packages to ensure that all data are valid prior to client receipt.

3 .0 DEFINITIONS

3.1 GC/MS: Gas Chromatography/Mass Spectroscopy

3.2 Capillary: Analytical column with an internal diameter less than or equal to 0.34 mm

3.3 EICP: Extracted ion current profile: Each compound contains a quantitation ion that is singled out and displayed as a peak

3.4 LIMS: Laboratory Information Management System

3.5 PQL: Practical Quantitation Limit

3.6 MDL: Method Detection Limit

3.7 IDL: Instrument Detection Limit

3.8 AMU: Atomic Mass Unit

3.9 VOA: Volatile Organic Compounds

3.10RSD: Relative Standard Deviation

3.11 RRF: Relative Standard Deviation

3.12 NIST: National Institute of Science and Technology

3.13 CRQL: Contract Required Quantitation Limit

3.14 QAPP: Quality Assurance Project Plan

3.15 LCS: Laboratory Control Sample

4.0 METHOD SUMMARY

4.1 Whole air samples that are collected in a specially prepared canister. VOC's are cryofocused on a glass trap, then concentrated on a sorent trap and finally refocused on a third trap

4.2 The volatile compounds are introduced in to the GC/MS by injecting the sample extract into the Gas Chromatograph (GC) with a narrow-bore fused-silica capillary column. The GC column is temperature programmed to separate the analytes, which are then detected with the MS connected to the GC.

4.3 The analytes eluted from the capillary column are introduced into the MS via auto injection. The identification of target analytes is accomplished by comparing their mass spectra with the electron impact spectra of authentic standards. Quantitation is accomplished by comparing the response of a major (quantitative) ion relative to an internal standard using a five-point calibration curve.

5.0 SAFETY

5.1 Most volatile compounds are considered hazardous. Always wear gloves and a lab coat when handling stocks and solutions.

5.2 Safety glasses with side shields are required whenever you are in the laboratory.

5.3 It is very important that special precaution be used when working with liquid nitrogen. The holding tanks are very heavy and the liquid nitrogen will cause burns.

6.0 INTERFERENCES

6.1 Raw GC/MS data from all samples and blanks must be evaluated for interference. Determine if the source of interference is in the preparation of the samples and take corrective action to eliminate the problem.

6.2 Contamination by carryover can occur whenever high-concentration and low-concentration samples are sequentially analyzed. Whenever an unusually concentrated sample is analyzed, it should be followed by the analysis of an instrument blank to check for cross-contamination.

7.0 APPARATUS AND MATERIALS

7.1 Instrument 6890N Series GC in conjunction with 5973N mass spectrometer capable of scanning from 35 to 300 amu every 1-second or less, using 70 volts (nominal) electron energy.

7.2 Entech 7100 Preconcentrator with an Entec7032L auto sampler capable of cryofocusing and concentrating samples using three separate modules.

7.2 Analytical Chromatography columns: 0.34mm ID x 60 M length and 1.4 um film thickness silicone-coated capillary column- DB-5 VRX by J & W Scientific or equivalent.

7.3 GC/MS Interface - GC to MS interface that gives acceptable calibration points at 50 ppbv per injection for each compound of interest and achieves acceptable tuning performance criteria may be used.

7.4 Data System – The computer system used is the HP Chem Station G1701DA system with Revision D.00.01 software package. This system is interfaced to the mass spectrometer. The system has continuous acquisition and storage on machine- readable media of all mass spectra obtained throughout the duration of the chromatographic program. The system has software that can search any GC/MS data file for ions of a specific mass and that can plot such ion abundance versus time or scan number. This type of plot is defined as an Extracted Ion Current Profile. The software allows integration of the abundance in any EICP between specified times or scan number limits. NBS95K version Mass Spectral Library is being used.

8.0 CHEMICALS AND REAGENTS

8.1 Helium @ 99.9999% purity

8.2 Liquid nitrogen (see section 5.3)

8.3 Stock standards

8.3.1 Stock standard solutions can be prepared from pure standard materials or purchased as certified solutions.

8.3.2 Stock standard solutions must be stored at room temperature, or as recommended by the manufacturer.

8.3.3 Stock standard solutions must be replaced after 1 year, or sooner if comparison with check standards indicates a problem.

8.4 Internal standard solutions

8.4.1 The recommended internal standards are Bromochloromethane, 1,4-Dichlorobenzene and Chlorobenzene.

8.4.2 Each 100cc of sample extract undergoing analysis and the calibration standards must be spiked with 50ppbv of each internal standard and surrogate.

8.5 GC/MS Tuning standard

8.5.1 A air sample solution containing 50ppbv of Bromofluorobenzene (BFB) must be prepared. The standard could also contain 50ppb each of internal standards.

8.5.2 The tuning standard may be– stored room temperature when not in use. When using premixed certified solutions, store according to the manufacturer's documented holding time and storage temperature recommendations.

8.6 Intermediate (working) standard

8.6.1 The working standard is prepared at 100 ppbv and 25 ppbv. It is used to make calibration standards. The working standard must contain all analytes of interest. Also a working standard is prepared at 50 ppbv containing internal standards and surrogate.

8.6.2 Working standard must be prepared every six months or sooner if comparisons with check standards indicates a problem.

8.7 Calibration standards

8.7.1 A minimum of five calibration standards must be prepared at five different concentrations. One of the calibration standards must correspond to a sample concentration at or below that necessary to meet the data quality objectives of the project. The remaining standards must correspond to the range of concentrations found in the actual samples.

8.7.2 See Table 1 for targets, surrogates, internal standards and the concentrations of the calibration standards.

8.7.3 Internal standards and surrogate is added to all calibration standards.

8.8 Internal Standards and Surrogate

8.8.1 Internal standard and surrogates are added to all calibration standards. See Table 1 for concentration.

8.8.2 The internal standard and surrogate must be prepared every six months or sooner if comparison with a check standard indicates a problem.

8.8.3 The internal standard and surrogate must be stored at room temperature.

9.0 SAMPLE COLLECTION, PRESERVATION AND HANDLING

9.1 Whole air samples are to be collected in 400cc "mini"-canister and kept at room temperature. Samples must be extracted within 14 days of collection.

9.2 Whole air samples can also be collected in Tedlar bags and kept at room temperature. Samples must be extracted within 72 hours of collection.

9.4 Program specific holding time requirements if any, must take precedence over the above-mentioned guidelines.

9.5 Samples, extracts and standards must be stored at separate locations to avoid cross-contamination.

10.0 PROCEDURE

10.1 Sample preparation

10.1.1 Once the samples have been collected and brought to room temperature. A pressure gauge is connected to the canister inlet. This will indicate the amount of sample that was collected. If amount is less the 100cc a volume of nitrogen has to be added. This volume has to be recorded for a dilution.

10.2 Analytical Procedure

10.2.1 Instrument maintenance

10.2.1.1 Appropriate instrument maintenance must be performed prior to initial calibration.

10.2.2 Instrument conditions

10.2.2.1 The following GC/MS instrument conditions are recommended:

Mass range:	35-300 amu
Scan time:	1 sec/scan
Initial temperature:	40 ^{0}C, hold for 4 minutes
Temperature program	40-250 ^{0}C at 10 ^{0}C /minute
Final temperature:	250 ^{0}C, hold until hexachloro-1,3-butadiene elutes and 1-3 more minutes.
Injector temperature:	110-150 ^{0}C
Injection volume:	100cc
Carrier gas:	Helium at 30 cm/sec

10.3 Instrument Calibration

10.3.1 Instrument Performance Check: Prior to any data collection activities involving samples, blanks, or standards it is necessary to show that the GC/MS system meets the instrument performance criteria below. The purpose of this check is to assure the correct mass calibration, mass resolution, and mass transmission. This is accomplished by the analysis of a 50-ppbv g injection of BFB.

10.3.1.1 BFB must meet the criteria before standards and samples are analyzed. The criteria must be demonstrated each 24-hour period that samples are analyzed. The BFB is analyzed once at the beginning of each 24-hour period during which samples or standards are analyzed. The 24-hour period begins with the injection time of the BFB and ends after 24 hours according to the system clock. The following abundance criteria is required before continuing analyses:

10.3.1.2 For tuning, the following approach has been found to be useful. Three scans (the peak apex scan and the scans immediately preceding and following the apex) are averaged. Alternately, other documented tuning criteria may be used, provided that method performance is not adversely affected. Background subtraction is required, and must be accomplished using a single scan acquired no more than 20 scans prior to the elution of BFB. The background subtraction is designed to eliminate column bleed and instrument background ions.

10.3.1.3 Tune acceptance criteria:

Mass	Ion Abundance Criteria
50	15.0-40.0 percent of mass 95
75	30.0-60.0 percent of mass 95
95	base peak, 100 percent relative abundance
96	5.0-9.0 percent of mass 95
173	Less than 2.0 percent of mass 174
174	greater than 50.0 percent of mass 95
175	5.0-9.0 percent of mass 174
176	Greater than 95.0 percent but greater than 101.0 percent of mass 174
177	5.0-9.0 percent of mass 176

10.3.2 Calibration standards must be analyzed once BFB meets acceptance criteria.

10.3.3 Calibration

10.3.3.1 A 5-point calibration curve must be analyzed prior to sample analysis. Dilute the intermediate standard (100-ppbv) as necessary to obtain the concentrations of 5,25,50,75, and 100 ppbv. The internal standards must be added at 50 ppbv to each concentration level (see list below). Analyze each standard in increasing concentration order to determine the instrument sensitivity and linearity of the GC/MS response for the target compounds. Analyze the following from each working standard canister:

From the 100ppbv working standard canister:

100ppv standard…use 100cc
75 ppbv standard…use 75cc
50 ppbv standard…use 50cc

From the 25ppbv working standard canister:

25ppv standard…use 100cc
5 ppbv standard…use 205cc

10.3.3.2 Label the calibration standards in the sequence as follows:

ASTD100, STD 1
ASTD75, STD 1
ASTD50, STD 1
ASTD25, STD 1
ASTD5, STD 1

10.3.3.3 calculate the response factor for each compound using the following equation:

$$RF = \frac{Ax}{Ais} * \frac{Cis}{Cx}$$

Where:

Ax = Area of the characteristic ion for the compound to measured (see *Table 1 and 2*).

Ais = Area of the characteristic ion for the specific internal standard (see *Table 2*).

Cis = Concentration of the internal standard (μg/ml).
Cx = Concentration of the compound to be measured (μg/ml).

10.3.3.4 calculate the average RF for each analytes in the curve

10.3.3.5 calculate the % Relative Standard Deviation of RF values for the initial calibration using the following equation:

$$\%RSD = \frac{\text{Standard Deviation (n-1)}}{\text{mean RF}} * 100$$

10.3.4 Calibration acceptance criteria

10.3.4.1 The BFB must meet the specified criteria

10.3.4.2 The %RSD is calculated and must be less than or equal to 30% for the CCC compounds. The %RSD of all other calibration compounds must be less than or equal to 100%. This criterion must be met for the initial calibration to be valid.

10.3.4.3 The System Performance Check Compounds (SPCCs) must meet minimum RF criteria specified in Table 3.

10.3.4.4 Evaluation of retention time: The relative retention time (RRT) of each target analytes in each calibration standard should agree within 0.06RRT units.

10.4 Calibration verification

10.4.1 Instrument Performance Check: Prior to any data collection activities involving samples, blanks, or standards, analyze a 50-ppbv injection of BFB). BFB must meet same criteria as the initial calibration.

10.4.2 Calibration verification standard: Analyze a 50-ppbv-calibration standard at the beginning of each 12-hour working period (that passed the BFB tune criteria). Calculate the % Difference between the average response factor from the calibration curve and the response factor from the continuing standard using the equation below:

$$\% \text{ Difference} = \frac{|RRFi - RRFc|}{RRFi} * 100$$

Where:

RRFi = Average relative response factor from initial calibration.

RRFc = Relative response factor from the current calibration check standard.

The verification standard must meet % D criteria mentioned in Table 4.

10.4.2.1 Internal standard retention time: The retention times of the internal standards in the calibration verification standards must be evaluated immediately after the run. The retention time of any internal standard should not change by more than 30 seconds from that in the mid-point standard level of the most recent initial calibration sequence. If the retention time shift is outside this limit, associated runs must be reanalyzed after meeting the criteria.

10.4.2.2 Internal standard response: The EICP area of any of the internal standards in the calibration verification standard should not change by a factor of two (-50% to +100%) from that in the mid-point standard of the most recent initial calibration.

10.4.2.3 Manual Integration: Permits the analyst to integrate the peak(s) of interest manually. This is to be applied when a peak of interest has not been integrated (ex. split peak) from baseline to baseline. In this case the analyst must be consistent in defining the baseline. All manual integration will be flagged with an “m” and will be initialed by the analyst. The spectra will be put in for all compounds of interest showing the manual integration.

10.5 Sample analysis

10.5.1 Once the instrument check and continuing standard have passed the analysis criteria, samples may be analyzed. Label the samples in analytical sequence as follows:

WGXXXXX-X,SBLKXXXX,matrix,dilution factor(Prep. Blank)
WGXXXXX-X,SBLKXXXXCS,matrix,dilution factor (Check sample)
L11111-X,ClientID,matrix,dilution factor (Sample)

10.5.2 Allow the sample extract to warm to room temperature. During the analysis, add 100cc ppbv of internal standard to the 100cc extract obtained from the sample “mini”-canister.

10.5.3 Inject the sample into the GC/MS system using the same operating conditions that were used for the calibration.

10.5.4 If the response of any quantitative ion exceeds the initial calibration range of the GC/MS system, the sample extract must be diluted and reanalyzed.

10.6 Qualitative analysis

10.6.1 The qualitative identification of compounds is based on retention time and comparison of the sample spectrum with characteristic ions in a reference mass spectrum. The characteristic ions from the reference mass spectrum are defined as the three ions of greatest relative intensity, or any ions over 30% relative intensity, if less than three such ions occur in the reference spectrum. The compounds are identified when the following criteria are met:

10.6.1.1 The intensities of the characteristic ions of a compound must maximize in the same scan or within one scan of each other.

10.6.1.2 The RRT of the sample component is within ±0.04 RRT units of the RRT of the standard component.

10.6.1.3 The relative intensities of the characteristic ions agree within 30 percent of the relative intensities of these ions in the reference spectrum from the most recent calibration verification standard.

10.6.1.4 Structural isomers that produce very similar mass spectra should be identified as individual isomers if they have sufficiently different GC retention times. Sufficient GC resolution is achieved if the height of the valley between two isomer peaks is less than 25 percent of the sum of the two peak heights. Otherwise, structural isomers are identified as isomeric pairs.

10.6.1.5 Identification is hampered when sample components are not resolved chromatographically and produce mass spectra containing ions contributed by more than one analyte. When gas chromatographic peaks obviously represent more than one sample component appropriate selection of analyte spectra and background spectra is important. When analytes coelute the identification criteria can be met, but each analyte spectrum will contain extraneous ions contributed by the coeluting compound.

10.6.1.6 Manual Integration: Permits the analyst to integrate the peak(s) of interest manually. This is to be applied when a peak of interest has not been integrated (ex. split peak) from baseline to baseline. In this case the analyst must be consistent in defining the baseline. All manual integration will be flagged with an “m” and will be initialed by the analyst. The spectra will be put in for all compounds of interest showing the manual integration.

10.6.2 For samples containing components not associated with the calibration standards, a library search may be made for the purpose of tentative identification.

10.7 Quantitative identification

10.7.1 Once a compound has been identified, the quantitation of that compound is based on the integrated abundance of the primary characteristic ion from the EICP.

10.7.2 The concentration of a compound in the extract is determined using the average response factor from initial calibration.

10.7.3 Use the equations below to quantitate the appropriate matrix:

$$\mu g/L = \frac{(Ax)(Is)(Df)}{(Ais)(RRF)(Vi)}$$

Where:

Ax = Area of the characteristic ion for the compound to be measured.

Ais = Area of the characteristic ion for the internal standard.
Is = Amount of the internal standard injected in nanograms
RRF = Average response factor (from initial cal.) for the compound being measured.
Vo = Volume of water extracted in milliliters
Vi = Volume of sample injected in milliliters
Vt = Volume of concentrated extracted in microliters
Df = Dilution factor

10.7.4 The GC/MS data system contains identification files (ID files) that automatically identify target compounds in standards and samples. Quantitation is performed using the internal standard method. The list of characteristic ions for each analyte is listed in *Table 2*. In all instances where the data system report has been edited or where manual integration or quantitation has been performed the GC/MS operator must identify edits or manual procedures by initialing and dating the changes made to the report. The data system flags a manual integration on the quantitation report using a "M" next to the area. Samples that contain target analytes above the linear range of the curve (+10 percent or 110 ppbv) must be diluted to put the analytes within the curve range. Flag the analytes that exceed the linear range in the qualifier section with an "E". Report the dilution analysis with the suffix "DL" where the sample name appears. If a dilution was initially performed and no target analytes are reported above the PQL, the sample must be reanalyzed at a more concentrated level.

10.8 Technical Acceptance Criteria for Sample analysis

10.8.1 The samples must be analyzed on a system meeting BFB, initial calibration and calibration verification criteria.

10.8.2 The samples must be extracted and analyzed within contract required holding times.

10.8.3 The sample must have an associated prep. blank meeting acceptance criteria.

10.8.4 All samples and blanks must have surrogate recovery within in-house control limits. No surrogate recovery can be less than 10%

10.8.5 The relative retention time of each surrogate must be within ± 0.06 RRT units of its relative retention time in the calibration verification standard.

10.8.6 The instrumental response (EICP area) for each of the internal standards must be within –50% and +100% of the response of the internal standards in the most recent calibration verification standard.

10.8.7 The retention time shift for each of the internal standards must be within +0.5 minutes between the sample and the most recent calibration verification standard.

10.8.8 The sample spectra quant ion must be within 30% of the most recent calibration verification standard.

10.8.9 Concentration of all analytes must be within the calibration range determined from the initial calibration.

10.9 Corrective Action

10.9.1 Corrective Action for sample analysis: The sample technical acceptance criteria must be met. The samples that did not meet criteria reanalysis.

10.9.2 Corrective Action for surrogate recovery failure: Check calculations, check spike standards. Reanalyze the samples that exceeded criteria. If the samples met criteria upon reanalysis, report the reanalysis only. If the sample produced similar results upon reextraction and reanalysis, the

problem may be matrix-related. Report both sets of analyses. Use 'R' qualifier for reanalysis. If the reanalysis of samples does not solve the problem, contact the project manager so the client may be notified.

10.9.3 Corrective Action for Internal Standard Response failures: If any of the internal standards exceeded acceptance criteria, check calculations. Verify that the standard concentration is accurate, and that the instrument did not malfunction. Reanalyze the sample to see if the problem was matrix related. If the reanalysis met criteria, report the reanalysis only. If the reanalysis produced similar results, report both analyses. Use 'R' qualifier to identify reanalysis results.

10.9.4 Corrective action for surrogate RRT/Internal standard retention time: If the surrogates or internal standards exceeded retention time criteria, follow the same guidelines used in Section 10.9.3

11.0 QUALITY CONTROL

11.1 Instrument performance must be evaluated to see if all BFB, initial calibration and calibration verification criteria requirements are met.

11.2 Method blanks

11.2.1 A Method blank is a volume of a clean reference matrix (nitrogen @ 99.9999% purity) carried through the entire analytical procedure. The volume of the method blank must be approximately equal to the volume of the associated samples. The purpose of the method blank is to determine the level of contamination associated with the preparation and analysis of samples.

11.2.2 Method blanks must be extracted with each batch of samples at a frequency of 1 for every 20 samples.

11.2.3 Method blanks must be analyzed under the same conditions as the samples.

11.2.4 Method blanks must contain no targets above CRQL. If the method blank does not meet this criterion, affected samples must be reanalyzed.

11.2.5 If the surrogate recoveries in the method blank do not meet the control limits, reanalyze the method blank. If the method blank does not meet criteria after reanalysis, reanalyze the associated samples.

11.3 Quality Control Check Sample.

11.3.1 A Check sample consists of an aliquot of a clean matrix similar to the sample matrix and of the same weight or volume. The CS is spiked with the all the target analytes at mid-level of the calibration curve. The spiking standard should be from a source different from that of the calibration standards.

11.3.2 A CS must be analyzed with every 20 samples or more frequently. The recoveries must be within the in-house control limits. If the recoveries fall outside control limits, the CS must be reanalyzed. If the recoveries are still outside control limits, affected samples should be reanalyzed.

11.4 Surrogate Recoveries

11.4.1 All samples, including quality control samples, are spiked with surrogates. The surrogate solution contains bromofluorobenzene at 50 ppbv.

11.4.2 All samples must meet the surrogate recovery criteria. If any samples exceed criteria, the sample must be reanalyzed. If the reanalysis produces similar results, contact the project manager.

11.5 Control Limits

11.5.1 All surrogate recoveries, and check sample data must be entered on the LIMS. In-house control limits must be calculated annually. Accuracy and precision data must be compared against the control limits.

11.6 Initial Demonstration of Proficiency (IDP)

11.6.1 IDP is established by generating data of acceptable accuracy and precision for target analytes for each preparative method and matrix by analyzing reference samples.

11.6.2 The reference samples are prepared from a spiking solution containing each analyte of interest. The solution should be made from stock standards prepared independently from those used for calibration. The concentration of targets in the reference sample may be 10-50 times the MDL.

11.6.3 Prepare and analyze 4 replicates of the reference sample by the same procedure used for analyzing actual samples. Calculate average recovery in ppbv and standard deviation of the recovery of each analyte of interest. The average recovery may fall in the range of 70-130%.

11.6.4 IDP procedure must be repeated whenever new staff is trained or significant changes in preparative or analytical methods are made.

11.7 Method Detection Limit (MDL)

11.7.1 The Method Detection Limit (MDL) for this procedure is used to judge the significance of a single measurement of a future sample. The MDL is the constituent that, when processed through the complete method, produces a signal with 99% probability that it is different from the blank. MDL is the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined by the analysis of samples in a given matrix type containing the analyte.

11.7.2 MDLs are determined annually.

12.0 DOCUMENTATION

12.1 The raw data is archived via CD-ROM and is stored in a secured area. The raw data will be kept in the laboratory for 5 years.

12.2 Chain of custody forms, instrument maintenance log, standards prep log, analytical run log, corrective action logs etc. must be filled out in a timely manner.

13.0 REFERENCES

Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition, January 1999

Table 1
Calibration standards for 5ppb level
(Concentration in ppbV)

COMPOUND	LV1	LV2	LV3	LV4	LV5	LV6	
Propylene	5	10	25	50	75	100	
Freon-12	5	10	25	50	75	100	
Chloromethane	5	10	25	50	75	100	
Fron-114	5	10	25	50	75	100	
Vinyl Chloride	5	10	25	50	75	100	
Bromomethane	5	10	25	50	75	100	
Chloroethane	5	10	25	50	75	100	
Vinyl Bromide	5	10	25	50	75	100	
Freon-11	5	10	25	50	75	100	
Isopropyl Alcohol	5	10	25	50	75	100	
Acetone	5	10	25	50	75	100	
1,1-Dichloroethane	5	10	25	50	75	100	
Methylene Chloride	5	10	25	50	75	100	
Freon-113	5	10	25	50	75	100	
Allyl Chloride	5	10	25	50	75	100	
Carbon Disulfide	5	10	25	50	75	100	
Trans-1,2-Dichlorethene	5	10	25	50	75	100	
Methyl Tert-Butyl Ether	5	10	25	50	75	100	
1,1-Dichloroethane	5	10	25	50	75	100	
Vinyl Acetate	5	10	25	50	75	100	
Methyl Ethyl Ketone	5	10	25	50	75	100	
Cis-1,2-Dichloroethylene	5	10	25	50	75	100	
Hexane	5	10	25	50	75	100	
Ethyl Acetate	5	10	25	50	75	100	
Chloroform	5	10	25	50	75	100	
Tetrahydrofuran	5	10	25	50	75	100	
1,2-Dichloroethane	5	10	25	50	75	100	
1,1,1-Trichloroethane	5	10	25	50	75	100	
Cyclohexane	5	10	25	50	75	100	

Carbon Tetrachloride	5	10	25	50	75	100	
Benzene	5	10	25	50	75	100	
1,4-Dioxane	5	10	25	50	75	100	
2,2,4-Trimethylpentane	5	10	25	50	75	100	
Heptane	5	10	25	50	75	100	
1,2-Dichloropropane	5	10	25	50	75	100	
Trichloroethylene	5	10	25	50	75	100	
Bromodichloromethane	5	10	25	50	75	100	
cis-1,3-Dichloropropene	5	10	25	50	75	100	
Trans-1,3-Dichloropropene	5	10	25	50	75	100	
1,1,2-Trichloroethane	5	10	25	50	75	100	
Toluene	5	10	25	50	75	100	
Dibromochloromethane	5	10	25	50	75	100	
Methyl Isobutyl Ketone	5	10	25	50	75	100	
Methyl Butyl Ketone	5	10	25	50	75	100	
1,2-Dibromomethane	5	10	25	50	75	100	
Tetrachloroethylene	5	10	25	50	75	100	
Chlorobenzene	5	10	25	50	75	100	
Ethylbenzene	5	10	25	50	75	100	
Bromoform	5	10	25	50	75	100	
Styrene	5	10	25	50	75	100	
o-xylene	5	10	25	50	75	100	
m -xylene	5	10	25	50	75	100	
p-xylene	5	10	25	50	75	100	
1,1,2,2-Tetrachloroethane	5	10	25	50	75	100	
4-Ethyltoluene	5	10	25	50	75	100	
1,3,5-Trimethylbenzene	5	10	25	50	75	100	
1,2,4-Trimethylbenzene	5	10	25	50	75	100	
1,3-Dichlorobenzene	5	10	25	50	75	100	
Benzyl Chloride	5	10	25	50	75	100	
1,4-Dichlorobenzene	5	10	25	50	75	100	
1,2-Dichlorobenzene	5	10	25	50	75	100	
1,2,4-Trichlorobenzene	5	10	25	50	75	100	
Hexachloro-1,3-Butadiene	5	10	25	50	75	100	

Bromofluorobenzene (surrogate)	50	50	50	50	50	50	
*Bromochloromethane	50	50	50	50	50	50	
*1,4-Difluorobenzene	50	50	50	50	50	50	
*Chlorobenzene-d5	50	50	50	50	50	50	

*Indicates internal standard

Table 1
Calibration standards for 1ug/M3 level
(Concentration in ppbV)

COMPOUND	LV1	LV2	LV3	LV4	LV5	LV6	LV7
Propylene	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Freon-12	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Chloromethane	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Fron-114	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Vinyl Chloride	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Bromomethane	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Chloroethane	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Vinyl Bromide	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Freon-11	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Isopropyl Alcohol	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Acetone	0.15	0.30	0.50	0.75	1.0	1.5	2.0
1,1-Dichloroethane	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Methylene Chloride	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Freon-113	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Allyl Chloride	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Carbon Disulfide	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Trans-1,2-Dichlorethene	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Methyl Tert-Butyl Ether	0.15	0.30	0.50	0.75	1.0	1.5	2.0
1,1-Dichloroethane	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Vinyl Acetate	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Methyl Ethyl Ketone	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Cis-1,2-Dichloroethylene	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Hexane	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Ethyl Acetate	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Chloroform	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Tetrahydrofuran	0.15	0.30	0.50	0.75	1.0	1.5	2.0
1,2-Dichloroethane	0.15	0.30	0.50	0.75	1.0	1.5	2.0
1,1,1-Trichloroethane	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Cyclohexane	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Carbon Tetrachloride	0.15	0.30	0.50	0.75	1.0	1.5	2.0

Benzene	0.15	0.30	0.50	0.75	1.0	1.5	2.0
1,4-Dioxane	0.15	0.30	0.50	0.75	1.0	1.5	2.0
2,2,4-Trimethylpentane	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Heptane	0.15	0.30	0.50	0.75	1.0	1.5	2.0
1,2-Dichloropropane	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Trichloroethylene	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Bromodichloromethane	0.15	0.30	0.50	0.75	1.0	1.5	2.0
cis-1,3-Dichloropropene	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Trans-1,3-Dichloropropene	0.15	0.30	0.50	0.75	1.0	1.5	2.0
1,1,2-Trichloroethane	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Toluene	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Dibromochloromethane	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Methyl Isobutyl Ketone	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Methyl Butyl Ketone	0.15	0.30	0.50	0.75	1.0	1.5	2.0
1,2-Dibromomethane	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Tetrachloroethylene	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Chlorobenzene	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Ethylbenzene	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Bromoform	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Styrene	0.15	0.30	0.50	0.75	1.0	1.5	2.0
o-xylene	0.15	0.30	0.50	0.75	1.0	1.5	2.0
m -xylene	0.15	0.30	0.50	0.75	1.0	1.5	2.0
p-xylene	0.15	0.30	0.50	0.75	1.0	1.5	2.0
1,1,2,2-Tetrachloroethane	0.15	0.30	0.50	0.75	1.0	1.5	2.0
4-Ethyltoluene	0.15	0.30	0.50	0.75	1.0	1.5	2.0
1,3,5-Trimethylbenzene	0.15	0.30	0.50	0.75	1.0	1.5	2.0
1,2,4-Trimethylbenzene	0.15	0.30	0.50	0.75	1.0	1.5	2.0
1,3-Dichlorobenzene	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Benzyl Chloride	0.15	0.30	0.50	0.75	1.0	1.5	2.0
1,4-Dichlorobenzene	0.15	0.30	0.50	0.75	1.0	1.5	2.0
1,2-Dichlorobenzene	0.15	0.30	0.50	0.75	1.0	1.5	2.0
1,2,4-Trichlorobenzene	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Hexachloro-1,3-Butadiene	0.15	0.30	0.50	0.75	1.0	1.5	2.0
Bromofluorobenzene	0.15	0.30	0.50	0.75	1.0	1.5	2.0

(surrogate) Bromofluorobenzene							
*Bromochloromethane	1	1	1	1	1	1	1
*1,4-Difluorobenzene	1	1	1	1	1	1	1
*Chlorobenzene-d5	1	1	1	1	1	1	1

*Indicates internal standard

Table 2
Characteristic Ions, PQLs

COMPOUND	EI PRIMARY	EI SECONDARY	EI TERTIARY	PQL ppb
Propylene	41	39		5
Freon-12	85	87		5
Chloromethane	50	52		5
Freon-114	85	135	87	5
Vinyl Chloride	62	27	64	5
1,3-Butadiene	39	54		5
Bromomethane	94	96		5
Chloroethane	64	29	27	5
Vinyl Bromide	106	106		5
Freon-11	101	103		5
Isopropyl Alcohol	45	43		20
Acetone	43	58		5
1,1-Dichloroethene	96	96	63	5
Methylene Chloride	84	84	86	5
Freon-113	101	101	103	5
Allyl chloride	76	41	78	5
Carbon Disulfide	76	78		5
Trans-1,2-Dichloroethene	61	96	98	5
Methyl Tert-Butyl Ether	73	41	53	5
1,1-Dichloroethane	63	27	65	5
Vinyl Acetate	43	86		5
Methyl Ethyl Ketone	43	57	72	5
cis-1,2-Dichloroethylene	61	96	98	5
Hexane	57	41	43	5
Ethyl Acetate	43	45	61	5
Chloroform	83	85	47	5
Tetrahydrofuran	42	71	72	5

1,2-Dichloroethane	62	27	64	5
1,1,1-Trichloroethane	97	99	61	5
Cyclohexane	56	41	84	5
Carbon Tetrachloride	117	119		5
Benzene	78	77	50	5
1,4-Dioxane	88	58		20
2,2,4-Trimethylpentane	57	41	56	5
Heptane	43	57	71	5
1,2-Dichloropropane	63	41	62	5
Trichloroethylene	130	132	95	5
Bromodichloromethane	83	85		5
cis-1,3-Dichloropropene	75	39	77	5
Trans-1,3-Dichloropropene	75	39	77	5
1,1,2-Trichloroethane	97	83	61	5
Toluene	92	91	92	5
Dibromochloromethane	129	127		5
Methyl Isobutyl Ketone	43	57	58	20
Methyl Butyl Ketone	43	57	58	20
1,2-Dibromomethane	107	109	27	5
Tetrachloroethylene	164	164	131	5
Chlorobenzene	112	77	114	5
Ethylbenzene	91	106		5
Bromoform	173	175		5
Styrene	104	78	103	5
o-xylene	91	106		5
m–xylene	91	106		5
p –xylene	91	106		5
1,1,2,2-Tetrachloroethane	83	85		5
4-Ethyltoluene	105	120		5
1,3,5-Trimethylbenzene	105	120		5
1,2,4-Trimethylbenzene	105	120		5

1,3-Dichlorobenzene	146	148	111	5
Benzyl Chloride	91	126		5
1,4-Dichlorobenzene	146	148	111	5
1,2-Dichlorobenzene	146	148	111	5
1,2,4-Trichlorobenzene	180	182	184	5
Hexachloro-1,3-Butadiene	225	227	223	5
Bromofluorobenzene (surrogate)	95			-
*Bromochloromethane	128			-
*1,4-Difluorobenzene	114			-
*Chlorobenzene-d5	117			-

*Indicates internal standard

Table 3

Volatile Internal Standards with Corresponding Analytes
Assigned for Quantitation

*Bromochloromethane	*1,4-Difluorobenzene	*Chlorobenzene-d5
Propylene	1,1,1-Trichloroethane	Toluene
Freon-12	Cyclohexane	Dibromochloromethane
Chloromethane	Carbon Tetrachloride	Methyl Isobutyl Ketone
Fron-114	Benzene	Methyl Butyl Ketone
Vinyl Chloride	1,4-Dioxane	1,2-Dibromomethane
Bromomethane	2,2,4-Trimethylpentane	Tetrachloroethylene
Chloroethane	Heptane	Chlorobenzene
Vinyl Bromide	1,2-Dichloropropane	Ethylbenzene
Freon-11	Trichloroethylene	Bromoform
Isopropyl Alcohol	Bromodichloromethane	Styrene
Acetone	cis-1,3-Dichloropropene	o-xylene
1,1-Dichloroethane	Trans-1,3-Dichloropropene	m -xylene
Methylene Chloride	1,1,2-Trichloroethane	p-xylene
Freon-113		1,1,2,2-Tetrachloroethane
Allyl Chloride		4-Ethyltoluene
Carbon Disulfide		1,3,5-Trimethylbenzene
Trans-1,2-Dichlorethene		1,2,4-Trimethylbenzene
Methyl Tert-Butyl Ether		1,3-Dichlorobenzene
1,1-Dichloroethane		Benzyl Chloride
Vinyl Acetate		1,4-Dichlorobenzene
Methyl Ethyl Ketone		1,2-Dichlorobenzene
Cis-1,2-Dichloroethylene		1,2,4-Trichlorobenzene
Hexane		Hexachloro-1,3-Butadiene
Ethyl Acetate		Bromofluorobenzene (surrogate)
Chloroform		
Tetrahydrofuran		
1,2-Dichloroethane		

*Indicates internal standard

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Attachment 2

Field Standard Operating Procedures

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Soil Drilling and Sample Collection

Rev. #: 1

Rev Date: March 3, 2009

Approval Signatures

Prepared by: _____ Date: 3/3/09

Reviewed by: _____ Date: 3/3/09
(Technical Expert)

I. Scope and Application

Overburden drilling is commonly performed using the hollow-stem auger drilling method. Other drilling methods suitable for overburden drilling, which are sometimes necessary due to site-specific geologic conditions, include: drive-and-wash, spun casing, Rotasonic, dual-rotary (Barber Rig), and fluid/mud rotary. Direct-push techniques (e.g., Geoprobe or cone penetrometer) may also be used. The drilling method to be used at a given site will be selected based on site-specific consideration of anticipated drilling depths, site or regional geologic knowledge, types of sampling to be conducted, required sample quality and volume, and cost.

No oils or grease will be used on equipment introduced into the boring (e.g., drill rod, casing, or sampling tools).

II. Personnel Qualifications

The Project Manager (a qualified geologist, environmental scientist, or engineer) will identify the appropriate soil boring locations, depth and soil sample intervals in a written plan.

Personnel responsible for overseeing drilling operations must have at least 16 hours of prior training overseeing drilling activities with an experienced geologist, environmental scientist, or engineer with at least 2 years of prior experience.

III. Equipment List

The following materials will be available during soil boring and sampling activities, as required:

- Site Plan with proposed soil boring/well locations;
- Work Plan or Field Sampling Plan (FSP), and site Health and Safety Plan (HASP);
- personal protective equipment (PPE), as required by the HASP;
- drilling equipment required by the American Society for Testing and Materials (ASTM) D 1586, when performing split-spoon sampling;
- disposable plastic liners, when drilling with direct-push equipment;
- appropriate soil sampling equipment (e.g., stainless steel spatulas, knife);

- equipment cleaning materials;
- appropriate sample containers and labels;
- chain-of-custody forms;
- insulated coolers with ice, when collecting samples requiring preservation by chilling;
- photoionization detector (PID) or flame ionization detector (FID); and
- field notebook and/or personal digital assistant (PDA).

IV. Cautions

Prior to beginning field work, underground utilities in the vicinity of the drilling areas will be identified by one of the following three actions (lines of evidence):

- Contact the State One Call
- Obtain a detailed site utility plan drawn to scale, preferably an “as-built” plan
- Conduct a detailed visual site inspection

In the event that one or more of the above lines of evidence cannot be conducted, or if the accuracy of utility location is questionable, a minimum of one additional line of evidence will be utilized as appropriate or suitable to the conditions. Examples of additional lines of evidence include but are not limited to:

- Private utility locating service
- Research of state, county or municipal utility records and maps including computer drawn maps or geographical information systems (GIS)
- Contact with the utility provider to obtain their utility location records
- Hand augering or digging
- Hydro-knife
- Air-knife

- Radio Frequency Detector (RFD)
- Ground Penetrating Radar (GPR)
- Any other method that may give ample evidence of the presence or location of subgrade utilities.

Overhead power lines also present risks and the following safe clearance must be maintained from them.

Power Line Voltage Phase to Phase (kV)	Minimum Safe Clearance (feet)
50 or below	10
Above 50 to 200	15
Above 200 to 350	20
Above 350 to 500	25
Above 500 to 750	35
Above 750 to 1,000	35

ANSI Standard B30.5-1994, 5-3.4.5

Avoid using drilling fluids or materials that could impact groundwater or soil quality, or could be incompatible with the subsurface conditions.

Water used for drilling and sampling of soil or bedrock, decontamination of drilling/sampling equipment, or grouting boreholes upon completion will be of a quality acceptable for project objectives. Testing of water supply should be considered.

Specifications of materials used for backfilling borehole will be obtained, reviewed and approved to meet project quality objectives.

V. Health and Safety Considerations

Field activities associated with overburden drilling and soil sampling will be performed in accordance with a site-specific HASP, a copy of which will be present on site during such activities.

VI. Procedure

Drilling Procedures

The drilling contractor will be responsible for obtaining accurate and representative samples; informing the supervising geologist of changes in drilling pressure; and keeping a separate general log of soils encountered, including blow counts (i.e., the number of blows from a soil sampling drive weight [140 pounds] required to drive the split-barrel sampler in 6-inch increments). Records will also be kept of occurrences of premature refusal due to boulders or construction materials that may have been used as fill. Where a boring cannot be advanced to the desired depth, the boring will be abandoned and an additional boring will be advanced at an adjacent location to obtain the required sample. Where it is desirable to avoid leaving vertical connections between depth intervals, the borehole will be sealed using cement and/or bentonite. Multiple refusals may lead to a decision by the supervising geologist to abandon that sampling location.

Soil Sampling Procedures

Samples of subsurface materials encountered while drilling soil borings will be collected using one of the following methods:

- 2-inch split-barrel (split-spoon) sampler, if using the ASTM D 1586 - Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils
- Plastic internal soil sample sleeves if using direct-push drilling.

Soil samples are typically field screened with an FID or PID at sites where volatile organic compounds are present in the subsurface. Field screening is performed using one of the following methods:

- Upon opening the sampler, the soil is split open and the PID or FID probe is placed in the opening and covered with a gloved hand. Such readings should be obtained at several locations along the length of the sample
- A portion of the collected sample is placed in a jar, which is covered with aluminum foil, sealed, and allowed to warm to room temperature. After warming, the cover is removed, the foil is pieced with the FID or PID probe, and a reading is obtained.

Samples selected for laboratory analysis will be handled, packed, and shipped in accordance with the procedures outlined in the Work Plan, FSP, or Chain-of-Custody, Handling, Packing, and Shipping SOP.

A geologist will be onsite during drilling and sampling operations to describe each soil sample on the soil boring log, including:

- percent recovery;
- structure and degree of sample disturbance;
- soil type;
- color;
- moisture condition;
- density;
- grain-size;
- consistency; and
- other observations, particularly relating to the presence of waste materials

Further details regarding geologic description of soil samples are presented in the Soil Description SOP.

Particular care will be taken to fully describe any sheens observed, oil saturation, staining, discoloration, evidence of chemical impacts, or unnatural materials.

VII. Waste Management

Water generated during cleaning procedures will be collected and contained onsite in appropriate containers for future analysis and appropriate disposal.

PPE (such as gloves, disposable clothing, and other disposable equipment) resulting from personnel cleaning procedures and soil sampling/handling activities will be placed in plastic bags. These bags will be transferred into appropriately labeled 55-gallon drums or a covered roll-off box for appropriate disposal.

Soil materials will be placed in sealed 55-gallon steel drums or covered roll-off boxes and stored in a secured area. Once full, the material will be analyzed to determine the appropriate disposal method.

VIII. Data Recording and Management

The supervising geologist or scientist will be responsible for documenting drilling events using a bound field notebook and/or PDA to record all relevant information in a clear and concise format. The record of drilling events will include:

- start and finish dates of drilling;
- name and location of project;
- project number, client, and site location;
- sample number and depths;
- blow counts and recovery;
- depth to water;
- type of drilling method;
- drilling equipment specifications, including the diameter of drilling tools;
- documentation of any elevated organic vapor readings;
- names of drillers, inspectors, or other people onsite; and
- weather conditions.

IX. Quality Assurance

Equipment will be cleaned prior to use onsite, between each drilling location, and prior to leaving the site. Drilling equipment and associated tools, including augers, drill rods, sampling equipment, wrenches, and other equipment or tools that may have come in contact with soils and/or waste materials will be cleaned with high-pressure steam-cleaning equipment using a potable water source. The drilling equipment will be cleaned in an area designated by the supervising engineer or geologist that is located outside of the work zone. More elaborate cleaning procedures may be

required for reusable soil samplers (split-spoons) when soil samples are obtained for laboratory analysis of chemical constituents.

X. References

American Society of Testing and Materials (ASTM) D 1586 - *Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils*.

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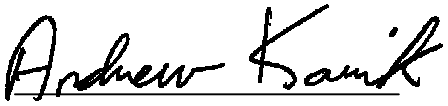
Groundwater Sampling Using HydroPunch™

Rev. #: 01

Rev Date: March 3, 2009

Approval Signatures

Prepared by:  Date: 3/3/09

Reviewed by:  Date: 3/3/09
(Technical Expert)

I. Scope and Application

This document describes procedures for collecting discrete-depth groundwater samples using the HydroPunch™ sampling device (QED Environmental Services, Inc.), or equivalent, during drilling in unconsolidated materials. HydroPunch™ can be used to collect a single sample from a selected depth, or multiple samples from a single borehole to produce a profile of groundwater quality data versus depth. The HydroPunch™ sampler is typically driven through open-ended drill casing or hollow-stem augers.

HydroPunch™ consists of a drive point, a stainless steel screen section, a sample reservoir integral within the tool body, and assorted O-rings and check valves to create watertight seals within the various components. Two models of HydroPunch™ have been developed, having slightly different designs and/or component parts as shown on the attached HydroPunch™ schematic drawings. All components are made of stainless steel, Teflon, or other relatively inert materials. The tool can be disassembled easily for cleaning between samples.

Although this document refers to groundwater sample collection, HydroPunch™ is also capable of obtaining samples of light or dense non-aqueous phase liquid (LNAPL or DNAPL, respectively), if present at sufficient saturation and pressure head at the depth of the ampler during deployment.

II. Personnel Qualifications

ARCADIS personnel directing, supervising, or leading groundwater sample collection activities using HydroPunch™ should have a minimum of 2 years of previous groundwater sampling experience and current health and safety training including 40-hour HAZWOPER training, site supervisor training, site-specific training, first aid, and CPR, as needed. Field personnel will also be compliant with client-specific training requirements. In addition, ARCADIS field sampling personnel will be versed in the relevant SOPs and posses the required skills and experience necessary to successfully complete the desired field work.

III. Equipment List

The following materials are required for the collection of discrete-depth groundwater samples using HydroPunch™.

- HydroPunch™ sampling device provided by drilling subcontractor

- Drill casing or augers having an effective inside diameter of at least 1.25 inches (to be provided by drilling subcontractor)
- Electronic water-level probe
- Groundwater sample containers provided by the testing laboratory
- Health and safety monitoring equipment and personal protective equipment
- Materials for decontamination of the sampler between samples

IV. Cautions

Because the HydroPunch™ sampler is a groundwater sampling device, it must be used in saturated soils. Positive hydraulic head is required to fill the sampler, and the sampler may fill slowly or not at all at depths just below the water table. HydroPunch™ I and HydroPunch™ II in the "groundwater mode" cannot be used at sampling depths less than 5 feet below the water table. HydroPunch™ II in the "hydrocarbon mode" is preferred for sampling at the water table.

Some types of geologic materials may not allow effective use of the HydroPunch™ sampler, even at significant depth below the water table. For example, extremely dense soils or those containing cobbles or boulders may resist penetration of the sampler, precluding its use. Low permeability soil such as silt and clay may not produce groundwater at a sufficient rate to fill the HydroPunch™ sampler within a practicable timeframe. For these types of situations, an alternative approach should be considered, such as collecting a sample of saturated soil for analysis.

Groundwater samples collected using HydroPunch™ should be considered screening-level data, suitable for obtaining a general understanding of groundwater quality and selecting depths for monitoring well screens. Samples obtained using HydroPunch™ are commonly more turbid than those produced from installed, developed monitoring wells. Higher turbidity could affect sample quality if samples are to be analyzed for sorptive analytes such as polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), pesticides or metals. For these types of analytes, unfiltered HydroPunch™ samples could produce concentrations that are higher than those of sediment-free aquifer water. Field or laboratory filtering of the samples obtained for these types of constituents should be considered. For less-sorptive analytes (volatile organic compounds, anions such as chloride, etc.), sample turbidity is unlikely to adversely impact the direct usability of unfiltered samples.

V. Health and Safety Considerations

- Sample collection will be performed using procedures consistent with the project Health and Safety Plan.
- Appropriate personal protective equipment must be worn by ARCADIS field personnel

VI. Procedure

The following steps will be followed during the collection of discrete-depth groundwater Samples using HydroPunch™:

1. Select the desired groundwater sampling depth.
2. The drilling subcontractor will advance the borehole to approximately 2 feet above the depth from which a discrete water sample is to be obtained.
3. The drilling subcontractor will disassemble the HydroPunch™ sampling device according to the manufacturer's instructions to allow the sampler to be decontaminated. The sampler should be completely disassembled, including O-rings and/or check valves.
4. Decontaminate the sampler as appropriate for the range of groundwater analytes to be sampled for, by washing with laboratory-grade detergent and potable water wash, followed by solvent rinse (if sampling for organics) and final rinse with deionized or distilled water. Check the condition of the O-rings during each cleaning, and replace if necessary.
5. The drilling subcontractor will reassemble the decontaminated HydroPunch™ sampling device according to the manufacturer's instructions and lower the device to the bottom of the borehole.
6. The drilling subcontractor will push or drive the HydroPunch™ 5 feet below the bottom of the casing or augers, then retract the sampler 3 feet upward. Subsurface friction will retain the drive point in place, exposing the screen and allowing groundwater to enter the sampling tool.
7. Allow sufficient time to allow the sampler to fill with water. Typically 30 minutes is sufficient, except in low permeability materials.
8. Collect a groundwater sample by:

- Retracting the sampler to ground surface – the drilling subcontractor will then open the sampler allowing collection of the groundwater sample [if using the HydroPunch™ I or else the HydroPunch™ II in groundwater mode (see Attachment A)]

- Lowering a bailer or a peristaltic or inertia pump tube through the rods and body of the sampler, and retrieving the bailer or operating the pump to collect the groundwater sample [if using the HydroPunch™ II in hydrocarbon mode (see Attachment A)]

9. Perform field filtering of samples if required by the work plan, FSP and/or QAPP.

10. Obtain field water quality measurements if required by the work plan, FSP and/or QAPP.

11. Label the sample containers at the time of sampling with the following information.

    - Project name and number
    - Sample location
    - Sample number
    - Date and time of collection
    - Sampler initials
    - Analyses required

12. Preserve, store, handle, and ship samples to the analytical laboratory under chain of custody procedures as described in by the work plan, FSP and/or QAPP.

VII. Waste Management

Investigation-derived waste will be managed as described in the Investigation-Derived Waste Handling and Storage SOP.

VIII. Data Recording and Management

Borehole identification, sample depth, sample date and time will be recorded in the field notebook, the boring log, and/or the personal digital assistant (PDA). The sample will also be identified on an appropriate chain of custody form, as appropriate for submittal to an analytical laboratory for analysis, if required. Consider digital photography to record unusual field conditions or to document compliance.

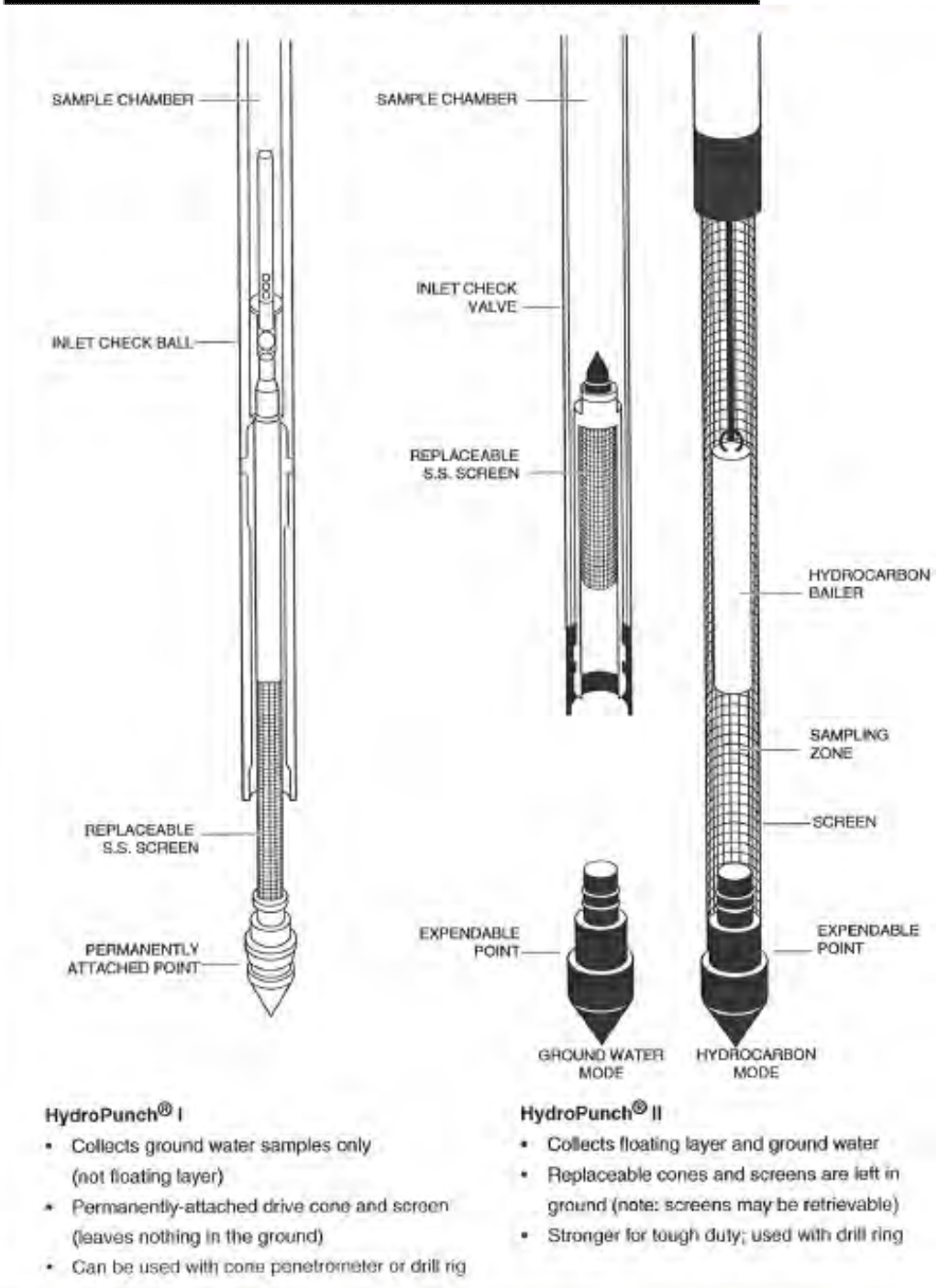
IX. Quality Assurance

The HydroPunch™ sampling device will be decontaminated as appropriate for the list of analytical parameters for which the groundwater samples are collected.

X. References

No references are required to accompany this SOP.

Attachment A - Hydropunch® Schematics



HydroPunch® I

- Collects ground water samples only (not floating layer)
- Permanently-attached drive cone and screen (leaves nothing in the ground)
- Can be used with cone penetrometer or drill rig

HydroPunch® II

- Collects floating layer and ground water
- Replaceable cones and screens are left in ground (note: screens may be retrievable)
- Stronger for tough duty; used with drill ring

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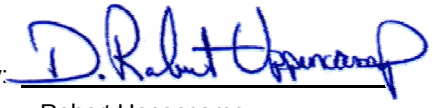
Administering Helium Tracer Gas for Leak Checks of Soil Gas or Sub-slab Sampling Points

Rev. #: 2

Rev Date: November 14, 2008

Approval Signatures

Prepared by:  Date: May 20, 2008
Mitch Wacksman

Reviewed by:  Date: May 20, 2008
Robert Uppencamp

Approved by:  Date: November 14, 2008
Christopher Lutes

I. Scope and Application

When collecting subsurface vapor samples as part of a vapor intrusion evaluation, a tracer gas serves as a quality assurance/quality control device to verify the integrity of the vapor port seal. Without the use of a tracer, verification that a soil vapor sample has not been diluted by ambient or indoor air is difficult.

This standard operating procedure (SOP) focuses on using helium as a tracer gas. However, depending on the nature of the contaminants of concern, other compounds can be used as a tracer including sulfur hexafluoride (SF6), butane and propane (or other gases). In all cases, the protocol for using a tracer gas is consistent and includes the following basic steps: (1) enrich the atmosphere in the immediate vicinity where the port or sample tubing intersects the surface with the tracer gas; and (2) measure a vapor sample from the sample tubing for the presence of high concentrations (> 10%) of the tracer. A plastic pail, bucket, garbage can or even a plastic bag can serve to keep the tracer gas in contact with the port during the testing.

There are two basic approaches to testing for the tracer gas:

1. Include the tracer gas in the list of target analytes reported by the laboratory; or

2. Use a portable monitoring device to analyze a sample of soil vapor for the tracer prior to sampling for the compounds of concern. (Note that tracer gas samples can be collected via syringe, Tedlar bag, etc. They need not be collected in SUMMA® canisters or minicans.)

This SOP focuses on monitoring helium using a portable sampling device, although helium can also be analyzed by the laboratory along with other volatile organic compounds (VOCs). Real-time tracer sampling is generally preferred as the results can be used to confirm the integrity of the port seals prior to formal sample collection.

During the initial stages of a subsurface vapor sampling program, tracer gas samples should be collected at each of the sampling ports. If the results of the initial samples indicate that the port seals are adequate, the Project Manager can consider reducing the number of locations at which tracer gas samples are used. At a minimum, at least 10% of the subsequent samples should be supported with tracer gas analyses. When using permanent soil vapor ports as part of a long-term monitoring program, the port should be tested prior to the first sampling event. Tracer gas testing of subsequent sampling events is not necessary unless conditions have changed at the site.

II. Personnel Qualifications

ARCADIS field sampling personnel will have current health and safety training, including 40-hour HAZWOPER training, site supervisor training, site-specific training, first-aid, and cardiopulmonary resuscitation (CPR), as needed. ARCADIS field sampling personnel will be well versed in the relevant SOPs and possess the required skills and experience necessary to successfully complete the desired field work. ARCADIS personnel responsible for leading the tracer gas testing must have previous experience conducting similar tests.

III. Equipment List

The equipment required to conduct a helium tracer gas test is presented below:

- Appropriate PPE for site (as required by the Health and Safety Plan)
- Helium (laboratory grade)
- Regulator for helium tank
- Shroud (plastic bucket, garbage can, etc)
    - The size of the shroud should be sufficient to fit over the sample port. It is worth noting that using a smaller shroud obviously uses less helium as well; this may be important when projects require a number of helium tracer tests.
    - The shroud will need to have three small holes in it. These holes will include one on the top (to accommodate the sample tubing), and two on the side (one for the helium detector probe, and one for the helium line).
    - The should ideally enclose the entire sampling train.
- Helium detector capable of measuring from 1 - 100% (Dielectric MGD-2002, Mark Model 9522, or equivalent)
- Tedlar bags
- Seal material for shroud (rubber gasket, modeling clay, bentonite, etc). Although the sealing material is not in direct contact with the sample if no leak occurs, sealing materials with high levels of VOC emissions should be

avoided, since they could easily contaminate a sample from a point in which a trace leak occurs.

- Field notebook

IV. Procedure

The procedure used to conduct the helium tracer test should be specific to the shroud being used and the methods of vapor port installation. The helium tracer test can be conducted when using temporary or permanent sample point installs and from inside or outside a facility. However when using the tracer gas within a indoor areas you must provide adequate ventilation because helium is an asphyxiant.

1. Attach Teflon or nylon sample tubing to the sample point. This can be accomplished utilizing a number of different methods depending on the sample install (i.e., barbed fitting, Swage-Lok fitting, ball valve, etc.).

2. Place the shroud over the sample point and tubing.

3. Pull the tubing through hole in top of shroud. Seal opening with modeling clay.

4. Place weight on top of shroud to help maintain a good seal with the ground.

5. Insert helium tubing into hole in side of shroud, seal with modeling clay to prevent leaks.

6. Fill shroud with helium. While filling shroud allow atmospheric air to escape either by leaving a crack with the surface or by providing a release value on the side of the shroud.

7. Use the helium detector to test level of helium gas from the bottom of the shroud (where the sample tubing intersects the ground). Helium should be added until the environment inside the shroud has > 60% helium.

8. Purge the sample point through the sample tubing into a Tedlar bag using a hand held sampling pump. The sample pump should be operating at a rate of approximately 100 ml/minute (the purge rate should typically not exceed the sample collection rate). Test the air in the Tedlar bag for helium using portable helium detector. If the port has been installed properly there should be zero helium in purge air.

9. If > 10% helium is noted in purge air, add more clay or other material to the seal

the sample port and repeat the testing procedure. If the seal cannot be fixed, re-install sample point.

10. Monitor and record helium level in shroud before, during and after tracer test.

11. Monitor and record helium level in purge exhaust.

12. At successful completion of tracer test and sample point purging, the soil vapor sample can be collected (if the helium shroud must be removed prior to sample collection be mindful not disturb the sample tubing and any established seals).

V. Cautions

Helium is an asphyxiant! Be cautious with its use indoors!

Care should be taken not to pressurize shroud while introducing helium. If the shroud is completely air tight and the helium is introduced quickly, the shroud can be over-pressurized and helium can be pushed into the ground.

Because minor leakage around the port seal should not materially affect the usability of the soil vapor sampling results, the mere presence of the tracer gas in the sample should not be a cause for alarm. Consequently, portable field monitoring devices with detection limits in the low ppm range are more than adequate for screening samples for the tracer. If high concentrations (> 10%) of tracer gas are observed in a sample, the port seal should be enhanced to reduce the infiltration of ambient air and the tracer test readministered. If the problem cannot rectified, a new sample point should be installed.

VI. Data Recording and Management

Measurements will be recorded in the field notebook at the time of measurement with notations of the project name, sample date, sample start and finish time, sample location, and the helium concentrations in both the shroud and the purge air before, during, and after tracer testing. Any problems encountered should also be recorded in the field notes.

APPENDIX: Compressed Gases—Use and Storage

In general, a compressed gas is any material contained under pressure that is dissolved or liquefied by compression or refrigeration. Compressed gas cylinders should be handled as high-energy sources and therefore as potential explosives and projectiles. Prudent safety practices should be followed when handling compressed gases since they expose workers to both chemical and physical hazards.

Handling

- Safety glasses with side shields (or safety goggles) and other appropriate personal protective equipment should be worn when working with compressed gases.
- Cylinders should be marked with a label that clearly identifies the contents.
- All cylinders should be checked for damage prior to use. Do not repair damaged cylinders or valves. Damaged or defective cylinders, valves, etc., should be taken out of use immediately and returned to the manufacturer/distributor for repair.
- All gas cylinders (full or empty) should be rigidly secured to a substantial structure at 2/3 height. Only two cylinders per restraint are allowed in the laboratory and only soldered link chains or belts with buckles are acceptable. Cylinder stands are also acceptable but not preferred.
- Handcarts shall be used when moving gas cylinders. Cylinders must be chained to the carts.
- All cylinders must be fitted with safety valve covers before they are moved.
- Only three-wheeled or four-wheeled carts should be used to move cylinders.
- A pressure-regulating device shall be used at all times to control the flow of gas from the cylinder.
- The main cylinder valve shall be the only means by which gas flow is to be shut off. The correct position for the main valve is all the way on or all the way off.
- Cylinder valves should never be lubricated, modified, forced, or tampered with.
- After connecting a cylinder, check for leaks at connections. Periodically check for leaks while the cylinder is in use.
- Regulators and valves should be tightened firmly with the proper size wrench. Do not use adjustable wrenches or pliers because they may damage the nuts.
- Cylinders should not be placed near heat or where they can become part of an electrical circuit.
- Cylinders should not be exposed to temperatures above 50 °C (122 °F). Some rupture devices on cylinders will release at about 65 °C (149 °F). Some small cylinders, such as lecture bottles, are not fitted with rupture devices and may explode if exposed to high temperatures.

- Rapid release of a compressed gas should be avoided because it will cause an unsecured gas hose to whip dangerously and also may build up enough static charge to ignite a flammable gas.
- Appropriate regulators should be used on each gas cylinder. Threads and the configuration of valve outlets are different for each family of gases to avoid improper use. Adaptors and homemade modifications are prohibited.
- Cylinders should never be bled completely empty. Leave a slight pressure to keep contaminants out.

Storage

- When not in use, cylinders should be stored with their main valve closed and the valve safety cap in place.
- Cylinders must be stored upright and not on their side. All cylinders should be secured.
- Cylinders awaiting use should be stored according to their hazard classes.
- Cylinders should not be located where objects may strike or fall on them.
- Cylinders should not be stored in damp areas or near salt, corrosive chemicals, chemical vapors, heat, or direct sunlight. Cylinders stored outside should be protected from the weather.

Special Precautions

Flammable Gases

- No more than two cylinders should be manifolded together; however several instruments or outlets are permitted for a single cylinder.
- Valves on flammable gas cylinders should be shut off when the laboratory is unattended and no experimental process is in progress.
- Flames involving a highly flammable gas should not be extinguished until the source of the gas has been safely shut off; otherwise it can reignite causing an explosion.

Acetylene Gas Cylinders

- Acetylene cylinders must always be stored upright. They contain acetone, which can discharge instead of or along with acetylene. Do not use an acetylene cylinder that has been stored or handled in a nonupright position until it has remained in an upright position for at least 30 minutes.
- A flame arrestor must protect the outlet line of an acetylene cylinder.
- Compatible tubing should be used to transport gaseous acetylene. Some tubing like copper forms explosive acetylides.

Lecture Bottles

- All lecture bottles should be marked with a label that clearly identifies the contents.
- Lecture bottles should be stored according to their hazard classes.
- Lecture bottles that contain toxic gases should be stored in a ventilated cabinet.
- Lecture bottles should be stored in a secure place to eliminate them from rolling or falling.
- Lecture bottles should not be stored near corrosives, heat, direct sunlight, or in damp areas.
- To avoid costly disposal fees, lecture bottles should only be purchased from suppliers that will accept returned bottles (full or empty). Contact the supplier before purchasing lecture bottles to ensure that they have a return policy.
- Lecture bottles should be dated upon initial use. It is advised that bottles be sent back to the supplier after one year to avoid accumulation of old bottles.

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Sub-Slab Soil-Gas Sampling and Analysis Using USEPA Method TO-15 – Permanent Probe Approach

Rev. #: 1

Rev Date: November 14, 2008

Approval Signatures

Prepared by: _____ Date: 11/14/08

Mitch Wacksman

Reviewed by: _____ Date: 11/14/08

(Technical Expert) Christopher Lutes

I. Scope and Application

This document describes the procedures to install a sub-slab sampling port and collect sub-slab soil-gas samples for the analysis of volatile organic compounds (VOCs) by United States Environmental Protection Agency (USEPA) Method TO-15 (TO-15). The TO-15 method uses a 6-liter SUMMA® passivated stainless steel canister. An evacuated SUMMA canister (less than 28 inches of mercury [Hg]) will provide a recoverable whole-gas sample of approximately 5.5 liters when allowed to fill to a vacuum of 2 inches of Hg. The whole-air sample is then analyzed for VOCs using a quadrupole or ion-trap gas chromatograph/mass spectrometer (GS/MS) system to provide compound detection limits of 0.5 parts per billion volume (ppbv).

The following sections list the necessary equipment and detailed instructions for installing sub-slab soil-gas probes and collecting soil-gas samples for VOC analysis.

II. Personnel Qualifications

ARCADIS field sampling personnel will have current health and safety training, including 40-hour HAZWOPER training, site supervisor training, site-specific training, first-aid, and cardiopulmonary resuscitation (CPR), as needed. ARCADIS field sampling personnel will be well versed in the relevant standard operating procedures (SOPs) and possess the required skills and experience necessary to successfully complete the desired field work. ARCADIS personnel responsible for leading sub-slab soil-gas sample collection activities must have previous sub-slab soil-gas sampling experience.

III. Equipment List

The equipment required to install a permanent sub-slab vapor probe is presented below:

- Electric impact drill;
- 5/8-inch and 1-inch-diameter concrete drill bits for impact drill;
- Stainless steel vapor probe (typically 3/8-inch outside diameter [OD], 2- to 2.5-inch long (length will ultimately depend on slab thickness), 1/8-inch inside diameter [ID] pipe, stainless steel pipe nipples with 0.5-inch OD stainless steel coupling, and recessed stainless steel plugs per DiGiulio et. al., 2003);
- Photoionization detector (PID);
- Teflon tubing; and

- Quick-setting hydraulic cement powder.

The equipment required for soil-gas sample collection is presented below:

- Stainless steel SUMMA® canisters (order at least one extra, if feasible);
- Flow controllers with in-line particulate filters and vacuum gauges; flow controllers are pre-calibrated to specified sample duration (e.g., 30 minutes, 8 hours, 24 hours) or flow rate (e.g., 200 milliliters per minute [mL/min]); confirm with the laboratory that the flow controller comes with an in-line particulate filter and pressure gauge (order at least one extra, if feasible);
- 1/4-inch ID tubing (Teflon®, or similar);
- Twist-to-lock fittings;
- Stainless steel "T" fitting (if collecting duplicate [i.e., split] samples);
- Portable vacuum pump capable of producing very low flow rates (e.g., 100 to 200 mL/min) with vacuum gauge;
- Rotameter or an electric flow sensor if vacuum pump does not have a flow gauge;
- Tracer gas source (e.g., helium);
- PID;
- Appropriate-sized open-end wrench (typically 9/16-inch and ½");
- Chain-of-custody (COC) form;
- Sample collection log (attached); and
- Field notebook.

IV. Cautions

Sampling personnel should not handle hazardous substances (such as gasoline), permanent marking pens, wear/apply fragrances, or smoke cigarettes/cigars before and/or during the sampling event.

Care should also be taken to ensure that the flow controller is pre-calibrated to the proper sample collection time (confirm with laboratory). Sample integrity is maintained if the sampling event is shorter than the target duration, but sample integrity can be compromised if the event is extended to the point that the canister reaches atmospheric pressure.

Care must be taken to properly seal around the vapor probe at slab surface to prevent leakage of atmosphere into the soil vapor probe during purging and sampling. Temporary points are fit snug into the pre-drilled hole using Teflon® tape and a hydrated bentonite seal at the surface. Permanent points are fit snug using quick-setting hydraulic cement powder.

A Shipping Determination must be performed, by DOT-trained personnel, for all environmental and geotechnical samples that are to be shipped, as well as some types of environmental equipment/supplies that are to be shipped.

V. Health and Safety Considerations

Field sampling equipment must be carefully handled to minimize the potential for injury and the spread of hazardous substances. For sub-slab vapor probe installation, drilling with an electric concrete impact drill should be done only by personnel with prior experience using such a piece of equipment.

VI. Procedure

Permanent Vapor Probe Installation

Permanent sub-slab soil vapor probes are installed using an electric drill and manual placement of the probe. Drill a 1-inch-diameter hole, approximately 1-inch deep, in the concrete and then use the 5/8-inch-diameter drill to advance the hole to approximately 3 inches below the base of the floor slab. The vapor probe is inserted into the hole and grouted with a quick-setting hydraulic cement powder. The vapor probe is equipped with a recessed threaded cap and stainless steel threaded fitting or compression fitting to allow collection of a soil gas sample through the stainless steel tubing. The vapor probe and tubing will be purged with a portable sampling pump prior to collecting the soil gas sample.

1. Remove, only to the extent necessary, any covering on top of the slab (e.g., carpet).

2. Drill a 5/8-inch-diameter hole through the slab using the electric drill. (Optional: Although not required, use a source of dust control/suppressant during drilling operations.)

3. Advance the hole to approximately 3 inches beneath the bottom of the slab.

4. Overdrill the upper 1 inch of slab to a hole diameter of 1 inch.

5. Insert the vapor probe so that it sits flush with the top of the slab.

6. Use a quick-setting hydraulic cement to grout the probe in-place and allow the grout to set.

7. Purge the soil vapor probe and tubing with a portable sampling pump prior to collecting the soil-gas sample (see sample collection section below).

8. Proceed to soil-gas sample collection.

9. When sub-slab soil-gas sampling is complete, plug the soil vapor probe opening with a stainless steel plug. Ensure that the probe is well sealed and will not pose a tripping hazard

Sub-Slab Soil-Gas Sample Collection

Preparation of SUMMA®-Type Canister and Collection of Sample

1. Record the following information in the field notebook, if appropriate (contact the local airport or other suitable information source [e.g., site-specific measurements, weatherunderground.com] to obtain the information):

    a. wind speed and direction;

    b. ambient temperature;

    c. barometric pressure; and

    d. relative humidity.

2. Connect a short piece of Teflon tubing to the sub-slab sampling port using a swage lock fitting.

3. Connect a portable vacuum pump to the sample tubing. Purge 1 to 2 (target 1.5) volumes of air from the vapor probe and sampling line using a portable pump [purge volume = 1.5 Pi r2h] at a rate of approximately 100 mL/min. Measure organic vapor levels with the PID. Lower flow rates maybe necessary if the slab is built directly on clay to avoid excessive vacuum.

4. If necessary, check the seal established around the soil vapor probe by using a tracer gas (e.g., helium) or other method established in the state guidance documents. [Note: Some states (e.g., New York) may not require use of a tracer gas in connection with sub-slab sampling. Refer to the Administering Tracer Gas SOP, adapted from NYSDOH 2005, for how to use a tracer gas.]

5. Remove the brass on stainless steel plug from the SUMMA® canister and connect the flow controller with in-line particulate filter and vacuum gauge to the SUMMA® canister. Do not open the valve on the SUMMA® canister. Record in the field notebook and on the COC form the flow controller number with the appropriate SUMMA® canister number.

6. Connect the Teflon sample collection tubing to the flow controller and the SUMMA® canister valve. Record in the field notebook the time sampling began and the canister pressure.

7. Connect the other end of the polyethylene tubing to the sub-slab sampling port.

8. Open the SUMMA® canister valves. Record in the field notebook the time sampling began and the canister pressure.

9. Take a photograph of the SUMMA® canister and surrounding area.

Termination of Sample Collection

1. Arrive at the SUMMA® canister location at least 10 to 15 minutes prior to the end of the required sampling interval (e.g., 30 to 60 minutes).

2. Record the final vacuum pressure. Stop collecting the sample by closing the SUMMA® canister valves. The canister should have a minimum amount of vacuum (approximately 2 inches of Hg or slightly greater).

3. Record the date and local time (24-hour basis) of valve closing in the field notebook, sample collection log (attached), and COC form.

4. Remove the particulate filter and flow controller from the SUMMA® canister, re-install the brass plug on the canister fitting, and tighten with the appropriate wrench.

5. Package the canister and flow controller in the shipping container supplied by the laboratory for return shipment to the laboratory. The SUMMA® canister does not require preservation with ice or refrigeration during shipment.

6. Complete the appropriate forms and sample labels as directed by the laboratory (e.g., affix card with a string).

7. Complete the COC form and place the requisite copies in a shipping container. Close the shipping container and affix a custody seal to the container closure. Ship the container to the laboratory via overnight carrier (e.g., Federal Express) for analysis.

VII. Waste Management

No specific waste management procedures are required.

VIII. Data Recording and Management

Measurements will be recorded in the field notebook at the time of measurement with notations of the project name, sample date, sample start and finish time, sample location (e.g., GPS coordinates, distance from permanent structure [e.g., two walls, corner of room]), canister serial number, flow controller serial number, initial vacuum reading, and final pressure reading. Field sampling logs and COC records will be transmitted to the Project Manager.

IX. Quality Assurance

Soil-gas sample analysis will be performed using USEPA TO-15 methodology. This method uses a quadrupole or ion-trap GC/MS with a capillary column to provide optimum detection limits. The GC/MS system requires a 1-liter gas sample (which can easily be recovered from a 6-liter canister) to provide a 0.5-ppbv detection limit. The 6-liter canister also provides several additional 1-liter samples in case subsequent re-analyses or dilutions are required. This system also offers the advantage of the GC/MS detector, which confirms the identity of detected compounds by evaluating their mass spectra in either the SCAN or SIM mode.

X. References

DiGiulio et. al. 2003. Draft Standard Operating Procedure (SOP) for Installation of Sub-Slab Vapor Probes and Sampling Using EPA TO-15 to Support Vapor Intrusion Investigations. http://www.cdphe.state.co.us/hm/indoorair.pdf (Attachment C)

New York State Department of Health (NYSDOH). 2005. DRAFT "Guidance for Evaluating Soil Vapor Intrusion in the State of New York" February 23, 2005.

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Sub-Slab Sample Collection Log

		Sample ID:	
Client:		**Boring Equipment:**	
Project:		**Sealant:**	
Location:		**Tubing information:**	
Project #:		**Miscellaneous Equipment:**	
Samplers:		**Subcontractor:**	
Sample Point Location:		**Moisture Content of Sampling Zone (circle one):**	Dry / Moist
Sampling Depth:		**Approximate Purge Volume and Method:**	
Time of Collection:			

Instrument Readings:

Time	Canister Pressure (inches of HG)	Temperature (F or C)	Relative Humidity (%)	Air Speed (ft/min)	Pressure Differential (inches of H20)	PID (ppm or ppb)

SUMMA Canister Information:

Size (circle one): 1 L 6 L

Canister ID:

Flow Controller ID: _____

General Observations/Notes:

Approximating One-Well Volume (for purging): When using 1¼-inch "Dummy Point" and a 6-inch sampling interval, sampling space will have a volume of approximately 150 mL. Each foot of ¼-inch tubing will have a volume of approximately 10 mL.

Please record current weather information including wind speed and direction, ambient temperature, barometric pressure and relative humidity via a suitable information source (e.g., weatherunderground.com).

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Sub-Slab Soil-Gas Sampling Using Temporary Sampling Ports

Rev. #: 2

Rev Date: November 14, 2008

Approval Signatures

Prepared by: _____ Date: May 20, 2008
Mitch Wacksman

Reviewed by: _____ Date: May 20, 2008
Robert Uppencamp

Approved by: _____ Date: November 14, 2008
Christopher Lutes

I. Scope and Application

This document describes the procedures to install a sub-slab sampling port and collect sub-slab soil gas samples for the analysis of volatile organic compounds (VOCs) by United States Environmental Protection Agency (USEPA) Method TO-15. In particular, this standard operating procedure (SOP) describes the installation and collection of a sub-slab soil gas sample using only hand tools and does not involve installation using a geoprobe or post run tubing (PRT) system. Method TO-15 uses a 6-liter or 1-liter SUMMA® passivated stainless steel canister. An evacuated SUMMA canister (less than 28 inches of mercury [Hg]) will provide a recoverable whole-gas sample that is then analyzed for VOCs using a quadrupole or ion-trap gas chromatograph/mass spectrometer (GC/MS) system to provide compound detection limits of 0.5 parts per billion volume (ppbv) or lower.

The following sections list the necessary equipment and detailed instructions for installing sub-slab soil gas ports and collecting soil-gas samples.

II. Personnel Qualifications

ARCADIS field sampling personnel will have current health and safety training, including 40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) training. Site supervisor training, site-specific training, first-aid, and cardiopulmonary resuscitation (CPR) may be appropriate at some sites. ARCADIS field sampling personnel will be well versed in the relevant SOPs and possess the required skills and experience necessary to successfully complete the desired field work. ARCADIS personnel responsible for leading sub-slab soil-gas sample collection activities must have previous sub-slab soil-gas sampling experience.

III. Equipment List

The equipment required to install and collect a temporary sub-slab vapor port is listed below. Any modifications to account for project- or regulatory-specific requirements should be noted in the accompanying work plan.

- Equipment for installing a sub-slab soil gas point
    - Appropriate PPE (as required by the Health and Safety Plan);
    - Hammer drill (Hilti, Bosch Hammer, or equilivant);
    - 1/2 inch-diameter concrete drill bit;

- Hand tools including open-end wrench (typically 9/16-inch);
- 1/4-inch OD tubing (Teflon, nylon, or Teflon-lined); Note that Nylaflow tubing has a somewhat higher background level of BTEX and much poorer recovery of tirchlorobenzene and naphthalene then Teflon, so should not be used on sites where these compounds are a concern (Hayes, 2006).
- Teflon® tape;
- Hydrated bentonite, VOC-free modeling clay or wax to seal drill hole;
- Extension cords; and
- Shop vac.

- Equipment for collecting a sub-slab soil gas point
  - Stainless steel SUMMA® canisters (6-liter, 1-liter or smaller; order at least one extra, if feasible);
  - Flow controllers with in-line particulate filters and vacuum gauges; flow controllers are pre-calibrated to specified sample duration (e.g., 30 minutes, 8 hours, 24 hours) or flow rate (e.g., 200 milliliters per minute [mL/min]); confirm with the laboratory that the flow controller comes with an in-line particulate filter and pressure gauge (order at least one extra, if feasible); Flow rate should be selected based on expected subslab material/soil type (see below).
  - Swage-Lok fittings;
  - Stainless steel Swage-Lok “T” fitting (if collecting duplicate [i.e., split] samples);
  - Portable vacuum pump capable of producing very low flow rates (e.g., 100 to 200 milliliters per minute [mL/min]) (recommend SKC-PCXR8); vacuum pump should also be equipped with a vacuum guage
  - Rotameter or an electric flow sensor if vacuum pump does not have and accurate flow gauge;

- Tracer gas testing supplies if applicable (refer to SOP for "Administering Tracer Gas");
- Photo Ionization Detector (PID) with a lamp of 11.7 eV; detectable to ppb range (optional);
- Tedlar bag to collect purge air;
- Portable weather meter, if appropriate (temperature, barometric pressure, humidity, etc);
- Quick setting grout or sika flex to seal abandoned holes;
- Chain-of-custody (COC) form;
- Sample collection log (attached); and
- Field notebook.

IV. Cautions

The following cautions and field tips should be reviewed and considered prior to installing or collecting a sub-slab soil gas sample.

- When drilling sample collection holes be mindful of any utilities that may be in the area. If the driller is concerned about a particular location, consult the project manager about moving it to another location. Don't be hesitant to use your Stop Work Authority, if something doesn't seem right stop and remedy the situation.
- Sampling personnel should not handle hazardous substances (such as gasoline), permanent marking pens, wear/apply fragrances, or smoke cigarettes/cigars before and/or during the sampling event.
- Ensure that the flow controller is pre-calibrated to the proper sample collection time by checking the regulators (check tags, markings, shipping forms) sent by the laboratory (if there is any doubt, confirm with laboratory).
- Care must be taken to properly seal around the vapor port at slab surface to prevent leakage of atmosphere into the soil vapor port during purging and sampling. Temporary points should be fit snug into the pre-drilled hole using

Teflon® tape or modeling clay and a seal hydrated bentonite, clay or wax at the surface.

- It is important to record the canister pressure, start and stop times and ID on a proper field sampling form. Often Summa canisters are collected with a 24 hour averaging period. You should observe and record the time/pressure at the start, and then again one or two hours after starting the sample collection. It is a good practice to lightly tap the pressure gauge with your finger before reading it to make sure it isn't stuck. If the canister is running correctly for a 24 hour period then the vacuum will have decreased slightly after an hour or two (for example from 29" to 27"). Consult your project manager (PM), risk assessor or air sampling expert by phone if the Summa canister does not appear to be working properly.

- Ensure that there is still measureable vacuum in the Summa after sampling. Sample integrity is maintained if the sampling event is shorter than the target duration, but sample integrity can be compromised if the event is extended to the point that the canister reaches atmospheric pressure. Excessive vacuum remaining in the canister can also result in elevated reporting limits.

- Many times the gauges sent from labs have large offset errors, or they stick. For the most precise pressure readings consider using a separate, more sensitive, device to do checks at the beginning and end of the sampling period. If this is used it must be tested beforehand to confirm that it does not introduce contaminants to the can during pressure checks

- When sampling carefully consider elevation. If your site is over 2,000' above sea level or the difference in elevation between your site and your lab is more than 2,000' then pressure effects will be significant. If you take your samples at a high elevation they will contain less air for a given ending pressure reading. High elevation samples analyzed at low elevation will result in more dilution at the lab, which could affect reporting limits. Conversely low elevation samples when received at high elevation may appear to not have much vacuum left in them http://www.uigi.com/Atmos_pressure.html.

- If possible, have equipment shipped a day or two before the sampling date so that all materials can be checked.

- Requesting extra canisters from the laboratory should also be considered to ensure that you have enough equipment on site in case of an equipment failure.

A Shipping Determination must be performed, by DOT-trained personnel, for all environmental and geotechnical samples that are to be shipped, as well as some types of environmental equipment/supplies that are to be shipped.

V. Health and Safety Considerations

Field sampling equipment must be carefully handled to minimize the potential for injury and the spread of hazardous substances. Review appropriate health and safety plan (HASP) and job safety analysis (JSA) prior to beginning work to be aware of all potential hazards associated with the job site and the specific installation. A full utility mark-out should be done prior to any drilling activities. If sample points are in questionable locations consult the project manager about moving sample point. For sub-slab vapor port installation, drilling with a hammer drill should be done only by personnel with prior experience using such a piece of equipment. New staff should be trained and supervised by experienced drill users.

VI. Procedure

Temporary sub-slab soil vapor ports are installed using equipment and procedures that allows the point to be installed quickly and abandoned after an initial sample is collected. These procedures are not recommended if the point is to be sampled more than once. Under those conditions refer to ARCADIS' SOP for permanent sub-slab soil gas installations.

Sub-slab Soil Gas Point Installation

1. A utility mark-out of the pertinent areas should be accomplished prior to any drilling activities.

2. Remove, only to the extent necessary, any covering on top of the slab (e.g., carpet).

3. Drill a 1/2 inch diameter hole through the concrete slab using the electric drill.

4. Advance the drill bit approximately 3 inches into the sub-slab material to create an open cavity. Note if possible from the drill cuttings any evidence for the types of materials in the immediate subslab – i.e. moisture barriers, sand, gravel, shrinkage gap?

5. Using a shop-vac, clean any material that may have fallen into and around the hole.

6. Re-drill the hole to ensure it remains clear. This can also be accomplished using a piece of steel rod, sample tubing, or even a piece of heavy wire (coat hanger).

7. Wrap the tubing with Teflon® tape or modeling clay, to the extent necessary, for a snug fit of tubing and hole.

8. Insert the tubing approximately 3 inches into the sub-slab material.

9. Prepare a hydrated bentonite mixture and apply bentonite at slab surface around the tubing. Instead of hydrated bentonite, either VOC free modeling clay or wax may be used to seal the tubing into the slab.

10. Purge the soil vapor port and tubing with a portable sampling pump. Purge approximately three volumes of air from the vapor port and sampling line using a portable pump [purge volume = 1.5 Pi r2h] at a rate of approximately 100 to 200 mL/min. All purge air should be collected into a tedlar bag to ensure VOCs are not released into any interior spaces. This flow rate should be suitable for a variety of gravel, silt and sand conditions but will not be achievable in some clays without excessive vacuum. Excessive vacuums should be avoided. The cutoff value for vacuum however differs in the sources however from 10" of water column (ITRC 2007) to 136" of water column or 10" of mercury (http://www.dtsc.ca.gov/lawsregspolicies/policies/SiteCleanup/upload/SMBR_ADV_activesoilgasinvst.pdf). A detailed discussion of the achievable flow rates in various permeability materials can be found in Nicholson 2007. Related issues of contaminant partitioning are summarized in ASTM D5314-92. Passive sampling approaches can be considered as an alternative for clay soils. Measure organic vapor levels with the PID, as appropriate.

11. Proceed to soil gas sample collection.

Sub-Slab Soil Gas Sample Collection

Once the temporary sample port is installed, the following procedure should be used to collect the sample in the Summa canister.

1. Remove the brass plug from the SUMMA® canister and connect the flow controller with in-line particulate filter and vacuum gauge to the SUMMA® canister. Do not open the valve on the SUMMA® canister.

2. Connect the sample collection tubing from the sample port to the flow controller and the SUMMA® canister valve.

3. Attach duplicate or other QA/QC samples as required by applicable regulations and guidance. Use a Swahe-Lok t-fitting supplied by the laboratory to connect two canisters to the sample port tubing.

4. If necessary, check the seal around the soil vapor port by using a tracer gas (e.g., helium) or other method established in the appropriate guidance document (see helium tracer gas SOP).

5. Open the SUMMA® canister valve to initiate sample collection.

6. Record the following information on the sample log, field notebook, and or COC:

    - Starting sample time;
    - Initial canister pressure;
    - Weather conditions including wind speed and direction; ambient outside and inside temperatures; barometric pressure; and relative humidity; and
    - Sample canister serial number and flow controller numbers.

7. If appropriate, take a photograph of the SUMMA® canister and surrounding area.

8. Depending on the sample collection duration it is generally advisable to wait for the canister to fill or to check on the canister at least once during the sample collection period. If the vacuum gauge does not appear to be working properly (see Section IV), then it may be appropriate to terminate the sample collection early and use another Summa canister for sample collection.

Termination of Sample Collection

Arrive at the SUMMA® canister location at least 10 to 15 minutes prior to the end of the required sampling interval in order to have sufficient time to terminate the sample collection.

1. Record the final vacuum pressure. Stop collecting the sample by closing the SUMMA® canister valves. The canister should have a minimum amount of vacuum (approximately 2 inches of Hg or slightly greater).

2. Record the date and time of valve closing in the sample collection log (attached) and COC form.

3. Remove the particulate filter and flow controller from the SUMMA® canister, re-install the brass plug on the canister fitting, and tighten with the appropriate wrench.

4. When the sub-slab soil gas sampling is complete, remove the tubing and grout the hole in the slab with quick-setting hydraulic cement powder, Sika-Flex, or other material similar to the slab. This step must be done carefully to ensure that the abandoned sampling point does not become a preferential flow pathway.

5. Replace the surface covering (e.g., carpet) to the extent practicable. Sample collection location should be returned to pre-sampling conditions.

6. Package the canister and flow controller in the shipping container supplied by the laboratory for return shipment to the laboratory. The SUMMA® canister does not require preservation with ice or refrigeration during shipment.

7. Complete the appropriate forms and sample labels as directed by the laboratory (e.g., affix card with a string).

8. Complete the COC form and place the requisite copies in a shipping container. Close the shipping container and affix a custody seal to the container closure. Ship the container to the laboratory via overnight carrier (e.g., Federal Express) for analysis.

9. Before shipping ensure that the valve is off and that Swagelok plug is on firmly.

VII. Waste Management

The volume of waste materials generated by these activities should be minimal. Personal protective equipment, such as gloves and other disposable equipment (i.e., tubing) should be collected by field personnel for proper disposal.

VIII. Data Recording and Management

Information collected in the field should be recorded in the field notebook as well as written on the field sampling log and COC, as appropriate. The field notebook and sampling log must include the project name, sample date, sample start and finish time,

sample location (e.g., global positioning system [GPS] coordinates, distance from permanent structure [e.g., two walls, corner of room]), canister serial number, flow controller serial number, initial vacuum reading, and final pressure reading. Field sampling logs and COC records will be transmitted to the PM.

IX. Quality Assurance

Duplicate samples should be collected in the field as a quality assurance step. Generally, duplicates are taken of 10% of samples, but project specific requirements should take precedence.

Soil-gas sample analysis will generally be performed using USEPA TO-15 methodology or a project specific constituent list. Method TO-15 uses a quadrupole or ion-trap GC/MS with a capillary column to provide optimum detection limits (typically 0.5-ppbv for most VOCs).

X. References

ASTM – "Standard Guide for Soil Gas Monitoring in the Vadose Zone", D5314-92.

Hayes, H. C., D.J. Benton and N. Khan "Impact of Sampling media on Soil Gas Measurements" Presented with short paper at AWMA Vapor Intrucion Conference January 2006, Philadelphia PA.

ITRC "Vapor Intrusion Pathway: A Practical Guide", January 2007, Appendix F: "regulators Checklist for Reviewing Soil Gas Data"

Nicholson, P, D. Bertrand and T. McAlary. "Soil Gas Sampling in Low-Permeability Materials" Presented at AWMA Specialty Conference on Vapor Intrusion, Providence RI, Sept 2007.

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Ambient Air Sampling and Analysis Using USEPA Method TO-15

Rev. #: 1

Rev Date: March 13, 2009

Approval Signatures

Prepared by: Nadine Weinberg Date: 3/13/09
Nadine Weinberg

Reviewed by: Christopher C Lutes Date: 3/13/09
Christopher Lutes (Technical Expert)

I. Scope and Application

This standard operating procedure (SOP) describes the procedures to collect ambient air samples for the analysis of volatile organic compounds (VOCs) using United States Environmental Protection Agency (USEPA) Method TO-15 (TO-15). The TO-15 method uses a 6-liter SUMMA® passivated stainless steel canister. An evacuated SUMMA® canister (<28 inches of mercury [Hg]) will provide a recoverable whole-gas sample of approximately 5.5 liters when allowed to fill to a vacuum of 2-7 inches of Hg. The whole-air sample is then analyzed for VOCs using a quadrupole or ion-trap gas chromatograph/mass spectrometer (GS/MS) system to provide compound detection limits of 0.5 parts per billion volume (ppbv).

The following sections list the necessary equipment and detailed instructions for placing the sampling device and collecting ambient air samples for VOC analysis.

II. Personnel Qualifications

ARCADIS field sampling personnel will have current health and safety training, including 40-hour HAZWOPER training, site supervisor training, site-specific training, first aid, and cardiopulmonary resuscitation (CPR), as needed. ARCADIS field sampling personnel will be well versed in the relevant SOPs and possess the required skills and experience necessary to successfully complete the desired field work. ARCADIS personnel responsible for leading ambient air sample collection activities must have previous ambient air sampling experience.

III. Equipment List

The equipment required for ambient air sample collection is presented below:

- 6-liter, stainless steel SUMMA® canisters (order at least one extra, if feasible);
- Flow controllers with in-line particulate filters and vacuum gauges (flow controllers are pre-calibrated by the laboratory to a specified sample duration [e.g., 8-hour]). Confirm with lab that flow controller comes with in-line particulate filter and pressure gauge (order an extra set for each extra SUMMA® canister, if feasible);
- Appropriate-sized open-end wrench (typically 9/16-inch);
- Chain-of-custody (COC) form;
- Field notebook;

- Sample collection log (attached);
- Camera;
- Lock and chain; and
- Ladder or similar to hold canister above the ground surface (optional).

IV. Cautions

Care must be taken to minimize the potential for introducing interferences during the sampling event. As such, care must be taken to keep the canister away from public roadways to prevent collection of automobile source pollutants (unless this is the objective of the study). Care must also be taken to keep the canister away from heavy pedestrian traffic areas (e.g., main entranceways, walkways). If the canister is not to be overseen for the entire sample duration, precautions should be taken to maintain the security of the sample (e.g., do not place in areas regularly accessed by the public, fasten the sampling device to a secure object using lock and chain, label the canister to indicate it is part of a scientific project, place the canister in secure housing that does not disrupt the integrity/validity of the sampling event). Sampling personnel should not handle hazardous substances (such as gasoline), permanent marking pens, wear/apply fragrances, or smoke cigarettes/cigars before and/or during the sampling event.

Care should also be taken to ensure that the flow controller is pre-calibrated to the proper sample collection time (confirm with laboratory). Sample integrity is maintained if the sampling event is shorter than the target duration, but sample integrity can be compromised if the event is extended to the point that the canister reaches atmospheric pressure.

A Shipping Determination must be performed, by DOT-trained personnel, for all environmental and geotechnical samples that are to be shipped, as well as some types of environmental equipment/supplies that are to be shipped.

V. Health and Safety Considerations

Field sampling equipment must be carefully handled to minimize the potential for injury and the spread of hazardous substances.

VI. Procedure

Preparation of SUMMA®-Type Canister and Collection of Sample

1. Record the following information in the field notebook (contact the local airport or other suitable information source [e.g., weatherunderground.com] to obtain the following information):

   - ambient temperature;
   - barometric pressure; and
   - relative humidity.

2. Choose the sample location in accordance with the sampling plan. If a breathing zone sample is required, place the canister on a ladder, tripod, or other similar stand to locate the canister orifice 3 to 5 feet above ground. If the canister will not be overseen for the entire sampling period, secure the canister as appropriate (e.g., lock and chain).

3. Record SUMMA® canister serial number and flow controller number in the field notebook and COC form. Assign sample identification on canister ID tag and record in the field notebook, sample collection log (attached), and COC form.

4. Remove the brass dust cap from the SUMMA® canister. Attach the flow controller with in-line particulate filter and vacuum gauge (leave swage-lock cap on the vacuum gauge during this procedure) to the SUMMA® canister with the appropriate wrench. Tighten with fingers first, then gently with the wrench.

5. Open the SUMMA® canister valve to initiate sample collection. Record the date and local time (24-hour basis) of valve opening in the field notebook, sample collection log, and COC form.

6. Record the initial vacuum pressure in the SUMMA® canister in the field notebook and COC form. If the initial vacuum pressure does not register less than -28 inches of Hg, then the SUMMA® canister is not appropriate for use and another canister should be used.

7. Take a photograph of the SUMMA® canister and surrounding area.

Termination of Sample Collection

1. Arrive at the SUMMA® canister location at least 10 to 15 minutes prior to the end of the sampling interval (e.g., 8-hour).

2. Stop collecting the sample when the canister vacuum reaches approximately 2-7 inches of Hg (leaving some vacuum in the canister provides a way to verify if the canister leaks before it reaches the laboratory) or when the desired sample time has elapsed.

3. Record the final vacuum pressure. Stop collecting the sample by closing the SUMMA® canister valve. Record the date and local time (24-hour basis) of valve closing in the field notebook, sample collection log, and COC form.

4. Remove the particulate filter and flow controller from the SUMMA® canister, re-install brass plug on canister fitting, and tighten with wrench.

5. Package the canister and flow controller in the shipping container supplied by the laboratory for return shipment to the laboratory. The SUMMA® canister does not require preservation with ice or refrigeration during shipment.

6. Complete the appropriate forms and sample labels as directed by the laboratory (e.g., affix card with string).

7. Complete COC forms and place requisite copies in shipping container. Close shipping container and affix custody seal to container closure. Ship to laboratory via overnight carrier (e.g., Federal Express) for analysis.

VII. Waste Management

No specific waste management procedures are required.

VIII. Data Recording and Management

Measurements will be recorded in the field notebook at the time of measurement, with notations of project name, sample date, sample start and finish times, sample location (e.g., GPS coordinates if available), canister serial number, flow controller number, initial vacuum reading, and final vacuum reading. Field sampling logs and COC records will be transmitted to the Project Manager.

IX. Quality Assurance

Ambient air sample analysis will be performed using USEPA Method TO-15. This method uses a quadrupole or ion-trap GC/MS with a capillary column to provide optimum detection limits. The GC/MS system requires a 1-liter gas sample (which can easily be recovered from a 6-liter canister) to provide a 0.5 ppbv detection limit. The 6-liter canister also provides several additional 1-liter samples in case subsequent re-

analyses or dilutions are required. This system also offers the advantage of the GC/MS detector, which confirms the identity of detected compounds by evaluating their mass spectra in either the SCAN or SIM mode.

X. References

[Click here and enter Text]

ARCADIS Infrastructure, environment, facilities	**Indoor/Ambient Air Sample Collection Log**	
	Sample ID:	

Client:		**Outdoor/Indoor:**	
Project:		**Sample Intake Height:**	
Location:		**Miscellaneous Equipment:**	
Project #:		**Time On/Off:**	
Samplers:		**Subcontractor:**	

Instrument Readings:

Time	Canister Pressure (inches of HG)	Temperature (F or C)	Relative Humidity (%)	Air Speed (ft/min)	Pressure Differential (inches of H20)	PID (ppm or ppb)

SUMMA Canister Information:

Size (circle one): 1 L 6 L

Canister ID:

Flow Controller ID: _____

General Observations/Notes:

Please record current weather information including wind speed and direction, ambient temperature, barometric pressure, and relative humidity via suitable information source (e.g., weatherunderground.com).

ARCADIS
Infrastructure, environment, facilities

Imagine the result

Indoor Air Sampling and Analysis Using USEPA Method TO-15

Rev. #: 1

Rev Date: March 13, 2009

Approval Signatures

Prepared by: Nadine Weinberg Date: 3/13/09
Nadine Weinberg

Reviewed by: Christopher Lutes Date: 3/13/09
Christopher Lutes (Technical Expert)

I. Scope and Application

This standard operating procedure (SOP) describes the procedures to collect indoor air samples for the analysis of volatile organic compounds (VOCs) using United States Environmental Protection Agency (USEPA) Method TO-15 (TO-15). The TO-15 method uses a 6-liter SUMMA® passivated stainless steel canister. An evacuated SUMMA® canister (<28 inches of mercury [Hg]) will provide a recoverable whole-gas sample of approximately 5.5 liters when allowed to fill to a vacuum of 2-7 inches of Hg. The whole-air sample is then analyzed for VOCs using a quadrupole or ion-trap gas chromatograph/mass spectrometer (GS/MS) system to provide compound detection limits of 0.5 parts per billion volume (ppbv).

The following sections list the necessary equipment and provide detailed instructions for placing the sampling device and collecting indoor air samples for VOC analysis.

II. Personnel Qualifications

ARCADIS field sampling personnel will have current health and safety training, including 40-hour HAZWOPER training, site supervisor training, site-specific training, first aid, and cardiopulmonary resuscitation (CPR), as needed. ARCADIS field sampling personnel will be well versed in the relevant SOPs and possess the required skills and experience necessary to successfully complete the desired field work. ARCADIS personnel responsible for leading indoor air sample collection activities must have previous indoor air sampling experience.

III. Equipment List

The equipment required for indoor air sample collection is presented below:

- Photoionization detector (PID) with VOC detection limit capabilities in the ppb range;
- 6-liter, stainless steel SUMMA® canisters (order at least one extra, if feasible);
- Flow controllers with in-line particulate filters and vacuum gauges (flow controllers are pre-calibrated by the laboratory to a specified sample duration [e.g., 8-hour, 24-hour]). Confirm with lab that flow controller comes with in-line particulate filter and pressure gauge (order an extra set for each extra SUMMA® canister, if feasible);

- Stainless steel “T” fitting (for connection to SUMMA® canisters and Teflon® tubing to collect split [i.e., duplicate] samples);
- Appropriate-sized open-end wrench (typically 9/16-inch);
- Chain-of-custody (COC) form;
- Building survey and product inventory form (Attachment A);
- Sample collection log (Attachment B);
- Field notebook;
- Camera;
- Lock and chain; and
- Ladder or similar to hold canister above the ground surface (optional).

IV. Cautions

Care must be taken to minimize the potential for introducing interferences during the sampling event. As such, care must be taken to keep the canister away from heavy pedestrian traffic areas (e.g., main entranceways, walkways). If the canister is not to be overseen for the entire sample duration, precautions should be taken to maintain the security of the sample (e.g., do not place in areas regularly accessed by the public, fasten the sampling device to a secure object using lock and chain, label the canister to indicate it is part of a scientific project, place the canister in secure housing that does not disrupt the integrity/validity of the sampling event). Sampling personnel should not handle hazardous substances (such as gasoline), permanent marking pens, wear/apply fragrances, or smoke cigarettes before and/or during the sampling event.

Care should also be taken to ensure that the flow controller is pre-calibrated to the proper sample collection time (confirm with laboratory). Sample integrity is maintained if the sampling event is shorter than the target duration, but sample integrity can be compromised if the event is extended to the point that the canister reaches atmospheric pressure.

A Shipping Determination must be performed, by DOT-trained personnel, for all environmental and geotechnical samples that are to be shipped, as well as some types of environmental equipment/supplies that are to be shipped.

V. Health and Safety Considerations

Field sampling equipment must be carefully handled to minimize the potential for injury and the spread of hazardous substances.

VI. Procedure

Initial Building Survey

1. Complete the appropriate building survey form and product inventory form (e.g., state-specific form or ARCADIS form, Attachment A) at least 48 hours in advance of sample collection.

2. Survey the area for the apparent presence of items or materials that may potentially produce or emit constituents of concern and interfere with analytical laboratory analysis of the collected sample. Record relevant information on survey form and document with photographs.

3. Using the PID, screen indoor air in the location intended for sampling and the vicinity of potential VOC sources to preliminarily assess for the potential gross presence of VOCs.

4. Record date, time, location, and PID readings in the field notebook.

5. Items or materials that contain constituents of concern and/or exhibit elevated PID readings shall be considered probable sources of VOCs. Request approval of the owner or occupant to have these items removed at least 48 hours prior to sampling.

6. Set a time with the owner or occupant to return for placement of SUMMA® canisters.

Preparation of SUMMA®-Type Canister and Collection of Sample

1. Record the following information in the field notebook (contact the local airport or other suitable information source [e.g., weatherunderground.com] to obtain the following information):

    - ambient temperature;

    - barometric pressure; and

- relative humidity.

2. Choose the sample location in accordance with the sampling plan. If a breathing zone sample is required, place the canister on a ladder, tripod, or other similar stand to locate the canister orifice 3 to 5 feet above ground or floor surface. If the canister will not be overseen for the entire sampling period, secure the canister as appropriate (e.g., lock and chain). Canister may be affixed to wall/ceiling support with nylon rope or placed on a stable surface. In general, areas near windows, doors, air supply vents, and/or other potential sources of "drafts" shall be avoided.

3. Record SUMMA® canister serial number and flow controller number in the field notebook and COC form. Assign sample identification on canister ID tag, and record in the field notebook, sample collection log (Attachment B), and COC form.

4. Remove the brass dust cap from the SUMMA® canister. Attach the flow controller with in-line particulate filter and vacuum gauge (leave swage-lock cap on the vacuum gauge during this procedure) to the SUMMA® canister with the appropriate-sized wrench. Tighten with fingers first, then gently with the wrench.

5. Open the SUMMA® canister valve to initiate sample collection. Record the date and local time (24-hour basis) of valve opening in the field notebook, sample collection log, and COC form. Collection of duplicate/split samples will include attaching a stainless steel "T" to split the indoor air stream to two SUMMA® canisters, one for the original investigative sample and one for the duplicate/split sample.

6. Record the initial vacuum pressure in the SUMMA® canister in the field notebook and COC form. If the initial vacuum pressure does not register less than -28 inches of Hg, then the SUMMA® canister is not appropriate for use and another canister should be used.

7. Take a photograph of the SUMMA® canister and surrounding area.

Termination of Sample Collection

1. Arrive at the SUMMA® canister location at least 10 to 15 minutes prior to the end of the sampling interval (e.g., 8-hour).

2. Stop collecting the sample when the canister vacuum reaches approximately 2-7 inches of Hg (leaving some vacuum in the canister provides a way to verify if the

canister leaks before it reaches the laboratory) or when the desired sample time has elapsed.

3. Record the final vacuum pressure. Stop collecting the sample by closing the SUMMA® canister valve. Record the date, local time (24-hour basis) of valve closing in the field notebook, sample collection log, and COC form.

4. Remove the particulate filter and flow controller from the SUMMA® canister, re-install brass plug on canister fitting, and tighten with wrench.

5. Package the canister and flow controller in the shipping container supplied by the laboratory for return shipment to the laboratory. The SUMMA® canister does not require preservation with ice or refrigeration during shipment.

6. Complete the appropriate forms and sample labels as directed by the laboratory (e.g., affix card with string).

7. Complete COC form and place requisite copies in shipping container. Close shipping container and affix custody seal to container closure. Ship to laboratory via overnight carrier (e.g., Federal Express) for analysis.

VII. Waste Management

No specific waste management procedures are required.

VIII. Data Recording and Management

PID measurements taken during the initial building survey will be recorded in the field notebook, with notations of project name, sample date, sample time, and sample location (e.g., description and GPS coordinates if available). A building survey form and product inventory form (Attachment A) will also be completed for each building within the facility being sampled during each sampling event.

Measurements will be recorded in the field notebook at the time of measurement, with notations of project name, sample date, sample start and finish times, sample location (e.g., description and GPS coordinates if available), canister serial number, flow controller number, initial vacuum reading, and final vacuum reading. Field notebooks and COC records will be transmitted to the Project Manager.

IX. Quality Assurance

Indoor air sample analysis will be performed using USEPA Method TO-15. This method uses a quadrupole or ion-trap GC/MS with a capillary column to provide optimum detection limits. The GC/MS system requires a 1-liter gas sample (which can easily be recovered from a 6-liter canister) to provide a 0.5 ppbv detection limit. The 6-liter canister also provides several additional 1-liter samples in case subsequent re-analyses or dilutions are required. This system also offers the advantage of the GC/MS detector, which confirms the identity of detected compounds by evaluating their mass spectra in either the SCAN or SIM mode.

X. References

[Click here and enter Text]

Attachment A – Building Survey and Product Inventory Form

Directions: This form must be completed for each residence or area involved in indoor air testing.

Preparer's Name: _____

Date/Time Prepared: _____

Preparer's Affiliation: _____

Phone No.: _____

Purpose of Investigation: _____

1. OCCUPANT:

Interviewed: Y / N

Last Name: _____ First Name: _____

Address: _____

County: _____

Home Phone: _____ Office Phone: _____

Number of Occupants/Persons at this Location: _____

Age of Occupants: _____

2. OWNER OR LANDLORD: (Check if Same as Occupant ___)

Interviewed: Y / N

Last Name: _____ First Name: _____

Address: _____

County: _____

Home Phone: _____ Office Phone: _____

3. BUILDING CHARACTERISTICS:

Type of Building: (circle appropriate response)

Residential	School	Commercial/Multi-use
Industrial	Church	Other: _____

If the Property is Residential, Type? (circle appropriate response)

Ranch		2-Family 3-Family
Raised Ranch	Split Level	Colonial
Cape Cod	Contemporary	Mobile Home
Duplex	Apartment House	Townhouses/Condos
Modular	Log Home	Other:_____

If Multiple Units, How Many? _____

If the Property is Commercial, Type?

Business Type(s) _____

Does it include residences (i.e., multi-use)? Y / N If yes, how many? _____

Other Characteristics:

Number of Floors_____ Building Age_____

Is the Building Insulated? Y / N How Air-Tight? Tight / Average / Not Tight

4. AIRFLOW:

Use air current tubes or tracer smoke to evaluate airflow patterns and qualitatively describe:

Airflow Between Floors

_____

_____

_____

Airflow Near Source

Outdoor Air Infiltration

Infiltration Into Air Ducts

5. BASEMENT AND CONSTRUCTION CHARACTERISTICS: (circle all that apply)

a.	**Above grade construction:**	wood frame	concrete	stone brick	
b.	**Basement type:**	full	crawlspace	slab	other _____
c.	**Basement floor:**	concrete	dirt	stone	other _____
d.	**Basement floor:**	uncovered	covered	covered with _____	
e.	**Concrete floor:**	unsealed	sealed	sealed with _____	
f.	**Foundation walls:**	poured	block stone	other _____	
g.	**Foundation walls:**	unsealed	sealed	sealed with _____	
h.	**The basement is:**	wet	damp	dry	moldy
i.	**The basement is:**	finished	unfinished	partially finished	
j.	**Sump present?**	Y / N			
k.	**Water in sump?**	Y / N / NA			

Basement/lowest level depth below grade: _____(feet)

Identify potential soil vapor entry points and approximate size (e.g., cracks, utility ports, drains)

_____

Are the basement walls or floor sealed with waterproof paint or epoxy coatings? Y / N

6. HEATING, VENTILATING, AND AIR CONDITIONING: (circle all that apply)

Type of heating system(s) used in this building: (circle all that apply – note primary)

Hot air circulation	Heat pump	Hot water baseboard
Space heaters	Stream radiation	Radiant floor
Electric baseboard	Wood stove	Outdoor wood boiler
Other _____		

The primary type of fuel used is:

Natural base	Fuel oil	Kerosene
Electric	Propane	Solar
Wood coal		

Domestic hot water tank fueled by: _____

Boiler/furnace located in: Basement Outdoors Main Floor Other_____

Air conditioning: Central Air Window Units Open Windows None

Are there air distribution ducts present? Y / N

Describe the supply and cold air return ductwork, and its condition where visible, including whether there is a cold air return and the tightness of duct joints. Indicate the locations on the floor plan diagram.

_____

_____

_____

7. OCCUPANCY:

Is basement/lowest level occupied? Full-time Occasionally Seldom Almost Never

General Use of Each Floor (e.g., family room, bedroom, laundry, workshop, storage):

Basement _____

1st Floor _____

2nd Floor _____

3rd Floor _____

4th Floor _____

8. FACTORS THAT MAY INFLUENCE INDOOR AIR QUALITY:

a. Is there an attached garage? Y / N

b. Does the garage have a separate heating unit? Y / N / NA

c. Are petroleum-powered machines or vehicles stored in the garage (e.g., lawnmower, ATV, car)?

Y / N / NA Please specify: _____

d. Has the building ever had a fire? Y / N When? _____

e. Is a kerosene or unvented gas space heater present? Y / N Where? _____

f. Is there a workshop or hobby/craft area? Y / N Where & Type? _____

g. Is there smoking in the building? Y / N How frequently? _____

h. Have cleaning products been used recently? Y / N When & Type? _____

i. Have cosmetic products been used recently? Y / N When & Type? _____

j. Has painting/staining been done in the last 6 months? Y / N Where & When? _____

k. **Is there new carpet, drapes or other textiles? Y / N Where & When?** _____

l. Have air fresheners been used recently? Y / N When & Type? _____

m. Is there a kitchen exhaust fan? Y / N If yes, where _____

n. Is there a bathroom exhaust fan? Y / N If yes, where vented?_____

o. Is there a clothes dryer? Y / N If yes, is it vented outside? Y / N

p. Has there been a pesticide application? Y / N When & Type?_____

q. Are there odors in the building? Y / N

If yes, please describe: _____

Do any of the building occupants use solvents (e.g., chemical manufacturing or laboratory, auto mechanic or auto body shop, painting, fuel oil delivery, boiler mechanic, pesticide application, cosmetologist) at work? Y / N

If yes, what types of solvents are used? _____

If yes, are their clothes washed at work? Y / N

Do any of the building occupants regularly use or work at a dry-cleaning service? (circle appropriate response)

Yes, use dry-cleaning regularly (weekly) No

Yes, use dry-cleaning infrequently (monthly or less) Unknown

Yes, work at a dry-cleaning service

Is there a radon mitigation system for the building/structure? Y / N

Date of Installation: _____

Is the system active or passive? Active/Passive

Are there any Outside Contaminant Sources? (circle appropriate responses)

Contaminated site with 1000-foot radius? Y / N Specify _____

Other stationary sources nearby (e.g., gas stations, emission stacks, etc.): _____

_____

Heavy vehicle traffic nearby (or other mobile sources): _____

9. WATER AND SEWAGE:

Water Supply: Public Water Drilled Well Driven Well Dug Well Other: _____

Sewage Disposal: Public Sewer Septic Tank Leach Field Dry Well Other: _____

10. RELOCATION INFORMATION: (for oil spill residential emergency)

a. Provide reasons why relocation is recommended: _____

_____

b. Residents choose to: remain in home relocate to friends/family relocate to hotel/motel

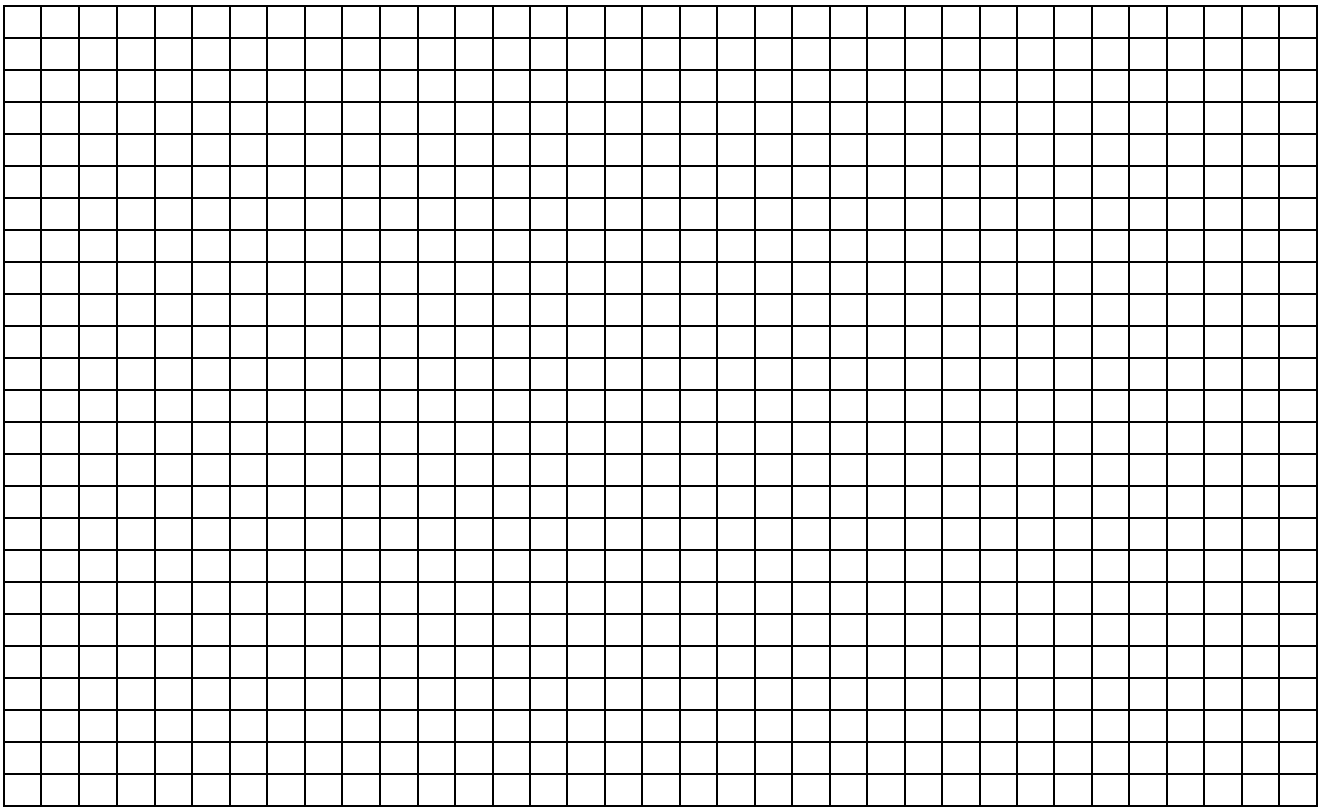
c. Responsibility for costs associated with reimbursement explained? Y / N

d. Relocation package provided and explained to residents? Y / N

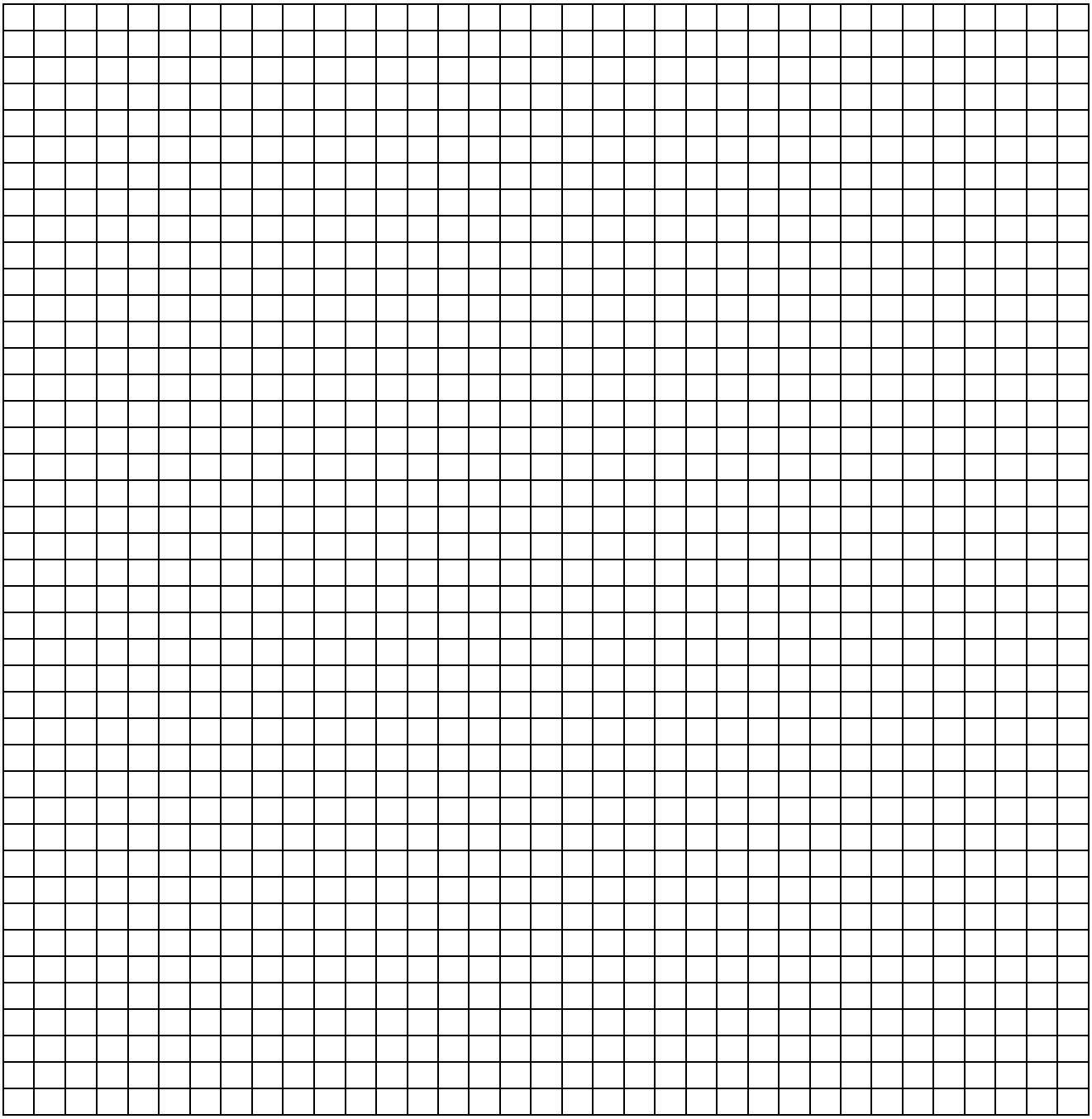
11. FLOOR PLANS:

Draw a plan view sketch of the basement and first floor of the building. Indicate air sampling locations, possible indoor air pollution sources and PID meter readings. If the building does not have a basement, please note.

Basement:



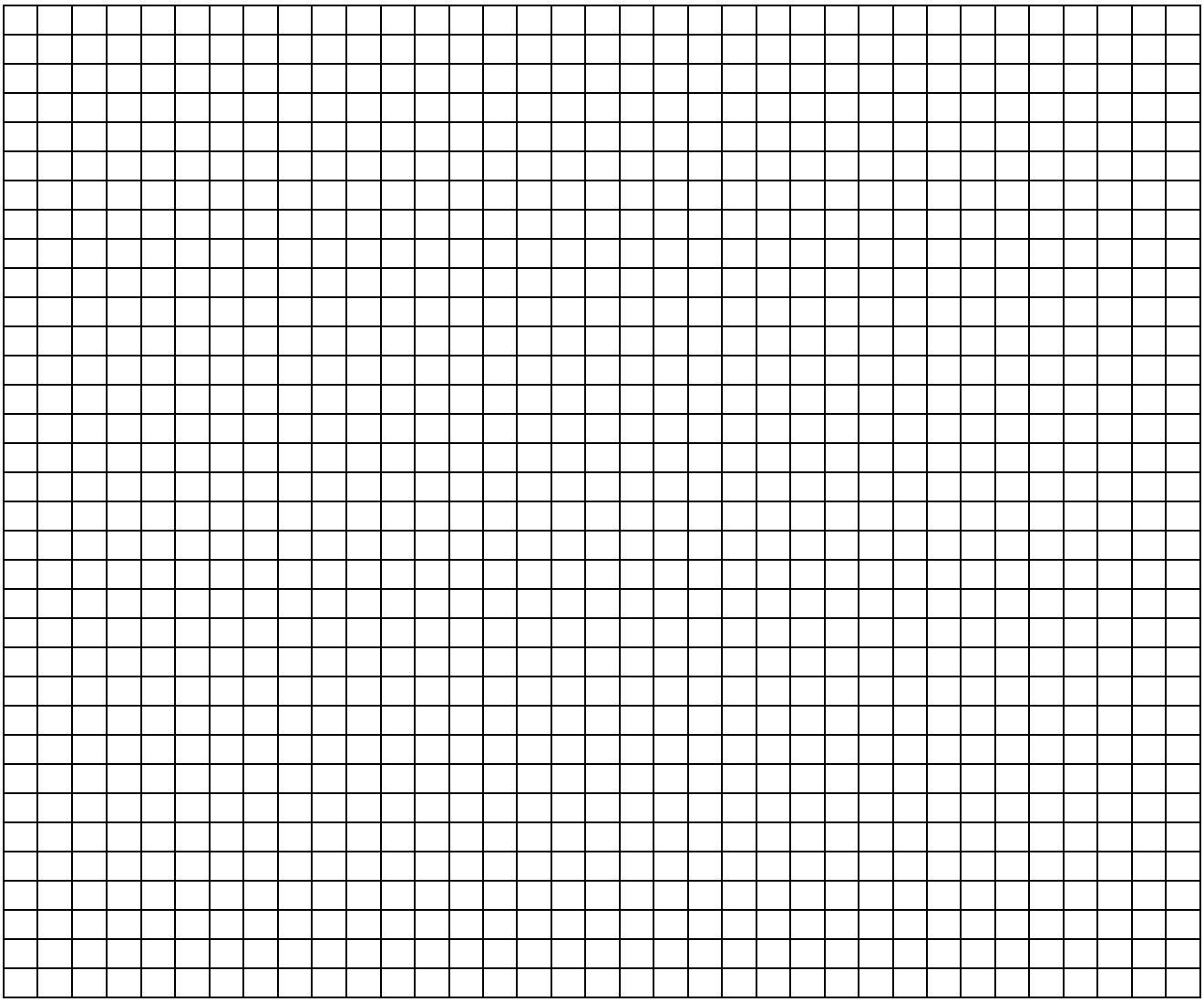
First Floor:



12. OUTDOOR PLOT:

Draw a sketch of the area surrounding the building being sampled. If applicable, provide information on spill locations, potential air contamination sources (industries, gas stations, repair shops, landfills, etc.), outdoor air sampling location(s), and PID meter readings.

Also indicate compass direction, wind direction and speed during sampling, the locations of the well and septic system, if applicable, and a qualifying statement to help locate the site on a topographic map.



13. PRODUCT INVENTORY FORM:

Make and Model of field instrument used: _____

List specific products found in the residence or area that have the potential to affect indoor air quality (e.g., gasoline or kerosene storage cans, glues, paints, cleaning solvents/products, polishes/waxes, new furniture/ carpet, nail polish/hairspray/cologne).

Location	Product Description	Size (units)	Condition*	Chemical Ingredients	Field Instrument Reading (units)	Photo** Y/N

14. SAMPLING INFORMATION:

Sample Technician: _____ Phone number: ( ) _____ - _____

Sample Source: Indoor Air / Sub-Slab / Near Slab Soil Gas / Exterior Soil Gas

Sampler Type: Tedlar Bag / Sorbent / Stainless Steel Canister / Other (specify): _____

Analytical Method: TO-15 / TO-17 / Other: _____ Cert. Laboratory: _____

Sample Locations (floor, room):

Field ID # _____ - _____ Field ID # _____ - _____

Field ID # _____ - _____ Field ID # _____ - _____

If distributed to occupants prior to sampling event, were the state-specific "Instructions for Occupants" followed? Yes / No

If not, describe modifications: _____

15. METEOROLOGICAL CONDITIONS:

Was there significant precipitation within 12 hours prior to (or during) the sampling event? Yes / No

Describe the general weather conditions: _____

_____

16. GENERAL OBSERVATIONS:

Provide any information that may be pertinent to the sampling event and may assist in the data interpretation process.

_____

_____

_____

_____

ATTACHMENT B

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Indoor/Ambient Air Sample Collection Log

		Sample ID:	
Client:		**Outdoor/Indoor:**	
Project:		**Sample Intake Height:**	
Location:		**Miscellaneous Equipment:**	
Project #:		**Time On/Off:**	
Samplers:		**Subcontractor:**	

Instrument Readings:

Time	Canister Pressure (inches of HG)	Temperature (F or C)	Relative Humidity (%)	Air Speed (ft/min)	Pressure Differential (inches of H20)	PID (ppm or ppb)

SUMMA Canister Information:

Size (circle one): 1 L 6 L

Canister ID:

Flow Controller ID: _____

General Observations/Notes:

Please record current weather information including wind speed and direction, ambient temperature, barometric pressure, and relative humidity via suitable information source (e.g., weatherunderground.com).

ARCADIS
Infrastructure, environment, facilities

Imagine the result

Ground Penetrating Radar

Rev. #: 02

Rev Date: May 2009

Approval Signatures

Prepared by: _____ Date: May 27, 2009

Reviewed by: _____ Date: May 27, 2009
(Technical Expert)

I. Scope and Application

This SOP document outlines the applications, limitations, and methodology for acquiring and interpreting subsurface data using ground penetrating radar (GPR). GPR is a non-invasive and non-destructive tool that detects electromagnetic responses to high frequency radio waves transmitted by the GPR unit as it is pulled along the surface. Subsurface objects or material contacts can be located based on differences in their dielectric potential and/or electrical resistivity. The two most important constraints of any GPR investigation are depth of penetration and required resolution. These two constraints are inversely related to the signal frequency applied; i.e., a higher frequency will yield better resolution, but less penetration and a lower frequency will yield less resolution and deeper penetration.

II. Personnel Qualifications

GPR investigations should be conducted by qualified and experienced operators, such as an experienced field technician and/or geophysicist. The GPR operator should be experienced in evaluating data quality in the field and be able to adjust data acquisition procedures in response to variable site conditions in order to identify anomalies and resolve target features. Inexperienced ARCADIS personnel directing or supervising GPR data acquisition, or interpreting processed GPR data should seek appropriate guidance and technical peer review from qualified and experienced personnel.

III. Equipment List

The following equipment will be available, as required, during GPR surveys.

- Personal protective equipment (PPE), as required in the site Health and Safety Plan (HASP);
- Appropriate forms, Site plans, field notebook, spray paint and camera;
- GSSI Model SIR-3000 radar instrument (or equivalent);
- a primary and, preferably, a secondary antennae of appropriate signal frequency[1] to match anticipated size and depth of targets;
- Non-conductive measuring tape or measuring wheel; and

[1] In general, the typical maximum depth of penetration varies from 9 feet with a 400 MHz antennae to 25 feet with a 200 MHz antennae.

- Connecting cables and 12-volt power source.

IV. Cautions

The effectiveness of GPR is site-specific and subject to the skill level of the operator. Reliability and efficiency is enhanced when used in conjunction with other geophysical methods. Soils with higher electrical conductivity rapidly attenuate the radar energy, reducing the penetration depth and resolution. Clayey soils and saturated soils, particularly when high in soluble salts, limit the usefulness of GPR. Other potential interference sources include subsurface debris, rebar reinforced concrete, above ground reflective objects (cars, surface water, transmission lines), and electromagnetic generating apparatus (electrical generators, radio transmitters).

Both metallic and nonmetallic utilities may be imaged by GPR. However, it should be noted that due to differences in the properties of materials, locating a plastic pipe may be more problematic than a metallic pipe because of a lesser dielectric contrast between plastic and soil. A guideline for effective locating depth for utilities is 1 inch (2.5 cm) diameter of utility can be discerned for each foot (0.3 m) of depth to a depth of 12 feet (3.7 m). For instance, one may expect to resolve a utility 10 inches (25 cm) in diameter at a depth of 10 feet (3 m). This is a general rule of thumb that can be applied to both metallic and non-metallic utilities, but should be used cautiously as the type of material can affect the resolution.

Also, the presence of reinforcing bar (rebar) in concrete can limit the resolution of pipes present below the concrete. The resolution of smaller diameter pipes present within or just below the concrete may be completed masked by the high response caused by the rebar.

V. Health and Safety Considerations

Minimize physical hazard exposure through use of proper PPE as prescribed in the HASP. Maintain awareness of other potential hazards associated with the physical location where the GPR investigation is being conducted and any ingress or egress conditions.

VI. Procedure

1. Become familiar with the details of the applicability and limitations of GPR.

2. Evaluate site-specific soil information to determine suitability of soils (clay content, saturation) for GPR. In general, soils with greater than 35% clay content are considered restrictive, and soils with less than 10% clay content are considered favorable for deep penetration with GPR.

3. Evaluate meteorological information regarding recent or forecasted precipitation that could impact soil moisture content and GPR effectiveness. Schedule GPR surveys appropriately.

4. Perform site reconnaissance in advance to identify potential sources of surface interference such as reinforced concrete, large metal objects, or electrical generators).

5. Consider complimentary technologies to supplement GPR and provide multiple lines of evidence. Technologies may include radio frequency, magnetic, and/or electromagnetic surveys.

6. Employ only qualified and experienced GPR operators. For utility locating and mapping applications, the GPR operator should be specifically experienced in evaluating data quality and identifying anomalies in the field requiring variations in data acquisition procedures to positively interpret and locate targets of concern.

7. Consider the depth and size of subsurface features that GPR will be used for identification. Attempt to match the signal frequency to the expected depth and size of the subsurface feature. Change antennae as necessary for variable depths and sizes of target objects. Consider the selection of a primary and secondary choice of antennae, and use multiple antennae as necessary. Evaluate GPR for known utility locations and/or relative to EM results, as an indication of potential effectiveness. A guideline for effective locating depths for utilities is 1-inch (2.5 cm) diameter of utility can be discerned for each foot (0.3 m) of depth to a depth of 12 feet (3.7 m). Expect a much coarser resolution below 12 feet.

8. Establish a reference grid over the area to be investigated and identify traverse locations in the field notebook or on a site plan map.

9. Select and input a dielectric constant into the GPR unit based on knowledge of the type of subsurface materials. Bear in mind that the dielectric constant is an approximation based on assumed subsurface materials and may vary based on the variability of the subsurface materials. The dielectric constant is necessary to estimate the depth of a target, but should be considered an approximation not an absolute. Multiple passes over a known utility may be necessary using different dielectric constants before an accurate depth to a target can be estimated.

10. The pace at which the GPR unit is moved along a traverse affects the target resolution. It is recommended that an initial starting pace should be

approximately 1.5 feet (0.5m) per second and modified if necessary during field operations. Appropriate pacing can be determined in advance if the size of the smallest target is known.

11. Record GPR data while slowly pulling the antenna along each survey traverse. Annotate the record at even distance increments (10 feet, or as needed) using the antenna's marker switch.

12. Multiple traverses in opposite directions over the area being scanned are recommended. A difference in data output for passes conducted in opposing directions may warrant a third pass. This is not necessarily reflective of poor data, but may indicate that anomalies observed are dipping at some angle from horizontal with the ground surface.

13. The width of a single GPR profile scan is actually somewhat broader than that of the antennae itself; however, it should be conservatively assumed that the scan width corresponds to the width of the antennae.

VII. Waste Management

GPR is a non-invasive procedure and should not result in the generation of derived wastes. Any trash or rubbish generated during the course of field activities should be disposed of in a proper trash receptacle.

VIII. Data Recording and Management

Conduct data processing and analysis in accordance with the manufacturer's recommendations and industry practice. Processed data is available in electronic form and as a paper printout. A copy of the field printout should be included in the project files along with the field notebook. Electronic data (raw and processed) should be maintained in accordance with data management procedures as outlined in the project sampling analysis plan (SAP), quality assurance project plan (QAPP), data quality objectives plan, or other applicable plan or guidance document.

IX. Quality Assurance

The following quality control procedures should be observed:

- Seek appropriate input prior to conducting a GPR survey to identify site-specific features (soil conditions/sources of interference) that may impact data acquisition.

- Operate all equipment in accordance with manufacturer's instructions and recommended procedures. Record all system components (Unit, antennae frequency, etc.) information in the field book.

- Data quality should be checked in the field to identify anomalies that may require adjustment to the data acquisition procedures. Make appropriate adjustments to data acquisition methods to achieve survey objectives, as feasible.

- It is recommended that the operation and performance of the GPR equipment is field checked (if possible) by locating existing underground utilities or structures of known depth, size, and construction. These characteristics should be similar to that of unidentified target objects.

- Data interpretation should undergo peer review by appropriate qualified and experienced personnel.

X. References

US Army Corps of Engineers, 1995. Geophysical Exploration for Engineering and Environmental Investigations, Engineering Manual (EM) 1110-1-1802.

ARCADIS
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Chain-of-Custody, Handling, Packing and Shipping

Rev. #: 2

Rev Date: March 6, 2009

Approval Signatures

Prepared by: _____ Date: 3/6/09
Caron Koll

Reviewed by: _____ Date: 3/6/09
Jane Kennedy(Technical Expert)

I. Scope and Application

This Standard Operating Procedure (SOP) describes the chain-of-custody, handling, packing, and shipping procedures for the management of samples to decrease the potential for cross-contamination, tampering, mis-identification, and breakage, and to insure that samples are maintained in a controlled environment from the time of collection until receipt by the analytical laboratory.

II. Personnel Qualifications

ARCADIS field sampling personnel will have current health and safety training, including 40-hour HAZWOPER training, Department of Transportation (DOT) training, site supervisor training, and site-specific training, as needed. In addition, ARCADIS field sampling personnel will be versed in the relevant SOPs and possess the skills and experience necessary to successfully complete the desired field work.

III. Equipment List

The following list provides materials that may be required for each project. Project documents and sample collection requirements should be reviewed prior to initiating field operations:

- indelible ink pens (black or blue);
- polyethylene bags (resealable-type);
- clear packing tape, strapping tape, duct tape;
- chain of custody
- DOT shipping forms, as applicable
- custody seals or tape;
- appropriate sample containers and labels,;
- insulated coolers of adequate size for samples and sufficient ice to maintain 4°C during collection and transfer of samples;
- wet ice;
- cushioning and absorbent material (i.e., bubble wrap or bags);

- temperature blank
- sample return shipping papers and addresses; and
- field notebook.

IV. Cautions

Review project requirements and select appropriate supplies prior to field mobilization.

Insure that appropriate sample containers with applicable preservatives, coolers, and packing material have been supplied by the laboratory.

Understand the offsite transfer requirements for the facility at which samples are collected.

If overnight courier service is required schedule pick-up or know where the drop-off service center is located and the hours of operation. Prior to using air transportation, confirm air shipment is acceptable under DOT and International Air Transport Association (IATA) regulation

Schedule pick-up time for laboratory courier or know location of laboratory/service center and hours of operation.

Understand DOT and IATA shipping requirements and evaluate dangerous goods shipping regulations relative to the samples being collected (i.e. complete an ARCADIS shipping determination). Review the ARCADIS SOPs for shipping, packaging and labeling of dangerous goods. Potential samples requiring compliance with this DOT regulation include:

- Methanol preservation for Volatile Organic Compounds in soil samples
- Non-aqueous phase liquids (NAPL)

V. Health and Safety Considerations

Follow health and safety procedures outlined in the project/site Health and Safety Plan (HASP).

Use caution and appropriate cut resistant gloves when tightening lids to 40 mL vials. These vials can break while tightening and can lacerate hand. Amber vials (thinner glass) are more prone to breakage.

Some sample containers contain preservatives.

- The preservatives must be retained in the sample container and should in no instance be rinsed out.
- Preservatives may be corrosive and standard care should be exercised to reduce potential contact to personnel skin or clothing. Follow project safety procedures if spillage is observed.
- If sample container caps are broken discard the bottle. Do not use for sample collection.

VI. Procedure

Chain-of-Custody Procedures

1. Prior to collecting samples, complete the chain-of-custody record header information by filling in the project number, project name, and the name(s) of the sampling technician(s) and other relevant project information. Attachment 1 provides an example chain-o- custody record

2. Chain-of-custody information MUST be printed legibly using indelible ink (black or blue).

3. After sample collection, enter the individual sample information on the chain-of-custody:

    a. Sample Identification indicates the well number or soil location that the sample was collected from. Appropriate values for this field include well locations, grid points, or soil boring identification numbers (e.g., MW-3, X-20, SB-30). When the depth interval is included, the complete sample ID would be “SB-30 (0.5-1.0) where the depth interval is in feet. Please note it is very important that the use of hyphens in sample names and depth units (i.e., feet or inches) remain consistent for all samples entered on the chain-of-custody form. DO NOT use the apostrophe or quotes in the sample ID. Sample names may also use the abbreviations “FB,” “TB,” and “DUP” as prefixes or suffixes to indicate that the sample is a field blank, trip blank, or field duplicate, respectively. NOTE: The sample

nomenclature may be dictated by the project database and require unique identification for each sample collected for the project. Consult the project data management plan for additional information regarding sample identification.

b. List the date o sample collection. The date format to be followed should be mm/dd/yy (e.g., 03/07/09) or mm/dd/yyyy (e.g. 03/07/2009).

c. List the time that the sample was collected. The time value should be presented using military format. For example, 3:15 P.M. should be entered as 15:15.

d. The composite field should be checked if the sample is a composite over a period of time or from several different locations and mixed prior to placing in sample containers.

e. The “Grab”. field should be marked with an “X” if the sample was collected as an individual grab sample. (e.g. monitoring well sample or soil interval).

f. Any sample preservation should be noted.

g. The analytical parameters that the samples are being analyzed for should be written legibly on the diagonal lines. As much detail as possible should be presented to allow the analytical laboratory to properly analyze the samples. For example, polychlorinated biphenyl (PCB) analyses may be represented by entering “PCBs” or “Method 8082.” Multiple methods and/or analytical parameters may be combined for each column (e.g., PCBs/VOCs/SVOCs or 8082/8260/8270). These columns should also be used to present project-specific parameter lists (e.g., Appendix IX+3 target analyte list. Each sample that requires a particular parameter analysis will be identified by placing the number of containers in the appropriate analytical parameter column. For metals in particular, indicate which metals are required.

h. Number of containers for each method requested. This information may be included under the parameter or as a total for the sample based on the chain of custody form used.

i. Note which samples should be used for site specific matrix spikes.

j. Indicate any special project requirements.

k. Indicate turnaround time required.

l. Provide contact name and phone number in the event that problems are encountered when samples are received at the laboratory.

m. If available attach the Laboratory Task Order or Work Authorization forms

n. The remarks field should be used to communicate special analytical requirements to the laboratory. These requirements may be on a per sample basis such as “extract and hold sample until notified,” or may be used to inform the laboratory of special reporting requirements for the entire sample delivery group (SDG). Reporting requirements that should be specified in the remarks column include: 1) turnaround time; 2) contact and address where data reports should be sent; 3) name of laboratory project manager; and 4) type of sample preservation used.

o. The “Relinquished By” field should contain the signature of the sampling technician who relinquished custody of the samples to the shipping courier or the analytical laboratory.

p. The “Date” field following the signature block indicates the date the samples were relinquished. The date format should be mm/dd/yyyy (e.g., 03/07/2005).

q. The “Time” field following the signature block indicates the time that the samples were relinquished. The time value should be presented using military format. For example, 3:15 P.M. should be entered as 15:15.

r. The “Received By” section is signed by sample courier or laboratory representative who received the samples from the sampling technician or it is signed upon laboratory receipt from the overnight courier service.

3. Complete as many chain-of-custody forms as necessary to properly document the collection and transfer of the samples to the analytical laboratory.

4. Upon completing the chain-of-custody forms, forward two copies to the analytical laboratory and retain one copy for the field records.

5. If electronic chain-of-custody forms are utilized, sign the form and make 1 copy for ARCADIS internal records and forward the original with the samples to the laboratory.

Handling Procedures

1. After completing the sample collection procedures, record the following information in the field notebook with indelible ink:

   - project number and site name;
   - sample identification code and other sample identification information, if appropriate;
   - sampling method;
   - date;
   - name of sampler(s);
   - time;
   - location (project reference);
   - location of field duplicates and both sample identifications;
   - locations that field QC samples were collected including equipment blanks, field blanks and additional sample volume for matrix spikes; and
   - any comments.

2. Complete the sample label with the following information in indelible ink:

   - sample type (e.g., surface water);
   - sample identification code and other sample identification information, if applicable;
   - analysis required;
   - date;
   - time sampled; and
   - initials of sampling personnel;

- sample matrix; and
- preservative added, if applicable.

3. Cover the label with clear packing tape to secure the label onto the container and to protect the label from liquid.

4. Confirm that all caps on the sample containers are secure and tightly closed.

5. In some instances it may be necessary to wrap the sample container cap with clear packing tape to prevent it from becoming loose.

6. For some projects individual custody seals may be required. Custody seal evidence tape may be placed on the shipping container or they may be placed on each sample container such that the cooler or cap cannot be opened without breaking the custody seal. The custody seal should be initialed and dated prior to relinquishing the samples.

Packing Procedures

Following collection, samples must be placed on wet ice to initiate cooling to 4°C immediately. Retain samples on ice until ready to pack for shipment to the laboratory.

1. Secure the outside and inside of the drain plug at the bottom of the cooler being used for sample transport with "Duct" tape.

2. Place a new large heavy duty plastic garbage bag inside each cooler

3. Place each sample bottle wrapped in bubble wrap inside the garbage bag. VOC vials may be grouped by sample in individual resealable plastic bags). If a cooler temperature blank is supplied by the laboratory, it should be packaged following the same procedures as the samples. If the laboratory did not include a temperature blank, do not add one. Place 1 to 2 inches of cushioning material (i.e., vermiculite) at the bottom of the cooler.

4. Place the sealed sample containers upright in the cooler.

5. Package ice in large resealable plastic bags and place inside the large garbage bag in the cooler. Samples placed on ice will be cooled to and maintained at a temperature of approximately 4°C.

6. Fill the remaining space in the cooler with cushioning material such as bubble wrap. The cooler must be securely packed and cushioned in an upright position and be surrounded (Note: to comply with 49 CFR 173.4, filled cooler must not exceed 64 pounds).

7. Place the completed chain-of-custody record(s) in a large resealable bag and tape the bag to the inside of the cooler lid.

8. Close the lid of the cooler and fasten with packing tape.

9. Wrap strapping tape around both ends of the cooler.

10. Mark the cooler on the outside with the following information: shipping address, return address, “Fragile, Handle with Care” labels on the top and on one side, and arrows indicating “This Side Up” on two adjacent sides.

11. Place custody seal evidence tape over front right and back left of the cooler lid, initial and date, then cover with clear plastic tape.

Note: Procedure numbers 2, 3, 5, and 6 may be modified in cases where laboratories provide customized shipping coolers. These cooler types are designed so the sample bottles and ice packs fit snugly within preformed styrofoam cushioning and insulating packing material.

Shipping Procedures

1. All samples will be delivered by an express carrier within 48 hours of sample collection. Alternatively, samples may be delivered directly to the laboratory or laboratory service center or a laboratory courier may be used for sample pickup.

2. If parameters with short holding times are required (e.g., VOCs [EnCore™ Sampler], nitrate, nitrite, ortho-phosphate and BOD), sampling personnel will take precautions to ship or deliver samples to the laboratory so that the holding times will not be exceeded.

3. Samples must be maintained at 4°C+2°C until shipment and through receipt at the laboratory

4. All shipments must be in accordance with DOT regulations and ARCADIS dangerous goods shipping SOPs.

5. When the samples are received by the laboratory, laboratory personnel will complete the chain-of-custody by recording the date and time of receipt of samples, measuring and recording the internal temperature of the shipping container, and checking the sample identification numbers on the containers to ensure they correspond with the chain-of-custody forms.

Any deviations between the chain-of-custody and the sample containers, broken containers, or temperature excursions will be communicated to ARCADIS immediately by the laboratory.

VII. Waste Management

Not applicable

VIII. Data Recording and Management

Chain-of-custody records will be transmitted to the ARCADIS PM or designee at the end of each day unless otherwise directed by the ARCADIS PM. The sampling team leader retains copies of the chain-of-custody forms for filing in . the project file. Record retention shall be in accordance with project requirements.

IX. Quality Assurance

Chain-of-custody forms will be legibly completed in accordance with the applicable project documents such as Sampling and Analysis Plan (SAP), Quality Assurance Project Plan (QAPP), Work Plan, or other project guidance documents. A copy of the completed chain-of-custody form will be sent to the ARCADIS Project Manager or designee for review.

X. References

Not Applicable

Attachment 1

ARCADIS
Infrastructure, environment, facilities

ID#:

CHAIN OF CUSTODY & LABORATORY ANALYSIS REQUEST FORM

Page ___ of ___

Lab Work Order #

Send Results to:

Contact & Company Name: | Telephone:

Address: | Fax:

City | State | Zip | E-mail Address:

Project Name/Location (City, State): | Project #:

Sampler's Printed Name: | Sampler's Signature:

Sample ID	Collection Date	Collection Time	Type (✓) Comp	Type (✓) Grab	Matrix

Preservative													
Filtered (✓)													
# of Containers													
Container Information													

PARAMETER ANALYSIS & METHOD

Keys

Preservation Key:
A. H_2SO_4
B. HCL
C. HNO_3
D. NaOH
E. None
F. Other: _____
G. Other: _____
H. Other: _____

Container Information Key:
1. 40 ml Vial
2. 1 L Amber
3. 250 ml Plastic
4. 500 ml Plastic
5. Encore
6. 2 oz. Glass
7. 4 oz. Glass
8. 8 oz. Glass
9. Other: _____
10. Other: _____

Matrix Key:
SO - Soil | SE - Sediment | NL - NAPL/Oil
W - Water | SL - Sludge | SW - Sample Wipe
T - Tissue | A - Air | Other: _____

REMARKS

Special Instructions/Comments:

☐ Special QA/QC Instructions(✓):

Laboratory Information and Receipt		Relinquished By	Received By	Relinquished By	Laboratory Received By
Lab Name:	Cooler Custody Seal (✓)	Printed Name:	Printed Name:	Printed Name:	Printed Name:
☐ Cooler packed with ice (✓)	☐ Intact ☐ Not Intact	Signature:	Signature:	Signature:	Signature:
Specify Turnaround Requirements:	Sample Receipt:	Firm:	Firm/Courier:	Firm/Courier:	Firm:
Shipping Tracking #:	Condition/Cooler Temp: _____	Date/Time:	Date/Time:	Date/Time:	Date/Time:

20730826 CofC AR Form 01.12.2007

Distribution: **WHITE – Laboratory returns with results** **YELLOW – Lab copy** **PINK – Retained by BBL**

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Monitoring Well Development

Rev. #: 2

Rev Date: March 18, 2009

Approval Signatures

Prepared by:  Date: 3/18/09
David Lipson

Reviewed by:  Date: 3/18/09
Michael Gefell (Technical Expert)

I. Scope and Application

Monitoring wells (or piezometers, well points, or micro-wells) will be developed to clear them of fine-grained sediment and any drilling fluids that may have been used during well installation, and enhance the hydraulic connection between the well and the surrounding geologic formation. Development will be accomplished by evacuating well water by either pumping or bailing. Prior to pumping or bailing, the screened interval can be gently surged using a surge block, bailer, or inertia pump with optional surge-block fitting. In addition, sediment accumulated in the bottom of the well can be removed by bailing with a bottom-loading bailer or pumping using a submersible or inertia pump with optional surge-block fitting.

Pumping methods will be selected based on site-specific geologic conditions, anticipated well yield, water table depth, and groundwater monitoring objectives, and may include one or more of the following.

- submersible pump
- inertial pump (Waterra™ pump or equivalent)
- bladder pump
- peristaltic pump
- centrifugal pump

When developing a well using the pumping method, the pump (or, with inertial pumps, the tubing) is lowered to the screened portion of the well. During purging, the pump or tubing is moved up and down the screened interval until the well yields relatively clear water.

Submersible pumps have a motor-driven impeller that pushes the groundwater through discharge tubing to the ground surface. Inertial pumps have a check valve at the bottom of stiff tubing which, when operated up and down, lifts water to the ground surface. Bladder pumps have a bottom check valve and a flexible internal bladder that fills from below and is then compressed using pressurized air to force water out the top of the bladder through the discharge tubing to the ground surface. These three types of pumps have a wide range of applicability in terms of well depth and water depth. Centrifugal and peristaltic pumps use atmospheric pressure to lift water from the well, and therefore can only be practically used where the depth to water is less than 25 feet.

II. Personnel Qualifications

Monitoring well development activities will be performed by persons who have been trained in proper well development procedures under the guidance of an experienced field geologist, engineer, or technician.

III. Equipment List

Materials for monitoring well development using a pump include the following

- health and safety equipment, as required by the site Health and Safety Plan (HASP)
- cleaning equipment
- photoionization detector (PID) to measure headspace vapors
- pump
- polyethylene pump discharge tubing
- plastic sheeting
- power source (generator or battery)
- field notebook and/or personal digital assistant (PDA)
- graduated pails
- appropriate containers
- monitoring well keys
- water level indicator

Materials for monitoring well development using a bailer include the following.

- personal protective equipment (PPE) as required by the HASP
- cleaning equipment
- PID to measure headspace vapors

- bottom-loading bailer, sand bailer
- polypropylene or nylon rope
- plastic sheeting
- graduated pails
- appropriate containers
- keys to wells
- field notebook and/or PDA
- water level indicator

IV. Cautions

Where surging is performed to assist in removing fine-grained material from the sand pack, surging must be performed in a gentle manner. Excessive suction could promote fine-grained sediment entry into the outside of the sand pack from the formation.

Avoid using development fluids or materials that could impact groundwater or soil quality, or could be incompatible with the subsurface conditions.

In some cases it may be necessary to add potable water to a well to allow surging and development, especially for new monitoring wells installed in low permeability formations. Before adding potable water to a well, the Project Manager (PM) must be notified and the PM shall make the decision regarding the appropriateness and applicability of adding potable water to a well during well development procedures. If potable water is to be added to a well as part of development, the potable water source should be sampled and analyzed for constituents of concern, and the results evaluated by the PM prior to adding the potable water to the well. If potable water is added to a well for development purposes, at the end of development the well will be purged dry to remove the potable water, or if the well no longer goes dry then the well will be purged to remove at least three times the volume of potable water that was added.

V. Health and Safety Considerations

Field activities associated with monitoring well development will be performed in accordance with a site-specific HASP, a copy of which will be present on site during such activities.

VI. Procedure

1. The procedures for monitoring well development are described below. (Note: Steps 7, 8, and 10 can be performed contemporaneously using an inertial pump with a surge-block fitting.)

2. Don appropriate PPE (as required by the HASP).

3. Place plastic sheeting around the well.

4. Clean all equipment entering each monitoring well, except for new, disposable materials that have not been previously used.

5. Open the well cover while standing upwind of the well, remove well cap. Insert PID probe approximately 4 to 6 inches into the casing or the well headspace and cover with gloved hand. Record the PID reading in the field notebook. If the well headspace reading is less than 5 PID units, proceed; if the headspace reading is greater than 5 PID units, screen the air within the breathing zone. If the PID reading in the breathing zone is below 5 PID units, proceed. If the PID reading is above 5 PID units, move upwind from well for 5 minutes to allow the volatiles to dissipate. Repeat the breathing zone test. If the reading is still above 5 PID units, don the appropriate respiratory protection in accordance with the requirements of the HASP. Record all PID readings.

6. Obtain an initial measurement of the depth to water and the total well depth from the reference point at the top of the well casing. Record these measurements in the field log book.

7. Lower a surge block or bailer into the screened portion of the well. Gently raise and lower the surge block or bailer within the screened interval of the well to force water in and out of the screen slots and sand pack. Continue surging for 15 to 30 minutes. Note that this step is optional but recommended for all new wells/piezometers, particularly in formations with a relatively high content of fine-grained material.

8. Lower a bottom-loading bailer to the bottom of the well and gently bounce the bailer on the bottom of the well to collect accumulated sediment, if any. Remove and empty the bailer. Repeat until the bailed water is free of excessive sediment and the bottom of the well feels solid. Alternatively, measurement of the well depth with a water level indicator can be used to verify that sediment and/or silt has been removed to the extent practicable, based on a comparison with the well installation log or previous measurement of total well depth.

9. After surging the well and removing excess accumulated sediment from the bottom of the well, re-measure the depth-to-water and the total well depth from the reference point at the top of the well casing. Record these measurements in the field log book.

10. Remove formation water by pumping or bailing. Where pumping is used, measure and record the pre-pumping water level. Operate the pump at a relatively constant rate. Measure the pumping rate using a calibrated container and stop watch, and record the pumping rate in the field log book. Measure and record the water level in the well at least once every 5 minutes during pumping. Note any relevant observations in terms of water color, visual level of turbidity, sheen, odors, etc. Pump or bail for 30 to 60 minutes or until termination criteria specified in the Work Plan or Field Sampling Plan (FSP) are reached. Record the total volume of water purged from the well.

11. If the well goes dry, stop pumping or bailing and allow well to recover. Resume pumping or bailing when sufficient water has recharged the well.

12. Contain all water in appropriate containers.

13. When complete, secure the lid back on the well.

14. Place disposable materials in plastic bags for appropriate disposal and decontaminate reusable, downhole pump components and/or bailer.

VII. Waste Management

Materials generated during monitoring well installation and development will be placed in appropriate labeled containers and disposed of as described in the Work Plan or Field Sampling Plan.

VIII. Data Recording and Management

Well development activities will be documented in a proper field notebook and/or PDA. Pertinent information will include personnel present on site; times of arrival and departure; significant weather conditions; timing of well development activities; development method(s); observations of purge water color, turbidity, odor, sheen, etc.; purge rate; and water levels before and during pumping.

IX. Quality Assurance

All reused, non-disposable, downhole well development equipment will be cleaned in accordance with the procedures outlined in the Field Equipment Cleaning-Decontamination SOP.

X. References

Not Applicable.

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Monitoring Well Installation

Rev. #: 2

Rev Date: August 22, 2008

Approval Signatures

Prepared by: _____ Date: 8/25/08

Reviewed by: _____ Date: 8/25/08
(Technical Expert)

I. Scope and Application

The procedures set out herein are designed to produce standard groundwater monitoring wells suitable for: (1) groundwater sampling, (2) water level measurement, (3) bulk hydraulic conductivity testing of formations adjacent to the open interval of the well.

Monitoring well boreholes in unconsolidated (overburden) materials are typically drilled using the hollow-stem auger drilling method. Other drilling methods that are also suitable for installing overburden monitoring wells, and are sometimes necessary due to site-specific geologic conditions, include: drive-and-wash, spun casing, Rotasonic, dual-rotary (Barber Rig), and fluid/mud rotary with core barrel or roller bit. Direct-push techniques (e.g., Geoprobe or cone penetrometer) and driven well points may also be used in some cases within the overburden. Monitoring wells within consolidated materials such as bedrock are commonly drilled using water-rotary (coring or tri-cone roller bit), air rotary or Rotasonic methods. The drilling method to be used at a given site will be selected based on site-specific consideration of anticipated drilling/well depths, site or regional geologic knowledge, type of monitoring to be conducted using the installed well, and cost.

No oils or grease will be used on equipment introduced into the boring (e.g., drill rod, casing, or sampling tools). No coated bentonite pellets will be used in the well drilling or construction process. Specifications of materials to be installed in the well will be obtained prior to mobilizing onsite, including:

- well casing;
- bentonite;
- sand; and
- grout.

Well materials will be inspected and, if needed, cleaned prior to installation.

II. Personnel Qualifications

Monitoring well installation activities will be performed by persons who have been trained in proper well installation procedures under the guidance of an experienced field geologist, engineer, or technician. Where field sampling is performed for soil or bedrock characterization, field personnel will have undergone in-field training in soil or

bedrock description methods, as described in the appropriate SOP(s) for those activities.

III. Equipment List

The following materials will be available during soil boring and monitoring well installation activities, as required:

- Site Plan with proposed soil boring/well locations;
- Work Plan or Field Sampling Plan (FSP), and site Health and Safety Plan (HASP);
- personal protective equipment (PPE), as required by the HASP;
- traffic cones, delineators, caution tape, and/or fencing as appropriate for securing the work area, if such are not provided by drillers;
- appropriate soil sampling equipment (e.g., stainless steel spatulas, knife);
- soil and/or bedrock logging equipment as specified in the appropriate SOPs;
- appropriate sample containers and labels;
- drum labels as required for investigation derived waste handling;
- chain-of-custody forms;
- insulated coolers with ice, when collecting samples requiring preservation by chilling;
- photoionization detector (PID) or flame ionization detector (FID);
- ziplock style bags;
- water level or oil/water interface meter;
- locks and keys for securing the well after installation;
- decontamination equipment (bucket, distilled or deionized water, cleansers appropriate for removing expected chemicals of concern, paper towels);

- field notebook.

Prior to mobilizing to the site, ARCADIS personnel will contact the drilling subcontractor or in-house driller (as appropriate) to confirm that appropriate sampling and well installation equipment will be provided. Specifications of the sampling and well installation equipment are expected to vary by project, and so communication with the driller will be necessary to ensure that the materials provided will meet the project objectives. Equipment typically provided by the driller could include:

- drilling equipment required by the American Society of Testing and Materials (ASTM) D 1586, when performing split-spoon sampling;
- disposable plastic liners, when drilling with direct-push equipment;
- drums for investigation derived waste;
- drilling and sampling equipment decontamination materials;
- decontamination pad materials, if required; and
- well construction materials.

IV. Cautions

Prior to beginning field work, underground utilities in the vicinity of the drilling areas will be delineated by the drilling contractor or an independent underground utility locator service. See separate SOP for utility clearance.

Some regulatory agencies require a minimum annular space between the well or permanent casing and the borehole wall. When specified, the minimum clearance is typically 2 inches on all sides (e.g., a 2-inch diameter well requires a 6-inch diameter borehole). In addition, some regulatory agencies have specific requirements regarding grout mixtures. Determine whether the oversight agency has any such requirements prior to finalizing the drilling and well installation plan.

If dense non-aqueous phase liquids (DNAPL) are known or expected to exist at the site, refer to the DNAPL Contingency Plan SOP for additional details regarding drilling and well installation to reduce the potential for inadvertent DNAPL remobilization.

Avoid using drilling fluids or materials that could impact groundwater or soil quality, or could be incompatible with the subsurface conditions.

Similarly, consider the material compatibility between the well materials and the surrounding environment. For example, PVC well materials are not preferred when DNAPL is present. In addition, some groundwater conditions leach metals from stainless steel.

Water used for drilling and sampling of soil or bedrock, decontamination of drilling/sampling equipment, or grouting boreholes upon completion will be of a quality acceptable for project objectives. Testing of water supply should be considered.

Specifications of materials used for backfilling bore hole will be obtained, reviewed and approved to meet project quality objectives. Bentonite is not recommended where DNAPLs are likely to be present. In these situations, neat cement grout is preferred.

No coated bentonite pellets will be used in monitoring well construction, as the coating could impact the water quality in the completed well.

Monitoring wells may be installed with Schedule 40 polyvinyl chloride (PVC) to a maximum depth of 200 feet below ground surface (bgs). PVC monitoring wells between 200 and 400 feet total depth will be constructed using Schedule 80 PVC. Monitoring wells deeper than 400 feet will be constructed using steel.

V. Health and Safety Considerations

Field activities associated with monitoring well installation will be performed in accordance with a site-specific HASP, a copy of which will be present on site during such activities.

VI. Procedures

The procedures for installing groundwater monitoring wells are presented below:

Hollow-Stem Auger, Drive-and-Wash, Spun Casing, Fluid/Mud Rotary, Rotasonic, and Dual-Rotary Drilling Methods

1. Locate boring/well location, establish work zone, and set up sampling equipment decontamination area.

2. Advance boring to desired depth. Collect soil and/or bedrock samples at appropriate interval as specified in the Work Plan and/or FSP. Collect, document, and store samples for laboratory analysis as specified in the Work Plan and/or FSP. Decontaminate equipment between samples in accordance with the Work Plan and/or FSP. A common sampling method that produces

high-quality soil samples with relatively little soil disturbance is the ASTM D 1586 - Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils. Split-spoon samples are obtained during drilling using hollow-stem auger, drive-and-wash, spun casing, and fluid/mud rotary. Rotasonic drilling produces large-diameter soil cores that tend to be more disturbed than split-spoon samples due to the vibratory action of the drill casing. Dual-rotary removes cuttings by compressed air and allows only a general assessment of geology. High-quality bedrock samples can be obtained by coring.

3. Describe each soil or bedrock sample as outlined in the appropriate SOP. Record descriptions in the field notebook and/or personal digital assistant (PDA). It should be noted that PDA logs must be electronically backed up and transferred to a location accessible to other project team members as soon as feasible to retain and protect the field data. During soil boring advancement, document all drilling events in field notebook, including blow counts (number of blows required to advance split-spoon sampler in 6-inch increments) and work stoppages. Blow counts will not be available if Rotasonic, dual-rotary, or direct-push methods are used. When drilling in bedrock, the rate of penetration (minutes per foot) is recorded.

4. If it is necessary to install a monitor well into a permeable zone below a confining layer, particularly if the deeper zone is believed to have water quality that differs significantly from the zone above the confining layer, then a telescopic well construction should be considered. In this case, the borehole is advanced approximately 3 to 5 feet into the top of the confining layer, and a permanent casing (typically PVC, black steel or stainless steel) is installed into the socket drilled into the top of the confining layer. The casing is then grouted in place. The preferred methods of grouting telescoping casings include: pressure-injection grouting using an inflatable packer installed temporarily into the base of the casing, such that grout is injected out the bottom of the casing until it is observed at ground surface outside the casing; displacement-method grouting (also known as the Halliburton method), which entails filling the casing with grout and displacing the grout out the bottom of the casing by pushing a drillable plug, typically made of wood to the bottom of the casing, following by tremie grouting the remainder of the annulus outside the casing; or tremie grouting the annulus surrounding the casing using a tremie pipe installed to the base of the borehole. In all three cases, the casing is grouted to the ground surface, and the grout is allowed to set prior to drilling deeper through the casing. Site-specific criteria and work plans should be created for the completion of non-standard monitoring wells, including telescopic wells.

5. In consolidated formations such as competent bedrock, a monitoring well may be completed with an open borehole interval without a screen and sandpack. In these cases, the borehole is advanced to the targeted depth of the top of the open interval. A permanent casing is then grouted in place following the procedures described in Step 4 above. After the grout sets, the borehole is advanced by drilling through the permanent casing to the targeted bottom depth of the open interval, which then serves as the monitoring interval for the well. If open-borehole interval stability is found to be questionable or if a specific depth interval is later selected for monitoring, a screened monitoring well may later be installed within the open-borehole interval, depending on the annular space and well diameter requirements.

6. Prior to screened well installation or after the completion of an open-bedrock well, the water level or oil/water interface probe should be used to determine the static water level in the borehole in relation to the proposed well screen or open-interval location. If necessary, an open-bedrock well may be drilled deeper to intersect the water table or a permeable water-bearing zone.

7. Upon completing the borehole to the desired depth, if a screened well construction is desired, install the monitoring well by lowering the screen and casing assembly with sump through the augers or casing. Monitoring wells typically will be constructed of 2-inch-diameter, flush-threaded PVC or stainless steel slotted well screen and blank riser casing. Smaller diameters may be used if wells are installed using direct-push methodology or if multiple wells are to be installed in a single borehole. The screen length will be specified in the Work Plan or FSP based on regulatory requirements and specific monitoring objectives. Monitoring well screens are usually 5 to 10 feet long, but may be up to 25 feet long in very low permeability, thick geologic formations. The screen length will depend on the purpose for the well and the objectives of the groundwater investigation. Typically, the slot size will be 0.010 inch and the sand pack will be 20-40, Morie No. 0, or equivalent. In very fine-grained formations where sample turbidity needs to be minimized, it may be preferred to use a 0.006-inch slot size and 30-65, Morie No. 00, or equivalent sand pack. Alternatively, where monitoring wells are installed in coarse-grained deposits and higher well yield is required, a 0.020-inch slot size and 10-20, Morie No. 1, or equivalent sand pack may be preferred. To the extent practicable, the slot size and sand pack gradation may be predetermined in the Work Plan or FSP based on site-specific grain-size analysis or other geologic considerations or monitoring objectives. A blank sump may be attached below the well screen if the well is being installed for DNAPL recovery/monitoring purposes. If so, the annular space around the sump will be backfilled with neat cement grout to the bottom of the well screen prior to placing the sand pack around the screen. A

blank riser will extend from the top of the screen to approximately 2.5 feet above grade or, if necessary, just below grade where conditions warrant a flush-mounted monitoring well. For wells greater than 50 feet deep, centralizers may be desired to assist in centralizing the monitoring well in the borehole during construction.

8. When the monitoring well assembly has been set in place and the grout has been placed around the sump (if any), place a washed silica sand pack in the annular space from the bottom of the boring to a height of 1 to 2 feet above the top of the well screen. The sand pack is placed and drilling equipment extracted in increments until the top of the sand pack is at the appropriate depth. The sand pack will be consistent with the screen slot size and the soil particle size in the screened interval, as specified in the Work Plan or FSP. A hydrated bentonite seal (a minimum of 2 feet thick) will then be placed in the annular space above the sand pack. If non-hydrated bentonite is used, the bentonite should be permitted to hydrate in place for a minimum of 30 minutes before proceeding. No coated bentonite pellets will be used in monitoring well drilling or construction. Potable water may be added to hydrate the bentonite if the seal is above the water table. Monitor the placement of the sand pack and bentonite with a weighted tape measure. During the extraction of the augers or casing, a cement/bentonite or neat cement grout will be placed in the annular space from the bentonite seal to a depth approximately 2 feet bgs.

9. Place a locking, steel protective casing (extended at least 1.5 feet below grade and 2 feet above grade) over the riser casing and secure with a neat cement seal. Alternatively, for flush-mount completions, place a steel curb box with a bolt-down lid over the riser casing and secure with a neat cement seal. In either case, the cement seal will extend approximately 1.5 to 2.0 feet below grade and laterally at least 1 foot in all directions from the protective casing, and should slope gently away to promote drainage away from the well. Monitoring wells will be labeled with the appropriate designation on both the inner and outer well casings or inside of the curb box lid.

   When an above-grade completion is used, the PVC riser will be sealed using an expandable locking plug and the top of the well will be vented by drilling a small-diameter (1/8 inch) hole near the top of the well casing or through the locking plug, or by cutting a vertical slot in the top of the well casing. When a flush-mount installation is used, the PVC riser will be sealed using an unvented, expandable locking plug.

10. During well installation, record construction details and actual measurements relayed by the drilling contractor and tabulate materials used (e.g., screen and riser footages; bags of bentonite, cement, and sand) in the field notebook.

11. After completing the well installation, lock the well, clean the area, and dispose of materials in accordance with the procedures outlined in Section VII below.

Direct-Push Method

The direct-push drilling method may also be used to complete soil borings and install monitoring wells. Examples of this technique include the Diedrich ESP vibratory probe system, GeoProbe®, or AMS Power Probe® dual-tube system. Environmental probe systems typically use a hydraulically operated percussion hammer. Depending on the equipment used, the hammer delivers 140- to 350-foot pounds of energy with each blow. The hammer provides the force needed to penetrate very stiff/medium dense soil formations. The hammer simultaneously advances an outer steel casing that contains a dual-tube liner for sampling soil. The outside diameter (OD) of the outer casing ranges from 1.75 to 2.4 inches and the OD of the inner sampling tube ranges from 1.1 to 1.8 inches. The outer casing isolates shallow layers and permits the unit to continue to probe at depth. The double-rod system provides a borehole that may be tremie-grouted from the bottom up. Alternatively, the inside diameter (ID) of the steel casing provides clearance for the installation of small-diameter (e.g., 0.75- to 1-inch ID) micro-wells. The procedures for installing monitoring wells in soil using the direct-push method are described below.

1. Locate boring/well location, establish work zone, and set up sample equipment decontamination area.

2. Advance soil boring to designated depth, collecting samples at intervals specified in the Work Plan. Samples will be collected using dedicated, disposable, plastic liners. Describe samples in accordance with the procedures outlined in Step 3 above. Collect samples for laboratory analysis as specified in the Work Plan and/or FSP.

3. Upon advancing the borehole to the desired depth, install the micro-well through the inner drill casing. The micro-well will consist of approximately 1-inch ID PVC or stainless steel slotted screen and blank riser. The sand pack, bentonite seal, and cement/bentonite grout will be installed as described, where applicable, in Step 7 and 8 above.

4. Install protective steel casing or flush-mount, as appropriate, as described in Step 9 above. During well installation, record construction details and tabulate materials used.

5. After completing the well installation, lock the well, clean the area, and dispose of materials in accordance with the procedures outlined in Section VII below.

Driven Well Point Installation

Well points will be installed by pushing or driving using a drilling rig or direct-push rig, or hand-driven where possible. The well point construction materials will consist of a 1- to 2-inch-diameter threaded steel casing with either 0.010- or 0.020-inch slotted stainless steel screen. The screen length will vary depending on the hydrogeologic conditions of the site. The casings will be joined together with threaded couplings and the terminal end will consist of a steel well point. Because they are driven or pushed to the desired depth, well points do not have annular backfill materials such as sand pack or grout.

VII. Waste Management

Investigation-derived wastes (IDW), including soil cuttings and excess drilling fluids (if used), decontamination liquids, and disposable materials (well material packages, PPE, etc.), will be placed in clearly labeled, appropriate containers, or managed as otherwise specified in the Work Plan, FSP, and/or IDW management SOP.

VIII. Data Recording and Management

Drilling activities will be documented in a field notebook. Pertinent information will include personnel present on site, times of arrival and departure, significant weather conditions, timing of well installation activities, soil descriptions, well construction specifications (screen and riser material and diameter, sump length, screen length and slot size, riser length, sand pack type), and quantities of materials used. In addition, the locations of newly-installed wells will be documented photographically or in a site sketch. If appropriate, a measuring wheel or engineer's tape will be used to determine approximate distances between important site features.

The well or piezometer location, ground surface elevation, and inner and outer casing elevations will be surveyed using the method specified in the site Work Plan. Generally, a local baseline control will be set up. This local baseline control can then be tied into the appropriate vertical and horizontal datum, such as the National Geodetic Vertical Datum of 1929 or 1988 and the State Plane Coordinate System. At a minimum, the elevation of the top of the inner casing used for water-level

measurements should be measured to the nearest 0.01 foot. Elevations will be established in relation to the National Geodetic Vertical Datum of 1929. A permanent mark will be placed on top of the inner casing to mark the point for water-level measurements.

IX. Quality Assurance

All drilling equipment and associated tools (including augers, drill rods, sampling equipment, wrenches, and any other equipment or tools) that may have come in contact with soil will be cleaned in accordance with the procedures outlined in the appropriate SOP. Well materials will also be cleaned prior to well installation.

X. References

American Society of Testing and Materials (ASTM) D 1586 - *Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils*.

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Multiple Gas Air Monitoring and Field Screening

Rev. #: 0

Rev Date: July 20, 2003

Approval Signatures

Prepared by: _____ Date: _____

Reviewed by: _____ Date: _____
(Technical Expert)

Reviewed by: _____ Date: _____
(Project Manager)

I. Scope and Application

Field screening with a one-to-five sensor instrument, such as a MultiRAE, is a procedure to measure relative concentrations of volatile organic compounds (VOCs), carbon monoxide, hydrogen sulfide, oxygen, and combustible gas, as well as other compounds. Characteristics of the MultiRAE are presented in Attachment 1. Field screening will be conducted on the following:

- Work area air to assess exposure to on-site workers of air contaminants via the air pathway;
- Well headspaces as a precautionary measure each time the well cover is opened; and
- Measuring ports of landfill gas monitoring locations.

II. Personnel Qualifications

User personnel should be familiar with monitor operation and read through the operation manual that is provided with the instrument in order to properly calibrate and operate the monitor.

III. Equipment List

The following materials, as required, shall be available while performing MultiRAE field screening:

- personal protective equipment (PPE), as required by the site Health and Safety Plan (HASP);
- MultiRAE Plus and operating manual;
- calibration canisters for the MultiRAE;
- sample jars;
- aluminum foil; and
- field notebook.

IV. Cautions

Alarm levels for the MultiRAE are as follows:

High - 3 beeps and flashes per second;

Low - 2 beeps and flashes per second; and

STEL and TWA - 1 beep and flash per second.

V. Health and Safety Considerations

Care should be taken when handling calibration gas cylinders as contents may be under pressure.

VI. Procedure

MultiRAE Calibration

MultiRAE field instruments contain an integrated photoionization detector (PID) which will be calibrated and operated to yield "total organic vapor" in parts per million (ppm) (v/v). Operation, maintenance, and calibration shall be performed in accordance with the manufacturer's instructions and entered on the PID Calibration and Maintenance Log (Attachment 2).

1. Don PPE, as required by the HASP.

2. Hold the "Mode" key to turn on. Alarm will beep once. Warm-up will take approximately 90 seconds.

3. After the 90 second warm-up, the MultiRAE should display all of the installed sensors. If there is no alarm and the sensor readings are in the correct range, then the MultiRAE is ready for use. If the readings are outside the correct range, then perform a "Fresh air calibration."

4. To calibrate the MultiRAE, hold the "Mode" and "N/-" keys for 5 seconds to get into the programming mode. Press "Y" or "N" at appropriate intervals and follow instructions on screen. When performing the "Fresh air calibration," make sure that the air is clean.

5. To perform the "Multiple Sensor Calibration," press "Y/+" at the appropriate screen. Attach the calibration gas regulator to the mixed gas cylinder and

attach calibration hose to MultiRAE. Turn on calibration gas. Follow instructions on screen. Disconnect regulator from gas cylinder when calibration is complete.

6. VOC can only be calibrated individually. At "Single Sensor Calibration," press the "Y/+" key. Use "Mode" key to select VOC. Attach calibration gas regulator to VOC (isobutylene) cylinder. Attach calibration hose to MultiRAE and make sure it is tight. With cursor on VOC, press "Y/+" key. Turn on calibration gas. Follow instructions on screen. Repeat if necessary for other gases. Disconnect regulator.

7. Set the alarms at desired levels by pressing "Y/+" to accept default or "N/-" to move on. Press "Mode" to escape.

8. To power off, hold the "Mode" key for full 5 seconds. Leave MultiRAE on charger when not in use.

Work Area Air Monitoring Procedures

1. Measure and record the background PID and other gas readings.

2. Measure and record the breathing space readings.

Well Headspace Screening Procedures

1. Measure and record the background PID and other gas readings.

2. Unlock and open the well cover while standing upwind of the well.

3. Remove the well cap.

4. Place the MultiRAE probe approximately 6 inches above the top of the casing.

5. Record all MultiRAE readings and proceed in accordance with the HASP.

VII. Waste Management

To be completed by Preparer and reviewed by Technical Expert.

VIII. Data Recording and Management

The MultiRAE has datalogging capabilities. Up to 20,000 points can be downloaded to a PC with the serial number of unit, user ID, site number, and calibration date. The datalogging interval is programmable from 1 to 3,600 seconds. Direct readings can also be taken.

IX. Quality Assurance

After each use, the readout unit should be wiped down with a clean cloth or paper towel.

The external pre-filter should always be used. Replace when it looks very dirty or when the MultiRAE is in pump alarm with the filter on; and you can clear the pump alarm with the filter off.

X. References

RAE Systems MultiRAE Plus Data Sheet, revised 1-10/00.

RAE Systems “Using the MultiRAE Personal Multigas Monitor” training materials PowerPoint presentation, undated.

ATTACHMENT 1

Characteristics of the MultiRAE PID and Personal Multigas Monitor

I. Introduction

PIDs are used in the field to detect a variety of compounds in air. PIDs can be used to detect leaks of volatile substances in drums and tanks, to determine the presence of volatile compounds in soil and water, and to make ambient air surveys. If personnel are thoroughly trained to operate the instrument and to interpret the data, these PID instruments can be a valuable tool. Its use can help in deciding the level of protection to be worn, assist in determining the implementation of other safety procedures, and in determining subsequent monitoring or sampling locations. The MultiRAE serves as a PID as well as explosimeter, which detects Lower Explosive Limits (LEL), as well as other specified gases.

Portable MultiRAEs detect the concentration of organic gases, as well as percent oxygen, hydrogen sulfide, carbon monoxide, and others. The basis for detection is the ionization of gaseous species. The incoming gas molecules are subjected to UV radiation, which ionizes molecules that have an ionization potential (IP) less than or equal to that rated for the UV source. Every molecule has a characteristic IP, which is the energy required to remove an electron from the molecule, thus yielding a positively charged ion and the free electron. These ions are attracted to an oppositely charged electrode, causing a current and an electric signal to the LED display. Compounds are measured on a ppm volume basis, except for oxygen and LEL. Oxygen is measured as percentage by volume and combustible gas as percentage of LEL toxic gases.

II. MultiRAE or Equivalent PID

The integrated PID detects the concentration of organic gases, as well as a few inorganic gases. The basis for detection is the ionization of gaseous species. The incoming gas molecules are subjected to UV radiation, which is energetic enough to ionize many gaseous compounds. Each molecule is transformed into charged ion pairs, creating a current between two electrodes. Every molecule has a characteristic IP, which is the energy required to remove an electron from the molecule, yielding a positively charged ion and the free electron.

The PID probe consists of a 10.6 eV lamp standard. This probe detects many aromatic and large-molecule hydrocarbons. In addition, the 10.6 eV lamp detects some smaller organic molecules and some halogenated hydrocarbons. The primary PID calibration gas is isobutylene.

A protected catalytic bead is used for combustible gases. Interchangeable electrochemical sensors are used for oxygen and toxic gases.

III. Limitations

The MultiRAE instrument can monitor several vapors and gases in air. Unlike a single PID monitor, the MultiRAE can measure up to five different gases, thus providing a broader range of toxic gas detection.

The integrated PID instrument of the MultiRAE is generally not specific, and its response to different compounds is relative to the calibration gases. Instrument readings may be higher or lower than the true concentration. This effect can be observed when monitoring total contaminant concentrations if several different compounds are being detected at once. In addition, the response of these instruments is not linear over the entire detection range. Therefore, care must be taken when interpreting the data. Concentrations should be reported in terms of the calibration gas and span potentiometer.

MultiRAE monitors are small, portable instruments and may not yield results as accurate as laboratory instruments. They are relatively easy to use and interpret when detecting total concentrations of known contaminants in air, but interpretation becomes more difficult when trying to identify the individual components of a mixture. This instrument can be used as an indicator for combustible gases or oxygen deficiency.

ATTACHMENT 2

PID CALIBRATION AND MAINTENANCE LOG

Instrument Model Number

Instrument Serial Number

Calibration Gas **ppm**

Date/Time	Initials	Battery Check	Calibration			
			Background Value	True Gas Value	Measured Gas Value	Adjust

COMMENTS:

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Photoionization Detector Air Monitoring and Field Screening

Rev. #: 0

Rev Date: July 28, 2003

Approval Signatures

Prepared by: _____ Date: _____

Reviewed by: _____ Date: _____
(Technical Expert)

Reviewed by: _____ Date: _____
(Project Manager)

I. Scope and Application

Field screening with a photoionization detector (PID), such as an HNu™, Photovac™, MicroTIP™, or MiniRAE™, is a procedure to measure relative concentrations of volatile organic compounds (VOCs) and other compounds. Characteristics of the PID are presented in Attachment 1 and the compounds a PID can detect are presented in Attachment 2. Field screening will be conducted on the following:

- Work area air to assess exposure to on-site workers of air contaminants via the air pathway;
- Well headspaces as a precautionary measure each time the well cover is opened; and
- Headspace of soil samples to assess the relative concentration of volatile organics in the sample.

II. Personnel Qualifications

To be completed by Preparer and reviewed by Technical Expert.

III. Equipment List

The following materials, as required, shall be available while performing PID field screening:

- personal protective equipment (PPE), as required by the site Health and Safety Plan (HASP);
- PID and operating manual;
- PID extra battery pack and battery charger;
- calibration canisters for the PID;
- sample jars;
- Q-tips;
- aluminum foil;
- field calibration log (attached); and

- field notebook.

IV. Cautions

PIDs are sensitive to moisture and may not function under high humidity. PIDs cannot be used to indicate oxygen deficiency or combustible gases.

V. Health and Safety Considerations

To be completed by Preparer and reviewed by Technical Expert.

VI. Procedure

PID Calibration

PID field instruments will be calibrated and operated to yield "total organic vapor" in parts per million (ppm) (v/v) relative to benzene or isobutylene (or equivalent). Operation, maintenance, and calibration shall be performed in accordance with the manufacturer's instructions and entered on the PID calibration and maintenance log (Attachment 3).

1. Don PPE, as required by the HASP.

2. Perform a BATTERY CHECK. Turn the FUNCTION switch to the BATTERY CHECK position. Check that the indicator is within or beyond the green battery arc. If battery is low, the battery must be charged before calibration.

3. Calibrate the PID. If equipped, turn the FUNCTION switch to the STANDBY position and rotate the ZERO POTENTIOMETER until the meter reads zero. Wait 15 to 20 seconds to confirm the adjustment. If unstable, readjust. If equipped, check to see that the SPAN POTENTIOMETER is adjusted for the probe being used (e.g., 9.8 for 10.2 electron volts [eV]). Set the FUNCTION switch to the desired ppm range (0-20, 0-200, or 0-2,000). A violet glow from the ultraviolet (UV) source should be visible at the sample inlet of the probe/sensor unit.

4. Listen for the fan operation to verify fan function.

5. Connect one end of the sampling hose to the calibration canister regulator outlet and the other end to the sampling probe of the PID. Crack the regulator valve and take a reading after 5 to 10 seconds. Adjust the span potentiometer to produce the concentration listed on the span gas cylinder. Record appropriate

information on a PID Calibration and Maintenance Log (Attachment 3, or equivalent).

6. If so equipped, set the alarm at desired level.

Work Area Air Monitoring

1. Measure and record the background PID reading.

2. Measure and record the breathing space reading.

Well Headspace Screening

1. Measure and record the background PID reading.

2. Unlock and open the well cover while standing upwind of the well.

3. Remove the well cap.

4. Place the PID probe approximately 6 inches above the top of the casing.

5. Record all PID readings and proceed in accordance with the HASP.

Field Screening Procedures

Soil samples will be field screened upon collection with the PID for a relative measure of the total volatile organic concentration. The following steps define the PID field screening procedures.

1. Half-fill two clean glass jars with the sample (if sufficient quantities of soil are available) to be analyzed. Quickly cover each open top with one or two sheets of clean aluminum foil and subsequently apply screw caps to tightly seal the jars. Sixteen-ounce (approximately 500 mL) soil or “mason” type jars are preferred; jars less than 8 ounces (approximately 250 mL) total capacity may not be used.

2. Allow headspace development for at least 10 minutes. Vigorously shake jars for 15 seconds at both the beginning and end of the headspace development period. Where ambient temperatures are below 32°F (0°C), headspace development should be within a heated building.

3. Subsequent to headspace development, remove screw lid to expose the foil seal. Quickly puncture foil seal with instrument sampling probe, to a point about one-half of the headspace depth. Exercise care to avoid contact with water droplets or soil particulates.

4. Following probe insertion through foil seal, record the highest meter response for each sample as the jar headspace concentration. Using the foil seal/probe insertion method, maximum response should occur between 2 and 5 seconds. Erratic meter response may occur at high organic vapor concentrations or conditions of elevated headspace moisture, in which case headspace data should be recorded and erratic meter response noted.

5. The headspace screening data from both jar samples should be recorded and compared; generally, replicate values should be consistent to plus or minus 20%. It should be noted that in some cases (e.g., 6-inch increment soil borings), sufficient sample quantities may not be available to perform duplicate screenings. One screening will be considered sufficient for this case.

6. PID field instruments will be operated and calibrated to yield “total organic vapors” in ppm (v/v) as benzene. PID instruments must be operated with at least a 10.0 eV (+) lamp source. Operation, maintenance, and calibration will be performed in accordance with the manufacturer’s specifications presented in Attachment 12-1. For jar headspace analysis, instrument calibration will be checked/adjusted at least twice per day, at the beginning and end of each day of use. Calibration will exceed twice per day if conditions and/or manufacturer’s specifications dictate.

7. Instrumentation with digital (LED/LCD) displays may not be able to discern maximum headspace response unless equipped with a “maximum hold” feature or strip-chart recorder.

VII. Waste Management

Do not dispose canisters of compressed gas, if there is still compressed gas in the canister. While standing outdoors and upwind of the canister, discharge gas in canister by opening valve until the pressure in the gauge is zero. DO NOT PUNCTURE CANISTER. When empty, mark “EMPTY” on canister and discard the canister in trash.

VIII. Data Recording and Management

Measurements will be record in the field notebook or boring logs at the time of measurement with notation of date, time, location, depth (if applicable), and item monitored. If a data memory is available, readings will be downloaded from the unit upon access to a computer with software to retrieve the data.

IX. Quality Assurance

After each use, the readout unit should be wiped down with a clean cloth or paper towel.

For a HNu, the UV light source window and ionization chamber should be cleaned once a month in the following manner:

1. With the PID off, disconnect the sensor/probe from the unit.

2. Remove the exhaust screw, grasp the end cap in one hand and the probe shell in the other, and pull apart.

3. Loosen the screws on top of the end cap and separate the end cap and ion chamber from the lamp and lamp housing.

4. Tilt the lamp housing with one hand over the opening so that the lamp slides out into your hand.

5. Clean the lamp with lens paper and HNu cleaning compound (except 11.7 eV). For the 11.7 eV lamp, use a chlorinated organic solvent.

6. Clean the ion chamber using methanol on a Q-tip and then dry gently at 50ºC to 60ºC for 30 minutes.

7. Following cleaning, reassemble by first sliding the lamp back into the lamp housing. Place ion chamber on top of the housing, making sure the contacts are properly aligned.

8. Place the end cap on top of the ion chamber and replace the two screws (tighten the screws only enough to seal the o-ring).

9. Line up the pins on the base of the lamp housing with pins inside the probe shell and slide the housing assembly into the shell.

X. References

To be completed by Preparer and reviewed by Technical Expert.

ATTACHMENT 1

Characteristics of the Photoionization Detector (PID)

I. Introduction

PIDs are used in the field to detect a variety of compounds in air. PIDs can be used to detect leaks of volatile substances in drums and tanks, to determine the presence of volatile compounds in soil and water, and to make ambient air surveys. If personnel are thoroughly trained to operate the instrument and interpret the data, these PID instruments can be a valuable tool. Its use can help in deciding the level of protection to be worn, assist in determining the implementation of other safety procedures, and in determining subsequent monitoring or sampling locations.

Portable PIDs detect the concentration of organic gases, as well as a few inorganic gases. The basis for detection is the ionization of gaseous species. The incoming gas molecules are subjected to UV radiation, which ionizes molecules that have an ionization potential (IP) less than or equal to that rated for the UV source. Every molecule has a characteristic IP, which is the energy required to remove an electron from the molecule, thus yielding a positively charged ion and the free electron. These ions are attracted to an oppositely charged electrode, causing a current and an electric signal to the LED display. Compounds are measured on a ppm volume basis.

II. HNu PI-101 / MiniRAE or Equivalent PID

The PIDs detect the concentration of organic gases, as well as a few inorganic gases. The basis for detection is the ionization of gaseous species. The incoming gas molecules are subjected to UV radiation, which is energetic enough to ionize many gaseous compounds. Each molecule is transformed into charged ion pairs, creating a current between two electrodes. Every molecule has a characteristic IP, which is the energy required to remove an electron from the molecule, yielding a positively charged ion and the free electron.

Three probes, each containing a different UV light source, are available for use with the PID. Probe energies are typically 9.5, 10.2, and 11.7 eV, respectively. All three probes detect many aromatic and large-molecule hydrocarbons. In addition, the 10.2 eV and 11.7 eV probes detect some smaller organic molecules and some halogenated hydrocarbons. The 10.2 eV probe is the most useful for environmental response work, as it is more durable than the 11.7 eV probe and detects more compounds than the 9.5 eV probe. A listing of molecules and compounds that the HNu can detect is presented in Attachment 2.

The primary PID calibration gas is either benzene or isobutylene. The span potentiometer knob is turned to 9.8 for benzene calibration. A knob setting of zero increases the sensitivity to benzene approximately 10-fold. Its lower detection limit is in the low ppm range. Additionally, response time is rapid; the dot matrix liquid crystal displays 90% of the indicated concentration within 3 seconds.

III. Limitations

The PID instrument can monitor several vapors and gases in air. Many non-volatile liquids, toxic solids, particulates, and other toxic gases and vapors, however, cannot be detected with PIDs (such as methane). Since the PIDs cannot detect all of the chemicals that may be present at a sample location, a zero reading on either instrument does not necessarily signify the absence of air contaminants.

The PID instrument is generally not specific and their response to different compounds is relative to the calibration gases. Instrument readings may be higher or lower than the true concentration. This effect can be observed when monitoring total contaminant concentrations if several different compounds are being detected at once. In addition, the response of these instruments is not linear over the entire detection range. Therefore, care must be taken when interpreting the data. Concentrations should be reported in terms of the calibration gas and probe type.

PIDs are small, portable instruments and may not yield results as accurate as laboratory instruments. PIDs were originally designed for specific industrial applications. They are relatively easy to use and interpret when detecting total concentrations of known contaminants in air, but interpretation becomes more difficult when trying to identify the individual components of a mixture. PIDs cannot be used as an indicator for combustible gases or oxygen deficiency.

ATTACHMENT 2

Molecules and Compounds Detected by a PID

Some Atoms and Simple Molecules

	IP(eV)	IP(eV)
H	13.595 I_2	9.28
C	11.264 HF	15.77
N	14.54 HCl	12.74
O	13.614 HBr	11.62
Si	8.149 HI	10.38
S	10.357 SO_2	12.34
F	17.42 CO_2	13.79
Cl	13.01 COS	11.18
Br	11.84 CS_2	10.08
I	10.48 N_2O	12.90
H_2	15.426 NO_2	9.78
N_2	15.580 O_3	12.80
O_2	12.075 H_2O	12.59
CO	14.01 H_2S	10.46
CN	15.13 H_2Se	9.88
NO	9.25 H_2Te	9.14
CH	11.1 HCN	3.91
OH	13.18 C_2N_2	13.8
F_2	15.7 NH_3	10.15
Cl_2	11.48 CH_3	9.840
Br_2	10.55 CH_4	12.98

Paraffins and Cycloparaffins

Molecule	IP(eV)
methane	12.98
ethane	11.65
propane	11.07
n-butane	10.63
i-butane	10.57
n-pentane	10.35
i-pentane	10.32
2,2-dimethylpropane	10.35
n-hexane	10.18
2-methlypentane	10.12
3-methlypentane	10.08
2,2-dimethlybutane	10.06
2,3-dimethlybutane	10.02
n-heptane	10.08
2,2,4-trimethlypentane	9.86
cyclopropane	10.06
cyclopentane	10.53
cyclohexane	9.88
methlycyclohexane	9.8

Alkyl Halides

IP(eV)	IP(eV)
HCl	12.74
Cl_2	11.48
CH_4	12.98
methyl chloride	11.28
dichloroemethane	11.35
trichloromethane	11.42
tetrachloromethane	11.47
ethyl chloride	10.98
1,2-dichloroethane	11.12
1-chloropropane	10.82
2-chloropropane	10.78
1,2-dichloropropane	10.87
1,3-dichloropropane	10.85
1-chlorobutane	10.67
2-chlorobutane	10.65
1-chloro-2-methylpropane	10.66
2-chloro-2-methylpropane	10.61
HBr	11.62
Br_2	10.55
methyl bromide	10.53
dibromomethane	10.49
tribromomethane	10.51
CH_2BrCl	10.77
$CHBr_2Cl$	10.59
ethyl bromide	10.29
1,1-dibromoethane	10.19
1-bromo-2-chloroethane	10.63
1-bromopropane	10.18
2-bromopropane	10.075
1,3-dibromopropane	10.07
1-bromobutane	10.13
2-bromobutane	9.98
1-bromo-2-methylpropane	10.09
2-bromo-2-methylpropane	9.89
1-bromopentane	10.10
HI	10.38
I_2	9.28

Alkyl Halides

Molecule	IP(eV)
methyl iodide	9.54
diiodomethane	9.34
ethyl iodide	9.33
1-iodopropane	9.26
2-iodopropane	9.17
1-iodobutane	9.21
2-iodobutane	9.09
1-iodo-2-methylpropane	9.18
2-iodo-2-methylpropane	9.02
1-iodopentane	9.19
F_2	15.7
HF	15.77
$CFCl_3$ (Freon 11)	11.77
CF_2Cl_2 (Freon 12)	12.31
CF_3Cl (Freon 13)	12.91
$CHClF_2$ (Freon 22)	12.45
$CFBR_3$	10.67
CF_2Br_2	11.07
CH_3CF_2Cl (Genetron 101)	11.98
$CFCl_2CF_2Cl$	11.99
CF_3CCl_3 (Freon 113)	11.78
$CFHBrCH_2Cr$	10.75
CF_2BrCH_2Br	10.83
CF_3CH_2I	10.00
n-C_3F_7I	10.36
n-$C_3F_7CH_2Cl$	11.84
n-$C_3F_7CH_2I$	9.96

Aliphatic Alcohol, Ether, Thiol, and Sulfides

Molecule	IP(eV)
H_2O	12.59
methyl alcohol	10.85
ethyl alcohol	10.48
n-propyl alcohol	10.20
i-propyl alcohol	10.16
n-butyl alcohol	10.04
dimethyl ether	10.00
diethyl ether	9.53
n-propyl ether	9.27
i-propyl ether	9.20
H_2S	10.46
methanethiol	9.440
ethanethiol	9.285
1-propanethiol	9.195
1-butanethiol	9.14
dimethyl sulfide	8.685
ethyl methyl sulfide	8.55
diethyl sulfide	8.430
di-n-propyl sulfide	8.30

Aliphatic Aldehydes and Ketones

Molecule	IP(eV)
CO_2	13.79
formaldehyde	10.87
acetaldehyde	10.21
propionaldehyde	9.98
n-butyraldehyde	9.86
isobutyraldehyde	9.74
n-valeraldehyde	9.82
isovaleraldehyde	9.71
acrolein	10.10
crotonaldehyde	9.73
benzaldehyde	9.53
acetone	9.69
methyl ethyl ketone	9.53
methyl n-propyl ketone	9.39
methyl i-propyl ketone	9.32
diethyl ketone	9.32
methyl n-butyl ketone	9.34
methyl i-butyl ketone	9.30
3,3-dimethyl butanone	9.17
2-heptanone	9.33
cyclopentanone	9.26
cyclohexanone	9.14
2,3-butanedione	9.23
2,4-pentanedione	8.87

Aliphatic Acids and Esters

Molecule	IP(eV)
CO_2	13.79
formic acid	11.05
acetic acid	10.37
propionic acid	10.24
n-butyric acid	10.16
isobutyric acid	10.02
n-valeric acid	10.12
methyl formate	10.815
ethyl formate	10.61
n-propyl formate	10.54
n-butyl formate	10.50
isobutyl formate	10.46
methyl acetate	10.27
ethyl acetate	10.11
n-propyl acetate	10.04
isopropyl acetate	9.99
n-butyl acetate	10.01
isobutyl acetate	9.97
sec-butyl acetate	9.91
methyl propionate	10.15
ethyl propionate	10.00
methyl n-butyrate	10.07
methyl isobutyrate	9.98

Aliphatic Amines and Amides

Molecule	IP(eV)
NH_3	10.15
methyl amine	8.97
ethyl amine	8.86
n-propyl amine	8.78
i-propyl amine	8.72
n-butyl amine	8.71
i-butyl amine	8.70
s-butyl amine	8.70
t-butyl amine	8.64
dimethyl amine	8.24
diethyl amine	8.01
di-n-propyl amine	7.84
di-i-propyl amine	7.73
di-n-butyl amine	7.69
trimethyl amine	7.82
triethyl amine	7.50
tri-n-propyl amine	7.23
formamide	10.25
acetamide	9.77
N-methyl acetamide	8.90
N,N-dimethyl formamide	9.12
N,N-dimethyl acetamide	8.81
N,N-diethyl formamide	8.89
N,N-diethyl acetamide	8.60

Other Aliphatic Molecules with N Atom

Molecule	IP(eV)
nitromethane	11.08
nitroethane	10.88
1-nitropropane	10.81
2-nitropropane	10.71
HCN	13.91
acetonitrile	12.22
propionitrile	11.84
n-butyronitrile	11.67
acrylonitrile	10.91
3-butene-nitrile	10.39
ethyl nitrate	11.22
n-propyl nitrate	
methyl thiocyanate	10.065
ethyl thiocyanate	9.89
methyl isothiocyanate	9.25
ethyl isothiocyanate	9.14

Olefins, Cyclo-ofefins, Acetylenes

Molecule	IP(eV)
ethylene	10.515
propylene	9.73
1-butene	9.58
2-methylpropene	9.23
trans-2-butene	9.13
cis-2-butene	9.13
1-pentene	9.50
2-methyl-1-butene	9.12
3-methyl-1-butene	9.51
3-methyl-2-butene	8.67
1-hexene	9.46
1,3-butadiene	9.07
isoprene	8.845
cyclopentene	9.01
cyclohexene	8.945
4-methylcyclohexene	8.91
4-cinylcylohexene	8.93
cyclo-octatetraene	7.99
acetylene	11.41
propyne	10.36
1-butyne	10.18

Some Derivatives of Olefins

Molecule	IP(eV)
vinyl chloride	9.995
cis-dichloroethylene	9.65
trans-dichloroethylene	9.66
trichloroethylene	9.45
tetrachloroethylene	9.32
vinyl bromide	9.80
1,2-dibromoethylene	9.45
tribromoethylene	9.27
3-chloropropene	10.04
2,3-dichloropropene	9.82
1-bromopropene	9.30
3-bromopropene	9.7
$CF_3CCl=CClCF_3$	10.36
$n\text{-}C_5F_{11}CF=CF_2$	10.48
acrolein	10.10
crotonaldehyde	9.73
mesityl oxide	9.08
vinyl methyl ether	8.93
allyl alcohol	9.67
vinyl acetate	9.19

Aromatic Compounds

Molecule	IP(eV)
benzene	9.245
toluene	8.82
ethyl benzene	8.76
n-propyl benzene	8.72
i-propyl benzene	8.69
n-butyl benzene	8.69
s-butyl benzene	8.68
t-butyl benzene	8.68
o-xylene	8.56
m-xylene	8.56
p-xylene	8.445
mesitylene	8.40
durene	8.025
styrene	8.47
alpha-methyl styrene	8.35
ethynylbenzene	8.815
naphthalene	8.12
1-methylnapthalene	7.69
2-methylnapthalene	7.955
biphenyl	8.27
phenol	8.50
anisole	8.22
phenetole	8.13
benzaldehyde	9.53
acetophenone	9.27
benzenethiol	8.33
phenyl isocyanate	8.77

Aromatic Compounds

Molecule	IP(eV)
phenyl isothiocyanate	8.520
benzonitrile	9.705
nitrobenzene	9.92
aniline	7.70
fluoro-benzene	9.195
chloro-benzene	9.07
bromo-benzene	8.98
iodo-benzene	8.73
o-dichlorobenzene	9.07
m-dichlorobenzene	9.12
p-dichlorobenzene	8.94
1-chloro-2-fluorobenzene	9.155
1-chloro-3-fluorobenzene	9.21
1-chloro-4-fluorobenzene	8.99
o-fluorotoluene	8.915
m-fluorotoluene	8.915
p-fluorotoluene	8.785
o-chlorotoluene	8.83
m-chlorotoluene	8.83
p-chlorotoluene	8.70
o-bromotoluene	8.79
m-bromotoluene	8.81
p-bromotoluene	8.67
o-iodotoluene	8.62
m-iodotoluene	8.61
p-iodotoluene	8.50
benzotrifluoride	9.68
o-fluorophenol	8.66

Heterocyclic Molecules

Molecule	IP(eV)
furan	8.89
2-methyl furan	8.39
2-furaldehyde	9.21
tetrahydrofuran	9.54
dihydropyran	8.34
tetrahydropyran	9.26
thiophene	8.860
2-chlorothiophene	8.68
2-bromothiophene	8.63
pyrrole	8.20
pyridine	9.32
2-picoline	9.02
3-picoline	9.04
4-picoline	9.04
2,3-lutidine	8.85
2,4-lutidine	8.85
2,6-lutidine	8.85

Miscellaneous Molecules

Molecule	IP(eV)
ethylene oxide	10.565
propylene oxide	10.22
p-dioxane	9.13
dimethoxymethane	10.00
diethoxymethane	9.70
1,1-dimethoxyethane	9.65
propiolactone	9.70
methyl disulfide	8.46
ethyl disulfide	8.27
diethyl sulfite	9.68
thiolacetic acid	10.00
acetyl chloride	11.02
acetyl bromide	10.55
cyclo-$C_6H_{11}CF_3$	10.46
(n-C_3F_7)(CH_3)C=O	10.58
trichlorovinylsilane	10.79
$(C_2F_5)_3N$	11.7
isoprene	9.08
phosgene	11.77

Notes:

Reference: HNu Systems, Inc., 1985
IP = Ionization Potential

ATTACHMENT 3

PID CALIBRATION AND MAINTENANCE LOG						
Instrument Model Number						
Instrument Serial Number						
Calibration Gas					**ppm**	
Date/Time	**Initials**	**Battery Check**	**Calibration**			
			Background Value	**True Gas Value**	**Measured Gas Value**	**Adjust**
COMMENTS:						

ARCADIS
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Standard Groundwater Sampling for Monitoring Wells

Rev. #: 1

Rev Date: July 16, 2008

Approval Signatures

Prepared by: Sonya A Cadle Date: 7/16/08

Reviewed by: Date: 7/16/08
(Technical Expert)

I. Scope and Application

This Standard Operating Procedure (SOP) describes the procedures to be used to collect groundwater samples using traditional purging and sampling techniques. For low-flow purging techniques, please refer to the Low Flow Purging SOP. Monitoring wells must be developed after installation at least 1 week prior to groundwater sample collection. Monitoring wells will not be sampled until the well has been developed. During precipitation events, groundwater sampling will be discontinued until precipitation ceases or a cover has been erected over the sampling area and monitoring well.

Both filtered and unfiltered groundwater samples may be collected using this SOP. Filtered samples may be obtained using a 1.0-, 0.45-, or 0.1-micron disposable filter.

II. Personnel Qualifications

ARCADIS personnel directing, supervising, or leading groundwater sample collection activities should have a minimum of 2 years of previous groundwater sampling experience. Field employees with less than 6 months of experience should be accompanied by a supervisor (as described above) to ensure that proper sample collection techniques are employed.

III. Equipment List

The following materials shall be available, as required, during groundwater sampling:

- site plan of monitoring well locations and site Field Sampling Plan (FSP);
- appropriate health and safety equipment, as specified in the site Health and Safety Plan (HASP);
- photoionization detector (PID) or flame ionization detector (FID), as needed, in accordance with the HASP;
- monitoring well construction logs or tables and historical water level information, if available;
- dedicated plastic sheeting or other clean surface to prevent sample contact with the ground;
- if bailers are to be used in sampling:

  - appropriate dedicated bottom-loading, bottom-emptying bailers (i.e., polyvinyl chloride [PVC], Teflon, or stainless steel);
  - polypropylene rope;
- if submersible pumps are to be used in sampling:
  - dedicated tubing and other equipment necessary for purging;
  - generator or battery for operation of pumps, if required;
  - a pump selected in accordance with the FSP or Work Plan (parameter-specific [e.g., submersible, bladder, peristaltic]);
- graduated buckets to measure purge water;
- water-level or oil/water interface probe, in accordance with the FSP or Work Plan;
- conductivity/temperature/pH meter;
- down-hole dissolved oxygen meter, oxidation reduction potential meter, and/or turbidity meter, if specified in the FSP;
- water sample containers appropriate for the analytical method(s) with preservative, as needed (parameter-specific);
- filter, as needed, in accordance with the analytical method and parameter;
- appropriate blanks (trip blank supplied by the laboratory), as specified in the FSP;
- Ziploc-type freezer bags for use as ice containers;
- appropriate transport containers (coolers) with ice and appropriate labeling, packing, and shipping materials;
- appropriate groundwater sampling log (example attached);
- chain-of-custody forms;
- site map with well locations and groundwater contour maps;

- keys to wells and contingent bolt cutters for rusted locks and replacement keyed-alike locks; and

- drums or other containers for purge water, as specified by the site investigation derived waste (IDW) management plan.

IV. Cautions

If heavy precipitation occurs and no cover over the sampling area and monitoring well can be erected, sampling must be discontinued until adequate cover is provided. Rain water could contaminate groundwater samples.

Remember that field logs and some forms are considered to be legal documents. All field logs and forms should therefore be filled out in indelible ink.

It may be necessary to field filter some parameters (e.g., metals) prior to collection, depending on preservation, analytical method, and project quality objectives.

Check monitoring well logs for use of bentonite pellets. Make note of potential use of bentonite pellets on the groundwater sampling log. Coated bentonite pellets have been found to contaminate monitoring wells with elevated levels of acetone.

Store and/or stage empty and full sample containers and coolers out of direct sunlight.

To mitigate potential cross-contamination, groundwater samples are to be collected in a pre-determined order from least impacted to more impacted based on previous analytical data. If no analytical data are available, samples are to be collected in the following order:

1. First sample the upgradient well(s).

2. Next, sample the well located furthest downgradient of the interpreted or known source.

3. The remaining wells should be progressively sampled in order from downgradient to upgradient, such that the wells closest to the interpreted or known source are sampled last.

Be careful not to over-tighten lids with Teflon liners or septa (e.g., 40 mL vials). Over-tightening can impair the integrity of the seal.

V. Health and Safety Considerations

If thunder or lighting is present, discontinue sampling until 30 minutes have passed after the last occurrence of thunder or lighting.

VI. Procedure

The procedures to sample monitoring wells will be as follows:

1. Don safety equipment, as required in the HASP. Depending on site-specific security and safety considerations, this often must be done prior to entering the work area.

2. Review equipment list (Section III above) to confirm that the appropriate equipment has been acquired.

3. Record site and monitoring well identification on the groundwater sampling log, along with date, arrival time, and weather conditions. Also identify the personnel present, equipment utilized, and other relevant data requested on the log.

4. Label all sample containers with indelible ink.

5. Place plastic sheeting adjacent to the well for use as a clean work area, if conditions allow. Otherwise, prevent sampling equipment from contacting the ground or other surface that could compromise sample integrity.

6. Remove lock from well and if rusted or broken, replace with a new brass keyed-alike lock.

7. Unlock and open the well cover while standing upwind of the well. Remove well cap and place on the plastic sheeting.

8. Set the sampling device,meters, and other sampling equipment on the plastic sheeting. If a dedicated sampling device stored in the well is to be used, this may also be set temporarily on the plastic sheeting, for convenience. However, if a dedicated sampling device is stored below the water table, removing it may compromise water-level data, so water level measurements should be taken prior to removing the device.

9. Obtain a water-level depth and bottom-of-well depth using an electric well probe and record on the groundwater sampling log using indelible ink. Clean the probe(s) after each use in accord with the FSP or the equipment

decontamination SOP.

Note: Water levels may be measured at all wells prior to initiating any sampling activities, depending on FSP requirements.

10. Calculate the number of gallons of water in the well using the length of water column (in feet). Record the well volume on the groundwater sampling log using indelible ink.

11. Remove the required purge volume of water from the well (measure purge water volume in measuring buckets). The required purge volume will be three to five well volumes (the water column in the well screen and casing) unless the well runs dry, in which case, the water that comes into the well will be sampled (USEPA, 1996). In any case, the pumping rate will be decreased during sampling to limit the potential for volatilization of organics potentially present in the groundwater.

12. Field parameter measurements will be periodically collected in accord with FSP specifications. The typical time intervals of field parameter measurement are (1) after each well volume removed, and (2) before sampling. If the field parameters are being measured above-ground (rather than with a downhole probe), then the final pre-sampling parameter measurement should be collected at the reduced flow rate to be used during sampling. The physical appearance of the purged water should be noted on the groundwater sampling log. In addition, water level measurements should be collected and recorded to verify that the well purging is in accord with the guidelines set forth in the previous step.

13. Unless otherwise specified by the applicable regulatory agencies, all purge water will be contained. Contained purge water will be managed in accordance with the FSP or Work Plan. If historical concentrations in the well are less than federal or state regulated concentrations appropriate for current land use, *and permission has been granted by the oversight regulatory agency* to dispose of clean purge water on the ground next to the well(s), then purge water will be allowed to infiltrate into the ground surface downgradient from the monitoring well after the well is sampled.

14. After the appropriate purge volume of groundwater in the well has been removed, or if the well has been bailed dry and allowed to recover, obtain the groundwater sample needed for analysis with the dedicated bailer or from the dedicated sampling tubing, pour the groundwater directly from the sampling device into the appropriate container in the order of volatilization sensitivity of

the parameters sampled, and tightly screw on the cap (snug, but not too tight). The suggested order for sample parameter collection, based on volatilization sensitivity, is presented below:

a. volatile organic compounds (VOCs);

b. semi-volatile organic compounds (SVOCs);

c. polychlorinated biphenyls (PCBs)/pesticides;

d. metals; and

e. wet chemistry.

15. When sampling for volatiles, water samples will be collected directly from the bailer or dedicated tubing into 40 mL vials with Teflon-lined septa.

16. For other analytical samples, sample containers for each analyte type should be filled in the order specified by the FSP. If a bailer is used, then the sample for dissolved metals and/or filtered PCBs should either be placed directly from the bailer into a pressure filter apparatus or pumped directly from the bailer with a peristaltic pump, through an in-line filter, into the pre-preserved sample bottle. If dedicated sample tubing is used, then the filter should be installed in-line just prior to filtered sample collection.

17. If sampling for total and filtered metals and/or PCBs, a filtered and unfiltered sample will be collected. Sample filtration for the filtered sample will be performed in the field utilizing a pump prior to preservation. Attach (clamp) a new 1.0-, 0.45-, or 0.1-micron filter to the discharge tubing of the pump (note the filter flow direction). Turn the pump on and allow 100 mL (or manufacturer recommended amount) of fluid through the filter before sample collection. Dispense the filtered liquid directly into the laboratory sample bottles. If bailers are used for purging and sampling, a proper volume of purge water will be placed in a disposable or decontaminated polyethylene container and pumped through the filter and into the sample container using a peristaltic pump.

18. Place the custody seal around the cap and the sampler container, if required. Note the time on the sample label. Secure with packing material and maintain at approximately 4°C on wet ice contained in double Ziploc-type freezer bags during storage in an insulated, durable transport container.

19. Replace the well cap and lock well, or install a new lock if needed.

20. Record the time sampling procedures were completed on the appropriate field logs (using indelible ink).

21. Complete the procedures for chain-of-custody, handling, packing, and shipping. Chain-of-custody forms should be filled out and checked against the labels on the sample containers progressively after each sample is collected.

22. Place all disposable sampling materials (such as plastic sheeting, disposable tubing or bailers, and health and safety equipment) in appropriate containers.

23. If new locks were installed, forward copies of the keys to the client Project Manager (PM) and ARCADIS PM at the end of the sampling activities.

VII. Waste Management

Purge water will be managed as specified in the FSP or Work Plan, and according to state and/or federal requirements. Personal protective equipment (PPE) and decontaminated fluids will be contained separately and staged at the sampling location. Containers must be labeled at the time of collection. Labels will include date, location(s), site name, city, state, and description of matrix contained (e.g., soil, groundwater, PPE). General guidelines for IDW management are set forth in a separate IDW management SOP.

VIII. Data Recording and Management

Initial field logs and chain-of-custody records will be transmitted to the ARCADIS PM at the end of each day unless otherwise directed by the PM. The groundwater team leader retains copies of the groundwater sampling logs. All field data should be recorded in indelible ink.

IX. Quality Assurance

Field-derived quality assurance blanks will be collected as specified in the FSP, depending on the project quality objectives. Typically, field rinse blanks will be collected when non-dedicated equipment is used during groundwater sampling. Field rinse blanks will be used to confirm that decontamination procedures are sufficient and samples are representative of site conditions. Trip blanks for VOCs, which aid in the detection of contaminates from other media, sources, or the container itself, will be kept with the coolers and the sample containers throughout the sampling activities.

X. References

USEPA. 1986. RCRA Groundwater Monitoring Technical Enforcement Guidance Document (September 1986).

USEPA. 1991. Handbook Groundwater, Volume ii Methodology, Office of Research and Development, Washington, DC. USEPN62S, /6-90/016b (July, 1991).

U.S. Geological Survey (USGS). 1977. National Handbook of Recommended Methods for Water-Data Acquisition: USGS Office of Water Data Coordination. Reston, Virginia.

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Test Pit Excavation (NON-ENTRY)

Rev. #: 2

Rev Date: May 28, 2008

Approval Signatures

Prepared by: Andrew Kamik Date: 5/28/2008

Reviewed by: Michael J Hefell Date: 5/28/2008
(Technical Expert)

I. Scope and Application

This SOP outlines policies and procedures for the advancement of test-pits using rubber-tire or track-mounted backhoes. For all work activities conducted by ARCADIS involving test pits or other excavations, ARCADIS staff will refer to and comply with ARCADIS HS Procedure No. ARC HSCS005, Excavation and Trenching. Test pits will be excavated using a decontaminated, rubber-tired backhoe or track-hoe as appropriate. Test pits may be performed based on the need to identify subsurface structures, facilitate the collection of soil samples and provide larger-scale subsurface characterization than allowed using soil borings. Personnel should stand upwind of the excavation area to the extent possible. Continuous air monitoring may be conducted as indicated in the site Health and Safety Plan (HASP). Excavating will be conducted at the selected locations that have been cleared for utilities until significant source materials, groundwater, or bedrock is encountered, or the purpose of the test pit has been met, or the physical limits of the backhoe have been reached. Test pit materials will be visually observed and described with respect to depth. Samples may be collected for laboratory or geotechnical analyses. Photographs of the test pits and excavated materials should be taken for future reference.

II. Personnel Qualifications

ARCADIS personnel overseeing, directing, or supervising the sampling portion of the test pit activities will have a minimum of 6 months of previous related experience under the supervision of an experienced (2 years) oversight person and at a minimum a 4-year degree (Bachelors) in environmental sciences, engineering, hydrogeology, or geology, and have completed health and safety training as required by OSHA Regulation 29 CFR 1910.120 (HAZWOPER). Personnel will also have completed any client-specific training as may be required. If the test pit is excavated by ARCADIS personnel, a competent person as defined by ARC HSCS005 will be on-site at all times.

If the test pit is excavated by a subcontractor, the subcontractor will provide the competent person per OSHA 1926.32(f). The excavation subcontractor will maintain all appropriate licenses and/or certifications as required by the State and Municipality. The equipment operator and any assistants working on site will, prior to beginning work, have completed all health and safety and other training as may be required by ARCADIS and the client.

III. Equipment List

The following equipment will be available, as required, during test pitting:

- rubber-tired (or track-mounted) backhoe in good working order;
- flame ionization detector (FID) and/or photoionization detector (PID), and/or other colorimetric;
- sample containers and forms;
- daily field log and/or field notebook;
- supplies and equipment to comply with site- and client-specific health and safety procedures;
- stainless steel shovel, scoop, hand auger, or trowel;
- digital camera;
- polyethylene sheeting; and
- ground stakes.

IV. Cautions

Water used for decontamination of excavation equipment will be of a quality acceptable for project objectives. Testing of water supply should be considered.

Work may be conducted on or in proximity to steep terrain. Site-specific health and safety issues will be thoroughly reviewed by all site personnel prior to beginning work.

V. Health and Safety Considerations

A site-specific Health and Safety Plan (HASP) meeting client requirements will be prepared along with Job Safety Analyses (JSAs) that outline the H&S hazards and controls for conducting the test pit activities. Project staff will review and be familiar with these plans and JSAs prior to work. These documents will detail the excavation safety requirements per ARC HSCS005. In addition, underground and above ground utilities will be located and cleared per ARCADIS H&S Procedure ARC HSFS019 – Utility Location.

VI. Procedures

Where necessary to characterize soil conditions, soil samples will be collected from the backhoe bucket, either directly or with a decontaminated stainless steel scoop or trowel.

Samples should be homogenized, if appropriate.

Material removed from the test pits during excavation will be placed on polyethylene sheeting. Visually clean soils will be segregated from soils that may contain source materials. Soils meeting field screening or laboratory analytical criteria may be placed back into the excavation. Soils not meeting screening or laboratory analytical criteria will be managed on site as described in the *Waste Management* section below. For sites that cannot be fully secured, clean fill will be available to backfill excavations immediately upon completion of test pits. To facilitate surveying, the location of the test pits will be marked with stakes after they have been backfilled. Stakes should be placed at the ends of the test pit and at any significant bend or corner, as appropriate.

VII. Waste Management

All water generated during decontamination procedures will be collected and contained onsite in 55-gallon drums or a temporary frac-tank pending laboratory analysis and appropriate disposal.

Personal protective equipment (such as gloves, disposable clothing, and other disposable equipment) resulting from personnel cleaning procedures and soil sampling/handling activities will be placed in plastic bags. These bags will be transferred into appropriately labeled 55-gallon drums for appropriate disposal.

Depending on volume generated, soil materials will be placed in sealed 55-gallon steel drums or stockpiled on site (placed on and covered by plastic sheeting). The material will be analyzed to determine the appropriate disposal method.

VIII. Data Recording and Management

The supervising geologist/engineer/scientist will be responsible for documenting activities using a daily field log to record all relevant information in a clear and concise format. As an alternative, a bound field notebook may be used at the discretion of field personnel to document field activities. Where appropriate, photographs will be taken to supplement written notes. The record of test pitting will include:

- start and finish dates of excavating;

- name and location of project;
- project number, client, and site location;
- sample number and depths;
- depth to water;
- observations of soil type/characteristics and lithology;
- documentation of any elevated organic vapor emissions;
- names of Contractor's personnel, inspectors, or other people onsite; and
- weather conditions.

IX. Quality Assurance

Equipment will be cleaned prior to use onsite. At the discretion of the ARCADIS Project Manager or field geologist/engineer/scientist, equipment may be decontaminated between each test pit location, and prior to leaving the site. All equipment and associated tools that may have come in contact with contaminated soils and/or waste materials will be cleaned with high-pressure steam cleaning equipment using a potable water source. More detailed equipment cleaning procedures are provided in the HASP.

X. References

United States Department of Labor. 1989. Occupational Safety & Health Administration (OSHA), Title 29 Code of Federal Regulations (CFR)Part 1926.651 Subpart P Excavations, .54 Federal Register (FR) 45959, October 31, 1989 and 59 FR 40730, Aug. 9, 1994.

ARCADIS HS Procedure No. ARC HSCS005, Excavation and Trenching, 12 May 2008.

ARCADIS H&S Procedure ARC HSFS019 – Utility Location, 22 February 2008

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Collecting and Describing Bedrock Core Samples

Rev. #: 1

Rev Date: April 24, 2006

Approval Signatures

Prepared by: _____ Date: _____

Reviewed by: Michael Gefell Date: 4/22/06
(Technical Expert)

Reviewed by: _____ Date: _____
(Project Manager)

I. Scope and Application

This document describes the procedures to be used to collect and describe bedrock core samples. Bedrock cores will be collected in accordance with ASTM Method D 2113-99, Standard Practice for Rock Core Drilling and Sampling of Rock for Site Investigation. The bedrock cores will be collected, labeled, and classified as outlined below.

II. Personnel Qualifications

When bedrock core sampling is to be used for geologic, hydrogeologic, and/or contaminate delineation, the coring activities will be observed, and recovered cores logged, by an experienced geologist. When bedrock core samples are to be used for engineering purposes (e.g., foundation design, rock mechanics, design of excavation support), field oversight staff will work under the direction of a geotechnical engineer.

III. Equipment List

Bedrock Core Sampling

- Core boxes;
- Permanent marking pen for labeling boxes and cores;
- Wood blocks to separate core runs in core boxes;
- Field logbook;
- Rock coring logs;
- Hand lens;
- Pen knife;
- Water-level probe;
- Munsell rock color chart;
- Tape measure;
- Rock hammer; and

- Rubber hammer (for tapping rock core out of core barrel).

IV. Cautions

Prior to beginning field work, the drilling contractor will contact and coordinate with an independent underground utility locator service to identify and locate buried utilities in the vicinity of the boring.

Avoid using drilling fluids or materials that could impact groundwater or soil quality, or could be incompatible with the subsurface conditions.

Water used for drilling and sampling of soil or bedrock, decontamination of drilling/sampling equipment, or grouting boreholes upon completion will be of a quality acceptable for project objectives. Testing of water supply should be considered.

Specifications of materials used for backfilling bore hole will be obtained, reviewed and approved to meet project quality objectives.

V. Health and Safety Considerations

Field activities associated with bedrock coring will be performed in accordance with a site-specific Health and Safety Plan (HASP), a copy of which will be present on site during such activities.

VI. Procedure

Prior to placing the core barrel into the hole, the driller will use air/water circulation to remove cuttings in the boring that may clog the barrel. Drilling rods will be carefully centered in initial borehole, if any, to reduce the potential for core breakage. The driller will maintain drilling bit pressure and water pressure at a consistent level throughout drilling, and runs will be completed without interruption, to the extent practical, so penetration rates (in feet per minute) can be determined.

Core samples will be placed in core boxes with increasing depths aligned left to right and core runs separated by wood blocks. Man-made breaks will be marked with a pen across the break. Wood blocks will be labeled and placed at the end of each core run to indicate run. A wooden space will be inserted if no sample is recovered and labeled “L.C.” (lost core) with corresponding depth. Attachment 1 contains additional instructions for handling, packing, and labeling core.

- The supervising geologist or geotechnical engineer will record the following parameters related to the core drilling process: penetration rates, drilling time, and core run length (i.e., minutes per foot);
- water loss; and
- drill type and size.

The following rock core characteristics will be described in the field, as appropriate:

- lithology (rock type);
- friability/fissibility;
- color;
- strength of intact rock;
- thickness;
- weathered state;
- particle angularity/shape;
- voids;
- particle sizes;
- structure/bedding (bedding planes, joints, fractures);
- Rock Quality Designation (RQD);
- rock core recovery length;
- description of discontinuities and fillings (including interpretation of natural vs. artificial bedrock fractures);
- formation name (if known);
- water content;
- texture;

- odors/discoloration;
- hardness;
- fossils;
- depth to water;
- Munsell color; and
- geologic contacts when observed.

A key to abbreviations that may be used when describing rock core descriptions is presented below. Additional information for describing rock structure, weathering states, and other rock descriptive terms to be used is presented in Attachment 3.

KEY TO CORE DESCRIPTION ABBREVIATIONS

BkN	-	broken
CAL	-	calcareous or calcite
cl	-	clay
F	-	foliation
Fe	-	iron staining on joint surface
GOG	-	gouge
HJ	-	horizontal joint
J	-	joint *
J//F	-	joint is parallel to foliation
JxF	-	joint crosses foliation
l	-	laminae

// - parallel

m - mud in opening

MB - mechanical break

N◦ - angle of fracture surface from horizontal, where N is the angle in degrees

QTZ - quartz

s - solution enlargement

S - stratification

sa - sand

si - silt

SZ - sheer zone

U - unfoliated or unstratified

v - vuggy

VJ - vertical joint

w - weathered

WZ - weathered zone

x - crossing

Z - zone

* "Joint" indicates any natural fracture.

The geologist/geotechnical engineer will document drilling events in the field logbook. Documented drilling events will include:

- drilling start and finish dates;
- project name and location;

- project number and client;
- corehole numbers;
- sample number and depth;
- sample type and size;
- type of drilling equipment;
- casing size;
- names of contractor's drillers; and
- weather conditions.

It is advisable to photograph recovered core in the labeled core box. The core should be wet when photographed to improve contrast and visibility of rock features.

VII. Waste Management

Investigation-derived wastes, including soil cuttings and excess drilling fluids (if used), decontamination liquids, and disposable materials (well material packages, personal protective equipment [PPE], etc.), will be placed in clearly labeled, appropriate containers, or managed as otherwise specified in the Work Plan.

VIII. Data Recording and Management

Coring activities will be documented in a field logbook. Information will include personnel present on site, times of arrival and departure, significant weather conditions, timing of well installation activities, rock descriptions, and quantities of materials used.

IX. Quality Assurance

Determine whether equipment cleaning is required. If so, follow the Equipment Cleaning SOP. Take care not to break the core. If core is broken, mark the break as described in this SOP to show that the break was artificial. If pieces of core are removed for inspection, make sure to return them to the core box oriented the same way they were when they were removed.

X. References

ASTM, 1999. *Standard Practice for Rock Core Drilling and Sampling of Rock for Site Investigation*, D 2113-99.

Blasland, Bouck & Lee, Inc. 2006. *Health and Safety Plan - Newburgh Project*.

Blasland, Bouck & Lee, Inc. 2006. *Newburgh Project Pre-Design Investigation - Area A*.

ATTACHMENT 1

Rock Core Handling And Packing

Handling of Core
The top of the core will be placed at the back left corner of the core box. The remaining core will be placed to the right of the preceeding section. The core box will be filled moving to the front sections of the box as needed. The begining of each run will be marked on the core and noted with a wooden block.

Core Labeling
The top of the core will be marked on each piece of core with an arrow. The arrow will indicate which end of core is nearer to ground surface. Other marks made on cores may include mechanical breaks and drilling footages.

Core Loss
Missing core will be shown by wood spacer blocks. The site geologist will insert the spacer and the core box in place of the missing section. The spacer should indicate the run number and footage of the missing section.

Core Box Storage
Core boxes from all wells will be moved from well heads on a regular basis and stored in a designated secure area. Whenever possible, the storage area should be inside.

Core Box Labeling
Labeling should include the following information:

- Outer core box cover
  - Project name, city, state, project number
  - Core information - Example

    Monitoring Well (MW1)
    Box 1 of 2
    Core Run 2, 22.5' - 32.5'
    Beginning Core Run 3, 32.5' - 40.5'

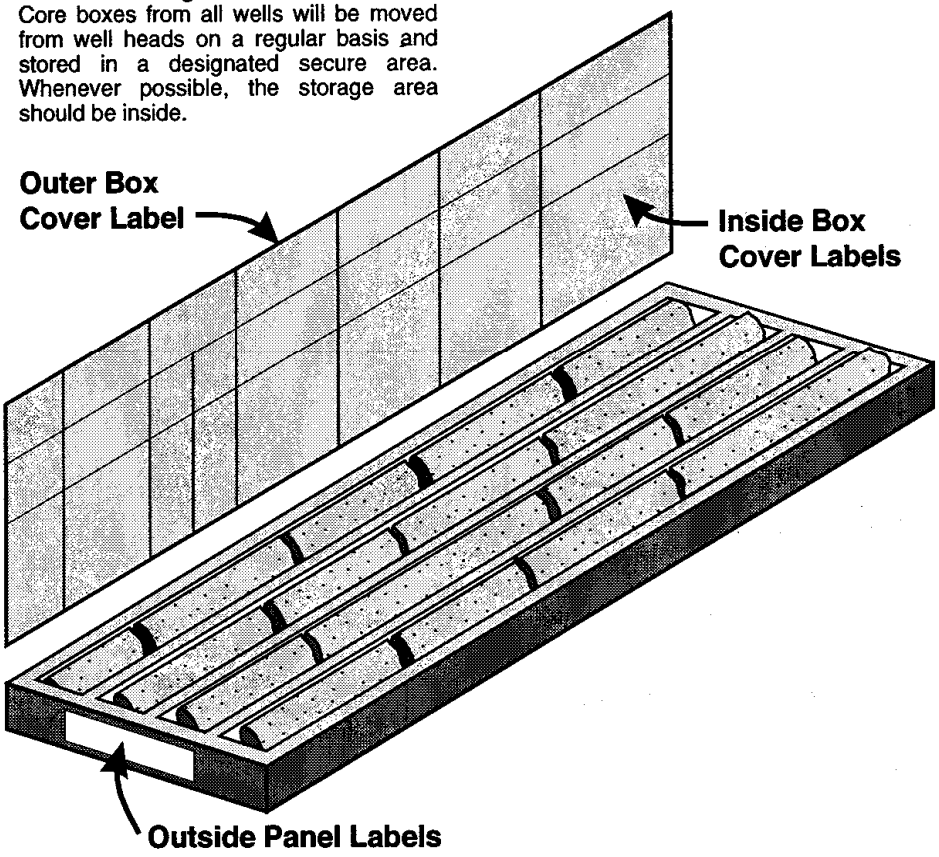
- Outside Panels:

Site Name	_____	Well Number	_____
Location	_____	Box ___ of	_____
Job Number	_____	Run#	
		Footage	

- Inside Box Cover:

Boring Well No.	Run No.	Depth (Ft. BGS) From	Depth (Ft. BGS) To	Actual Recovery	RQD %	FID/PID (ppm)	Comments

One row will be recorded for each core run or partial core run within the box.



ATTACHMENT 2

Rock Quality Designation (RQD) and Fracture Frequency

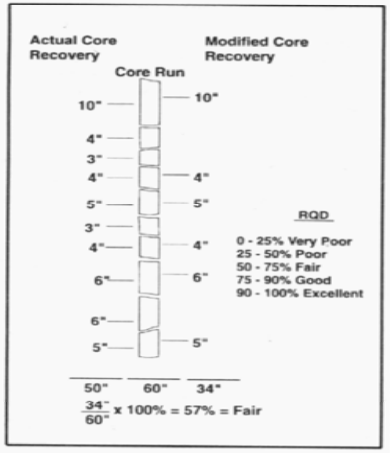
Core borings are a useful means of obtaining information about the quality of rock mass. The recoverable core indicates the character of the intact rock and the number and character of the natural discontinuities.

A quantitative index that has proved useful in logging NX core is a rock quality designation (RQD) developed by Deere (1963). The RQD is a modified core recovery percentage in which all the pieces of a sound NX core over 4 inches long are counted as recovery. The length of the core run is the distance to the nearest tenth of a foot from the corrected depth of the hole at the end of the subject run. The smaller pieces are considered to be due to close shearing, jointing, faulting, or weathering in the rock mass and are not counted. The RQD is a more general measure of the core quality than is the fracture frequency. Core loss, weathered and soft zones, as well as fractures, are accounted for in this determination. The RQD provides a preliminary estimate of the variation of the in-situ rock mass properties of the "sound" portion of the rock core. Thus, a general estimate of the behavior of the rock mass can be made. An RQD approaching 100 percent denotes an excellent quality rock mass with properties similar to that of an intact specimen. RQD values ranging from 0 to 50 percent are indicative of a poor quality rock mass having a small fraction of the strength and stiffness measured for an intact specimen.

An example of determining the RQD from a core run of 60 inches measured from corrected depth to corrected depth is given in the adjacent figure. For this particular case, the core recovery was 50 inches and the modified core recovery was 34 inches. This yields an RQD of 57% (34"/60" x 100), classifying the rock mass in the fair category.

Problems arise in the use of RQD for determining the in-situ rock mass quality. The RQD evaluates fractures in the core caused by the drilling process, as well as in natural fractures previously existing in the rock mass. For example, when the core hole penetrates a fault zone or a joint, additional breaks may form that, although not natural fractures, are caused by natural planes of weakness existing in the rock mass. These fresh breaks occur during drilling and handling of the core and are not related to the quality of the rock mass. The skill of the driller will affect the amount of breakage and the core loss that occurs. Poor drilling techniques will "penalize" the rock by lowering its apparent quality. It is often difficult to distinguish between drilling breaks and those natural and incipient fractures that reflect the quality of the rock mass. In certain instances, it may be advisable to include all fractures when estimating RQD. Obviously, some judgement is involved in core logging.

Another problem with the use of the RQD index is that the determinations are not sensitive to the tightness of the individual joints, whereas in some instances, the in-situ deformation modulus may be strongly affected by the average joint opening.



RQD of a Single Core Run. Calculation is typical of a single core run. Note that the run is calculated from corrected depth to corrected depth. Rock core pieces which are included by the geologist as RQD should be marked with chalk, crayon, or marking pen so that RQD% can be checked and verified at a later time (i.e., after transit).

Engineering Classification of Rock Mass Quality		
Term	**RQD (%)**	**Velocity Index (V_f/Vl)²**
Very Poor	0 - 25	0 - 0.2
Poor	25 - 50	0.2 - 0.4
Fair	50- 75	0.4 - 0.6
Good	75 - 90	0.6 - 0.8
Excellent	90 - 100	0.8 - 1.0

Strength of Intact Rock		
Term	**Field Test**	**Approximate Range of Uniaxial Compressive Strength (kg/cm² or tsf)**
Extremely Hard	Many blows with geological hammer required to break intact specimen.	>2,000
Very Hard	Hand held specimen breaks with hammer end of pick under more than one blow.	1,000 - 2,000
Hard	Cannot be scraped or peeled with knife; hand-held specimen can be broken with single, moderate blow with pick.	500 - 1,000
Moderately Hard	Can be scraped or peeled with knife. Indentation 1 mm to 3 mm shows in specimen with moderate blow with pick.	125 - 500
Moderately Soft	Material crumbles under moderate blow with sharp end of pick and can be peeled with a knife, but is too hard to hand-trim for triaxial test specimen.	50 - 125
Soft		12 - 50

ATTACHMENT 3
Additional Information for Describing Rock Core

Soil/Rock Structure Descriptions

Term	Description
Pocket	Small erratic deposit, usually less than 1 foot in size
Fissures	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided	Fracture planes appear to be polished or glossy, sometimes striated
Blocky	Cohesive soil can be broken down into small angular lumps with resist further breakdown
Lensed	Inclusions of small pockets of different materials, such as lenses of sand scattered through a mass of clay; note thickness
Homogeneous	Same color and appearance throughout
Laminated	Alternating layers less than 1/4" thick

Rock Weathering States

Term	Rock Mass	Soil Mass
Fresh	No visible sign of decomposition or discoloration. Rings under hammer impact.	No visible sign of soil material weathering; perhaps slight discoloration on major discontinuity surfaces.
Slightly Weathered	Slight discoloration inward from open fractures; otherwise similar to fresh.	In fine soils, discoloration indicates weathering of soil materials and discontinuity surfaces; there is not a marked change in consistency of the discolored soil. Relics of fresh soil may be present. In coarse soils, individual fragments and discontinuities are discolored; there is no marked change in relative density.
Moderately Weathered	Discoloration throughout. Weaker minerals such as feldspar decomposed. Strength somewhat less than fresh rock, but cores cannot be broken by hand or scraped by knife. Texture preserved.	In fine soils, the soil is discolored; less than 35% of the soil shows marked change in consistency; relics of fresh and slightly weathered soil are present. In coarse soils, more than 35% of the soil has markedly lower relative density.
Highly Weathered	Most minerals somewhat decomposed. Specimens can be broken by hand with effort or shaved with knife. Core stones present in rock mass. Texture becomes indistinct, but fabric preserved.	In fine soils, the soil is discolored and more than 35% of the soil shows marked change in consistency; relics of fresh and slightly weathered soil are present. In coarse soils, more than 35% of the soil has markedly lower relative density.
Extremely Weathered	Minerals decomposed to soil, but fabric and structure preserved (Saprolite). Specimens easily crumbled or penetrated.	In fine soils, the soil is discolored, relics of slightly weathered soil are absent; the soil shows a marked change in consistency from the fresh soil. In coarse soils, there is a marked decrease in relative density.
Decomposed (Residual Soil)	Advanced state of decomposition resulting in plastic soils. Rock fabric and structure completely destroyed.	N/A

Rock Descriptive Terms

	Term	Defining Characteristics	
Hardness	Soft	Scratched by a fingernail	
	Medium Hard	Scratched by a knife	
	Hard	Difficult to scratch with a penknife	
	Very Hard	Cannot be scratched with a penknife	
Bedding Planes	Laminated	<0.04 in.	<1 mm.
	Parting	0.04 in. - 0.24 in.	1 mm - 6 mm
	Banded	0.24 in. - 1 in.	6 mm - 3 cm
	Thin	1 in. - 4 in.	3 cm - 9.1 cm
	Medium	4 in. - 12 in.	30.5 cm - 1 M
	Thick	12 in. - 36 in.	30.5 cm - 1M
	Massive	>36 in.	>1 M
Joints and Fracture Spacing	Very Close	<2 in.	<5.1 cm
	Close	2 in. - 1 ft.	5.1 - 30.5 cm
	Moderately Close	1 ft. - 10 ft.	30.5 cm - 91.4 cm
	Wide	3 ft. - 10 ft.	91.4 cm - 3 M
	Very Wide	>10 ft.	>3M
Voids	Porous	Smaller than a pinhead. Their presence is indicated by the degree of absorbency.	
	Pitted	Pinhead size to 1/4 inch. If only thin walls separate the individual pits, the core may be described as honeycombed.	
	Vug	1/4 inch to the diameter of the core. The upper limit will vary with core size.	
	Cavity	Larger than the diameter of the core.	

Sample Rock Core Sketch	Sample Abbreviations/Symbols
 HJ J30°x F 3J20°x //F Fe BkN Z Cl GOG	See key to core descriptions in SOP text.

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Manual In-Situ Hydraulic Conductivity Test Procedures

Rev. #: 01

Rev Date: March 17, 2004

Approval Signatures

Prepared by: _____ Date: _____

Reviewed by: _____ Date: _____
(Technical Expert)

I. Scope and Application

The objective of this Standard Operating Procedure (SOP) is to describe the procedures to collect in-situ hydraulic conductivity data from the geologic formation immediately surrounding the screened interval of monitoring wells and piezometers by conducting falling-head slug tests and rising-head bailer tests. This SOP describes the equipment, field procedures, materials, and documentation procedures necessary to evaluate hydraulic conductivity.

This is a standard (i.e., typically applicable) operating procedure which may be varied or changed as required, dependent upon site conditions, equipment limitations, or limitations imposed by the procedure. The ultimate procedure employed will be documented in the project work plans or reports. If changes to the sampling procedures are required due to unanticipated field conditions, the changes will be discussed with DTSC as soon as practicable and documented in the report.

II. Personnel Qualifications

ARCADIS field sampling personnel will have current health and safety training including 40-hour HAZWOPER training, site supervisor training, site-specific training, first aid, and CPR, as needed. In addition, ARCADIS field sampling personnel will be versed in the relevant SOPs and posses the required skills and experience necessary to successfully complete the desired field work.

III. Equipment List

The following materials shall be available, as required, during in-situ hydraulic conductivity testing:

- Appropriate personal protective equipment as specified in the Site Health and Safety Plan
- Equipment decontamination supplies (See *Field Sampling Equipment Decontamination Procedures* SOP)
- Photoionization detector (PID)
- Plastic sheeting
- Stopwatch

- Polypropylene rope
- Lab-decontaminated disposable bailers
- Plastic bucket
- Appropriate field logs/forms
- Oil-water indicator
- White masking tape
- 10-foot measuring tape with gradation in hundredths of a foot
- Indelible ink pen
- Monitoring well keys
- Bolt cutters
- Monitoring well locks
- Field notebook.

IV. Cautions

Falling head tests are not applicable if the water table is below the top of the well screen interval.

Before performing a hydraulic conductivity test, allow monitoring well water levels to equilibrate with atmospheric pressure. Gauge water levels periodically for 5 to 10 minutes to monitor changes in head. Monitoring wells without vents (flush mounts) may not equilibrate with atmospheric pressure.

Repeatedly introducing the water-level indicator may alter the water-level measurements. Avoid splashing the probe into the water table or lowering the probe too far beyond the water table depth.

Avoid introduction of surface soil or other material into the monitoring well by staging down-hole equipment on a clean and dry working surface.

A minimum of two field sampling personnel are required to adequately perform this test.

V. Health and Safety Considerations

Volatile organics present in the monitoring well head space should be measured with a photoionization detector (PID) to evaluate potential hazards and recorded in the field logbook.

Well covers and casing should be removed carefully to avoid potential contact with insects or animals nesting in the well casings.

VI. Procedure

The following section describes in detail the specific procedure to hydraulic conductivity tests.

1. Identify site, well number, date, and time on the In-Situ Hydraulic Conductivity Test Log and field logbook, along with other appropriate hydraulic conductivity testing information.

2. Place clean plastic sheeting on the ground next to the well.

3. Unlock and open the monitoring well cover while standing upwind from the well.

4. Measure the volatile organics present in the monitoring well head space with a PID and record the PID reading in the field logbook.

5. Before performing a hydraulic conductivity test, allow the water level in the well to equilibrate with atmospheric pressure. Gauge water levels periodically for 5 to 10 minutes to monitor changes in head. Monitoring wells without vents (flush mounts) may not equilibrate with atmospheric pressure.

6. After the water level equilibrates, lower the water level probe into the monitoring well. When the tip of the probe reaches the static water level, place masking tape on the oil-water indicator tape from a reference point to 5 feet above the reference point.

7. Using a waterproof pen, mark the static water level on the masking tape at the reference point. Label the mark “S” for static water level.

8. Remove the oil-water indicator tape and probe from the well and place it on the clean plastic sheeting.

9. Measure a length of rope equal to the depth to static water level plus 10 additional feet.

10. Secure one end of the rope to the bailer and the other end to the well casing using a bowline knot.

11. Assign one person to be responsible for lowering the bailer into the well and recording time intervals in the log. Assign another person to be responsible for lowering the water-level probe into the well and locating and communicating water-level depths to person recording information in the log.

12. Slowly lower the bailer into the well unit until it is just below the water level.

13. Set stop watch.

14. When both people are ready, remove the bailer from the water and start the stop watch at the same time. Place bailed water into the bucket for subsequent proper waste management.

15. Lower the water-level probe into the well. Where the water level is first found, mark the tape as a reference point and record the time. Monitor and mark/record the water level on the masking tape at approximately 5-second intervals (recording the exact time intervals) until the water level returns to the initial conditions.

16. After 3 minutes, measure water levels at approximate 15-second intervals for 5 minutes.

17. After 8 minutes, measure water levels at approximate 1-minute intervals for 10 minutes. When water level readings stabilize, the length of the time intervals may be increased until the water level reaches the initial static level.

18. Changes in water level will be measured to the nearest hundredth from the masking tape and recorded along with the corresponding change in time reading.

19. Remove the masking tape from the water-level indicator and clean the probe as appropriate. Decontaminate the oil-water level indicator with an Alconox and water scrub, a distilled water rinse, a solvent rinse, and another distilled water rinse.

20. Secure the monitoring well prior to leaving by replacing the well cap and/or cover and lock it.

The above Steps 11 through 20 will be modified using Steps 11 through 18, as presented below, when a pressure transducer and automatic data logger are used.

The following section describes in detail the specific procedure to conduct slug tests with a pressure transducer and automatic data logger:

11. Deploy the pressure transducer in the well to a predetermined depth making sure it will be below the slug once the slug is fully submerged. Record this depth in the field notebook. The installation depth also depends on the amount of water displacement and the range of the pressure transducer. If the transducer is installed at a depth below its maximum range, damage may occur to the sensor and the output reading will not be correct. One PSI is equal to approximately 2.31 feet of water. If a 5 PSI pressure transducer is utilized, the range is 11.55 feet of water and the pressure transducer should not be installed at a depth below 11.55 feet.

12. Secure the transducer cable to the well with masking tape to eliminate any movement of the pressure transducer and ensure stability.

13. Measure out a length of rope and attach it to the slug. It is important that the slug does not come in contact with the transducer sensor once it is inserted in the well.

14. Run a rising head slug test by inserting the decontaminated slug and allowing the water level to equilibrate (i.e., return to within 0.05 feet of the static water level). Remove the slug and begin recording the data immediately. Collect the water level data according to a predetermined schedule while water levels rise and the aquifer returns to static or near-static conditions.

OR

Run a falling head test by inserting the decontaminated slug and immediately collecting the water level data according to a predetermined schedule while the water levels fall and the aquifer returns to static or near-static conditions (i.e., returns to within 0.05 feet of the static water level). Do not disturb the slug following its introduction into the well because this will adversely affect the test results.

15. Review the data to determine if a meaningful test has been conducted and perform a duplicate test if deemed necessary. (Results of duplicate test should be within a half order of magnitude). Record the start and finish time of the test.

16. Transfer the data from the data logger to the laptop computer and create a spreadsheet compatible file. Copy recorded data to a floppy disk.

17. Remove the pressure transducer and cable from the well. Decontaminate all test equipment that came into contact with the groundwater in accordance with the *Field Sampling Equipment Decontamination Procedures* SOP

18. Secure the monitoring well prior to leaving by replacing the well cap and/or cover and lock it.

VII. Waste Management

Decontamination water should be containerized and characterized in accordance with California Environmental Protection Agency's procedures for *Representative Sampling of Groundwater for Hazardous Substances* (CalEPA, 1995). Rinse water, personal protective equipment, and other residuals generated during equipment decontamination will be placed in appropriate containers and labeled. Containerized waste will be disposed of consistent with appropriate procedures as outlined in the *Handling and Storage of Investigation-Derived Waste* SOP.

VIII. Data Recording and Management

In-Situ Hydraulic Conductivity Test Log will be completed. Field equipment decontamination activities will be recorded in the field.

IX. Quality Assurance

Depending on data quality objectives, a duplicate hydraulic conductivity test may be conducted 24 hours after the initial test.

X. References

California Environmental Protection Agency (CalEPA). 1995. *Monitoring Well Design and Construction for Hydrogeologic Characterization.* Guidance Manual for Ground Water Investigations. July 1995.