Work Plan

Paerdegat Basin

Brooklyn, New York

Submitted to:
National Grid USA
175 East Old Country Road
Hicksville, NY 11801

Submitted by:
GEI Consultants, Inc.
455 Winding Brook Drive
Glastonbury, CT 06033
860-368-5300

October 22, 2012
Revised February 14, 2013
Revised March 13, 2013
Revised April 2, 3013
129600-1-1101

Work Plan
Paerdegat Basin
Brooklyn, New York
March 2013

CERTIFICATION

I, Barry Girouard, certify that I am currently a Qualified Environmental Professional, as defined in 6 NYCRR Part 375, and that this Work Plan was prepared in accordance with all applicable statutes and regulations and in general conformance with the DER Technical Guidance for Site Investigations and Remediation (DER-10).

This is an initial Work Plan to obtain preliminary data on an expedited basis regarding sediments to be dredged this spring and the presence of impacts. A subsequent Work Plan in substantial compliance with DER-10 will be submitted to address any additional investigations required.

Introduction

This modified Work Plan was prepared by GEI Consultants, Inc. (GEI) for National Grid (NG). The Work Plan outlines the scope of work for an investigation to determine if a release of gas condensate has impacted sediments, surface water, biota or structures in Paerdegat Basin. Paerdegat Basin is located in Brooklyn, New York as indicated in Figure 1.

The original Work Plan was submitted to the New York State Department of Environmental Conservation (NYSDEC) on October 22, 2012. In a letter to NG dated January 14, 2013 the NYSDEC requested a number of modifications to the plan, which included comments from the New York State Department of Health (NYSDOH), the United States Environmental Protection Agency (USEPA) and the New York City Department of Environmental Protection (NYCDEP). On February 4, 2013, a meeting was held between NG, NYSDEC, NYSDOH and GEI to discuss implementation of the Work Plan. To address these comments a revised Work Plan was submitted on February 14, 2013. Comments on the revised Work Plan were received from the USEPA in an email dated February 22, 2013, from the NYSDEC in a memorandum dated February 26, 2013, and from the NYCDEP in emails dated February 28, 2013, March 4, 2013, and March 5, 2013. NG responded to the USEPA comments in an email dated February 28, 2013 and to two of the NYSDEC comments in an email dated March 8, 2013. Final revisions were made to the Work Plan on April 2, 2013. This Work Plan is representative of the final version addressing all comment and revisions identified by NYSDEC.

A time constraint of late March was introduced because the NYCDEP needs to examine the sediment data prior to dredging sections of Paerdegat Basin. The contract for the dredging is currently scheduled to be awarded by the end of March. In addition, the original Work Plan had elements that cannot be implemented during seasonal restrictions, therefore a revised, shorter work plan version has been prepared covering tasks that can be completed given the time and weather constraints. A major difference between this Plan and the original version is that mobile organisms are not currently available. As a result biota sampling will include collection of sessile forms only.

We understand that site characterization in accordance with NYSDEC's DER-10 Technical Guidance for Site Investigation and Remediation (DER-10) is required. A separate Work Plan will be prepared in accordance with DER-10 to address sampling that cannot be completed now and is necessary to determine if either a remedial investigation is required, or that the gas condensate release poses little or no threat to public health and the environment.

This scope of work includes the following sampling tasks:

- Intertidal sediment sampling
- Subtidal sediment and surface water sampling from shoreline structures including the docks and piers at the marinas, CSO wall and at the mouth of the basin
- Subtidal sediment and surface water sampling from the survey boat; weather and ice permitting

Biota sampling (mussels only)

- Structure sampling (piles, docks, and bulkheads)

As per the February 4th meeting, NYSDEC staff will review this first round of sampling data to determine whether substantive bioaccumulation of spilled PCBs is likely to occur, and based on their review, will determine whether subsequent sampling rounds will be required. The second sampling event (if conducted) will likely include sampling of finfish species (analyzed as standard fillets) which anglers may consume. The second event will also include the site characterization study as outlined in DER-10. This revised Work Plan incorporates some, but not all, of the elements requested in the January 14th letter. Elements that could be addressed in the time available were included. The remainder of the requested elements will be included in the Work Plan developed for the second round of sampling.

Background

During abandonment of two 24-inch diameter gas transmission pipelines, which tie together a 30- inch gas main on both sides of the basin, there was a release of gas condensate from a temporary standpipe pit that was initially installed as part of the gas line abandonment project. The release ultimately discharged into Paerdegat Basin. The locations of the standpipe and pipe outfall into Paerdegat Basin are indicated in Figure 2.

The standpipe pit is located along the southeast side of Seaview Avenue near the intersection with Paerdegat Avenue North. During gas line abandonment work on September 27, 2012, cement grout was pumped into the gas line from the west side of Paerdegat Basin. The gas line runs beneath Paerdegat Basin. At the standpipe pit location, as a result of the cement grout filling operation, residual gas condensate within the gas line was inadvertently forced through a vent installed at the standpipe.

Emergency response activities were conducted under the direct supervision of the United States Coast Guard (USCG), NYSDEC and NYCDEP. Extensive emergency spill response efforts have been completed to recover the material released and work is ongoing to address residual impacts in upland areas.

An oil-like sheen was visible on the surface water of Paerdegat Basin following the release of gas condensate. Sheen transport was observed on surface water in much of the Basin including the area of fixed and free-standing structures in the water (i.e., boats, docks, piers, and bulkheads). Wind action caused the sheen extent to spread primarily toward the headwaters (North end) of the basin from the release point. During response actions undertaken following the release, extensive absorbent sweep materials and containment boom was used to clean up the sheen and isolate the sheen to prevent it from moving southward towards Jamaica Bay. This effort was successful in containing the sheen in the Basin and soaking up the visible oil. By October 8th essentially all visible sheen had been removed or had evaporated. Following this effort boat hulls were cleaned in accordance with USCG directives. However, other structures contacting surface water in the Basin such as recreational boat docks, piers, and bulkheads have

not been tested for potential impact from the release and it is not known whether or not sediment, surface water, and biota have been impacted. Sampling of sediment, surface water, biota, and structures and analysis for PCBs will be undertaken to assess potential impact from the release of the gas condensate fluid.

Proposed Field Investigations

The proposed field investigation includes the collection of surface sediment at 42 sampling stations, 20 biological tissue (mussel) samples from five stations, surface water from five stations, and 47 porous structure samples on docks, piers and bulkheads in Paerdegat Basin. All samples will be analyzed for PCBs. Proposed sample locations are indicated on Figure 2, 3 and 4. Actual sample locations may have to be adjusted based on field conditions at the time the field work is done. GEI will conduct the sampling activities for all media on behalf of National Grid.

Shoreline Survey and Sediment Sampling

The NYSDEC requested that a detailed shoreline survey be performed to document the potential presence of oily residues that may remain following the response action. Where possible, that survey will be performed by GEI field staff walking the shoreline. This will likely be possible in areas such as the marinas and other easily accessible areas; however, much of the shoreline consists of wetlands and mud-flat areas (including constructed wetlands currently being developed). These sections of the shoreline may not be accessible on foot depending on stability of sediment and tidal stages. GEI field staff will plan survey activities around low tidal regimes and coordinate with project managers to discuss accessibility. GEI will also conduct a visual survey by boat of the entire shoreline of the Basin. The objective will be to document the presence or absence of visible product or oily residues, primarily by sheen observation or possible staining of the *Spartina* shoots in restoration areas. GEI will coordinate with NYSDEC's Division of Fish, Wildlife and Marine Resources to participate in the survey activities if representatives are available.

GEI will document the shoreline conditions and observations of any sheen or oily residues using photographs, and field notes. GPS coordinates of observed oily residues will be recorded. Petroleum-related releases un-related to the gas condensate liquid release may have caused oily residue or sheen impacts in the intertidal zone of the basin. Regardless of potential source, GEI will adjust proposed sample locations to include the collection of sediment samples for laboratory analyses from any accessible area of oily residue or sheen to evaluate the potential for the observed impact to be related to the gas condensate release. The documented observations will be included in GEI's sampling report.

Surface Sediment, Surface Water and Biota Tissue Sampling

The sampling plan will be implemented over an approximate two week period. The scope of work for field investigation includes the following:

- Intertidal surface sediment sampling: this effort will involve 14 stations along the *Spartina* restoration side and other areas accessible on foot.
- Subtidal surface sediment sampling from shoreline structures: this will include 11 subtidal stations. This includes four from the CSO wall and floating docks, seven from marina docks and one at the mouth of the basin. A surface water sample will also be collected from the station located near the outfall.
- Subtidal surface sediment sampling from the survey boat: this will consist of 17 stations using the research vessel including three reference stations to be taken in Jamaica Bay. Surface water samples will be collected from three of these stations within the basin and one from Jamaica Bay.
- Biota sampling for mussels: up to 20 samples from five stations, however, the actual number of stations will depend upon availability of mussels.

Intertidal Surface Sediment Sampling

The objective of this sampling task is to determine whether or not PCBs are present and to characterize the extent and concentrations of PCBs in the intertidal zone. The study zone will range from the mean low water (MLW) to the mean high water line with stations as shown in Figure 2. Surficial sediment will be collected from 14 stations with stainless steel trowels decontaminated based on NYSDEC DER-10 protocol between stations as described in the QAPP. Single use, disposable sampling equipment may also be used to collect sample aliquots. Locations will be recorded utilizing GPS. Sediment samples will be photographically recorded. Complete chain of custody records will be maintained.

Subtidal Surface Sediment and Water Sampling From Shoreline Structures

The objective of this sampling task is to determine whether or not PCBs are present and to characterize the extent and concentrations of PCBs in the subtidal zones. Sediment samples will be collected from the 11 stations identified on Figure 2 using a petite PONAR sampling device. A surface water sample will also be collected within this area. Subtidal sampling is focused on near shore collection under and around hard structures such as floating docks and bulkheads. The exact sample locations may require field modification due to obstructions that may be encountered. The petit PONAR sampler will be deployed manually at the sampling station until sufficient sediment sample volume is obtained for the desired analytical requirements (see below). Based on input from NYSDEC the primary focus is to characterize the upper 1-inch of the sediment surface. As a result efforts will be made to obtain sediment material from the top fraction of material in each retrieved PONAR sampler. The PONAR and all re-usable sampling

equipment will be decontaminated between sample locations based on NYSDEC DER-10 protocol and outlined in the QAPP. Single use, disposable sampling equipment may also be used to collect sample aliquots from the PONAR device and transfer the sediments to the laboratory sample containers. The sediment sampling locations will be recorded with a GPS and the sediment samples will be photographically recorded. Complete chain of custody records will be maintained.

Subtidal Surface Sediment and Water Sampling Utilizing the Survey Vessel

Sediment samples will be collected from 17 stations using a petite PONAR sampling device and five direct surface water samples will be collected as shown on Figure 2 (within basin) and Figure 3 (within Jamaica Bay). GEI's sampling vessel, the RV Kingfisher will be used to access the offshore stations for sample collections (weather and ice conditions permitting). The exact sample locations may be modified in the field should obstructions be encountered. The petit PONAR sampler will be deployed at the sampling station until sufficient sediment sample volume is obtained for the desired analytical requirements (see below). Collection strategy will again be focused on characterizing the upper 1-inch of the sediment surface. At six of the sample locations sediment cores will be collected, logged and archived for contingent analysis. Efforts will be made to obtain sediment material from the top fraction of material in each retrieved PONAR sample. The petit PONAR, core sampler and all re-usable sampling equipment will be decontaminated between sample locations based on NYSDEC DER-10 protocol and outlined in the QAPP. Single use, disposable sampling equipment may also be used to collect sample aliquots from the PONAR device and transfer the sediments to the laboratory sample containers. Surface water samples will be directly sampled. The sampling locations will be recorded with an on-board GPS and the sediment samples will be photographically recorded. Complete chain of custody records will be maintained.

Biota Tissue Sampling for Mussels

Mussels are non-mobile, therefore good indicators for bioaccumulation of metals and/or persistent organics in the water column or sediment. Mussels will be collected if they are encountered in the intertidal zones (e.g., attached to *Spartina* stubs), from the floating docks and piers at the marinas in Paerdegat Basin, and on hard surfaces at the head or mouth of the basin. Priority will be given to attempt and locate up to four target stations in intertidal regions upstream and/or downstream of the outfall. The initial shoreline survey will provide a better understanding of the feasibility of these sample locations; however, it is important to note the exact locations of biota sampling stations will be highly dependent on field conditions and the availability of mussels. At least one target station will be located at one of the marinas on the east side of the basin near the outfall. If mussels are not available in intertidal regions, another target station or stations located at the marina on the west side of the basin will be sampled if mussels are present there. Four samples from five stations will be analyzed, if feasible.

The total weights of mussels collected per station will be recorded. All biota samples will be wrapped in aluminum foil, packed in plastic bags and immediately placed on ice in coolers for same day shipment to the analytical laboratory. All samples will be processed in the analytical laboratory. The mussels will be shucked and the soft tissue retained for analysis. The sampling locations will be recorded with a GPS and photographically recorded. Complete chain of custody records will be maintained. If sufficient weight of samples are collected (e.g., >20 grams for each sample type) for all 20 samples prior to the last day, the sampling for that effort may be discontinued. If sample mass from each station is insufficient for laboratory requirements, samples will be composited and submitted on an area basis as opposed to individual stations.

Structure Sampling

Sample Locations and Rationale

The objective of this sampling task is to determine if PCBs are present at or above the 1 mg/kg USEPA clean-up level in structures that could have been impacted by the spill. Proposed sample locations are indicated on Figure 4. Floating docks, piers and bulkheads in the area of investigation in the Basin will be inspected for oil-like staining where access is permitted by the owner. Proposed sample locations will be adjusted to locations where oil-staining is observed with suspected impact from the gas condensate release. If no oil-staining is observed or not suspected to be related to the recent release of gas condensate, samples of the outer surface of the structures in contact with the surface water will be collected at the scum line as indicated in Figure 3. It may not be possible to collect samples from some locations for safety reasons or due to accessibility.

A summary of the proposed structure sample locations is presented in the following table.

Location	**Number of Samples**	**Sample Media**
Docks and Piers		
Hudson River Yacht Club	10	Wood and Styrofoam
Midget Squadron Marina	18	Wood and Styrofoam
Kayak Club	3	Wood and Styrofoam
Diamond Point Club	6	Wood and Styrofoam
Paerdegat Squadron	4	Wood and Styrofoam
Canarsie Athletic Club	4	Wood and Styrofoam
Bulkheads		
CSO Outfall Structure Bulkhead	2	Concrete

Sampling Methods

Samples of wood and Styrofoam materials will be collected from the surface using USEPA sampling protocols for collection of porous materials for PCB analysis (USEPA, May 2011). A wood chisel, sharp knife or handheld rotary drill with a corer attachment will be used to collect surface samples from the porous material. The depth of sampling will not exceed 1/2 inch into the surface sampled. Samples of wooden and Styrofoam dock materials will be collected and analyzed as discrete samples. Samples collected from wooden piers which are exposed to daily tidal fluctuations, will be comprised of a composite of three subsamples collected during low tide from three locations representative of depth approximate heights of the low tide, mid tide and high tide. Samples of dock material will be collected from the side wall of the dock while kneeling on the dock surface.

The concrete bulkhead at the CSO outfall is considered porous materials and samples of it will be collected using a vibratory hammer drill and core as described in USEPA sampling protocols (May, 2011).

Some samples may require the use of a boat for added safety during sample collection. All samples will be placed in laboratory provided sampling jars for PCB analysis.

Equipment Decontamination

After any cleaning required by the QAPP and NYSDEC DER-10 protocol each piece of equipment that could potentially be contaminated by PCBs will be rinsed or swabbed with hexane to meet the applicable decontamination standards in 40 CFR 761.79(c). Hexane is an approved performance-based organic decontamination fluid (PODF) under the self-implementing decontamination standards in 40 CFR 761.79(c).

Proposed Sample Analysis

Based upon analytical results of the condensate oil collected from the standpipe, the condensate included PCBs, volatile organic compounds (VOCs) and semivolatile organic compounds. The highest concentration contaminant is PCB Aroclor 1242. Given that this compound is present at the highest concentration, partitions strongly to sediments, is persistent in the environment and can bioaccumulate in biota, PCBs are the primary contaminants of concern for this Work Plan. All samples will be analyzed for PCB Aroclors and 20% of the sediment samples will also be analyzed for VOCs. The analyses will be done on an expedited turn-around-time basis.

Sediment samples will be analyzed for the following parameters:

- PCBs according to USEPA Method 8082A

- Target compound list VOCs according to USEPA Method 8260B at seven of the sample locations
- Total organic carbon (TOC) according to USEPA Method Lloyd Kahn
- Grain Size according to ASTM D422
- Samples will be archived with the potential for future analysis of PCB congeners according to USEPA Method 1668A for forensic evaluations
- Percent moisture

Surface water, biological tissue and porous structural material samples will be analyzed for the following parameter:

- PCBs according to USEPA Method 8082A
- Samples will be archived with potential future analysis of PCB congeners according to USEPA Method 1668A for forensic evaluations
- Percent moisture
- Percent lipid (for biological tissue samples only).

Investigation-Derived Waste

Wastewaters produced during decontamination will be collected and contained within 55-gallon, Unites States Department of Transportation (USDOT) drums. National Grid will arrange for the disposal of the investigation-derived wastes after they have been characterized. All appropriate documentation for waste characterization and disposal will be included in the final report.

Sampling Schedule

Upon NYSDEC approval of the work plan, GEI estimates approximately five days to mobilize for the field work. Dependent upon weather conditions and access, GEI estimates that the field program can be conducted in approximately two work weeks. Attached is a Gantt chart, which depicts the proposed project schedule. Our intended daily work schedule for the field work is as follows:

Day One – Shoreline Survey and start structure sampling
Day Two – Begin intertidal surface sediment collections and continue structure sampling (Intertidal sampling will tide dependant, which may affect the sampling schedule).
Day Three – Continue intertidal surface sediment collections and structure sampling
Day Four – Begin subtidal sample collection from shoreline structures, and continue structure sampling
Day Five – Continue subtidal sample collection from shoreline structures, and continue structure sampling
Day Six – Begin subtidal sample collections from the RV Kingfisher, start mussel collections

Day Seven – Continue sample collections from the RV Kingfisher and mussel collections
Day Eight and Nine – Complete any unfinished tasks, demobilize

Report

Prior to preparation of a final report an interim data report will be provided. This interim report will consist of a table, which provides a summary of analytical results and a figure showing the sampling locations. The interim data report will be provided as soon as possible after laboratory analysis and data validation is completed. This is estimated to be within two weeks of collection of the samples for sediment and structures, and with three weeks for tissue samples.

GEI will prepare a report summarizing the investigation work. A preliminary table of contents for this report is as follows:

- Executive Summary
- Introduction
- Field Investigations
- Analytical Results
- Findings and Conclusions
- Recommendations

The report will include figures indicating the sample locations and any sheens cleaned of observed during sampling, tables with a summary of the analytical results the weights of mussels collected from each station and photographs.

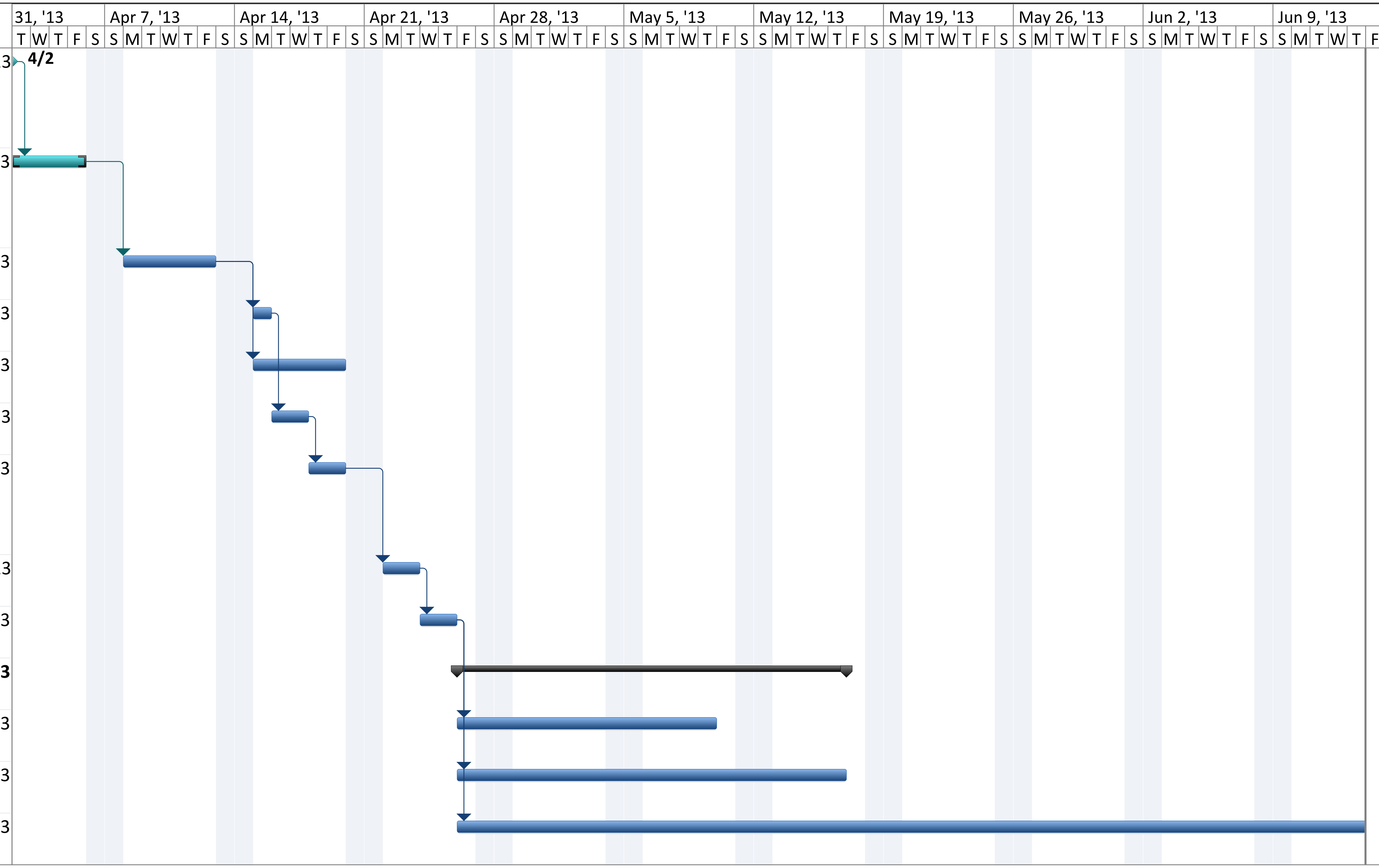
Health and Safety

A site-specific health and safety plan has been prepared for this work (Attachment A). All work will be done in accordance with this plan.

Quality Assurance

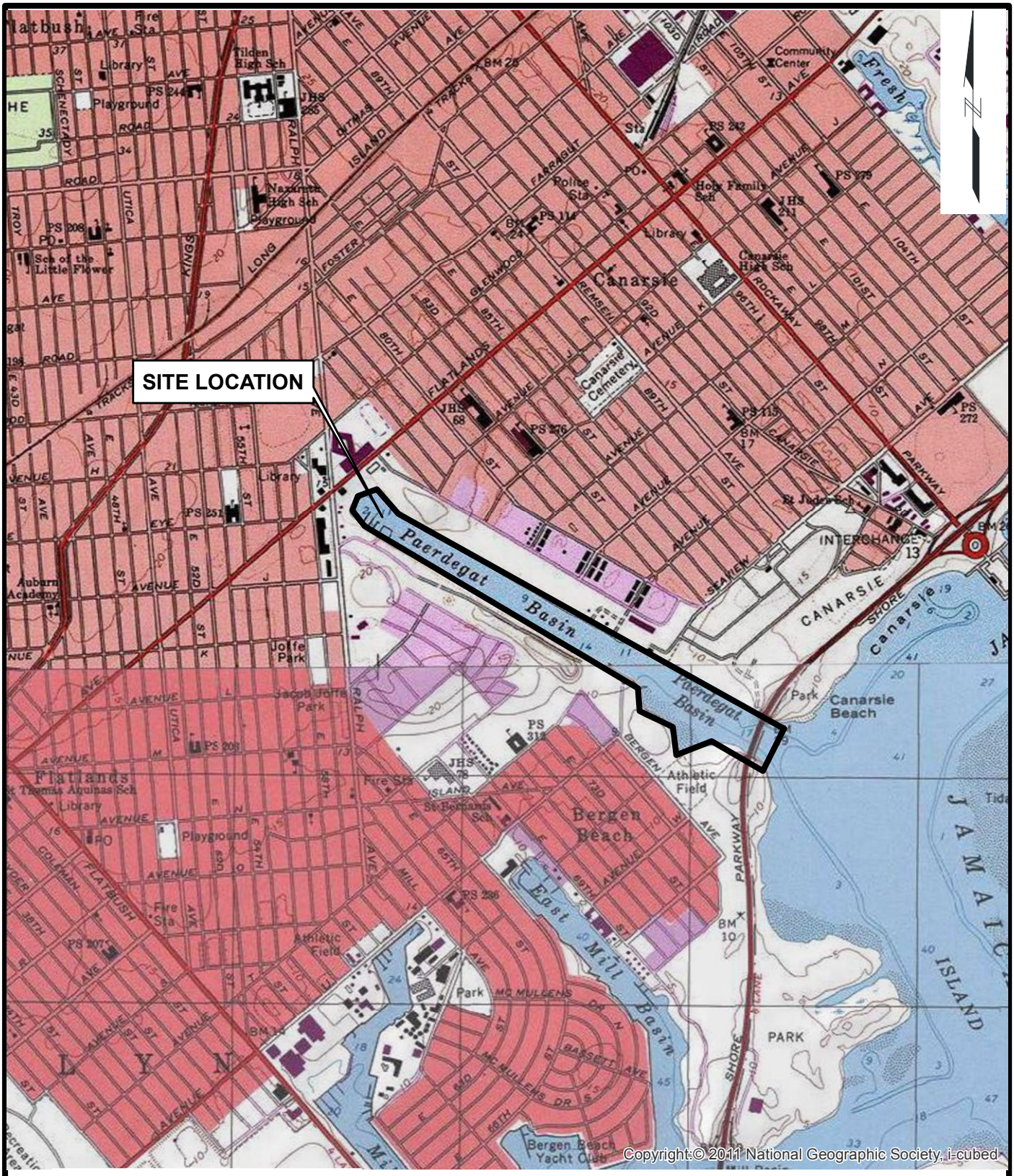
Quality Assurance Project Plan (QAPP) has been prepared for this work (Attachment B). All work will be done in accordance with this plan.

ID	Task Name	Duration	Start	Finish
1	Submit Final Work Plan to NYSDEC	0 days	Tue 4/2/13	Tue 4/2/13
2	NYSDEC Approval of Work Plan	4 days	Tue 4/2/13	Fri 4/5/13
3	Mobilization	5 days	Mon 4/8/13	Fri 4/12/13
4	Shoreline Survey	1 day	Mon 4/15/13	Mon 4/15/13
5	Structure Sampling	5 days	Mon 4/15/13	Fri 4/19/13
6	Intertidal Sampling	2 days	Tue 4/16/13	Wed 4/17/13
7	Subtidal Sampling from Shore	2 days	Thu 4/18/13	Fri 4/19/13
8	Subtidal Sampling from Boat	2 days	Mon 4/22/13	Tue 4/23/13
9	Contingency	2 days	Wed 4/24/13	Thu 4/25/13
10	**Interim Data Report**	**15 days**	**Fri 4/26/13**	**Thu 5/16/13**
11	Sediment and Structures	10 days	Fri 4/26/13	Thu 5/9/13
12	Mussel Tissue	15 days	Fri 4/26/13	Thu 5/16/13
13	Final Report	35 days	Fri 4/26/13	Thu 6/13/13



Project: Paerdegat Work Plan Sch
Date: Tue 4/2/13

Task
Split
Milestone
Summary
Project Summary
External Tasks
External Milestone
Inactive Task
Inactive Milestone
Inactive Summary
Manual Task
Duration-only
Manual Summary Rollup
Manual Summary
Start-only
Finish-only
Deadline
Progress



SOURCE:
1. USGS TOPOGRAPHIC MAP NATIONAL GEOGRPAHIC TOPO! ACCESSED VIA ARCGIS ONLINE.

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PAERDEGAT BASIN INVESTIGATION
PAERDEGAT BASIN
BROOKLYN, NEW YORK

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SITE LOCATION MAP

Project 129600 | March 2013 | Figure 1

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LEGEND

Type

- Intertidal Sediment Sample Location
- Subtidal Sample Location
- Subtidal Sample and Core Location
- Subtidal, Core and Surface Water Sample Location
- Subtidal and Surface Water Sample Location

NOTES:
1. ALL LOCATIONS ARE APPROXIMATE

SOURCES:
1. AERIAL PHOTOGRAPH BING MAPS © 2010 MICROSOFT CORP.

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BROOKLYN, NEW YORK

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PROPOSED INTERTIDAL AND SUBTIDAL SAMPLING STATIONS PAERDEGAT BAY

Project 129600 | March 2013 | Figure 2

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NOTES:
1. ALL LOCATIONS ARE APPROXIMATE

SOURCES:
1. AERIAL PHOTOGRAPH BING MAPS © 2010 MICROSOFT CORP.

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PROPOSED SUBTIDAL SAMPLING STATIONS JAMAICA BAY

Project 129600 | March 2013 | Figure 3

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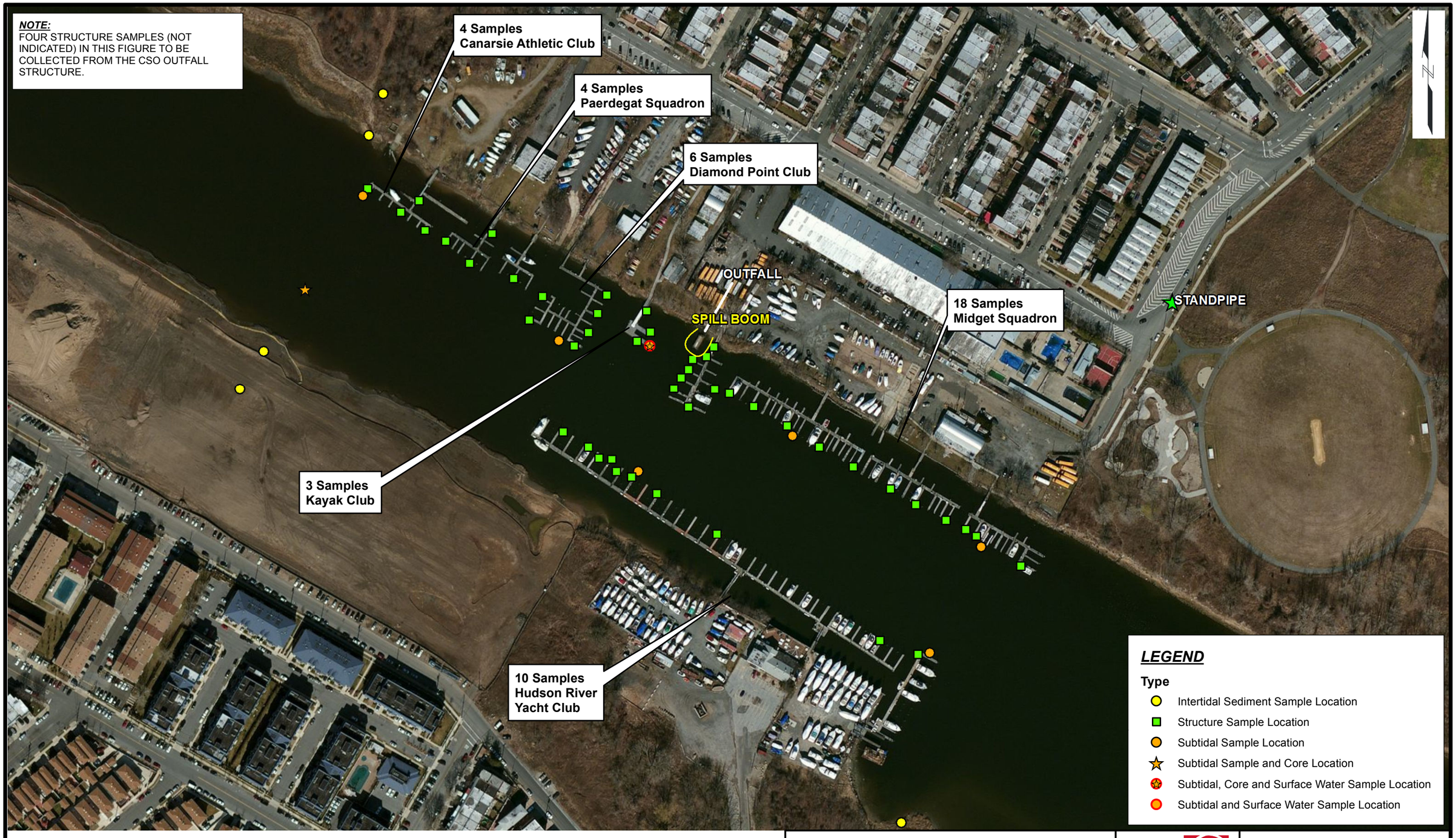

NOTES:
1. ALL LOCATIONS ARE APPROXIMATE

SOURCES:
1. AERIAL PHOTOGRAPH BING MAPS © 2010 MICROSOFT CORP.

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PROPOSED STRUCTURE (MARINA, DOCKS, AND PIERS) SAMPLING STATIONS

Project 129600 | March 2013 | Figure 4

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Quality Assurance Project Plan (QAPP)

Paerdegat Basin

Brooklyn, New York

Prepared By:
GEI Consultants, Inc.
455 Winding Brook Drive Suite 201
Glastonbury, CT 06033
860-368-5300

Revision 4
April 2013

Project No. 129600-1-1101

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Figures

Attachments

INTRODUCTION

This Quality Assurance Project Plan (QAPP) is intended to integrate the technical and quality control aspects of a surface sediment investigation at the Paedegat Basin Site. This QAPP is supplemented by detailed information in the Surface Sediment and Tissue Sampling Work Plan. This QAPP details the planning processes for collecting data and describes the implementation of the quality assurance (QA) and quality control (QC) activities developed for this program. The purpose of this QAPP is to generate project data that are technically valid and legally defensible. The QAPP consists of four main components:

- Project Management;
- Measurement and Data Acquisition;
- Assessment and Oversight; and
- Data Validation and Usability.

The above components will incorporate QA/QC requirements cited within the following United States Environmental Protection Agency (USEPA) and New York State Department of Environmental Conservation (NYSDEC) documents:

- USEPA *Requirements for Quality Assurance Project Plans*, USEPA QA/R-5, February 2006
- USEPA *Guidance for the Data Quality Objectives Process*, QA/G-4, August 2000
- USEPA, US Department of Defense, and US Department of Energy *Uniform Federal Policy (UFP) for Quality Assurance Project Plans*, Final Version March 2005
- NYSDEC. 2010, *DER-10 Technical Guidance for Site Investigation and Remediation*.
- Analytical Services Protocol (ASP). NYSDEC.

QAPP Worksheet #1 -- Title and Approval Page

Site Name/Project Name: Paedegat Basin Site

Site Location: Paedegat Basin, Brooklyn, New York

Document Title: *QAPP for Paedegat Basin*

Lead Organization: National Grid

Preparer's Name and Organization: Kimberly Bradley, GEI Consultants, Inc.

Preparer's Address, Telephone Number and E-mail Address:

455 Winding Brook Drive, Suite 201, Glastonbury, CT. 06033, kbradley@geiconsultants.com

Preparation Date: 03/19/13

Organization	Name	Signature
Investigative Organization's Project Manager	Barry Giroux	
Investigative Organizations Project QC Officer	Brian Skelly	
Lead Organizations Project Manager	William Ryan	

Approval Signatures:_____

Printed Name/Title:_____

Approval Authority:_____

QAPP Worksheet #2 -- QAPP Identifying Information

Site Number/Code:

Operable Unit: Not Applicable

Contractor Name: GEI Consultants, Inc.

Contractor Number: Not Applicable

Contract Title: Not Applicable

Work Assignment Number: Not Applicable

1. **Identify guidance used to prepare QAPP:**
   Uniform Federal Policy for Quality Assurance Project Plans, NYSDEC Analytical Services Protocol (ASP), NYSDEC DER-10

2. **Identify regulatory program:** New York State Department of Environmental Conservation (NYSDEC) Administrative Order on Content

3. **Identify approval entity:** New York State Department of Environmental Conservation (NYSDEC)

4. This QAPP is project Specific.

5. Scoping Sessions occurred in October 2012/January 2013.

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

7. **List organizational partners (stakeholders) and connection with lead organization:**
   The primary project organizational partners include representatives from National Grid and GEI Consultants, Inc. National Grid will provide project and contract management guidance.

8. **List data users:** New York State Depatement of Environmental Conservation, National Grid, and GEI Consultants, Inc.

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

QAPP Worksheet #2 -- QAPP Identifying Information (cont.)

Circle QAPP elements and required information that are not applicable to the project. Provide an explanation in the QAPP.

Required QAPP Element(s) and Corresponding QAPP Section(s)	Optional QAPP Worksheet # in QAPP Workbook	Required Information
Project Management and Objectives		
2.1 Title and Approval Page	1	- Title and Approval Page
2.2 Document Format and Table of Contents 2.2.1 Document Control Format 2.2.2 Document Control Numbering System 2.2.3 Table of Contents 2.2.4 QAPP Identifying Information	2	- Table of Contents - QAPP Identifying Information
2.3 Distribution List and Project Personnel Sign Off Sheet 2.3.1 Distribution List 2.3.2 Project Personnel Sign-Off Sheet	3 4	- Distribution List - Project Personnel Sign-Off Sheet
2.4 Project Organization 2.4.1 Project Organizational Chart 2.4.2 Communication Pathways 2.4.3 Personnel Responsibilities and Qualifications 2.4.4 Special Training Requirements and Certification	5 6 7 8	- Project Organizational Chart - Communication Pathways - Personnel Responsibilities and Qualifications Table - Special Personnel Training Requirements Table

QAPP Worksheet #2 -- QAPP Identifying Information (cont.)

Required QAPP Element(s) and Corresponding QAPP Section(s)	Optional QAPP Worksheet # in QAPP Workbook	Required Information
2.5 Project Planning/Problem Definition		- Project Planning Session Documentation (including Data Needs tables)
2.5.1 Project Planning (Scoping)	9	- Project Scoping Session Participants Sheet
2.5.2 Problem Definition, Site History, and Background		- Problem Definition, Site History, and Background
	10	- Site Maps (historical and present)
2.6 Project Quality Objectives and Measurement Performance Criteria	11	- Site-Specific PQOs
2.6.1 Development of Project Quality Objectives Using the Systematic Planning Process		
2.6.2 Measurement Performance Criteria	12	- Measurement Performance Criteria Table
2.7 Secondary Data Evaluation		- Sources of Secondary Data and Information
	13	- Secondary Data Criteria and Limitations Table
2.8 Project Overview and Schedule	14	- Summary of Project Tasks
2.8.1 Project Overview	15	- Reference Limits and Evaluation Table
2.8.2 Project Schedule		- Project Schedule/Timeline Table
	16	

QAPP Worksheet #2 -- QAPP Identifying Information (cont.)

Required QAPP Element(s) and Corresponding QAPP Section(s)	Optional QAPP Worksheet # in QAPP Workbook	Required Information
Measurement/Data Acquisition		
3.1 Sampling Tasks 3.1.1 Sampling Process Design and Rationale 3.1.2 Sampling Procedures and Requirements 3.1.2.1 Sampling Collection Procedures 3.1.2.2 Sample Containers, Volume, and Preservation 3.1.2.3 Equipment/Sample Containers Cleaning and Decontamination Procedures 3.1.2.4 Field Equipment Calibration, Maintenance, Testing, and Inspection Procedures 3.1.2.5 Supply Inspection and Acceptance Procedures 3.1.2.6 Field Documentation Procedures	17 18 19 20 21 22	- Sampling Design and Rationale - Sample Location Map - Sampling Locations and Methods/ SOP Requirements Table - Analytical Methods/SOP Requirements Table - Field Quality Control Sample Summary Table - Sampling SOPs - Project Sampling SOP References Table - Field Equipment Calibration, Maintenance, Testing, and Inspection Table

QAPP Worksheet #2 -- QAPP Identifying Information (cont.)

Required QAPP Element(s) and Corresponding QAPP Section(s)	Optional QAPP Worksheet # in QAPP Workbook	Required Information
3.2 Analytical Tasks		- Analytical SOPs
3.2.1 Analytical SOPs	23	- Analytical SOP References Table
3.2.2 Analytical Instrument Calibration Procedures	24	- Analytical Instrument Calibration Table
3.2.3 Analytical Instrument and Equipment Maintenance, Testing, and Inspection Procedures		- Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table
3.2.4 Analytical Supply Inspection and Acceptance Procedures	25	
3.3 Sample Collection Documentation, Handling, Tracking, and Custody Procedures	26	- Sample Collection Documentation Handling, Tracking, and Custody SOPs
3.3.1 Sample Collection Documentation		- Sample Container Identification
3.3.2 Sample Handling and Tracking System		- Sample Handling Flow Diagram
3.3.3 Sample Custody		- Example Chain-of-Custody Form and Seal
3.4 Quality Control Samples	27	- QC Samples Table
3.4.1 Sampling Quality Control Samples		- Screening/Confirmatory Analysis Decision Tree
3.4.2 Analytical Quality Control Samples		

QAPP Worksheet #2 -- QAPP Identifying Information (cont.)

Required QAPP Element(s) and Corresponding QAPP Section(s)	Optional QAPP Worksheet # in QAPP Workbook	Required Information
3.5 Data Management Tasks 3.5.1 Project Documentation and Records 3.5.2 Data Package Deliverables	28 29	- Project Documents and Records Table - Analytical Services Table - Data Management SOPs
3.5.3 Data Reporting Formats 3.5.4 Data Handling and Management 3.5.5 Data Tracking and Control	30 32 31	
Assessment/Oversight		
4.1 Assessments and Response Actions 4.1.1 Planned Assessments 4.1.2 Assessment Findings and Corrective Action Responses	 30 31	- Assessments and Response Actions - Planned Project Assessments Table - Audit Checklists - Assessment Findings and Corrective Action Responses Table
4.2 QA Management Reports	32	- QA Management Reports Table
4.3 Final Project Report	34	

QAPP Worksheet #2 -- QAPP Identifying Information (cont.)

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

QAPP Worksheet #3 -- Distribution List

List those entities to which copies of the approved QAPP, subsequent QAPP revisions, addenda, and amendments will be distributed.

QAPP Recipients	Title	Organization	Telephone Number	Fax Number	E-mail Address	Document Control Number
Jane O'Connell	NYSDEC Project Coordinator	NYSDEC DER (R2)	718.482.4599		jhoconne@gw.dec.state.ny.us	
Shaun Bollers	NYSDEC Project Contact	NYSDEC DER (R2)	718.482.4096	718.482.6358	snboller@gw.dec.state.ny.us	
William Ryan	Lead Organizations Project Manager	National Grid	516.545.2586		william.ryan@nationalgrid.com	
Barry Giroux	Investigative Organizations Project Manager	GEI Consultants	860.368.5300	860.368.5307	bgiroux@geiconsultants.com	
David Terry	Investigative Organizations In-house Consultant	GEI Consultants	860.368.5300	860.368.5307	dterry@geiconsultants.com	
Brian Skelly	Investigative Organizations Project Quality Control Officer	GEI Consultants	860.368.5300	860.368.5307	bskelly@geiconsultants.com	
Lorie MacKinnon	Data Validator	GEI Consultants	603. 974.0939		lmackinnon@geiconsultants.com	
Kimberly Bradley	Field Team Leader/Site Safety Officer	GEI Consultants	860.368.5300	860.368.5307	kbradley@geiconsultants.com	

Electronic copies of the final QAPP and related project documents will also be available in the project directory and the project database for personnel named in the organization chart provided as Figure 1 and other personnel who will be assigned to work on the project. Those names will be responsible for distributing the QAPP and related documents to others in their organization.
Note: Per the requirements of DER-10 Chapter 2.4(a)2.ii, the current resumes for Barry Giroux (PM) and Lori ManKinnon (Data Validator) are included in Attachment F.

QAPP Worksheet #4 -- Project Personnel Sign-Off Sheet

Have copies of this form signed by key project personnel from each organization to indicate that they have read the applicable QAPP sections and will perform the tasks as described. Ask each organization to forward signed sheets to the central project file.

Organization: GEI Consultants, Inc.

Project Personnel	Title	Telephone Number	Signature	Date QAPP Read Email Receipt
Barry Giroux	Investigative Organizations Project Manager	860.368.5300		
David Terry	Investigative Organizations In-House Consultant	860.368.5300		
Roy Stoecker	Investigative Organizations Biological Senior Consultant	631.751.4600		
Brian Skelly	Investigative Organizations Project Quality Control Officer	860.368.5300		
Lorie MacKinnon	Data Validation/Data Reviewer	603.974.0939		
Mary Beth Billerman	Field Team	631.751.4600		
Kimberly Bradley	Field Team Leader/ Project Safety Officer	860.368.5300		

QAPP Worksheet #4 Project Personnel Sign-Off Sheet (cont.)

Have copies of this form signed by key project personnel from each organization to indicate that they have read the applicable QAPP sections and will perform the tasks as described. Ask each organization to forward signed sheets to the central project file.

Organization: New York Department of Environmental Conservation

Project Personnel	Title	Telephone Number	Signature	Date QAPP Read Email Receipt
Shaun Bollers	NYSDEC Project Contact	718.482.4096		

QAPP Worksheet #4 Project Personnel Sign-Off Sheet (cont.)

Have copies of this form signed by key project personnel from each organization to indicate that they have read the applicable QAPP sections and will perform the tasks as described. Ask each organization to forward signed sheets to the central project file.

Organization: National Grid

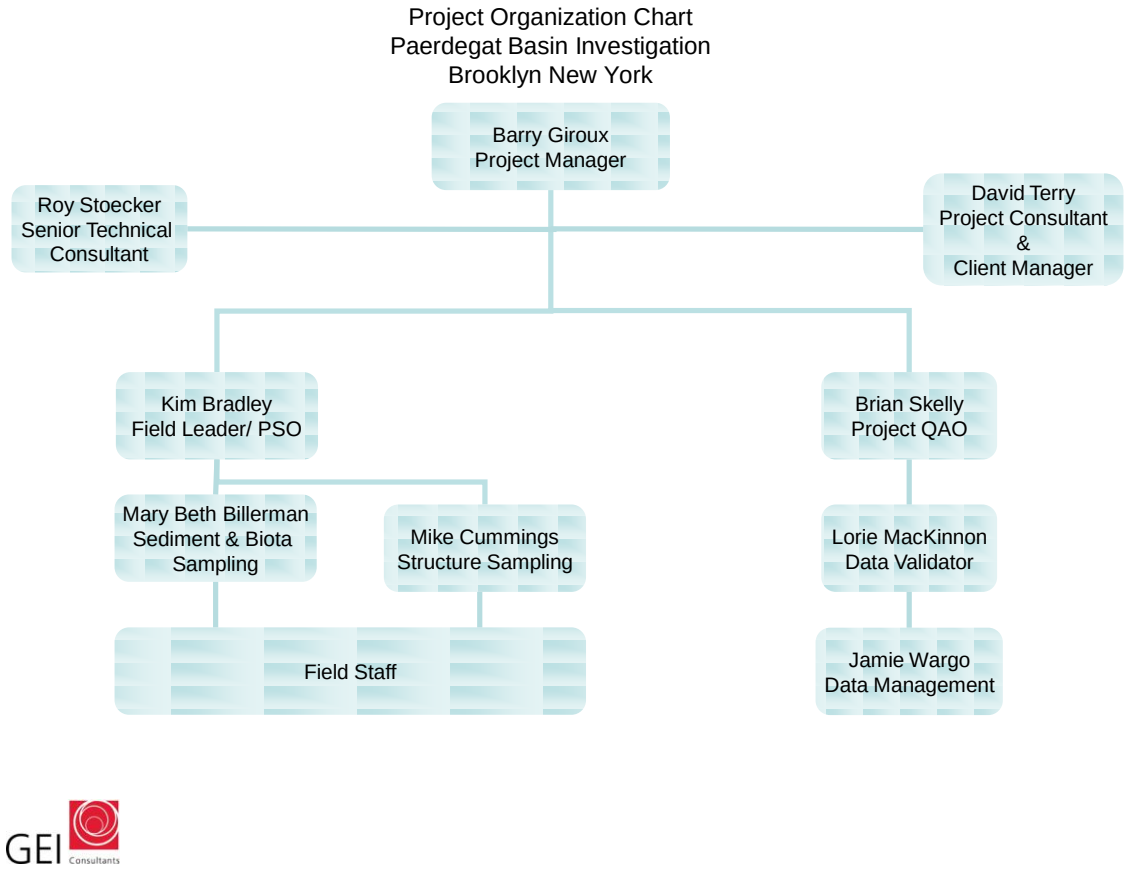
Project Personnel	Title	Telephone Number	Signature	Date QAPP Read Email Receipt
William Ryan	Lead Organizations Project Manager	516.545.2586		

QAPP Worksheet #5 – Project Organizational Chart

Project Organization

The Organization Chart, provided as Figure 1, the description of project organization, and the roles of the team members are summarized below:

Figure 1. Project Organization Chart



Project/Task Organization Overview

The project management team will consist of representatives from National Grid, NYSDEC, and GEI Consultants, Inc. (GEI). GEI will provide technical oversight to the project during the planning and investigation, serve as the primary contractor, bear responsibility for developing and implementing the investigation, and provide project management for the other subcontractors.

Investigation Team Members

This section contains a description of the project organizational structure. The National Grid Project Manager will have contract management with responsibility for the

Paerdegat Basin Investigation. GEI, as the primary contractor, will be responsible for developing and implementing the investigation, and conduct project management for other subcontractors. Additional project team members from other companies may serve as subcontractors to GEI.

Project Manager (PM) – The PM is accountable to the PO throughout the duration of the project. The PM will be the primary point of contact with National Grid. The PM may delegate authority to expedite and facilitate the implementation of the project plan.

The PM is responsible for:

- Coordination with National Grid;
- Budget control;
- Subcontractor performance;
- Project coordination to implement Work Plans;
- Allocation of staffing and resources to implement the QA/QC program and the Health and Safety Plan (HASP); and
- Review of investigation, engineering, and interim reports.

Corporate Health and Safety Manager (CHSM) – The Corporate Health and Safety Manager is responsible for development and implementation of GEI's Health and Safety program. The CHSM serves as the administrator of GEI's Corporate Health and Safety program. The CHSM bears responsibility for:

- Proper training for GEI field personnel;
- Medical clearance of GEI field personnel;
- Field personnel having adequate experience with personal protective equipment;
- Providing guidance on data interpretation;
- Determining levels of worker protection; and
- Directing and assisting the Project Safety Officer (PSO).

Project Safety Officer (PSO) - The PSO is knowledgeable in safety and worker protection techniques as they relate to the project, as instructed and guided by the CHSM. Responsibilities include monitoring daily compliance of work to the HASP, having the ability and authority to make needed changes or additions to the HASP and providing technical assistance to the Project Manager on problems relating to work safety.

The PSO is responsible for the development and set-up of emergency procedures and personnel decontamination procedures. The PSO or designee will complete a daily diary of activities with health and safety relevance. If unsafe work conditions are encountered, the PSO is authorized to stop work. Resolution of all health and safety problems will be coordinated through the Technical PM.

Project Quality Control Officer – The Project QC Officer is responsible for project specific supervision and monitoring of the QA program and reports to the Project Manager. Additional responsibilities include:

- Ensuring that field personnel are familiar with and adhere to proper sample identification, and chain-of-custody procedures;
- Coordinating with the analytical laboratory for the receipt of samples, the reporting of analytical results, and recommending corrective actions to correct deficiencies in the analytical protocol or sampling.

Field Team Leader – The Field Team Leader will serve as the contact person GEI for field investigations and activities. The Field Team Leader will be responsible for the logistics of the field activities. The Field Team Leader will:

- Ensure that proper sampling procedures and field measurement techniques are performed,
- Inspect and replace equipment;
- Prepare daily activity reports;
- Prepare samples (in coordination with the Sample Management Officer) for shipment;
- Coordinate field activities; and
- Schedule sampling and other field activities.

QAPP Worksheet #6 -- QAPP Communication Pathways

Communication Pathways

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathways, etc.)
Approval of Amendments to the QAPP	GEI Consultants, Inc.	Project Quality Control Officer) and Lead Organization's Project Manager	860.368.5300	Obtain initial approval from the Investigative Organization PM and submit documented amendments within 10 working days of initial approval
Document and Records Control	GEI Consultants, Inc.	Investigative Organization Project Manager	860.368.5300	Project Document Preparation and distribution. Document and records control posting procedure implemented within 5 working days of receipt by GEI Consultants, Inc.
Stop Work and Initiation of Corrective action	GEI Consultants, Inc.	Investigative Organization Project Manager	860.368.5300	The PM communicates within 24 hours of stop work to the project organization by phone, with confirming e-mail.
Real time modification, notifications and approval	GEI Consultants, Inc.	Field Team Leader	860.368.5300	Real time modification to the project will require the approval of the Project Quality Officer and PM (or designee) and will be documented using the Field Change Order Form in Attachment E within 5 working days.
Reporting of serious issues	GEI Consultants, Inc.	Project Managers	860.368.5300	Report any serious issues to National Grid and other concerned parties by e-mail or memo.
Meeting Minutes	GEI Consultants, Inc.	Investigative Organization Project Manager	860.368.5300	Post approved meeting minutes or distribute by email within 5 working days of meeting.
Corrective action, assessment finding	GEI Consultants, Inc.	Project Safety Officer/Quality Control Officer	860.368.5300	Problems or negative assessment findings are reported to the PM by e-mail within 3 days.

QAPP Worksheet #7 -- Personnel Responsibilities and Qualifications Table

Name	Title	Organizational Affiliation	Responsibilities	Years of Professional Experience	Education and Experience Qualifications
William Ryan	Project Manager	National Grid	Lead Organization's Project Manager	20 +	MS Public Health-Environmental & Occupational Health Science
Barry Giroux	Project Manager	GEI Consultants, Inc.	Investigative Organization's Project Manager	20+	P.E., BS Civil Engineering
David Terry	Project Manager	GEI Consultants, Inc.	Investigative Organization's In House Consultant	20	PG, MS Geology
Roy Stoecker	Senior Consultant	GEI Consultants, Inc.	Investigative Organization's In House Consultant	20+	PhD Botany
Mary Beth Billerman	Project Manager/Scientist	GEI Consultants, Inc.	Field Team Coordination	9	BS Environmental Science
Kimberly Bradley	Project Scientist	GEI Consultants, Inc.	Field Team Leader/ Site Safety Officer	6+	MS Environmental Sciences
Brian Skelly	Project Manager	GEI Consultants, Inc.	Project Quality Officer	10	MS Environmental Sciences
Kirk Young	Project Manager	Test America	Laboratory Manager	20 +	MS Environmental Sciences

QAPP Worksheet #8 -- Special Personnel Training Requirements Table

Project Function	Specialized Training – Title or Description of Course	Training Provider	Training Date	Personnel/ Groups Receiving Training	Personnel Titles / Organizational Affiliation	Location of Training Records/Certificates
Field Team	Safety and OSHA training and medical monitoring as specified in the HASP; Field Sampling training	GEI Consultants, Inc.	Training dates kept in company/ project training records	All field team members working on Project Properties.	All GEI Consultant and subcontractor personnel working on the Project Properties	GEI Consultant's Project Files; available upon request

QAPP Worksheet #9 -- Project Scoping Session Participants Sheets

Project Team Participants

Project Name: **Paerdegat Basin Spill** **Projected Date(s) of Sampling:** October 2012 **Project Managers:** W. Ryan, National Grid, B. Giroux, GEI Consultants	**Site Name:** Paerdegat Basin Site **Site Location:** Brooklyn, New York

Date of Session: October 15, 2012

Scoping Session Purpose: Scope Investigation

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Jane O'Connell	NYSDEC Project Manager	NYSDEC DER (2)	(718) 482-4599	jhoconne@gw.dec.state.ny.us	Project Manager
William Ryan	Lead Organization Project Manager	National Grid	(516) 545-2586	william.ryan@nationalgrid.com	Project Manager
David Terry	Investigative Organization In House Consultant	GEI Consultants	860-368-5412	dterry@geiconsultants.com	In-House Consultant
Roy Stoecker	Investigative Senior Principal	GEI Consultants	860-368-5414	rstoecker@geiconsultants.com	Senior Scientist

Many of the members of the NYSDEC, National Grid and GEI Consultants investigative team participated on the October 15, 2012 call. Full participation is listed on a contact sheet sent out by Jane O'Connell on October 17, 2012.

Comments/Decisions: The data quality objectives and data needs for the project were developed provided during communications
Action Items: Complete project planning documents (HASP, Work Plan, QAPP)

QAPP Worksheet #9 -- Project Scoping Session Participants Sheets

Project Team Participants

Project Name: **Paerdegat Basin Spill** **Projected Date(s) of Sampling:** To Be February/March 2013 **Project Managers:** W. Ryan, National Grid, B. Giroux, GEI Consultants	**Site Name:** Paerdegat Basin Site **Site Location:** Brooklyn, New York

Date of Session: February 4, 2013

Scoping Session Purpose: Scope Investigation Comments

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Jane O'Connell	NYSDEC Project Manager	NYSDEC DER (2)	(718) 482-4599	jhoconne@gw.dec.state.ny.us	Project Manager
William Ryan	Lead Organization Project Manager	National Grid	(516) 545-2586	william.ryan@nationalgrid.com	Project Manager
Barry Giroux	Investigative Project Manager	GEI Consultants	860-368-5412	bgiroux@geiconsultants.com	In-House Consultant
Roy Stoecker	Investigative Senior Principal	GEI Consultants	860-368-5414	rstoecker@geiconsultants.com	Senior Scientist

Other members of the NYSDECand associated agencies participated in the February 4, 2013 meeing. Full participation is listed on a contact sheet sent out by Roy Stoecker on February 5, 2013 .

Comments/Decisions: The data quality objectives and data needs for the project were developed provided during communications
Action Items: Complete project planning documents (HASP, Work Plan, QAPP)

QAPP Worksheet #10 – Problem Definition

The problem to be addressed by the project:

During abandonment of a 24-inch diameter gas transmission pipeline there was a release of gas condensate from a temporary standpipe pit that was initially installed as part of the gas line abandonment project. The release flowed from the standpipe along a paved road to a nearby stormwater catch basin and then into Paerdegat Basin. The New York Fire Department reportedly also flushed the gas condensate liquids pooled on the ground surface and caused the liquids to flow into the catch basin.

The standpipe pit is located along the southeast side of Seaview Avenue near the intersection with Paerdegat Ave North. During gas line abandonment services on September 27, 2012, cement grout was pumped into the gas line from the west side of Paerdegat Basin near the Hudson River Yacht Club. The gas line runs beneath Paerdegat Basin. At the standpipe pit location, as a result of the cement grout filling operation, residual gas condensate within the gas line was inadvertently forced through a vent installed at the standpipe.

The environmental questions being asked:

Has the release of gas condensate impacted sediments, surface water, biota or structures in Paerdegat Basin?

Observations from any site reconnaissance reports:

An oil-like sheen was visible on the surface water of Paerdegat Basin following the release of gas condensate. Sheen transport was observed on surface water in most areas in the Basin including the area of fixed and free-standing structures in the water (i.e., boats, docks, piers, and bulkheads). Wind action caused the sheen extent to spread primarily toward the headwaters of the basin from the release point. During immediate response actions undertaken following the release, boat hulls were cleaned and wipe tested for PCBs. However, other structures contacting surface water in the Basin such as recreational boat docks, piers, and bulkheads have not been tested for potential impact from the release and it is not known whether or not sediment, surface water and biota have been

impacted. Sampling of sediment, surface water, biota, and structures and analysis for PCBs will be undertaken to assess potential impact from the release of the gas condensate fluid.

A synopsis of secondary data or information from site reports:

Upon being notified of the release, National Grid notified the National Response Center (NRC) and the NYSDEC. Emergency response activities were conducted under the direct supervision of the United States Coast Guard (USCG), NYSDEC and NYCDEP. Extensive emergency spill response efforts have been completed to recover the material released and work is ongoing to address residual impacts in upland areas.

The possible classes of contaminants and the affected matrices:

Based upon analytical results of the condensate oil collected from the standpipe, the condensate includes PCBs, volatile organic compounds and semi-volatile organic compounds.

The rationale for inclusion of chemical and nonchemical analyses:

The highest concentration contaminant is PCB Aroclor 1242. Given that this compound is present at the highest concentration, partitions strongly to sediments, is persistent in the environment and can bioaccumulate in biota, PCBs are the contaminants of concern for this Work Plan. Samples will be analyzed for PCB Aroclors. The PCB Aroclor analysis will be done on an expedited turn-around-time basis. If Aroclor 1242 is detected in a sample PCB congener analysis will be performed on that sample.

Project decision conditions:

QAPP Worksheet #11 -- Project Quality Objectives/Systematic Planning Process Statements

Who will use the data?

National Grid, NYSDEC and GEI will use this data.

What will the data be used for?

The data will be used to determine the presence of PCB Arolclor 1242 in the environment.

What type of data are needed (matrix, target analytes, analytical groups, field screening, on-site analytical or off-site laboratory techniques, sampling techniques)?

Surface sediment at 42 sampling stations, surface water from five stations, 20 biological tissue (mussels) samples from five sampling stations, and 47 porous surface samples on docks and peirs in Paerdegat Basin. Evaluate each sample for the prescnce of Aroclor 1242 at an offsite laboratory (Test America Burlington). Sampling techniques are documents in the GEI Field SOPs and Work Plan.

How "good" do the data need to be in order to support the environmental decision?

The data quality objectives (DQOs) for this project have been established in accordance with *Guidance for the Data Quality Objectives Process* (USEPA, 2000), NYSDEC Analytical Services Protocol (ASP), and NYSDEC DER-10, and will provide technically defensible data established for the project as indicators of environmental quality. The DQOs were developed to obtain the necessary data to sufficiently assess risks to human health and the environment. The type, number, and location of samples as well as the sample analysis methods have been prescribed per the Sampling Analysis Plan (2010); therefore, the Quantitation Limits (QLs) achievable by the prescribed analysis will meet the DQOs for this project.

Worksheet 15, Reference and Evaluation Table, summarizes the analytical parameters and the associated Project Action Levels (PALs) and QLs.

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

Surface sediment will be collected at 40 sampling stations, surface water at five sampling stations, 20 biological tissue (mussels) samples at five sampling stations, and 47 porous surface samples on docks and peirs in Paerdegat Basin are proposed.

Where, when, and how should the data be collected/generated?
Data will be collected as soon as possible (target of mid-to-late February 2013), using standard sampling approaches documented in the Work Plan.

Who will collect and generate the data?
GEI will collect environmental monitoring data and samples and tabulate and report field measurements. Test America will analyze samples for chemical analytical parameters and issue reports of analyses. GEI will conduct data validation and usability assessment.

How will the data be reported?
Test America, will submit reports of analyses to GEI, according to the requirements in Worksheet 29, including electronic data deliverables (EDD).

How will the data be archived?
GEI will maintain electronic and hard copies of the data. The data will be submitted to National Grid and NYSDEC. The availability of the data and the length of time the data is available will be at the discretion of the NYSDEC.

QAPP Worksheet #12 (UFP-QAPP Manual Section 2.6.2) -- Measurement Performance Criteria Table

Matrix	Sediment
Analytical Group	TOC –Lloyd Kahn
Concentration Level	unknown

Sampling Procedure[2]	Analytical Method/SOP[3]	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and / or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
PB-04	006 - Lloyd Kahn/ BR-WC-008, current version	Sensitivity	< RL	Method Blank (MB)	A
		Accuracy/Bias	%R (75-125)	Lab Control Sample (LCS)	A
		Precision (lab)	50% RPD	Sample Duplicate (DP)	A
		Accuracy/Bias	%R (75-125)	Matrix Spikes (MS)	A

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

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

QAPP Worksheet #12 - Measurement Performance Criteria Table (cont.)

Matrix	Sediment
Analytical Group	Grain Size/ Bulk Density
Concentration Level	unknown

Sampling Procedure[2]	Analytical Method/SOP[3]	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and / or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
PB-04	007	NA	NA	NA	NA

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

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

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

QAPP Worksheet #12 - Measurement Performance Criteria Table (cont.)

Matrix	Sediment
Analytical Group	PCB Aroclors
Concentration Level	

Sampling Procedure[2]	Analytical Method/SOP[3]	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
PB-04 PB-09	011-SW846 8082 / SOP PT-GC-001	Sensitivity and Accuracy	Less than CRQLs	Equipment Blank	S&A
		Precision	<RPD 50% for duplicate values greater than or equal to 5 times the CRQL	Field Duplicates	S&A
		Accuracy/Bias/ Precision	Per recovery and RPD% requirements of laboratory as listed in SOP	MS/MSD	A
		Accuracy/Bias	Per recovery requirements of laboratory as listed in SOP	LCS	A
		Sensitivity	MDLs	MDLs	A
		Sensitivity	Less than CRQLs	Method Blanks	A
		Completeness	> 90% sample collection, >90% laboratory analysis	Data Completeness Check	S&A

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

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

QAPP Worksheet #12 - Measurement Performance Criteria Table (cont.)

Matrix	Sediment
Analytical Group	Volatiles
Concentration Level	Low Level

Sampling Procedure[2]	Analytical Method/SOP[3]	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
GC-05	021-SW846 8260B / SOP PT-MS-002	Sensitivity and Accuracy	Less than CRQLs	Equipment Blank and Trip Blank	S&A
		Precision	<RPD 50% for duplicate values greater than or equal to 5 times the CRQL	Field Duplicates	S&A
		Accuracy/Bias/ Precision	Per recovery and RPD% requirements of laboratory	MS/MSD	A
		Accuracy/Bias	Deuterated Monitoring Compound recoveries per requirements	Deuterated Monitoring Compounds	A
		Sensitivity	MDLs	MDLs	A
		Sensitivity	Less than CRQLs	Method Blanks	A
		Completeness	> 90% sample collection, >90% laboratory analysis	Data Completeness Check	S&A

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

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

QAPP Worksheet #12 - Measurement Performance Criteria Table (cont.)

Matrix	Sediment
Analytical Group	PCB Congeners by 1668A
Concentration Level	Low

Sampling Procedure[2]	Analytical Method/SOP[3]	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and / or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
PB-04 PB-09	002 - KNOX-ID-0013	Accuracy	50-150% for Toxics/LOCs	LCS	A
		Precision	0-50% RPD for Toxics/LOCs	Field Duplicate	S & A
		Bias/Contamination	No target analyte > EML	Method Blanks	A
		Completeness	90-100% valid data	Data Validation completeness check	S & A

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

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

QAPP Worksheet #12 - continued

Matrix	Aqueous
Analytical Group	PCB Aroclors
Concentration Level	

Sampling Procedure[2]	Analytical Method/SOP[3]	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
PB-04	011-SW846 8082 / SOP PT-GC-001	Sensitivity and Accuracy	Less than CRQLs	Equipment Blank	S&A
		Precision	<RPD 30% for duplicate values greater than or equal to 5 times the CRQL	Field Duplicates	S&A
		Accuracy/Bias/ Precision	Per recovery and RPD% requirements of laboratory as listed in SOP	MS/MSD	A
		Accuracy/Bias	Per recovery requirements of laboratory as listed in SOP	LCS	A
		Sensitivity	MDLs	MDLs	A
		Sensitivity	Less than CRQLs	Method Blanks	A
		Completeness	> 90% sample collection, >90% laboratory analysis	Data Completeness Check	S&A

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

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

Matrix	Tissue
Analytical Group	PCB Aroclors
Concentration Level	

Sampling Procedure[2]	**Analytical Method/SOP**[3]	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
PB-04	011-SW846 8082 / SOP PT-GC-001	Sensitivity and Accuracy	Less than CRQLs	Equipment Blank	S&A
		Precision	<RPD 30% for duplicate values greater than or equal to 5 times the CRQL	Field Duplicates	S&A
		Accuracy/Bias/ Precision	Per recovery and RPD% requirements of laboratory as listed in SOP	MS/MSD	A
		Accuracy/Bias	Per recovery requirements of laboratory as listed in SOP	LCS	A
		Sensitivity	MDLs	MDLs	A
		Sensitivity	Less than CRQLs	Method Blanks	A
		Completeness	> 90% sample collection, >90% laboratory analysis	Data Completeness Check	S&A

QAPP Worksheet #13 – Secondary Data Criteria and Limitations

Secondary Data	Data Source (originating organization, report title and date)	Data Generator(s) (originating organization, data types, data generation / collection dates)	How Data Will Be Used	Limitations on Data Use

QAPP Worksheet #14 – Summary of Project Tasks

Sampling Tasks:

Collect surface sediment at 42 sampling stations, surface water at five sampling stations, 20 biological tissue (mussels) samples at five sampling stations, and 47 porus surface samples on docks and peirs in Paerdegat Basin. Evaluate each sample for soil, sediment, and tissue chemistry, specifically Aroclor 1242. All sample custody will be tracked through the use of Chains of Custody (Attachment D).

Determine if PCB Aroclor 1242 is present in soil, sediment, or biological tissue samples.

Analysis Tasks:

Analyze surficial soil and sediment samples from 42 sampling station plus field determined sampling locations for chemistry and characteristics:

- PCBs according to USEPA Method 8082A
- Target compound list volatile organic carbons (VOCs) at seven sample locations
- Total organic carbon (TOC) according to USEPA Method Lloyd Kahn
- Grain Size according to ASTM D422
- Samples will be archived with potential future analysis of PCB congeners according to USEPA Method 1668A
- Percent Moisture

Analyze surface water at five sampling stations for chemistry:

- PCBs according to USEPA Method 8082A
- Samples will be archived with potential future analysis of PCB congeners according to USEPA Method 1668A

Analyze 20 biological tissue (mussels) samples from five sampling stations for chemistry:

- PCBs according to USEPA Method 8082A
- Samples will be archived with potential future analysis of PCB congeners according to USEPA Method 1668A

- Percent moisture
- Percent lipids

Analyze semi-porous materials from 47 sampling stations with structures adjacent to the area of release for chemistry:

- PCBs according to USEPA Method 8082A
- Samples will be archived with potential future analysis of PCB congeners according to USEPA Method 1668A

Soils and semi-porous materials will be reported on a dry-weight basis, while surface water and mussel tissue will be reported on a wet-weight basis.

Quality Control Tasks:
The analytical and testing laboratories will be required to analyze QC samples. USEPA methods and the other documents and procedures are given in Worksheet 28. Quality control samples are shown by matrix and analytical group in Worksheet 20.

Secondary Data:
Information from previous investigations in the vicinity of Paergant Basin and Jamacia Bay.

Other Data:

Data Management Tasks:
All analytical data will be stored in a database on a server which will be maintained in the GEI office in Glastonbury, CT. All electronic data will be backed up. Hardcopies of data will also be stored in project files. See Worksheet 29 for discussion of data management.

Documentation and Records:
All hardcopy data (field notebooks, photos, hardcopies of Chain of Custody forms) will be stored at the GEI office in Glastonbury, CT and stored in the project files.

Assessment / Audit Tasks

The Work Plan and SOPs will be reviewed prior to the performance of tasks.

Data Review Tasks:

GEI will conduct verification of sampling and laboratory data. Chemical data that is generated will be validated by GEI data validators (see Worksheets 23, 28, 35 and 36).

QAPP Worksheet #15 -- Reference Limits and Evaluation Tables

Complete this worksheet for each matrix, analytical group, and concentration level. Identify the target analytes/contaminants of concern and project-required action limits. Next, determine the quantitation limits (QLs) that must be met to achieve the project quality objectives. Finally, list the published and achievable detection and quantitation limits for each analyte.

Matrix: Sediment
Analytical Group: PCBs - USEPA 8082A
Concentration Level: Low to moderate

Analyte	CAS Number	NYDEC ER-L	NYDEC ER-M	Project Quantitation Limit Goal[2] (mg/Kg)	Laboratory-specific	
					QLs (mg/Kg)	DLs (mg/Kg)
PCB-1016	12674-11-2	0.007	NE	0.017	0.017	0.0056
PCB-1221	11104-28-2	NE	NE	0.017	0.017	0.0043
PCB-1232	11141-16-5	NE	NE	0.017	0.017	0.0033
PCB-1242	53469-21-9	NE	NE	0.017	0.017	0.0067
PCB-1248	12672-29-6	0.03	NE	0.017	0.017	0.002
PCB-1254	11097-69-1	NE	NE	0.017	0.017	0.0028
PCB-1260	11096-82-5	0.005	NE	0.017	0.017	0.0024
PCB-1262	37324-23-5	NE	NE	0.017	0.017	0.0015
PCB-1268	11100-14-4	NE	NE	0.017	0.017	0.0014

Notes:
NE = Not established
NYDEC – New York Department of Environmental Conservation Sediment Screening Guidance
ER-L - Effects Range Low
ER-M - Effects Range Medium
ER-L and ER-M from "Sediments Classification Methods Compendium." Long and MacDonald 1992.

QAPP Worksheet #15 -- Reference Limits and Evaluation Tables (cont.)

Matrix: Tissue
Analytical Group: PCBs - USEPA 8082A
Concentration Level: Low to moderate

Analyte	CAS Number			Project Quantitation Limit Goal[2] (ug/Kg)	Laboratory-specific	
					QLs (ug/Kg)	DLs (ug/Kg)
PCB-1016	12674-11-2			34	34	4.6
PCB-1221	11104-28-2			34	34	2.4
PCB-1232	11141-16-5			34	34	4.2
PCB-1242	53469-21-9			34	34	2.8
PCB-1248	12672-29-6			34	34	1.4
PCB-1254	11097-69-1			34	34	6.6
PCB-1260	11096-82-5			34	34	4.4
PCB-1262	37324-23-5			34	34	2.4
PCB-1268	11100-14-4			34	34	0.96

Notes:

QAPP Worksheet #15 -- Reference Limits and Evaluation Tables (cont.)

Matrix: Aqueous
Analytical Group: PCBs - USEPA 8082A
Concentration Level: Low to moderate

Analyte	CAS Number	6 NYCRRs Part 703 SW(AA) (ug/L)	6 NYCRRs Part 703 SW(AC) (ug/L)	6 NYCRRs Part 703 SW(FC) (ug/L)	Project Quantitation Limit Goal[2] (ug/L)	Laboratory-specific	
						QLs (ug/L)	DLs (ug/L)
PCB-1016	12674-11-2	NE	NE	NE	0.5	0.5	0.031
PCB-1221	11104-28-2	NE	NE	NE	0.5	0.5	0.041
PCB-1232	11141-16-5	NE	NE	NE	0.5	0.5	0.065
PCB-1242	53469-21-9	NE	NE	NE	0.5	0.5	0.037
PCB-1248	12672-29-6	NE	NE	NE	0.5	0.5	0.034
PCB-1254	11097-69-1	NE	NE	NE	0.5	0.5	0.044
PCB-1260	11096-82-5	NE	NE	NE	0.5	0.5	0.03
PCB-1262	37324-23-5	NE	NE	NE	0.5	0.5	0.044
PCB-1268	11100-14-4	NE	NE	NE	0.5	0.5	0.02

Notes:

QAPP Worksheet #15 -- Reference Limits and Evaluation Tables (cont.)

Matrix: Sediment
Analytical Group: Volatiles - USEPA 8260B
Concentration Level: Low to moderate

Analyte	CAS Number	NYSDEC ER-L (mg/kg)	NYSDEC ER-M (mg/kg)	Project Quantitation Limit Goal2 (ug/Kg)	MDLs (ug/Kg)	Laboratory-specific QLs (ug/Kg)
1,1,1,2-Tetrachloroethane	630-20-6	NE	NE	5	0.13	5
1,1,1-Trichloroethane	71-55-6	NE	NE	5	0.7	5
1,1,2,2-Tetrachloroethane	79-34-5	NE	NE	5	0.26	5
Freon TF	76-13-1	NE	NE	5	0.33	5
1,1,2-Trichloroethane	79-00-5	NE	NE	5	0.34	5
1,1-Dichloroethane	75-34-3	NE	NE	5	0.41	5
1,1-Dichloroethene	75-35-4	NE	NE	5	0.37	5
1,1-Dichloropropene	563-58-6	NE	NE	5	0.93	5
1,2,3-Trichlorobenzene	87-61-6	NE	NE	5	0.15	5
1,2,3-Trichloropropane	96-18-4	NE	NE	5	0.3	5
1,2,4-Trichlorobenzene	120-82-1	NE	0.0048	5	0.2	5
1,2,4-Trimethylbenzene	95-63-6	NE	NE	5	0.18	5
1,2-Dibromo-3-Chloropropane	96-12-8	NE	NE	5	0.91	5

1,2-Dibromoethane	106-93-4	NE	NE	5	0.15	5
1,2-Dichlorobenzene	95-50-1	NE	0.013	5	0.22	5
1,2-Dichloroethane	107-06-2	NE	NE	5	0.62	5
1,2-Dichloropropane	78-87-5	NE	NE	5	0.29	5
1,3,5-Trimethylbenzene	108-67-8	NE	NE	5	0.18	5
1,3-Dichlorobenzene	541-73-1	NE	NE	5	0.15	5
1,3-Dichloropropane	142-28-9	NE	NE	5	0.19	5
1,4-Dioxane	123-91-1	NE	NE	250	23	250
1,4-Dichlorobenzene	106-46-7	NE	0.11	5	0.23	5
2,2-Dichloropropane	594-20-7	NE	NE	5	0.43	5
2-Butanone	78-93-3	NE	NE	5	1.5	5
2-Chloroethyl vinyl ether	110-75-8	NE	NE	5	0.53	5
2-Chlorotoluene	95-49-8	NE	NE	5	0.14	5
2-Hexanone	591-78-6	NE	NE	5	0.49	5
4-Chlorotoluene	106-43-4	NE	NE	5	0.35	5
4-Isopropyltoluene	99-87-6	NE	NE	5	0.12	5
4-Methyl-2-pentanone	108-10-1	NE	NE	5	0.6	5
Acetone	67-64-1	NE	NE	5	1	5
Benzene	71-43-2	0.34	NE	5	0.71	5
Bromobenzene	108-86-1	NE	NE	5	0.087	5
Bromoform	75-25-2	NE	NE	5	0.2	5
Bromomethane	74-83-9	NE	NE	5	0.74	5

Carbon tetrachloride	56-23-5	NE	NE	5	0.76	5
Chlorobenzene	108-90-7	NE	NE	5	0.076	5
Dibromochloromethane	124-48-1	NE	NE	5	0.11	5
Chloroethane	75-00-3	NE	NE	5	0.38	5
Chloromethane	74-87-3	NE	NE	5	0.26	5
Chloroform	67-66-3	NE	NE	5	0.32	5
cis-1,2-Dichloroethene	156-59-2	NE	NE	5	0.42	5
cis-1,3-Dichloropropene	10061-01-5	NE	NE	5	0.35	5
Cyclohexane	110-82-7	NE	NE	5	0.85	5
Dibromomethane	74-95-3	NE	NE	5	0.27	5
Bromochloromethane	74-97-5	NE	NE	5	0.37	5
Bromodichloromethane	75-27-4	NE	NE	5	0.21	5
Dichlorodifluoromethane	75-71-8	NE	NE	5	0.23	5
Methylene Chloride	75-09-2	NE	NE	5	0.55	5
Ethylbenzene	100-41-4	1.4	NE	5	0.056	5
Hexachlorobutadiene	87-68-3	NE	NE	5	0.17	5
Methyl iodide	74-88-4	NE	NE	5	0.31	5
Isobutyl alcohol	78-83-1	NE	NE	250	49	250
Isopropylbenzene	98-82-8	NE	NE	5	0.077	5
Methyl acetate	79-20-9	NE	NE	5	0.63	5
Methyl t-butyl ether	1634-04-4	NE	NE	5	0.3	5

m&p-Xylene	179601-23-1	NE	NE	5	0.7	5
Naphthalene	91-20-3	NE	NE	5	0.26	5
n-Butylbenzene	104-51-8	NE	NE	5	0.19	5
n-Propylbenzene	103-65-1	NE	NE	5	0.11	5
o-Xylene	95-47-6	NE	NE	5	0.061	5
sec-Butylbenzene	135-98-8	NE	NE	5	0.089	5
Styrene	100-42-5	NE	NE	5	0.1	5
tert-Butylbenzene	98-06-6	NE	NE	5	0.1	5
Tetrachloroethene	127-18-4	0.45	NE	5	0.11	5
Tetrahydrofuran	109-99-9	2.5	NE	50	6.1	50
Toluene	108-88-3	NE	NE	5	0.1	5
trans-1,2-Dichloroethene	156-60-5	NE	NE	5	0.37	5
trans-1,3-Dichloropropene	10061-02-6	NE	NE	5	0.13	5
Trichloroethene	79-01-6	1.6	NE	5	0.48	5
Trichlorofluoromethane	75-69-4	NE	NE	5	0.33	5
Vinyl acetate	108-05-4	NE	NE	5	0.7	5
Vinyl chloride	75-01-4	NE	NE	5	0.3	5
Xylenes, Total	1330-20-7	0.12	NE	5	0.73	5
Carbon disulfide	75-15-0	NE	NE	5	0.31	5
Methylcyclohexane	108-87-2	NE	NE	5	0.17	5

Notes:

NE = Not established

NYDEC - New York Department of Environmental Protection; Sediment Screening Guidance

ER-L - Effects Range Low

ER-M - Effects Range Medium

ER-L and ER-M from "Sediments Classification Methods Compendium." Long and MacDonald 1992.

QAPP Worksheet #15 -- Reference Limits and Evaluation Tables (cont.)

Matrix: Sediment
Analytical Group: PCB Congeners - USEPA 1668A
Concentration Level: Low

Sediment / PCB Congeners — Analyte	CAS	NYDEC ER-L	NYDEC ER-M	Project Quantitation Limit (mg/kg)	MDL (mg/kg)	QL (mg/kg)
2-Chlorobiphenyl	2051-60-7	NE	NE	0.00001	0.000008	0.00001
3-Chlorobiphenyl	2051-61-8	NE	NE	0.00001	4E-07	0.00001
4-Chlorobiphenyl	2051-62-9	NE	NE	0.00001	0.000009	0.00001
2,2'-Dichlorobiphenyl	13029-08-8	NE	NE	0.00002	0.000017	0.00002
2,3-Dichlorobiphenyl	16605-91-7	NE	NE	0.00001	0.000001	0.00001
2,3'-Dichlorobiphenyl	25569-80-6	NE	NE	0.00001	0.000001	0.00001
2,4-Dichlorobiphenyl	33284-50-3	NE	NE	0.00001	0.000002	0.00001
2,4'-Dichlorbiphenyl	34883-43-7	NE	NE	0.00002	0.000012	0.00002
2,5-Dichlorobiphenyl	34883-39-1	NE	NE	0.00001	0.000002	0.00001
2,6-Dichlorobiphenyl	33146-45-1	NE	NE	0.00001	0.000002	0.00001
3,3'-Dichlorobiphenyl	2050-67-1	NE	NE	0.00002	0.00001	0.00002
3,4-Dichlorobiphenyl	2974-92-7	NE	NE	0.00001	0.000003	0.00001
3,4'-Dichlorobiphenyl	2974-90-5	NE	NE	0.00001	0.000003	0.00001
3,5-Dichlorobiphenyl	34883-41-5	NE	NE	0.00001	0.000003	0.00001
4,4'-Dichlorobiphenyl	2050-68-2	NE	NE	0.00001	0.000018	0.00001
2,2',3-Trichlorobiphenyl	38444-78-9	NE	NE	0.00001	0.000004	0.00001
2,2',4-Trichlorobiphenyl	37680-66-3	NE	NE	0.00001	0.000009	0.00001
2,2',5-Trichlorobiphenyl	37680-65-2	NE	NE	0.00002	0.000017	0.00002
2,2',6-Trichlorobiphenyl	38444-73-4	NE	NE	0.00001	0.000004	0.00001
2,3,3'-Trichlorobiphenyl	38444-84-7	NE	NE	0.00002	0.000019	0.00002

2,3,4-Trichlorobiphenyl	55702-46-0	NE	NE	0.00001	0.000005	0.00001
2,3,4'-Trichlorobiphenyl	38444-85-8	NE	NE	0.00001	0.000009	0.00001
2,3,5-Trichlorobiphenyl	55720-44-0	NE	NE	0.00001	0.000005	0.00001
2,3,6-Trichlorobiphenyl	55702-45-9	NE	NE	0.00001	0.000005	0.00001
2,3',4-Trichlorobiphenyl	55712-37-3	NE	NE	0.00001	0.000005	0.00001
2,3',5-Trichlorobiphenyl	38444-81-4	NE	NE	0.00001	0.000008	0.00001
2,3',6-Trichlorobiphenyl	38444-76-7	NE	NE	0.00001	0.000006	0.00001
2,4,4'-Trichlorobiphenyl	7012-37-5	NE	NE	0.00002	0.000019	0.00002
2,4,5-Trichlorobiphenyl	15862-07-4	NE	NE	0.00001	0.000008	0.00001
2,4,6-Trichlorobiphenyl	35693-92-6	NE	NE	0.00002	0.000017	0.00002
2,4',5-Trichlorobiphenyl	16606-02-3	NE	NE	0.00002	0.000015	0.00002
2,4',6-Trichlorobiphenyl	38444-77-8	NE	NE	0.00001	0.000008	0.00001
2',3,4-Trichlorobiphenyl	38444-86-9	NE	NE	0.00001	0.000005	0.00001
2',3,5-Trichlorobiphenyl	37680-68-5	NE	NE	0.00001	0.000007	0.00001
3,3',4-Trichlorobiphenyl	37680-69-6	NE	NE	0.00001	0.000008	0.00001
3,3',5-Trichlorobiphenyl	38444-87-0	NE	NE	0.00001	0.000008	0.00001
3,4,4'-Trichlorobiphenyl	38444-90-5	NE	NE	0.00001	0.000013	0.00001
3,4,5-Trichlorobiphenyl	53555-66-1	NE	NE	0.00001	0.000008	0.00001
3,4',5-Trichlorobiphenyl	38444-88-1	NE	NE	0.00001	0.000009	0.00001
2,2',3,3'-Tetrachlorobiphenyl	38444-93-8	NE	NE	0.00001	0.000012	0.00001
2,2',3,4-Tetrachlorobiphenyl	52663-59-9	NE	NE	0.00001	0.000012	0.00001
2,2',3,4'-Tetrachlorobiphenyl	36559-22-5	NE	NE	0.00001	0.000006	0.00001
2,2',3,5-Tetrachlorobiphenyl	70362-46-8	NE	NE	0.00001	0.000009	0.00001
2,2',3,5'-Tetrachlorobiphenyl	41464-39-5	NE	NE	0.00001	0.000019	0.00001
2,2',3,6-Tetrachlorobiphenyl	70362-45-7	NE	NE	0.00001	0.000005	0.00001
2,2',3,6'-Tetrachlorobiphenyl	41464-47-5	NE	NE	0.00001	0.00001	0.00001
2,2',4,4'-Tetrachlorobiphenyl	2437-79-8	NE	NE	0.00001	0.000019	0.00001
2,2',4,5-Tetrachlorobiphenyl	70362-47-9	NE	NE	0.00001	0.000008	0.00001
2,2',4,5'-Tetrachlorobiphenyl	41464-40-8	NE	NE	0.00001	0.000011	0.00001

2,2',4,6-Tetrachlorobiphenyl	62796-65-0	NE	NE	0.00001	0.000006	0.00001
2,2',4,6'-Tetrachlorobiphenyl	68194-04-7	NE	NE	0.00001	0.000005	0.00001
2,2',5,5'-Tetrachlorobiphenyl	35693-99-3	NE	NE	0.00001	0.000019	0.00001
2,2',5,6'-Tetrachlorobiphenyl	41464-41-9	NE	NE	0.00001	0.000006	0.00001
2,2',6,6'-Tetrachlorobiphenyl	15968-05-5	NE	NE	0.00001	0.000012	0.00001
2,3,3',4-Tetrachlorobiphenyl	74338-24-2	NE	NE	0.00001	0.000012	0.00001
2,3,3',4'-Tetrachlorobiphenyl	41464-43-1	NE	NE	0.00001	0.00001	0.00001
2,3,3',5-Tetrachlorobiphenyl	70424-67-8	NE	NE	0.00001	0.000012	0.00001
2,3,3',5'-Tetrachlorobiphenyl	41464-49-7	NE	NE	0.00001	0.000013	0.00001
2,3,3',6-Tetrachlorobiphenyl	74472-33-6	NE	NE	0.00001	0.000006	0.00001
2,3,4,4'-Tetrachlorobiphenyl	33025-41-1	NE	NE	0.00001	0.000013	0.00001
2,3,4,5-Tetrachlorobiphenyl	33284-53-6	NE	NE	0.00002	0.000017	0.00002
2,3,4,6-Tetrachlorobiphenyl	54230-22-7	NE	NE	0.00001	0.000006	0.00001
2,3,4',5-Tetrachlorobiphenyl	74472-34-7	NE	NE	0.00001	0.000014	0.00001
2,3,4',6-Tetrachlorobiphenyl	52663-58-8	NE	NE	0.00001	0.000007	0.00001
2,3,5,6-Tetrachlorobiphenyl	33284-54-7	NE	NE	0.00001	0.000019	0.00001
2,3',4,4'-Tetrachlorobiphenyl	32598-10-0	NE	NE	0.00001	0.000016	0.00001
2,3',4,5-Tetrachlorobiphenyl	73575-53-8	NE	NE	0.00001	0.000015	0.00001
2,3',4,5'-Tetrachlorobiphenyl	73575-52-7	NE	NE	0.00001	0.000015	0.00001
2,3',4,6-Tetrachlorobiphenyl	60233-24-1	NE	NE	0.00001	0.000011	0.00001
2,3',4',5-Tetrachlorobiphenyl	32598-11-1	NE	NE	0.00002	0.000017	0.00002
2,3',4',6-Tetrachlorobiphenyl	41464-46-4	NE	NE	0.00001	0.000012	0.00001
2,3',5,5'-Tetrachlorobiphenyl	41464-42-0	NE	NE	0.00001	0.000016	0.00001
2,3',5',6-Tetrachlorobiphenyl	74338-23-1	NE	NE	0.00001	0.000016	0.00001
2,4,4',5-Tetrachlorobiphenyl	32690-93-0	NE	NE	0.00002	0.000017	0.00002
2,4,4',6-Tetrachlorobiphenyl	32598-12-2	NE	NE	0.00001	0.000006	0.00001
2',3,4,5-Tetrachlorobiphenyl	70362-48-0	NE	NE	0.00001	0.000017	0.00001
3,3',4,4'-Tetrachlorobiphenyl	32598-13-3	NE	NE	0.00001	0.000017	0.00001
3,3',4,5-Tetrachlorobiphenyl	70362-49-1	NE	NE	0.00001	0.000017	0.00001

3,3',4,5'-Tetrachlorobiphenyl	41464-48-6	NE	NE	0.00001	0.000017	0.00001
3,3',5,5'-Tetrachlorobiphenyl	33284-52-5	NE	NE	0.00001	0.000018	0.00001
3,4,4',5-Tetrachlorobiphenyl	70362-50-4	NE	NE	0.00001	0.000018	0.00001
2,2',3,3',4-Pentachlorobiphenyl	52663-62-4	NE	NE	0.00001	0.000013	0.00001
2,2',3,3',5-Pentachlorobiphenyl	60145-20-2	NE	NE	0.00001	0.000022	0.00001
2,2',3,3',6-Pentachlorobiphenyl	52663-60-2	NE	NE	0.00001	0.000012	0.00001
2,2',3,4,4'-Pentachlorobiphenyl	65510-45-4	NE	NE	0.00001	0.00001	0.00001
2,2',3,4,5-Pentachlorobiphenyl	55312-69-1	NE	NE	0.00001	0.000015	0.00001
2,2',3,4,5'-Pentachlorobiphenyl	38380-02-8	NE	NE	0.00001	0.000015	0.00001
2,2',3,4,6-Pentachlorobiphenyl	55215-17-3	NE	NE	0.00001	0.000012	0.00001
2,2',3,4,6'-Pentachlorobiphenyl	73575-57-2	NE	NE	0.00001	0.000019	0.00001
2,2',3,4',5-Pentachlorobiphenyl	68194-07-0	NE	NE	0.00001	0.000024	0.00001
2,2',3,4',6-Pentachlorobiphenyl	68194-05-8	NE	NE	0.00001	0.000012	0.00001
2,2',3,5,5'-Pentachlorobiphenyl	52663-61-3	NE	NE	0.00001	0.000012	0.00001
2,2',3,5,6-Pentachlorobiphenyl	73575-56-1	NE	NE	0.00001	0.000022	0.00001
2,2',3,5,6'-Pentachlorobiphenyl	73575-55-0	NE	NE	0.00001	0.000012	0.00001
2,2',3,5',6-Pentachlorobiphenyl	38379-99-6	NE	NE	0.00001	0.000022	0.00001
2,2',3,6,6'-Pentachlorobiphenyl	73575-54-9	NE	NE	0.00001	0.000021	0.00001
2,2',3',4,5-Pentachlorobiphenyl	41464-51-1	NE	NE	0.00001	0.000015	0.00001
2,2',3',4,6-Pentachlorobiphenyl	60233-25-2	NE	NE	0.00001	0.000022	0.00001
2,2',4,4',5-Pentachlorobiphenyl	38380-01-7	NE	NE	0.00001	0.000022	0.00001
2,2',4,4',6-Pentachlorobiphenyl	39485-83-1	NE	NE	0.00001	0.000022	0.00001
2,2',4,5,5'-Pentachlorobiphenyl	37680-73-2	NE	NE	0.00001	0.000024	0.00001
2,2',4,5,6'-Pentachlorobiphenyl	68194-06-9	NE	NE	0.00001	0.000022	0.00001
2,2',4,5',6-Pentachlorobiphenyl	60145-21-3	NE	NE	0.00001	0.000023	0.00001
2,2',4,6,6'-Pentachlorobiphenyl	56558-16-8	NE	NE	0.00001	0.000023	0.00001
2,3,3',4,4'-Pentachlorobiphenyl	32598-14-4	NE	NE	0.00001	0.000011	0.00001
2,3,3',4,5-Pentachlorobiphenyl	70424-69-0	NE	NE	0.00001	0.000014	0.00001
2,3,3',4',5-Pentachlorobiphenyl	70424-68-9	NE	NE	0.00001	0.000027	0.00001

2,3,3',4,5'-Pentachlorobiphenyl	70362-41-3	NE	NE	0.00001	0.000015	0.00001
2,3,3',4,6-Pentachlorobiphenyl	74472-35-8	NE	NE	0.00001	0.00001	0.00001
2,3,3',4',6-Pentachlorobiphenyl	38380-03-9	NE	NE	0.00001	0.000024	0.00001
2,3,3',5,5'-Pentachlorobiphenyl	39635-32-0	NE	NE	0.00001	0.000024	0.00001
2,3,3',5,6-Pentachlorobiphenyl	74472-36-9	NE	NE	0.00001	0.000025	0.00001
2,3,3',5',6-Pentachlorobiphenyl	68194-10-5	NE	NE	0.00001	0.000024	0.00001
2,3,4,4',5-Pentachlorobiphenyl	74472-37-0	NE	NE	0.00001	0.000012	0.00001
2,3,4,4',6-Pentachlorobiphenyl	74472-38-1	NE	NE	0.00001	0.000024	0.00001
2,3,4,5,6-Pentachlorobiphenyl	18259-05-7	NE	NE	0.00001	0.00001	0.00001
2,3,4',5,6-Pentachlorobiphenyl	68194-11-6	NE	NE	0.00001	0.00001	0.00001
2,3',4,4',5-Pentachlorobiphenyl	31508-00-6	NE	NE	0.00001	0.000019	0.00001
2,3',4,4',6-Pentachlorobiphenyl	56558-17-9	NE	NE	0.00001	0.000015	0.00001
2,3',4,5,5'-Pentachlorobiphenyl	68194-12-7	NE	NE	0.00001	0.000015	0.00001
2,3',4,5',6-Pentachlorobiphenyl	56558-18-0	NE	NE	0.00001	0.000021	0.00001
2',3,3',4,5-Pentachlorobiphenyl	76842-07-4	NE	NE	0.00001	0.000012	0.00001
2',3,4,4',5-Pentachlorobiphenyl	65510-44-3	NE	NE	0.00001	0.000015	0.00001
2',3,4,5,5'-Pentachlorobiphenyl	70424-70-3	NE	NE	0.00001	0.000027	0.00001
2',3,4,5,6'-Pentachlorobiphenyl	74472-39-2	NE	NE	0.00001	0.000015	0.00001
3,3',4,4',5-Pentachlorobiphenyl	57465-28-8	NE	NE	0.00001	0.000014	0.00001
3,3',4,5,5'-Pentachlorobiphenyl	39635-33-1	NE	NE	0.00001	0.000028	0.00001
2,2',3,3',4,4'-Hexachlorobiphenyl	38380-07-3	NE	NE	0.00001	0.000012	0.00001
2,2',3,3',4,5-Hexachlorobiphenyl	55215-18-4	NE	NE	0.00001	0.000021	0.00001
2,2',3,3',4,5'-Hexachlorobiphenyl	52663-66-8	NE	NE	0.00001	0.000014	0.00001
2,2',3,3',4,6-Hexachlorobiphenyl	61798-70-7	NE	NE	0.00001	0.000012	0.00001
2,2',3,3',4,6'-Hexachlorobiphenyl	38380-05-1	NE	NE	0.00001	0.000012	0.00001
2,2',3,3',5,5'-Hexachlorobiphenyl	35694-04-3	NE	NE	0.00001	0.000017	0.00001
2,2',3,3',5,6-Hexachlorobiphenyl	52704-70-8	NE	NE	0.00001	0.000013	0.00001
2,2',3,3',5,6'-Hexachlorobiphenyl	52744-13-5	NE	NE	0.00001	0.000011	0.00001
2,2',3,3',6,6'-Hexachlorobiphenyl	38411-22-2	NE	NE	0.00001	0.000009	0.00001

2,2',3,4,4',5-Hexachlorobiphenyl	35694-06-5	NE	NE	0.00001	0.00003	0.00001
2,2',3,4,4',5'-Hexachlorobiphenyl	35065-28-2	NE	NE	0.00001	0.000021	0.00001
2,2',3,4,4',6-Hexachlorobiphenyl	56030-56-9	NE	NE	0.00001	0.00002	0.00001
2,2',3,4,4',6'-Hexachlorobiphenyl	59291-64-4	NE	NE	0.00001	0.00002	0.00001
2,2',3,4,5,5'-Hexachlorobiphenyl	52712-04-6	NE	NE	0.00001	0.000009	0.00001
2,2',3,4,5,6-Hexachlorobiphenyl	41411-61-4	NE	NE	0.00001	0.000031	0.00001
2,2',3,4,5,6'-Hexachlorobiphenyl	68194-15-0	NE	NE	0.00001	0.000013	0.00001
2,2',3,4,5',6-Hexachlorobiphenyl	68194-14-9	NE	NE	0.00001	0.000017	0.00001
2,2',3,4,6,6'-Hexachlorobiphenyl	74472-40-5	NE	NE	0.00001	0.000032	0.00001
2,2',3,4',5,5'-Hexachlorobiphenyl	51908-16-8	NE	NE	0.00001	0.000018	0.00001
2,2',3,4',5,6-Hexachlorobiphenyl	68194-13-8	NE	NE	0.00001	0.000018	0.00001
2,2',3,4',5,6'-Hexachlorobiphenyl	74472-41-6	NE	NE	0.00001	0.000032	0.00001
2,2',3,4',5',6-Hexachlorobiphenyl	38380-04-0	NE	NE	0.00001	0.000018	0.00001
2,2',3,4',6,6'-Hexachlorobiphenyl	68194-08-1	NE	NE	0.00001	0.000033	0.00001
2,2',3,5,5',6-Hexachlorobiphenyl	52663-63-5	NE	NE	0.00001	0.000011	0.00001
2,2',3,5,6,6'-Hexachlorobiphenyl	68194-09-2	NE	NE	0.00001	0.000024	0.00001
2,2',4,4',5,5'-Hexachlorobiphenyl	35065-27-1	NE	NE	0.00001	0.000013	0.00001
2,2',4,4',5,6'-Hexachlorobiphenyl	60145-22-4	NE	NE	0.00001	0.000011	0.00001
2,2',4,4',6,6'-Hexachlorobiphenyl	33979-03-2	NE	NE	0.00001	0.000034	0.00001
2,3,3',4,4',5-Hexachlorobiphenyl	38380-08-4	NE	NE	0.00001	0.000013	0.00001
2,3,3',4,4',5'-Hexachlorobiphenyl	69782-90-7	NE	NE	0.00001	0.000013	0.00001
2,3,3',4,4',6-Hexachlorobiphenyl	74472-42-7	NE	NE	0.00001	0.00001	0.00001
2,3,3',4,5,5'-Hexachlorobiphenyl	39635-35-3	NE	NE	0.00001	0.000035	0.00001
2,3,3',4,5,6-Hexachlorobiphenyl	41411-62-5	NE	NE	0.00001	0.000021	0.00001
2,3,3',4,5',6-Hexachlorobiphenyl	74472-43-8	NE	NE	0.00001	0.000035	0.00001
2,3,3',4',5,5'-Hexachlorobiphenyl	39635-34-2	NE	NE	0.00001	0.000035	0.00001
2,3,3',4',5,6-Hexachlorobiphenyl	74472-44-9	NE	NE	0.00001	0.000021	0.00001
2,3,3',4',5',6-Hexachlorobiphenyl	74472-45-0	NE	NE	0.00001	0.000014	0.00001
2,3,3',5,5',6-Hexachlorobiphenyl	74472-46-1	NE	NE	0.00001	0.000036	0.00001

2,3,4,4',5,6-Hexachlorobiphenyl	41411-63-6	NE	NE	0.00001	0.000012	0.00001
2,3',4,4',5,5'-Hexachlorobiphenyl	52663-72-6	NE	NE	0.00001	0.000011	0.00001
2,3',4,4',5',6-Hexachlorobiphenyl	59291-65-5	NE	NE	0.00001	0.000013	0.00001
3,3',4,4',5,5'-Hexachlorobiphenyl	32774-16-6	NE	NE	0.00001	0.000016	0.00001
2,2',3,3',4,4',5-Heptachlorobiphenyl	35065-30-6	NE	NE	0.00001	0.000016	0.00001
2,2',3,3',4,4',6-Heptachlorobiphenyl	52663-71-5	NE	NE	0.00001	0.000037	0.00001
2,2',3,3',4,5,5'-Heptachlorobiphenyl	52663-74-8	NE	NE	0.00001	0.000038	0.00001
2,2',3,3',4,5,6-Heptachlorobiphenyl	68194-16-1	NE	NE	0.00001	0.000037	0.00001
2,2',3,3',4,5,6'-Heptachlorobiphenyl	38411-25-5	NE	NE	0.00001	0.000019	0.00001
2,2',3,3',4,5',6-Heptachlorobiphenyl	40186-70-7	NE	NE	0.00001	0.000038	0.00001
2,2',3,3',4,6,6'-Heptachlorobiphenyl	52663-65-7	NE	NE	0.00001	0.000039	0.00001
2,2',3,3',4',5,6-Heptachlorobiphenyl	52663-70-4	NE	NE	0.00001	0.000014	0.00001
2,2',3,3',5,5',6-Heptachlorobiphenyl	52663-67-9	NE	NE	0.00001	0.000022	0.00001
2,2',3,3',5,6,6'-Heptachlorobiphenyl	52663-64-6	NE	NE	0.00001	0.000023	0.00001
2,2',3,4,4',5,5'-Heptachlorobiphenyl	35065-29-3	NE	NE	0.00001	0.000014	0.00001
2,2',3,4,4',5,6-Heptachlorobiphenyl	74472-47-2	NE	NE	0.00001	0.00004	0.00001
2,2',3,4,4',5,6'-Heptachlorobiphenyl	60145-23-5	NE	NE	0.00001	0.00004	0.00001
2,2',3,4,4',5',6-Heptachlorobiphenyl	52663-69-1	NE	NE	0.00001	0.00004	0.00001
2,2',3,4,4',6,6'-Heptachlorobiphenyl	74472-48-3	NE	NE	0.00001	0.00004	0.00001
2,2',3,4,5,5',6-Heptachlorobiphenyl	52712-05-7	NE	NE	0.00001	0.00004	0.00001
2,2',3,4,5,6,6'-Heptachlorobiphenyl	74472-49-4	NE	NE	0.00001	0.000041	0.00001
2,2',3,4',5,5',6-Heptachlorobiphenyl	52663-68-0	NE	NE	0.00001	0.000019	0.00001
2,2',3,4',5,6,6'-Heptachlorobiphenyl	74487-85-7	NE	NE	0.00001	0.000023	0.00001
2,3,3',4,4',5,5'-Heptachlorobiphenyl	39635-31-9	NE	NE	0.00001	0.000018	0.00001
2,3,3',4,4',5,6-Heptachlorobiphenyl	41411-64-7	NE	NE	0.00001	0.000023	0.00001
2,3,3',4,4',5',6-Heptachlorobiphenyl	74472-50-7	NE	NE	0.00001	0.000042	0.00001
2,3,3',4,5,5',6-Heptachlorobiphenyl	74472-51-8	NE	NE	0.00001	0.000042	0.00001
2,3,3',4',5,5',6-Heptachlorobiphenyl	69782-91-8	NE	NE	0.00001	0.000014	0.00001
2,2',3,3',4,4',5,5'-Octachlorobiphenyl	35694-08-7	NE	NE	0.00001	0.000017	0.00001

2,2',3,3',4,4',5,6-Octachlorobiphenyl	52663-78-2	NE	NE	0.00001	0.000043	0.00001
2,2',3,3',4,4',5,6'-Octachlorobiphenyl	42740-50-1	NE	NE	0.00001	0.000043	0.00001
2,2',3,3',4,4',6,6'-Octachlorobiphenyl	33091-17-7	NE	NE	0.00001	0.000025	0.00001
2,2',3,3',4,5,5',6-Octachlorobiphenyl	68194-17-2	NE	NE	0.00001	0.00002	0.00001
2,2',3,3',4,5,6,6'-Octachlorobiphenyl	52663-73-7	NE	NE	0.00001	0.00002	0.00001
2,2',3,3',4,5',6,6'-Octachlorobiphenyl	40186-71-8	NE	NE	0.00001	0.000025	0.00001
2,2',3,3',4,5,5',6'-Octachlorobiphenyl	52663-75-9	NE	NE	0.00001	0.000044	0.00001
2,2',3,3',5,5',6,6'-Octachlorobiphenyl	2136-99-4	NE	NE	0.00001	0.000044	0.00001
2,2',3,4,4',5,5',6-Octachlorobiphenyl	52663-76-0	NE	NE	0.00001	0.000044	0.00001
2,2',3,4,4',5,6,6'-Octachlorobiphenyl	74472-52-9	NE	NE	0.00001	0.000045	0.00001
2,3,3',4,4',5,5',6-Octachlorobiphenyl	74472-53-0	NE	NE	0.00001	0.000045	0.00001
2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl	40186-72-9	NE	NE	0.00001	0.000045	0.00001
2,2',3,3',4,4',5,6,6'-Nonachlorobiphenyl	52663-79-3	NE	NE	0.00001	0.000045	0.00001
2,2',3,3',4,5,5',6,6'-Nonachlorobiphenyl	52663-77-1	NE	NE	0.00001	0.000046	0.00001
Decachlorobiphenyl	2051-24-3	NE	NE	0.00001	0.000015	0.00001

Notes:

NE = Not established

NYDEC - New York Department of Environmental Conservation; Technical Guidance for Screening Contaminated Sediment

ER-L - Effects Range Low

ER-M - Effects Range Medium

ER-L and ER-M from "Sediments Classification Methods Compendium." Long and MacDonald 1992.

Matrix: Sediment
Analytical Group: TOC Lloyd Kahn and Black Carbon
Concentration Level: Unknown

Sediment / Analyte	TOC	CAS	NYDEC ER-L	NYDEC ER-M	Project Quantitation Limit (mg/kg)	MDL (mg/kg)	QL (mg/kg)
TOC		7440-44-0	NE	NE	1000	220	1000

Notes:
NE = Not established
NYDEC - New York Department of Environmental Conservation; Technical Guidance for Screening Contaminated Sediment
ER-L - Effects Range Low
ER-M - Effects Range Medium
ER-L and ER-M from "Sediments Classification Methods Compendium." Long and MacDonald 1992.

QAPP Worksheet #16 – Project Schedule/ Timeline Table

Activities	Organization	Anticipated Time Frame of Initiation	Anticipated Time Frame of Completion	Deliverable	Deliverable Due Date
Development Sampling Plan, Investigation Scope of Work, and QAPP	GEI	October 2012, Revised March 2013	March/April 2013	Final WP, QAPP	March/April 2013
Sampling Event	GEI	March -April 2013	April 2013	Interm Data Report	May 2013
Laboratory Analyses – All Events	Laboratories	Upon sample receipt	Dependant on Individual Laboratory Schedules	Laboratory Deliverable	Approximately 1 month after sample receipt

QAPP Worksheet #17 -- QAPP Sampling Design and Rationale

Describe and provide a rationale for choosing the sampling approach:

This Work Plan was prepared by GEI Consultants, Inc. (GEI) for National Grid and outlines the scope of work for an investigation to determine if a release of gas condensate has impacted sediments, surface water, biota or structures in Paerdegat Basin. Paerdegat Basin is located in Brooklyn, New York as indicated Figure 1 in the current Work Plan.

This plan is based upon a field inspection conducted by GEI on October 16, 2012 and is also responsive to the NYSDEC comments of October 15, 2012, amendments from the GEI conference call of October 17, 2012, and review letter from NYSDEC received January 14, 2013 and follow up meeting held February 4, 2013. The scope of work includes the following:

- Intertidal sediment sampling
- Subtidal sediment and surface water sampling from shoreline structures including the CSO wall and the mouth of the Basin
- Subtidal sediment and surface water sampling from the survey boat; weather and ice permitting
- Biota sampling (mussels only)
- Structure sampling (piles, docks, and bulkheads)

Describe the sampling design and rationale in terms of what matrices will be sampled, what analytical groups will and at what concentration levels, the sampling locations (including QC, critical, and background samples), the number of samples to be taken, and the sampling frequency (including seasonal considerations):

The proposed field investigations include the collection of sediment at 42 sampling stations, 20 biological tissue (mussels) samples from five stations, surface water from five stations, and 47 porous structure samples on docks, piers and bulkheads in Paerdegat Basin. All samples will be analyzed for PCBs. Proposed sample locations are indicated on Figure 2 in the Work Plan. Actual sample locations may have to be adjusted based on field conditions at the time the field work is done. GEI will conduct the sampling activities for all media on behalf of National Grid.

Shoreline Survey and Contingent Sediment Sampling

The NYSDEC requested that a detailed shoreline survey be performed to document the potential presence of oily residues that may remain following the response action. Where possible, that survey will be performed by GEI staff walking the shoreline.

This will likely be possible in areas such as the marinas and other easily accessible areas. However, because much of the shoreline consists of wetlands and mud-flat areas (including constructed wetlands currently being developed), large sections of the shoreline may not be accessible on foot. Therefore, GEI will also conduct a visual shoreline survey by boat of the entire shoreline of the Basin. The objective will be to document presence/absence of visible product or oily residues, primarily by sheen or possibly by staining of the *Spartina* shoots in the restoration areas. The survey will be conducted around low tide. We will notify staff at NYSDEC's Division of Fish, Wildlife and Marine Resources so that they can participate in the survey if they are available.

GEI will document the shoreline conditions and observations of any sheen or oily residues using video photographs and field notes. GPS coordinates of any observed oily residues will be recorded. It is likely that other petroleum-related releases un-related to the gas condensate liquid release have caused oily residue or sheen impacts in the intertidal zone of the basin. Therefore, regardless of potential source, GEI will adjust its proposed sample locations to include the collection of soil/sediment samples for laboratory analyses from any accessible area of oily residue or sheen to evaluate the potential for the observed impact to be related to the gas condensate release. The documented observations will be included in GEI's sampling report.

Sediment, Surface Water and Biota Sampling

The sampling plan will be implemented over an approximate one week period. The scope of work for field investigation includes the following:

- Intertidal surface sediment sampling: this effort will involve 14 stations along the *Spartina* restoration side and other areas accessible on foot.
- Subtidal surface sediment sampling from shoreline structures: this will include 12 subtidal stations. This includes four from the CSO wall and floating docks, seven from marina docks and one at the mouth of the basin. A surface water sample will also be collected from the station located near the outfall.
- Subtidal surface sediment sampling from the survey boat (weather and ice permitting): this will consist of 14 stations using the research vessel including three reference stations to be taken in Jamaica Bay. Surface water samples will be collected from three of these stations within the basin and one from Jamaica Bay.
- Biota sampling for mussels: up to 20 samples from five stations, however, the actual number of stations will depend upon availability of mussels.

Intertidal Sample Locations

The objective of this sampling task is to characterize the extent and concentrations of PCBs in the intertidal zone. The

study zone will range from the mean low water (MLW) to the mean high water line with stations as shown in Figure 2 in the Work Plan. Surficial sediment will be collected from eighteen stations with stainless steel trowels cleaned between stations as described in the QAPP. Single use, disposable sampling equipment may also be used to collect sample aliquots. Locations will be recorded utilizing GPS. Sediment samples will be photographically recorded. Complete chain of custody records will be maintained.

Subtidal Sediment and Surface Water Sampling From Shoreline Structures

The objective of this element is to characterize the extent and concentrations of PCBs in the subtidal zones. Sediment samples will be collected from the 12 stations using a petite PONAR sampling device. Three surface water samples will be collected at locations shown on Figure 2 in the Work Plan. Limited surface water sampling is porposed due to the time that has elapsed since the initial release, the low solubility of PCBs, and because the analysis of samples conducted immediately after the release did not detect any PCBs. This particular protocol is for nearshore collections under and around hard structures such as floating docks and bulkheads. The exact sample locations may be modified in the field should obstructions be encountered. The PONAR sampler will be deployed manually at the sampling station until sufficient sediment sample volume is obtained for the desired analytical requirements (see below). Based on input from NYSDEC the primary focus is to characterize the upper 1-inch of the sediment surface. As a result efforts will be made to obtain sediment material from the top fraction of material in each retrieved PONAR sampler. The PONAR and all re-usable sampling equipment will be decontaminated between sample locations. Single use, disposable sampling equipment may also be used to collect sample aliquots from the PONAR device and transfer the sediments to the laboratory sample containers. The sediment sampling locations will be recorded with a GPS and the sediment samples will be photographically recorded. Complete chain of custody records will be maintained.

Subtidal Sediment and Surface Sampling Utilizing the Survey Vessel

Sediment samples will be collected from 15 stations using a petite PONAR sampling device and four direct surface water samples will be collected as shown on Figure 2 (within basin) and Figure 3 (within Jamaica Bay) in the Work Plan. GEI's sampling vessel, the RV Kingfisher will be used to access the offshore stations for sample collections (weather and ice conditions permitting). The exact sample locations may be modified in the field should obstructions be encountered. The PONAR sampler will be deployed at the sampling station until sufficient sediment sample volume is obtained for the desired analytical requirements (see below). Collection strategy will again be focused on characterizing the upper 1-inch of the sediment surface.Efforts will be made to obtain sediment material from the top fraction of material in each retrieved PONAR sampler. The PONAR and all re-usable sampling equipment will be decontaminated between sample locations. Single use, disposable sampling equipment may also be used to collect sample aliquots from the PONAR device and transfer the sediments to the laboratory sample containers. Surface water samples will be directly sampled. The sampling locations will be recorded with an on-board GPS and the sediment

samples will be photographically recorded. Complete chain of custody records will be maintained.

Biota Tissue Sampling for Mussels

Mussels are non-mobile, therefore good indicators for bioaccumulation of metals and/or persistent organics in the water column or sediment. Mussels will be collected if they are encountered in the intertidal zones (e.g., attached to *Spartina* stubs), from the floating docks and piers at the marinas in Paerdegat Basin, and on hard surfaces at the head or mouth of the basin. Priority will be given to attempt and locate up to four target stations in intertidal regions upstream and/or downstream of the outfall. The initial shoreline survey will provide a better understanding of the feasibility of these sample locations; however, it is important to note the exact locations of biota sampling stations will be highly dependent on field conditions and the availability of mussels. At least one target station will be located at one of the marinas on the east side of the basin near the outfall. If mussels are not available in intertidal regions, another potential target station will be located at marina on the west side of the basin.

The total weights of mussels collected per station will be recorded. All biota samples will be wrapped in aluminum foil, packed in plastic bags and immediately placed on ice in coolers for same day shipment to the analytical laboratory. All samples will be processed in the analytical laboratory. The mussels will be shucked and the soft tissue retained for analysis. The sampling locations will be recorded with a GPS and photographically recorded. Complete chain of custody records will be maintained. If sufficient weight of samples are collected (e.g., >20 grams for each sample type) for all 20 samples prior to the last day, the sampling for that effort may be discontinued. If sample mass from each station is insufficient for laboratory requirements, samples will be composited and submitted on an area basis as opposed to individual stations.

Structure Sampling

Sample Locations and Rationale

The objective of this element is to determine if PCBs are present at or above the USEPA clean up criteria of 1 mg/kg in structures that could have been impacted by the spill. Proposed sample locations are indicatedon Figure 4 in the Work Plan. Floating docks, piers and bulkheads in the area of investigation in the Basin will be inspected for oil-like staining where access is permitted by the owner. Proposed sample locations will be adjusted to to locations where oil-staining is observed with suspected impact from the gas condensate release. If no oil-staining is observed or not suspected to be related to the recent release of gas condensate, samples of the outer surface of the structures in contact with the surface water will be collected at the scum line as as

indicated in Figure 3 in the Work Plan. It may not be possible to collect samples from some locations for safety reasons or due to accessibility.

A summary of the proposed structure sample locations is presented in the following table.

Location	Number of Samples	Sample Media
Docks and Piers		
Hudson River Yacht Club	10	Wood and Styrofoam
Midget Squadron Marina	18	Wood and Styrofoam
Kayak Club	3	Wood and Styrofoam
Diamond Point Club	6	Wood and Styrofoam
Paerdegat Squadron	4	Wood and Styrofoam
Canarsie Athletic Club	4	Wood and Styrofoam
Bulkheads		
CSO Outfall Structure Bulkhead	2	Concrete

Sampling Methods

Samples of wood and Styrofoam materials will be collected from the surface using USEPA sampling protocols for collection of porous materials for PCB analysis (USEPA, May 2011). Wood chisels or handheld rotary drill with a corer attachment will be used to collect surface samples from the porous material. The depth of sampling will not exceed 1/2 inch into the surface sampled. Samples of wooden and Styrofoam dock materials will be collected and analyzed as discrete samples. Samples collected from wooden piers which are exposed to daily tidal fluctuations, will be comprised of a composite of three subsamples collected during low tide from three locations representative of depth approximate heights of the low tide, mid tide and high tide.

Samples of dock material will be collected from the side wall of the dock while kneeling on the dock surface.

The concrete bulkhead at the CSO outfall is considered porous materials and samples of it will be collected using a vibratory hammer drill and core as described in USEPA sampling protocols (May, 2011).

Some samples may require the use of a boat for added safety during sample collection. All samples will be placed in laboratory provided sampling jars for PCB analysis.

Proposed Sample Analysis

Based upon analytical results of the condensate oil collected from the standpipe , the condensate included PCBs, volatile organic compounds (VOCs) and semivolatile organic compounds. The highest concentration contaminant is PCB Aroclor 1242. Given that this compound is present at the highest concentration, partitions strongly to sediments, is persistent in the environment and can bioaccumulate in biota, PCBs are the primary contaminants of concern for this Work Plan. All samples will be analyzed for PCB Aroclors and 20% of the sediment samples will also be analyzed for VOCs. The analyses will be done on an expedited turn-around-time basis.

Sediment samples will be analyzed for the following parameters:

- PCBs according to USEPA Method 8082A
- Target compound list VOCs according to USEPA Method 8260B at seven of the sample locations
- Total organic carbon (TOC) according to USEPA Method Lloyd Kahn
- Grain Size according to ASTM D422
- Samples will be archived with the potential for future analysis of PCB congeners according to USEPA Method 1668A for forensic evaluations
- Percent Moisture

Surface water, biological tissue and porous structural material samples will be analyzed for the following parameter:

- PCBs according to USEPA Method 8082A
- Samples will be archived with potential future analysis of PCB congeners according to USEPA Method 1668A for forensic evaluations
- Percent moisture

- Percent lipid (for biological tissue samples only).

Soils and semi-porous materials will be reported on a dry-weight basis, while surface water and mussel tissue will be reported on a wet-weight basis.

QAPP Worksheet #18 -- Sampling Locations and Methods/SOP Requirements Table

Locations	Sample ID	Matrix	Depth (inch)	Analytical Group	Concentration Level	Number of Samples[1]	Sampling SOP Reference[2]	Rationale for Sampling Location
Stations SD-001 through SD-042	NG-PB-SD-001 through NG-PB-042	Sediment	0-1	PCBs Aroclors*, TOC,Grain size, percent moisture, VOCs (subset of 7 samples)	Unknown	42	PB-04	See Work Plan
Stations T-001 through T-005	NG-PB-T-001 through PB-T-020	Tissue (mussels)	NA	Tissue PCB Aroclors*, percent moisture, percent lipid	Unknown	20	PB-10	See Work Plan
Stations SW-001 through SW-005	NG-PB-SW-001 through PB-SW-005	Surface Water	0-5	PCBs Aroclors*	Unknown	5	PB-08	See Work Plan
Stations PS-001 through PS-047	NG-PB-PS-001 through PB-PS-047	Porous solid	0-0.5	PCBs Aroclors*	Unknown	47	PB-09	See Work Plan

Notes:

[1]Does not include quality assurance/ quality control samples. Quality assurance/ quality control samples will include blind duplicate samples, matrix spike/ matrix spike duplicate samples, and equipment rinsate blank samples. These samples will be completed on a frequency of 1 per 20 samples per matrix or once per week of sampling per matrix.

[2]Appropriate letter or number from the Project Sampling SOP References table (Worksheet #21).

* Samples will be archived with potential future analysis of PCB congeners according to USEPA Method 1668A

QAPP Worksheet #19 – Analytical SOP Requirements Table

For each matrix, analytical group and concentration level, list the analytical and preparation method/SOP and associated sample volume, container specifications, preservation requirements, and maximum holding time.

Matrix	**Analytical Group**	**Concentration Level**	**Analytical and Preparation Method / SOP Reference**[1]	**Sample Volume**	**Containers** (number, size, and type)	**Preservation Requirements** (chemical, temperature, light protected)	**Maximum Holding Time** (preparation / analysis)
Solid/Sediment	PCBs Aroclors	unknown	Method SW846 8082A BR-GC-005(A), BR-EX-027(P)	50 g	4 oz. glass jar	Cool to 4 ± 2 C	14 days for extraction and 40 days for analysis.
Sediment	TOC Lloyd Kahn	unknown	Lloyd Khan / 006	10 g	Taken from 32 oz glass jar	4 C	14 days
Sediment	Grain Size	unknown	ASTM D422 / 007	500 g	Taken 32 oz glass jar	4 C	NA
Sediment	PCB Congeners	Low	1668A / 002	4 oz	8 oz. amber glass jar	<6 °C in transit to lab. Lab storage at < -10 °C	Up to 1 year when stored frozen and in the dark
Sediment	VOCs	Low	Method 8260B BR-MV-006(A), BR-MV-007(P)	(2) 40 mL glass vials	2 x 5 grams	To Lab: Cool 4±2°C At lab: Freeze -20 ± 10°C 5 mL of VOA Free water	48Hours to Freeze 14 days to analysis
				(1) 40 mL glass vial	1 x 5 grams	Cool 4±2°C 10 mL of Methanol	14 days to analysis
Tissue	PCBs Aroclors	unknown	Method SW846 8082A BR-GC-005(A), BR-EX-009(P)	20 g	Foil and ziplock bag	Cool to 4 ± 2 C	14 days for extraction and 40 days for analysis.

Matrix	**Analytical Group**	**Concentration Level**	**Analytical and Preparation Method / SOP Reference[1]**	**Sample Volume**	**Containers** (number, size, and type)	**Preservation Requirements** (chemical, temperature, light protected)	**Maximum Holding Time** (preparation / analysis)
Tissue	PCB Congeners	Low	1668A / 002	20 g	Foil and ziplock bag/ transfer in lab	<6 °C in transit to lab. Lab storage at < -10 °C	Up to 1 year when stored frozen and in the dark
Water	PCBs Aroclors	Low	Method SW846 8082A BR-GC-005(A), BR-EX-005(P)	1 L	(1) 1 L amber glass bottle	Cool to 4 ± 2 C	7 days for extraction and 40 days for analysis.

[1]Specify the appropriate reference letter or number from the Analytical SOP References table (Worksheet #23).

QAPP Worksheet #20 -- Field Quality Control Sample Summary Table

Matrix	Analytical Group	Conc. Level	Analytical and Preparation SOP Reference	No. of Sampling Locations	No. of Field Duplicate Pairs[1]	No. of MS/MSD[1]	No. of Rinsate Blanks[1]	No. of Trip Blanks[2]	Total No. of Samples to Lab
Sediment	PCBs	Unknown	EPA Method 8082A	42	1 (1 per 20)	1 (1 per 20)	1 (1 per 20)	0	48
Sediment	PCB Congeners	Unknown	EPA Method 1668A	42	1 (1 per 20)	1 (1 per 20)	1 (1 per 20)	0	48
Sediment	TOC	Unknown	EPA Method Lloyd Kahn	42	1 (1 per 20)	1 (1 per 20)	1 (1 per 20)	0	48
Sediment	Grain Size	Unknown	ASTM D422	42	1 (1 per 20)	1 (1 per 20)	0	0	46
Surface Water	PCBs	Unknown	EPA Method 8082A	5	1 (1 per 20)	1 (1 per 20)	1 (1 per 20)	0	8
Tissue	PCBs	Unknown	EPA Method 8082A	20	0 (1 per 20)	1 (1 per 20)	0 (1 per 20)	0	21

Notes

[1] Quality assurance/ quality control samples will include field duplicate samples, matrix spike/ matrix spike duplicate samples, and equipment rinsate blank samples. These samples will be completed on a frequency of 1 per 20 samples or once per week of sampling.

[2] Trip blanks are only required for volatile organic carbon samples. These samples will be completed on a frequency of 1 per 20 samples or once per week of sampling.

QAPP Worksheet #21 – Project Sampling SOP Reference Table

The following is a list of all SOPs associated with project sampling including, but not limited to sample collection, sample preservation, equipment cleaning and decontamination, equipment testing, inspection and maintenance, supply inspection and acceptance, and sample handling and custody.

Reference Number	Title, Revision Date and/or Number	Originating Organization	Equipment Type	Modified for Project Work? (Y/N)	Comments
PB-01	Field Notebook	GEI Consultants	NA	No	Attachment B
PB-02	Equipment Decontamination	GEI Consultants	Various – see SOP	No	Attachment B
PB-03	Water Saftey	GEI Consultants	Various – see SOP	No	Attachment B
PB-04	Sediment Sampling- Ponar or Shipex Grab Sampler	GEI Consultants	Ponar	No	Attachment B
PB-05	Sample Handling and Chain of Custody	GEI Consultants	NA	No	Attachment B
PB-06	Sample Handling	GEI Consultants	NA	No	Attachment B
PB-07	YSI Quick Card	GEI Consultants	YSI	No	Attachment B
PB-08	Biological Tissue Sampling	GEI Consultants	Various – see SOP	Yes	Attachment B
PB-09	Semi-porous Surface Sampling	GEI Consultants	Various – see SOP	Yes	Attachment B
PB-10	Surface Water Sampling	GEI Consultants	Various – see SOP	No	Attachment B
PB-11	Mussel Tissue Extraction	GEI Consultants	Various – see SOP	Yes	Attachment B
PB-12	Sediment Sampling Using Vibracore Equipment	GEI Consultants	Various – see SOP	No	Attachment B

Procedural modifications to these documents may be warranted depending upon field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification will be approved in advance by the GEI Project QA Coordinator and GEI Manager and communicated to the Respondents and to the USEPA. Deviations will be documented in the field records.

QAPP Worksheet #22 – Field Equipment Calibration, Maintenance, Testing and Inspection Table

Identify all field equipment and instruments (other than analytical instrumentation) that require calibration, maintenance, testing, or inspection and provide the SOP reference number for each type of equipment. In addition, document the frequency of activity, acceptance criteria, and corrective action requirements on the worksheet.

Field Equipment	Calibration Activity	Maint. Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Resp. Person	SOP Reference[1]
Multi-parameter water quality sonde	PB-07 provided in Attachment B	PB-07 provided in Attachment B	PB-07 provided in Attachment B	PB-07 provided in Attachment B	PB-07 provided in Attachment B	PB-07 provided in Attachment B	PB-07 provided in Attachment B	Field Team Leader*	PB-07 provided in Attachment B

Notes:

[1]Specify the appropriate reference letter or number from the Project Sampling SOP References table (Worksheet #21).

*Calibration will be performed by field team leader and field personell trained through GEI SOPs for Multi-parameter water quality sonde calibration.

Field Instrumentation: The Field Team Leader will be responsible for insuring that these instruments are calibrated before each field sampling event. Field equipment must be inspected and calibrated before use according to the criteria given in the Field Sampling Plan. If problems occur with field instruments or equipment which cannot be resolved by the field team personnel they should contact the Field Team Leader. If field equipment fails inspection it is the Field Team Leader's responsibility to investigate and resolve the problem. The GEI Field Team Leader can coordinate with equipment vendors assist in resolution of problems with field equipment and supply or obtain any spare or replacement parts or equipment.

QAPP Worksheet #23 -- Analytical SOP References Table

All referenced analytical SOP's can be found in Attachment C.

Analytical SOP References Table						
Lab SOP Number	**Title, Revision Date, and/or Number**	**Definitive or Screening Data**	**Matrix and Analytical Group**	**Instrument**	**Organization Performing Analysis**	**Modified for Project Work (Y/N)**
BR-EX-002r11_EXcleanup	Extract Clean Up Procedures	Defninitive	Solid/Sediment PCBs	GC	TestAmerica-Burlington	N
BR-GC-005	PCBs by Gas Chromatography (GC) SOP No. BR-GC-005, Rev 11, 04/01/11	Definitive	Solid/Sediment PCBs	GC	TestAmerica-Burlington	N
BR-GC-005	PCBs by Gas Chromatography (GC) SOP No. BR-GC-005, Rev 11, 04/01/11	Definitive	Aqueous PCBs	GC	TestAmerica-Burlington	N
BR-GC-005	PCBs by Gas Chromatography (GC) SOP No. BR-GC-005, Rev 11, 04/01/11	Definitive	Tissue PCBs	GC	TestAmerica-Burlington	N
BR-EX-027	Automated Soxhlet Extraction (SW846 3541) SOP No. BR-EX-027, Rev 0, 11/10/10	Definitive	Solid/Sediment PCBs	NA Preparation	TestAmerica-Burlington	N
BR-EX-005	Separatory Funnel Extraction (SW-846 3510C) SOP No. BR-EX-005, Rev 9, 12/08/11	Definitive	Aqueous PCBs	NA Preparation	TestAmerica-Burlington	N
BR-EX-009	Homogenization of Biota & Tissue SOP No. BR-EX-009, Rev 7, 08/01/12	Definitive	Tissue PCBs	NA Preparation	TestAmerica-Burlington	N
BR-WC-008 Current Version	TOC Lloyd Kahn/	Definitive	Solid/Sediment	Carlo Erba Elemental	TestAmerica-Burlington	N

				Analyzer		
BR-GT-006 BR-GT-018	Grain Size	Definitive	Solid/Sediment	NA	TestAmerica-Burlington	N
BR-MV-006	Volatile Organic Compounds by GC/MS (SW-846 8260B) SOP No. BR-MV-006, Rev 8, 05/28/10	Definitive	Solid/Sediment Volatiles	GC/MS	TestAmerica-Burlington	N
BR-MV-007	VOA Sample Preservation & Screen Analysis Procedure (SW-846 5030A, 5035 and 5035A) SOP No. BR-MV- 007, Rev 5, 12/05/08	Definitive	Solid/Sediment Volatiles	NA Preparation	TestAmerica-Burlington	N

QAPP Worksheet #24 -- Analytical Instrument Calibration Table

Analytical Instrument Calibration Table						
Instrument	**Calibration Procedure**	**Frequency of Calibration**	**Acceptance Criteria**	**Corrective Action (CA)**	**Person Responsible for CA**	**SOP Reference**
GC	Five-point calibration	Before sample analysis, when CCVs indicate calibration is no longer valid; after major instrument maintenance	Option 1: Mean relative standard deviation (RSD) for all analytes ≤ 20% Option2: Linear Regression: r > 0.995	Correct problem, reanalyze, and repeat calibration.	Laboratory Analyst	SOP BR-GC-005
GC	Initial Calibration Verification	Immediately after each initial calibration	%R ± 20% of true value	Correct problem and verify second source standard. If that fails repeat calibration.	Laboratory Analyst	SOP BR-GC-005
GC	Continuing Calibration Verification	Daily before sample analysis, every 10 samples and at the end of the analytical sequence	% Difference or Drift ±20%	See Laboratory SOP	Laboratory Analyst	SOP BR-GC-005

QAPP Worksheet #24 - Analytical Instrument Calibration Table (cont.)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
HRMS	Mass Resolution Check	Before ICAL	- Document acceptable mass resolution check prior to analysis of ICAL per method.	Inspect system; adjust source tune parameters to achieve required mass resolution.	Analyst	002-KNOX-ID-0013
HRMS	Initial Calibration (ICAL)	Prior to sample analysis; after major instrument changes/maintenance or when continuing calibration criteria are no longer met.	- Analyte peaks and labeled IS peaks must have a S/N ratio of 10 or more in the CS0.5 standard - Percent valley between PCB 34 and 23 must be <= 40% - Percent valley between PCB 187 and 182 must be <= 40% - %RSD for analytes calculated using isotope dilution <= 20% - % RSD for all other analytes and internal standards <= 35%	Inspect analytical system; correct problem; repeat ICAL	Analyst	002-KNOX-ID-0013
HRMS	Initial Calibration Verification (ICV)	After ICAL and prior to sample analysis	%D can not exceed 35% for more than 4 analytes or labeled standards. %D must not exceed 50% any one analyte or labeled standard. Note: the RFs from the CS3 level of the ICAL are used to quantitated the ICV.	Inspect system; correct problem. Reanalyze ICV. Repeat ICAL if necessary.	Analyst	002-KNOX-ID-0013
HRMS	Continuing Calibration Verification (CCV)	At the beginning of each 12 hour analytical shift	- Document acceptable mass resolution checks at the start and end of each 12 hour analytical shift - The CS3 solution is used to verify RFs. The CS3 CCAL	Inspect system; correct problem; reanalyze CCV. Repeat ICAL if necessary.	Analyst	002-KNOX-ID-0013

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
			check is analyzed at the start of each 12 hour analytical shift. - S/N ratio for each analyte and labeled Is must be 10 or greater - CCV %D for Toxics/LOCs <= 30% - CCV %D for non-toxic/LOC analyte must be within 40-160% - Absolute RTs for all labeled IS must be within 15 seconds of the RTs established during the ICAL.			
LRMS	Initial Calibration (ICAL)	Prior to sample analysis; after major instrument changes/maintenance or when continuing calibration criteria are no longer met.	- %RSD for all parent PAHs must be <=30% - For each parent PAH linearity must be documented by obtaining a r^2 of 0.990 or greater	Inspect analytical system; correct problem; repeat ICAL.	Analyst	003-KNOX-ID-0018
LRMS	Initial Calibration Verification (ICV)	After ICAL and prior to sample analysis	%D can not exceed 35%	Inspect system; correct problem. Reanalyze ICV. Repeat ICAL if necessary.	Analyst	KNOX-ID-0018
LRMS	Continuing Calibration Verification (CCV)	At the beginning of each 24 hour analytical shift	- Two CCVs are analyzed at the start of each 24 hour analytical sequence - The %D for each parent PAH	Inspect system; correct problem; reanalyze CCV. Repeat ICAL if	Analyst	003-KNOX-ID-0018

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
			should be <=30% - In the event a parent PAH CCV %D is greater than 30%, calculate the mean RF CCV %D using both CCV runs. If this mean is <=30%D an acceptable CCAL has been obtained	necessary.		
5310C - TOC	Initial Calibration	The instrument is calibrated at the beginning of each day or if the CCV/CCB fails to meet acceptance criteria.	The calibration correlation coefficient is $\geq$0.995.	Recalibrate and/or perform the necessary equipment maintenance. Check the calibration standards. Reanalyze the affected data.	Analyst/Supervisor	029-PT-WC-017
	Initial Calibration Verification (ICV)	Analyze a standard at the beginning after calibration	The acceptance criterion for the initial calibration verification standard is 90 to 110% recovery of true value.	Recalibrate and/or perform the necessary equipment maintenance. Check the calibration standards. Reanalyze the affected data.	Analyst/Supervisor	
	Initial Calibration Blank (ICB)	Before beginning a sample sequence, following ICV.	The result must be < RL.	Terminate analysis; Correct the problem; Recalibrate.	Analyst/Supervisor	

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
	CCV	Analyze a standard at the beginning and end of the sequence and after every 10 environmental samples.	The acceptance criterion for the continuing calibration standard ± 10% of the initial curve.	Recalibrate and/or perform the necessary equipment maintenance. Check the calibration standard. Reanalyze the affected data.	Analyst/Supervisor	
	CCB	Immediately following CCV and at the end of the sequence.	The result must be < RL.	Correct the problem, then reprepare and reanalyze calibration blank and previous 10 samples.	Analyst/Supervisor	
GC/MS SW-846 8260B	Tune Standard	Prior to initial calibration and every 12 hours	See Laboratory SOP	Reanalyze, retune mass spectrometer; no samples may be analyzed without a valid tune.	Laboratory Analyst	SOP BR-MV-006
GC/MS SW-846 8260B	Five-point calibration	Before sample analysis, when CCVs indicate calibration is no longer valid; after major instrument maintenance	Option 1: Mean relative standard deviation (RSD) for all analytes ≤ 20% Option2: Linear Regression: r > 0.995	Instrument maintenance, standard, inspection, recalibration	Laboratory Analyst	SOP BR-MV-006
GC/MS SW-846 8260B	Initial Calibration Verification	Immediately after each initial calibration	%R ± 25% of true value	Correct problem and verify second source standard. If that fails repeat calibration.	Laboratory Analyst	SOP BR-MV-006
GC/MS SW-846 8260B	Continuing Calibration Verification	Beginning of each 12-hour window after the tune standard	See Laboratory SOP	See Laboratory SOP	Laboratory Analyst	SOP BR-MV-006

QAPP Worksheet #24 -- Analytical Instrument Calibration Table (cont.)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
Incubators	Temperatures checked daily during weekdays	Thermometers calibrated biannually	Must match temperature range in log book	Report/discontinue use/Repair	QA officer	034-039
Scales	Checked monthly	Vendor calibrator annually	Must match range in QC packet	Report/discontinue use/Repair	QA officer	034-039
Microscopes	Micrometer checked	Vendor calibration and maintenance annually	Must be uniform with analyst verification	Report/discontinue use/Repair	QA officer	034
Pipettors	Checked quarterly	Vendor calibrator annually	Must match range in QC packet	Report/clean/Repair	QA officer	034-039

QAPP Worksheet #25 – Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table

Identify all analytical instrumentation that requires maintenance, testing, or inspection and provide the SOP reference number for each. In addition, document the frequency, acceptance criteria, and corrective action requirements on the worksheet.

Instrument / Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference[1]
TOC – 5310C	Check Oxygen supply Persulfate supply Acid supply Carrier gas flow rate (~ 150 cc/min) IR millivolts for stability (after 30 min. warm-up) Reagent reservoirs	TOC	Check injection port septum after 50-200 runs. Tube end-fitting connections after 100 hours or use. Indicating drying tube. NDIR zero, after 100 hours of use. Sample pump, after 2000 hours for use. Digestion vessel/condensation chamber, after 2000 hours of	As needed	CCV +/- 10%	Recalibrate and/or perform the necessary equipment maintenance. Check the calibration standards. Reanalyze the affected data	Analyst/ Supervisor	029- PT-WC-017

Instrument / Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference[1]
			use. Permeation tube, after 2000 hours of use. NDIR cell, after 2000 hours of use					
GC	Replace Septa, Clean and replace Injection Port Liner, Replace or clip Guard Column Replace or clip Analytical Column Bake, Re-foil, Refurbish Detector		Check Septa, Injection Port Liner, Guard Column and Analytical Column	As required	Passing calibration	Perform maintenance, check standards, recalibrate	Laboratory Analyst	SOP BR-QAM
GC/MS (VOA)	Clean Injection Port and Liner, Change Septa, Cut 2-3 inches from GC Column, Fill Autosampler rinse vials, Clean Purge and Trap mount and purge vessel		Check Injection Port and GC columns, Check autosampler rinse vials, check purge and trap mount and purge vessel, check Purge Flow	As required	Passing calibration	Perform maintenance, check standards, recalibrate	Laboratory Analyst	SOP BR-QAM

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference[1]
Carlo Erba Elemental Analyzer	Oven maintenance	Lloyd Kahn	Pass calibration and blank checks	Daily	Linear Regression r $\geq$ 0.995 ICB < RL CCV 85-115 %	Perform Maintenance, Check Standards, Recalibrate, Reanalyze	Assigned Lab personnel	006
Costech Elemental Combustion System	Oven maintenance	Lloyd Kahn	Pass calibration and blank checks	Daily	Linear Regression r $\geq$ 0.995 ICB < RL CCV 85-115 %	Perform Maintenance, Check Standards, Recalibrate, Reanalyze	Assigned Lab personnel	006
HRMS	Injection port maintenance, clean ion volume, clean source, replace filament	Refer to Worksheet #24	Refer to Worksheet #24	As needed	Refer to Worksheet #24	Refer to Worksheet #24	Analyst	002-KNOX-ID-0013
HRMS	Tune instrument to maximize sensitivity and mass resolution	Refer to Worksheet #24	Refer to Worksheet #24	Daily	Refer to Worksheet #24	Refer to Worksheet #24	Analyst	002-KNOX-ID-0013
HRMS	Change carrier gas filters	Refer to Worksheet #24	Refer to Worksheet #24	Yearly	Refer to Worksheet #24	Refer to Worksheet #24	Analyst	002-KNOX-ID-0013
HRMS	Change mechanical pump fluid	Refer to Worksheet #24	Refer to Worksheet #24	Yearly	Refer to Worksheet #24	Refer to Worksheet #24	Analyst	002-KNOX-ID-0013

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference[1]
LRMS	Injection port maintenance, clean source, replace filament	Refer to Worksheet #24	Refer to Worksheet #24	As needed	Refer to Worksheet #24	Refer to Worksheet #24	Analyst	003-KNOX-ID-0018
LRMS	Tune to maximize sensitivity and mass resolution	Refer to Worksheet #24	Refer to Worksheet #24	As needed	Refer to Worksheet #24	Refer to Worksheet #24	Analyst	003-KNOX-ID-0018
Scales	Clean, calibrate	Vendor tests yearly	As needed and yearly	Monthly	As documented in log books	Report/repair	QA Officer	036, 037,038,039, 040
Microscopes	Clean	Vendor tests yearly	As needed and yearly	As needed and yearly	As documented in log books	Report/repair	QA Officer	036
Pipettors	Clean, change o-ring	Vendor tests yearly	As needed and yearly	As needed and quarterly	As documented in log books	Report/repair	QA Officer	036, 037,038,039, 040

[1]Specify the appropriate reference letter or number from the Analytical SOP References table (Worksheet #23).

QAPP Worksheet #26 – Sample Handling System

Use this worksheet to identify components of the project-specific sample handling system. Record personnel, and their organizational affiliations, who are primarily responsible for ensuring proper handling, custody, and storage of field samples from the time of collection, to laboratory delivery, to final sample disposal. Indicate the number of days field samples and their extracts/ digestates will be archived prior to disposal.

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): GEI Consultants Field Team supervised by the Field Team Leader will collect samples.
Sample Packaging (Personnel/Organization): GEI Consultants Field Team
Coordination of Shipment (Personnel/Organization): GEI Consultants Field Team
Type of Shipment/Carrier: Federal Express for Overnight Delivery or courier to the laboratory
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): Assigned laboratory personnel
Sample Custody and Storage (Personnel/Organization): Assigned laboratory personnel
Sample Preparation (Personnel/Organization): Assigned laboratory personnel
Sample Determinative Analysis (Personnel/Organization): Assigned laboratory personnel
SAMPLE ARCHIVING
Field Sample Storage (No. of days from sample collection): Samples will not be stored in the field, but will be kept in cooler at 4 degree C and shipped within 24 hours of collection. If due to an emergency they are stored in the field, they will be kept in a cooler or transferred to a refrigerator kept at 4 degrees C.
Sample Extract/Digestate Storage (No. of days from extraction/digestion): Sample extraction and digestion will be conducted according to the SOPs and the requirements given in Worksheet 19.
Biological Sample Storage (No. of days from sample collection): NA
SAMPLE DISPOSAL
Personnel/Organization: Test America Laboratories Sample Custodians
Number of Days from Analysis: At least 60 days

QAPP Worksheet #26 – Sample Handling System (cont.)

Sample Handling System

Sample handling and custody procedures ensure the timely, correct, and complete analysis of each sample for all parameters requested. A sample is considered to be in a person's custody if it is in:

- his/her possession;
- his/her view, after being in his/her possession;
- his/her possession and has been placed in a secure location; or
- a designated secure area.

Sample custody documentation provides a written record of sample collection and analysis. The sample custody procedures provide for specific identification of samples associated with an exact location, the recording of pertinent information associated with the sample, including time of sample collection and any preservation techniques, and a Chain of Custody (COC) record which serves as physical evidence of sample custody. Custody procedures will be similar to the procedures outlined in the USEPA's Contract Laboratory Program Guidance for Field Samplers (USEPA, 2007). The COC documentation system provides the means to individually identify, track, and monitor each sample from the time of collection through final data reporting. Sample custody procedures are developed in three areas: sample collection, laboratory analysis, and final evidence files, which are described below.

Field Sample Handling and Custody

Field records provide a means of recording information for each field activity performed at the Site. COC procedures document pertinent sampling data and all transfers of custody until the samples reach the analytical laboratory. The sample packaging and shipment procedures summarized below will ensure that the samples arrive at the laboratory with the COC intact. Worksheet 19 lists the specific sample preservation requirements for each test method.

QAPP Worksheet #26 – Sample Handling System Field Procedures (cont.)

The general responsibilities of the field team are listed below:

- The field sampler is personally responsible for the care and custody of the samples until they are transferred to the Sample Management Officer (SMO) or until they are properly dispatched. As few people as possible should handle the samples.
- The Field Team Leader, or designee, is responsible for entering the proper information in the field logbook, including all pertinent information such as sample identification number, date and time of sample collection, type of analysis, and description of sample location. The information entered into the field log book will be used to generate a COC.
- All sample containers will be labeled with the project identification, sample identification, matrix, type of analysis required, and preservation requirements.
- The samples will be properly preserved, bagged, and packed into coolers. The original COC form will be placed into the lead cooler and will be shipped to the laboratory.
- The SMO or designee will review all field activities to determine whether proper custody procedures were followed during the field work and if additional samples are required.

Field Records

The field log book will provide the means of recording data collection activities. Entries will be described in as much detail as possible, so that persons going to the Project Properties can reconstruct a particular situation without reliance on memory. At the beginning of each field day, the date, start time, weather, and names of all sampling team members present will be entered. The names of visitors to the Project Properties and the purpose of their visit will also be recorded. All field measurements, as well as the instrument(s), will be noted.

Samples will be collected following the sampling procedures documented in the workplan. Observations such as sampling conditions or any problems will also be recorded. Sample identification numbers will be assigned at the time the data are entered in the logbook. Field duplicate samples, which will receive a unique sample identification number, are “blind” to the laboratory and will be identified under the sample description so that they can be associated with their respective samples by project staff.

QAPP Worksheet #26 – Sample Handling System (cont.)

Sample Identification System

All samples collected from the Project Properties must be identified with a sample label in addition to an entry on a COC record. Indelible ink will be used to complete sample labels and handwritten COC records. Each sample will be identified by a unique sample number assigned by the field team as described in the workplan. The unique sample identification will include a sequential sample number, the well location identification (ID), and the type of sample and the depth of the sample, if applicable.

Sample Labels/Tags

Sample labels will require the field team to complete the following information for each sample container:

1. Sample Number;
2. Sample Matrix;
3. Parameters to be analyzed;
4. Date of Collection;
5. Time of Collection;
6. Preservation Method(s); and
7. Sampler's Name.

QAPP Worksheet #27 -- Sample Custody Requirements

Describe the procedures that will be used to maintain sample custody and integrity. Include examples of chain-of-custody forms, traffic reports, sample identification, custody seals, laboratory sample receipt forms, and laboratory sample transfer forms.

Field Sample Custody Procedures (sample collection, packaging, shipment, and delivery to laboratory):
Samples will be collected per the procedures described in the workplan. The field sample custody procedures including sample packing, shipment, and delivery requirements are discussed in the text in Worksheets 17 and 26.

Laboratory Sample Custody Procedures (receipt of samples, archiving, disposal):
Each laboratory will have a sample custodian who accepts custody of the samples and verifies that the information on the sample labels matches the information on the COC. The sample custodian will document any discrepancies and will sign and date all appropriate receiving documents. The sample custodian will also document the condition of the samples upon receipt at the laboratory. The laboratory sample custody procedures ware discussed further in the following text.

Sample Identification Procedures:
The sample identification scheme that will be employed is described in the Surface Sediment Investigation Work Plan. Sample labeling procedures are discussed in the text in Worksheet 26.

Chain-of-Custody Procedures:
A COC record will accompany the samples from the time of sampling through all transfers of custody. The COC procedures are detailed in the following text.

QAPP Worksheet #27 -- Sample Custody Requirements (cont.)

Sample Custody Requirements:

Chain of Custody Procedure

The following information should be recorded on COC forms. All COC forms must be signed in ink:

- Project name and/or project number;
- Signature of SMO or designee;
- Sampling station number;
- Date and time of collection;
- Grab or composite sample designation;
- Sample matrix;
- Sampling location description;
- Field identification number;
- Analyses required;
- Preservation technique;
- Signatures and dates for transfers of custody; and
- (if applicable) Air express/shipper's bill of lading identification numbers.

The COC form serves as an official communication to the laboratory detailing the particular analyses required for each sample. The COC record will accompany the samples from the time of sampling through all transfers of custody. It will be kept on file at the laboratory where samples are analyzed and archived. Three copies of the COC form are created; one copy is retained by the Field Team Leader and two are sent to the laboratory. An electronic copy of each COC should be also made and kept in the project directory. The SMO or designee completes a COC record to accompany each shipment from the field to the laboratory.

The completed COC is put in a zip-lock bag and taped to the inside cover of the sample shipping container. If there is more than one container in a shipment, copies of the COC form will be placed in each container. Each container is then sealed with custody seals and custody is transferred to the laboratory.

QAPP Worksheet #27 -- Sample Custody Requirements (cont.)

Transfer of Custody and Shipment

The custody of samples must be maintained from the time of sampling through shipment and relinquishment to the laboratory. Instructions for transferring custody are given below:

- All samples are accompanied by a COC. When transferring custody of samples, the individuals relinquishing and receiving will sign, date, and note the time on the COC. This form documents sample custody transfer from the SMO or designee, through the shipper, to the analytical laboratory. Since a common carrier will usually not accept responsibility for handling COC forms, the name of the carrier is entered under "Received by," the bill-of-lading number is recorded in the comments section, and the COC form is placed in a zip-lock plastic bag and taped to the inside lid of the lead shipping cooler. Copies of the COC form will be placed in each additional cooler in a shipment.

- Samples will be packaged for shipment and either picked up at a pre-arranged location by the laboratory or dispatched to the appropriate laboratory via overnight delivery service. A separate COC record must accompany each shipment. Shipping containers will be sealed for shipment to the laboratory. Two custody seals will be applied to each cooler to document that the container was properly sealed and to determine if the container was tampered with during shipment. The custody seals will be placed on the coolers in such a manner that the custody seal would be broken if the cooler were opened (*i.e.*, diagonally opposite corners of the cooler lid).

- The original COC will accompany the shipment. A copy will be retained by the Field Team Leader.

- If the samples are sent by common carrier or air freight, proper documentation must be maintained. For example, the bill of lading must be retained by the Field Team Leader.

Laboratory Custody Procedures

The laboratory custody procedures will be equivalent to those described in the latest edition of the SOW. The following will be addressed in the laboratory custody SOPs:

- A designated sample custodian accepts custody of the samples and verifies that the information on the sample labels matches the information on the COC. The sample custodian will document any discrepancies and will sign and date all appropriate receiving documents. The sample custodian will also document the condition of the samples upon receipt at the laboratory.

QAPP Worksheet #27 -- Sample Custody Requirements (cont.)

- Once the samples have been accepted by the laboratory, checked and logged in, they must be maintained in accordance with laboratory custody and security requirements.
- To ensure traceability of samples while in the possession of the laboratory, a method for sample identification that has been documented in a laboratory SOP will be used to assign sample numbers.
- The following stages of analysis must be documented by the laboratory:
  - Sample Extraction/Preparation.
  - Sample Analysis.
  - Data Reduction.
  - Data Reporting.
- Laboratory personnel are responsible for the custody of samples until they are returned to the sample custodian.
- When sample analyses and QA checks have been completed in the laboratory, the used portion of the sample must be stored or disposed of in accordance with the protocols specified in the SOW or the subcontract agreement. Identifying labels, data sheets, COCs, and laboratory records will be retained until analyses and QA checks are completed in accordance with the protocols specified in the subcontract agreement.

Final Evidence Files

This is the final phase of sample custody. The COC records and sample analysis request form copies are archived in their respective project files. Laboratory custody forms, sample preparation and analysis logbooks, and data packages will become part of the laboratory final evidence file. Other relevant documentation including records, reports, and correspondence, logs, pictures, and data review reports will be archived by GEI Consultants.

Sample Holding Times

Information on sample holding times and required preservation for each test method are provided in Worksheet 19.

Sample Packaging and Shipping Requirements

Custody of samples must be maintained through the shipment of samples to the selected laboratory. All samples will be packaged and shipped at the end of each day unless other arrangements are made with the laboratory.

QAPP Worksheet #28 (UFP-QAPP Manual Section 3.4) -- QC Samples Table (cont.)

Matrix	Aqueous / Solid / Sediment / Tissue
Analytical Group	PCBs
Analytical Method/ SOP Reference	BR-GC-005

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	One per extraction batch of 20 or fewer samples	< LOQ	See laboratory SOP	TestAmerica Laboratory	Contamination	See worksheet 15 for lab CRQL
Surrogates	Each sample, standard, blank	See worksheet 15	See laboratory SOP	TestAmerica Laboratory	Accuracy/Bias	Per Laboratory SOP
Laboratory Control Sample	One per extraction batch of 20 or fewer samples	See worksheet 15	See laboratory SOP	TestAmerica Laboratory	Accuracy	Per Laboratory SOP
Matrix Spike/Matrix Spike Duplicates	Per client Request	See worksheet 15	See laboratory SOP	TestAmerica Laboratory	Accuracy/Bias and Precision	Per laboratory SOP
Method Detection Limits	Annual	Per Laboratory SOP	Reanalyze MDL	TestAmerica Laboratory	Sensitivity	Low enough to support CRQLs

QAPP Worksheet #28 (UFP-QAPP Manual Section 3.4) -- QC Samples Table (cont.)

Matrix	Sediment
Analytical Group	Total Organic Carbon
Concentration Level	Low
Sampling SOP	See Worksheet 20
Analytical Method / SOP Reference	Lloyd Kahn, 006
Analytical Organization	Test America, Inc Burlington VT
Number of Sample Locations	See Worksheet 18

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Equip blank	One per day per type of sampling equipment	Per laboratory SOP	Investigate source of contamination	Assigned Lab personnel	Accuracy/Bias	Per laboratory SOP
Matrix Spike/Matrix Spike Duplicates (MS/MSD)	Per client submission	Per laboratory SOP	None if blank spike passes	Assigned Lab personnel	Accuracy/Bias	Per laboratory SOP
Field Duplicate	1 per 20 field samples	QAPP	If the limits exceed limits for the field duplicate, this will be addressed by the GEI Data Reviewer	GEI Field Team Leader	Precision	RPD < 30% for duplicate for values greater than or equal to five times the CRQL
LFB Method Blank (MB)	Once per batch	QAPP	Re-prep Batch	Assigned Lab personnel	Sensitivity	Per laboratory SOP

QAPP Worksheet #28 (UFP-QAPP Manual Section 3.4) -- QC Samples Table (cont.)

Matrix	Aqueous / Solid / Sediment
Analytical Group	Volatile Organics
Analytical Method/ SOP Reference	BR-MV-006

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	Once every 12 hours	< LOQ	Reanalyze Batch	TestAmerica Laboratory	Contamination	See worksheet 15 for lab CRQL
Surrogates	Each sample, standard, blank	See worksheet 15	Reanalyze sample	TestAmerica Laboratory	Accuracy/Bias	Per Laboratory SOP
Laboratory Control Sample	Once every 12 hours	Per Worksheet 15	Reanalyze Batch	TestAmerica Laboratory	Accuracy	Per Laboratory SOP
Matrix Spike/Matrix Spike Duplicates (MS/MSD)	Each group of field samples in an SDG or each SDG, whichever is most frequent	See worksheet 15	None if laboratory control sample passes	TestAmerica Laboratory	Accuracy/Bias and Precision	Per laboratory SOP
Internal Standard	Each sample, standard, Blank	Area between 50-100% of area of daily calibration internal standard area	Reanalyze Sample	TestAmerica Laboratory	Instrument Performance	Per Laboratory SOP
Method Detection Limits	Annual	Per Laboratory SOP	Reanalyze MDL	TestAmerica Laboratory	Sensitivity	Low enough to support CRQLs

QAPP Worksheet #28 (UFP-QAPP Manual Section 3.4) -- QC Samples Table (cont.)

Matrix	Sediment
Analytical Group	PCB Congeners
Concentration Level	Low
Sampling SOP	See Worksheet 20
Analytical Method / SOP Reference	002
Analytical Organization	TestAmerica Knoxville, TN
Number of Sample Locations	See Worksheet 18

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	1 per batch (20 or fewer client samples)	No Target Analytes > EML	Reanalyze Method Blank (MB) and samples if instrument performance is believed to have contributed to MB failure. If sample results >20x blank or ND, report results. If analyte result in MB > RL and sufficient sample is available, re-prepare and reanalyze batch if project data quality objectives are not met or flag data in consultation with client.	Analyst/Section Supervisor/PM	Accuracy/Bias-Contamination	No Target Analytes > EML
Laboratory Control Sample	1 per batch (20 or fewer client samples)	Toxic/LOC Analytes percent recovery between 50% and 150%	Verify calculations. Reanalyze extract if instrument performance is believed to have contributed to LCS failure. If LCS recovery is high and the analyte is not detected, document excursion in narrative. If sufficient sample is available, re-prepare and reanalyze batch or flag data in consultation with client.	Analyst/Section Supervisor/PM	Accuracy/Bias	Laboratory SOP % Recovery Control Limits
Internal Standards	Every client sample field QC and lab QC sample	Percent recovery between 30% and 140%	Verify calculations. For low recovery calculate S/N ratio. If S/N is >= 10 and EDL <= EML report data as is and narrate.	Analyst/Section Supervisor/PM	Accuracy/Bias	Laboratory SOP % Recovery Control Limits

QAPP Worksheet #29 -- Project Documents and Records Table

This section identifies the documents and records that will be generated for all aspects of the project including, but not limited to, sample collection and field measurement, on- and off-site analysis, and data assessment.

Project Documents and Records Table

Sample Collection Documents and Records (as applicable):

- Field Notes and or data sheets
- Chain of Custody Forms
- Air bills
- Analytical and Testing Sample Data Packages
- Data Validation Reports

On-Site Activities Documents and Records:

- Sample collection and processing record and custody records.
- Sample custody records
- Air bills (if applicable)
- Custody records
- Copies of field notes

Off-Site Analysis Documents and Records

- Chain of Custody (COC) records will be made and stored in the project files
- Copies of air bills (if applicable) will be kept in project files

• Copies of all Analytical Data Deliverables stored in Lab and transferred to Project files, instrument calibration records, lab, raw data stored in electronically or in hardcopy. Laboratory electronic data deliverables (EDD) will be obtained in a NYS DEC EDD ("EqUIS") format.**Data Assessment Documents and Records**

- Project Records: Copies of all field notes must be sent to GEI Consultants, Inc.
- Project Records: Copies of COC must be kept by GEI Consultants, Inc.
- Field and/or lab inspection reports/checklists
- Corrective action documentation
- Data validation narratives

- QA Review sheet
- Copies of Form 1
- Final Report

This section describes the project data management process, tracing the path of the data from their generation to their final use or storage. All project data and information must be documented in a format useable to the project personnel.

Project Document Control System
Project documents will be controlled by the GEI Consultants, Inc. Project Manager who will maintain and distribute the hardcopies and electronic copies of the project documents, including any amendments. Electronic copies of project information will be maintained in the project directory on the server at GEI Consultants, Glastonbury, CT office, which is backed up at least once per day.

Data Recording
Data for this project will be collected by handwritten entries and will be recorded into field logbooks or on forms. Software may be the used to generate COC records and sample labels, or COCs and labels may be created manually. Computer-generated data associated with laboratory analyses will be managed under the control of the laboratory's laboratory information management system (LIMS).

Laboratory Data Transmittal
Laboratory data are managed by the laboratory's LIMS system, beginning with sample check-in on the sample receiving data terminal. Full laboratory data reports will be delivered to GEI Consultants, Inc. and will include electronic data deliverables (EDDs).

Data Storage and Retrieval
Paper copies of the forms, electronic copies of files, and the photographic log will be transmitted regularly to the GEI PM or designee. The completed forms and notebooks will be stored in the custody of the PM for the duration of the project. The full laboratory data reports submitted to GEI Consultants, Inc. will be stored in the custody of the Project Quality Officer or designee.

The Laboratory will maintain copies of documents and backups of all data associated with the analyses of samples. Raw data and electronic media of all field samples, including QC samples and blanks, will be archived from the date of generation and will be kept by the laboratory. Hard copies of project files will be archived at a secure facility and retained until the end of the contract. Data will be transferred to National Grid upon completion of the project. Retrieval of data by others will be at the discretion of National Grid and the NYSDEC. The length of time that records will be archived will be at the discretion of the National Grid and NYSDEC.

Each laboratory will archive, electronically, the sample analyses and submit the electronic data files along with the data deliverable package. Laboratory electronic data deliverables (EDD) will be obtained in a NYS DEC EDD ("EqUIS") format.

QAPP Worksheet #30 – Analytical Services Table

Identify all laboratories or organizations that will provide analytical services for the project, including on-site screening, on-site definitive, and off-site laboratory analytical work. Group by matrix, analytical group, concentration, and sample location or ID number. If applicable, identify the subcontractor laboratories and backup laboratory or organization that will be used if the primary laboratory or organization cannot be used.

Matrix	Analytical Group	Concentration Level	Sample Locations/ID Numbers	Analytical SOP	Data Package Turnaround Time	Laboratory/ Organization	Backup Laboratory/Organization
Sediment Samples							
Sediment	PCBs USEPA Method 8082A	Low	See Worksheet 18	001	Validation Level Data Package: Fifteen Business Days	TestAmerica-Burlington, VT	A backup lab has not been assigned at this time
Sediment	PCB Congeners USEPA Method 1668A	Low	See Worksheet 18	002	Validation Level Data Package: Fifteen Business Days	TestAmerica-Knoxville, TN	A backup lab has not been assigned at this time
Sediment	Total Organic Carbon USEPA Method Lloyd Kahn	Low	See Worksheet 18	003	Validation Level Data Package: Fifteen Business Days	TestAmerica-Burlington, VT	A backup lab has not been assigned at this time
Sediment	Grain Size ASTM D422	Standard	See Worksheet 18	004	Validation Level Data Package: Ten Business Days	TestAmerica-Burlington, VT	A backup lab has not been assigned at this time

Note: Environmental data suppliers (labs) will provide accredited information by the NYSDOH ELAP in appropriate analytical categories.

QAPP Worksheet #31 – Planned Project Assessment Table

Identify the type, frequency, and responsible parties of planned assessment activities that will be performed for the project.

Assessment Type	**Frequency**	**Internal or External**	**Organization Performing Assessment**	**Person(s) Responsible for Performing Assessment** (title and organizational affiliation)	**Person(s) Responsible for Responding to Assessment Findings** (title and organizational affiliation)	**Person(s) Responsible for Identifying and Implementing Corrective Actions (CA)** (title and organizational affiliation)	**Person(s) Responsible for Monitoring Effectiveness of CA** (title and organizational affiliation)
Field Safety Audit	Discretionary	Internal	GEI	GEI Corporate Health and Safety Officer	GEI PMs	GEI PMs	GEI PMs
Contractor Performance Evaluation	Monthly or as warranted	External	National Grid	National Grid delegate	GEI PMs	GEI PMs	GEI PMs

QAPP Worksheet #32 – Assessment Findings and Response Actions

For each type of assessment describe procedures for handling QAPP and project deviations encountered during the planned project assessments.

PROJECT ASSESSMENT TABLE

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Party responsible for performing assessment	Person(s) responsible for responding to assessment findings	Person(s) responsible for identifying and implementing corrective actions
Field Sampling Assessment	Project commencement and as needed.	Internal	GEI	Field Team Leader/Project Safety Officer, GEI, Inc.	Project Manager, GEI	Project Manager, GEI
Fixed Laboratory Technical Systems Audit	As needed.	External	GEI	Project QA/QC Officer, GEI, Inc.	Project Manager, Project Laboratory	Project Manager, Project Laboratory

Field Oversight

Field oversight of the project will be conducted by the Task Manager/Field Leader on a daily basis. The Task Manager/Field Leader will oversee the field samplers and subcontractors to see that the work goes smoothly and according to the site-specific plans. Corrective actions will be addressed immediately in the field and any issues that might possibly impact the data will be documented in the field notes.

Field Sampling Assessment

An assessment of field sampling procedures would take place on-Site early in the field program so that necessary corrective action measures can be implemented, if required. The assessment would consist of an evaluation by the Field Team Leader and Project Safety Officer of sampling techniques, field parameter measurements, record keeping including log books and COCs, sample collection and handling sample design, subcontractor oversight and health and safety.

QAPP Worksheet #32 – Assessment Findings and Response Actions (cont.)

Fixed Laboratory Technical Systems Audit

A laboratory technical systems audit would consist of a review of any, but not necessarily all, of the following: sample handling procedures, equipment condition and operation, analytical methods and procedures and overall conformance with SOPs provided in this QAPP. The audit may span a period of one or more days, so that the audit team can view various types of analytical procedures that will be used on the project.

Assessment Findings and Corrective Action Responses

Deficiencies that are found as a result of the audits will be communicated both verbally to the responsible party upon discovery and will also be documented in a written audit report. A formal corrective action response in writing will be requested from the responsible party. The response will document the reason for the deficiency and the actions that will be put in place to correct the deficiency. Corrective action responses will be filed in the project files.

Additional QAPP Non-Conformances

The corrective action procedures discussed in this section will also be applied to significant deviations from procedures outlined in this QAPP. Project personnel who determine that a deviation has occurred will document the deviation and notify the GEI project manager. The project manager will evaluate the severity of the deviation, document deviations, and implement corrective action procedures as appropriate.

QAPP Worksheet #33 – Planned Project Assessment Table

Identify the frequency and type of planned QA Management Reports, the project delivery dates, the personnel responsible for report preparation, and the report recipients.

Type of Report	Frequency (daily, weekly monthly, quarterly, annually, etc.)	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation (Title and Organizational Affiliation)	Report Recipient(s) (Title and Organizational Affiliation)
Data Validation Report	After laboratory data are received	Within 30 days after receiving the full deliverable	Data Validator	Project QC Officer and Project Manager

The National Grid PM will receive various types of management reports, such as the results of the data validation reports. In addition, monthly progress report, provided to National Grid and USEPA, may contain a section on quality control issues. Problems or issues that arise between regular reporting periods may be identified to program management. The progress report will include an assessment of problems with the measurement data, including accuracy, precision, completeness, representativeness, and comparability.

QAPP Worksheet #34 – Sampling and Analysis Verification (Step 1) Process Table

Describe the processes that will be followed to verify project data. Describe how each item will be verified, when the activity will occur, and what documentation is necessary, and identify the person responsible. *Internal* or *external* is in relation to the data generator.

Verification Input	Description	Internal/ External	Responsible for Verification (Name, Organization)
Chain of custody (COC)	Form will be internally reviewed upon completion and verified against field logs and laboratory reports. Review will occur with the completion of each report.	I	GEI Consultants, Inc.
Field report	Field reports will be verified with the field logbooks.	I	GEI Consultants, Inc.
Laboratory data packages	Laboratory data packages will be used to verify the reported results in the project report and against QAPP criteria.	I	GEI Consultants, Inc.

Data Verification

- The Field Team Leader or designee is required to review the logbook entries for errors or omissions. This information is transmitted to the Project QC Officer or designee for correction.

- In addition, the Project QC Officer or designee is responsible for reviewing field data for completeness and to verify that the field crew followed the QC requirements detailed in this QAPP (*e.g.*, the collection of QC samples at the required frequency, response checking the field instruments). If any problems with the information are found, the Project QC Officer or designee will document the problems.

The Project QC Officer or designee reviews the field data.

QAPP Worksheet #35 – Sampling and Analysis Validation (Steps IIa and IIb) Process Table

Describe the processes that will be followed to validate project data. Validation inputs include items such as those listed in Table of the UFP-QAPP Manual (Section 5.1). Describe how each item will be validated, when the activity will occur, and what documentation is necessary and identify the person responsible. Differentiate between steps IIa and IIb of validation.

Step IIa/IIb	Validation Input	Description	Responsible for Validation (Name, Organization)
IIa	Methods	Records support implementation of SOP in QAPP.	GEI Consultants, Inc
IIa	Chain of Custody	Examine traceability of data from sample collection to generation of project report	GEI Consultants, Inc
IIb	Deviations from SOP and project documents.	Determine impacts of any deviation from methods and the project plan.	GEI Consultants, Inc

QAPP Worksheet #36 – Sampling and Analysis Validation (Steps IIa and IIb) SummaryTable

Identify the matrices, analytical groups, and concentration levels that each entity performing validation will be responsible for, as well as criteria that will be used to validate those data.

Step IIa/ IIb	Matrix	Analytical Group1	Concentration Level	Validation Criteria	Data Validator (title and organizational affiliation)
IIa/ IIb	Sediment/solid and Tissue	Chemical Parameters	Low to High	NYSDEC Validation Criteria*	Lorie MacKinnon, GEI Consultants, Data Validator
IIa/ IIb	Sediment/solid and tissue	Chemical/Geotechnical Parameters	Low to High	NYSDEC Validation Guidance* and Laboratory SOP Criteria	Lorie MacKinnon, GEI Consultants, Data Validator

[1]. Analytical data on chemical parameters produced by subcontract laboratories will be reviewed by a qualified data validator assigned by GEI.

*Validation will be performed in accordance with the NYSDEC DER-10 based on a Category B NYSDEC ASP Category B Data Deliverable, followed by validation per *USEPA Region II Functional Guidelines for Evaluating Organic Analyses* (September 2006b).

QAPP Worksheet #37—Data Usability Assessment

Summarize the usability assessment process and all procedures, including interim steps and any statistics, equations, and computer algorithms that will be used:
The GEI Consultants' data validator will validate chemical data in accordance with the protocols outlined on Worksheet 35. Data validation alone does not insure usability of the data. Other factors will be considered, including comparison of actual reporting limits achieved by the lab on the samples collected to the project action levels and data needs.

Describe the evaluative procedures used to assess overall measurement error associated with the project:
As part of the data validation process, the validator identifies any qualifications, the bias (if known) of the data, applies qualifiers and comments on the usability of the data. Once the validation package is received from the validator it is reviewed by the Project Quality Officer or a designee. Any QA/QC problems with the validation will be discussed with the validator and laboratories. Data will be compared to appropriate reference limits provided in Worksheet No. 15.

Identify the personnel responsible for performing the usability assessment:
The usability of the data is the responsibility of the project team. The PMs will reconvene the project team after all data has been validated and reviewed. The data users performing the remediation design will participate in a usability assessment to determine if the data is sufficient to meet the data needs and the project DQOs, and will recommend if additional data is required. A data assessment report will be issued by the PM or his designee documenting the results of the usability assessment review performed by the project team. The report will be submitted to the USEPA and National Grid for their approval and regulatory review.

Describe the documentation that will be generated during usability assessment and how usability assessment results will be presented so that they identify trends, relationships (correlations), and anomalies:
The Data Validation Report will present the findings of the data evaluation processes. Resulting data quality and conformance with evaluation guidelines will be presented.

References

American National Standards Institute, 1994. *Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs* (ANSI/ASQC E4-1994).

National Institute of Occupational Safety and Health, 1985. “Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities” (October1985, DHHS NIOSH Publication No. 85-115, as amended).

New York State Department of Environmental Conservation (1998) *Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations* (Division of Water Technical and Operational Guidance Series 1.1.1)

New York State Department of Environmental Conservation (NYSDEC), 2010, *DER-10 Technical Guidance for Site Investigation and Remediation*.

NYSDEC. 2005. Analytical Services Protocol (ASP)

USEPA, 1988b. "Standard Operating Safety Guides" (OSWER, 1988).

USEPA, 1990. “Guidance for Data Usability in Risk Assessment,” (OSWER Directive #9285.7-05, October 1990);

USEPA, 1996. SW-846, “Test Methods for Evaluating Solid Waste,” Including Promulgated Final Update III. 3rd Edition. December 1996.

USEPA, 2000. *Guidance for the Data Quality Objectives Process*, EPA QA/G-4.

USEPA, 2002a. *Guidance for Quality Assurance Project Plans*. USEPA QA/G-5.

USEPA. 2002b. *Guidance on Choosing a Sampling Design for Environmental Data Collection, for Use in Developing a Quality Assurance Project Plan*. EPA QA/G-5S Final. USPA. EPA/240/R-02/005. December.

USEPA, 2004a. *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual* (Part E, Supplemental Guidance for Dermal Risk Assessment).

USEPA, 2004b. *Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*, OSWER 9240.1-45 EPA 540-R-04-004, October 2004

USEPA, 2005a. “Uniform Federal Policy for Implementing Quality Systems”, (EPA-505-F-03-001, March 2005);

USEPA, 2005b. “Uniform Federal Policy for Quality Assurance Project Plans”, Parts 1, 2A, 2B, and 3, (EPA-505-B-04-900A, B and C, March 2005);

USEPA, 2005c. Contract Laboratory Program, Statement of Work for Organic Analysis, Multi-Media, Multi-Concentration (SOM01.1), May 2005.

USEPA, 2005d. SOP NO. HW-32 Standard Operating Procedure for Implementing the National Strategy for Procuring Analytical Services for All OSWER Programs (Superfund, RCRA, and Brownfields, Revision 5, March 17, 2005.

USEPA, 2006a. *Guidance on Systematic Planning using the Data Quality Objectives Process.* EPA/240/B-06/001; QA/G4. February 2006.

USEPA, 2006b. SOP NO. HW-37/Aroclor Validation of Data USEPA Contract Laboratory Program for Organic Analysis of Low/Medium Concentration of Aroclor Organic Compounds SOM01.1, Revision 0, April 2006.

USEPA, 2007a. Contract Laboratory Program Guidance for Field Samplers, OSWER 9240.0-44, EPA 540-R-07-06, July 2007.

USEPA, 2007b. Introduction to the Analytical Services Branch (ASB) Contract Laboratory Program, EPA 540-R-07-05, OWER 9240.0-42, January 2007.

USEPA, 2007c. Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review, OSWER 9240.1-46, EPA-540-R-04-003, July 2007.

USEPA, 2007d. Modifications Updating SOM01.1 To SOM01.2 October 5, 2005, (Updated 02-12-2007) Amended 04-11-2007).

USEPA, 2007e. Basic Manual for Electronic Data EPA Region 2, Version 1.1, November 2007.

Attachment A

Regulations and Guidance Documents

New York State
Department of Environmental Conservation

Division of Fish, Wildlife and Marine Resources

Technical Guidance for Screening Contaminated Sediments

GEORGE E. PATAKI, *Governor*

JOHN P. CAHILL, *Commissioner*

New York State Department of Environmental Conservation
Division of Fish, Wildlife and Marine Resources

Technical Guidance for Screening Contaminated Sediments

Change Sheet for January 25, 1999

This document is a reprint of the original "Technical Guidance for Screening Contaminated Sediments" that was first printed in November 1993, and subsequently reprinted in July 1994 and March 1998, with the following changes noted:

- Additional sediment screening values have been added to Table 1 for benzene, toluene, ethylbenzene, xylene, and nine polycyclic aromatic hydrcarbon compounds. The 13 new substances have not been integrated alphabetically into table 1. They are listed separately as an aditional page (page 25).

In all other respects, this edition is an exact reprint of the editions dated November 1993, July 1994, and March 1998 w/changes

New York State Department of Environmental Conservation
Division of Fish, Wildlife and Marine Resources

Technical Guidance for Screening Contaminated Sediments

Change Sheet for March 2, 1998

This document is a reprint of the original "Technical Guidance for Screening Contaminated Sediments" that was first printed in November 1993, and reprinted in July 1994, with the following changes noted:

- The Division of Fish and Wildlife and the Division of Marine Resources were merged into a single entity, the Division of Fish, Wildlife and Marine Resources

- New tables have been added for screening marine and estuarine sediments only. The new tables have been taken from Long et al (1995), and are included as appendix 4. These tables have been distributed with earlier editions of this document as an addendum since April 25, 1996. Wherever the current text makes reference to Table 2 for screening sediments for metals contamination, Table 3 in Appendix 4 should be used instead if the sediments are in marine or estuarine water bodies.

In all other respects, this edition is an exact reprint of the November 1993 and July 1994 document.

New York State Department of Environmental Conservation
Division of Fish and Wildlife
Division of Marine Resources

Technical Guidance for Screening Contaminated Sediment

22 November 1993

(reprinted July 1994, March 1998, January 1999)

This document describes the methodology used by the Division of Fish and Wildlife and the Division of Marine Resources for establishing sediment criteria for the purposes of identifying contaminated sediments. Sediments with contaminant concentrations that exceed the criteria listed in this document are considered to be contaminated, and potentially causing harmful impacts to marine and aquatic ecosystems. These criteria do not necessarily represent the final concentrations that must be achieved through sediment remediation. Comprehensive sediment testing and risk management are necessary to establish when remediation is appropriate and what final contaminant concentrations the sediment remediation efforts should achieve.

- ORIGINAL SIGNED -
Kenneth F. Wich
Director
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- ORIGINAL SIGNED -
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Director
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Table of Contents

1. Executive Summary

The Department of Environmental Conservation originally proposed sediment criteria in 1989, as an appendix of a Cleanup Standards Task Force Report. These criteria were controversial because the proposed methodology, equilibrium partitioning, had not yet been endorsed by the U.S. Environmental Protection Agency (EPA) Science Advisory Board, and because the criteria themselves were perceived as remediation target concentrations. This revised sediment criteria document was prepared to incorporate scientific literature published since 1989, and to establish the purpose of sediment criteria for screening; that is, to identify areas of sediment contamination and to make a preliminary assessment of the risk posed by the contamination to human health and the environment. Criteria are developed for two classes of contaminants - non-polar organic contaminants and metals. Non-polar organic contaminant criteria are derived using the equilibrium partitioning approach, which has now been endorsed by the EPA Science Advisory Board. This approach estimates the biological impacts that a contaminant may cause based on it's affinity to sorb to organic carbon in the sediment. The concentration of biologically available contaminant is predicted and related to potential toxicity and bioaccumulation by using existing criteria established for the water column. New York State water quality standards and guidance values are used to derive sediment criteria. EPA water quality criteria are used only when New York State has not published a standard or guidance value for a particular compound. Water quality criteria for bioaccumulation proposed by the Divisions of Fish and Wildlife and Marine Resources are used when no New York State water quality standard or guidance value for bioaccumulation has been developed.

Metals criteria are derived from Ministry of Ontario guidelines and NOAA data that make use of the screening level approach. This methodology measures the concentration of contaminants present in areas where ecological impacts have been noted, and correlates the contaminant concentration with the severity of the impact. Toxicity mitigating conditions such as acid volatile sulfides are not considered because with the screening level approach, the metal concentrations present are correlated directly to a measurable ecological impact. Finally, this document discusses risk management for contaminated sediment, and makes recommendations for implementing sediment criteria. Table 1 lists sediment criteria for 64 non-polar organic compounds or classes of compounds, and Table 2 lists sediment criteria for 12 metals.

II. Background and Objectives

The Department of Environmental Conservation originally proposed draft sediment criteria in December 1989 as Appendix D to the Draft Clean Up Standards Task Force Report (DEC 1991). These criteria were based on the EPA equilibrium partitioning (EP) model, which had at that time just been submitted to the EPA Science Advisory Board for review. Two problems developed relative to these criteria. The first was that the equilibrium partitioning model did not receive a complete endorsement by the EPA Science Advisory Board (EPA SAB 1990). The SAB raised questions about the degree of uncertainty, sources of variability, and applicability of EP-based sediment criteria. Secondly, the New York State sediment criteria were published in the context of a clean-up standards report for contaminated sediment remediation. The perception of the reviewers and potential users was that the criteria represented mandatory clean-up levels that must be achieved by remediation methodologies. Appendix D of the Draft Clean-up Standards Task Force Report did state that risk management decisions were necessary and appropriate in the application of the sediment criteria, but the perception remained that the low concentrations described therein were in fact the primary target levels for sediment remediation. This issue was further clouded by real-world environmental problems such as dioxin in the New York-New Jersey Harbor area. Dredging and dredge spoil disposal is necessary for continued harbor operation, but attainment of the dioxin sediment criterion described in Appendix D could be economically unachievable.

There were three objectives for revising the sediment criteria document. The first objective was simply to clarify the document, make it easier to read, and provide greater scientific documentation to support the information presented.

The second objective was to incorporate scientific literature that has been published since 1989. This revision will be based primarily upon an EPA Proposed Technical Support Document (TSD) for the Development of Sediment Quality Criteria (EPA 1991). The EPA TSD was also published verbatim in peer-reviewed scientific literature (DiToro et al., 1991). The revised sediment criteria document will also incorporate a new EPA Science Advisory Board Report that endorses the equilibrium partitioning methodology and commends the EPA for satisfactorily addressing many of the concerns noted in the original SAB review (EPA SAB 1992). Also, this revision incorporates the 1992 Ministry of Ontario Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario, for metals concentrations in sediment (Persaud et al., 1992). These guidelines were only draft in 1989, when the first sediment criteria document was produced.

The final objective of the revised document was to establish the role of EP-based sediment criteria as screening criteria; that is, for identifying areas of sediment contamination, and providing an initial assessment of potential adverse

impacts. While attainment of the EP-based sediment criteria will provide the maximum assurance of environmental protection, it is not necessary in all cases and at all times to achieve these criteria through remediation efforts. Risk assessment, risk management, and the results of further biological and chemical tests and analyses are vital tools for managing sediment contamination. To view sediment criteria in a one-dimensional, go/no go context is to miss potential opportunities for resource utilization through appropriately identified and managed risk.

Ill. Need, Basis, and Concept of Sediment Criteria

Sediments can be loosely defined as a collection of fine-, medium-, and course- grain minerals and organic particles that are found at the bottom of lakes [and ponds], rivers [and streams], bays, estuaries, and oceans (Adams et al., 1992). Sediments are essential components of aquatic [and marine] ecosystems. They provide habitat for a wide variety of benthic organisms as well as juvenile forms of pelagic organisms. The organisms in sediments are in constant contact with the sediments, and therefore, constant contact with any contaminants that may be adsorbed to the sediment particles. Potential impacts to benthic organisms include both acute and chronic toxicity with individual-, population-, and community- level affects, bioaccumulation of contaminants, and the potential to pass contaminants along to predators of benthic species (Adams, et al, 1992; Marcus, 1991; Milleman and Kinney, 1992).

Potential to harm benthic organisms is not the only adverse impact of contaminated sediments. They serve as diffuse sources of contamination to the overlying water body; slowly releasing the contaminant back into the water column (Marcus, 1991; DEC, 1989).

Contamination is a concept that is not always clearly defined relative to sediments. The mere presence of a foreign substance in a sediment could be construed as contamination. However, the presence of a foreign substance does not necessarily mean it is harmful. Metals can be present in naturally occurring concentrations (background levels) in species, or forms, that are not harmful to aquatic life. While there are no naturally occurring background concentrations for synthetic organic compounds, the presence of a synthetic organic compound does not necessarily imply harm. Some evaluation must be made to estimate the potential risk to aquatic life or human health that the compound will have.

The EPA has defined a contaminant as: "Any solid, liquid, semisolid, dissolved solid, gaseous material, or disease-causing agent which upon exposure, ingestion, inhalation, or assimilation into any organism, either directly from the environment or indirectly by ingestion through food chains, may . . . pose a risk of or cause death, disease, behavioral abnormalities, cancer, genetic mutations,

physiological malfunctions ... or physical deformations, in the organism or their offspring" (EPA, 1992). This definition clearly explains that a contaminant is not simply the presence of a foreign substance, but an element of harm to some organism, species, population, or community must be involved.

The EPA defines sediment criteria in the following manner: A sediment criterion is a specific level of protection from the adverse effects of sediment associated pollutants, for beneficial uses of the environment, for biota, or for human health ... (EPA, 1992). A sediment criterion, then, must relate to the element of harm that the contaminant possesses by specifying an appropriate level of protection. To develop sediment criteria, it is necessary to identify the potential elements of harm to the various organisms, populations, and communities that could be affected. The criterion must then specify the level of protection necessary to balance each identified element of harm.

A corollary of the EPA definition is that if the specified level of protection is not attained, then a certain level of risk exists. The concentration of a contaminant in sediment can be compared to a number of criteria and their associated levels of protection, to determine the overall potential risk posed by that particular contaminant concentration to various exposed organisms. Only if the contaminant concentration is less than all of the available criteria can exposure to the sediment, or to organisms that inhabit the sediment, be considered to be without significant risk from those contaminants (risk could still result from other sources, such as contaminants for which criteria have not yet been derived). This is the concept of screening criteria. By comparing the contaminant concentration to various criteria and their associated levels of protection, the resource manager can begin to identify the appropriate tests, studies, and procedures to quantify and refine the level of risk; set remediation goals; prioritize remediation actions; and select risk management and communications options.

EP-based sediment criteria are tied to water quality standards, guidance values, (DEC, 1991) and criteria (EPA, 1991)[1]. Within the framework of New York State water quality regulations, five primary levels of protection are identified (6NYCRR, 1991) from which sediment criteria can be derived. These are:

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[1]Water quality standards and guidance values are New York State regulatory terms that are essentially synonymous with the EPA term criterion. A standard is a water quality criterion that has been adopted into regulation. A guidance value is a water quality criterion that has been derived in the same manner as a standard, but has not yet been adopted into regulation, or subjected to public review and comment. When referring to water quality in this document, the use of the general term criteria will mean either a New York standard or guidance value.

A. Protection of human health from acute or chronic toxicity;

B. Protection of human health from toxic effects of bioaccumulation;

C. Protection of aquatic life from acute toxicity;

D. Protection of aquatic life from chronic toxicity;

E. Protection of wildlife from toxic effects of bioaccumulation.

Other levels of protection include fish flesh tainting, and aesthetics (taste, odor, or appearance). Human health-based criteria can be further subdivided into oncogenic (cancer causing) effects and non-oncogenic effects (6NYCRR, 1991). Unfortunately, water quality standards or guidance values do not usually exist for all five levels of protection simultaneously.

This document will identify a series of screening criteria concentrations for a number of contaminants that can be used to identify areas of sediment contamination, and evaluate the potential risk that the contaminated sediment may pose to human health or the environment. A contaminated sediment can be identified as one in which the concentration of a contaminant in the sediment exceeds any of the sediment criteria for that contaminant. Once a sediment has been identified as contaminated, a site-specific evaluation procedure must be employed to quantify the level of risk, establish remediation goals, and determine the appropriate risk management actions. The site-specific evaluation might include for example: additional chemical testing; sediment toxicity testing; or sediment bioaccumulation tests.

Sediment contaminants. primarily consist of heavy metals and persistent organic compounds (EPA, 1990). Sediment criteria for non-polar organic compounds are derived using equilibrium partitioning methodology (EPA, 1991, DiToro, et al., 1991). This document will derive sediment criteria for non-polar organic contaminants listed in the TOGS 1.1.1. (DoW, 1991), using the water quality standards and guidance values listed there. If a water quality criterion for a particular contaminant is not identified in TOGS 1.1.1., an EPA water quality criterion is used. These criteria are annotated with the suffix (E). Proposed water quality criteria for the protection of human health and piscivorous wildlife from bioaccumulative affects are derived using procedures identified in Appendix 1; Newell et a[. (1987); and 6NYCRR Parts 702.8 and 702.13. These criteria are annotated with the suffix (P). With the exception of PCBs, these water quality guidance values are not yet listed in TOGS 1.1.1.

Sediment criteria for metals are based upon procedures and data developed by the Ministry of Ontario (Persaud et al., 1992), and the National Oceanic and

Atmospheric Agency (NOAA) (Long and Morgan, 1990). Sediment criteria for polar organic compounds are not derived. Instead, contaminant concentrations in pore water should be compared directly to surface water quality criteria; see section V. Some polar organics such as phenolic compounds behave as non-polar compounds under conditions of neutral pH. For these compounds, EP-based sediment criteria can be derived. Both the equilibrium partitioning methodology and the Ministry of Ontario procedures are discussed below.

IV. Derivation of Sediment Quality Criteria for Non-polar Organic Compounds using Equilibrium Partitioning.

A. Characteristics of Non-polar Organics

Non-polar organic compounds are substances that contain carbon, and do not exhibit a net electrical (ionic) charge (Nebergall, et al. 1968). Non-polar organic contaminants tend to be of low solubility in water. Otherwise they would dissolve and not accumulate in sediments (Manahan, 1991). Many non-polar contaminants are highly soluble in lipids, and thus can be bioaccumulated. They are persistent, meaning they do not break down or degrade rapidly, and can remain in sediments for long periods of time. The International Joint Commission defines persistent compounds as compounds with a half life greater than 56 days (IJC, 1978). Some contaminants such as pesticides can cause direct, acute toxicity to exposed benthic organisms in low concentrations. Others such as DDT, PCB, and dioxin are more insidious and bioaccumulate over time to cause chronic toxicity effects such as reproductive failure, either in populations exposed directly to the contaminated sediment or to organisms further up the food chain (Rand and Petrocelli, 1985).

B. Fundamentals of Equilibrium Partitioning (EP)

The basis for the EP methodology for deriving sediment criteria is that the toxicity of a contaminant in a sediment is attributable to the fraction of the contaminant that dissolves in the interstitial pore water, and is considered to be freely biologically available. The EP methodology predicts the concentration of contaminant that will dissolve in the interstitial pore water from three factors: 1) the concentration of contaminant in the sediment; 2) the concentration of organic carbon in the sediment; and 3) the affinity of the contaminant for organic carbon in the sediment.

The affinity of a contaminant for sediment organic carbon can be directly measured. The sediment/water partition coefficient or K_P is a measure of the concentration of a contaminant sorbed to the sediment divided by the concentration dissolved in water (measured in l/kg), after mixing. The K_P is only useful as a site specific measure because the K_P will vary with different sediment

samples. The EPA (1991) reported that the organic carbon content of a sediment accounts for most of the variation in the uptake of the contaminant by the sediment. The K_{OC}, or sediment organic carbon/water partition coefficient is a measure of the concentration of contaminant that adsorbs to the organic carbon content of the sediment divided by the concentration dissolved in water, after mixing (measured in l/kg). When normalized for organic carbon, concentrations of a contaminant in different sediment samples are comparable. Another partition coefficient that is closely correlated with K_{OC} and is useful for predicting soil adsorption is the octanol/water partition coefficient, or K_{OW} (Kenaga, 1980). Voice, et al. (1983) citing Karickhoff (1979), reports that the relationship between the three coefficients can be described in two equations:

$$K_{OC} = K_P/f_{OC}$$

and

$$\log_{10}K_{OC} = \log_{10}K_{OW} - 0.21 \quad \text{(also in Kenaga, 1980)}$$

where f_{OC} is the fraction of solids by weight that is comprised of organic carbon.

The EPA (1991) refers to DiToro (1985) to define the relationship between K_{OC} and K_{OW} as:

$$\text{Log}_{10}K_{OC} = 0.00028 + 0.983\log_{10} K_{OW}$$

Using the DiToro (1 985) relationship, the Koc very nearly equals the K_{OW}. Using either relationship, it can be readily seen that the Koc and Kow for a given non-polar organic compound are very similar, and vary in direct proportion. In their initial review of the equilibrium partitioning methodology, the EPA SAB considered the equating of K_{OC} and K_{OW} to be a source of uncertainty (EPA SAB 1990). In their 1992 review, the EPA SAB states that uncertainties have diminished largely as a result of more accurate determination's of K_{OW}s, and that occasionally the Kow may not be a good predictor of the Koc (EPA SAB 1992).

When a non-polar organic contaminant enters the sediment, it will partition between the sediment and pore water in three compartments: a fraction will adsorb to the organic carbon in the sediment; another fraction will adsorb to dissolved organic carbon in the interstitial pore water; and a third fraction will dissolve in the pore water. An equilibrium will be established so that any change in the contaminant concentration in one compartment will result in a corresponding change in the contaminant concentration in other compartments. For example, if some of the contaminant dissolved in the pore water is removed, some of the contaminant adsorbed to the sediments will desorb to balance the loss from the pore water. If dissolved contaminant is added to the pore water, it will not all

remain in the pore water, but some will adsorb to dissolved organic carbon and sediment organic carbon, re-establishing the equilibrium. Interestingly, the EPA (1991) noted that an increase in the volume of dissolved organic carbon in the pore water causes contaminant sorbed to the sediment to desorb and in turn sorb to the dissolved organic carbon. The freely dissolved fraction of the contaminant remains practically unchanged.

Equilibrium partitioning methodology contends that sediment toxicity is attributable to the concentration of contaminant dissolved in the interstitial pore water and considered to be biologically available (EPA 1989, EPA 1991). It can be inferred, then, that a water quality criterion developed to protect aquatic life from contaminants dissolved in the water column should also protect benthic aquatic life from contaminant concentrations dissolved in pore water. The EPA (1991) compared the sensitivity of benthic organisms to the sensitivity of water column organisms to toxicity from the same chemicals, and found that they were very similar. Therefore the prediction that exceeding a water column-based criterion in sediment pore water would harm benthic organisms was considered valid.

C. Derivation of Sediment Criteria using Equilibrium Partitioning

To derive an organic carbon normalized sediment criterion, two items of information are required:

A. An ambient water quality criterion for a particular contaminant;

B. the K_{OW} partition coefficient for the contaminant;

For example, the PCB water quality criterion (see footnote 1 on page 4) for the protection of piscivorous wildlife from bioaccumulation is 0.001 ug/l. The K_{OW} for PCB is $10^{6.14}$, or 1,380,384.3 l/kg. The organic carbon normalized PCB sediment criterion (SCoc) would be:

$$SC_{OC} = WQC * K_{OW}$$

$$PCB\ SC_{OC} = 0.001\ /ug/l * 1{,}380{,}384.3\ l/kg * 1\ kg/1{,}000\ gOC$$

$$1.38\ (\approx 1.4)\ \mu g/gOC$$

1 kg/1,000 gOC is a conversion factor.

The meaning of the criterion is: based on the equilibrium partitioning characteristic of PCBs, in order not to exceed the water quality criterion of 0.001 ug/l in the pore water, the concentration of PCB in the sediment must not exceed 1.4 μg for each gram of organic carbon in the sediment.

To apply this SC_{OC} on a site specific basis, the concentration of organic carbon in the sediment at the site must be known. If a sediment sample was known to contain 3% organic carbon, the site specific sediment criterion (SC) for PCB could be derived:

$$SC = SC_{OC} * f_{OC}$$

f_{OC} = 3% OC/kg sediment = 30 gOC/kg

PCB SC = 1.4 μg/gOC * 30 gOC/kg = 42 μg PCB/kg sediment

This criterion states that: if there are less than 42 ug PCB/kg of sediment in a sediment containing > 3% organic carbon, there is no appreciable risk to piscivorous wildlife from consuming fish or other aquatic life from the water body over the contaminated sediment.

D. Limitations of Equilibrium Partitioning Derived Sediment Criteria

There are several limitations to the application of EP-based criteria:

1. EP-based criteria are only applicable to non-polar organic compounds, or other substances that behave as non-polar organic compounds in the sediment and prevailing environmental conditions, such as pH.

2. EP-based criteria apply only to the specific level of protection identified in the criterion. In the example above, the 42 μg/kg PCB concentration in the 3% sediment sample does not pose appreciable risk to wildlife, however, it may or may not pose a risk to human beings. A sediment criterion derived from a human health-based water quality criterion must be compared to make that determination.

3. EP-based criteria should only be derived for sediments with organic carbon fractions between approximately 0.2 - 12% (EPA SAB, 1992). Outside of this range, other factors that the EP methodology does not account for may influence contaminant partitioning.

4. The equilibrium partitioning method should not be applied to broad classes of compounds or mixtures if one K_{OW} value is used to represent the entire class or the mixture (EPA SAB, 1992). In this respect, PCB congeners would not be considered a broad class of compounds; they are a narrow class of quite similar compounds.

5. For compounds with a K_{OW} less than 100 ($\log_{10}K_{OW} \leq 2$), the water quality criterion can be greater than the site specific sediment quality

criterion. This implies that virtually all of the contaminant is biologically available. Since the water quality criterion delineates the concentration that is harmful to aquatic life, it is not reasonable that a smaller concentration in the sediments would be harmful to benthic organisms, especially considering that some fraction of the contaminant will be sorbed to the sediment and not biologically available. For these compounds, the organic carbon normalized sediment criterion should be derived in the manner described above. However, when determining the site specific criterion, compare the product of the SC_{OC} * f_{OC} with the water quality criterion, converted from a volumetric to mass units (μg/l * 1/kg = μg/kg). If the water criterion is greater than the site specific sediment quality criterion, use the water quality criterion as the sediment criterion. For example, the $\log_{10}K_{OW}$ of benzidine is 1.4. The SC_{OC} for the protection of benthic life (chronic toxicity), based on a TOGS 1.1.1. water quality criterion of 0.1 μg/l is 0.003 μg/gOC. If the sediment contained 3% organic carbon, the site specific SC would be 0.09 μg/kg. The water quality criterion (converted from a volumetric measure to a mass measure) of 0.1 μg/kg is greater, so the site specific sediment criterion should be 0.1 μg/kg. If the site contained 5% organic carbon the site specific sediment criterion would be 0.15 μg/kg, which is greater than the water quality criterion of 0.1 μg/I. In this instance, the 0.15 μg/kg would be the appropriate criterion to use.

6. Derivation of EP-based criteria assumes that an equilibrium between the sediment/pore water compartments has been achieved. Rand and Petrocelli (1985) indicate that the sorption-desorption equilibria are achieved rapidly, usually in a few minutes to several hours. Voice et al. (1983) found that in laboratory studies, equilibria were generally achieved in about 4 hours. In investigating contamination of stable sediments with long term exposure to a contaminant, it is likely that equilibrium has been achieved. However for spill sites, and areas with unstable sediments, attainment of the equilibrium condition may be questionable. The EPA SAB (1992) recommends that EP-based criteria not be used in areas of rapid deposition or erosion (e.g.>10 cm/yr), such as active dredge disposal areas, areas of heavy boat and barge traffic, and some river channels.

7. The EP methodology is not a highly accurate procedure in and of itself. Several related sampling and analysis procedures could introduce additional variation and uncertainty into the results. Some of these factors include: the value of the K_{OW} used and how it was derived; how the sediment sample was taken and analyzed for contaminant content; and how the organic content of the sediment sample (f_{OC}) was determined. For consistent application of sediment criteria, these factors must be considered systematically and consistently. ASTM (1993) recommendations should be followed for the proper collection, storage, and analysis techniques when

applying EP-based sediment criteria. The analysis method is particularly important for determination of sediment total organic carbon, because there are several methods available that may give variable results. The authors and EPA (1992b) recommend the use of catalytic combustion with nondispersive infrared carbon dioxide detection (Leonard, 1991) when developing total organic carbon-normalized criteria for non-polar organic compounds. However, unless the "true" K_{OW} differs by a factor of 10, or the 'true' f_{OC} differs by 50 - 100% from the K_{OW} and f_{OC} values used to derive the sediment criteria, the level of imprecision introduced into the criteria calculation will be minor. An EP-based criterion applies to a single sediment sample. Results obtained from composite samples may be misleading in that the contaminant concentration at a single point or depth might be diluted with uncontaminated samples. Conversely, a contaminated sample mixed with uncontaminated samples from other points or depths might cause a greater area appear to be contaminated than actually is.

8. There are still a number of uncertainties related to equilibrium partitioning-derived sediment criteria. These include such factors as particle size, particle density, organic carbon content, K_{OW}/K_{OC} relationship, route of exposure, the impact of dissolved organic carbon, and the uncertainty of extrapolating laboratory data to field conditions (EPA, 1991; EPA SAB, 1992). Despite these uncertainties, the EPA has found that sediment toxicity from laboratory experiments generally falls within a factor of 5 of the toxicity predicted by equilibrium partitioning. EP-based criteria are considered to be valid for screening and assessment. These preliminary assessments can be followed up with further testing if necessary to more accurately quantify risk.

Table 1 lists 52 non-polar organic compounds or classes of compounds for which sediment criteria have been derived using the equilibrium partitioning methodology. The derivation procedure is the same as that recommended by the EPA (1991). The only difference is that New York State water quality standards and guidance values are used instead of EPA ambient water quality criteria. EPA criteria have been used to derive a sediment quality criterion only when a New York standard or guidance value is not available. Four criteria, corresponding to four of the five levels of protection, are listed for each contaminant whenever possible. Sediment criteria are not derived for the protection of human health from toxicity, because that type of exposure would constitute human consumption of the interstitial pore water within the contaminated area, which is an unreasonable assumption. A sediment is considered to be contaminated if the contaminant concentration exceeds any of the criteria listed. The table also identifies the K_{OW} and the water quality criterion used to derive the sediment criterion. Water quality criteria are from DoW TOGS 1.1.1., unless suffixed with an (E), which indicates an EPA water quality criterion. Proposed water quality criteria for the protection of human health and piscivorous wildlife from bioaccumulative effects are used when

no TOGS 1.1.1. criterion for bioaccumulation has been developed. These criterion are annotated with the suffix (P), and are derived according to the method described in Appendix 1 and Newell et al. (1987).

V. Polar Organics - Application of Water Quality Criteria to Pore Water via Direct Measurement of Pore Water

For polar organics (except for phenols) no algorithms have been developed yet for sediment criteria that account for sediment characteristics which may affect substance toxicity. However, in order to screen sediments for potential impacts from polar organic compounds, interstitial (pore) water from sediment samples should not exceed existing water quality standards and guidance values for polar organics in TOGS 1. 1. 1.

The application of these criteria to pore water is complicated by dissolved organic carbon (DOC) in pore water that is generally much higher than DOC in the water column. DOC tends to reduce toxicity and bioaccumulation of chemicals by reducing their availability for uptake by the organism. However, even though water column DOC is usually low, water quality criteria are not modified to account for the effects of DOC. If the partitioning coefficient between DOC and water for a contaminant is known, that coefficient could be used to account for the effect of DOC on toxicity or bioaccumulation in the application of water quality criteria to pore water. The bioaccumulation of contaminants with low K_{OW} is generally not suppressed by water column DOC, indicating that the effects of DOC can probably be ignored. In any case, a conservative risk assessment is assured if the effects of DOC in pore water are ignored during a preliminary screening. In follow-on assessments, DOC affects should be evaluated. As a consequence, the water quality criteria becomes the pore water criteria, and sediment criteria per se are not derived for these compounds.

VI. Derivation of Sediment Quality Criteria for Metals

A. Characteristics of Metals as Sediment Contaminants

A wide variety of metals in a wide variety of forms can be found in marine and aquatic sediments. Some concentrations occur naturally, while others have been introduced through man's activities. Very low concentrations of most metals are required nutrients for living organisms, but in excess concentrations, metals can be harmful (Rand and Petrocelli, 1985). The properties that metals exhibit in water depend largely on the form in which the metal occurs (Manahan, 1991). In waterbodies, metals are typically found (Demayo et. a[, 1978):

1. Dissolved as free ions and complexes;

2. As particulates:

a. inorganic precipitates such as hydroxides, sulfide, carbonates, and sulfates;

b. sorbed onto or complexed with high molecular weight organic compounds or clay particles;

3. Mixed or sorbed to bottom sediments;

4. Incorporated into the tissues of biota.

The toxicity and bioavailability of metals in water [and sediment] vary with the form of the metals (EPA 1992a). The form of the metal, and thereby the toxicity of a metal, are highly influenced by environmental conditions such as pH, alkalinity, REDOX potential, and the availability of complexing ions or ligands. Very generally, it can be said that the dissolved fraction of metals seems to account for most toxicity, however, some particulate forms of some metals also exhibit toxicity (EPA 1992a).

Metals in water can generally be measured as total (total recoverable) dissolved metal. Currently, the EPA recommends using water effects ratios for evaluating the impact of metals on surface water quality (EPA 1993). Conduct toxicity tests using water from a specified site, and compare the toxicity with reference toxicity tests in relatively pure water. The resulting "water effects ratio" can then be used to adjust either a total recoverable metal criterion or effluent limitation, or dissolved metals water quality criterion (preferred in areas of highly variable suspended solids concentrations) to account for local conditions.

In sediments, metals exhibit the same variety of forms as in water; they can dissolve as ions or soluble complexes in the interstitial pore water, precipitate as organic or inorganic compounds, or sorb to binding sites in the sediment. The complexity of metals behavior in water and sediments makes it impossible to accurately predict the levels at which toxic effects will occur. For metals, the primary concern in sediments is toxicity to benthic organisms. Metals can bioaccumulate in organisms. Bioaccumulation of metals is highly variable and dependent on the form of the metal and how it enters the organism (Doull et al., 1980). Different organs and tissues will have different affinities for different metals and species of metals. Metals can be absorbed by an organism but be bound by proteins known as metallothioneins into relatively harmless forms. Toxicity of metals are dependent on many environmental conditions and are difficult at best to predict consistently.

B. Establishing Screening Level Concentrations

Because of the inability to predict biological affects from metals concentrations in sediment, the best alternative is to identify adverse ecological effects that are attributable to sediment-borne metals concentrations, and measure what concentration caused the adverse effect. The Ontario Ministry of the Environment issued metals guidelines derived by the "Screening Level Concentration" approach. This is an effects-based approach which uses field data on co-occurrence of benthic animals and contaminants (Persaud et al., 1992). The Ontario guidelines span background, lowest effect levels and severe effect levels. The methods used to derive these guidelines do not account for the effects of organic content, acid volatile sulfide concentration, particle size distribution or iron and manganese oxide content, or other toxicity-mitigating factors on the bioavailability of metals within the sediments, because the total metals concentration is related directly to an observed, measurable ecological effect. It is possible that this methodology might not discern toxicity from other compounds besides metals.

Long and Morgan (1990) reviewed and categorized chemical effects data in sediments according to low and median toxic effects ["Effects Range-Low (ER-L)" and "Effects Range-Median (ER-M)" concentrations] and "Overall Apparent Effects Thresholds" for benthic organisms observed in field studies across the nation. Effects levels reported were associated with bulk sediment concentrations without normalizing for any toxicity mitigating factors. For metals, effects levels in Long and Morgan (1990) may be compared with effects levels taken from Persaud et al. (1992). Both are based on a selection of observed effects from field studies, although Persaud et al. (1 992) is restricted to Great Lakes data while Long and Morgan (1 990) used both fresh and salt water data. For six metals (arsenic, cadmium, chromium, copper, lead and nickel), the lowest effects levels described by Persaud et al. (1992) are lower than the ER-L (effects range-low) from Long and Morgan (1990). This could be because in the relatively pure waters of Lake Ontario, fewer ligands were available to complex metal ions, so biological affects were noted at lower metals concentrations. The Long and Morgan (1990) study included more eutrophic waters, wherein, metals could be complexed to a greater extent into biologically unavailable forms. Exposed organisms were able to tolerate higher total metals concentrations because the greater fraction of metal present was biologically unavailable.

To establish screening criteria for sediments in New York State, two levels of protection as a basis sediment quality screening criteria were established, following the Ministry of Ontario Guidelines definitions. These are the Lowest Effect Level and the Severe Effect Level. The Lowest Effect Level indicates a level of sediment contamination that can be tolerated by the majority of benthic organisms, but still causes toxicity to a few species. The Severe Effect Level indicates the concentration at which pronounced disturbance of the sediment

dwelling community can be expected (Persaud et al. 1992). The ER-L and ER-M

from Long and Morgan (1990) were compared with the Lowest Effect Level and Severe Effect Level from Persaud et al. (1 990). The lowest concentration in each of the two effect levels was selected as the New York sediment screening criteria. These sediment criteria for metals are listed in Table 2. If a total metals concentration in a sediment sample is less than the Lowest Effect Level listed in Table 2, the effects of the metal in the sediment are considered to be acceptable. If the concentration is greater than the lowest effect level but less than the severe effect level concentration, the sediment is considered to be contaminated, with moderate impacts to benthic life. If the concentration is greater than the severe effect level, the sediment is contaminated and significant harm to benthic aquatic life is anticipated.

Background concentrations described in Persaud et al. (1992) were not used to establish criteria. For some metals, cadmium and copper for example, Persaud lists a Lowest Effect Level that exceeds the typical background concentration. Because a metal concentration in sediment is considered to be naturally occurring, or background, does not mean that the concentration is not causing an adverse ecological effect.

As noted above, metals guidelines from Persaud et al. (1992) are based on freshwater sediments only, and effects levels in Long and Morgan (1990) reflect data from both fresh and salt water. Although differences in the bioavailability of metals in fresh and salt water sediments may be elucidated in the future, at this time, the sediment criteria identified in Table 2 are considered suitable for identifying areas of metal contaminated sediment, assessing potential risk, and identifying suitable follow-up tests, studies, and risk management options in both fresh and salt water sediments.

C. Limitations to Sediment Criteria for Metals

There are limitations to the application of the metals sediment quality criteria listed in Table 2:

1. Persaud et al. (1 992) values are based on oligotrophic waters with low concentrations of metals-complexing ligands. These criteria are possibly over-protective when applied to more eutrophic waters. However, many streams and ponds in New York are oligotrophic, and the low effects concentrations are justified. These criteria are intended to be used for screening; that is, to identify potentially contaminated sites and provide a qualitative estimate of risk. Once a site is found to be contaminated with metals, further studies are necessary to quantify risk and determine if remediation actions are necessary. Remediation should not be based solely on exceedances of these criteria.
2. These criteria have limited applicability to mixtures of metals. Metals

criteria are most clearly applicable to sediments with high concentrations of a single metal, or situations where one metal has a disproportionately greater abundance in a sediment sample than any other metal. The presence of one metal can significantly affect the impact that another metal has on an organism. The effect can be synergistic, additive, or antagonistic (Eisler, 1993). A reasonable level of protection can be expected if none of the criteria are exceeded for metals that are present, however, effects may be present if the sum of the fractions of criteria over sediment concentrations exceed one, for all of the metals present. For example, in a sediment sample, four metals are detected. The concentration of each metal in the sediment sample is 0.3 of its corresponding sediment criterion. The sum of the fractions would be 1.2. In this case, further testing is warranted.

3. Total metals, or the bulk metals concentration should be measured in sediment samples.

VII. Use of Sediment Criteria in Risk Management Decisions

Once it has been determined that a sediment criterion is exceeded, more information is required to determine if remediation is necessary and what actual risks to the environment are present. The volume and location of sediment exceeding a criterion, which levels of protection are exceeded, the persistence of the contaminant, the uncertainty about the criteria, and the results of more detailed, site specific sediment tests all play a role in making decisions about how, and how much sediment to clean up in order to eliminate or minimize adverse effects. If the volume of sediment that exceeds sediment criteria is small and the sediment is fairly accessible, the remediation of all contaminated sediment may be the most expedient action. If volumes of sediment are large and/or difficult to remediate either because of accessibility, sensitivity of the impaired habitat, or lack of efficacious technology, further risk management evaluations are warranted. In general the areal extent of the contaminated sediments should be a factor in considering the need for, and method of remediation.

Once the source of contaminants to sediments is terminated, the length of time a particular area of sediments remain contaminated will depend on the persistence of the chemicals, and the site-specific characteristics of the sediment such as: rate of sedimentation; resuspension; and biological and chemical degradation. If a contaminant is not persistent (e.g. contaminant concentrations would be expected to fall to acceptable levels within six months to a year), and the effect of the contaminant is not severe, then sediment remediation may not be necessary. Even for a persistent contaminant, it may not be necessary to re-mediate the sediments if the contaminated area is a deposition zone, and the natural burying of the contaminated sediments beneath the zone of biological

activity and availability would be expected to occur within a short time, and resuspension of the contaminants was unlikely.

EPA SAB (1 992) examined a number of factors relating to the uncertainty of EP based sediment criteria, including sediment composition variability, measurement variation and Kow - Koc correlations and measurements. They report that all these variabilities amount to an estimated uncertainty factor of five. This suggests with good confidence that sediment criteria exceeded by a factor of five will result in the onset of toxicity. Toxicity could also result from sediment contaminant concentrations just below the sediment criterion. The EPA SAB (1992) identifies the range of concentrations from 1/5 - 5 times an EP-derived sediment criterion as a "grey" area, where observable impacts may or may not occur. Based on the statistical analysis of EP-derived sediment criteria, there is a high degree of confidence that contaminant concentrations -< 1/5 of a sediment criterion pose little or no risk. Similarly, if a contaminant concentration in sediment exceeds an EP-derived sediment criterion by a factor of 5, there is little or no doubt that adverse ecological impacts are occurring. Within the range in-between, the actual occurrence of effects is unknown. However, to avoid making the criteria excessively overprotective or under protective, the best use of the factor of 5 is in interpreting the results of sediment screening, not to modify the criteria.

The onset of chronic toxicity may be difficult to detect in natural systems. Water quality criteria designed to prevent acute toxicity are generally about ten times greater than comparable chronic criteria. Therefore, in general, sediments with contaminants at 50 times chronic toxicity sediment criteria concentrations (a factor of five for uncertainty and a factor of ten based on acute to chronic toxicity ratios), will result in the onset of acute toxicity to benthic animals with a high degree of confidence.

It must also be noted that with this uncertainty the possibility exists that the sediment criteria may be somewhat underprotective as well as than overprotective.

Sediment criteria for metals are based on empirical evidence from both lab and field studies without an attempt to normalize for any toxicity mitigating factors in the sediment. Variability of toxicity from metals in any given sediment is evident (Appendix 2). Many of the Lowest Effect Levels from Persaud et al. (1 992) are lower than the mean background concentrations in Great Lake sediments. This suggests that in some sediments relatively low levels of metals, even below mean background, are toxic, whereas in other sediments fairly high levels, up to and possibly even above background, may not be toxic. For all metals, the Severe Effect Level criteria exceeds mean background considerably; consequently, significant and noticeable toxicity is expected in all sediments that exceed that level of protection.

VIll. Implementation of Sediment Criteria for Screening

Implementation guidance can be outlined in a strategy to apply sediment criteria for screening areas suspected of sediment contamination and recommending actions to take if they are exceeded.

1. Compare sediment contaminant concentrations with sediment criteria

    a. Quantify the area and volume of sediment wherein the criteria is exceeded; determine whether biota are exposed to contaminated sediment, e.g. deeply buried sediments may be below active biological zones.

    b. Describe the significance of exceedances in terms of the predicted effects. For example, would bioaccumulation or toxicity be the predominant impact. Based on the levels of protection exceeded, evaluate whether impacts are expected to be isolated or widespread through the ecosystem of concern. Consider the potential for transport of contaminants by natural processes to other areas.

2. For naturally occurring substances such as metals, compare sediment concentrations in the area of interest with local background concentrations in areas known to be unaffected by anthropogenic sources of contamination. Evaluate sediments relative to sediment criteria to identify contaminated sites. Compare suspected contaminated sites with uncontaminated sites, looking for adverse ecological impacts.

3. If sediment concentrations of a compound are less than all of the sediment criteria for that substance, aquatic resources can be considered to be not at risk (from that compound). However, additional testing would be warranted if the concentration of numerous contaminants were just below the criteria thresholds.

4. If sediment contaminant concentrations exceed criteria, and especially if widespread in the area of interest, steps may be taken to verify the need for remediation:

    a. For sediments with non-persistent, non-polar organic contaminants that are not causing observable acute or significant chronic toxicity, further remedial investigation or sediment remediation is not necessary if the source of contamination will be eliminated and the sediment will cleanse itself. Many chemicals with $\log K_{OW} < 3$ can be expected to be non-persistent in sediments. If it is decided not to remediate sediments contaminated with non-persistent chemicals, then, assurance

must be made that water quality standards in offsite waters will not be contravened, and the public is informed of risks related to the contamination.

b. For sediments exceeding criteria based on aquatic life toxicity, including metals Lowest Effect Levels:

1. Assess the degree of impairment to the benthic community; compare site specific impairment with sediment contaminant concentrations; correlate site specific level of impairment with other known level of impairments and contaminant concentrations.

2. Collect sediment samples and conduct acute and chronic toxicity tests with fish and benthic invertebrates; correlate toxicity test results with sediment contaminant concentrations. It is important to follow established toxicity identification evaluation (TIE) techniques to ensure correct identification of the cause of toxicity, e.g. ammonia is a common cause of toxicity to benthic animals that can be mistakenly attributed to other toxics. Similarly, dissolved oxygen depletion in organically enriched sites such as wetlands could be confused with acute toxicity from contaminants.

3. For non-polar organic contaminants, exceedance of sediment criteria based on aquatic life chronic toxicity by a factor of 50 in a significantly large area indicates that biota are probably impaired and to achieve restoration of the ecosystem will require remediation of organic contaminants present.

4. For metals, if Severe Effect Levels are exceeded in significant portions of the ecosystem of concern, biota are most likely impaired and to achieve restoration of the ecosystem would likely require remediation of metals present.

C. For sediments exceeding criteria based on human health concerns:

1. Collect data on residues in edible, resident biota from the areas of concern and compare with tolerances, action levels, guidance values, or 1×10^{-6} cancer risk levels, or

2. Collect sediment samples, expose representative edible biota to sediments, measure residue in biota.

d. For sediment contaminant concentrations exceeding sediment criteria for the protection of piscivorous wildlife:

1. Collect data on residues in resident prey of piscivorous wildlife and compare with fish flesh criteria for protection of wildlife.

2. Expose wildlife food supply to contaminated sediment and measure residues in the food supply; compare with food supply residue levels known to be toxic to wildlife.

If sediment concentrations and criteria are less than analytical detection limits, ecological assessments are necessary to measure toxicity of sediments or residues in organisms exposed to sediments suspected of contamination. Generally, it is reasonable to predict that some, possibly high, levels of toxicity or bioaccumulation may associated with contaminants in sediments below analytical detection.

Table 1. Sediment criteria for non-polar organic contaminants. Water quality criteria used are taken from Togs 1.1.1. If a water quality criterion was not listed in TOGS 1.1.1., then an EPA criterion was used. These are annotated with the suffix (E). EPA criteria were extracted from the "Water Quality Criteria Summary" chart (EPA, 1991). EPA water quality criteria for the protection of human health (bioaccumulation) were taken from the "Recalculated Values - Organisms Only" column. Wildlife (bioaccumulation) and Human Health (bioaccumulation) protection criteria were derived in Appendix 1, unless TOGS 1.1.1. (bioaccumulation) criteria already existed. Although these criteria are only proposed, they are useful as guidance for estimating potential human health risks. These criteria are annotated with a suffix (P), for "Proposed criteria values".

			Levels of Protection							
			Human Health Bioaccumulation		**Benthic Aquatic Life Acute Toxicity**		**Benthic Aquatic Life Chronic Toxicity**		**Wildlife Bioaccumulation**	
Contaminant	**LogK_{ow}**	**Fresh-FW Salt -SW Both -FS**	**Water Qual Criteria µg/l**	**Sediment Criteria µg/gOC**	**Water Qual Criteria µg/l**	**Sediment Criteria µg/gOC**	**Water Qual Criteria µg/l**	**Sediment Criteria µg/gOC**	**Water Qual Criteria µg/l**	**Sediment Criteria µg/gOC**
Acenapthene	4.33	FW SW						140(E)[2] 240(E)[1]		
Aldrin & Dieldrin	5.0	FS	0.001	0.1					0.0077 (P)	0.77
Azinphosmethyl	2.4	FW SW					0.005 0.01	0.001 0.003		
Azobenzene	3.82	FS	0.16 (P)	1.0						
Benzene	2.0	FS	6.0	0.6						
Benzo(a)pyrene[3]	6.04	FW SW	0.0012 0.0006	1.3 0.7						

[2]EPA proposed sediment quality criterion for the protection of benthic organisms.

[3]These values also apply to benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, indeno(1,2,3-cd)pyrene, and methylbenz(a)anthracene.

Contaminant	$LogK_{ow}$	Fresh-FW Salt -SW Both -FS	Levels of Protection: Human Health Bioaccumulation Water Qual Criteria µg/l	Human Health Bioaccumulation Sediment Criteria µg/gOC	Benthic Aquatic Life Acute Toxicity Water Qual Criteria µg/l	Benthic Aquatic Life Acute Toxicity Sediment Criteria µg/gOC	Benthic Aquatic Life Chronic Toxicity Water Qual Criteria µg/l	Benthic Aquatic Life Chronic Toxicity Sediment Criteria µg/gOC	Wildlife Bioaccumulation Water Qual Criteria µg/l	Wildlife Bioaccumulation Sediment Criteria µg/gOC
Benzidine	1.4	FW	0.1	0.003						
Bis(2-chloroethyl) ether	1.73	FS	0.5 (P)	0.03						
Bis(2-ethylhexyl) phthalate	5.3	FW					0.6	199.5		
Carbofuran	2.26	FW			10.0	1.82	1.0	0.2		
Carbon tetrachloride	2.64	FS	1.3 (P)	0.6						
Chlordane	2.78	FW SW	0.002 0.002	0.001 0.001	2.4 (E) 0.09 (E)	1.4 0.05	0.043 (E) 0.004 (E)	0.03 0.002	0.01 (P) 0.01 (P)	0.006 0.006
Chlorobenzene	2.84	FS			50.0	34.6	5.0	3.5		
Chloro-o-toluidine	≈2.0	FS	6.5 (P)	0.65						
Chlorpyrifos	5.11	FW SW			0.083 (E) 0.011 (E)	10.7 1.4	0.041 (E) 0.0056 (E)	5.3 0.72		
DDT, DDD, & DDE[4]	6.0	FW SW	0.00001 (P) 0.00001 (P)	0.01 0.01	1.1 (E) 0.13 (E)	1100 130	0.001 (E) 0.001 (E)	1.0 1.0	0.001 0.001	1.0 1.0
Diazinon	1.92	FW					0.08	0.007		
Dichlorobenzenes	3.38	FS			50.0	120.0	5.0	12.0		
1,2 Dichloroethane	1.48	FS	24.0 (P)	0.7						
1,1 Dichloroethylene	1.48	FS	0.8 (P)	0.02						

[4]Criteria for acute and chronic benthic toxicity apply to DDT only.

			Levels of Protection							
			Human Health Bioaccumulation		Benthic Aquatic Life Acute Toxicity		Benthic Aquatic Life Chronic Toxicity		Wildlife Bioaccumulation	
Contaminant	**LogK_{ow}**	**Fresh-FW Salt -SW Both -FS**	**Water Qual Criteria µg/l**	**Sediment Criteria µg/gOC**	**Water Qual Criteria µg/l**	**Sediment Criteria µg/gOC**	**Water Qual Criteria µg/l**	**Sediment Criteria µg/gOC**	**Water Qual Criteria µg/l**	**Sediment Criteria µg/gOC**
Dieldrin	5.0	FW SW	0.001 0.001	0.1 0.1				9.0 (E)[5] 17.0 (E)		
Diphenylhydrazine	3.03	FS	0.54 (E)	0.58						
Endosulfan	3.55	FW SW			0.22 0.034	0.78 0.12	0.009 0.001	0.03 0.004		
Endrin	5.6	FW SW	0.002	0.8				4.0 (E)[1] 0.73 (E)[1]	0.0019 (P)	0.8
Fluoranthene	5.19	FW SW						1020 (E)[1] 1340 (E)[1]		
Heptachlor & Heptachlor Epoxide	4.4	FW SW	0.00003 (P) 0.00003 (P)	0.0008 0.0008	0.52 (E) 0.053 (E)	13.1 1.3	0.0038(E) 0.0036(E)	0.1 0.09	0.001	0.03
Hexachlorobenzene	6.18	FW	0.0001 (P)	0.15	6.0 (E)	9081	3.68 (E)	5570	0.008 (P)	12
Hexachlorobutadiene	3.74	FW SW	0.06 (P) 0.06 (P)	0.3 0.3	10.0 3.0	55.0 16.4	1.0 0.3	5.5 1.6	0.7 (P) 0.7 (P)	4 4

[5]EPA proposed sediment quality criteria for the protection of benthic organisms.

			Levels of Protection							
			Human Health Bioaccumulation		Benthic Aquatic Life Acute Toxicity		Benthic Aquatic Life Chronic Toxicity		Wildlife Bioaccumulation	
Contaminant	**LogK_{ow}**	**Fresh-FW Salt -SW Both -FS**	**Water Qual Criteria µg/l**	**Sediment Criteria µg/gOC**	**Water Qual Criteria µg/l**	**Sediment Criteria µg/gOC**	**Water Qual Criteria µg/l**	**Sediment Criteria µg/gOC**	**Water Qual Criteria µg/l**	**Sediment Criteria µg/gOC**
Hexachlorocyclohexanes	3.8	FW SW	0.009 (P) 0.009 (P)	0.06 0.06	2.0 0.16	12.6 1.0	0.01 0.004	0.06 0.03	0.23 (P) 0.23 (P)	1.5 1.5
Hexachlorocyclopentadiene	3.99	FW SW			4.5 0.7	44.0 6.8	0.45 0.07	4.4 0.7		
Isodecyldiphenyl phosphate	5.4	FW			22	5526	1.7	427		
Linear Alkyl Benzene Sulfonates	3.97	FW					40	373		
Malathion	2.2	FS					0.1	0.02		
Methoxychlor	4.3	FS					0.03	0.6		
Mirex	5.83	FS	0.0001 (P)	0.07			0.001	0.7	0.0055 (P)	3.7
Octachlorostyrene	≈6.0	FS							0.0005 (P)	0.5
Parathion and Methyl Parathion	2.5	FW			0.065 (E)	0.02	0.008	0.003		
Pentachlorophenol	5.0	FW			1.0	100	0.4	40		
Phenanthrene	4.45	FW SW						120 (E)[6] 160 (E)[1]		
Phenols, total chlorinated	2.75	FW					1.0	0.6		

[6]EPA proposed sediment quality criteria for the protection of benthic organisms.

			Levels of Protection							
			Human Health Bioaccumulation		Benthic Aquatic Life Acute Toxicity		Benthic Aquatic Life Chronic Toxicity		Wildlife Bioaccumulation	
Contaminant	**LogK_{ow}**	**Fresh-FW Salt -SW Both -FS**	**Water Qual Criteria µg/l**	**Sediment Criteria µg/gOC**	**Water Qual Criteria µg/l**	**Sediment Criteria µg/gOC**	**Water Qual Criteria µg/l**	**Sediment Criteria µg/gOC**	**Water Qual Criteria µg/l**	**Sediment Criteria µg/gOC**
Phenols, total unchlorinated	2.0	FW					5.0	0.5		
PCB	6.14	FW SW	0.0000006 0.0000006	0.0008 0.0008	2.0 (E) 10.0 (E)	2760.8 13803.8	0.014 (E) 0.03 (E)	19.3 41.4	0.001 0.001	1.4 1.4
2,3,7,8-TCDD	7.0	FS	0.000001	0.01					$2x10^{-8}$ (P)	0.0002
1,1,2,2-Tetrachloroethane	2.56	FS	0.7 (P)	0.3						
Tetrachloroethylene	2.88	FS	1.0	0.8						
o-Toluidine	1.4	FS	18.0 (P)	0.5						
Toxaphene	3.3	FW SW	0.009 (P) 0.009 (P)	0.02 0.02	1.6 0.07	3.2 0.14	0.005 0.005	0.01 0.01		
Trichlorobenzenes	4.26	FS			50	910	5	91		
1,1,2-Trichloroethane	2.17	FS	4.0 (P)	0.6						
Trichloroethylene	2.29	FS	11.0	2.0						
Triphenyl phosphate	4.59	FW			40	1556	4	156		
Vinyl Chloride	0.6	FS	18.0 (P)	0.07						

			Levels of Protection							
			Human Health Bioaccumulation		Benthic Aquatic Life Acute Toxicity		Benthic Aquatic Life Chronic Toxicity		Wildlife Bioaccumulation	
Contaminant	**LogK_{ow}**	**Fresh-FW Salt -SW Both -FS**	**Water Qual Criteria µg/l**	**Sediment Criteria µg/gOC**	**Water Qual Criteria µg/l**	**Sediment Criteria µg/gOC**	**Water Qual Criteria µg/l**	**Sediment Criteria µg/gOC**	**Water Qual Criteria µg/l**	**Sediment Criteria µg/gOC**
Anthracene	4.45	FW			35	986	3.8	107		
Benz(a)anthracene	5.61	FW			0.23	94	0.03	12		
Benzene	2.13	FW SW			760 670	103 90	210 190	28 26		
Ethylbenzene	3.15	FW SW			150 41	212 58	17 4.5	24 6.4		
Fluorene	4.18	FW SW			4.8 23	73 348	0.54 2.5	8 38		
Isopropylbenzene (cumeme)	3.66	FW			23	105	2.6	12		
2-methylnaphthalene	3.86	FW SW			42 48	304 348	4.7 4.2	34 30		
Naphthalene	3.37	FW SW			110 140	258 328	13 16	30 38		
Pyrene	5.32	FW			42	8775	4.6	961		
Toluene	2.69	FW SW			480 430	235 211	100 92	49 45		
1,2,4-trimethylbenzene	3.75	FW SW			290 170	1631 956	33 19	186 107		
Xylene	3.15	FW SW			590 170	833 240	65 19	92 27		

Table 2. Sediment Criteria for Metals. Two levels of risk have been established for metals contamination in sediments. These are the Lowest Effect Level and the Severe Effect Level. The Lowest Effect Level for each metal is the lowest of either the Persaud et al. (1992) Lowest Effect Level or the Long and Morgan (1990) Effect Range-Low. Similarly, the Severe Effect Level for each metal is the lowest of either the Persaud et al. (1992) Severe Effect Level or the Long and Morgan (1990) Effect Range-Moderate. A sediment is considered contaminated if either criterion is exceeded. If both criteria are exceeded, the sediment is considered to be severely impacted. If only the Lowest Effect Level criterion is exceeded, the impact is considered moderate. The units are µg/g, or ppm, except for iron, which is listed as a percentage. An "L" following a criterion means that it was taken from Long and Morgan (1990); a "P" following a criterion indicates that it is from Persaud et al. (1992). Complete tables from both sources can be found in appendix 2.

Metal	Lowest Effect Level µg/g (ppm)	Severe Effect Level µg/g (ppm)
Antimony	2.0 (L)	25.0 (L)
Arsenic	6.0 (P)	33.0 (P)
Cadmium	0.6 (P)	9.0 (L)
Chromium	26.0 (P)	110.0 (P)
Copper	16.0 (P)	110.0 (P)
Iron (%)	2.0% (P)	4.0% (P)
Lead	31.0 (P)	110.0 (L)
Manganese	460.0 (P)	1100.0 (L)
Mercury	0.15 (L)	1.3 (L)
Nickel	16.0 (P)	50.0 (L)
Silver	1.0 (L)	2.2 (L)
Zinc	120.0 (P/L)	270.0 (L)

Appendix 1. Basis for the Water Quality Criteria Used for Deriving Sediment Criteria for the Protection of Human and Health and Piscivorous Wildlife from Bioaccumulation Effects.

This appendix provides the basis and calculations for ambient water quality criteria in Table 1 with the suffix (P), which were developed by the Divisions of Fish and Wildlife and Marine Resources for use in calculation of sediment criteria.

Human health (bioaccumulation) based criteria in Table 1 with the (P) suffix are derived according to the method in 6NYCRR 702.8.

$$\text{Water Quality Criterion, ug/l} = \frac{\text{ADI, ug/d}}{0.033 \text{ kg/d} \times \text{BF}}$$

where

ADI, ug/d = acceptable daily intake for humans taken from fact sheets supporting drinking water standards and guidance values in TOGS 1. 1. 1

0.033 kg/d = the human daily intake from fish consumption cited in Part 702.8, and

BF = bioaccumulation factor

Wildlife residue based criteria in Table 1 with the (P) suffix are derived according to the method in 6NYCRR 702.13.

$$\text{Water Quality Criterion, ug/l} = \frac{\text{A, mg/kg}}{\text{BF}}$$

where

A = a fish flesh criterion for protection of piscivorous wildlife taken from Newell et a[(1987), and

BF = Bioaccumulation Factor

Bfs for human health based criteria are about 3% lipid based, whereas the BCF's for wildlife based criteria are about 10% lipid based. BFs were determined as a best judgement from review of available information in EPA water quality criteria documents, EPA (1 979), and other scientific literature.

Aldrin and Dieldrin

Wildlife Residue Based Criterion

$$0.0077 \text{ mg/l} = \frac{0.12 \text{ mg/kg}}{15570}$$

Azobenzene

Human Health Residue Based Criterion

$$0.16 \text{ ug/l} = \frac{1 \text{ ug/d}}{0.033 \text{ kg/d} \times 179}$$

Bis (2-chloro-ethyl) ether

Human Health Residue Based Criterion

$$0.5 \text{ ug/l} = \frac{0.06 \text{ ug/d}}{0.033 \text{ kg/d} \times 4}$$

Carbon tetrachloride

Human Health Residue Based Criterion

$$1.3 \text{ ug/l} = \frac{0.8 \text{ ug/d}}{0.033 \text{ kg/d} \times 19}$$

Chlordane

Wildlife Residue Based Criterion

$$0.01 \text{ ug/l} = \frac{0.5 \text{ mg/kg}}{47020}$$

Chloro-o-toluidine

Human Health Residue Based Criterion

$$6.5 \text{ ug/l} = \frac{1.4 \text{ ug/d}}{0.033 \text{ kg/d} \times 15}$$

DDT, DDD & DDE

Human Health Residue Based Criterion

$$0.00001 \text{ ug/l} = \frac{0.02 \text{ ug/d}}{0.033 \text{ kg/d} \times 53610}$$

1.2-Dichloroethane

Human Health Residue Based Criterion

$$24 \text{ ug/l} = \frac{1.6 \text{ ug/d}}{0.033 \text{ kg/d} \times 2}$$

1,1-Dichlorethylene

Human Health Residue Based Criterion

$$0.8 \text{ ug/l} = \frac{0.14 \text{ ug/d}}{0.033 \text{ kg/d} \times 2}$$

Endrin

Wildlife Residue Based Criterion

$$0.0019 \text{ ug/l} = \frac{0.025 \text{ mg/kg}}{13240}$$

Heptachlor & Heptachlor Epoxide

Human Health Residue Based Criterion

$$0.00003 \text{ ug/l} = \frac{0.018 \text{ ug/d}}{0.33 \text{ kg/d} \times 15666}$$

Hexachlorobenzene

Human Health Residue Based Criterion

$$0.0001 \text{ ug/l} = \frac{0.04 \text{ ug/d}}{0.033 \text{ kg/d} \times 12000}$$

Wildlife Residue Based Criterion

$$0.008 \text{ ug/l} = \frac{0.33 \text{ mg/kg}}{40000}$$

Hexachlorobutadiene

Human Health Residue Based Criterion

$$0.06 \text{ ug/l} = \frac{1 \text{ ug/d}}{0.033 \text{ kg/d} \times 545}$$

Wildlife Residue Based Criterion

$$0.7 \text{ ug/l} = \frac{1.3 \text{ ma/kg}}{1818}$$

Hexachlorocyclohexanes

Human Health Residue Based Criterion

$$0.009 \text{ ug/l} = \frac{0.04 \text{ ug/d}}{0.033 \text{ kg/d} \times 130}$$

Wildlife Residue Based Criterion

$$0.23 \text{ ug/l} = \frac{0.1 \text{ mg/kg}}{433}$$

Mirex

Human Health Residue Based Criterion

$$0.0001 \text{ ug/l} = \frac{0.08 \text{ ug/d}}{0.033 \text{ kg/d} \times 18100}$$

Wildlife Residue Based Criterion

$$0.0055 \text{ ug/l} = \frac{0.33 \text{ mg/kg}}{60333}$$

Octachlorostyrene

Wildlife Residue Based Criterion

$$0.0005 \text{ ug/l} = \frac{0.02 \text{ mg/kg}}{40000}$$

2,3,7,8-Tetrachlorodibenzodioxin

Wildlife Residue Based Criterion

$$2 \times 10\text{-}8 \text{ ug/l} = \frac{0.000003 \text{ mg/kg}}{150{,}000}$$

1,1,2,2-Tetrachloroethane

Human Health Residue Based Criterion

$$0.7 \text{ ug/l} = \frac{0.4 \text{ ug/d}}{0.033 \text{ kg/d} \times 17}$$

0-Toluidine

Human Health Residue Based Criterion

$$18 \text{ ug/l} = \frac{1.2 \text{ ug/d}}{0.033 \text{ kg/d} \times 2}$$

Toxaphene

Human Health Residue Based Criterion

$$0.009 \text{ ug/l} = \frac{0.02 \text{ ug/d}}{0.033 \text{ kg/d} \times 67}$$

1,1,2-Trichloroethane

Human Health Residue Based Criterion

$$4 \text{ ug/l} = \frac{1.2 \text{ ug/d}}{0.033 \text{ kg/d} \times 9}$$

Vinyl Chloride

Human Health Residue Based Criterion

$$18 \text{ ug/l} = \frac{0.6 \text{ ug/d}}{0.033 \text{ kg/d} \times 1}$$

Appendix 2. The following tables are photocopied directly from Long and Morgan (1990) and Persaud et. al. (1992). They are presented here to provide further information about the metals criteria developed in Table 2., and the text above.

Copied directly from Persuad et. al. (1992)

Table 1: Provincial Sediment Quality Guidelines for Metals and Nutrients.
(values[a] in ug/g (ppm) dry weight unless otherwise noted)

METALS	No Effect Level	Lowest Effect Level	Severe Effect Level
Arsenic	-	6	33
Cadmium	-	0.6	10
Chromium	-	26	110
Copper	-	16	110
Iron (%)	-	2	4
Lead	-	31	250
Manganese	-	460	1100
Mercury	-	0.2	2
Nickel	-	16	75
Zinc	-	120	820
NUTRIENTS			
TOC (%)	-	1	10
TKN	-	550	4800
TP	-	600	2000

[a] - values less than 10 have been rounded to 1 significant digit. Values greater than 10 have been rounded to two significant digits except for round numbers which remain unchanged (e.g., 400).

"-" - denotes insufficient data/no suitable method.

TOC - Total Organic Carbon TKN - Total Kjeldahl Nitrogen TP - Total Phosphorus

(June 1992)

Copied Directly from Long and Morgan (1990)

Table 70. Summary of ER-L, ER-M, and overall apparent effects thresholds concentrations for selected chemicals in sediment (dry weight).

Chemical Analyte	ER-L Concentration	ER-M Concentration	ER-L:ER-M Ratio	Overall Apparent Effects Threshold	Subjective Degree of Confidence in ER-L/ER-M Values
Trace Elements (ppm)					
Antimony	2	25	12.5	25	Moderate/moderate
Arsenic	33	85	2.6	50	Low/moderate
Cadmium	5	9	1.8	5	High/high
Chromium	80	145	1.8	No	Moderate/moderate
Copper	70	390	5.6	300	High/high
Lead	35	110	3.1	300	Moderate/high
Mercury	0.15	1.3	8.7	1	Moderate/high
Nickel	30	50	1.7	NSD*	Moderate/moderate
Silver	1	2.2	2.2	1.7	Moderate/moderate
Tin	NA	NA	NA	NA	NA
Zinc	120	270	2.2	260	High/high
Polychlorinated Biphenyls (ppb)					
Total PCBs	50	400	7.6	370	Moderate/moderate
DDT and Metabolites (ppb)					
DDT	1	7	7	6	Low/low
DDD	2	20	10	NSD	Moderate/low
DDE	2	15	7.5	NSD	Low/low
Total DDT	3	350	117	No	Moderate/moderate
Other Pesticides (ppb)					
Lindane	NA	NA	NA	NSD	NA**
Chlordane	0.5	6	12	2	Low/low
Heptachlor	NA	NA	NA	NSD	NA
Dieldrin	0.02	8	400	No	Low/low
Aldrin	NA	NA	NA	NSD	NA
Endrin	0.02	45	2250	NSD	Low/low
Mirex	NA	NA	NA	NSD	NA
Polynuclear Aromatic Hydrocarbons (ppb)					
Acenaphthene	150	650	4.3	150	Low/low
Anthracene	85	960	11.3	300	Low/moderate
Benzo(a)anthracene	230	1600	7	550	Low/moderate
Benzo(a)pyrene	400	2500	6.2	700	Moderate/moderate
Benzo(e)pyrene	NA	NA	NA	NSD	NA
Biphenyl	NA	NA	NA	NSD	NA
Chrysene	400	2800	7	900	Moderate/moderate
Dibenz(a,h)anthracene	60	260	4.3	100	Moderate/moderate
2,6-dimethylnaphthylene	NA	NA	NA	NSD	NA
Fluoranthene	600	3600	6	1000	High/high
Fluorene	35	640	18.3	350	Low/low
1-methylnaphthalene	NA	NA	NA	NSD	NA
2-methylnaphthalene	65	670	10.3	300	Low/moderate
1-methylphenanthrene	NA	NA	NA	NSD	NA
Naphthalene	340	2100	6.2	500	Moderate/high
Perylene	NA	NA	NA	NSD	NA
Phenanthrene	225	1380	6.1	260	Moderate/moderate
Pyrene	350	2200	6.3	1000	Moderate/moderate
2,3,5-trimethylnaphthalene	NA	NA	NA	NSD	NA
Total PAH	4000	35000	8.8	22000	Low/low

* NSD = not sufficient data
** NA = not available

Appendix 3. Literature Cited

6NYCRR. 1991. New York Compilation of Codes, Rules, and Regulations, Volume 6, Section 703.5. The five primary levels of protection are not explicitly stated, but can be derived from table 2; Basis for Establishment of Standards.

Adams, W.J., Kimerle, R.A., and J.W. Barnett, Jr., 1992. Sediment Quality and Aquatic Life Assessment. Environmental Science and Technology 26(10):1865-1875.

ASTM, 1993. Standard Guide for Collection, Storage, Characterization, and Manipulation of Sediments for Toxicological Testing (El 391-93), American Society for Testing and Materials, Philadelphia, PA.

DEC, 1989. Nonpoint Source Assessment Report. New York Department of Environmental Conservation, Division of Water, Bureau of Water Quality Management.

DEC, 1991. New York Department of Environmental Conservation, DRAFT Cleanup Policy and Guidelines, Volume II-Appendix, Appendix D: Clean-up Criteria for Aquatic Sediments. Cleanup Standards Task Force.

Demayo, A., Davis, A.R., and M.A. Forbes, 1978. Forms of Metals in Water. Scientific Series No. 87, Fisheries and Environment Canada, Inland Water Directorate, Water Quality Branch, Ottawa, Canada.

DiToro, D.M., 1985. A Particle Interaction Model of Reversible Organic Chemical Sorption. Chemosphere 14:1503-1538.

DiToro, D.M., Zarba, C.S., Hansen, D.J., Berry, W.J., Swartz, R.C., Cowan, C.E., Pavlou, S.P., Allen, H.E., Thomas, N.A., and P.R. Paquin, 1991. Technical Basis for Establishing Sediment Quality Criteria for Nonionic Organic Chemicals by Using Equilibrium Partitioning. Environmental Toxicology and Chemistry, 10(l2): l541 - 1586.

Doull, J., Klassen, C.D., and M.O. Amdur, 1980. Toxicology: The Basic Science of Poisons. Macmillan Publishing Co., Inc., New York.

DoW, 1991. New York Department of Environmental Conservation, Division of Water, Technical and Operational Guidance Series Ambient Water Quality Standards and Guidance Values (Originator: John Zambrano) dated November 15, 1991.

Eisler, R. 1993. Zinc Hazards to Fish, Wildlife, and Invertebrates: a Synoptic Review. US Fish and Wildlife Service Biological Report 10 dated April 1993, Publications Unit, USFWS, 1849 C St., N.W., Mail Stop 130, Webb Building, Washington, D.C., 20240.

EPA, 1989. Briefing Report to the EPA Science Advisory Board on the Equilibrium Partitioning Approach to Generating Sediment Quality Criteria. US Environmental Protection Agency, EPA 440/5-89-002, Washington D.C.

EPA, 1990. Managing Contaminated Sediments. US Environmental Protection Agency, Sediment Oversight Technical Committee, EPA 506/6-90/002, Washington, D.C.

EPA, 1991. Proposed Technical Basis for Establishing Sediment Quality Criteria for Nonionic Organic Chemicals Using Equilibrium Partitioning. US Environmental Protection Agency, Office of Science and Technology, Health and Ecological Criteria Division, Washington, D.C. 20460.

EPA, 1992. Draft Outline, EPA's Contaminated Sediment Management Strategy: A Proposal for Discussion. US Environmental Protection Agency, Sediment Steering Committee.

EPA, 1992a. Interim Guidance on Interpretation and Implementation of Aquatic Life Criteria for Metals. U.S. Environmental Protection Agency, Health and Ecological Criteria Division, Office of Science and Technology.

EPA, 1992b. Sediment Classification Methods Compendium. US Environmental Protection Agency, Office of Science and Technology, Sediment Oversight Technical Committee, Washington, D.C.

EPA, 1993. Memorandum, from Martha G. Prothro, Acting Assistant Administrator for Water, subject: Office of Water Policy and Technical Guidance on Interpretation and Implementation of Aquatic Life Metals Criteria, dated 1 Oct 93.

EPA SAB, 1990. Evaluation of the Equilibrium Partitioning (EqP) Approach for Assessing Sediment Quality. US Environmental Protection Agency Science Advisory Board, Report of the Sediment Criteria Subcommittee of The Ecological Process and Effects Committee. EPA-SAB-EPEC-90-006.

EPA SAB, 1992. An SAB Report: Review of Sediment Criteria Development Methodology for Non-Ionic Organic Contaminants. U.S. Environmental Protection Agency Science Advisory Board, Sediment Quality Subcommittee of the Ecological Process and Effects Committee. EPA-SAB-EPEC-93-002.

IJC, 1978. Great Lakes Water Quality Agreement of 1978. International Joint Commission, Canada and the United States, Ottawa, Canada.

Karickhoff, S.W., Brown, D.S., and T.A. Scott, 1979. Water Res. 13, p 241.

Kenaga, E.E., and C.A.I. Goring, 1980. Relationship Between Water Solubility, Soil Sorbtion, Octanol-Water Partitioning, and Concentration of Chemicals in Biota. in Aquatic Toxicology, Proceedings of the Third Annual Symposium on Aquatic Toxicology, Eaton, Parrish, and Hendricks, editors. ASTM STP 707, Philadelphia, Pa.

Leonard, E., 1991. Standard Operating Procedures for Total Organic Carbon Analysis of Sediment Samples. US Environmental Protection Agency, Office of Research and Development, Environmental Research Laboratory, Duluth, MN.

Long, E.R., and L.G. Morgan, 1990. The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National States and Trends Program. National Oceanic Atmospheric Administration (NOAA) Technical Memorandum No. 5, OMA52, NOAA National Ocean Service, Seattle, Washington.

Manahan, S.E., 1991. Environmental Chemistry. Lewis Publishers, Inc., 121 South Main St., Chelsea, Michigan 48118.

Marcus, W.A., 1991. Managing Contaminated Sediments in Aquatic Environments: Identification, Regulation, and Remediation. Environmental Law Reporter, 21 ELR 10020-10032

Millemann, B. and E. Kinney, 1992. Getting to the Bottom of it: Threats to Human Health and the Environment from Contaminated Underwater Sediments. Coast Alliance.

Nebergall, W.H., Schmidt, F.C., and H.F. Holtclaw, Jr., 1968. General Chemistry. D.C. Heath and Company, Lexington, Massachusetts

Newell, A.J., Johnson, D.W., and L.K. Allen, 1987. Niagara River Biota Contamination Project: Fish Flesh Criteria for Piscivorous Wildlife. New York Department of Environmental Conservation, Division of Fish and Wildlife, Bureau of Environmental Protection, Technical Report 87-3.

Persaud, D., Jaagumagi, R., and A. Hayton, 1992. Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario. Ontario Ministry of the Environment, Queen's Printer for Ontario.

Rand, G.M., and S.R. Petrocelli, 1985. Fundamentals of Aquatic Toxicology. Hemisphere Publishing Corporation.

Voice, T.C., Rice, C.P., and W.J. Weber, Jr., 1983. Effects of Solids Concentration on the Sorptive Partitioning of Hydrophobic Pollutants in Aquatic Systems. Environmental Science and Technology 17(9):513-517.

Appendix 4. Change in the Guidance for Marine and Estuarine Sediments

The 22 November 1993, Technical Guidance for Screening Contaminated Sediments (reprinted July 1994) makes use of the sediment guidance values from a number of sources, including the ER-L and ER-M guidance values from Long and Morgan (1990). Long, MacDonald, Smith, and Calder (1995) further refined and enhanced the marine and estuarine data used by Long and Morgan (1990) and published new ERL and ERM specifically for marine and estuarine sediments. **For evaluation of risk from contaminants in marine and estuarine sediment,** the Division of Fish, Wildlife and Marine Resources will now use the Long et al (1995) guidance values rather than the Long and Morgan (1990) values. For non-polar organic compounds not listed in Long et al (1995) (Table 4, below), the equilibrium partitioning-derived values in Table 1. (pp 20-24 above) for saltwater should be used. The following Tables 3 and 4 are reproduced directly from:

Long, E.R., MacDonald, D.D., Smith, S.L., and F.D. Calder, 1995. "Incidence of Adverse Biological Effects Within Ranges of Chemical Concentrations in Marine and Estuarine Sediments". Environmental Management 19(1):81-97.

Table 3. ERL and ERM guideline values for trace metals (ppm, dry wt.) and percent incidence of biological effects in concentration ranges defined by the two values.

	Guidelines		Percent (ratios) incidence of effects[a]		
Chemical	ERL	ERM	<ERL	ERL-ERM	>ERM
Arsenic	8.2	70	5.0 (2/40)	11.1 (8/73)	63.0 (17/27)
Cadmium	1.2	9.6	6.6 (7/106)	36.6 (32/87)	65.7 (44/67)
Chromium	81	370	2.9 (3/102)	21.1 (15/71)	95.0 (19/20)
Copper	34	270	9.4 (6/64)	29.1 (32/110)	83.7 (36/43)
Lead	46.7	218	8.0 (7/87)	35.8 (29/81)	90.2 (37/41)
Mercury	0.15	0.71	8.3 (4/48)	23.5 (16/68)	42.3 (22/52)
Nickel	20.9	51.6	1.9 (1/54)	16.7 (8/48)	16.9 (10/59)
Silver	1.0	3.7	2.6 (1/39)	32.3 (11/34)	92.8 (13/14)
Zinc	150	410	6.1 (6/99)	47.0 (31/66)	69.8 (37/53)

[a]Number of data entries within each concentration range in which biological effects were observed divided by the total number of entries within each range.

Table 4. ERL and ERM guideline values for organic compounds (ppb, dry wt) and percent incidence of biological effects in concentration ranges defined by the two values.

	Guidelines		Percent (ratios) incidence of effects[a]		
Chemical	ERL	ERM	<ERL	ERL-ERM	>ERM
Acenaphthene	16	500	20.0 (3/15)	32.4 (11/34)	84.2 (16/19)
Acenaphthylene	44	640	14.3 (1/7)	17.9 (5/28)	100 (9/9)
Anthracene	85.3	1100	25.0 (4/16)	44.2 (19/43)	85.2 (23/27)
Fluorene	19	540	27.3 (3/11)	36.5 (19/52)	86.7 (26/30)
2-Methyl naphthalene	70	670	12.5 (2/16)	73.3 (11/15)	100 (15/15)
Naphthalene	160	2100	16.0 (4/25)	41.0 (16/39)	88.9 (24/27)
Phenanthrene	240	1500	18.5 (5/27)	46.2 (18/39)	90.3 (28/31)
Low-molecular weight PAH	552	3160	13.0 (3/23)	48.1 (13/27)	100 (16/16)
Benz(a)anthracene	261	1600	21.1 (4/19)	43.8 (14/32)	92.5 (25/27)
Benzo(a)pyrene	430	1600	10.3 (3/29)	63.0 (17/27)	80.0 (24/30)
Chrysene	384	2800	19.0 (4/21)	45.0 (18/40)	88.5 (23/26)
Dibenzo(a,h)anthracene	63.4	260	11.5 (3/26)	54.5 (12/22)	66.7 (16/24)
Fluoranthene	600	5100	20.6 (7/34)	63.6 (28/44)	92.3 (36/39)
Pyrene	665	2600	17.2 (5/29)	53.1 (17/32)	87.5 (28/32)
High molecular weight PAH	1700	9600	10.5 (2/19)	40.0 (10/25)	81.2 (13/16)
Total PAH	4022	44792	14.3 (3/21)	36.1 (13/36)	85.0 (17/20)
p,p'-DDE	2.2	27	5.0 (1/20)	50.0 (10/20)	50.0 (12/24)
Total DDT	1.58	46.1	20.0 (2/10)	75.0 (12/16)	53.6 (15/28)
Total PCBs	22.7	180	18.5 (5/27)	40.8 (20/49)	51.0 (25/49)

[a]Number of data entries within each concentration range in which biological effects were observed divided by the total number of entries within each range.

Attachment B

Field Standard Operating Procedures

Field Standard Operating Procedures

Reference Number	Title
PB-01	Field Notebook
PB-02	Equipment Decontamination
PB-03	Water Safety
PB-04	Sediment Sampling- Ponar or Shipex Grab Sampler
PB-05	Sample Handling and Chain of Custody
PB-06	Sample Handling
PB-07	YSI Quick Card
PB-08	Biological Tissue Sampling
PB-09	Semi-porous Surface Sampling
PB-10	Surface Water Sampling
PB-11	Mussel Tissue Extraction
PB-12	Sediment Sampling Using Vibracore Equipment

STANDARD OPERATING PROCEDURE

FD-001 Field Notebook and Boring Log Forms

1. Objective

Proper documentation of all site activities is a crucial part of the field investigation process. Documentation, relative to sampling procedures, includes sample labels, sample seals, field logbooks, boring log forms, chain of custody records, sample analysis request forms, and laboratory sample logs. The field notebook serves as a record of significant field activities performed or observed during the project. The field notebook provides a factual basis for preparing field observation reports, if required, and reports to clients and regulatory agencies. Example field notes are provided in Appendix A. The field notebook can be used to record all soil boring information or, if desired, a separate boring log form can be used to document all soil boring information. The boring log form provides a factual basis for generating graphical boring logs for inclusion in reports to clients and regulatory agencies. An example boring log form is provided in Appendix A.

2. Execution

- Use a separate all-weather bound notebook for each site/location/project number. If separate boring log forms are used for soil borings, use a new form for each boring.
- Write neatly using black or blue waterproof pen (or note if field conditions [i.e., cold or wet weather] require use of pencil).
- Write the project name, project number, book number (i.e., 1 of 3), and date on the front cover. On the inside cover, identify the project name, project number, and “Return Book To:” the office address of the project manager.
- Number all of the pages of the field book starting with the first entry.
- Record activities as they occur. If separate boring log forms are being used, the field notebook should refer to the particular form.
- Neatly cross out mistakes using a single line and initial them. Erasures are not permitted. If an error is made on a document assigned to one individual, that individual will make all corrections. The person who made the entry will correct any subsequent error discovered on an accountable document. All subsequent corrections will be initialed and dated.
- Sign or initial and date the bottom of every page with an entry. Place a diagonal line through unused portions of a page.
- Record the following information upon each arrival at the site:
    1. Date/time/weather/project number
    2. GEI personnel
    3. Purpose of visit/daily objectives

4. Record conversations with: [Recommendation - If possible, record telephone numbers of individual contacts for the site in the field notebook.]
5. Contractors
6. Clients
7. Visitors (include complete names, titles, and affiliations whenever possible).
8. GEI office staff
9. Landowners (site or abutters)
10. Note time of arrival and departure of individuals visiting the site

- Additional observations to record:
  1. Type and quantity of monitoring well construction materials used
  2. Use of field data sheets or electronic logging equipment (e.g. boring logs, monitoring well sampling logs, etc.)
  3. Ambient air monitoring data
  4. Locations and descriptions of sampling points
  5. Sample media (soil, sediment, groundwater, etc.)
  6. Sample collection method
  7. Number and volume of sample(s) collected and sample bottle preservatives used
  8. Sample identification number (s) and date and time of sample collection
  9. Approximate volume of groundwater removed before sampling
  10. Field observations
  11. Any field observations made such as pH, temperature, turbidity, conductivity, water level, etc.
  12. References for all maps and photographs of the sampling site(s)
  13. Information pertaining to sample documentation: bottle lot numbers/ dates, method of sample shipments, chain-of custody record numbers, and overnight shipping numbers.
  14. Surveying data (including sketches with north arrows)
  15. Changes in weather
  16. Rationale for critical field decisions
  17. Recommendations made to the client representative and GEI Project Manager
  18. Include a site sketch or representative site photograph of conditions at the end of the day, if required
  19. Time
  20. Summarize work completed/work remaining

- Place a diagonal line though and sign portions of pages not used or skipped
- Bottom of each page signed and dated

3. Limitations

- Only record facts.
- Allow time at the end of the day to write your journal, and make it a priority, even at the expense of observing time.
- Record all observations regardless of relevancy.
- Identify conditions or events that could affect/impede your ability to observe conditions.
- Do not use spiral notebooks because pages can be easily removed.

4. Field Book and Boring Log Form Maintenance

Field notebooks and boring log forms are the primary sources of factual information that is the basis for technical reports. As such, their physical condition must be protected and maintained.

- When possible, digital scans of all field documents should be made at the end of each day and saved to the GEI network server in the appropriate project files.
- If digital scans cannot be generated and saved, hard copies should be made and saved separately from the field book and boring log forms.
- Regardless, when a field project is completed and field staff have returned to the office, a complete digital scan of all documents will be generated and saved to the network server in the appropriate project files.
- All original hard copies will be stored in file cabinets in the office, along with other relevant project files and managed per GEI's document retention policies.

5. References

New Jersey DEP Field Sampling Procedures Manual, August 2005.

Yerington Mine Site SOP-03 Standard Operating Procedure Field Notes and Documentation, Revision 0 Revision Date: June 6, 2006.

6. Attachments

Attachment A - Example Field Notes

7. Contact

Jerry Zak

STANDARD OPERATING PROCEDURE

QA-001 Equipment Decontamination

1. Objective

This SOP describes methods used for preventing or reducing cross-contamination, and provides general guidelines for sampling equipment decontamination procedures. Preventing or minimizing cross contamination in sampled media and in samples is important for preventing the introduction of error into sampling results and for protecting the health and safety of site personnel. Removing or neutralizing contaminants that have accumulated on sampling equipment ensures protection of personnel from permeating substances, reduces or eliminates transfer of contaminants to clean areas, prevents the mixing of incompatible substances, and minimizes the likelihood of sample cross-contamination.

2. Execution

- Inspect equipment for cleanliness prior to moving onto a site and prior to relocating to each new sampling location. All contractor-provided equipment (augers, rods, spoons, backhoe buckets) shall be decontaminated by steam cleaning **prior to coming on site.**
- Equipment decontamination is a sequential procedure consisting of the following general steps: Alconox-solution wash (or equivalent non-phosphate detergent); potable water rinse; methanol wash, and three distilled-water rinses.
- Alconox solution is a mixture of approximately 1 cup of Alconox per 1 gallon of potable water. Alconox solution wash requires scrubbing the equipment with a brush soaked in Alconox solution and removing any visible contamination or dirt from the equipment.
- Before advancing each boring, drilling equipment (including augers, casing, rods, and washtub) must be decontaminated by steam cleaning.
- Split-spoon samplers must be decontaminated prior to collecting each sample. The split-spoon decontamination procedure includes: a gross wash and scrub in a bucket of Alconox solution; potable water rinse; methanol wash, and three distilled-water rinses.
- Pumps and tubing used for sample collection and well development must be decontaminated by flushing with a minimum of one gallon of potable water; then flushing with a minimum of one pint of methanol and rinsing twice with distilled water.
- For pumps and tubing, perform a final rinse of the sampling equipment with the water being sampled.

3. Limitations

- Do not store the deionized/distilled water in polyethylene bottles, use Nalgene, glass, or Teflon. Polyethylene may leach phthalates.
- Do not attempt to decontaminate string or rope - replace it.
- Due to eye and skin absorption hazards, safety glasses and gloves must be worn when handling decontamination solvents.
- The decontamination procedure may require modification based on site specific conditions and methods used should not interfere with the site-specific chemical analyses. The procedure may also require modification based on state regulations.
- Steam cleaning with potable water is an acceptable decontamination method for drilling equipment (i.e., augers).
- If sampling for metals, the decontamination procedure requires modification to include rinsing with a 1:1 nitric acid and rinsing with deionized water in place of distilled water.
- Dedicated equipment need not be decontaminated beyond initial decontamination prior to field use.

4. References

Environmental Response Team (ERT), US EPA. Sampling Equipment Decontamination, SOP No. 2006, Revision 0.0. August 11, 1994.

US EPA Region 9. Sampling Equipment Decontamination, SOP No. 1230, Revision 1.September 1999.

5. Attachments

None

6. Contact

Brian Conte

SUMMARY GUIDANCE

SS-001 Water Safety

1. Objective

The safe deployment and return of personnel during field activities while aboard a boat.

2. Execution

Boat safety practices will be conducted in general accordance with guidance provided in the United States Army Corps of Engineers (USACE) Safety and Health Requirements Manual (EM) 385-1-1. Personnel will board the barge at specified locations to be determined and agreed upon prior to field deployment. The following safety practices shall be adhered to:

- Every employee shall wear a Personal Flotation Device (PFD) at all times when underway aboard any boat less than 25 feet except when that boat is equipped with a fully enclosed cabin and the employee is inside. Boats under 25 feet must also, at a minimum, have Coast Guard approved PFDs on board for each person and at least one throwable flotation device, such as a seat cushion.
- For every boating activity, a trip plan must be communicated to someone in a position to know when you are overdue and take appropriate action.
- For every trip requiring more than one day, daily voice-radio communications with an appropriate base must be maintained.
- The consumption of alcoholic beverages and the use of illegal drugs shall not be permitted at any time aboard boats owned and/or operated by the department.
- Firearms shall not be kept in a loaded condition aboard boats owned and/or operated by the department except when carried by law enforcement personnel or when actively being fired for work related purposes.
- Contractors working in an exposed marine location shall monitor the National Oceanic and Atmospheric Administration (NOAA) marine weather broadcasts and shall use other local commercial weather forecasting services as may be available.
- Type III Personal Floatation Devices (PFDs) will be worn by boat/barge occupants at all times when working over water.
- For retrieving a person overboard, the boat operator will throw a life ring and line, and use a ladder attached to the barge or the support

boat step transom to allow the person to climb out of the water. For retrieving a person overboard, the support boat will also be equipped with a life ring attached to approximately 90 feet of rope. The barge and the support boat will be equipped with an ABC rated fire extinguisher(s).

- Emergency procedures for fire and man overboard will be reviewed on the first day of operations and any time a change of personnel occurs.

3. Limitations

None

4. References

United States Army Corps of Engineers, Safety and Health Requirements Manual (EM), 385-1-1.November 3, 2003 – Section 19 Floating Plant and Marine Activities

5. Attachments

None

6. Contact

Robin DeHate, GEI Corporate Health & Safety Officer

STANDARD OPERATING PROCEDURE

SS-002 Ponar or Shipek Grab Sampler

1. Objective

Surficial sediment samples will be collected from the upper 6 inches (approximate) using a Ponar or Shipek type grab sampler. Both of these sampling devices have the advantages of being relatively easy to handle and operate, readily available, moderately priced, and versatile in terms of the range of substrate types they can effectively sample. In addition, both of these grab samplers provide sufficient sample volume (8.2 or 2.4 cubic liters, respectively) to allow sub sampling for multiple analytes.

2. Materials

Equipment needed for collection of sediment samples may include (depending on technique chosen):

- Ponar/Shipek Sampler
- Stainless steel sampling tools
- Laboratory provided sample bottles
- Resealable plastic bags
- Ice
- Coolers, packing material
- Chain of custody records, custody seals
- Decontamination equipment/supplies
- Maps/plot plan
- Safety equipment
- Tape measure
- Camera
- Field data sheets/field notebook/waterproof pen
- Permanent markers
- Sample bottle labels
- Paper towels
- Personal Protection Equipment (PPE)
- Global Positioning System (GPS)

3. Execution

- Prior to sample collection, the grab sampler will be decontaminated.
- When deploying the grab sampler, the speed of descent should be controlled, with no “free fall” allowed. In deep waters, use of a winching system is recommended to control both the rate of descent and ascent.
- The sampler will be carefully lowered the last few feet to minimize dispersal of fine material due to a sampler-induced shock wave.

- At the time of the sample collection, the sample location will be surveyed with GPS survey equipment.
- After the sample is collected, the sampling device should be lifted slowly off the bottom and raised to the surface at a slow and steady rate.
- Sediments in direct contact with sides or teeth of the grab sampler will be excluded from samples to prevent potential contamination from the grab sampling device when possible.
- Prior to sampling directly from the grab sampler, the overlying water will be removed by opening the jaws of the Ponar slightly and allowing the water to drain. If the overlying water is turbid, then the suspended solids will be allowed to settle, if possible, prior to draining.
- Where sampling directly from the sampler is not possible or feasible, the sampler will be slowly opened over a sample platform. The sampler will be placed such that the sample may be deposited with minimal disturbance.
- Photograph the sample in color with a camera. Place a small label with sample field ID number and approximate depth so that it appears in each frame. SOP FD-004 Photodocumentation provides further guidance on photodocumentation.
- Sediments will be described in accordance with the soil description procedure listed below in SOP SM-003 Soil Classification.
- Place sediment samples into pre-cleaned laboratory provided jars for the appropriate analyses as determined in the work plan. Label each jar with the unique grab sample identification number and depth of the sample.
- Place the sample containers into plastic sealable bags or bubble wrap and place them in an iced cooler until transfer shipment to the analytical laboratories. Add the sample to the chain of custody form.

4. Limitations

Careful use of grab samplers is required to avoid problems such as loss of fine-grained surface sediments from the bow wave during descent, mixing of sediment layers upon impact, lack of sediment penetration, and loss of sediment from tilting or washout upon ascent.

There are two primary interferences or potential problems associated with sediment sampling. These include cross contamination of samples and improper sample collection.

- Cross contamination problems can be eliminated or minimized through the use of dedicated or disposable sampling equipment. If this is not possible or practical, then decontamination of sampling equipment is necessary.

- Improper sample collection can involve using contaminated equipment, equipment that is potentially not compatible with the contaminants of concern, disturbance of the stream or impoundment substrate, and sampling in an obviously disturbed or non-representative area. Be sure to use sampling equipment of an appropriate composition based upon the suspected contaminants and analyses to be performed.

Following proper decontamination procedures, minimizing disturbance of the sample site, and careful selection of sampling locations will eliminate these problems.

If the above sampling protocols are followed, it will minimize the effects of typical disadvantages to Ponar or Shipek samplers such as possible shock wave and loss of very fine grained surface deposits, potential for water column contamination, and nearby down current sediment re-deposition. The potential does exist for larger materials such as twigs and stones to prevent jaw closure that will result in collection of unacceptable sample. In areas with significant debris in sediment, collection of a representative sediment surface sample may not be possible due to method and equipment limitations.

5. References

U.S. Environmental Protection Agency, Office of Water, Office of Science & Technology. 2001. Methods for Collection, Storage and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manual. EPA-823B-01-002, October 2001.

State of Ohio, Environmental Protection Agency, Division of Surface Water. 2001. Sediment Sampling Guide and Methodologies, Second Edition. November 2001.

ASTM, 2003. D4823-95 (2003) Standard Guide for Core Sampling Submerged, Unconsolidated Sediments. ASTM International, West Conshohocken, PA. August 2003.

Newfield's Environmental Forensics Laboratory, 2005. Geochronologic Sample Handling Procedure.

6. Attachments

None

7. Contact

Kim Bradley

STANDARD OPERATING PROCEDURE

FD-003 Sample Handling and Chain of Custody

1. Objective

To properly collect, label, document, preserve, package, transport environmental samples, and to provide a record of the custody of any environmental field sample from time of collection to delivery to the laboratory. The Chain-of-Custody (COC) can be used as a legal document to guarantee that samples were not mishandled and that they were delivered to the laboratory within the timeframe necessary to start analysis. A sample is under custody if:

a) it is in GEI's possession; or
b) it is in GEI's view after being in GEI's possession; or
c) it was in GEI's possession and then it was locked up to prevent tampering; or
d) it is in a designated secure area. GEI facilities are designated secure areas.

2. Execution

- Review the work plan prior to sampling to determine the following:
  i. The analysis required by the period and sample volumes required by the laboratory to perform those analysis. (Be explicit when requesting analysis on the COC (e.g. rather than "VOCs" (Volatile Organic Compounds) write "VOCs 8260".)
  ii. The turnaround time required by the project.
  iii. If the data will be sent directly from the laboratory to the data validator or Data Group.
  iv. Holding time restrictions for sampling media and analytical methods.
- Label the jar or bottle not on the cap.
- Following sample collection, the sample container is labeled using a waterproof marker with the sample ID, the date and time (military time) of sample collection, project number, sample preservatives, and the sampler's initials. Sample custody begins at this time.
- Record the above information in the field notebook.
- Individually wrap sample jars with packing material. Place samples in a chilled (4°C) cooler immediately after collection.
- Complete a chain of custody (COC) for the samples as described below, and sign off on the COC each time a new person takes possession of the samples. A COC form must accompany each shipment/delivery of samples to the laboratory. GEI or Laboratory COC forms may be used as long as the laboratory form contains the same required information as described below.

- An example COC is provided in Attachment A.
- Place a custody seal on the cooler if shipping.
- Transport samples to the laboratory as soon as possible. It is preferable the samples are sent from the field rather than brought back to the office for submission at a later date.

2.1. Chain-of-Custody (COC) Completion

- Record the project name and number, the sampler's name(s) and the state where the samples were collected.
- For each sample, enter the sample identification number, date and time (military time) collected, whether the sample is a grab or composite sample and the number of sample containers. Record the type of analysis (including laboratory method; e.g. EPA-SW846 Method XX) requested and the preservative (if appropriate) in the vertical boxes.
- When samples are ready to be relinquished, complete the bottom of the form with date and time (military time) and signatures of relinquisher and receiver of samples as indicated. The sample collector is always the first signature while the analytical laboratory is the final signature. Theoretically, all individuals handling the samples between collection and laboratory should sign the form; however, if a common carrier (i.e., Federal Express, UPS) is used for shipping, GEI must identify the carrier in the 'Received by' box on the COC. If the sampler hand delivers the samples to the laboratory, the received box must be signed by the laboratory.
- The forms are in triplicate (white, yellow, and pink copies). The pink copy should be retained by the sampling personnel and provided to the Data Group for proper filing. The white and yellow copies should accompany the samples to the laboratory.
- Prior to sample shipment, the COC must be placed inside the cooler (in a ziplock bag or other watertight package taped inside the lid of the cooler), and the cooler must be sealed with a signed COC seal.
- If a common carrier such as FedEx is used to transport the samples to the laboratory, include the carrier tracking number and identify the carrier in the "Received by" box on the COC.
- Any unused sampling containers/media that is sent back to the lab should be included on the COC. Return samples to the laboratory in a timely manner.
- Field duplicates should be anonymous to the laboratory, but must be recorded for use by the Data Group. To keep track of this information, link the field duplicate with the proper sample in the field copy of the COC and also the field book.

- After the samples are sent to the laboratory, the field copy must be sent to the Data Group. You can send the field copy with duplicate information in the mail to the Data Group.

3. Limitations

- The field notebook must document all GEI personnel who had custody of any samples prior to shipping the samples to the laboratory, the samples must be relinquished to the shipper and the COC signed and dated by the sampler and the shipper, even if both people are GEI personnel.
- Keep the number of people involved in collecting and handling samples and data to a minimum.
- Only allow people associated with the project to handle samples and data.
- Always document the transfer of samples and data from one person to another on chain-of-custody forms.
- Always accompany samples and data with their chain-of-custody forms.
- Give samples and data positive identification at all times that is legible and written with permanent ink.
- When sending samples via a common carrier, use one COC per package.
- Do not send samples from more than one site with separate COCs in a single package.

4. References

New Jersey Department of Environmental Protection, Field Sampling Procedures Manual, August 2005.

Connecticut Department of Environmental Protection, Guidance for Collecting and Preserving Soil and Sediment Samples for Laboratory

Determination of Volatile Organic Compounds, Version 2.0 February 28, 2006.

5. Attachments

Attachment A – Example Chain of Custody

6. Contact

Brian Skelly

STANDARD OPERATING PROCEDURE

SC-002 Sample Handling

1. Objective

Sample handling involves the collection and shipping of environmental samples to a laboratory for chemical analysis. The overall objective of sample handling is to ensure that samples are properly:

- labeled and documented;
- preserved;
- packaged; and
- transported to laboratories.

2. Execution

- Prior to mobilizing to the field, select a shipper or arrange for a courier for sample delivery to the laboratory. If using a shipper (i.e., Federal Express, or UPS) determine the time constraints for pickup requests, the location and hours of the nearest shipping office, and any size/weight restrictions.
- Label all laboratory glassware with waterproof ink prior to collecting samples. The label should have an adhesive and be placed on the jar or bottle, not on the cap. In addition, clear packing tape should be placed over the sample label to secure it to the bottle as moisture from the samples can loosen the label adhesive.
- Record the following information on the label and in the field notebook (See Field Notebook SOP FD-001): project number, sample identification (i.e. MW-201 or SS-2), date, and time (military time) of collection, sampler's initials, and preservative, if present.
- If sample jars are not pre-preserved, add preservative as appropriate.
- At each sampling location, samples must be collected in order of volatility, most volatile first. Samples collected for volatile analysis must be placed in sample containers immediately upon retrieval of the sample.
- Aqueous samples for volatile analysis must be collected without air bubbles. Soil samples for volatile analysis should be compacted to eliminate as much headspace as possible. Other laboratory glassware should also be filled when possible. Care must be taken to avoid getting soils on the threads of sample jars, which can cause a faulty seal.
- If compositing of samples is performed in the field, specify basis for composite (i.e. volume, weight, spoon recovery, etc.) and record procedure for compositing sample in the field book.

- The sample cooler should have any water drains securely sealed with duct tape, both on the inside and outside of the cooler. A layer of packing material should be placed on the bottom of the cooler as a cushion. A large plastic bag will then be placed inside the cooler to contain all sample containers and ice for chilling samples. Refer to TestAmerica Packing Samples for Shipment Back to the Laboratory Attachment for reference.
- Once samples have been collected, place samples in a cooler with ice or a blue pack (if allowed) to chill samples to 4°C and start the chain-of-custody form (SOP FD-003 Sample Handling and *Chain of Custody*). Only use double bagged ice and not loose ice when packing cooler.
- For shipping, individually wrap each sample bottle with bubble packing or suitable packing material and place the wrapped bottles upright in the cooler with sufficient packing material between samples to avoid breakage.
- Place a layer of packing material above and below the sample bottles. Place blue ice packs or ice bags on top of the packing material. Fill the remaining space in the cooler with packing material to eliminate the possibility of vertical movement of samples.
- Seal the large plastic bag with the samples and ice inside.
- Place the completed and signed chain-of-custody form in a plastic ziplock-type bag and place on top of the packing material in the cooler, or taped to the inside lid of the cooler.
- Fill out the appropriate shipping or courier forms and attach to the top or handle of the cooler. If necessary, place the proper shipping labels on the cooler. Have the courier sign the COC form (or write pickup by FEDEX, UPS, etc. with date and time). Place a signed and dated custody seal on the cooler.
- All samples should be submitted as soon as possible. It is preferable for samples to be mailed prior to returning to the office.
- A copy of the waybills must be kept by the field supervisor to track shipments if necessary.

3. Limitations

- At all times, follow safety procedures as defined in the site-specific Health and Safety Plan.
- Field personnel must be aware of analyses which have short holding times and schedule sampling events and shipping accordingly. Shipment of samples for analyses with short holding times must be planned in advance. Refer to the project work plan, quality assurance project plan, or state/federal regulations for holding time and preservative information. Contact the laboratory ahead of time when

shipping samples with short holding time to ensure the lab is prepared for these analyses.

- In general, glassware for aqueous samples contains preservatives, (i.e. HNO3, HCl, etc). When collecting the sample, take care not to overfill the container, thus flushing the preservative out of the bottle.
- Never composite samples for VOCs in the field. Collect individual aliquots and direct the laboratory to perform compositing.
- Collection of aqueous samples should not be performed over the opening of a monitoring well. Preservatives from overfilling, a marker pen or other objects could fall into the well.
- If the recharge volume for a monitoring well is low, completely fill all volatile vials and then collect the minimum sample volume required for each remaining analysis.
- During subsurface soil sampling, if the recovery from the split-spoon sample is inadequate, if appropriate, resample the bottom of the borehole to obtain proper sample volume.
- Laboratories will homogenize and test the contents of the sample container, unless directed otherwise. Samples should not contain rocks, twigs, leaves, etc. unless these materials are of interest.

4. References

New Jersey Department of Environmental Protection, Field Sampling Procedures Manual, August 2005.

Connecticut Department of Environmental Protection, Guidance for Collecting and Preserving Soil and Sediment Samples for Laboratory

Determination of Volatile Organic Compounds, Version 2.0 February 28, 2006.

5. Attachments

Attachment 1 - General Guidelines for selecting equipment on the basis of construction material and target analyte(s)

Attachment 2 – TestAmerica Packing Samples for Shipment Back to the Laboratory

6. Contact

Jennifer Sandorf

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To ensure accuracy, prevent lost time, and avoid additional fees:

- Do not store or use this equipment in a wet environment.
- Do not store this equipment in extremely high or low temperature environments.
- Use care to ensure that water and debris does not contact internal parts, connections, or accessories.
- Place re-chargeable batteries (if provided) on charge for at least 4 hours prior to use.
- Do not mark equipment or accessories with permanent marker or duct tape
- All contaminants must be removed from equipment and accessories prior to return.

The following items are included for the rental term. If they are not returned at the end of the rental or sustain damage, the replacement cost will be applied to your invoice.

Handheld Display

Cable

Flow Cell

Stand

Storage Cup

Comm. Cable

Sensor Guard

Manual

YSI FIELD CALIBRATION GUIDE

- Turn 650 MDS on.
- Press enter on sonde menu. (Sonde will connect with display.)
- Scroll down sonde menu and highlight Report. Press enter and scroll down to DO CHG and Ph mV and press enter. When there is a solid dot next to the parameter that means it is turned on. Also make sure the following parameters are turned on: Temp C; SpCond µS/cm; Cond µS/cm; DOsat%; DO mg/L; pH; and Orp mV. Press esc.
- Select Calibrate, and press enter.
- It is our recommendation that our calibration procedures and our calibration solutions are used. Failure to use our procedures with our solutions may compromise the accuracy of your results.
- **Start your calibration with conductivity first.**
  - Using our conductivity calibration solution, 1000 µS/cm, completely submerge probes in solution. Highlight Conductivity and press enter.
  - Highlight SpCond and press enter.
  - Now at "enter value" screen, enter the value, (If using our solutions enter 1 mS/cm, and it will calibrate to 1000 µS/cm.) Press enter once value is entered.
  - Here is where you need to check your DO CHG. **It should read 50 with an accuracy range of +/- 25.**
  - Check your SpCond, and Cond readings. If they display a drastic spike every few seconds try re-skinning the DO probe again. You may also need to change your KCL Solution. (6 month shelf life mixed)
  - If SpCond reading seems too high pre-cal, (1200+), you might want to change your cal solutions.
  - When the SpCond and Cond readings have become stable, count to ten and press enter.
  - The values for SpCond, and Cond will calibrate.
  - Press enter to return to calibration parameters screen.
  - Rinse and dry probes thoroughly.
- **Calibrate Ph Second**
  - Highlight Ph and press enter.
  - Highlight 3 point cal and press enter.
  - Always start your Ph calibration with 7. Press enter.
  - Check your Ph mV readings and make sure they are within specifications.

    Buffer 7 = 0 +/- 50 mv
    Buffer 4 = +180 +/- 50 mv
    Buffer 10 = -180 +/- 50 mv
  - When the Ph readings have become stable, count to ten and press enter.
  - Once calibrated press enter again to proceed to the next "enter value" screen. Rinse and dry probes thoroughly between each solution.
  - Enter 4, and press enter.
  - Repeat steps.
  - Enter 10 for last Ph value and press enter.
  - Repeat step.
  - Press enter again to return to the 1, 2, and 3 point cal screen. Press escape to return to calibration parameters screen. Rinse and dry probes thoroughly.
- **ORP Calibration**
  - Before you do your ORP calibration you need to be aware of the temperature so you can enter the correct value.
  - Place Orp container on Ph/Orp combo probe. Orp solution in calibration cup needs to be changed after 3 – 5 uses. Mixed Zobell solution has a shelf life of six months from the day it was mixed. Unmixed Zobell solution has an expiration date on the bottle.
  - Highlight Orp and press enter. "Enter value" screen will appear.
  - Enter correct value corresponding with temperature on chart and press enter.

°C	100mV ORP	Zobell
10	124.4	250.5
15	116.7	244
20	109.1	237.5
25	100	231
30	93.1	224.5
35	84.9	218
40	76.3	211.5

  - When the Orp value has become stable, count to ten and press enter.
  - Press enter to continue to calibration parameter screen.
  - Remove Orp container, being careful not to disturb the DO o-ring and membrane, rinse and dry probes thoroughly.
- **DO Calibration**
  - Put on storage/calibration container. (Make sure there is a wet sponge in the container, and container is on loosely.)
  - With the storage/calibration container on, highlight DO and press enter.
  - Highlight DO% and press enter. Press enter again for the barometric pressure displayed.
  - When the DO% value has become stable, count to ten and press enter.
  - Press enter to return to calibration parameter screen.
- **Exiting Calibration Mode**
  - Press escape from calibration parameter screen to return to sonde menu screen.
  - Scroll down and highlight Report and press enter.
  - Scroll down to Ph mV and DO CHG, and turn them off by highlighting them and pressing enter. No solid dot next to the parameter means that it is turned off. Ph mV, and DO CHG are only needed for calibration and checking the status of the probes, and are not needed for field reports.
  - Once parameters are selected for field reports and are turned on, press escape twice and return to the 650 menu.

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STANDARD OPERATING PROCEDURE

BS-008 Fish and Benthic Macroinvertebrate Tissue Sampling

1. Objective

This SOP details the methods for proper collection, documentation, and handling for whole body tissue analysis for fish, crab, and mussel.

2. Materials

Equipment needed for collection of tissue samples may include:

- Commercial minnow trap
- Commercial crab pot
- Canned cat food (bait)
- Hand scraper
- 5 gallon bucket
- Measuring board (1 millimeter increments, at least 500 mm long)
- Scale (at least 1 gram increments)
- Aluminum foil
- Labeling tape
- Plastic bags (small and 5 gallon sizes)
- Ice or dry ice
- Coolers, packing material
- Chain of custody records, custody seals
- Decontamination equipment/supplies
- Maps/plot plan
- Safety equipment
- Camera
- Field data sheets/field notebook/waterproof pen
- Permanent markers
- Sample bottle labels
- Paper towels
- Personal Protection Equipment (PPE)
- Global Positioning System (GPS)

3. Execution

- Bait minnow traps and crab pots and deploy at designated sample locations. Traps should be tied to a stake or other secure object along shore and an identification card should be secured to the line denoting location number and relevant contact information.
- Traps containing organisms should not be permitted to become exposed (and dry) at low tide.
- Check traps at least twice daily; once in the morning and once in the evening.
- Transfer any captured organisms into a 5 gallon bucket containing surface water.
- After traps have been emptied, bait and redeploy traps.
- Time deployed and each time checked, weather conditions, tide level, organisms captured, and time redeployed should be recorded within the field notebook.
- Mussels should be collected using a hand scraper to dislodge individuals exposed during low tide.

Sample Processing

- Photograph any organism captured and record length and weight. Measurements and photograph number should be recorded in the field book, along with date, species, and location. Any abnormalities in organisms should also be recorded.
- Non-targeted species should be returned to the water after measurement.
- Length of fish is defined as the maximum body length, measured from tip of the head to the end of the longest caudal fin ray. Crabs should be measured for the maximum lateral distance across the carapace. Mussel shell length should be measured from the hinge to the outer-most portion of the shell.
- Refer to the SAP for details on target species and, tissue biomass or number of individuals need for tissue analysis.
- Individual fish should be wrapped in aluminum foil and a sample label should be placed on the outside of the foil denoting the date, sample location, fish species, length, and weight.

- Place wrapped fish in individually labeled plastic bags, which should then be placed in a labeled 5 gallon bag; one 5 gallon bag per sample location.
- Crabs and mussels should similarly be wrapped in aluminum foil and placed in individually labeled plastic bags. Individual bags should be placed in the larger bag for that sample location.
- All bags should immediately be placed on ice and stored in a cooler and maintained at 3 °C.
- Large Location sample bags should be bubble wrapped and placed in an iced cooler until transfer shipment to the analytical laboratories. Samples should be added to chain of custody form.
- If shipping time is to exceed 24 hours, samples should be frozen on dry ice.

4. Limitations

There is potential that not enough organisms will be collected at each sample location for tissue analysis. If not enough biomass can be recovered, alternative species may have to be targeted, or composite samples from multiple locations may be required.

Careful handling of organisms is required to avoid damaging of tissues and to prevent unnecessary stress to targeted and non-targeted organisms.

5. References

U.S. Environmental Protection Agency (USEPA). 2000. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories. Volume 1 – Fish Sampling and Analysis. Third Edition. Office of Water. EPA 823-B-00-007. November.

6. Attachments

None

7. Contact

Kim Bradley

STANDARD OPERATING PROCEDURE

SM-009 Porous Surface Sampling for Polychlorinated Biphenyls (PCBs)

1. Objective

Describe methods for collection of porous surface samples (0-0.5 inches) for polychlorinated biphenyls (PCBs) analysis.

Two techniques of sample collection for PCBs are described in this procedure: hard and soft porous sampling. Hard-porous surfaces include concrete, brick, and asphalt. Soft-porous surfaces include wood, wall plasterboard, rubber, caulking, and low density plastics.

The hard-porous sampling method produces a uniform, finely ground powder that is easily homogenized, extracted and analyzed. The soft porous sampling uses a chisel or sharp knife to generate a representative sample to be extracted for analysis.

2. Execution

2.1 Hard-Porous Sampling

- Hard-porous samples are collected using an impact hammer drill, which generates a dust or powder. Having several decontaminated impact drill bits on hand will help expedite sampling when numerous sample locations are to be drilled.
- Sample locations may be pre-marked using a crayon or a non-contaminating spray paint. Note, the actual sample point must not be marked.
- Depending on the appearance of the sample location, or the objectives of the sampling, it may be appropriate to wipe the surface with a clean dry cloth prior to sampling.
- All sampling decisions and activities should be noted in the field notebook (See Limitations Below).
- Suspected stained areas should be preferentially selected.
- A ½-inch deep hole (using a 1-inch diameter drill bit) generates about 10 grams of powder.
- At each sample location, collect at least three samples of each type of hard porous surface, regardless of the amount of each type of porous surface present.
- Drill bits and sample collection pans (if used), must be decontaminated between samples.
- Lock a clean 1-inch diameter carbide drill bit into the impact hammer drill and plug the drill into an appropriate power source. A gasoline generator will be needed if electricity is not available.

- Begin drilling in the designated location. Apply steady even pressure and let the drill do the work. Applying too much pressure will generate excessive heat and dull the drill bit prematurely. The drill will provide a finely ground powder that can be easily collected, homogenized, and analyzed.
- A decontaminated stainless steel scoop can be used to collect the sample. The powder can be collected directly from the surface.

2.2 Soft-Porous Sampling

- If possible, remove any non-porous inclusions from the sampling location by brushing or wiping, as appropriate.
- Samples should be collected at a depth of no more than 0.5 inches using a metal chisel of sharp cutting knife.
- It is important to collect at least 10 grams for analysis.

2.3 Sample Handling, Preservation, and Storage

- Samples must be collected in glass two-ounce containers with a Teflon-lined cap.
- Samples ate to be shipped refrigerated and maintained at 4°C until the time of extraction and analysis.
- The holding time for PCB samples is 14 days to extraction.
- SC-002 Sample Handling provides additional guidance.
- Complete Sample Collection Logs, if appropriate, and Chain of Custody Forms, label sample containers, and complete documentation.

2.4 Decontamination

- Assemble two decontamination buckets. The first bucket contains a detergent and potable water solution, and the second is for rinsate.
- Place all used drill bits and utensils in the detergent and water bucket.
- Scrub each piece thoroughly using a scrub brush.
- Rinse each piece with water and hexane.
- Place the rinsed pieces on clean paper towels and individually dry and inspect each piece. Note: all pieces should be dry prior to reuse.
- All investigational-derived waste must be handled and disposed of in accordance with federal, state, and local regulations. Further guidance on Investigational Derived Waste is provided in GEI SOP SC-003. The waste will be treated as PCB waste if the samples are positive for PCBs.

3. Limitations

- This SOP does not cover multiple depth interval sampling.
- Sampling of wood surfaces can employ the hard or soft porous methodology.
- Porous sampling may require removing tiles or laminate coverings with asbestos containing adhesives. These coverings should not be removed without an assessment of the presence of asbestos. If asbestos is present,

the asbestos-containing material will need to be removed prior to any concrete sampling.

- If collecting multiple samples using this method, avoid cross-contamination by decontaminating all sampling tools prior to collecting the next sample. If the sampler's gloves come in contact with the sampled material during sampling, gloves should also be changed prior to collecting the next sample.

4. References

Standard Operating Procedures for Sampling Porous Surfaces for Polychlorinated Biphenyls (PCBs), The United States Environmental Protection Agency Region 1, May 2011.

Environmental Restoration Project Standard Operating Procedure for Los Alamos National Laboratory, Los Alamos National Laboratory, December 2001.

5. Contact

Brian Conte

STANDARD OPERATING PROCEDURE

SW-001 Surface Water Sampling

1. Objective

This Standard Operating Procedure (SOP) is applicable to the collection of representative surface water samples from streams, rivers, lakes, ponds, lagoons, and surface impoundments. It includes samples collected from depth as well as samples collected from the surface. These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitations, or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report. Location, equipment, and sampling situations will dictate the applicable method of sample collection for each point. Representative surface water samples will be collected from one of these four techniques.

- Kemmmer bottle
- Van Doren sampler
- Direct method
- Peristaltic pump

2. Materials

Equipment needed for collection of surface water samples may include (depending on technique chosen):

- Kemmerer bottles
- Van Doren sampler
- Line and messengers
- Peristaltic pump
- Teflon™/polyethylene tubing
- Laboratory provided sample bottles
- Resealable plastic bags Ice
- Coolers, packing material
- Chain of custody records, custody seals
- Decontamination equipment/supplies
- Maps/plot plan
- Safety equipment
- Tape measure
- Survey stakes, flags, or buoys and anchors
- Camera
- Field data sheets/field notebook/waterproof pen
- Permanent marker
- Sample bottle labels
- Paper towels

- Secchi Disk – Illustration provided as Figure 1
- Personal Protection Equipment (PPE)
- Global Positioning System (GPS) survey equipment

3. Execution

3.1. Pre-Sampling Procedures

3.1.1. Sample Location

A GPS navigation system will be used to identify and record sample location coordinates. If required, the proposed locations may be adjusted based on sample location access and obstructions.

3.1.2. Water Quality Data

Water quality data will be collected during sampling from the sample depth interval using an appropriate instrument to measure pH, specific conductance, temperature, turbidity, dissolved oxygen, and oxidation-reduction potential. In addition, water clarity will be measured at each sample location using a secchi disk. The water quality meter will be calibrated daily in accordance with manufacturer's specifications.

3.2. Sample Collection

3.2.1. Kemmerer Bottle

A Kemmerer bottle will be used in most situations to collect representative samples at the specific depths that are required. A picture of the Kemmerer bottle is provided as Figure 2. Sampling procedures are as follows:

- Prior to sample collection, the Kemmerer bottle will be properly decontaminated. The sampling device will be set so that the upper and lower stoppers are pulled away from the body of the sampler, allowing the surface water to enter tube.
- Lower the pre-set sampling device to the predetermined depth while avoiding disturbance of the bottom sediments.
- When the Kemmerer bottle is at the required depth, send the weighted messenger down the suspension line, closing the sampling device.
- Retrieve the sampler and discharge the first 10-20 milliliters (mL) from the drain to clear potential contamination from the valve.
- This procedure may be repeated if additional sample volume is needed to fulfill analytical requirements. Subsequent grabs may be composited or transferred directly to appropriate sample containers.

3.2.2. Van Doren Sampler

A Van Doren sampler will be used to collect surface water from a very specific sampling depth or from a shallow water body. A picture of the Van Doran sampler is provided as Figure 3. Since the sampler is suspended

horizontally, the depth interval sampled is the diameter of the sampling tube. The sampling procedure is as follows:

- Prior to sample collection, the Van Doren Sampler will be properly decontaminated. The sampling device will be set so that the end stoppers are pulled away from the body allowing surface water to enter the tube.
- Lower the pre-set sampling device to the predetermined depth. Avoid disturbance of the bottom.
- When the Van Doren is at the required depth, send the weighted messenger down the suspension line, closing the sampling device.
- Retrieve the sampler and discharge the first 10-20 mL from the drain to clear potential contamination from the valve.
- This procedure may be repeated if additional sample volume is needed to fulfill analytical requirements. Subsequent grabs may be composited or transferred directly to appropriate sample containers.

3.2.3. Direct Method

For surface water samples collected within the top 6-inches of the water column, the direct method will be utilized to collect water samples directly into unpreserved the sample container(s).

- Analytical samples that require field preservation will be transferred from the unpreserved container to a laboratory pre-preserved sampling container.
- Ensure that all samples are collected using adequate protective clothing in accordance with the site-specific Health and Safety Plan (HASP).
- Samples will be collected in a downstream to upstream direction. In shallow locations, collect the sample under the water surface while pointing the sample container upstream; the container must be upstream of the collector.
- Avoid disturbing the sediment surface during collection. The sample container will be held below the surface to avoid the collection of floating debris.

3.2.4. Peristaltic Pump

A peristaltic pump will be used to collect surface water from a very specific sampling depth or from a remote location that cannot be accessed with other sampling methods. Since the tubing can be weighted and suspended horizontally, the depth interval sampled is the opening of the sampling tubing. The sampling procedure is as follows:

- Prior to sample collection, the tubing weights will be thoroughly decontaminated. Clean, disposable Teflon™ or polyethylene tubing will be cut to the predetermined sampling depth. The outside of the tubing will be marked with appropriate gradations to determine actual

sample depth. The tubing will be affixed to an YSI, *In-situ* Troll 9000 or similar water quality meter to ensure water quality measurements are representative of the sample interval conditions.

- Lower the tubing and water quality meter to the predetermined sample depth. Avoid disturbance of the bottom.
- When the tubing is at the required depth, turn on the peristaltic pump.
- Discharge the two submerged tubing volumes from the pump to obtain a representative surface water sample.

3.2.5. Sample Interferences

Proper sampling procedures will be used to collect samples in accordance with this SOP to prevent cross contamination and improper sample collection. Common causes of sample interferences are listed below to ensure that the samplers can avoid potential sample collection problems.

- Cross Contamination: Eliminated or minimized through the use of dedicated or disposable sampling equipment where appropriate. Where the use of dedicated or disposable sampling equipment is not possible or practical, the equipment will be decontaminated in accordance with the SOP QA-001 Equipment Decontamination.

- Improper Sample Collection: Typical improper sample collection techniques include:
  i. Improper decontamination of sampling equipment
  ii. Use of sampling equipment or sample containers that are not compatible with the contaminants of concern or the laboratory analytical method
  iii. Excess sediment in the sample due to disturbance of the canal sediments by sampling equipment
  iv. Sample collection in an obviously disturbed or non-representative area
  v. Sample collection during a period of increased surface water velocity that causes significant re-suspension of canal sediments (i.e. tidal influences, storm surge)

3.2.6. Quality Assurance/Quality Control (QA/QC)

QA/QC procedures that apply to the these activities include QA/QC laboratory samples including blind duplicate, matrix spike and matrix spike duplicate (MS/MSD) samples, and field blank samples. QA/QC samples are detailed in the Work Plan and the Draft Quality Assurance Project Plan (QAPP). Prior to collection of the QA/QC samples, equipment will be decontaminated in accordance with procedures described in SOP QA-001 Equipment Decontamination.

The following general QA procedures apply:

- All data must be documented on field data sheets or within site field notebooks.
- All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation and they must be documented as indicated in the Draft QAPP.
- To avoid the incidental inclusion of disturbed sediment in the sample, surface water should be collected from a downstream to upstream direction and upstream of any activity that may disturb the sediment (i.e., wake from boat).

4. Limitations

There are two primary interferences or potential problems associated with surface water sampling. These include cross contamination of samples and improper sample collection.

- Cross contamination problems can be eliminated or minimized through the use of dedicated or disposable sampling equipment. If this is not possible or practical, then decontamination of sampling equipment is necessary.
- Improper sample collection can involve using contaminated equipment, equipment that is potentially not compatible with the contaminants of concern, disturbance of the stream or impoundment substrate, and sampling in an obviously disturbed or non-representative area. Be sure to use sampling equipment of an appropriate composition based upon the suspected contaminants and analyses to be performed.

Following proper decontamination procedures, minimizing disturbance of the sample site, and careful selection of sampling locations will eliminate these problems. Proper timing for the collection of samples must be taken into consideration due to tidal influences and low or fast-flowing streams or rivers.

5. References

Wilde, F.D., D.B. Radtke, J. Gibs and R.T. Iwatsubo. 1998. National Field Manual for the Collection of Water-Quality Data - Selection of Equipment for Water Sampling. U.S. Geological Survey Techniques of Water - Resources Investigations, Book 9, Chap. A2, variously paged. http://water.usgs.gov/owq/FieldManual/index.html and http://water.usgs.gov/owq/FieldManual/mastererrat.html

U.S. Environmental Protection Agency. 1984. Characterization of Hazardous Waste Sites - A Methods Manual: Volume II. Available Sampling Methods, Second Edition. EPA/600/4-84-076.

U.S. Environmental Protection Agency. 2002. U.S. EPA Environmental Response Team, Standard Operating Procedures #2013, Surface Water Sampling. EPA, 12/17/02.

6. Attachments

Figures 1, 2, and 3

7. Contact

Steven Canton

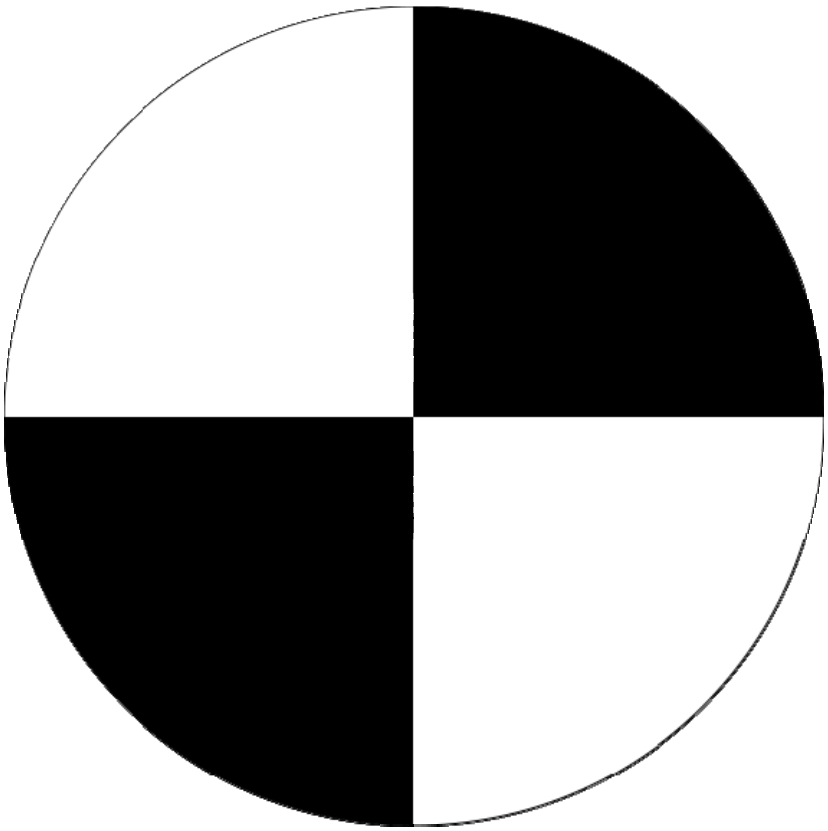

Figure 1 - Secchi Disk

Figure 2 – Kemmerer Bottle

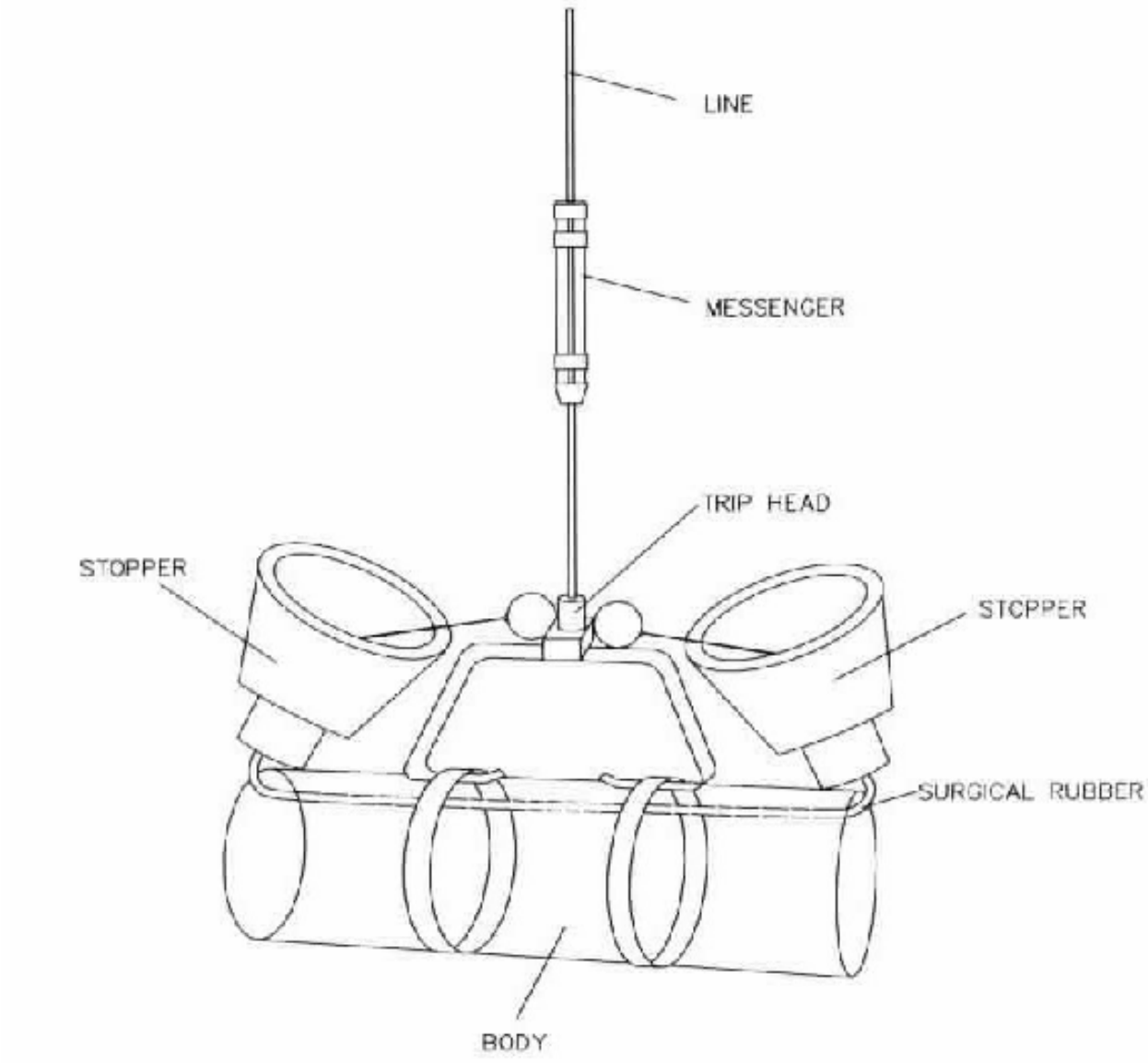

Figure 3 - Van Doran Sampler

STANDARD OPERATING PROCEDURE

BS-009 Mussel Handling and Tissue Extraction

1. Objective

This SOP details the methods for proper extraction of soft tissue from mussels for tissue analysis.

2. Materials

Equipment needed for collection of tissue may include:

- Commercial shucking knife
- Ice
- DI water

3. Execution

- Specimens should be unwrapped and inspected upon arrival to ensure samples have not been compromised. Any samples deemed unsuitable should be placed back in storage and the project manager should be informed of any issues. Compromised specimens should not be processed unless permission is given by the project manager or replacement samples are obtained.

Sample Processing

- If frozen, mussels should not be thawed to prevent the loss of liquids during tissue removal
- Organisms should be rinsed thoroughly with organic- and metal-free water prior to tissue removal to remove any external debris
- Using a shucking knife, the byssal threads (i.e. “beard”) from mussels should be removed and should not be included in the tissue analysis
- Insert the shucking knife near the hinge of the mussel
- Once the knife is able to penetrate into the shell, run the knife around the entire length of the shell in order to sever the adductor muscle
- Working the knife blade at the front of the shell, separate the two shell halves
- Scrape all soft tissue from the top and bottom shell halves. This includes viscera, meat, and body fluids
- Tissues should be placed on a clean surface or in a clean container until further processing or compositing of samples

4. Limitations

There is potential that not enough organisms will be collected at each sample location for tissue analysis. If not enough biomass can be recovered, alternative species may have to be targeted, or composite samples from multiple locations may be required.

5. References

U.S. Environmental Protection Agency (USEPA). 2000. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories. Volume 1 – Fish Sampling and Analysis. Third Edition. Office of Water. EPA 823-B-00-007. November.

6. Attachments

None

7. Contact

Kim Bradley

STANDARD OPERATING PROCEDURE

SS-002 Sediment Sampling Using Vibracore Equipment

1. Objective

Describe use of Vibracore methods to collect sediment samples.

Fine-grained sediments, such as sands, silts and clays can be collected using Vibracore (VC) equipment. The VC consists of a metal core barrel with a cutting edge, a sample retaining ring, a replaceable plastic liner, and an air powered piston vibrator to drive the core pipe into the unconsolidated sediments. A new plastic liner is used for each sample.

2. Materials

Equipment needed for collection of sediment samples may include (depending on technique chosen):

- Vibracore sampler
- Stainless steel sampling tools
- Laboratory provided sample bottles
- Resealable plastic bags
- Ice
- Coolers, packing material
- Chain of custody records, custody seals
- Decontamination equipment/supplies
- Maps/plot plan
- Safety equipment
- Tape measure
- Camera
- Field data sheets/field notebook/waterproof pen
- Permanent markers
- Sample bottle labels
- Paper towels
- Personal Protection Equipment (PPE)
- Global Positioning System (GPS)

3. Execution

- Sample from downstream to upstream locations so that disturbed sediment will not affect subsequent sampling locations.
- If sediment samples are being collected for laboratory analysis, the sampling equipment (i.e., cutting shoe, retainer, and sampling barrel) shall be decontaminated prior to the collection of samples at each location. Decontamination shall be conducted in accordance with SOP QA-001 –

Equipment Decontamination or according to any requirements that are outlined in the site-specific work plan(s).

- Moor the VC watercraft in a multi-point fashion.
- Measure and record the depth of the water column (depth to top of sediments).
- If possible, record the latitude, longitude, and elevation of the sample location using Global Positioning System (GPS) equipment.
- If GPS is not available, mark the sampling locations with a labeled stake, buoy, flagging, or other device, and document the locations by measuring from known reference points.
- Vibrate the core barrel into the sediments. Penetration rates will vary depending on the sediment type. When the target depth is attained, retrieve the core.
- If sufficient room is available on the VC watercraft, log the core in accordance with SOP SM-003 Soil Classification and collect analytical samples. Note attributes such as cementation, color and mineralogy (if it can be determined). The presence of iron-staining, or other staining, presence of organic matter, shells, debris or detritus will be recorded. Any odors (i.e., tar-like vs. gasoline-like vs. fuel oil-like, etc.) will be recorded. Any visual impacts will be recorded (i.e., sheens vs. non-aqueous phase liquid (NAPL) vs. staining vs. oil blebs).
- Otherwise, ferry core samples to a field representative on shore as soon as practical for logging and sampling.
- Screen for Volatile Organic Compounds (VOCs) throughout the core and record any instrument response. A photoionization detector will be used for this process. When selecting portions of the core for screening, select undisturbed portions if present. Otherwise, disturbed portions may be screened. Screening should be performed in accordance with SOP SC-004 Head Space Screening.
- Analytical samples will be selected based on criteria stipulated in the associated site-specific work plan. Analytical samples shall be collected with stainless steel spatulas (or similar) that have been decontaminated according to procedures that are outlined in SOP QA-001 Equipment Decontamination or the site-specific work plan(s). The samples shall be contained in laboratory provided jars or glassware and kept cool. The sample identification, date, time, and associated details will be recorded. Pertinent information regarding the samples will be recorded on a chain-of-custody form.

4. Limitations

4.1. When marking locations in navigable waterways, inform the appropriate regulatory agencies and take precautions to prevent navigational hazards before, during, and after sampling.

5. References

Annual Book of ASTM Standards (1993), Section 4, v. 4.08 Soil and Rock; Building Stones; Geosynthetics, D2488-90, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), American Society for Testing and Materials (ASTM).

6. Contacts

Kim Bradley
Ryan Hoffman

Attachment C

Laboratory Standard Operating Procedures

Laboratory Standard Operating Procedures

Lab SOP Number	Title, Revision Date, and/or Number
BR-EX-002r11_EXcleanup	Extract Clean Up Procedures
BR-GC-005	PCBs by Gas Chromatography (GC) SOP No. BR-GC-005, Rev 11, 04/01/11
BR-GC-005	PCBs by Gas Chromatography (GC) SOP No. BR-GC-005, Rev 11, 04/01/11
BR-GC-005	PCBs by Gas Chromatography (GC) SOP No. BR-GC-005, Rev 11, 04/01/11
BR-EX-027	Automated Soxhlet Extraction (SW846 3541) SOP No. BR-EX-027, Rev 0, 11/10/10
BR-EX-005	Separatory Funnel Extraction (SW-846 3510C) SOP No. BR-EX-005, Rev 9, 12/08/11
BR-EX-009	Homogenization of Biota & Tissue SOP No. BR-EX-009, Rev 7, 08/01/12
BR-WC-008 Current Version	TOC Lloyd Kahn/
BR-GT-006 BR-GT-018	Grain Size

SOP Change in Progress Attachment (CIPA)

SOP Number	SOP Title	SOP Revision	SOP Effective Date	CIPA Effective Date
BR-EX-005	Separatory Funnel Extraction (SW-846 3510C)	9	11/08/11	10/01/12

The following revisions were made to this standard operating procedure (SOP). These changes are effective as of the CIPA Effective Date. This change to this document is authorized by the laboratory's QA Department.

Page 7 of 12, Section 10.4 Extraction Concentration (KD-Technique):

Remove the phrase (KD-Technique) from header 10.4 so that the new header reads:

10.4 Extraction Concentration

Insert the following text between 10.4 and 10.4.1:

The following sections describe the procedures for the concentration of extracts. Any of the three techniques described may be used. However some techniques are more efficient than others to achieve the final extract volume. Use the following guidelines to select the concentration technique: For the concentration of volumes greater than 5 mL, use Macro Concentration. To concentrate extract volumes between 5 and 1 mL use Micro Concentration. To concentrate extract volumes below 1 mL, use Nitrogen Blowdown.

Title: SEPARATORY FUNNEL EXTRACTION (SW-846 3510C)

Approval Signatures:

William S. Cicero
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Christopher G. Callahan
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Dan Helfrich
Health & Safety Coordinator

Approval Date: November 8, 2011

Facility Distribution No. Electronic **Distributed To: Facility Intranet**

The controlled copy of this SOP is the PDF copy of the SOP that is posted to the laboratory's SOP Directory. Printed copies of this SOP or electronic copies of this SOP distributed outside the facility are considered uncontrolled.

1.0 Scope and Application

This SOP describes the laboratory procedure for the isolation of organic compounds from aqueous samples by separatory funnel liquid-liquid extraction.

1.1 Analytes, Matrix(s), and Reporting Limits

Refer to analytical methods for analyte lists and reporting limits.

2.0 Summary of Method

A measured volume of sample, usually 1 L, is serially extracted at a specified pH with methylene chloride using a separatory funnel rotator. The extract is dried with anhydrous sodium sulfate then concentrated, and if necessary, exchanged into a solvent compatible for extract cleanup or the determinative analysis method.

This SOP is based on the following reference method:

- SW-846 Method 3510C Separatory Funnel Liquid-Liquid Extraction, Revision 3, December, 1996.

3.0 Definitions

A list of terms and definitions are provided in Appendix A.

4.0 Interferences

Method interference may be caused by contaminants in solvents, reagents, glassware and other sample processing equipment that can cause interference and/or elevated baselines in chromatography. All reagents and solvents used during this procedure should be reagent grade or high purity in order to minimize interference. All glassware must be cleaned in accordance with laboratory SOP BR-EX-017 *Glassware Cleaning Procedure* and rinsed with acetone and methylene chloride prior to use.

The decomposition of some analytes has been demonstrated under basic extraction conditions. Organochlorine pesticides may dechlorinate, phthalate esters may exchange, and phenols may react to form tannates. These reactions increase with increasing pH, and are decreased by the shorter reaction times available in Method 3510. Method 3510 is preferred over Method 3520 for the analysis of these classes of compounds. However, the recovery of phenols may be optimized by using Method 3520, and performing the initial extraction at the acid pH.

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

Nitrile gloves should be used when performing this extraction. Latex and vinyl gloves provide no significant protection against the organic solvents used in this SOP and should not be used.

During Kuderna-Danish (KD) concentration do not allow the extract to boil to dryness. The solvent vapors remaining in the KD apparatus may superheat and create an explosion or fire hazard.

The use of separatory funnels to extract aqueous samples with methylene chloride creates excessive pressure very rapidly. Initial venting should be done immediately after the sample container has been sealed and inverted. Vent the funnel into the hood away from people and other samples. This is considered a high-risk activity, and a face shield should be worn over safety glasses or goggle when it is performed.

The following analytes have been tentatively classified as known or suspected, human or mammalian carcinogens: benzo(a)anthracene, benzidine, 3,3'dichlorobenzindine, benzo(a)pyrene, alpha-BHC, beta-BHC, gamma-BHC, delta-BHC, dibenz(a,h)anthracene, N-nitrosodimethylamine, 4,4'-DDT, and polychlorinated biphenyl compounds. Primary standards of these toxic compounds should be prepared in hood.

During Kuderna-Danish (KD) concentration, do not allow the extract to boil to dryness. The solvent vapors remaining in the KD apparatus may superheat and create an explosion or fire hazard.

The KD apparatus has ground glass joints which can become stuck. Technicians must use Kevlar or other cut/puncture resistant gloves when separating stuck joints.

5.2 Primary Materials Used

Table 1 lists those 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.

6.0 Equipment and Supplies

Catalog numbers listed in this SOP are subject to change at the discretion of the vendor. Analysts are cautioned to be sure equipment used meets the specification of this SOP.

6.1 Extraction Equipment

- Separatory Funnel Shaker, Glas-Col or equivalent.
- Teflon Separatory funnel: 2 Liter, with stopcock and cap, Fisher Scientific or equivalent.
- Glass Funnel: 75mm, Fisher Scientific or equivalent.

6.2 Extract Concentration (KD Apparatus)

- Concentrator Tube: 10 mL graduated, ChemGlass Catalog Number CG-1316-11 or equivalent.
- Snyder Column: Three ball macro AMK Catalog Number SC2-01 or equivalent.
- Snyder Column: Two ball micro AMK Catalog Number SC3-01 or equivalent.
- Evaporation Flask: 500 mL attached to concentrator tube with clip, AMK Catalog Number KDF-500 or equivalent.
- Boiling Chips: silicon carbide, approximately 10/40 mesh, solvent extracted in methylene chloride, Troemner Catalog Number 133B or equivalent.
- Heating mantle rheostat controlled for water bath capable of temperature control (± 5°C). ChemGlass Catalog Number PL3122 or equivalent.
- Water Bath: capable of temperature control to ±5°C, Barnstead Corporation Catalog Number HM0500-HS1 or equivalent.
- Solvent Vapor Recovery System: Kontes K-54000-1006, K-547300-000, Ace Glass Catalog Number 6614-30 or equivalent.

6.3 Miscellaneous

- pH Paper/Strips: Range 1-14.
- pH Meter. Denver Instruments Model UB5 or equivalent.
- Pasteur Glass Pipettes: 1 mL, disposable. Fisher Scientific or equivalent.
- 0.5 mL – 2.0 mL Syringes: Hamilton Gastight® Syringes or equivalent.
- Vials and Caps: 1.8, 4, 8, 16, and 40 mL with Teflon lined septa and screw caps. Fisher Scientific.
- Graduated Cylinder: 1 Liter, Class A. Fisher Scientific or equivalent.
- Glass Wool

7.0 Reagents and Standards

7.1 Reagents

- Sodium Sulfate (granular, anhydrous), Na_2SO_4. J.T. Baker or equivalent. Purify by heating at 400°C for at least 4 hours.
- Methylene Chloride (CH_2C_{12}): Pesticide Quality, J.T. Baker or equivalent.
- Hexane, (C_6H_{14}), Pesticide Quality, J.T. Baker or equivalent.
- Acetone, ($(CH_3)_2CO$), Pesticide Quality, J.T. Baker or equivalent.
- Reagent Water: RO water filtered through a Nanopure System.
- Sodium Hydroxide (NaOH): Reagent Grade, J.T. Baker.
- Sulfuric Acid, (H_2SO_4): Reagent Grade, J.T. Baker.

7.1.1 Prepared Reagents

- NaOH Solution (6N): In a 2.5 L clear glass bottle dissolve 240 g NaOH in reagent water and dilute to 1 Liter. Store the solution in reagent bottle at room temperature. Assign an expiration date of 6 months from date of preparation unless the parent material expires earlier, in which case, use the earliest expiration date.

- H_2SO_4 Solution (1:1 v/v): Add 500 mL of reagent water to a 1 L volumetric flask. Slowly add 500 mL of H_2SO_4 to the flask to dilute to volume. Store the solution in reagent bottle at room temperature. Assign an expiration date of 6 months from date of preparation unless the parent material expires earlier, in which case, use the earliest expiration date.

7.2 Standards

Purchase stock standards as certified solutions from commercial vendors. Prepare surrogate and spiking solutions in the laboratory by diluting a known volume of the stock standard solutions in an appropriate solvent. Record the preparation of standard in the LIMS (TALS) module established for this purpose.

Store prepared standard solutions in glass containers at 4°C or below. Unless otherwise specified, assign an expiration date of 6 months from the date of preparation or in accordance with the expiration date of the parent standard, whichever is sooner. The recommended formulation for each standard used in this procedure is provided in the analytical method along with the recommended source materials, expiration dates and storage conditions.

8.0 Sample Collection, Preservation, Shipment and Storage

The laboratory does not perform sample collection so these procedures are not included in this SOP. Sampling requirements may be found in the published reference method.

Listed below are the minimum sample size for collection, preservation for shipment to the laboratory and holding time requirements as specified by SW-846 Chapter 4, Table 4-1. Footnotes to this table specify this information is guidance and does not represent EPA requirements. Selection of containers, preservation techniques and sample collection size should be based on project specific data quality objectives.

Matrix	Sample Container	Minimum Sample Size	Preservation	Holding Time[1]	Reference
Water	1L Amber Glass	4X1L	Cool to ≤ 6°	Extraction: 7 days	SW-846 Chapter 4

[1]Extraction holding time is determined from sampling date.

Unless otherwise specified by client or regulatory program, after analysis, samples and extracts are retained for a minimum of 30 days after provision of the project report and then disposed of in accordance with applicable regulations.

9.0 Quality Control

9.1 Sample QC

The laboratory prepares the following quality control samples with each batch of samples.

QC Item	Frequency	Acceptance Criteria
Method Blank (MB)	1 in 20 or fewer samples	See Analytical SOP
Laboratory Control Sample (LCS)	1 in 20 or fewer samples	See Analytical SOP
Matrix Spike(s) MS/MSD	Client Request	See Analytical SOP
Sample Duplicate (SD)	Client Request	See Analytical SOP

9.2 Instrument QC

Refer to the analytical SOP for the determinative test method.

10.0 Procedure

10.1 Instrument Calibration

Check the calibration of the pH meter and the balance each day of use prior to use and record these checks in the logbook designated for this purpose.

Verify the calibration of any mechanical pipettes used is current and if it is not, notify QA. The QA department checks the calibration of pipettes quarterly in accordance with the procedures specified in laboratory SOP BR-QA-008.

10.2 Equipment Preparation

Prepare glassware using the procedures described in laboratory SOP BR-EX-017 and rinse with acetone and methylene chloride prior to use. Label the glassware for each field and QC sample clearly and unambiguously during each step of the extraction procedure. Solvent will erase grease pens and “sharpie ink”; so use caution to ensure labels are not obliterated during the procedure.

Assemble a drying funnel for each field and QC sample by placing a plug of glass wool in a 75mm glass funnel then add a sufficient amount of purified granular sodium sulfate to fill the funnel ¾ full. Rinse the funnel with ~30 mL of acetone and ~ 30 mL of methylene chloride each and discard the solvent rinse.

Assemble a KD setup for each field and QC sample by attaching a 10 mL concentrator tube to a 500 mL evaporation flask and attach this to the drying funnel.

10.3 Extraction

If samples were received in 1 L containers, mark the meniscus of the sample container with a permanent marker. If a different size container was provided, measure 1 L of sample into a graduated cylinder. Transfer 1 L of reagent water to individual separatory funnels to serve as the method blank and LCS.

Add the proper type and volume of surrogate solution to each sample container (or graduated cylinder) and to the MB and LCS. Add the proper type and volume of spike solution to any samples designated as MS/MSD and to the LCS. See the extraction conditions workbook for type, concentration and amount of surrogate and spike solution to use for each test method. If the sample container is filled to the top of the bottle, remove and discard an amount of sample sufficient to add the spike and surrogate solution.

Check the pH of each sample using a calibrated pH meter or wide range pH paper. Adjust the pH, if necessary, using 1:1 sulfuric acid solution or 6N sodium hydroxide solution. See the extractions conditions workbook to determine the extraction pH for each test method. If using the pH meter, thoroughly rinse the probe of the pH meter with reagent water between each sample in order to avoid cross-contamination. If using pH paper, do not dip the paper into the sample, instead aliquot a drop of sample onto the pH paper.

Quantitatively transfer the entire sample into the 2 L separatory funnel. Rinse the sample container with ~60 mL methylene chloride and pour the rinsate into the separatory funnel extractor. To measure the sample volume, fill the sample container with tap mater to the mark of

the meniscus and pour the water into a graduated cylinder for volume measurement. Record the sample volume in the TALS worksheet.

Note: If high analyte concentrations are anticipated, a smaller sample volume may be taken and diluted to 1L with reagent water. If smaller volumes are used, it may be necessary to adjust the volume of surrogate and spike solution. Consult with the Department Supervisor for further guidance.

Cap and shake each separatory funnel vigorously for 15-20 seconds. Immediately after the first shake, vent the separatory funnel into a fume hood. Place the separatory funnel on the Sep. Funnel shaker and shake for 2 minutes. After the 2 minute shake is complete allow sufficient time for the organic layer to separate from the water layer. If an emulsion forms and it is more than one-third the size of the solvent layer, filter, centrifuge, or stir the extract to remove the emulsion.

Drain the solvent portion from the extractor into the drying funnel/concentration apparatus and repeat the extraction two more times using fresh portions of methylene chloride, combining the three extracts. If further pH adjustment and secondary extraction is required adjust the pH and repeat the extraction three more times.

Concentrate the extract using KD technique and adjust the extract to the final volume required for the test method.

10.4 Extract Concentration (KD Technique)

10.4.1 Macro Concentration

Macro Snyder Column (K-D)

Add one or two clean boiling chips to the K-D evaporation flask and attach a three-ball Snyder column to the flask. Add ~1 mL of methylene chloride to the top of the column then place the K-D apparatus in a hot water bath (60-70°C) so that the concentrator tube is partially immersed in the hot water and the entire lower rounded surface of the flask is bathed in hot water vapor.

Attach the solvent vapor recovery glassware to the Snyder column. Adjust the vertical position of the apparatus and check the water bath temperature. The water bath temperature should be between 54.8 – 74.8°C when methylene chloride is the extraction solvent and 84-89°C when hexane is the extraction solvent. Higher water bath temperatures may be used so long as the recovery of target analytes is not impacted. The boiling point of each solvent is provided in the following table:

Solvent	Boiling Point	Water Bath Temperature
Hexane	69°C	84 – 89°C
Methylene Chloride	39.8°C	54.8 – 74.8°C

Monitor the concentration and do not let the extract evaporate to dryness. At the proper rate of distillation the balls of the column will actively chatter but the chambers will not flood with solvent.

When the apparent volume of the extract reaches desired amount remove the K-D apparatus from the water bath and allow it to drain and cool for at least 10 minutes.

10.4.2 Micro Concentration

Add one or two clean boiling chips to the concentrator tube and attach a two ball micro-Snyder column to the tube. Place the concentrator tube into the water bath so that the concentrator tube is partially immersed in hot water. Adjust the vertical position of the concentrator tube and check the temperature of the water bath to ensure the proper temperature for the extract solvent.

Continuously monitor the distillation process to ensure sample extracts do not evaporate to dryness. At the proper rate of distillation, the balls of the column will actively chatter, but the chambers will not flood with solvent. Remove setup when desired sample volume is reached.

10.4.3 Nitrogen Blowdown

Nitrogen blow down may be used to concentrate extracts as needed.

Place the concentrator tube in a warm water bath maintained at a temperature of 35°C. Apply a steady stream of nitrogen until the desired final extract volume is achieved. Rinse the internal wall of the concentrator tube several times with the appropriate solvent during the evaporation and ensure the solvent level in the concentrator is positioned such to prevent water condensations. Monitor the concentration carefully and do not allow the extract to evaporate to dryness.

10.5 Extract Preparation & Handling

Transfer the extract to labeled Teflon lined screw cap vial.

Adjust the extract to volume using a reference vial for final extract volumes greater than 1 mL and by using the tip of concentration tubes for volumes 1 mL and less. Before using the reference vial, verify the reference vials were prepared on the same day by an analyst authorized to prepare reference vials. Place the extracts in refrigerated storage maintained at a temperature of 4°C±2 in preparation for subsequent cleanup or analysis as specified by the method chain.

If the TALS log-in does not include cleanup methods in the method chain and there is reason to believe the extract may require cleanup (color, odor, viscosity, etc.) notify the PM of the situation so he/she can determine if cleanup should be performed prior to analysis.

Complete the TALS batch worksheet and perform primary review of the extraction batch.

11.0 Calculations / Data Reduction

11.1 Calculations

Calculations are provided in the analytical SOP for each method parameter.

11.2 Data Review

Refer to laboratory SOP BR-QA-019 for the required elements of each step of data review.

11.2.1 Primary Review

Review the batch worksheet for correctness and completeness. Record any problems encountered during the extraction process with a nonconformance memo (NCM).

11.2.2 Secondary Review

Review the batch worksheet for correctness and completeness and to ensure the extraction performed is consistent the SOP and project specifications.

Print the output worksheets and release extracts and output worksheet to the analytical department or to the next step in the method chain such as extract cleanup.

If the TALS log-in does not include cleanup methods in the method chain and there is reason to believe the extract may require cleanup (color, odor, viscosity, etc.) notify the PM of the situation so he/she can determine if cleanup should be performed prior to analysis.

For additional guidance regarding the laboratory's protocol and required elements for data review refer to laboratory SOP BR-QA-019.

12.0 Method Performance

12.1 Detection Limit (DL), Limit of Detection (LOD) and Limit of Quantitation (LOQ)

Refer to the analytical SOP for DL, LOD and LOQ requirements.

12.2 Demonstration of Capabilities (DOC)

Each analyst must complete an Initial Demonstration of Capability prior to unsupervised performance of this method.

12.3 Training Requirements

Any employee that performs any portion of the procedure described in this SOP must have documentation in their employee training file that they have read this version of this SOP.

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 Safety Manual 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 BR-EH-001 *Hazardous Waste*. The following waste streams are produced when this method is carried out.

- Organic Solvents - Satellite container: 55 Gallon Covered and Vented Drum.
- Extracted water samples - Satellite Container: 55 Gallon Covered and Vented Drum.
- Vials containing extracts - Satellite Container: 5 Gallon Covered Bucket (inside fume hood).
- Solid Waste - Satellite Container: Solid Waste 5 Gallon Plastic Bucket (inside fume hood).

15.0 References / Cross-References

- SW-846 Method 3510C Separatory Funnel Liquid-Liquid Extraction, Revision 3, December 1996.
- Laboratory SOP BR-EX-017
- Laboratory SOP BR-QA-019
- Laboratory SOP BR-QA-005
- Laboratory SOP BR-EH-001
- Corporate Environmental Health and Safety Manual

16.0 Method Modifications

There are no modifications of the referenced method.

17.0 Attachments

- Table 1: Primary Materials Used
- Appendix A: Terms and Definitions

18.0 Revision History

Revision 9:
- Title Page: Update Approval Signatures and copyright date
- Section 8: Updated text to cite regulatory reference and add that this information is guidance per the language in SW-846 Chapter 4.
- Section 10.5: Added procedure for use of reference vials and final extract volume adjustment and added laboratory policy for cleanups when cleanups are not included in method chain.
- Section 11.0: Added statement about laboratory for cleanups when cleanups are not included in the method chain.

Revision 8:
- Updated Title Page
- All Sections: Added TALS terminology and removed reference to bench sheets and added reference to extraction conditions workbook.
- All Sections: Changed Sep Funnel rotator to Sep. Funnel shaker.
- Section 10.3: Changed sequence of procedure so that surrogate and spike solutions are added to sample container before transfer to extraction vessel and to perform pH measurement and adjustment before transfer to extraction vessel.

Revision 7:
- Sections 5.0 & 5.2: Updated with new language.
- Section 6.3: Remove balance and added glass wool.

Table 1: Primary Materials Used

Material[1]	Hazards	Exposure Limit[2]	Signs and symptoms of exposure
Acetone	Flammable	1000 ppm-TWA	Inhalation of vapors irritates the respiratory tract. May cause coughing, dizziness, dullness, and headache.
Hexane	Flammable Irritant	500 ppm-TWA	Inhalation of vapors irritates the respiratory tract. Overexposure may cause lightheadedness, nausea, headache, and blurred vision. Vapors may cause irritation to the skin and eyes.
Sulfuric Acid[1]	Corrosive Oxidizer Dehydra-dator	1 mg/m^3	This material will cause burns if comes into contact with the skin or eyes. Inhalation of vapors will cause irritation of the nasal and respiratory system.
Sodium Hydroxide	Corrosive Poison	2 ppm, 5 mg/m^3	This material will cause burns if comes into contact with the skin or eyes. Inhalation of Sodium Hydroxide dust will cause irritation of the nasal and respiratory system.
Methylene Chloride	Carcinogen Irritant	25 ppm-TWA 125 ppm-STEL	Causes irritation to respiratory tract. Has a strong narcotic effect with symptoms of mental confusion, light-headedness, fatigue, nausea, vomiting and headache. Causes irritation, redness and pain to the skin and eyes. Prolonged contact can cause burns. Liquid degreases the skin. May be absorbed through skin.

[1] *Always add acid to water to prevent violent reactions.*
[2] *Exposure limit refers to the OSHA regulatory exposure limit.*

Appendix A: Terms and Definitions

Batch: environmental samples that are prepared and/or analyzed together with the same process, using the same lot(s) of reagents. A preparation/digestion batch is composed of one to 20 environmental samples of similar matrix, meeting the above criteria. An analytical batch is composed of prepared environmental samples (extracts, digestates and concentrates), which are analyzed together as a group.

Corrective Action: the action taken to eliminate the cause of an existing nonconformity, defect or other undesirable occurrence in order to prevent recurrence.

Holding Time: the maximum time that a sample may be held before preparation and/or analysis as promulgated by regulation or as specified in a test method.

Intermediate Standard: a solution made from one or more stock standards at a concentration between the stock and working standard. Intermediate standards may be certified stock standard solutions purchased from a vendor and are also known as secondary standards.

Laboratory Control Sample (LCS): a blank matrix spiked with a known amount of analyte(s) processed simultaneously with and under the same conditions as samples through all steps of the procedure.

Matrix Spike (MS): a field sample to which a known amount of target analyte(s) is added.

Matrix Spike Duplicate (MSD): a second replicate matrix spike

Method Blank (MB): a blank matrix processed simultaneously with and under the same conditions as samples through all steps of the procedure. Also known as the preparation blank (PB).

Non-conformance: an indication, judgment, or state of not having met the requirements of the relevant specification, contract or regulation.

Preservation: refrigeration and/or reagents added at the time of sample collection to maintain the chemical, physical, and/or biological integrity of the sample.

Quality Control Sample (QC): a sample used to assess the performance of all or a portion of the measurement system.

Stock Standard: a solution made with one or more neat standards usually with a high concentration. Also known as a primary standard. Stock standards may be certified solutions purchased from a vendor.

Surrogate: a substance with properties that mimic the analyte of interest but that are unlikely to be found in environmental samples.

Title: HOMOGENIZATION OF BIOTA & TISSUE

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Approval Date: August 1, 2012

Facility Distribution No. Electronic **Distributed To: Facility Intranet**

The controlled copy of this SOP is the PDF copy of the SOP that is posted to the laboratory's SOP Directory. Printed copies of this SOP or electronic copies of this SOP distributed outside the facility are considered uncontrolled.

1.0 Scope and Application

This SOP describes the laboratory procedure for the whole body homogenization and extraction of biota and tissue samples by tissuemizer in preparation for analysis by a variety of chromatographic procedures.

NOTE: Pre-preparation of tissue such as dissection, sportsman filet, sample compositing, shucking, etc. may be performed by the laboratory per customer specification. These procedures are project specific and instructions are not included in this SOP.

2.0 Summary of Method

2.1 Homogenization

Tissue samples are homogenized using a titanium blade homogenizer. Biota samples are homogenized using stainless steel knives and/or a food processor. The homogenized sample(s) are transferred to labeled glass jars and stored in a freezer maintained at a temperature of -15ºC (±5ºC) in preparation for extraction.

The laboratory's standard procedure is to perform whole body homogenization of the tissue sample. Any customer specifications for dissection or homogenization of certain parts of the tissue sample, compositing multiple samples or other must be negotiated with the laboratory during project initiation and specific instructions for sample processing must be prepared and provided to the extraction laboratory by the laboratory PM. In the absence of instruction, the laboratory will homogenize the entire sample.

The homogenization procedure is a laboratory developed procedure based on the procedures described in the Sampling and Analytical Methods of the National Status and Trends Program, National Benthic Surveillance and Mussel Watch Projects 1984-1992, Volume IV, National Status and Trends Program for Marine Environmental Quality.

2.2 Extraction

A portion of homogenized sample is mixed with anhydrous sodium sulfate then macerated for 3 minutes in an appropriate extraction solvent using the Tissumizer. The solvent layer decanted poured through sodium sulfate and collected in a collection vessel. The extraction is repeated two more times with fresh portions of extraction solvent. After extraction, the combined extracts are concentrated to an appropriate final volume using K-D Technique. Percent lipids are determined following procedures given in laboratory SOP BR-EX-016 Percent Lipid Determination and extract cleanup is performed when necessary.

The extraction procedure is a laboratory developed procedure based on the procedures described in the Sampling and Analytical Methods of the National Status and Trends Program, National Benthic Surveillance and Mussel Watch Projects 1984-1992, Volume IV, National Status and Trends Program for Marine Environmental Quality.

3.0 Definitions

- Biota: flora and fauna. For this SOP, all reference to "biota" refers to plant material.

- Tissue: an aggregate of cells usually of a particular kind together with their intercellular substance that form one of the structural materials of a plant or animal. For this SOP, all reference to "tissue" refers to structural materials from an animal.

A list of general terms and definitions are provided in Appendix A.

4.0 Interferences

Method interference may be caused by contaminants in solvents, reagents, glassware and other sample processing equipment that can cause interference and/or elevated baselines in chromatography. All reagents and solvents used during this procedure should be reagent grade or high purity in order to minimize interference. All glassware must be cleaned in accordance with laboratory SOP BR-EX-017 Glassware Cleaning, and rinsed with acetone and methylene chloride prior to use.

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

Nitrile gloves should be used when performing this extraction. Latex and vinyl gloves provide no significant protection against the organic solvents used in this SOP, and should not be used.

During Kuderna-Danish (KD) concentration, do not allow the extract to boil to dryness. The solvent vapors remaining in the KD apparatus may superheat and create an explosion or fire hazard.

5.2 Primary Materials Used

Table 1 lists those materials used in this procedure that have a serious or significant hazard rating along with the exposure limits and primary hazards associated with that material as identified in the MSDS. **NOTE: This list does not include all materials used in the method.** 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.

6.0 Equipment and Supplies

Catalog numbers listed in this SOP are subject to change at the discretion of the vendor. Analysts are cautioned to be sure equipment used meets the specification of this SOP.

6.1 Homogenization Equipment

- Cutting Board- High density polyethylene 16X23"

- Homogenizer equipped with 55 mm Titanium Blade Omni International or equivalent.
- Food Processor Cuisinart or equivalent
- Stainless steel knives
- Glass Jars, wide mouth; 125 mL-1000 mL. ESS or equivalent.
- Meat Grinder

6.2 Extraction Equipment

- Tissuemizer equipped with a 20 mm x 195 Generator probe. Omni International PowerGen 700 or equivalent.
- Filter Funnels – 100 mm diameter for filtration/drying. Fisher Scientific or equivalent.
- No. 54 Filter paper. Whatman 18.5 cm, or equivalent.
- Beakers – 400 mL. Fisher Scientific or equivalent.

6.3 Extract Concentration (KD Apparatus)

- Concentrator Tube, 10 mL Graduated: ChemGlass Catalog # CG-1316-11 or equivalent
- Snyder Column: Three ball macro, AMK Catalog # SC2-01 or equivalent
- Snyder Column: Two ball micro, AMK Catalog # SC3-01 or equivalent
- Evaporation Flask: 500 mL attached to concentrator tube with clip, AMK Catalog Number KDF-500 or equivalent.
- Boiling Chips: Silicon carbide, approximately 10/40 mesh, solvent extracted in methylene chloride, Troemner Catalog # 133B or equivalent.
- Heating Mantle: Rheostat controlled for water bath capable of temperature control (±5°C). ChemGlass Catalog # PL3122 or equivalent.
- Water Bath, capable of temperature control to ±5°C. Barnstead Corporation Catalog # HM0500-HS1 or equivalent.
- Solvent Vapor Recovery System, Kontes K-54000-1006, K-547300-000, Ace Glass Catalog # 6614-30 or equivalent.

6.4 Miscellaneous

- Disposable Glass Pasteur Pipette and bulb: Fisher Scientific or equivalent.
- Top Loading balance: Capable of measuring to 0.01 gram accuracy, Mettler Model # PM4800 or equivalent.
- Vials and caps: 2, 4, 8, and 16 mL with Teflon lined septa and screw caps, Fisher Scientific or equivalent.
- Teflon and Stainless Steel Spatulas, Fisher Scientific or equivalent.
- Adjustable Pipette: Finnpipette or equivalent
- 0.5 mL – 2.0 mL Hamilton Gastight® syringes or equivalent.
- Paper towels

7.0 Reagents and Standards

7.1 Reagents

- Sodium Sulfate (Na_2SO_4), Granular Anhydrous: J.T. Baker or equivalent. Purify by heating at 400°C for at least 4 hours.
- Methylene Chloride (CH_2C_{12}): Pesticide Quality, J.T Baker or equivalent.

- Hexane, (C_6H_{14}): Pesticide Quality, J.T. Baker or equivalent.
- Acetone, ($(CH_3)_2CO$): Pesticide Quality, J.T. Baker or equivalent.
- Reagent Water: RO water filtered through a Nanopure System.
- Alkaline Liquid Detergent: Contrex or equivalent.

Methylene Chloride/Acetone (1:1): In a 4 L amber glass bottle mix 2 L methylene chloride with 2 L acetone. Store the solution in a fume hood. Assign an expiration date of 6 months from date of preparation unless the parent material expires earlier, in which case, use the earliest expiration date.

Hexane /Acetone (1:1): In a 4 L amber glass bottle mix 2 L hexane with 2 L acetone. Store the solution in a fume hood. Assign an expiration date of 6 months from date of preparation unless the parent material expires earlier, in which case, use the earliest expiration date.

7.2 Standards

Purchase certified stock standards from commercial vendors and from these prepare surrogate and spiking solutions by diluting a known volume of the stock standard solutions in an appropriate solvent. Record the preparation of all standards in the LIMS module. The formulations for the preparation of surrogate and spiking standards are provided in analytical SOPs.

Unless otherwise specified in the analytical SOP store prepared in glass containers at 4°C or below and assign an expiration date of 6 months from the date of preparation unless the parent standards expire earlier in which case use the earliest expiration date.

Assay surrogate and spike solutions before each use to verify the made to concentration is within specifications. Maintain records of the assay per the procedure established for the work section.

8.0 Sample Collection, Preservation, Shipment and Storage

The laboratory does not perform sample collection so these procedures are not included in this SOP.

The laboratory recommends that tissue and biota samples be collected in glass jars or sealable plastic bags. Immediately following collection, biota samples should be iced to a temperature of 4°C (±2°C) and tissue samples should be frozen and maintained at a temperature of -15°C (±5°C) until the time of homogenization. After homogenization, all homogenized samples must be stored in a freezer maintained at a temperature of -15°C (±5°C).

Tissue and biota samples must be extracted within the holding time specified in the client's quality assurance plan. In the absence of client specifications, the following HT will be used:

SVOA GC/MS: 14 Days from Date of Collection
Pesticides: 14 Days from Date of Collection
PCB: 365 Days from Date of Collection
Mercury: 28 Days from Date of Collection
Metals: 180 Days from Date of Collection

After extraction any remaining sample should be returned immediately to the freezer or stored per the project specifications.

Unless otherwise specified by client or regulatory program, after analysis, samples and extracts are retained for a minimum of 30 days after provision of the project report and then disposed of in accordance with applicable regulations.

9.0 Quality Control

9.1 Sample QC

The laboratory prepares the following quality control samples with each batch of samples.

QC Item	Frequency	Acceptance Criteria
Method Blank (MB)	1 in 20 or fewer samples	See Analytical SOP
Laboratory Control Sample (LCS)	1 in 20 or fewer samples	See Analytical SOP
Matrix Spike(s) MS/MSD	Client Request .	See Analytical SOP
Sample Duplicate (SD)	Client Request	See Analytical SOP

10.0 Procedure

10.1 Instrument Calibration

Check the calibration of the balance each day of use prior to use.

Check the calibration of the adjustable pipettes quarterly.

Perform periodic maintenance on the tissuemizer's generator probe as necessary. Maintenance may include but is not limited to the replacement of Teflon bearings and rotor shafts when a loud squealing noise is heard. Refer to the PowerGen 700 Homogenizer Instruction Manual for further guidance and for the manufacturer's recommended maintenance program.

10.2 Whole Body Homogenization of Tissue Samples

Remove the samples from storage and let the sample(s) thaw completely.

Wash all equipment with detergent and hot water, then rinse with reagent water and acetone prior to use and also after each sample.

Prepare a equipment blank to ensure the equipment is clean. To prepare the blank, transfer a representative amount of reagent water (similar to the size of the samples) to a clear glass jar. Let the water come into contact with all equipment that will be used to homogenize the samples. This process should be done randomly during homogenization to verify the cleaning process.

If possible obtain a glass jar large enough to accommodate the entire sample. Label the jar with the sample's lab ID and place the jar on the analytical balance. Tare the balance. Put on a pair of nitrile gloves and with your hands transfer the sample from the storage container to the labeled jar. Record the pre-homogenization weight of the sample in the worksheet.

Transfer the sample to a pre-cleaned cutting board. Cut the sample into 1-3" sections using a stainless steel knife then place the sections of samples in the labeled jar.

Insert the titanium blade into the jar and homogenize the sample at 2000-4000 RPM until the sample becomes slurry. Manual mixing with a stainless steel or Teflon spatula may be required

to insure complete homogenization. Remove the blade from the sample jar and scrape any remaining sample from the blade into the labeled jar. Place the jar on the top-loading balance and record the post homogenization weight in the worksheet.

NOTE: Samples greater than 12 inches or samples with weight measurements that exceed 1-2 pounds should be homogenized in a stainless steel meat grinder prior to use of the titanium blade. If the sample is extremely large homogenization with a knife may be necessary. If the homogenized tissue sample cannot fit into a single container, pass the sample through the meat grinder multiple times, homogenize the slurry and transfer to multiple containers.

10.3 Homogenization of Biota Samples

Wash all equipment with detergent and hot water, then rinse with reagent water and acetone prior to use and also after each sample.

Prepare a equipment blank to ensure the equipment is clean. To prepare the blank, transfer a representative amount of reagent water (similar to the size of the samples) to a clear glass jar. Let the water come into contact with all equipment that will be used to homogenize the samples. This process should be done randomly during homogenization to verify the cleaning process.

Remove the samples from storage and let warm to ambient temperature. Select a glass jar large enough to accommodate the entire sample. Label the jar with the sample's lab ID and place the jar on the top-loading balance. Tare the balance. Remove the biota sample from the storage container and place in the labeled jar. Record the pre-homogenization weight of the sample into the worksheet.

Remove the sample and place on a pre-cleaned cutting board. Slice the material into very fine sections using a stainless steel knife or a food processor. Return homogenized sample back into the jar and place on the top-loading balance. Record the post homogenization weight into the worksheet.

10.4 Extraction

Clean all glassware prior to use following the procedure given in laboratory SOP BR-EX-017. Label all glassware with field and QC samples ID numbers clearly and unambiguously during each step of the extraction procedure. Solvents will erase grease pens and "sharpie ink", so caution must be taken to ensure that the labels are not obliterated during the procedure.

Assemble a KD apparatus set-up and prepare a glass funnel for each sample to be extracted. Fold a 185 mm Whatman® 54 filter into quarters and place a filter in each funnel. Fill each funnel ~3/4 full with purified granular anhydrous sodium sulfate. Rinse the funnel with ~30 mL acetone and methylene chloride each and discard the solvent rinse. Place a prepared funnel onto each K-D setup.

Assemble the Tissuemizer by attaching the 20 mm x 195 mm-generator probe to the Tissumizer motor. Place the Tissuemizer in the fume hood and attach to the aluminum staging using clamps. Clean the Tissuemizer prior to use by running the generator probe for 10 seconds in a 400 mL beaker filled with ~ 200 mL of reagent water. Discard the reagent water and repeat with another aliquot of reagent water. Repeat the cleaning step two more times each with ~250 mL of acetone.

Mix the sample using a stainless steel or Teflon spatula. Place a labeled 400 mL beaker onto the top-loading balance and depress the "tare" button. Referring to the extraction condition spreadsheet, weigh out the appropriate amount of sample and record sample weight ± 1 gram into TALS. Repeat for all samples. Transfer two additional aliquots of the sample selected for the MS and MSD into labeled 400 mL beakers. Transfer the same weight of sodium sulfate each into labeled 400 mL beakers to serve as the method blank (MB) and laboratory control sample (LCS).

Add a sufficient volume of granular sodium sulfate to each sample and mix thoroughly with a stainless steel spatula until a free-flowing mixture is formed.

Add the appropriate volume of surrogate spike to each field sample and QC sample. Add the appropriate volume of spike solution to the laboratory control samples and the MS/MSD.

Add 100 mL of the appropriate extraction solvent to each beaker. Use 1:1 $MeCl_2$/Acetone for samples to be analyzed by GC/MS and 1:1 Hexane/Acetone for GC/ECD.

Refer to the Extractions Condition Worksheet to determine the type and amounts of solution added and the extraction solvent used for each test method.

Immerse the generator probe in the first sample beaker so that it is approximately ½" into the extraction solvent. Turn on the Tissuemizer. Adjust the speed on the motor until the solvent begins to vortex in the beaker, but does not splash out of the beaker. Extract the sample for 3 minutes. During extraction move the beaker in a circular motion to ensure that the entire sample is subject to extraction. Remove the beaker and decant the extraction solvent into the sample's corresponding funnel and K-D apparatus. Repeat the extraction 2 more times with ~100 mL of extraction solvent. After the 3rd extraction, pour the entire contents of the beaker into the funnel, rinse the beaker with more of the extraction solvent, and pour this into the funnel as well.

Rinse the funnel with ~30 mL of extraction solvent and allow the solvent to completely drain into the K-D apparatus. Remove the funnel from the K-D apparatus and discard the contents of the funnel. Clean the generator probe and repeat the extraction for each sample.

Concentrate the extracts following the procedure given in section 10.5 in preparation for percent lipids determination and extract cleanup. After concentration and prior to extract cleanup, set aside a 1 mL aliquot of the concentrated extract and determine the percent lipids following procedures given in laboratory SOP BR-EX-016 *Percent Lipids Determination.*

Perform extract cleanup as appropriate following procedures given in laboratory SOPs BR-EX-002 and BR-EX-011. Refer to extraction condition spreadsheet for details. After cleanup, concentrate the extracts following the procedure given in section 10.5.

Enter the extraction data into the TALS. Assemble any associated paperwork and submit the extracts to the supervisor for a final project check. After review is complete, relinquish the extracts to the appropriate analytical department and place in the refrigerated storage area.

Note: Immediately following concentration, all sample extracts must be stored in a refrigerator maintained at a temperature of 4ºC (±2°C) in order to maintain thermal preservation.

10.5 Extract Concentration (KD Apparatus)

10.5.1 Macro Concentration

Macro Snyder Column (K-D)

Add one or two clean boiling chips to the K-D evaporation flask and attach a three-ball Snyder column to the flask. Add ~1 mL of methylene chloride to the top of the column then place the K-D apparatus in a hot water bath (60-70°C) so that the concentrator tube is partially immersed in the hot water and the entire lower rounded surface of the flask is bathed in hot water vapor.

Attach the solvent vapor recovery glassware to the Snyder column. Adjust the vertical position of the apparatus and check the water bath temperature. The water bath temperature should be between 54.8 – 74.8°C when methylene chloride is the extraction solvent and 84-89°C when hexane is the extraction solvent. Higher water bath temperatures may be used so long as the recovery of target analytes is not impacted. The boiling point of each solvent is provided in the following table:

Solvent	Boiling Point	Water Bath Temperature
Hexane	69°C	84 – 89°C
Methylene Chloride	39.8°C	54.8 – 74.8°C

Monitor the concentration and do not let the extract evaporate to dryness. At the proper rate of distillation the balls of the column will actively chatter but the chambers will not flood with solvent.

When the apparent volume of the extract reaches desired amount remove the K-D apparatus from the water bath and allow it to drain and cool for at least 10 minutes.

Micro Synder Column (K-D)

Add one or two clean boiling chips to the concentrator tube and attach a two ball micro-Snyder column to the tube. Place the concentrator tube into the water bath so that the concentrator tube is partially immersed in hot water. Adjust the vertical position of the concentrator tube and check the temperature of the water bath to ensure the proper temperature for the extract solvent.

Continuously monitor the distillation process to ensure sample extracts do not evaporate to dryness. At the proper rate of distillation, the balls of the column will actively chatter, but the chambers will not flood with solvent. Remove setup when desired sample volume is reached.

Nitrogen Blowdown

Nitrogen blow down may be used to concentrate extracts as needed.

Place the concentrator tube in a warm water bath maintained at a temperature of 35°C. Apply a steady stream of nitrogen until the desired final extract volume is achieved. Rinse the internal wall of the concentrator tube several times with the appropriate solvent during the evaporation and ensure the solvent level in the concentrator is positioned such to prevent water condensations. Monitor the concentration carefully and do not allow the extract to evaporate to dryness.

11.0 Calculations / Data Reduction

11.1 Data Review

11.1.1 Primary Review

Review the TALS worksheet for correctness and completeness. Record any problems encountered during the extraction process into TALS or complete a NCM, when necessary. Set aside the extracts and paperwork for secondary review.

11.1.2 Secondary Review

Review the TALS worksheet against the extraction conditions spreadsheet and/or project notes to ensure the extraction performed is consistent with project specifications. Authorize release of the extracts to the appropriate analytical department.

For additional guidance regarding the laboratory's protocol and required elements for data review refer to laboratory SOP BR-QA -019 *Data Review*.

12.0 Method Performance

12.1 Limit of Detection (LOD) and Limit of Quantitation (LOQ)

Refer to the SOP for the test method for requirements for determination of LOD and LOQ. These procedures are not included in sample preparation SOPs.

12.2 Demonstration of Capabilities (DOC)

Each analyst must complete an Initial Demonstration of Capability prior to unsupervised performance of this method.

12.3 Training Requirements

Any employee that performs any portion of the procedure described in this SOP must have documentation in their employee training file that they have read this version of this SOP.

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 Safety Manual 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 BR-EH-001 *Hazardous Waste*. The following waste streams are produced when this method is carried out.

- Organic Solvents - Satellite container: 55 gallon covered and vented drum.
- Vials containing extracts - Satellite container: 5 gallon covered bucket in fume hood.

- Methylene Chloride-Waste-Satellite Container: 55 Gallon Waste Drum
- Sulfuric Acid Waste-Satellite Container: 2.5L Waste Bottle Labeled with appropriate acid type (sulfuric).
- Solid Waste-Satellite Container: Solid Waste 5 Gallon Plastic Bucket (inside fume hood)

15.0 References / Cross-References

- Comprehensive Descriptions of Trace Organic Analytical Methods given in the Sampling and Analytical Methods of the National Status and Trends Program, National Benthic Surveillance and Mussel Watch Projects 1984-1992, Volume IV, National Status and Trends Program for Marine Environmental Quality.

- GERG Trace Organic Contaminant Analytical Techniques published in NOAA Technical Memorandum NOS Orca 71, Sampling and Analytical Methods of the National Status and Trends Program, National Benthic Surveillance and Mussel Watch Projects 1984-1992, Volume IV, Comprehensive Descriptions of Trace Organic Analytical Methods, July 1993.

- CW-E-M-001 *Corporate Environmental Health and Safety Manual*
- BR-EX-016 *Percent Lipid Determination*
- BR-EX-017 *Glassware Cleaning*
- BR-EX-002 *Extract Cleanup Procedure*
- BR-EX-011 *Gel-Permiation Cleanup*
- BR-QA -019 *Data Review*
- BR-QA-005 *Determination of LOD, LOQ, & RLs*
- BR-EH-001 *Hazardous Waste*

16.0 Method Modifications

Not applicable.

17.0 Attachments

- Table 1: Primary Materials Used
- Appendix A: Terms and Definitions

18.0 Revision History

Revision 5, Effective Date 5/20/08:
- Title Page: Updated approval signatures.
- Section 6.0: Inserted vendor information
- Section 8.0: Inserted table
- Section 15.0: Added cross referenced methods with the SOP
- All Sections: Fixed typographical errors

Revision 6, Effective Date 05/20/10:
- Title Page: Updated approval signatures
- Section 6.1: Addition of Meat Grinder to equipment list
- Section 10.1: Changed pipette calibrations to be done quarterly
- All Sections: Fixed typographical errors
- All Sections: Changed benchsheets reference to extraction condition spreadsheet
- All Sections: Changed LIMS references to TALS

Revision 7, Effective Date 08/01/12

- Section 8.0: Updated Holding Time requirements
- Section 9.1: Changed frequency of MS/MSD to client request

Table 1: Primary Materials Used

Material[1]	Hazards	Exposure Limit[2]	Signs and symptoms of exposure
Acetone	Flammable	1000 ppm-TWA	Inhalation of vapors irritates the respiratory tract. May cause coughing, dizziness, dullness, and headache.
Hexane	Flammable Irritant	500 ppm-TWA	Inhalation of vapors irritates the respiratory tract. Overexposure may cause lightheadedness, nausea, headache, and blurred vision. Vapors may cause irritation to the skin and eyes.
Methylene Chloride	Carcinogen Irritant	25 ppm-TWA 125 ppm-STEL	Causes irritation to respiratory tract. Has a strong narcotic effect with symptoms of mental confusion, light-headedness, fatigue, nausea, vomiting and headache. Causes irritation, redness and pain to the skin and eyes. Prolonged contact can cause burns. Liquid degreases the skin. May be absorbed through skin.

[1] *Always add acid to water to prevent violent reactions.*
[2] *Exposure limit refers to the OSHA regulatory exposure limit.*

Appendix A: Terms and Definitions

Analyte: The specific chemicals or components for which a sample is analyzed. (EPA Risk Assessment Guide for Superfund, OSHA Glossary).

Batch: environmental samples that are prepared and/or analyzed together with the same process, using the same lot(s) of reagents. A preparation/digestion batch is composed of one to 20 environmental samples of similar matrix, meeting the above criteria. An analytical batch is composed of prepared environmental samples (extracts, digestates and concentrates), which are analyzed together as a group.

Calibration: a set of operations that establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument or measuring system, or values represented by a material measure or a reference material and the corresponding values realized by the standards.

Corrective Action: the action taken to eliminate the cause of an existing nonconformity, defect or other undesirable occurrence in order to prevent recurrence.

Holding Time: the maximum time that a sample may be held before preparation and/or analysis as promulgated by regulation or as specified in a test method.

Laboratory Control Sample (LCS): a blank matrix spiked with a known amount of analyte(s) processed simultaneously with and under the same conditions as samples through all steps of the procedure.

Matrix Spike (MS): a field sample to which a known amount of target analyte(s) is added.

Matrix Spike Duplicate (MSD): a second replicate matrix spike

Method Blank (MB): a blank matrix processed simultaneously with and under the same conditions as samples through all steps of the procedure. Also known as the preparation blank (PB).

Non-conformance: an indication, judgment, or state of not having met the requirements of the relevant specification, contract or regulation.

Preservation: refrigeration and/or reagents added at the time of sample collection to maintain the chemical, physical, and/or biological integrity of the sample.

Quality Control Sample (QC): a sample used to assess the performance of all or a portion of the measurement system.

Stock Standard: a solution made with one or more neat standards usually with a high concentration. Also known as a primary standard. Stock standards may be certified solutions purchased from a vendor.

Surrogate: a substance with properties that mimic the analyte of interest but that are unlikely to be found in environmental samples.

SOP Change in Progress Attachment (CIPA)

SOP Number	SOP Title	SOP Revision	SOP Effective Date	CIPA Effective Date
BR-EX-027	Soxtherm Extraction (SW-846 3541)	0	11/10/10	10/01/12

The following revisions were made to this standard operating procedure (SOP). These changes are effective as of the CIPA Effective Date. This change to this document is authorized by the laboratory's QA Department.

Page 7 of 12, Section 10.5 Extraction Concentration (KD-Apparatus):

Remove the phrase (KD-Apparatus) from header 10.4 so that the text is:

10.5 Extraction Concentration

Insert the following text between 10.5 and 10.5.1:

The following sections describe the procedures for the concentration of extracts. Any of the three techniques described may be used. However some techniques are more efficient than others to achieve the final extract volume. Use the following guidelines to select the concentration technique: For the concentration of volumes greater than 5 mL, use Macro Concentration. To concentrate extract volumes between 5 and 1 mL use Micro Concentration. To concentrate extract volumes below 1 mL, use Nitrogen Blowdown.

Change the text in the header for 10.5.1 from Micro Snyder Column Concentration to Macro Snyder Column Concentration.

10.5.1 Macro Snyder Column Concentration

Title: AUTOMATED SOXHLET EXTRACTION (SW-846 3541)

Approval Signatures:

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Approval Date: November 10, 2010

Facility Distribution No. Electronic **Distributed To: Facility Intranet**

The controlled copy of this SOP is the PDF copy of the SOP that is posted to the laboratory's SOP Directory. Printed copies of this SOP or electronic copies of this SOP distributed outside the facility are considered uncontrolled.

1.0 Scope and Application

This SOP describes the laboratory procedure for automated soxhlet extraction of organic analytes from soils, sediment and waste solids and the subsequent concentration of the extracts in preparation for analysis by GC or GC/MS.

1.1 Analytes, Matrix(s), and Reporting Limits

Refer to analytical methods for analyte lists and reporting limits.

2.0 Summary of Method

A portion of sample is dried with anhydrous sodium sulfate, placed in an extraction thimble and extracted with an appropriate solvent for 3 hours. Following extraction the extract is concentrated using a Kuderna-Danish (K-D) apparatus to an appropriate final volume in preparation for cleanup and/or determinative analysis.

This procedure is based on the following reference method:

SW-846 Method 3541, Automated Soxhlet Extraction, Revision 0, 1994. Test Methods for Evaluating Solid Waste Physical/Chemical Methods, Third Edition, September 1986.

3.0 Definitions

A list of terms and definitions are provided in Appendix A.

4.0 Interferences

Method interferences may be caused by contaminants in solvents, reagents, glassware and other sample processing equipment. These contaminants can lead to elevated baselines and discrete artifacts that appear in gas chromatograms. These materials are demonstrated to be free of interferences by the analysis of method blanks. Interferences from phthalate esters can also pose a problem for the chlorinated pesticides analysis. To avoid this type of interference, the use of plastics in the laboratory must be minimized.

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

Nitrile gloves should be used when performing this extraction. Latex and vinyl gloves provide no significant protection against the organic solvents used in this SOP, and should not be used.

The following analytes have been tentatively classified as known or suspected, human or mammalian carcinogens:benzo(a)anthracene,benzidine, 3,3'dichlorobenzindine, benzo(a)pyrene, alpha-BHC,beta-BHC, gamma-BHC, delta-BHC, dibenz(a,h)anthracene, N-nitrosodimethylamine, 4,4'-DDT, and polychlorinated biphenyl compounds. Primary standards of these toxic compounds should be prepared in hood.

During Kuderna-Danish (KD) concentration, do not allow the extract to boil to dryness. The solvent vapors remaining in the KD apparatus may superheat and create an explosion or fire hazard.

The KD apparatus has ground glass joints which can become stuck. Technicians must use Kevlar or other cut/puncture resistant gloves when separating stuck joints.

5.2 Primary Materials Used

Table 1 lists those 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.

6.0 Equipment and Supplies

Catalog numbers listed in this SOP are subject to change at the discretion of the vendor. Analysts are cautioned to be sure equipment used meets the specification of this SOP.

6.1 Extraction Equipment

- Automated Soxhlet Extraction System: Gerhardt SX001-6 place extraction unit or equivalent.
- 54 mm Glass beaker, AMK Glass or equivalent.
- 45 mm Extraction Thimble w/holder, AMK Glass or equivalent.
- Water Chiller, VWR or equivalent.
- Ultra-High Purity Nitrogen.

6.2 Extract Concentration (KD Apparatus)

- Concentrator tube, 10 mL graduated. ChemGlass Catalog Number CG-1316-11 or equivalent
- Snyder Column, Three ball macro AMK Catalog Number SC2-01 or equivalent
- Snyder Column, Two ball micro AMK Catalog Number SC3-01 or equivalent
- Evaporation Flask, 500 mL attached to concentrator tube with clip. AMK Catalog Number KDF-500 or equivalent
- Boiling Chips, silicon carbide, approximately 10/40 mesh, solvent extracted in methylene chloride. Troemner Catalog Number 133B or equivalent.
- Heating mantle rheostat controlled for water bath capable of temperature control (± 5°C). ChemGlass Catalog Number PL3122 or equivalent.
- Water Bath, capable of temperature control to ±5°C. Barnstead Corporation Catalog Number HM0500-HS1 or equivalent.
- Solvent Vapor Recovery System, Kontes K-54000-1006, K-547300-000, Ace Glass Catalog Number 6614-30 or equivalent.

6.3 Miscellaneous

- Disposable glass Pasteur pipette and bulb.
- Top Loading balance: Capable of measuring to 0.01 gram accuracy. Mettler Model Number PM4800 or equivalent.
- Teflon and Stainless Steel Spatulas
- Adjustable pipette, capable of measuring 200 uL to 5 mL, Finnpipette or equivalent.
- 0.5 mL – 2.0 mL Hamilton Gastight® syringes or equivalent.
- 2, 4, 8, or 16 mL Teflon lined screw vial Fisher Scientific or equivalent

7.0 Reagents and Standards

7.1 Reagents

- Sodium Sulfate (granular, anhydrous), Na_2SO_4. J.T. Baker or equivalent. Purify by heating at 400°C for at least 4 hours
- Methylene Chloride (CH_2C_{12}), Pesticide quality, J.T Baker or equivalent.
- Hexane, (C_6H_{14}), Pesticide Quality. J.T. Baker or equivalent.
- Acetone, ($(CH_3)_2CO$), Pesticide quality. J.T. Baker or equivalent.

7.2 Prepared Reagents

Methylene Chloride/Acetone (1:1): In a 4 L amber glass bottle mix 2 L methylene chloride with 2 L acetone. Store the solution in a fume hood.

Hexane /Acetone (1:1): In a 4 L amber glass bottle mix 2 L hexane with 2 L acetone. Store the solution in a fume hood.

7.3 Standards

Purchase stock standards as certified solutions from commercial vendors. Prepare surrogate and spiking solutions in the laboratory by diluting a known volume of the stock standard solutions in an appropriate solvent. Record the preparation of standard in the LIMS (TALS) module established for this purpose.

Store prepared standard solutions in glass containers at 4°C or below. Unless otherwise specified, assign an expiration date of 6 months from the date of preparation or in accordance with the expiration date of the parent standard, whichever is sooner. The recommended formulation for each standard used in this procedure is provided in the analytical method along with the recommended source materials, expiration dates and storage conditions.

8.0 Sample Collection, Preservation, Shipment and Storage

The laboratory does not perform sample collection so these procedures are not included in this SOP. Sampling requirements may be found in the published reference method.

Listed below are minimum sample size, preservation and holding time requirements:

Matrix	Sample Container	Minimum Sample Size	Preservation	Holding Time[1]	Reference
Solid	Glass with PTFE lined lid	50g	4°C	Extraction: 14 days	SW-846 3540C
Tissue	Glass with PTFE lined lid	50g	-10°C	Extraction: 14 days	SW-846 3540C

[1]Extraction holding time is determined from sampling date.

Unless otherwise specified by client or regulatory program, after analysis, samples and extracts are retained for a minimum of 30 days after provision of the project report and then disposed of in accordance with applicable regulations.

9.0 Quality Control

9.1 Sample QC

The laboratory prepares the following quality control samples with each batch of samples.

QC Item	Frequency	Acceptance Criteria
Method Blank (MB)	1 in 20 or fewer samples	See Analytical SOP
Laboratory Control Sample (LCS)	1 in 20 or fewer samples	See Analytical SOP
Matrix Spike(s) MS/MSD	Client Request	See Analytical SOP
Sample Duplicate (SD)	Client Request	See Analytical SOP

9.2 Instrument QC

For information regarding instrument QC refer to the analytical SOP for the determinative test method.

10.0 Procedure

10.1 Instrument Calibration

Check the calibration of the balance each day of use prior to use and record these checks in the logbook designated for this purpose.

Check the calibration of any mechanical pipettes quarterly in accordance with the procedures specified in laboratory SOP BR-QA-008.

10.2 Glassware & Equipment Set-Up

Prepare glassware using the procedures described in laboratory SOP BR-EX-017 and rinse with acetone and methylene chloride prior to use. Label the glassware for each field and QC sample clearly and unambiguously during each step of the extraction procedure. Solvent will erase grease pens and “sharpie ink”; so use caution to ensure labels are not obliterated during the procedure.

Turn on the water chiller to the soxtherm unit. Check to ensure there is sufficient water in the unit and refill if necessary.

Start the flow of ultra-high purity nitrogen to the extraction units and set the pressure to 70 psi. Check the pressure gauge of the nitrogen cylinder and replace the tank if the pressure reading is less than 500 psi.

Initiate the following cleaning program using 120 mL of the 1:1 acetone/methylene chloride solution then discard the solution to the appropriate waste collection vessel after use.

Pre-Cleaning Operating Conditions (Program #2)

Temp Max:	150°C
Boiling Time:	20 Minute
Solvent Reduction A:	2 X 15 mL
Extraction Time:	20 Minute
Solvent Reduction B:	1X15 mL
Cool Time:	10 Minute
Total Process Time:	1 hours and 3 minutes.

The recommended operating conditions for the soxtherm units are:

Operating Conditions (Program #1)

Temp Max:	150°C
Boiling Time:	55 Minute
Solvent Reduction A:	5 X 15 mL
Extraction Time:	55 Minute
Solvent Reduction B:	1X15 mL
Cool Time:	20 Minute
Total Process Time:	2 hours and 55 minutes.

10.3 Sample Preparation

Mix samples thoroughly following the procedures specified in laboratory SOP BR-QA-020. Do no decant water from sediment samples if a large amount of water is present, contact the Project Manager for further guidance.

Initiate an extraction batch in TALS module ADII.

Place a labeled beaker on the balance and tare the balance. Measure 15 g (+/- 0.05 g) into the tared beaker and upload the sample mass into the TALS worksheet. Repeat for each sample and any designated MS/MSD or sample duplicates. Use anhydrous granular sodium sulfate for the method blank and LCS.

Mix each sample with a sufficient amount of granular anhydrous sodium sulfate to ensure a free-flowing mixture then transfer the sample into an extraction thimble.

Add ~6-12 silicon carborundum chips to each extraction beaker then place the extraction thimble into an extraction beaker.

Pipette the proper type and volume of surrogate solution to the sample container (or graduated cylinder) and add the proper type and volume of spike solution to the sample container for the

MS/MSD and LCS. See the extraction conditions workbook for type, concentration and amount of surrogate and spike solution used for each test method.

Add 120 mL of extraction solvent to each extraction beaker. For GC methods use 1:1 acetone/hexane solution as the extraction solvent and for GC/MS, use 1:1 acetone/methylene chloride.

10.4 Extraction

Place the extraction beakers into the extraction unit to ensure a tight seal between the extraction beaker and extraction unit. Check to ensure the chilled water and nitrogen systems are on and operating properly.

Turn on the soxtherm controller, press number "1" on controller pad to select program 1 and depress the enter key twice to begin the extraction process.

Periodically check the extraction units and do not allow the solvent in the extraction beaker to evaporate to dryness. If the solvent volume becomes low, lift the beakers off the boiling plate by switching the pneumatic control switch and add an additional amount of solvent to assure sufficient solvent volume until the extraction cycle is complete.

When the extraction cycle is finished, remove the beakers from the extraction unit and allow them to cool. Shut the soxtherm and Chiller "off" by depressing the "on" button. Shut the nitrogen off by turning the gas regulator counter clockwise.

Concentrate the extracts to an appropriate final volume.

10.5 Extract Concentration (KD Apparatus)

10.5.1 Micro Snyder Column Concentration

Transfer the extract to a 25 mL concentrator tube. Rinse the extraction beaker with 1~2 mL of the appropriate extraction solvent and transfer the rinsate to the concentrator tube to complete quantitative transfer.

Add one or two clean boiling chips to the K-D evaporation flask and attach a three-ball Snyder column to the flask. Add ~1 mL of methylene chloride to the top of the column then place the K-D apparatus in a hot water bath so that the concentrator tube is partially immersed in the hot water and the entire lower rounded surface of the flask is bathed in hot water vapor. Attach the solvent vapor recovery glassware to the Snyder column. Adjust the vertical position of the apparatus and check the water bath temperature.

The water bath temperature should be between 54.8 – 74.8°C when methylene chloride is the extraction solvent and 84-89°C when hexane is the extraction solvent. Higher water bath temperatures may be used so long as the recovery of target analytes is not impacted. The boiling point of each solvent is provided in the following table:

Solvent	Boiling Point	Water Bath Temperature
Hexane	69°C	84 – 89°C
Methylene Chloride	39.8°C	54.8 – 74.8°C

Monitor the concentration and do not let the extract evaporate to dryness. At the proper rate of distillation the balls of the column will actively chatter but the chambers will not flood with solvent.

When the apparent volume of the extract is near the desired final volume remove the K-D apparatus from the water bath and allow it to drain and cool for at least 10 minutes. If samples require a solvent exchange add approximately 5-6 mL of the exchange solvent to the concentrator tube and return to the hot water bath for further concentration. Further concentrate the extract to final volume using micro-synder concentration or nitrogen blow down. Refer to the Extraction Conditions Spreadsheet for final extract volume for each test method, method.

Caution: *Do not allow extracts designated for 8270 PAH to concentrate to less than 1 mL in order to minimize volatilization of target compounds.*

Micro-Snyder Concentration: Add one or two clean boiling chips to the concentrator tube and attach a two ball micro-Snyder column to the tube. Place the concentrator tube into the water bath so that the concentrator tube is partially immersed in hot water. Adjust the vertical position of the concentrator tube and check the temperature of the water bath to ensure the proper temperature for the extract solvent.

Continuously monitor the distillation process to ensure sample extracts do not evaporate to dryness. At the proper rate of distillation, the balls of the column will actively chatter, but the chambers will not flood with solvent. Remove setup when desired sample volume is reached.

Nitrogen Blow Down: Place the concentrator tube in a warm water bath maintained at a temperature of 35°C. Apply a steady stream of nitrogen until the desired final extract volume is achieved. Rinse the internal wall of the concentrator tube several times with the appropriate solvent during the evaporation and ensure the solvent level in the concentrator is positioned such to prevent water condensations. Monitor the concentration carefully and do not allow the extract to evaporate to dryness.

10.6 Extract Preparation & Handling

For final extract volumes less than or equal to 1.0 mL adjust the extract volume using a graduated concentrator tube. For final extract volumes greater than 1.0 mL use a comparison vial. Transfer the extract to labeled Teflon lined screw cap via and store refrigerated. Complete the batch worksheet and perform primary review.

11.0 Calculations / Data Reduction

11.1 Calculations

Calculations are provided in the analytical SOP for each method parameter.

11.2 Data Review

Primary Review: Review the batch worksheet for correctness and completeness. Record any problems encountered during the extraction process with a nonconformance memo (NCM).

Secondary Review: Review the batch worksheet for correctness and completeness and to ensure the extraction performed is consistent the SOP and project specifications. Print the output worksheets and release extracts and output worksheet to the analytical department or to the next step in the method chain such as extract cleanup.

For additional guidance regarding the laboratory's protocol and required elements for data review refer to laboratory SOP BR-QA-019.

12.0 Method Performance

12.1 Method Detection Limit Study (MDL)

A Method Detection Limit (MDL) Study must be determined for each test method associated with this extraction procedure during initial method set-up or prior to the analysis of field samples. The MDLs are verified annually or after major instrument maintenance. The procedure for the determination of MDLs is described in laboratory SOP BR-QA-005.

12.2 Demonstration of Capabilities (DOC)

Each analyst must complete an Initial Demonstration of Capability prior to unsupervised performance of this method.

12.3 Training Requirements

Any employee that performs any portion of the procedure described in this SOP must have documentation in their employee training file that they have read this version of this SOP.

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 Safety Manual 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 BR-EH-001 *Hazardous Waste*. The following waste streams are produced when this method is carried out.

- Solid Waste – Satellite Container: 5 Gallon Polyethylene Bucket
- Solvent Waste- Satellite Container: Steel 55 Gallon Drum

15.0 References / Cross-References

- SW-846 Method 3541, Automated Soxhlet Extraction, Revision 0, 1994. Test Methods for Evaluating Solid Waste Physical/Chemical Methods, Third Edition, September 1986.
- Laboratory SOP BR-EX-017 *Glassware Cleaning*
- Laboratory SOP BR-WC-006 *Percent Solids*
- Corporate Environmental Health and Safety Manual (CW-E-M-001)
- Laboratory SOP BR-QA-020 *Procedures for Sample Homogenization & Subsampling*
- Laboratory SOP BR-QA -019 *Data Review*
- Laboratory SOP BR-QA-005 *Determination of LOD, LOQ, & RL*

- Laboratory SOP BR-EH-001 *Hazardous Waste*
- Laboratory SOP BR-EX-002 *Extract Cleanup Procedures*

16.0 Method Modifications

None

17.0 Attachments

- Table 1: Primary Materials Used
- Appendix A: Terms and Definitions

18.0 Revision History

This is the first version of this SOP.

Table 1: Primary Materials Used

Material[1]	Hazards	Exposure Limit[2]	Signs and symptoms of exposure
Acetone	Flammable	1000 ppm-TWA	Inhalation of vapors irritates the respiratory tract. May cause coughing, dizziness, dullness, and headache.
Hexane	Flammable Irritant	500 ppm-TWA	Inhalation of vapors irritates the respiratory tract. Overexposure may cause lightheadedness, nausea, headache, and blurred vision. Vapors may cause irritation to the skin and eyes.
Methylene Chloride	Carcinogen Irritant	25 ppm-TWA 125 ppm-STEL	Causes irritation to respiratory tract. Has a strong narcotic effect with symptoms of mental confusion, light-headedness, fatigue, nausea, vomiting and headache. Causes irritation, redness and pain to the skin and eyes. Prolonged contact can cause burns. Liquid degreases the skin. May be absorbed through skin.

[1] *Always add acid to water to prevent violent reactions.*
[2] *Exposure limit refers to the OSHA regulatory exposure limit.*

Appendix A: Terms and Definitions

Acceptance Criteria: specified limits placed on characteristics of an item, process or service defined in requirement documents.

Analyte: The specific chemicals or components for which a sample is analyzed. (EPA Risk Assessment Guide for Superfund, OSHA Glossary).

Batch: environmental samples that are prepared and/or analyzed together with the same process, using the same lot(s) of reagents. A preparation/digestion batch is composed of one to 20 environmental samples of similar matrix, meeting the above criteria. An analytical batch is composed of prepared environmental samples (extracts, digestates and concentrates), which are analyzed together as a group.

Corrective Action: the action taken to eliminate the cause of an existing nonconformity, defect or other undesirable occurrence in order to prevent recurrence.

Holding Time: the maximum time that a sample may be held before preparation and/or analysis as promulgated by regulation or as specified in a test method.

Laboratory Control Sample (LCS): a blank matrix spiked with a known amount of analyte(s) processed simultaneously with and under the same conditions as samples through all steps of the procedure.

Matrix Spike (MS): a field sample to which a known amount of target analyte(s) is added.

Matrix Spike Duplicate (MSD): a second replicate matrix spike

Method Blank (MB): a blank matrix processed simultaneously with and under the same conditions as samples through all steps of the procedure. Also known as the preparation blank (PB).

Non-conformance: an indication, judgment, or state of not having met the requirements of the relevant specification, contract or regulation.

Preservation: refrigeration and/or reagents added at the time of sample collection to maintain the chemical, physical, and/or biological integrity of the sample.

Quality Control Sample (QC): a sample used to assess the performance of all or a portion of the measurement system.

Reporting Limit (RL): the level to which data is reported for a specific test method and/or sample.

Stock Standard: a solution made with one or more neat standards usually with a high concentration. Also known as a primary standard. Stock standards may be certified solutions purchased from a vendor.

Surrogate: a substance with properties that mimic the analyte of interest but that are unlikely to be found in environmental samples.

Title: Polychlorinated Biphenyls (PCBs) by GC/ECD (SW846 8082A)

Approval Signatures:

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1.0 Scope and Application

This SOP describes the laboratory procedure used to determine the concentration of polychlorinated biphenyls (PCBs) as Aroclors using dual column gas chromatography with electron capture detectors (GC/ECD).

This SOP is applicable to instrument analysis only. Extraction and extract cleanup procedures are provided in separate SOPs.

1.1 Analytes, Matrices, and Reporting Limits

This procedure may be used for a variety of matrices including: water, soil, sediment and tissue.

The list of target compounds that can be determined from this method along with the associated reporting limits (RL) is provided in Table 1.

2.0 Summary of Method

2 uL of extract is injected into a dual capillary column gas chromatograph equipped with electron capture detectors (GC/ECD). The chromatographic data is used to determine the list of analytes provided in Table 1.

This SOP is based on the following reference method:

- SW-846 Method 8082A Polychlorinated Biphenyls (PCBs) by Gas Chromatography, Revision 0, February 2007.

If the laboratory procedure is modified from the above reference method, a list of modifications will be provided in Section 16.0 of this SOP.

3.0 Definitions

A list of terms and definitions are provided in Appendix A.

4.0 Interferences

- Method interference may be caused by contaminants in the extraction solvent. Solvents should be stored away from organochlorine compounds to minimize contamination.

- Non-target compounds co-extracted from the sample matrix can also cause interference, the extent of which will vary depending on the nature of the samples. Elemental sulfur is often found in sediment samples and its presence will result in broad peaks. Samples are screened prior to analysis, and those samples that contain high levels of sulfur are subject to sulfur cleanup (SW-846 3660B). Cleanup procedures that may be used for this method include: GPC (SW-846-3640A), silica gel (SW-846 3630C), Florisil (SW-846 3620B), and Sulfuric acid Cleanup (SW-846 3665A).

- Phthalate esters introduced during sample preparation can pose a problem in the determination of target analytes. Common flexible plastics contain varying amounts of

phthalate esters. These phthalate esters can be easily extracted or leached during extraction. To minimize this interference, avoid contact with any plastic materials.

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

The gas chromatograph contains zones that have elevated temperatures. The analyst must be aware of the locations of those zones and must cool them to room temperature prior to working on them.

There are areas of high voltage in the gas chromatograph. 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

Table 2 lists 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.

6.0 Equipment and Supplies

Catalog numbers listed in this SOP are subject to change at the discretion of the vendor. Analysts are cautioned to be sure equipment used meets the specification of this SOP.

6.1 Miscellaneous

- Autosampler Vials, National Scientific or equivalent.
- Hydrogen Generator: Parker Balston.
- Volumetric Syringes, Class “A” (10µl, 25µl, 50µl, 100µl, 250µl and 500µl), Hamilton or equivalent.

6.2 Analytical System

- Computer Hardware/Software: GC Acquisition Platform - VAX 4505 (GVAX) Multichrom V2.11. Data Processing - Hewlett-Packard 9000-series computers, an HP 9000 K200 (Chemsvr5)/ HP-UX 10.20 and Target V3.5 or higher.

- GC/ECD: with dual columns, dual ECDs, and auto-sampler capable of a 2-µl injection split onto two columns: HP 5890 with Leap Technology CTC A200SE and A200S Fisons autosamplers, Agilent Technologies 6890N with 7683 Series injector, or equivalent.
- GC Columns: A dual fused silica capillary column system that will provide simultaneous primary and confirmation analyses:

    - RTX-5, (30m x 0.25 mmID x 0.25um)
    - RTX-35, (30m x 0.25 mmID x 0.25um)

Equivalent columns may be used provided the elution orders are documented and compound separations are maintained.

7.0 Reagents and Standards

7.1 Reagents

- Hexane, Ultra-Resi Analyzed, JT Baker or equivalent.

7.2 Standards

Purchase stock standard solutions from commercial vendors and from these prepare calibration and working standards by diluting a known volume of stock standard in an appropriate solvent to the final volume needed to achieve the desired concentration. The recommended formulation for each standard used in this procedure is provided in Appendix B along with the recommended source materials, expiration dates and storage conditions.

8.0 Sample Collection, Preservation, Shipment and Storage

The laboratory does not perform sample collection, so these procedures are not included in this SOP. Sampling requirements may be found in the published reference method. Listed below are minimum sample size, preservation, and holding time requirements needed for this test.

Matrix	Sample Container	Minimum Sample Size	Preservation	Extract Holding Time	Reference
Water	Glass	1 L	Chilled to 4°C	40 Days	SW-846 8082A
Solid	Glass	50 g	Chilled to 4°C	40 Days	SW-846 8082A

[1]Analytical holding time is determined from date of initiation of extraction.

Unless otherwise specified by client or regulatory program, after analysis, samples and extracts are retained for a minimum of 30 days after provision of the project report and then disposed of in accordance with applicable regulations.

9.0 Quality Control

9.1 Sample QC

The laboratory prepares the following quality control samples with each batch of samples.

QC Item	Frequency	Acceptance Criteria
Method Blank (MB)	1 in 20 or fewer samples	See Table 3
Laboratory Control Sample (LCS)	1 in 20 or fewer samples	See Table 3

Matrix Spike(s) MS/MSD	Client Request	See Table 3
Sample Duplicate (SD)	Client Request	See Table 3

9.2 Instrument QC

The following instrument QC is performed:

QC Item	Frequency	Acceptance Criteria
Initial Calibration (ICAL)	Initially; when ICV or CCV fail	See Table 3
Second Source Calibration Verification (ICV)	Once, after each ICAL	See Table 3
Continuing Calibration Verification (CCV)	Daily, every 10 samples, end of sequence	See Table 3
Retention Time Windows	As Needed	See Table 3

10.0 Procedure

10.1 Instrument Operating Conditions

Install a five meter deactivated guard column into the injection port and connect the guard column to the separate analytical columns using a glass "Y". The analytical columns are installed into independent ECD detectors.

The recommended instrument operating conditions are as follows:

Initial Temperature:	130°C for 1 minute Temperature Program: 20°C per minute to 190°C to 5°C per minute to 225°C to 20.0°C per minute to 300°C. Hold for 6 minutes.
Detector Temperature	300°C
Injector Temperature:	200°C
Injection volume:	2μL
Carrier Gas:	Hydrogen (supplied by hydrogen generators)

Optimize the flow rate of the carrier gas by injecting an un-retained substance onto the column at an isothermal oven state and adjusting the flow to obtain the recommended dead volume time.

10.2 Retention Time Window Establishment

Whenever a new GC column is installed, establish RT windows for each analyte by analyzing three standards over a 72-hour period. Calculate the mean RT and Standard Deviation (SD). The RT window is calculated as the mean RT ± 3SD. If the SD is <0.01 minutes, a default SD of 0.01 minutes may be used.

If this procedure results in RT windows that are too tight, favoring false negatives, the laboratory may opt to use an alternate method to determine the RT windows. An alternate method consists of using a RT window of ± 0.05 minutes. The center of the RT window is set at the midpoint calibration level in the initial calibration sequence. RT windows are then updated daily (minimum frequency), re-centering the windows on the retention times established in a CCV.

10.3 Instrument Calibration

10.3.1 Initial Calibration (ICAL)

Clean the injection port and column with a hexane instrument blank prior to calibration.

To calibrate the instrument analyze a standard containing a mixture of Aroclor 1016 and Aroclor1260 (AR1660) at a minimum of five concentrations and use this multi-point calibration to determine the concentration of AR1016 and AR1260 in sample.

The mixed AR1660 standard includes most of the peaks represented in the other Aroclors so the multi-point calibration can also be used to demonstrate linearity of the instrument and that a sample does not contain peaks that represent the other Aroclors but it is not sufficient for pattern recognition. For the remaining Aroclors analyze a single-point standard at a concentration near the mid-point of the calibration and use these standards for pattern recognition and calculation of a single-point calibration factor. The laboratory does not perform a multi-point calibration for the remaining Aroclors unless requested for the project or by regulatory requirement.

Prepare the calibration standards using the formulations provided in Appendix B then transfer ~100 ugL to an autosampler vial insert. Place the vials in the autosampler, set the autosampler to inject 2-µl of each standard onto the instrument and initiate the analytical sequence.

A minimum of 3 peaks must be chosen for each Aroclor, and preferably 5 peaks. The peaks must be characteristic of the Aroclor in question. Choose peaks in the Aroclor standards that are at least 25% of the height of the largest Aroclor peak. For each Aroclor, the set of 3 to 5 peaks should include at least one peak that is unique to that Aroclor. Use at least five peaks for the Aroclor 1016/1260 mixture.

The data processing system calculates the Calibration Factor (CF), mean CF, and Percent Relative Standard Deviation (%RSD) for each analyte on both columns. The %RSD for each target analyte must be less than or equal to 20% in order to use the mean CF for quantification. This evaluation is performed for each quantitation peak chosen for each Aroclor. All peaks must pass the 20% evaluation, not the average of the 5 peaks chosen for quantitation. If this criterion is not met, use another suitable quantification method for that analyte or correct the problem and repeat the calibration. Once a method of quantification is chosen for a specific compound, it must be consistent throughout the entire analytical sequence until a new initial calibration is performed.

The calibration factor is used to determine the linearity of the calibration.

Alternate Quantification Option:

Linear Regression: Generate a curve of concentration vs. response for each analyte and calculate the correlation coefficient. The calibration must have a correlation coefficient (r) $\geq$ 0.995. If this criterion is not met, correct the problem and repeat the calibration. The use of linear regression requires a minimum of 5 calibration points.

10.3.2 Second Source Calibration Verification (ICV)

Immediately after each calibration and prior to the analysis of any QC or field samples, verify the accuracy of the initial calibration by analyzing a second source ICV.

Prepare the ICV using the formulation provided in Appendix B. Inject 2 µl of the ICV standard onto the instrument in the same manner as performed for the initial calibration standards.

The percent recovery of the average concentration of the peaks chosen for quantitation must be within ± 20% of the expected value (%R 80-120). If this criterion is not met, correct the problem and reanalyze the ICV. If reanalysis fails, remake the calibration standards and/or perform instrument maintenance and recalibrate. The acceptance criteria must be met on both columns.

10.3.3 Continuing Calibration Verification (CCV)

Analyze a CCV (1660) at or below the mid-calibration range each day before sample analysis, after every ten sample injections and at the end of each analytical sequence.

Note: The laboratory does not perform a CCV for the remaining Aroclors unless requested for the project or by regulatory requirement.

The data system calculates the calibration factor (CF) and percent difference using the average percent difference of the peaks chosen for quantitation.

The percent difference or drift must be within ±20% and the retention time (RT) must be within the established RT window. Acceptance criteria must be met on both columns.

If the CCV fails, it may be repeated once. If repeat analysis fails, corrective action must be taken. If the two CCVs do not meet the criteria, recalibration is required prior to running samples. Samples must be bracketed by passing CCVs. Samples analyzed before and after CCV failures must be reanalyzed, unless the CCV is high and there are no detects in the associated samples. (NELAC Requirement)

10.4 Troubleshooting

Check the following items in case of calibration failures:

- ICAL Failure – Perform injection port maintenance, install new guard column, check detector ends to see if detector jet has slipped. In extreme cases, install new columns, particularly if the chromatography has degraded as evidenced by peak shapes.
- CCV Failure – Perform Injection port maintenance; if injection port maintenance does not restore CCV, install a new guard column and remove one or more loops from each analytical column.
- Needle crushed during injection - Replace the needle and check the injection port for obstructions and check the autosampler for misalignment.
- Auto-sampler failure - Reset the auto-sampler.
- Power failure - Reset run in Multichrom and re-acquire or re-initiate run sequence.

10.5 Analysis

Remove the extract from refrigerated storage and warm to room temperature.

Transfer approximately 100 uL of extract to an autosampler vial and place the vials in the autosampler in a sequence that begins with the calibration standards followed by the analysis of an ICV, QC samples, field samples and continuing calibration verification standards (CCVs).

Enter the sample ID's into the data acquisition program in the order that the samples were placed in the autosampler tray and initiate the analytical sequence.

An example analytical sequence that includes calibration is as follows:

Injection Number	Lab Description
1	Instrument Blank
2	Instrument Blank
3	Instrument Blank
4	AR1221 (200 ppb)
5	AR1232 (200 ppb)
6	AR1242 (200 ppb)
7	AR1248 (200 ppb)
8	AR1254 (200 ppb)
9	AR1262 (200 ppb)
10	AR1268 (200 ppb)
11	AR1660 (50 ppb)
12	AR1660 (100 ppb)
13	AR1660 (200 ppb)
14	AR1660 (400 ppb)
15	AR1660 (800 ppb)
16	Instrument Blank
17	ICV
18-27	10 injections
28	CCV (AR1660 200ppb)
	Repeat steps 18-28

Cleaning blanks (IBLK) consisting of hexane may be analyzed after high-level samples at the discretion of the analyst.

11.0 Calculations / Data Reduction

11.1 Qualitative Identification

The data processing system identifies the target analytes by comparing the retention time of the peaks to the established retention time windows.

Review and accept or reject the qualitative identifications made by the data processing system using the following guidelines:

Compare the retention time of the peak to the established RT window, taking into account the shift of the surrogate peaks. If the surrogate peaks have shifted, open the retention time window in the direction of the shift. The processing system identifies the peak in the retention time window that is closest to the expected retention time set in the Target method, so the peak may need to be re-identified if a shift has occurred. The data system does not recognize Aroclor patterns. The analyst manually identifies Aroclors by comparing the pattern in the samples to the patterns in the initial calibration standards. Weathering of PCB's in the environment may alter the PCB's to the point that the pattern no longer matches the pattern established for that Aroclor in

the initial calibration. The laboratory takes the best pattern match approach to the identification and quantification of weathered PCB's.

Look for shoulders on the side of large peaks that may be peaks of interest. The processing system does not always automatically integrate shoulders from larger peaks, so manual integration (split) of the shoulder may be necessary.

Each target analyte must be detected on each column for qualitative identification to be made.

11.2 Quantitative Identification

Using an average of the chosen quantification peaks per Aroclor the data system calculates the corrected concentration for each target analyte using the equations given in Appendix C. If sample interference is suspected, the laboratory may remove up to two quantification peaks per column. The higher value between the two columns is reported as the primary result unless there is evidence of chromatographic anomalies, in which case the lower value will be reported. This deviation must be noted in the project narrative.

11.3 Calculations

See Appendix C.

11.4 Data Review

See laboratory SOP BR-QA-019 for data review requirements.

11.4.1 Primary Review

Review project documents to ensure those project requirements were met. If project requirements were not met, immediately notify the project manager (PM) to determine an appropriate course of action.

Confirm qualitative and quantitative identification criteria using the criteria provided in Sections 11.1 and 11.2. If the data system does not properly integrate the peaks perform manual integration in accordance with laboratory SOP BR-QA-006.

Upload the data files from the data processing system to the laboratory information management system (TALS). Complete the batch information for standards and reagents and verify ICAL and QC sample associations. Review the results and set results to primary, secondary, acceptable or rejected as appropriate. Dilute and reanalyze samples whose results exceed the calibration range. The dilution analysis should result in a determination within the calibration range, preferably in the upper half of the calibration range. A more concentrated analysis is not necessary unless the project requires it. Dilution analyses may be performed to minimize matrix interference.

If a sample was analyzed immediately following a high concentration sample, review the results of the sample for any sign of carryover. If carryover is suspected, reanalyze the sample.

Create a non-conformance report (NCM) for any calibration, QC and sample data that is reported outside established acceptance criteria and/or schedule necessary corrective action. Set batch to 1st level review and complete the data review checklist.

11.4.2 Secondary Data Review

Verify quantitative and qualitative identification in the initial calibration standards and spot check such for ~15% of the remaining data in the batch.

If manual integrations were performed:

- Review each integration to verify that the integration meets the requirements for manual integration as specified in laboratory SOP BR-QA-006. If an error is suspected or found consult with the analyst that performed the integration analyst and request correction or notify the Department Manager, Technical Director or QA Manager. Do not "fix" the integration. Reintegration by a secondary data reviewer must not be performed except in limited circumstances as approved by the department supervisor or other laboratory management. If those instances where the secondary reviewer performs the integration, this person is now considered the primary analyst and each integration performed by the secondary reviewer must be subsequently reviewed by a peer analyst or the department supervisor to verify the integration is consistent and compliant with the requirements specified in laboratory SOP BR-QA-006.

- Check to ensure an appropriate technical reason code is provided for each manual integration. Acceptable technical reason codes are provided in laboratory SOP BR-QA-005.

Review project documents to ensure those project requirements were met. If project requirements were not met, immediately notify the project manager (PM) to determine an appropriate course of action.

Verify that the acceptance criteria for the calibration and QC items listed in Table 1 were met. If the results do not fall within the established limits verify the recommended corrective actions were performed. If not, initiate corrective actions and/or verify an NCM was created to document the criteria exception. Verify analytical results are qualified accordingly. Set batch to 2nd level review and complete the data review checklist.

11.5 Data Reporting

The report format, application of data qualifiers and creation of the data deliverable is performed by the LIMS using the formatter set by the project manager during log-in.

Records of electronic and hardcopy data are maintained as described in laboratory SOP BR-QA-014.

12.0 Method Performance

12.1 Limit of Detection (LOD) and Limit of Quantitation (LOQ)

Establish a LOD and LOQ at initial method set up following the procedures specified in laboratory SOP BR-QA-005. Verify the LOD and LOQ at the frequency established for the method using the procedures specified in same SOP. The frequency of LOD and LOQ verification depends on the strictest frequency of the regulatory program for which the method supports. The frequency requirement is documented in a spreadsheet maintained by the QA Department.

12.2 Demonstration of Capabilities (DOC)

Perform a method demonstration of capability at initial set-up and when there is a significant change in instrumentation or procedure.

Each analyst that performs the analytical procedure must complete an initial demonstration of capability (IDOC) prior to independent analysis of client samples. Each analyst must demonstrate on-going proficiency (ODOC) annually thereafter. DOC procedures are further described in the laboratory's quality system manual (QAM) and in the laboratory SOP for employee training.

12.3 Training Requirements

Any employee that performs any portion of the procedure described in this SOP must have documentation in their employee training file that they have read this version of the SOP.

Instrument analysts, prior to independent analysis of client samples, must also have documentation of demonstration of initial proficiency (IDOC) and annual on-going proficiency (ODOC) in their employee training files.

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 Safety Manual for "Waste Management and Pollution Prevention."

14.0 Waste Management

14.1 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 BR-EH-001. The following waste streams are produced when this method is carried out.

- Vials containing sample extracts: Satellite container: 15 gallon bucket connected to a fume hood.
- Solvent Waste: Satellite container: 1 L glass bottle located in fume hood.

15.0 References / Cross-References

- SW-846 Method 8082A Polychlorinated Biphenyls (PCBs) by Gas Chromatography, Revision 0, February 2007.
- Corporate Environmental Health and Safety Manual (CW-E-M-001)
- Laboratory SOP BR-QA-011
- Laboratory SOP BR-LP-011
- Laboratory SOP BR-QA-014
- Laboratory SOP BR-QA-006
- Laboratory SOP BR-QA-005

16.0 Method Modifications

Not applicable.

17.0 Attachments

- Table 1: Target Compound List and Reporting Limit
- Table 1A: Accuracy and Precision Limits
- Table 2: Primary Materials Used
- Table 3: QC Summary & Recommended Corrective Action
- Appendix A: Terms and Definitions
- Appendix B: Standard Preparation Tables
- Appendix C: Equations

18.0 Revision History

BR-GC-005, Rev. 11:

- Title Page: Updated method reference
- Section 2.0: Updated method reference
- Section 10.3: Changed CCV criteria from 15% to 20%
- Table 3: Changed CCV criteria from 15% to 20%

BR-GC-005, Rev. 10:

- Updated approval signatures
- Section 10: Inserted note regarding multi-point calibrations for other Aroclors.

BR-GC-005, Rev. 9

- Updated reference method in Section 2.0.
- Changed QC criteria for %D from 15% to 20%.
- Added language to Section 10.2 to allow for updating RT windows using CCVs.
- Added language to Section 11.4.1 to allow for dilution to minimize matrix interference.
- Added standard preparation tables to Appendix B to allow for the preparation of 5 point calibrations for each of the Aroclors

Table 1: Routine Target Analyte List & Reporting Limits (RL)

ANALYTE	Routine Reporting Limit (RL)[1,2]	
	Water (ug/L)	Solid (ug/Kg)
AR1016	0.50	17
AR1221	0.50	17
AR1232	0.50	17
AR1242	0.50	17
AR1248	0.50	17
AR1254	0.50	17
AR1260	0.50	17
AR1262	0.50	17
AR1268	0.50	17

[1]*The routine RL is the unadjusted value that can be achieved in a blank matrix.*
[2]*The RL for tissue matrix is project defined.*

Table 1A: Routine Accuracy and Precision Limits[1]

Analyte	In-House Limits (%R)		Precision (RPD) (≤)
	Water	Solid	
AR1016	55-120	55-120	30
AR1260	60-125	55-125	30
Surrogate: Decachlorobiphenyl (DCB)	30-150	45-125	NA
Surrogate:TCX (Advisory)[2]	55-120	30-130	NA

[1] *The limits in this table are those used as of the effective date of this SOP. Current limits are stored in the LIMS database.*
[2] *The control limits for TCX are advisory. Corrective action is not performed when recovery is outside limits.*

Table 2: Primary Materials Used

Material [1]	Hazards	Exposure Limit[2]	Signs and symptoms of exposure
Hexane	Flammable Irritant	500 ppm-TWA	Inhalation of vapors irritates the respiratory tract. Overexposure may cause lightheadedness, nausea, headache, and blurred vision. Vapors may cause irritation to the skin and eyes.

[1] *Always add acid to water to prevent violent reactions.*
[2] *Exposure limit refers to the OSHA regulatory exposure limit.*

Table 3: QC Summary, Frequency, Acceptance Criteria and Recommended Corrective Action

QC Item	Frequency	Acceptance Criteria	Recommended Corrective Action[1]
ICAL	Before sample analysis, when CCVs indicate calibration is no longer valid; after major instrument maintenance	Option 1: RSD for each analyte ≤ 20% Option 2: Linear Regression: r ≥ 0.995	Correct problem, reanalyze, repeat calibration.
ICV	After each initial calibration	(% R) ± 20% from expected value	Correct problem and verify second source standard. If that fails, repeat initial calibration.
CCV	Daily before sample analysis, every 10 samples and at the end of the analytical sequence	% Difference or Drift ±20%	See Section 10.3
MB	One per extraction batch of 20 or fewer samples	Target Analyte < RL	Examine project DQO's and take appropriate corrective action, which may include re-analysis of MB, re-extraction of batch, and/or non-conformance report (NCR). Corrective action must be documented on NCR. If there are no detects in samples, or if all detects are > 10 X MB level, re-prep and reanalysis may not be required.
LCS	One per extraction batch of 20 or fewer samples	See Table 1A	Examine project DQO's and take appropriate corrective action, which may include re-analysis of LCS, re-extraction of batch, and/or non-conformance report (NCR). Corrective action must be documented on NCR. Flag all reported values outside of control limits.
MS/MSD SD	Per client request	See Table 1A	Evaluate data and determine if a matrix effect or analytical error is indicated. If analytical error, re-analyze and/or re-extract. Flag all reported values outside of control limits.
Surrogate	All field and QC samples	See Table 1A	Evaluate data and determine if a matrix effect or analytical error is indicated. If analytical error, re-analyze or re-extract. If matrix effect, review project DQOs to determine if a matrix effect must be confirmed by re-analysis. Flag all reported values outside of control limits.

[1]*The recommended corrective action may include some or all of the items listed in this column. The corrective action taken may be dependent on project data quality objectives and/or analyst judgment but must be sufficient to ensure that results will be valid. If corrective action is not taken or is not successful, data must be flagged with appropriate qualifiers.*

Appendix A: Terms and Definitions

Acceptance Criteria: specified limits placed on characteristics of an item, process or service defined in requirement documents.

Accuracy: the degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components which are due to sampling and analytical operations; a data quality indicator.

Analyte: The specific chemicals or components for which a sample is analyzed. (EPA Risk Assessment Guide for Superfund, OSHA Glossary).

Batch: environmental samples that are prepared and/or analyzed together with the same process, using the same lot(s) of reagents. A preparation/digestion batch is composed of one to 20 environmental samples of similar matrix, meeting the above criteria. An analytical batch is composed of prepared environmental samples (extracts, digestates and concentrates), which are analyzed together as a group.

Calibration: a set of operations that establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument or measuring system, or values represented by a material measure or a reference material and the corresponding values realized by the standards.

Calibration Curve: the graphical relationship between the known values or a series of calibration standards and their instrument response.

Calibration Standard: A substance or reference used to calibrate an instrument.

Continuing Calibration Verification (CCV): a single or multi-parameter calibration standard used to verify the stability of the method over time. Usually from the same source as the calibration curve.

Corrective Action: the action taken to eliminate the cause of an existing nonconformity, defect or other undesirable occurrence in order to prevent recurrence.

Data Qualifier: a letter designation or symbol appended to an analytical result used to convey information to the data user. (Laboratory)

Demonstration of Capability (DOC): procedure to establish the ability to generate acceptable accuracy and precision.

Holding Time: the maximum time that a sample may be held before preparation and/or analysis as promulgated by regulation or as specified in a test method.

Initial Calibration: Analysis of analytical standards for a series of different specified concentrations used to define the quantitative response, linearity and dynamic range of the instrument to target analytes.

Intermediate Standard: a solution made from one or more stock standards at a concentration between the stock and working standard. Intermediate standards may be certified stock standard solutions purchased from a vendor and are also known as secondary standards.

Laboratory Control Sample (LCS): a blank matrix spiked with a known amount of analyte(s) processed simultaneously with and under the same conditions as samples through all steps of the procedure.

Matrix Spike (MS): a field sample to which a known amount of target analyte(s) is added.

Matrix Spike Duplicate (MSD): a second replicate matrix spike

Method Blank (MB): a blank matrix processed simultaneously with and under the same conditions as samples through all steps of the procedure. Also known as the preparation blank (PB).

Method Detection Limit (MDL): the minimum amount of a substance that can be measured with a specified degree of confidence that the amount is greater than zero using a specific measurement system. The MDL is a statistical estimation at a specified confidence interval of the concentration at which relative uncertainty is ±100%. The MDL represents a range where qualitative detection occurs. Quantitative results are only produced in this range and qualified with the proper data reporting flag when a project requires this type of data reporting.

Non-conformance: an indication, judgment, or state of not having met the requirements of the relevant specification, contract or regulation.

Precision: the degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves.

Preservation: refrigeration and/or reagents added at the time of sample collection to maintain the chemical, physical, and/or biological integrity of the sample.

Quality Control Sample (QC): a sample used to assess the performance of all or a portion of the measurement system.

Reporting Limit (RL): the level to which data is reported for a specific test method and/or sample.

Stock Standard: a solution made with one or more neat standards usually with a high concentration. Also known as a primary standard. Stock standards may be certified solutions purchased from a vendor.

Surrogate: a substance with properties that mimic the analyte of interest but that are unlikely to be found in environmental samples.

Appendix B: Standard Preparation Tables

The standard formulations contained in this Appendix are recommended and are subject to change. If the concentration of the stock standard is different than those noted in this table, adjust the standard preparation formulation accordingly. Unless otherwise specified, prepare the standard solutions in hexane using Class A volumetric glassware and Hamilton syringes. Unless otherwise specified for a standard solution, assign an expiration date of 6 months from date of preparation unless the parent standard expires sooner in which case use the earliest expiration date. Store the prepared solutions under refrigeration and protected from light at a temperature of 4ºC (±2). See laboratory SOP BR-QA-002 *Standard Preparation* for further guidance.

Intermediate Calibration Standards (10 mg/L)

Parent Standard	Vendor	Component	Stock Standard Concentration (mg/L)	Volume Added (mL)	Final Volume (mL)	Final Concentration (mg/L)
AR1660[1]	Restek #32039	Aroclor 1016 Aroclor 1260	1000	0.40	40	10
AR1254	Restek #32011	Aroclor 1254	1000	0.40	40	10
AR1248	Restek #32010	Aroclor 1248	1000	0.40	40	10
AR1242	Restek #32009	Aroclor 1242	1000	0.40	40	10
AR1232	Restek #32008	Aroclor 1232	1000	0.40	40	10
AR1221	Restek #32007	Aroclor 1221	1000	0.40	40	10
AR1262	Restek #32409	Aroclor 1262	1000	0.40	40	10
AR1268	Restek #32410	Aroclor 1268	1000	0.40	40	10

[1] *Standard is a mix of AR1016/AR1260. Concentration shown is the concentration of each Aroclor in the mixed standard.*

Intermediate ICV Standard (10 mg/L)

Parent Standard	Vendor	Component	Stock Standard Concentration (mg/L)	Volume Added (mL)	Final Volume (mL)	Final Concentration (mg/L)
AR1660	Ultra Scientific PPM8082	Aroclor 1016 Aroclor 1260	1000	0.40	40	10

Surrogate Solution (10 mg/L)

Parent Standard	Vendor	Component	Stock Standard Concentration (mg/L)	Volume Added (mL)	Final Volume (mL)	Final Concentration (mg/L)
Pesticide Surrogate	Restek #3200	TCX DCB	1000	0.40	40	10

Working ICV Standard (200 ug/L)

Parent Standard	Vendor	Component	Parent Standard Concentration (mg/L)	Volume Added (mL)	Final Volume (mL)	Final Concentration (ug/L)
Intermediate ICV	Laboratory Prepared	Aroclor 1016 Aroclor 1260	10	0.80	40	200
Surrogate	Laboratory Prepared	TCX DCB	10	0.080		20

AR1660 Calibration Standard: CAL Level 5 (800 ug/L)[1]

Parent Standard	Vendor	Component	Parent Standard Concentration (mg/L)	Volume Added (mL)	Final Volume (mL)	Final Concentration (ug/L)
AR1660 Intermediate	Laboratory Prepared	Aroclor 1016 Aroclor 1260	10	8.0	100	800
Surrogate	Laboratory Prepared	TCX DCB	10	0.80		80

[1] *This standard is the parent standard for each level of the AR1660 calibration standards*

AR1660 Calibration Standard(s): CAL Levels 1- 4

Parent Standard	Calibration Standard	Parent Standard Concentration (ug/L)	Volume Added (mL)	Final Volume (mL)	Final Concentration (ug/L)
AR1660 Level 5	AR1660 CAL Level 4	800	20	40	400
AR1660 Level 5	AR1660 CAL Level 3	800	10	40	200
AR1660 Level 5	AR1660 CAL Level 2	800	5.0	40	100
AR1660 Level 5	AR1660 CAL Level 1	800	2.5	40	50

AR1221 Calibration Standard: CAL Level 5 (800 ug/L)[1]

Parent Standard	Vendor	Component	Parent Standard Concentration (mg/L)	Volume Added (mL)	Final Volume (mL)	Final Concentration (ug/L)
AR1221 Intermediate	Laboratory Prepared	Aroclor 1221	10	8.0	100	800
Surrogate	Laboratory Prepared	TCX DCB	10	0.80		80

[1] *This standard is the parent standard for each level of the AR1221 calibration standards*

AR1221 Calibration Standard(s): CAL Levels 1- 4

Parent Standard	Calibration Standard	Parent Standard Concentration (ug/L)	Volume Added (mL)	Final Volume (mL)	Final Concentration (ug/L)
AR1221 Level 5	AR1221 CAL Level 4	800	20	40	400
AR1221 Level 5	AR1221 CAL Level 3	800	10	40	200
AR1221 Level 5	AR1221 CAL Level 2	800	5.0	40	100
AR1221 Level 5	AR1221 CAL Level 1	800	2.5	40	50

AR1232 Calibration Standard: CAL Level 5 (800 ug/L)[1]

Parent Standard	Vendor	Component	Parent Standard Concentration (mg/L)	Volume Added (mL)	Final Volume (mL)	Final Concentration (ug/L)
AR1232 Intermediate	Laboratory Prepared	Aroclor 1232	10	8.0	100	800
Surrogate	Laboratory Prepared	TCX DCB	10	0.80		80

[1] *This standard is the parent standard for each level of the AR1232 calibration standards*

AR1232 Calibration Standard(s): CAL Levels 1- 4

Parent Standard	Calibration Standard	Parent Standard Concentration (ug/L)	Volume Added (mL)	Final Volume (mL)	Final Concentration (ug/L)
AR1232 Level 5	AR1232 CAL Level 4	800	20	40	400
AR1232 Level 5	AR1232 CAL Level 3	800	10	40	200
AR1232 Level 5	AR1232 CAL Level 2	800	5.0	40	100
AR1232 Level 5	AR1232 CAL Level 1	800	2.5	40	50

AR1242 Calibration Standard: CAL Level 5 (800 ug/L)[1]

Parent Standard	Vendor	Component	Parent Standard Concentration (mg/L)	Volume Added (mL)	Final Volume (mL)	Final Concentration (ug/L)
AR1242 Intermediate	Laboratory Prepared	Aroclor 1242	10	8.0	100	800
Surrogate	Laboratory Prepared	TCX DCB	10	0.80		80

[1] *This standard is the parent standard for each level of the AR1242 calibration standards*

AR1242 Calibration Standard(s): CAL Levels 1- 4

Parent Standard	Calibration Standard	Parent Standard Concentration (ug/L)	Volume Added (mL)	Final Volume (mL)	Final Concentration (ug/L)
AR1242 Level 5	AR1242 CAL Level 4	800	20	40	400
AR1242 Level 5	AR1242 CAL Level 3	800	10	40	200
AR1242 Level 5	AR1242 CAL Level 2	800	5.0	40	100
AR1242 Level 5	AR1242 CAL Level 1	800	2.5	40	50

AR1248 Calibration Standard: CAL Level 5 (800 ug/L)[1]

Parent Standard	Vendor	Component	Parent Standard Concentration (mg/L)	Volume Added (mL)	Final Volume (mL)	Final Concentration (ug/L)
AR1248 Intermediate	Laboratory Prepared	Aroclor 1248	10	8.0	100	800
Surrogate	Laboratory Prepared	TCX DCB	10	0.80		80

[1] *This standard is the parent standard for each level of the AR1248 calibration standards*

AR1248 Calibration Standard(s): CAL Levels 1- 4

Parent Standard	Calibration Standard	Parent Standard Concentration (ug/L)	Volume Added (mL)	Final Volume (mL)	Final Concentration (ug/L)
AR1248 Level 5	AR1248 CAL Level 4	800	20	40	400
AR1248 Level 5	AR1248 CAL Level 3	800	10	40	200
AR1248 Level 5	AR1248 CAL Level 2	800	5.0	40	100
AR1248 Level 5	AR1248 CAL Level 1	800	2.5	40	50

AR1254 Calibration Standard: CAL Level 5 (800 ug/L)[1]

Parent Standard	Vendor	Component	Parent Standard Concentration (mg/L)	Volume Added (mL)	Final Volume (mL)	Final Concentration (ug/L)
AR1254 Intermediate	Laboratory Prepared	Aroclor 1254	10	8.0	100	800
Surrogate	Laboratory Prepared	TCX DCB	10	0.80		80

[1] *This standard is the parent standard for each level of the AR1254 calibration standards*

AR1254 Calibration Standard(s): CAL Levels 1- 4

Parent Standard	Calibration Standard	Parent Standard Concentration (ug/L)	Volume Added (mL)	Final Volume (mL)	Final Concentration (ug/L)
AR1254 Level 5	AR1254 CAL Level 4	800	20	40	400
AR1254 Level 5	AR1254 CAL Level 3	800	10	40	200
AR1254 Level 5	AR1254 CAL Level 2	800	5.0	40	100
AR1254 Level 5	AR1254 CAL Level 1	800	2.5	40	50

AR1262 Calibration Standard: CAL Level 5 (800 ug/L)[1]

Parent Standard	Vendor	Component	Parent Standard Concentration (mg/L)	Volume Added (mL)	Final Volume (mL)	Final Concentration (ug/L)
AR1262 Intermediate	Laboratory Prepared	Aroclor 1262	10	8.0	100	800
Surrogate	Laboratory Prepared	TCX DCB	10	0.80		80

[1] *This standard is the parent standard for each level of the AR1262 calibration standards*

AR1262 Calibration Standard(s): CAL Levels 1- 4

Parent Standard	Calibration Standard	Parent Standard Concentration (ug/L)	Volume Added (mL)	Final Volume (mL)	Final Concentration (ug/L)
AR1262 Level 5	AR1262 CAL Level 4	800	20	40	400
AR1262 Level 5	AR1262 CAL Level 3	800	10	40	200
AR1262 Level 5	AR1262 CAL Level 2	800	5.0	40	100
AR1262 Level 5	AR1262 CAL Level 1	800	2.5	40	50

AR1268 Calibration Standard: CAL Level 5 (800 ug/L)[1]

Parent Standard	Vendor	Component	Parent Standard Concentration (mg/L)	Volume Added (mL)	Final Volume (mL)	Final Concentration (ug/L)
AR1268 Intermediate	Laboratory Prepared	Aroclor 1268	10	8.0	100	800
Surrogate	Laboratory Prepared	TCX DCB	10	0.80		80

[1] *This standard is the parent standard for each level of the AR1268 calibration standards*

AR1268 Calibration Standard(s): CAL Levels 1- 4

Parent Standard	Calibration Standard	Parent Standard Concentration (ug/L)	Volume Added (mL)	Final Volume (mL)	Final Concentration (ug/L)
AR1268 Level 5	AR1268 CAL Level 4	800	20	40	400
AR1268 Level 5	AR1268 CAL Level 3	800	10	40	200
AR1268 Level 5	AR1268 CAL Level 2	800	5.0	40	100
AR1268 Level 5	AR1268 CAL Level 1	800	2.5	40	50

Appendix C: Equations

Calibration Factor (CF_x) = $\frac{\text{Peak area or height}_{(x)}}{\text{Standard concentration}_{(ug/L)}}$

Mean Calibration Factor ($\overline{CF}$) = $\frac{\sum_{i=1}^{n} CF_i}{n}$

where: n = number of calibration levels

Standard Deviation of the Calibration Factor (SD) = $\sqrt{\frac{\sum_{i=1}^{n}\left(CF_i - \overline{CF}\right)2}{n-1}}$

where: n = number of calibration levels

Percent Relative Standard Deviation (RSD) of the Calibration Factor =
$\frac{SD}{\overline{CF}} \times 100\%$

Percent Difference (%D) = $\frac{CF_v - \overline{CF}}{\overline{CF}} \times 100\%$ Add absolute value signs

where: CF_v = Calibration Factor from the Continuing Calibration Verification (CCV)

Percent Drift = $\frac{\text{Calculated Concentration – Theoretical Concentration}}{\text{Theoretical Concentration}}$ X 100%

Percent Recovery (%R) = $\frac{C_s}{C_n} \times 100\%$

where: C_s = Concentration of the Spiked Field or QC Sample
C_n = Nominal Concentration of Spike Added

Percent Recovery (%R) for MS/MSD = $\frac{C_s - C_u}{C_n} \times 100\%$

where: C_s = Concentration of the Spiked Sample
C_u = Concentration of the Unspiked Sample
C_n = Nominal Concentration of Spike Added

Relative Percent Difference (RPD) = $\dfrac{|C_1 - C_2|}{\left(\dfrac{C_1 + C_2}{2}\right)} \times 100\%$

where: C_1 = Measured Concentration of First Sample
C_2 = Measured Concentration of Second Sample

Sample Concentration

Extract

$C_{extract}\,(ug/L) = \dfrac{\text{Peak Area (or Height)}}{\overline{CF}}$

Note: The concentrations of the 3-5 peaks chosen for quantification is calculated and the average is then taken for final calculation.

Water

$$C_{sample}(ug/L) = C_{extract}(ug/L) \times \frac{\text{extract volume (L)}}{\text{sample volume (L)}} \times DF$$

Solid

$$C_{sample}(ug/Kg) = C_{extract}(ug/L) \times \frac{\text{extract volume (L)}}{\text{sample weight (Kg)}} \times \frac{100}{\%\,\text{solids}} \times DF$$

Quality Assurance Manual

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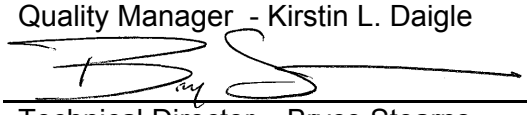
Title Page:

Quality Assurance Manual
Approval Signatures

	October 25, 2011
Laboratory Director – William S. Cicero	
	October 24, 2011
Quality Manager - Kirstin L. Daigle	
	October 24, 2011
Technical Director – Bryce Stearns	

SECTION 2. TABLE OF CONTENTS

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REFERENCED CORPORATE SOPs AND POLICIES

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

REFERENCED LABORATORY SOPs

SOP Reference	Title
BR-QA-003	Document Control
BR-QA-004	Complaint Resolution
BR-QA-011	Employee Training and Demonstration of Proficiency
BR-QA-005	Detection Limits, Limit of Detection and Limit of Quantitation
BR-QA-006	Manual Integration
BR-QA-020	Sample Homogenization and Subsampling
BR-SM-001	Sample Management

SECTION 3. INTRODUCTION, SCOPE AND APPLICABILITY

3.1 Introduction and Compliance References

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

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

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

- EPA 600/4-88/039, *Methods for the Determination of Organic Compounds in Drinking Water,* EPA, Revised July 1991.
- EPA 600/R-95/131, *Methods for the Determination of Organic Compounds in Drinking Water,* Supplement III, EPA, August 1995.
- EPA 600/4-79-019, *Handbook for Analytical Quality Control in Water and Wastewater Laboratories,* EPA, March 1979.
- *Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846), Third Edition, September 1986, Final Update I, July 1992, Final Update IIA, August 1993, Final Update II, September 1994; Final Update IIB, January 1995; Final Update III, December 1996; Final Update IV, January 2008.*
- *U.S. Department of Defense, Quality Systems Manual for Environmental Laboratories, Version 4.2, October 2010.*
- Federal Register, 40 CFR Parts 136, 141, 172, 173, 178, 179 and 261.
- *Manual for the Certification of Laboratories Analyzing Drinking Water (EPA 815-R-05-004, January 2005) (DW labs only)*
- APHA, *Standard Methods for the Examination of Water and Wastewater,* 18th Edition, 19th, 20th, 21st, and on-line Editions.
- *U.S. Department of Energy* Order 414.1B, *Quality Assurance*, Approved 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 3.6, November 2010.
- 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).

3.2 Terms and Definitions

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

Refer to Appendix 2 for the Glossary/Acronyms.

3.3 Scope / Fields of Testing

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

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

3.4 Management of the Manual

3.4.1 Review Process

The template on which this manual is based is reviewed annually by Corporate Quality Management Personnel to assure that it remains in compliance with Section 3.1. The manual itself is reviewed annually by senior laboratory management to assure that it reflects current practices and meets the requirements of the laboratory's clients and regulators as well as the CQMP. Occasionally, the manual may need changes in order to meet new or changing regulations and operations. The QA Manager will review the changes in the normal course of business and incorporate changes into revised sections of the document. All updates will be

reviewed and approved by the senior laboratory management staff according to the laboratory's Document Control procedure (SOP No. BR-QA-003).

SECTION 4. MANAGEMENT REQUIREMENTS

4.1 Overview

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

4.2 Roles and Responsibilities

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

4.2.1 Additional Requirements for Laboratories

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

4.2.2 Quality Assurance (QA) Manager or Designee

The QA Manager has responsibility and authority to ensure the continuous implementation of the quality system.

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

- Serves as the focal point for QA/QC in the laboratory.
- Having functions independent from laboratory operations for which he/she has quality assurance oversight.
- Maintaining and updating the QAM.
- Monitoring and evaluating laboratory certifications; scheduling proficiency testing samples.

- Monitoring and communicating regulatory changes that may affect the laboratory to management.
- Training and advising the laboratory staff on quality assurance/quality control procedures that are pertinent to their daily activities.
- Have documented training and/or experience in QA/QC procedures and the laboratory's Quality System.
- Having a general knowledge of the analytical test methods for which data audit/review is performed (and/or having the means of getting this information when needed).
- Arranging for or conducting internal audits on quality systems and the technical operation.
- The laboratory QA Manager will maintain records of all ethics-related training, including the type and proof of attendance.
- Maintain, improve, and evaluate the corrective action database and the corrective and preventive action systems.
- Notifying laboratory management of deficiencies in the quality system and ensuring corrective action is taken. Procedures that do not meet the standards set forth in the QAM or laboratory SOPs shall be investigated following procedures outlined in Section 12 and if deemed necessary may be temporarily suspended during the investigation.
- Objectively monitor standards of performance in quality control and quality assurance without outside (e.g., managerial) influence.
- Coordinating of document control of SOPs, MDLs, control limits, and miscellaneous forms and information.
- Review a percentage of all final data reports for internal consistency. Review of Chain of Custody (COC), correspondence with the analytical request, batch QC status, completeness of any corrective action statements, 5% of calculations, format, holding time, sensibility and completeness of the project file contents.
- Review of external audit reports and data validation requests.
- Follow-up with audits to ensure client QAPP requirements are met.
- Establishment of reporting schedule and preparation of various quality reports for the Laboratory Director, clients and/or Corporate QA.
- Development of suggestions and recommendations to improve quality systems.
- Research of current state and federal requirements and guidelines.
- Captains the QA team to enable communication and to distribute duties and responsibilities.
- Ensuring Communication & monitoring standards of performance to ensure that systems are in place to produce the level of quality as defined in this document.
- Notifying laboratory management of deficiencies in the quality system and ensuring corrective action is taken. Procedures that do not meet the standards set forth in the QAM or laboratory SOPs are temporarily suspended following the procedures outlined in Section 12.
- Evaluation of the thoroughness and effectiveness of training.
- Compliance with ISO 17025. (where applicable)

4.2.3 Technical Manager (AKA Technical Director) & Department Manager (DM)

The Technical Director report(s) directly to the Laboratory Director. The Technical Director along with the Laboratory Director, the QA Manager and each Department Manager is accountable for compliance with the ISO 17025 Standard. The Technical Director works with QA and the Department Managers to solve day to day technical issues, provide technical training and guidance to laboratory staff, project managers, and clients, and assists with method development and validation.

The Department Managers report to the Laboratory Directory. The DMs maintain overall responsibility for a defined portion of the laboratory. These responsibilities include but are not limited to:

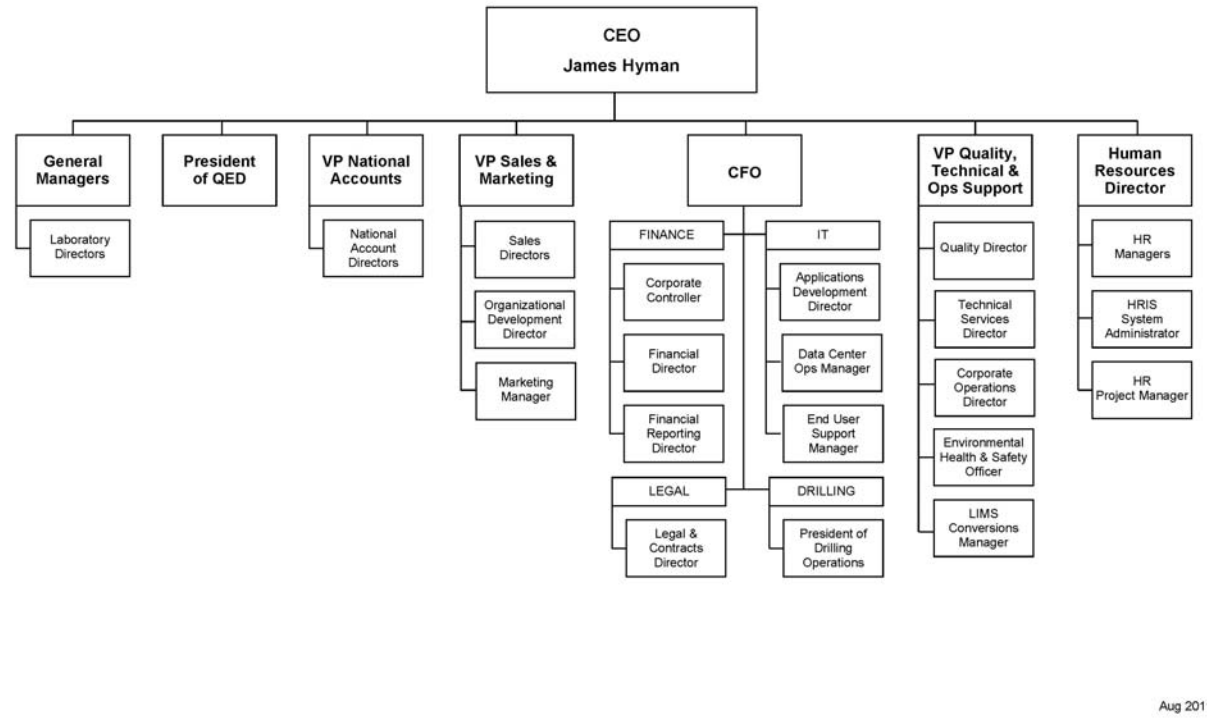
- Day-to-day supervision of laboratory operations for the appropriate field of accreditation and reporting of results. Working with the QA Manager to coordinate preparation of test method SOPs and performs subsequent analyst training and interpretation of the SOPs for implementation and unusual project samples.
- Reviews and approves proposals from marketing, in accordance with the established procedure for the review of requests and contracts.
- Monitoring the validity of the analyses performed and data generated in the laboratory.
- Providing training and development programs to applicable laboratory staff as new hires and, subsequently, on a scheduled basis. Training includes instruction on calculations, instrumentation management to include troubleshooting and preventive maintenance.
- Enhancing efficiency and improving quality through technical advances and improved LIMS utilization. Capital forecasting and instrument life cycle planning for second generation methods and instruments as well as asset inventory management.
- Working with the QA Manager to scheduling all QA/QC-related requirements for compliance, e.g., MDLs, etc.
- Captains department personnel to communicate quality, technical, personnel, and instrumental issues for a consistent team approach.

4.3 Deputies

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

Key Personnel	Deputy
William S. Cicero Laboratory Director	Bryce E. Stearns, Technical Director Kirstin L. Daigle, QA Manager
Kirstin L. Daigle QA Manager	William S. Cicero, Laboratory Director Bryce E. Stearns, Technical Director Frances S. Bertsch, QA Assistant
Bryce E. Stearns Technical Director	William S. Cicero, Laboratory Director Kirstin L. Daigle, QA Manager
Dan E. Helfrich EHS Coordinator	William S. Cicero, Laboratory Director

Figure 4-1. Corporate and Laboratory Organization Charts



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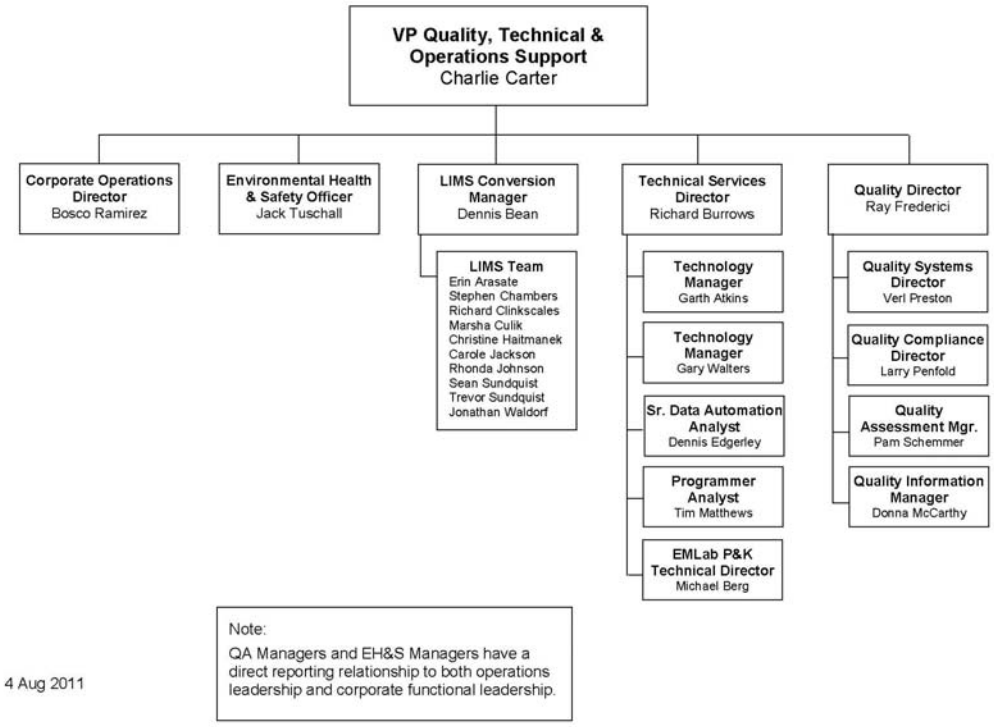

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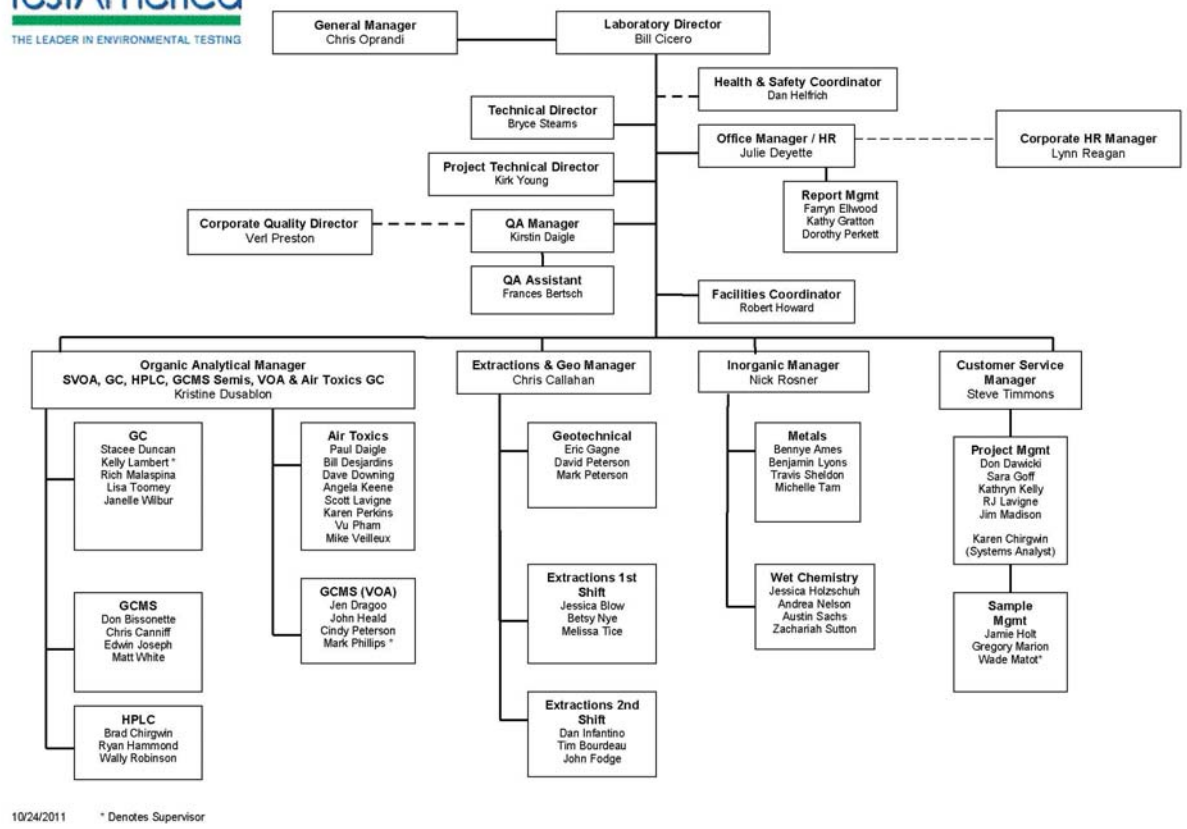
Burlington Laboratory Organization



SECTION 5. QUALITY SYSTEM

5.1 Quality Policy Statement

It is TestAmerica's Policy to:

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

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

5.2 Ethics and Data Integrity

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

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

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

5.3 Quality System Documentation

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

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

5.3.1 Order of Precedence

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

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

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

5.4 QA/QC Objectives for the Measurement of Data

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

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

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

Historically, laboratories have described their QC objectives in terms of precision, accuracy, representativeness, comparability, completeness, selectivity and sensitivity (PARCCSS).

5.4.1 Precision

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

5.4.2 Accuracy

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

5.4.3 Representativeness

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

identical samples or sample aliquots.

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

5.4.4 Comparability

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

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

5.4.5 Completeness

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

5.4.6 Selectivity

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

5.4.7 Sensitivity

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

5.5 Criteria for Quality Indicators

The laboratory limits used quality control are stored in the LIMS database and may also be published in laboratory SOPs. Limits for accuracy and precision are laboratory generated or are

derived from US EPA methods when they are required. Where US EPA method limits are not required, the laboratory has developed limits from evaluation of data from similar matrices. The laboratory procedure for establishment of control limits is described in laboratory SOP BR-QA-013.

5.6 Statistical Quality Control

Statistically-derived precision and accuracy limits are required by selected methods (such as SW-846) and by program. The laboratory routinely utilizes statistically-derived limits to evaluate method performance and determine when corrective action is appropriate. If a method requires the generation of limits from historical data the lab develops such limits from data stored in the LIMS database following the procedure specified in laboratory SOP BR-QA-013.

For each job analysts are instructed to use the current limits that are entered as reference data data in the Laboratory Information Management System (LIMS) On occasion, a client requests contract-specified limits for a specific project in which case project specific limits are entered into each LIMS job by the PM handling the project.

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

5.6.1 QC Charts

The laboratory's procedures for the creation of control charts are described in laboratory SOP BR-QA-013. Control charts are created from data stored in the LIMS. The charts are evaluated by QA or technical staff to determine if limits need to be updated or to assess the need for corrective actions to improve method performance.

5.7 Quality System Metrics

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

SECTION 6. DOCUMENT CONTROL

6.1 Overview

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

- Laboratory Quality Assurance Manual
- Laboratory Standard Operating Procedures (SOP)
- Laboratory Policies

- Work Instructions and Forms
- Corporate Policies and Procedures distributed outside the intranet

Corporate Quality posts Corporate Manuals, SOPs, Policies, Work Instructions, White Papers and Training Materials on the company intranet site. These Corporate documents are only considered controlled when they are read on the intranet site. Printed copies are considered uncontrolled unless the laboratory physically distributes them as controlled documents. A detailed description of the procedure for issuing, authorizing, controlling, distributing, and archiving Corporate documents is found in Corporate SOP No. CW-Q-S-001, Corporate Document Control and Archiving. The laboratory's internal document control procedure is defined in SOP BR-QA-003.

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

The laboratory records for supporting records such as audit reports and responses, logbooks, standard logs, training files, MDL studies, Proficiency Testing (PT) studies, certifications and related correspondence, and corrective action reports are kept by the QA department. Raw analytical data consists of bound logbooks, instrument printouts, any other notes, magnetic media, electronic data and final reports are retained electronically, by each analytical section or by the QA department.

6.2 Document Approval and Issue

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

Controlled documents are authorized by the QA Department. To develop a new document, the department manager or any employee with approval from the department manager submits an electronic draft to the QA Department for suggestions and approval before use. Upon approval QA personnel add the identifying version information to the document and retains a copy of the document as the official document on file. The document is then provided to all applicable operational units (may include electronic access) by either electronic or hardcopy distribution.

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

Quality System Policies and Procedures will be reviewed annually and revised as appropriate. Changes to documents occur when a procedural change warrants.

6.3 Procedures for Document Control Policy

For changes to the QA Manual, refer to SOP BR-QA-003. Uncontrolled copies must not be used within the laboratory. Previous revisions are stored by the QA department. The current revision is located in the public controlled document folder accessible to all employees.

For changes to SOPs, refer to SOP No. CW-Q-S-002, Writing a Standard Operating Procedure SOP.

Forms, worksheets, work instructions and information are organized by the QA department in accordance with the procedures specified in laboratory SOP BR-QA-003.

6.4 Obsolete Documents

All invalid or obsolete documents are removed, or otherwise prevented from unintended use. The laboratory has specific procedures as described above to accomplish this. In general, obsolete documents are collected from employees according to distribution lists and are marked obsolete on the cover or destroyed. At least one copy of the obsolete document is archived according to SOP BR-QA-003.

SECTION 7. SERVICE TO THE CLIENT

7.1 Overview

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

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

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

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

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

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

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

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

7.2 Review Sequence and Key Personnel

Work requests are reviewed by appropriate personnel at each stage of evaluation.

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

For new, complex or large projects, the proposed contract is given to the Sales Directors, who will decide which lab will receive the work based on the scope of work and other requirements, including certification, testing methodology, and available capacity to perform the work. The contract review process is outlined in TestAmerica's Corporate SOP No. CA-L-P-002**,** Contract Compliance Policy.

This review encompasses all facets of the operation. The scope of work is distributed to the appropriate personnel, as needed based on scope of contract, to evaluate all of the requirements shown above. Appropriate personnel include but are not limited to:

- Legal & Contracts Director
- General Manager
- Laboratory Director
- Laboratory Project Manager
- Laboratory Technical Manager/Director
- Laboratory Department Manager
- Laboratory Customer Service Manager
- Information Technology Manager

- Account Executives
- Laboratory and/or Corporate Quality Managers
- Laboratory and/or Corporate Environmental Health and Safety Managers/Directors

In the event that one of the above personnel is not available to review the contract, his or her back-up will fulfill the review requirements. The Laboratory Director reviews the formal laboratory quote and makes final acceptance for their facility. The Project Manager, Sales Director, Legal Contracts Director, Account Executive or Proposal Coordinator then submits the final proposal to the client. The Legal & Contracts Director and facility Customer Service Manager maintains copies of all signed contracts.

7.3 Documentation

Appropriate records are maintained for every contract or work request. All stages of the contract review process are documented and include records of any significant changes. Records of review are organized and kept by the designated project manager (PM).

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

Records are maintained of pertinent discussions with a client relating to the client's requirements or the results of the work during the period of execution of the contract. These records are retained by the laboratory PM.

7.3.1 Project-Specific Quality Planning

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

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

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

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

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

7.4 Special Services

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

Note: ISO/IEC 17025 states that a laboratory "shall afford clients or their representatives cooperation to clarify the client's request". This topic is discussed in Section 7.

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

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

7.5 Client Communication

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

Technical Managers and the Quality Assurance Manager are available to discuss any technical questions or concerns that the client may have.

7.6 Reporting

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

7.7 Client Surveys

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

SECTION 8. SUBCONTRACTING OF TESTS

8.1 Overview

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

When contracting with our clients, the laboratory makes commitments regarding the services to be performed and the data quality for the results to be generated. When the need arises to outsource testing for our clients because project scope, changes in laboratory capabilities, capacity or unforeseen circumstances, we must be assured that the subcontractors or work sharing laboratories understand the requirements and will meet the same commitments we have made to the client. Refer to TestAmerica's Corporate SOP's on Subcontracting Procedures (CA-L-S-002) and the Work Sharing Process (CA-C-S-001).

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

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

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

8.2 Qualifying and Monitoring Subcontracators

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

- The first priority is to attempt to place the work in a qualified TestAmerica laboratory;
- Firms specified by the client for the task. (Documentation that a subcontractor was designated by the client must be maintained with the project file. This documentation can be as simple as placing a copy of an e-mail from the client in the project folder);
- Firms listed as pre-qualified and currently under a subcontract with TestAmerica: A listing of all approved subcontracting laboratories is available on the TestAmerica intranet site. Supporting documentation is maintained by corporate offices and by the TestAmerica laboratory originally requesting approval of the subcontract lab.

- Firms identified in accordance with the company's Small Business Subcontracting program as small, women-owned, veteran-owned and/or minority-owned businesses;
- NELAC or A2LA accredited laboratories.
- In addition, the firm must hold the appropriate certification to perform the work required.

All TestAmerica laboratories are pre-qualified for work sharing provided they hold the appropriate accreditations, can adhere to the project/program requirements, and the client approved sending samples to that laboratory. The client must provide acknowledgement that the samples can be sent to that facility (an e-mail is sufficient documentation or if acknowledgement is verbal, the date, time, and name of person providing acknowledgement must be documented). The originating laboratory is responsible for communicating all technical, quality, and deliverable requirements as well as other contract needs. (Corporate SOP No. CA-C-S-001, Work Sharing Process).

When the potential sub-contract laboratory has not been previously approved, management staff may nominate a laboratory as a subcontractor based on need. The decision to nominate a laboratory must be approved by the Laboratory Director. The Laboratory Director requests that the QA Manager begin the process of approving the subcontract laboratory as outlined in Corporate SOP No. CA-L-S-002, Subcontracting Procedures. The client must provide acknowledgement that the samples can be sent to that facility (an e-mail is sufficient documentation or if acknowledgement is verbal, the date, time, and name of person providing acknowledgement must be documented).

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

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

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

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

8.3 Oversight and Reporting

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

Prior to sending samples to the subcontracted laboratory, the PM confirms their certification status to determine if it's current and scope-inclusive. The information is documented and in the project folder. An example form that may be used for documentation is provided as Figure 8-1. For TestAmerica laboratories, certifications can be viewed on the company's TotalAccess Database.

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

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

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

Non-NELAC accredited work must be identified in the subcontractor's report as appropriate. If NELAC accreditation is not required, the report does not need to include this information.

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

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

8.4 Contingency Planning

The Laboratory Director may waive the full qualification of a subcontractor process temporarily to meet emergency needs; however, this decision & justification must be documented in the

project files, and the 'Purchase Order Terms And Conditions For Subcontracted Laboratory Services' must be sent with the samples and Chain-of-Custody. In the event this provision is utilized, the laboratory (e.g., PM) will be required to verify and document the applicable accreditations of the subcontractor. All other quality and accreditation requirements will still be applicable, but the subcontractor need not have signed a subcontract with TestAmerica at this time. The comprehensive approval process must then be initiated within 30 calendar days of subcontracting.

Figure 8-1.

Example - Subcontracted Sample Form

Date/Time: _____

Subcontracted Laboratory Information:

- Subcontractor's Name: _____
- Subcontractor Point of Contact: _____
- Subcontractor's Address: _____
- Subcontractor's Phone: _____
- Analyte/Method: _____
- Certified for State of Origin: _____
- NELAC Certified: Yes_____No_____
- **USDA Permit (__Domestic __ Foreign)** **Yes**_____**No**_____
- ISO 17025 Certified: Yes_____No_____
- CLP-like Required: Yes_____No_____
  (Full doc required)
- Requested Sample Due Date: _____
  (Must be put on COC)
- **Client POC Approval on-file to Subcontract Samples to Sub Laboratory:** **Yes**_____**No**_____

Project Manager: _____

Laboratory Sample # Range: _____
(Only of Subcontracted Samples)

Laboratory Project Number (Billing Control #): _____

All subcontracted samples are to be sent via bonded carrier and Priority Overnight. Please attach tracking number below and maintain these records in the project files.

PM Signature_____**Date**_____

SECTION 9. PURCHASING SERVICES AND SUPPLIES

9.1 Overview

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

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

9.2 Glassware

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

9.3 Reagents, Standards & Supplies

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

9.3.1 Purchasing

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

9.3.2 Receiving

It is the responsibility of the manager that placed the order to receive the shipment. It is the responsibility of the manager or their designee who ordered the materials to document the date

materials where received. Once the ordered reagents or materials are received the information on the label or packaging to the original order to ensure that the purchase meets the quality level specified. Material Safety Data Sheets (MSDSs) are available online through the Company's intranet website. Anyone may review these for relevant information on the safe handling and emergency precautions of on-site chemicals.

9.3.3 Specifications

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

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

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

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

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

Compressed gases in use are checked for pressure and secure positioning daily. The minimum total pressure must be 120 psig for Helium, 100 psig for liquid Argon and 30 psig for Nitrogen or the tank must be replaced. To prevent a tank from going to dryness, close observation of the tank gauge must take place as pressure decreases towards the minimum psig, or the tank must be replaced. The quality of the gases must meet method or manufacturer specification or be of a grade that does not cause any analytical interference.

Water used in the preparation of standards or reagents must have a specific conductivity of less than 1- µmhom/cm (or specific resistivity of greater than 1.0 megohm-cm) at 25^{o}C. The specific conductivity is checked and recorded daily. If the water's specific conductivity is greater than the specified limit, the Facility Manager and appropriate Technical Managers must be notified

immediately in order to notify all departments, decide on cessation (based on intended use) of activities, and make arrangements for correction.

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

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

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

Records of manufacturer's certification and traceability statements are maintained in each laboratory section. These records include date of receipt, lot number (when applicable), and expiration date (when applicable). Incorporation of the item into the record indicates that the analyst has compared the new certificate with the previous one for the same purpose and that no difference is noted, unless approved and so documented by the Technical Manager, Technical Director or QA Manager.

9.3.4 Storage

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

9.4 Purchase of Equipment / Instruments / Software

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

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

9.5 Services

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

9.6 Suppliers

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

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

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

The Corporate Purchasing Group will work through the appropriate channels to gather the information required to clearly identify the problem and will contact the vendor to report the problem and to make any necessary arrangements for exchange, return authorization, credit, etc.
As deemed appropriate, the Vendor Performance Reports will be summarized and reviewed to determine corrective action necessary, or service improvements required by vendors

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

9.6.1 New Vendor Procedure

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

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

SECTION 10. COMPLAINTS

10.1 Overview

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

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

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

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

The process of complaint resolution and documentation utilizes the procedures outlined in Section 12 (Corrective Actions) and is documented following laboratory SOP BR-QA-004.

10.2 External Complaints

An employee that receives a complaint initiates the complaint resolution process by first documenting the complaint according to laboratory SOP BR-QA-004.

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

The general steps in the complaint handling process are:

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

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

10.3 Internal Complaints

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

10.4 Management Review

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

SECTION 11. CONTROL OF NON-CONFORMING WORK

11.1 Overview

When data discrepancies are discovered or deviations and departures from laboratory SOPs, policies and/or client requests have occurred, corrective action is taken immediately. First, the laboratory evaluates the significance of the nonconforming work. Then, a corrective action plan is initiated based on the outcome of the evaluation. If it is determined that the nonconforming work is an isolated incident, the plan could be as simple as adding a qualifier to the final results and/or making a notation in the case narrative. If it is determined that the nonconforming work is a systematic or improper practices issue, the corrective action plan could include a more in depth investigation and a possible suspension of an analytical method. In all cases, the actions taken are documented using the laboratory's corrective action system (refer to Section 12).

Due to the frequently unique nature of environmental samples, sometimes departures from documented policies and procedures are needed. Any modifications to the routine procedure are documented in the project record and described in the case narrative submitted with the report.

Project Management may encounter situations where a client may request that a special procedure be applied to a sample that is not standard lab practice. Any project specific modifications to the procedure are documented in the project record.

11.2 Responsibilities and Authorities

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

The Laboratory Director, a Technical Manager or a member of the QA team may authorize departures from documented procedures or policies. The departures may be a result of

procedural changes due to the nature of the sample; a one-time procedure for a client; QC failures with insufficient sample to reanalyze, etc. In most cases, the client will be informed of the departure prior to the reporting of the data. Any departures must be documented. Any impacted data must be referenced in a case narrative and/or flagged with an appropriate data qualifier.

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

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

The Laboratory Director, QA Manager, ECOs, Corporate Quality, the COO, General Managers and the Quality Directors have the authority and responsibility to halt work, withhold final reports, or suspend an analysis for due cause as well as authorize the resumption of work.

11.3 Evaluation of Significance and Actions Taken

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

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

11.4 Prevention of NonConforming Work

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

11.5 Method Suspension / Restriction (Stop Work Procedures)

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

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

The Laboratory Director shall arrange for the appropriate personnel to meet with the QA Manager as needed. This meeting shall be held to confirm that there is a problem, that suspension/restriction of the method is required and will be concluded with a discussion of the steps necessary to bring the method/target or test fully back on line. In some cases, that may not be necessary if all appropriate personnel have already agreed there is a problem and there is agreement on the steps needed to bring the method, target or test fully back on line.
The QA Manager will also initiate a corrective action report as described in Section 12 if one has not already been started. A copy of any meeting notes and agreed upon steps should be faxed or e-mailed by the laboratory to the appropriate General Manager and member of Corporate QA. This fax/e-mail acts as notification of the incident.

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

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

SECTION 12. CORRECTIVE ACTION

12.1 Overview

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

documented using Non-Conformance Reports (NCR) and Corrective Action Reports (CAR) (refer to Figure 12-1).

12.2 General

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

The purpose of a corrective action system is to:

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

12.2.1 Non-Conformance Report (NCR) - is used to document the following types of corrective actions:

- Deviations from an established procedure or SOP
- QC outside of limits (non-matrix related)
- Isolated reporting / calculation errors
- Client complaints
- Discrepancies in materials / goods received vs. manufacturer packing slips.

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

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

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

12.3 Closed Loop Corrective Action Process

Any employee in the company can initiate a corrective action. There are four main components to a closed-loop corrective action process once an issue has been identified: Cause Analysis,

Selection and Implementation of Corrective Actions (both short and long term), Monitoring of the Corrective Actions, and Follow-up.

12.3.1 Cause Analysis

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

12.3.2 Selection and Implementation of Corrective Actions

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

12.3.3 Root Cause Analysis

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

To perform root cause analysis, systematically analyze and document the root causes of the more significant problems reported then identify, track, and implement the corrective actions required to reduce the likelihood of recurrence of significant incidents. Trend the Root Cause data from these incidents to identify Root Causes that, when corrected, can lead to dramatic improvements in performance by eliminating entire classes of problems.

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

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

12.3.4 Monitoring of the Corrective Actions

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

12.3.5 Follow-up Audits

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

(Also refer to Section 15.1.4, Special Audits.)

12.4 Technical Corrective Actions

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

Table 12-1 includes examples of general technical corrective actions. For specific criteria and corrective actions, refer to specific method SOPs.

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

To the extent possible, samples shall be reported only if all quality control measures are acceptable. If the deficiency does not impair the usability of the results, data will be reported with

an appropriate data qualifier and/or the deficiency will be noted in the case narrative. Where sample results may be impaired, the Project Manager is notified by an NCM and appropriate corrective action (e.g., reanalysis) is taken and documented**.**

12.5 Basic Corrections

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

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

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

Figure 12-1.
Example - Corrective Action Report

CORRECTIVE ACTION REPORT (CAR)			Tracking Number:
Initiated By:		Assigned To:	
Initiation Date:		CC:	
Due Date:			
Section 1: Describe Problem & Attach Supporting Documentation As Needed			
Corrective Action Prompted By:			
Recurring NCR	Internal Audit	External Audit	Complaint / Other
Section 2: Root Cause Analysis			
Section 3: Describe Actions Required to Correct & Prevent Problem			
Section 4: QA Review and Close Out			
Action Taken Was:	Acceptable	Not Acceptable	Other
Comments:			
Close Out Date:		Closed By:	
Section 5: Follow Up (From Close-Out Date)			
Time Frame:	Performed By:	Date:	Is action taken preventing recurrence?
1 Month			
3 Month			
6 Month			
Comments:			

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Table 12-1. Example – General Corrective Action Procedures

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

QC Activity *(Individual Responsible for Initiation/Assessment)*	Acceptance Criteria	Recommended Corrective Action
Laboratory Control Sample (LCS) (Analyst, Data Reviewer)	% Recovery within limits in TALS	- Batch must be re-prepared and re-analyzed. This includes any allowable marginal exceedance. When not using marginal exceedances, the following exceptions apply: 1) when the acceptance criteria for the positive control are exceeded high (i.e., high bias) and there are associated samples that are non-detects, then those non-detects may be reported with data qualifying codes; 2) when the acceptance criteria for the positive control are exceeded low (i.e., low bias), those sample results may be reported if they exceed a maximum regulatory limit/decision level with data qualifying codes. **Note:** If there is insufficient sample or the holding time cannot be met, contact client and report with flags.
Surrogates (Analyst, Data Reviewer)	- % Recovery within limits in TALS.	- Individual sample must be repeated. Place comment in LIMS. - Surrogate results outside criteria shall be reported with qualifiers.
Method Blank (MB) (Analyst, Data Reviewer)	< Reporting Limit or as specified by regulatory program.	- Reanalyze blank. - If still positive, determine source of contamination. If necessary, reprocess (i.e. digest or extract) entire sample batch. Report blank results. - Qualify the result(s) if the concentration of a targeted analyte in the MB is at or above the reporting limit AND is > 1/10 of the amount measured in the sample.
Proficiency Testing (PT) Samples (QA Manager, Technical Manager(s)	- Criteria supplied by PT Supplier.	- Any failures or warnings must be investigated for cause. Failures may result in the need to repeat a PT sample to show the problem is corrected.
Internal / External Audits (QA Manager, Technical Manager(s) Laboratory Director)	- Defined in Quality System documentation such as SOPs, QAM, etc..	- Non-conformances must be investigated through CAR system and necessary corrections must be made.

QC Activity *(Individual Responsible for Initiation/Assessment)*	Acceptance Criteria	Recommended Corrective Action
Reporting / Calculation Errors (Depends on issue – possible individuals include: Analysts, Data Reviewers, Project Managers, Technical Managers, QA Manager, Corporate QA, Corporate Management)	- SOP CW-L-S-002Internal Investigation of Potential Data Discrepancies and Determination for Data Recall.	- Corrective action is determined by type of error. Follow the procedures in SOP CW-L-S-002 or your lab's CA SOP.
Client Complaints (Project Managers, Lab Director/Manager, Sales and Marketing)	-	- Corrective action is determined by the type of complaint. For example, a complaint regarding an incorrect address on a report will result in the report being corrected and then follow-up must be performed on the reasons the address was incorrect (e.g., database needs to be updated).
QA Monthly Report (Refer to Section 16 for an example) (QA Manager, Lab Director/Manager, Technical Manager(s)	- QAM, SOPs.	- Corrective action is determined by the type of issue. For example, CARs for the month are reviewed and possible trends are investigated.
Health and Safety Violation (Safety Officer, Lab Director/Manager, Technical Manager(s)	- Environmental Health and Safety (EHS) Manual.	- Non-conformance is investigated and corrected through CAR system.

SECTION 13. PREVENTIVE ACTION / IMPROVEMENT

13.1 Overview

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

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

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

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

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

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

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

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

13.2 Management of Change

The Management of Change process is designed to manage significant events and changes that occur within the laboratory such as the addition of new equipment or personnel.

Procedures for minimization of potential risks inherent with a new event or change are described in various laboratory standard operating procedures.

SECTION 14. CONTROL OF RECORDS

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

14.1 Overview

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

Table 14-1. Record Index[1]

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

	Record Types [1]:	Retention Time:
Administrative Records	Finance and Accounting	10 years
	EH&S Manual, Permits	7 years
	Disposal Records	Indefinitely
	Employee Handbook	Indefinitely
	Personnel files, Employee Signature & Initials, Administrative Training Records (e.g., Ethics)	7 Years (HR Personnel Files must be maintained indefinitely)
	Administrative Policies Technical Training Records	7 years

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

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

Access to the data is limited to laboratory and company employees and shall be documented with an access log**.** Records are maintained for a minimum of five years unless otherwise specified by a client or regulatory requirement.

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

14.1.2 Programs with Longer Retention Requirements

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

Table 14-2. Example: Special Record Retention Requirements

Program	[1]Retention Requirement
Drinking Water – All States	**5 years (project records)** **10 years - Radiochemistry (project records)**
Drinking Water Lead and Copper Rule	12 years (project records)
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]Note: Extended retention requirements must be noted with the archive documents or addressed in facility-specific records retention procedures.

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

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

- The records include the identity of personnel involved in sampling, sample receipt, preparation, or testing. All analytical work contains the initials (at least) of the personnel involved.

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

- The record keeping system facilitates the retrieval of all working files and archived records for inspection and verification purpose. Instrument data is stored by instrument. Run logs

are maintained for each instrument. Where an analysis is performed without an instrument, bound logbooks or bench sheets are used to record and file data. Standard and reagent information is recorded in logbooks or entered into the LIMS for each method as required.

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

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

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

- Hard copy data may be scanned into PDF format for record storage as long as the scanning process can be verified in order to ensure that no data is lost and the data files and storage media must be tested to verify the laboratory’s ability to retrieve the information prior to the destruction of the hard copy that was scanned.

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

14.2 Technical and Analytical Records

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

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

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

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

- laboratory sample ID code**;**
- Date of analysis; Time of Analysis is also required if the holding time is seventy-two (72) hours or less, or when time critical steps are included in the analysis (e.g., drying times, incubations, etc.); instrumental analyses have the date and time of analysis recorded as part of their general operations. Where a time critical step exists in an analysis, location for such a time is included as part of the documentation in a specific logbook or on a benchsheet.
- Instrumentation identification and instrument operating conditions/parameters.
- analysis type**;**
- all manual calculations and manual integrations**;**
- analyst's or operator's initials/signature**;**

- sample preparation
- test results**;**
- standard and reagent origin, receipt, preparation, and use**;**
- calibration criteria, frequency and acceptance criteria**;**
- data and statistical calculations, review, confirmation, interpretation, assessment and reporting conventions**;**
- quality control protocols and assessment**;**
- electronic data security, software documentation and verification, software and hardware audits, backups, and records of any changes to automated data entries; and
- Method performance criteria including expected quality control requirements.

14.3 Laboratory Support Activities

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

- all original raw data, whether hard copy or electronic, for calibrations, samples and quality control measures, including analysts' work sheets and data output records (chromatograms, strip charts, and other instrument response readout records)**;**
- a written description or reference to the specific test method used which includes a description of the specific computational steps used to translate parametric observations into a reportable analytical value**;**
- copies of final reports**;**
- archived SOPs**;**
- correspondence relating to laboratory activities for a specific project**;**
- all corrective action reports, audits and audit responses**;**
- proficiency test results and raw data; and
- results of data review, verification, and crosschecking procedures

14.3.1 Sample Handling Records

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

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

protect the integrity of samples.

14.4 Administrative Records

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

14.5 Records Management, Storage and Disposal

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

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

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

The laboratory has a record management system (a.k.a., document control) for control of laboratory notebooks, instrument logbooks, standards logbooks, and records for data reduction, validation, storage and reporting. The procedures for document are described in laboratory SOP BR-QA-003.

14.5.1 Transfer of Ownership

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

14.5.2 Records Disposal

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

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

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

SECTION 15. AUDITS

15.1 Internal Audits

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

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

Table 15-1. Types of Internal Audits and Frequency

Description	Performed by	Frequency
Quality Systems Audits	QA Department, QA approved designee, or Corporate QA	All areas of the laboratory annually
Method Audits	Joint responsibility: a) QA Manager or designee b) Technical Manager or Designee (Refer to CA-Q-S-004)	Methods Audits Frequency: 50% of methods annually 100% of methods annually (DoD Labs)
Special	QA Department or Designee	Surveillance or spot checks performed as needed, e.g., to confirm corrective actions from other audits.
Performance Testing	Analysts with QA oversight	Two successful per year for each TNI field of proficiency testing or as dictated by regulatory requirements

15.1.1 Annual Quality Systems Audit

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

15.1.2 QA Technical Audits

QA technical audits are based on client projects, associated sample delivery groups, and the methods performed. Reported results are compared to raw data to verify the authenticity of results. The validity of calibrations and QC results are compared to data qualifiers, footnotes, and case narratives. Documentation is assessed by examining run logs and records of manual integrations. Manual calculations are checked. Where possible, electronic audit miner programs (e.g., MintMiner and Chrom AuditMiner) 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 Quality Assurance Manager or qualified designee at least every two years.

15.1.4 Special Audits

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

15.1.5 Performance Testing

The laboratory participates semi-annually in performance audits conducted through the analysis of PT samples provided by a third party. The laboratory generally participates in the following types of PT studies: water, 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

External audits are performed when certifying agencies or clients conduct on-site inspections or submit performance testing samples for analysis. It is TestAmerica's policy to cooperate fully with regulatory authorities and clients. The laboratory makes every effort to provide the auditors with access to personnel, documentation, and assistance. Laboratory supervisors are responsible for providing corrective actions to the QA Manager who coordinates the response for any deficiencies discovered during an external audit. Audit responses are due in the time

allotted by the client or agency performing the audit. When requested, a copy of the audit report and the labs corrective action plan will be forwarded to Corporate Quality.

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

15.2.1 Confidential Business Information (CBI) Considerations

During on-site audits, auditors may come into possession of information claimed as business confidential. A business confidentiality claim is defined as "a claim or allegation that business information is entitled to confidential treatment for reasons of business confidentiality or a request for a determination that such information is entitled to such treatment." When information is claimed as business confidential, the laboratory must place on (or attach to) the information at the time it is submitted to the auditor, a cover sheet, stamped or typed legend or other suitable form of notice, employing language such as "trade secret", "proprietary" or "company confidential". Confidential portions of documents otherwise non-confidential must be clearly identified. CBI may be purged of references to client identity by the responsible laboratory official at the time of removal from the laboratory. However, sample identifiers may not be obscured from the information. Additional information regarding CBI can be found in within the 2009 TNI standards.

15.3 Audit Findings

Audit findings are documented in audit reports and tracked by the QA department. The laboratory's corrective action responses for internal and external audits include action plans and date for completion. If a completion date cannot be met, a new a completion date must be set and agreed to by the QA Manager.

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

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

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

SECTION 16. MANAGEMENT REVIEWS

16.1 Quality Assurance Report

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

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

16.2 Annual Management Review

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

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

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

- Compliance to the Ethics Policy and Data Integrity Plan. Including any evidence/incidents of inappropriate actions or vulnerabilities related to data Integrity.

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

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

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

16.3 Potential Integrity Related Managerial Reviews

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

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

SECTION 17. PERSONNEL

17.1 Overview

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

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

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

All personnel are responsible for complying with all QA/QC requirements that pertain to the laboratory and their area of responsibility. Each staff member must have a combination of experience and education to adequately demonstrate a specific knowledge of their particular

area of responsibility. Technical staff must also have a general knowledge of lab operations, test methods, QA/QC procedures and records management.

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

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

17.2 Education and Experience Requirements for Technical Personnel

The laboratory makes every effort to hire analytical staffs that possess a college degree (AA, BA, BS) in an applied science with some chemistry in the curriculum. Exceptions can be made based upon the individual's experience and ability to learn. Selection of qualified candidates for laboratory employment begins with documentation of minimum education, training, and experience prerequisites needed to perform the prescribed task. Minimum education and training requirements for TestAmerica employees are outlined in job descriptions and are generally summarized for analytical staff in the table below.

The laboratory maintains job descriptions for all personnel who manage, perform or verify work affecting the quality of the environmental testing the laboratory performs. Job Descriptions are located on the TestAmerica intranet site's Human Resources web-page.

As a general rule for analytical staff:

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

Specialty	Education	Experience
Technical Manager / Department Manager– **General**	Bachelors Degree in an applied science or engineering. The Technical Manager must also have 24 semester hours in chemistry An advanced (MS, PhD.) degree may substitute for one year of experience	And 2 years experience in environmental analysis of representative analytes for which they will oversee

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

17.3 Training

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

Orientation to the laboratory's policies and procedures, in-house method training, and employee attendance at outside training courses and conferences all contribute toward employee proficiency. Below are examples of various areas of required employee training:

Required Training	Time Frame	Employee Type
Environmental Health & Safety	Prior to lab work	All
Ethics – New Hires	1 week of hire	All
Ethics – Comprehensive	90 days of hire	All
Data Integrity	30 days of hire	Technical and PMs
Quality Assurance	90 days of hire	All
Ethics – Comprehensive Refresher	Annually	All
Initial Demonstration of Capability (DOC)	Prior to unsupervised method performance	Technical

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

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

- Each employee must have documentation in their training file that they have read, understood and agreed to follow the most recent version of the laboratory QA Manual and SOPs in their area of responsibility. This documentation is updated as SOPs are updated.

- Documentation from any training courses or workshops on specific equipment, analytical techniques or other relevant topics are maintained in their training file.
- Documentation of proficiency (refer to Section 19).
- An Ethics Agreement signed by each staff member (renewed each year) and evidence of annual ethics training.
- A Confidentiality Agreement signed by each staff member signed at the time of employment.
- Human Resources maintains documentation and attestation forms on employment status & records; benefit programs; timekeeping/payroll; and employee conduct (e.g., ethics). This information is maintained in the employee's secured personnel file.

Evidence of successful training could include such items as:

- Adequate documentation of training within operational areas, including one-on-one technical training for individual technologies, and particularly for people cross-trained.
- Analysts knowledge to refer to QA Manual for quality issues.
- Analysts following SOPs, i.e., practice matches SOPs.
- Analysts regularly communicate to supervisors and QA if SOPs need revision, rather than waiting for auditors to find problems.

Further details of the laboratory's training program are described in the Laboratory Training SOP BR-QA-011.

17.4 Data Integrity and Ethics Training Program

Establishing and maintaining a high ethical standard is an important element of a Quality System. Ethics and data integrity training is integral to the success of TestAmerica and is provided for each employee at TestAmerica. It is a formal part of the initial employee orientation within 1 week of hire followed by technical data integrity training within 30 days, comprehensive training within 90 days, and an annual refresher for all employees. Senior management at each facility performs the ethics training for their staff.

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

Violations of this Ethics Policy will not be tolerated. Employees who violate this policy will be subject to disciplinary actions up to and including termination. Criminal violations may also be referred to the Government for prosecution. In addition, such actions could jeopardize TestAmerica's ability to do work on Government contracts, and for that reason, TestAmerica has a Zero Tolerance approach to such violations.
Employees are trained as to the legal and environmental repercussions that result from data misrepresentation. Key topics covered in the presentation include:

- Organizational mission and its relationship to the critical need for honesty and full disclosure in all analytical reporting.

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

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

SECTION 18. ACCOMMODATIONS AND ENVIRONMENTAL CONDITIONS

18.1 Overview

The laboratory is a 22,000 ft^2 secure laboratory facility with controlled access and designed to accommodate an efficient workflow and to provide a safe and comfortable work environment for employees. All visitors sign in and are escorted by laboratory personnel. Access is controlled by various measures.

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

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

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

18.2 Environment

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

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

The laboratory provides for the effective monitoring, control and recording of environmental conditions that may affect the results of environmental tests as required by the relevant specifications, methods, and procedures.

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

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

18.3 Work Areas

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

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

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

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

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

18.4 Floor Plan

A floor plan can be found in Appendix 1.

18.5 Building Security

Building cards are distributed to employees as necessary.

Visitors to the laboratory sign in and out in a visitor's logbook. A visitor is defined as any person who visits the laboratory who is not an employee of the laboratory. In addition to signing into the laboratory, the Environmental, Health and Safety Manual contains requirements for visitors and vendors. There are specific safety forms that must be reviewed and signed. Visitors (with the exception of company employees) are escorted by laboratory personnel at all times, or the location of the visitor is noted in the visitor's logbook. Signs are posted in the laboratory designating employee only areas - "Authorized employees beyond this point".

SECTION 19. TEST METHODS AND METHOD VALIDATION

19.1 Overview

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

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

19.2 Standard Operating Procedures (SOPS)

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

- All SOPs contain a revision number, effective date, and appropriate approval signatures. Controlled copies are available to all staff.
- Procedures for writing an SOP are incorporated by reference to TestAmerica's Corporate SOP entitled 'Writing a Standard Operating Procedure', No. CW-Q-S-002.
- SOPs are reviewed at a minimum of every 2 years except for SOPs for Drinking Water and DoD SOPs which are reviewed annually. Whenever necessary, SOPs may be revised to ensure continuing suitability and compliance with applicable requirements.

19.3 Laboratory Methods Manual

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

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

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

19.4 Selection of Methods

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

19.4.1 Sources of Methods

Routine analytical services are performed using standard EPA-approved methodology. In some cases, modification of standard approved methods may be necessary to provide accurate analyses of particularly complex matrices. When the use of specific methods for sample analysis is mandated through project or regulatory requirements, only those methods shall be used.

When clients do not specify the method to be used or methods are not required, the methods used will be clearly validated and documented in an SOP and available to clients and/or the end user of the data.

The analytical methods used by the laboratory are those currently accepted and approved by the U. S. EPA and the state or territory from which the samples were collected. Reference methods include:

- *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 July 1, 1995, Appendix A to Part 136 - Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater (EPA 600 Series)*
- *Methods for Chemical Analysis of Water and Wastes, EPA 600 (4-79-020), 1983.*
- *Methods for the Determination of Inorganic Substances in Environmental Samples, EPA-600/R-93/100, August 1993.*
- *Methods for the Determination of Metals in Environmental Samples, EPA/600/4-91/010, June 1991. Supplement I: EPA-600/R-94/111, May 1994.*

- *Methods for the Determination of Organic Compounds in Drinking Water, EPA-600/4-88-039, December 1988, Revised, July 1991, Supplement I, EPA-600-4-90-020, July 1990, Supplement II, EPA-600/R-92-129, August 1992. Supplement III EPA/600/R-95/131 - August 1995 (EPA 500 Series) (EPA 500 Series methods)*
- *Technical Notes on Drinking Water Methods, EPA-600/R94-173, October 1994*
- *NIOSH Manual of Analytical Methods, 4th ed., August 1994.*
- *Standard Methods for the Examination of Water and Wastewater, 18th/19th /20th/ on-line 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*

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

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

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

19.4.2 Demonstration of Capability

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

A demonstration of capability (DOC) is performed whenever there is a change in instrument type (e.g., new instrumentation), method or personnel (e.g., analyst hasn't performed the test within the last 12 months).

The initial demonstration of capability must be thoroughly documented and approved by the Technical Manager and QA Manager prior to independently analyzing client samples. All associated documentation must be retained in accordance with the laboratories archiving procedures.

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

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

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

19.4.3 Initial Demonstration of Capability (IDOC) Procedures

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

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

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

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

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

19.4.3.6 Compare the information obtained above to the corresponding acceptance criteria for precision and accuracy in the test method (if applicable) or in laboratory generated acceptance

criteria (LCS or interim criteria) if there is no mandatory criteria established. If any one of the parameters do not meet the acceptance criteria, the performance is unacceptable for that parameter.

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

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

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

A certification statement (refer to Figure 19-1 as an example) shall be used to document the completion of each initial demonstration of capability. A copy of the certification is archived in the analyst's training folder.

19.5 Laboratory Developed Methods and Non-Standard Methods

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

19.6 Validation of Methods

Validation is the confirmation by examination and the provision of objective evidence that the particular requirements for a specific intended use are fulfilled.
All non-standard methods, laboratory designed/developed methods, standard methods used outside of their scope, and major modifications to published methods must be validated to confirm they are fit for their intended use. The validation will be as extensive as necessary to meet the needs of the given application. The results are documented with the validation procedure used and contain a statement as to the fitness for use.

19.6.1 Method Validation and Verification Activities for All New Methods

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

19.6.1.1 Determination of Method Selectivity

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

19.6.1.2 Determination of Method Sensitivity

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

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

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

19.6.1.4 Determination of Interferences

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

19.6.1.5 Determination of Range

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

19.6.1.6 Determination of Accuracy and Precision

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

19.6.1.7 Documentation of Method

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

19.6.1.8 Continued Demonstration of Method Performance

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

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

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

Refer to the laboratory SOP No. BR-QA-005 for details on the laboratory's MDL process, including detection limit procedures specific to the CLP SOWs for ISM and SOM.

19.8 Instrument Detection Limits (IDL)

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

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

If IDL is > than the MDL, it may be used as the reported MDL.

19.9 Verification of Detection and Reporting Limits

Once the MDL is determined, it must be verified on each instrument used for the given method. TestAmerica defines the DoD QSM Detection Limit (DL) as being equal to the MDL. TestAmerica also defines the DoD QSM Limit of Detection (LOD) as being equal to the lowest concentration standard that successfully verifies the MDL, also referred to as the MDLV standard. MDL and MDLV standards are extracted/digested and analyzed through the entire analytical process. The MDL and MDLV determinations do not apply to methods that are not readily spiked (e.g. pH, turbidity, etc.) or where the lab does not report to the MDL. If the MDLV standard is not successful, then the laboratory will redevelop their MDL or perform and pass two consecutive MDLVs at a higher concentration and set the LOD at the higher concentration. Initial and quarterly verification is required for all methods listed in the laboratory's DoD ELAP

Scope of Accreditation. Refer to the laboratory SOP BR-QA-005 Method Detection Limits (MDLs/DLs) for further details.

The laboratory quantitation limit is equivalent to the DoD Limit of Quantitation (LOQ), which is at a concentration equal to or greater than the lowest non-zero calibration standard. The DoD QSM requires the laboratory to perform an initial characterization of the bias and precision at the LOQ and quarterly LOQ verifications thereafter. If the quarterly verification results are not consistent with three-standard deviation confidence limits established initially, then the bias and precision will be reevaluated and clients contacted for any on-going projects. For DoD projects, TestAmerica makes a distinction between the Reporting Limit (RL) and the LOQ. The RL is a level at or above the LOQ that is used for specific project reporting purposes, as agreed to between the laboratory and the client. The RL cannot be lower than the LOQ concentration, but may be higher.

19.10 Retention Time Windows

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

19.11 Evaluation of Selectivity

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

19.12 Estimation of Uncertainty of Measurement

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

19.12.2 Uncertainty is not error. Error is a single value, the difference between the true result and the measured result. On environmental samples, the true result is never known. The measurement is the sum of the unknown true value and the unknown error. Unknown error is a combination of systematic error, or bias, and random error. Bias varies predictably, constantly,

and independently from the number of measurements. Random error is unpredictable, assumed to be Gaussian in distribution, and reducible by increasing the number of measurements.

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

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

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

19.13 Sample Reanalysis Guidelines

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

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

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

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

19.14 Control of Data

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

19.14.1 Computer and Electronic Data Related Requirements

The three basic objectives of our computer security procedures and policies are shown below. More detail is outlined in corporate IT procedure and policies. The laboratory is currently running TALS which is a custom in-house developed LIMS system has been highly customized to meet the needs of the laboratory. It is referred to as LIMS for the remainder of this section. The LIMS utilizes an SQL database which is an industry standard relational database platform. It is referred to as Database for the remainder of this section.

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

- LIMS Database Integrity is achieved through data input validation, internal user controls, and data change requirements.
- Spreadsheets and other software developed in-house must be verified with documentation through hand calculations prior to use. Cells containing calculations must be lock-protected and controlled.
- Instrument hardware and software adjustments are safeguarded through maintenance logs, audit trails and controlled access.

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

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

19.14.2 Data Reduction

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

Manual integration of peaks will be documented and reviewed and the raw data will be flagged in accordance with the TestAmerica Corporate SOP No. CA-Q-S-002, *Acceptable Manual Integration Practices* and laboratory SOP BR-QA-006.

Analytical results are reduced to appropriate concentration units specified by the analytical method, taking into account factors such as dilution, sample weight or volume, etc. Blank correction will be applied only when required by the method or per manufacturer's indication; otherwise, it

should not be performed. Calculations are independently verified by appropriate laboratory staff. Calculations and data reduction steps for various methods are summarized in the respective analytical SOPs or program requirements.

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

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

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

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

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

19.14.3 Logbook / Worksheet Use Guidelines

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

- Corrections are made following the procedures outlined in Section 12.
- Logbooks are controlled by the QA department. A record is maintained of all logbooks in the lab.
- Unused portions of pages must be "Z"'d out, signed and dated.

- Worksheets are created with the approval of the QA Manager at the facility. The QA department controls all worksheets following the procedures in Section 6.

19.14.4 Review / Verification Procedures

Review procedures are out lined in several SOP BR-QA-019 to ensure that reported data are free from calculation and transcription errors, that QC parameters have been reviewed and evaluated before data is reported. The laboratory also has an SOP for manual integration, BR-QA-005. The general review concepts are discussed below, more specific information can be found in the SOPs.

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

19.14.4.2 The next level of data review occurs with the Analysts. As results are generated, analysts review their work to ensure that the results generated meet QC requirements and relevant 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, initial and continuing calibration results, laboratory control samples, sample data, qualifiers and spike information are evaluated. Where calibration is not required on a daily basis, secondary review of the initial calibration results may be conducted at the time of calibration. Approximately 15% of all sample data from manual methods and from automated methods, all GC/MS spectra and all manual integrations are reviewed. Manual integrations are also electronically reviewed utilizing auditing software to help ensure compliance to ethics and manual integration policies. Issues that deem further review include the following:

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

19.14.4.3 Unacceptable analytical results may require reanalysis of the samples. Any problems are brought to the attention of the Department Manager, Project Manager,

QA Manager or Technical Director, as necessary. Corrective action is initiated whenever necessary.

19.14.4.4 The results are then entered or directly transferred into the computer database and a report is prepared for the client.

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

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

19.14.5 Manual Integrations

Computerized data systems provide the analyst with the ability to re-integrate raw instrument data in order to optimize the interpretation of the data. Though manual integration of data is an invaluable tool for resolving variations in instrument performance and some sample matrix problems, when used improperly, this technique would make unacceptable data appear to meet quality control acceptance limits. Improper re-integrations lead to legally indefensible data, a poor reputation, or possible laboratory decertification. Because guidelines for re-integration of data are not provided in the methods and most methods were written prior to widespread implementation of computerized data systems, the laboratory trains all analytical staff on proper manual integration techniques using TestAmerica's Corporate SOP (CA-Q-S-002) as the guideline for our internal SOP BR-QA-006.

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

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

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

19.14.5.4 All manual integrations receive a second level review. Manual integrations must be indicated on an expanded scale “after” chromatograms such that the integration performed can be easily evaluated during data review. Expanded scale “before” chromatograms are also required for all manual integrations on QC parameters (calibrations, calibration verifications, laboratory control samples, internal standards, surrogates, etc.) unless the laboratory has another documented corporate approved procedure in place that can demonstrate an active process for detection and deterrence of improper integration practices.

Figure 19-1. Example - Demonstration of Capability Documentation

Analyst Demonstration of Capability

TestAmerica Burlington

Michelle Tam

10/12/2011

Preparation Method(s):	3010A
Analytical Method(s):	6020
Matrix:	Water
Method Description:	Metals (ICP/MS)
Preparation SOP No:	BR-ME-009R16
Analytical SOP No:	BR-ME-003R7

We, the undersigned, CERTIFY that:

1. The analyst identified above, using the cited test method with the specifications in the cited SOP, which is in use at this facility for the analysis of samples under the laboratory's Quality Assurance Plan, has completed the Demonstration of Capability(DOC).
2. The test method(s) was performed by the analyst identified on this certificate.
3. A copy of test method(s) and laboratory SOPs are available for all personnel on-site. **These documents have been reviewed by the analyst as part of this DOC.**
4. The data associated with the 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. The associated information is organized and available for review.

Michelle Tam — M. Chadkin Tam — 10/12/11
Analyst **Signature** **Date**

Bruce Stearns — — 10/12/11
Technical Director **Signature** **Date**

Kirstin Daigle — Kirstin Daigle — 10/13/11
Quality Assurance Officer **Signature** **Date**

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SECTION 20. EQUIPMENT and CALIBRATIONS

20.1 Overview

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

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

20.2 Preventive Maintenance

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

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

Table 20-2 lists examples of scheduled routine maintenance. It is the responsibility of each Department Manager to ensure that instrument maintenance logs are kept for all equipment in his/her department. Preventative maintenance procedures may be / are also outlined in analytical SOPs or instrument manuals.

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

- Documentation must include all major maintenance activities such as contracted preventive maintenance and service and in-house activities such as the replacement of electrical components, lamps, tubing, valves, columns, detectors, cleaning and adjustments.
- Each entry in the instrument log includes the Analyst's initials, the date, a detailed description of the problem (or maintenance needed/scheduled), a detailed explanation of the solution or maintenance performed, and a verification that the equipment is functioning properly (state what was used to determine a return to control. e.g. CCV run on *'date'* was acceptable, or instrument recalibrated on 'date' with acceptable verification, etc.) must also be documented in the instrument records.

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

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

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

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

20.3 Support Equipment

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

20.3.1 Weights and Balances

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

Each balance is checked prior to initial serviceable use with at least two certified ASTM type 1 weights spanning its range of use (weights that have been calibrated to ASTM type 1 weights may also be used for daily verification). ASTM type 1 weights used only for calibration of other weights (and no other purpose) are inspected for corrosion, damage or nicks at least annually and if no damage is observed, they are calibrated at least every 5 years by an outside calibration laboratory. Any weights (including ASTM Type 1) used for daily balance checks or other purposes are recalibrated/recertified annually to NIST standards (this may be done internally if laboratory maintains “calibration only” ASTM type 1 weights).
All balances are serviced annually by a qualified service representative, who supplies the laboratory with a certificate that identifies traceability of the calibration to the NIST standards.

All of this information is recorded in logs, and the recalibration/recertification certificates are kept on file.

20.3.2 pH, Conductivity, and Turbidity Meters

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

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

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

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

20.3.3 Thermometers

All thermometers are calibrated on an annual basis with a NIST-traceable thermometer. IR thermometers, digital probes and thermocouples are calibrated quarterly.

The mercury/digital NIST thermometer is recalibrated every five years (unless thermometer has been exposed to temperature extremes or apparent separation of internal liquid) by an approved outside service and the provided certificate of traceability is kept on file. The NIST thermometer(s) have increments of 1 degree (0.5 degree or less increments are required for drinking water microbiological laboratories), and have ranges applicable to method and certification requirements. The NIST traceable thermometer is used for no other purpose than to calibrate other thermometers.

All of this information is documented in logbooks. Monitoring method-specific temperatures, including incubators, heating blocks, water baths, and ovens, is documented in support equipment logbooks.

20.3.4 Refrigerators/Freezer Units, Waterbaths, Ovens and Incubators

The temperatures of all refrigerator units and freezers used for sample and standard storage are monitored each day.

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

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

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

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

All of this information is documented in logbooks designated for this purpose.

20.3.5 Autopipettors, Dilutors, and Syringes

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

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

Micro-syringes are purchased from Hamilton Company. Each syringe is traceable to NIST. The laboratory keeps on file an "Accuracy and Precision Statement of Conformance" from Hamilton attesting established accuracy.

20.4 Instrument Calibrations

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

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

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

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

Note: Instruments are calibrated during initial instrument set up and as needed after that based on the instrument performance checks as specified in each test method. If instrument performance checks continue to indicate the calibration is valid over a time-frame that exceeds one calendar year; the company requires that the instrument be recalibrated at least annually.

Note: The following sections describe general requirements for instrument calibration and provide guidance for when the method does not specify a procedure or the procedure in the method is vague. These requirements may not be applicable to all test methods. The calibration procedure used for each test method is always specified in the laboratory's SOP for the test method.

20.4.1 Calibration Standards

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

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

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

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

All initial calibrations are verified with a standard obtained from a second source and traceable to a national standard, when available (or vendor certified different lot if a second source is not available). For unique situations, such as air analysis where no other source or lot is available, a standard made by a different analyst at a different time or a different preparation would be considered a second source. This verification occurs immediately after the calibration curve has been analyzed, and before the analysis of any samples.

20.4.1.1 Calibration Verification

The calibration relationship established during the initial calibration must be verified initially and at least daily as specified in the laboratory method SOPs in accordance with the referenced analytical methods and in the 2009 TNI Standard. The process of calibration verification applies to both external standard and internal standard calibration techniques, as well as to linear and non-linear calibration models. Initial calibration verification is with a standard source secondary (second source standard) to the calibration standards, but continuing calibration verifications may use the same source standards as the calibration curve.

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

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

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

Note: If an internal standard calibration is being used (basically GCMS) then bracketing standards are not required, only daily verifications are needed. The results from these verification standards must meet the calibration verification criteria and the retention time criteria (if applicable).

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

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

Note: If an internal standard calibration is being used (basically GCMS) then bracketing standards are not required, only daily verifications are needed. The results from these verification standards must meet the calibration verification criteria and the retention time criteria (if applicable).

If the results of a CCV are outside the established acceptance criteria and analysis of a second consecutive (and immediate) CCV fails to produce results within acceptance criteria, corrective action shall be performed. Once corrective actions have been completed & documented, the laboratory shall demonstrate acceptable instrument / method performance by analyzing two consecutive CCVs, or a new initial instrument calibration shall be performed.

Sample analyses and reporting of data may not occur or continue until the analytical system is calibrated or calibration verified. However, data associated with an unacceptable calibration verification may be fully useable based upon discussion and approval of the client:

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

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

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

20.4.1.2 Verification of Linear and Non-Linear Calibrations

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

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

- When the acceptance criteria for the calibration verification are exceeded high, i.e., high bias, and there are associated samples that are non-detects, then those non-detects may be reported. Otherwise, the samples affected by the unacceptable calibration verification shall be reanalyzed after a new calibration curve has been established, evaluated and accepted.

- When the acceptance criteria for the calibration verification are exceeded low, i.e., low bias, those sample results may be reported if they exceed a maximum regulatory limit/decision level. Otherwise, the samples affected by the unacceptable verification shall be reanalyzed after a new calibration curve has been established, evaluated and accepted. Alternatively, a reporting limit standard may be analyzed to demonstrate that the laboratory can still support non-detects at their reporting limit.

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

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

Note: If the TIC compound is not part of the client target analyte list but is calibrated by the laboratory and is both qualitatively and/or quantitatively identifiable, it should not be reported as a TIC. If the compound is reported on the same form as true TICs, it should be qualified and/or narrated that the reported compound is qualitatively and quantitatively (if verification in control) reported compared to a known standard that is in control (where applicable).

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

20.6 GC/MS Tuning

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

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

Table 20-1. Example: Instrumentation List

Instrument Type	Manufacturer	Model Number	Serial Number	Year Put into Service	Condition When Received
Analytical Balance	Mettler	AT200	113081164	UNKNOWN	UNKNOWN
Analytical Balance	Mettler	ML204	1123452701	2010	NEW
Analytical Balance	Metler	ML204	1123452699	2010	NEW
Analytical Balance	Sartorius	XM1000P	40090006	UNKNOWN	UNKNOWN
Automated Distillation Apparatus	Westco	Easy Dist	1090	2002	NEW
Automated Distillation Apparatus	Westco	Easy Dist	1091	2002	NEW
COD	HACH	45600-00	11000022452	UNKNOWN	UNKNOWN
Conductivity Meter	Oaklon	CON110	35607-85	2001	
CVAA	Leeman (CV3)	HydraAA112-0064-1	2031	2003	NEW
CVAA	Leeman (CV4)	HydraAA112-0064-1	8015	2008	NEW
GC/ECD/ECD	Agilent (7424)	6890N	US10332093	2003	NEW
GC/ECD/ECD	Agilent (3283)	6890N	US10805001	2008	NEW
GC/ECD/ECD	Hewlett-Packard (2618)Screen	5890II	3203A41055	1987	UNKNOWN
GC/ECD/ECD	Agilent (7227)	6890N	CN10602095	2006	NEW
GC/ECD/ECD	Agilent (0825)	6890N	US10202136	2002	NEW
GC/ECD/ECD	Agilent (1031)	7890A	CN10301031	2010	NEW
GC/ECD/ECD	Agilent (5253)	6890N	CN10723008	2007	NEW
GC/ECD/ECD	Agilent (0911)	6890N	US10230082	2002	NEW
GC/ECD/ECD	Agilent (5005)	6890N	CN10615005	2009	USED
GC/FID/ECD	Hewlett-Packard (Screen)	5890	GC 2415A01109	UNKNOWN	UNKNOWN
GC/FID/FID	Hewlett-Packard (3012)	5890II	3235A45259	1984	UNKNOWN
GC/FID/FID/TCD	Varian (CP3800)	CP-3800	S/N 10328	2003	NEW
GC/FID/TCD	Varian (2866)	VR-3600	2866	1998	UNKNOWN
GC/FPD/FPD	Hewlett-Packard (2860)	5890II	2950A27078	1990	UNKNOWN
GC/MS	Hewlett-Packard (N)	5890II / 5971	3203A40979	1998	NEW
GC/MS	Hewlett Packard (V)	5890II / 5972	3336A61485	1998	NEW
GC/MS	Agilent (B)	6890N/ 5973	CN10317006	2003	NEW
GC/MS	Agilent (C)	6890N / 5973	CN10424016	UNKNOWN	NEW

GC/MS	Agilent (G)	6890N / 5973	CN10437065	UNKNOWN	USED
GC/MS	Agilent (E)	6890N / 5973	CN10453004	2005	NEW
GC/MS	Agilent (F)	6890N/ 5973	CN10531065	2005	NEW
GC/MS	Agilent (S)	7890A/5975	CN10211095	2010	NEW
GC/MS	Agilent (T)	7890A/5975	CN10211037	2010	USED
GC/MS	Hewlett-Packard (L)	5890II / 5971	3203A40982	1998	NEW
GC/MS	Hewlett-Packard (M)	5890II / 5971	3203A40980	1998	NEW
GC/MS	Agilent (D)	6890N / 5973	CN10439015	2004	NEW
GC/MS	Hewlett-Packard (P)	5890II / 5971	3203A40985	1992	USED
GC/MS	Hewlett-Packard (Q)	5890II / 5971	3203A40983	1992	NEW
GC/MS	Hewlett-Packard (R)	5890II / 5971	3203A40984	1992	NEW
GC/MS	Hewlett-Packard (U)	5890II Plus/ 5972	3336A61535	1997	NEW
GC/MS	Agilent (H)	6890N / 5975	CN10608102	2006	NEW
GC/MS	Agilent (Z)	6890A/ 5973	US00036343	2000	NEW
GC/MS	Agilent (J)	6890N / 5973	CN10430052	2009	USED
GC/FID	Hewlett-Packard (6453-K) Screen	5890 II	3203A41768	UNKNOWN	UNKNOWN
GPC	J2 Scientific (I)	Autoinject 110	02D-1030-2.1	2002	NEW
GPC	J2 Scientific (H)	Autoinject 110	02D-1031-2.1	2001	NEW
GPC	J2 Scientific (J)	AccuPrep	03G1076-3.0	2003	NEW
HPLC/UV	Dionex (1488)	P680	1680407	1991	UNKNOWN
HPLC/UV/PDA	Waters (1208)	600	60004790RP	1988	NEW
Hydrogen Generator	Parker Hannafin	H2-800	h2-800081C	2006	NEW
Hydrogen Generator	Parker Hannafin	H2-800	h2-800099C	2006	NEW
ICP-MS	Thermo Elemental (2)	X7	X0288	2003	NEW
ICP-OES	Thermo Electron Corp (7)	iCAP 6000	ICP20063302	2006	NEW
LC/MS/MS	Waters (1111)	Acquity/Quattro micro	QAA929	2005	NEW
LC	Waters (3062)	616	MX5NM6829M	UNKNOWN	NEW
pH Meter	Denver Instruments	UB-5	UB503B365	UNKNOWN	UNKNOWN
Soxtherm	Gerhardt (SOXA)	SE3AS306A	4012396	UNKNOWN	UNKNOWN
Soxtherm	Gerhardt (SOXB)	SE3AS306A	4022047	UNKNOWN	UNKNOWN
Soxtherm	Gerhardt (SOXC)	SE3AS306A	4022046	UNKNOWN	UNKNOWN
Soxtherm	Gerhardt (SOXD)	SE3AS306A	4022045	UNKNOWN	UNKNOWN

Soxtherm	Gerhardt (SOXE)	SE3AS306A	4022030	UNKNOWN	UNKNOWN
Soxtherm	Gerhardt (SOXF)	SE3AS306A	4012397	UNKNOWN	UNKNOWN
TKN Digestion System	Aim Lab	AIM600 Block	5048A23014	2011	NEW
TOC	Carlo Erba	NA 1500	220465	1991	UNKNOWN
TOC	Carlo Erba	EA1108	249146	1991	UNKNOWN
TOC	Costech	4010	231009973	2005	UNKNOWN
TOC	Shimadzu	TOC-V CPH	H5131480032AE	2011	NEW
Turbidimeter	HF Scientific	Micro 100	208463	2001	UNKNOWN
UV/VIS	Genesys	Spectronic 20	3SGEO38002	1999	UNKNOWN
UV/VIS	Genesys	Spectronic 20	3SGE165024	2002	UNKNOWN
UV/VIS	Lachat	Quick Chem 8000	A83000-2167	2000	UNKNOWN

Table 20-2. Example: Schedule of Routine Maintenance

Instrument	Procedure	Frequency
Leeman Mercury Analyzer	Check Peristaltic Pump tubing	As required
	Lubricate Autosampler rods	Monthly
	Clean Autosampler	Weekly
	Check and fill Rinse Vessel	As required
	Check and fill Stannous Chloride	As required
	Check Waste Vessel	Daily
	Empty Waste Vessel	As required
ICP	Check Peristaltic Pump tubing	As required
	Clean Torch	Daily
	Replace Torch	As required
	Check and fill Rinse Vessel	As required
	Check and fill IS Vessel	As required
	Fill Standards Cup	Daily
	Check Waste Vessel	Daily
	Empty Waste Vessel	As required
	Check and clean Cones	As required
	Perform Auto Peak Adjustment	As required
ICP MS	Check Peristaltic Pump tubing	As required
	Clean Torch	As required
	Check and fill Rinse Vessel	As required
	Check and fill IS Vessel	As required
	Fill standards cup	Daily
	Check Waste Vessel	Daily
	Empty Waste Vessel	As required
	Check and clean Cones	As required
UV-Vis Spectrophotometer	Clean ambient flow cell	As required
	Wavelength verification check	As required
	Clean Cuvette with Cuvette Cleaning Solution	As required
Hewlett Packard GC/MS (VOA)	Clean Injection Port and Liner	As required
	Change Septa	As required
	Cut 2-3 inches from GC Column	As required
	Fill Autosampler rinse vials	As required
	Clean Purge and Trap mount and purge vessel	As required
	Check Purge Flow	As required
Hewlett Packard GC/MS (SVOA)	Clean Injection Port and Liner	Daily
	Change Septa	Daily
	Replace or clip Guard Column	Daily
	Replace or clip Analytical Column	Daily
	Fill Autosampler rinse vials	Daily
Hewlett Packard GC/MS (Air)	Check GC / Entech Column Interface	As required
	Check Nitrogen Tank Volume	As required
	Check Nitrogen Valves Software and Valves	As required
	Cut 2-3 inches from GC Column	As required
Gas Chromatograph	Replace Septa	As required
	Clean and replace Injection Port Liner	As required
	Replace or clip Guard Column	As required
	Replace or clip Analytical Column	As required
	Bake, Re-foil, Refurbish Detector	As required

Instrument	Procedure	Frequency
Zero Air Generator	Change pre-filter cartridge Replace catalyst module Check Indicator Beads in Moisture Filters Bake and Refill Mol Sieve Dry Rite Beads	Annually Indicator Light Blinks Daily As required
Hydrogen Generator	Fill Water Reservoir Replace Water in Water Reservoir Replace Ionic Bags in Water Reservoir	Daily Semi-Annually Semi-Annually
HPLC	Change Transfer Lines Replace Guard Column Replace Analytical Column Replace or clean Pump Head Check Valves Change Plunger Seals Change Suppressor Change Eluent Generator Cartridge and CR-ATC	As required As required As required As required As required As required As required
LC/MS/MS	Replace Guard Column Replace Analytical Column Replace or clean Pump Head Check Valves Change Plunger Seals Change In Line Filter Clean or Change Sample Cone Clean Source	As required As required As required As required As required As required As required
Balances	Class “1” traceable weight check Clean pan and check if level Field service	Daily, when used Daily Annually
Latchat	Change Tubing Replace Bulb	As required As required
Conductivity Meter	Calibrate	Daily
Turbidimeter	Calibrate Check light bulb	As required Daily, when used
Drying Ovens	Temperature monitoring Temperature adjustments	Daily As required
Refrigerators/ Freezers	Temperature monitoring Temperature adjustment Defrosting/cleaning	Daily As required As required
pH/Specific Ion Meter	Calibrate Clean electrode	Daily As required
Centrifuge	Check brushes and bearings	Every 6 months or as needed
Water baths	Temperature monitoring Water replaced	Daily, when used Monthly or as needed

SECTION 21. MEASUREMENT TRACEABILITY

21.1 Overview

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

21.2 NIST-Traceable Weights and Thermometers

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

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

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.

21.3 Reference Standards / Materials

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

All reference, primary and working standards/materials, whether commercially purchased or laboratory prepared, must be checked regularly to ensure that the variability of the standard or material from the ‘true’ value does not exceed method requirements. The accuracy of calibration

standards is checked by comparison with a standard from a second source. In cases where a second standard manufacturer is not available, a vendor certified different lot is acceptable for use as a second source. For unique situations, such as air analysis where no other source or lot is available, a standard made by a different analyst would be considered a second source. The appropriate Quality Control (QC) criteria for specific standards are defined in laboratory SOPs. In most cases, the analysis of an Initial Calibration Verification (ICV) or LCS (where there is no sample preparation) is used as the second source confirmation. These checks are generally performed as an integral part of the analysis method (e.g. calibration checks, laboratory control samples).

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

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

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

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

All manufacturer or vendor supplied Certificate of Analysis or Purity must be retained, stored appropriately, and readily available for use and inspection. These records are maintained **in each lab section.** Records must be kept of the date of receipt and date of expiration of standards, reagents and reference materials. In addition, records of preparation of laboratory standards, reagents, and reference materials must be retained, stored appropriately, and be readily available for use and inspection. For detailed information on documentation and labeling, please refer to method specific SOPs.

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

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

- Standard ID
- Description of Standard
- Preparer's name

- Final volume
- Solvent type and lot number
- Preparation Date
- Expiration Date
- Parent standard ID (if applicable)
- Parent Standard Analyte Concentration (if applicable)
- Parent Standard Amount used (if applicable)
- Component Analytes
- Final concentration of each analyte
- Comment box (text field)

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

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

- Expiration Date (include prep date for reagents)
- Standard ID
- Special Health/Safety warnings if applicable

Records must also be maintained of the date of receipt for commercially purchased items or date of preparation for laboratory prepared items. Special Health/Safety warnings must also be available to the analyst. This information is maintained on the company's intranet and in test method SOPs.

21.4.3 In addition, the following information may be helpful:

- Date opened (for multi-use containers, if applicable)
- Description of standard (if different from manufacturer's label or if standard was prepared in the laboratory)
- Concentration (if applicable)
- Initials of analyst preparing standard or opening container

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

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

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

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

SECTION 22. SAMPLING

22.1 Overview

The laboratory does not provide sampling services. The laboratory's responsibility in the sample collection process lies in supplying the sampler with 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

22.2 Sampling Containers

The laboratory offers clean sampling containers for use by clients. These containers are obtained from reputable container manufacturers and meet EPA specifications as required. Any certificates of cleanliness that are provided by the supplier are maintained at the laboratory.

22.2.1 Preservatives

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

- Hydrochloric Acid – Reagent ACS (Certified VOA Free) or equivalent
- Methanol – Purge and Trap grade
- Nitric Acid – Instra-Analyzed or equivalent
- Sodium Bisulfate – ACS Grade or equivalent
- Sodium Hydroxide – Instra-Analyzed or equivalent
- Sulfuric Acid – Instra-Analyzed or equivalent
- Sodium Thiosulfate – ACS Grade or equivalent

22.3 Definition of Holding Time

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

22.4 Sampling Containers, Preservation Requirements, Holding Times

The preservation and holding time criteria specified in the laboratory SOPs are derived from the source documents for the methods. If method required holding times or preservation requirements are not met, the reports will be qualified using a flag, footnote or case narrative. As soon as possible or "ASAP" is an EPA designation for tests for which rapid analysis is advised, but for which neither EPA nor the laboratory have a basis for a holding time.

22.5 Sample Aliquots / Subsampling

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

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

Guidelines on taking sample aliquots & subsampling are located in test method SOPs.

SECTION 23. HANDLING OF SAMPLES

Sample management procedures at the laboratory ensure that sample integrity and custody are maintained and documented from sampling/receipt through disposal.

23.1 Chain of Custody (COC)

The COC form is the written documented history of any sample and is initiated when bottles are sent to the field, or at the time of sampling. This form is completed by the sampling personnel and accompanies the samples to the laboratory where it is received and stored under the laboratory's custody. The purpose of the COC form is to provide a legal written record of the handling of samples from the time of collection until they are received at the laboratory. It also serves as the primary written request for analyses from the client to the laboratory. The COC form acts as a purchase order for analytical services when no other contractual agreement is in effect. An example of a COC form may be found in Figure 23-1.

23.1.1 Field Documentation

The information the sampler needs to provide at the time of sampling on the container label is:

- Sample identification
- Date and time
- Preservative

During the sampling process, the COC form is completed and must be legible (see Figure 23-1). This form should include information such as:

- Client name, address, phone number and fax number (if available)
- Project name and/or number
- The sample identification

- Date, time and location of sampling
- Sample collectors name
- The matrix description
- The container description
- The total number of each type of container
- Preservatives used
- Analysis requested
- Requested turnaround time (TAT)
- Any special instructions
- Purchase Order number or billing information (e.g. quote number) if available
- The date and time that each person received or relinquished the sample(s), including their signed name.

When the sampling personnel deliver the samples directly to TestAmerica personnel, the samples are stored in a cooler with ice, as applicable, and remain solely in the possession of the client's field technician until the samples are delivered to the laboratory personnel. The sample collector must assure that each container is in his/her physical possession or in his/her view at all times, or stored in such a place and manner to preclude tampering. The field technician relinquishes the samples in writing on the COC form to the sample control personnel at the laboratory or to a TestAmerica courier. When sampling personnel deliver the samples through a common carrier (Fed-Ex, UPS), the CoC relinquished date/time is completed by the field personnel and samples are released to the carrier. Samples are only considered to be received by lab when personnel at the fixed laboratory facility have physical contact with the samples.

Note: Independent couriers are not required to sign the COC form. The COC is usually kept in the sealed sample cooler. The receipt from the courier is stored in log-in by date; it lists all receipts each date.

23.1.2 Legal / Evidentiary Chain-of-Custody

If the client requests legal COC sample management personnel will initiate an internal COC for laboratory use by analysts and a sample disposal record.

23.2 Sample Receipt

Samples are received at the laboratory by designated sample receiving personnel and a unique laboratory project identification number is assigned. Each sample container shall be assigned a unique sample identification number that is cross-referenced to the client identification number such that traceability of test samples is unambiguous and documented. Each sample container is affixed with a durable sample identification label. Sample acceptance, receipt, tracking and storage procedures are summarized in the following sections.

23.2.1 Laboratory Receipt

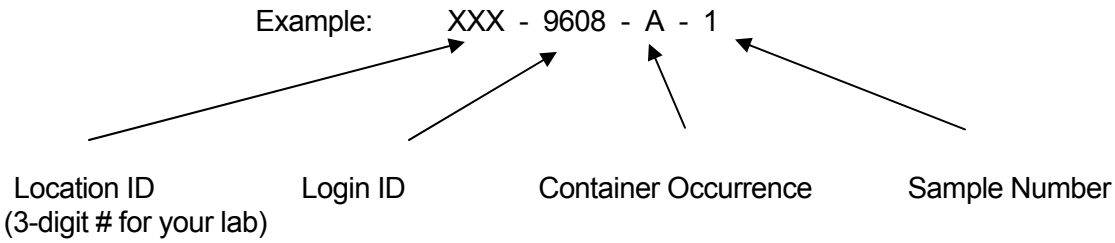
When samples arrive at the laboratory, sample receiving personnel inspect the coolers and samples. The integrity of each sample must be determined by comparing sample labels or tags with the COC and by visual checks of the container for possible damage. Any non-conformance,

irregularity, or compromised sample receipt must be documented*]* and brought to the immediate attention of the client. The COC, shipping documents, documentation of any non-conformance, irregularity, or compromised sample receipt, record of client contact, and resulting instructions become part of the project record.

23.2.1.1 Unique Sample Identification

All samples that are processed through the laboratory receive a unique sample identification to ensure that there can be no confusion regarding the identity of such samples at anytime. This system includes identification for all samples, subsamples and subsequent extracts and/or digestates.

The laboratory assigns a unique identification (e.g., Sample ID) code to each sample container received at the laboratory. This Primary ID is made up of the following information (consisting of 4 components):



The above example states that TestAmerica <location> Laboratory (Location XXX). Login ID is 9608 (unique to a particular client/job occurrence). The container code indicates it is the first container ("A") of Sample #1.

If the primary container goes through a prep step that creates a "new" container, then the new container is considered secondary and gets another ID. An example of this being a client sample in a 1-Liter amber bottle is sent through a Liquid/Liquid Extraction and an extraction vial is created from this step. The vial would be a SECONDARY container. The secondary ID has 5 components.

Example: ~~XXX - 9608 -~~ A - 1 - **A**

Secondary Container Occurrence

Example: 220-9608-A-1-A, would indicate the PRIMARY container listed above that went through a step that created the 1st occurrence of a Secondary container.

With this system, a client sample can literally be tracked throughout the laboratory in every step from receipt to disposal.

23.3 Sample Acceptance Policy

The laboratory has a written sample acceptance policy (Figure 23-2) that clearly outlines the circumstances under which samples shall be accepted or rejected. These include:

- a complete COC;
- samples must be properly labeled;
- proper sample containers with adequate volume for the analysis (Sampling Guide) and necessary QC;
- samples must be preserved according to the requirements of the requested analytical method (Sampling Guide);
- sample holding times must be adhered to (Sampling Guide);
- the project manager will be notified if any sample is received in damaged condition.

Data from samples which do not meet these criteria are flagged and the nature of the variation from policy is defined. A copy of the sample acceptance policy is provided to each client prior to shipment of samples.

23.3.1 After inspecting the samples, the sample receiving personnel sign and date the COC form, make any necessary notes of the samples' conditions and store them in appropriate refrigerators or storage locations.

23.3.2 Any deviations from these checks that question the suitability of the sample for analysis, or incomplete documentation as to the tests required will be resolved by consultation with the client. If the sample acceptance policy criteria are not met, the laboratory shall either:

- Retain all correspondence and/or records of communications with the client regarding the disposition of rejected samples, or

- Fully document any decision to proceed with sample analysis that does not meet sample acceptance criteria.

Once sample acceptance is verified, the samples are logged into the LIMS according to laboratory SOP BR-SM-001.

23.4 Sample Storage

In order to avoid deterioration, contamination or damage to a sample during storage and handling, from the time of receipt until all analyses are complete, samples are stored in refrigerators, freezers or protected locations suitable for the sample matrix. In addition, samples to be analyzed for volatile organic parameters are stored in separate refrigerators designated for volatile organic parameters only. Samples are never to be stored with reagents, standards or materials that may create contamination.

To ensure the integrity of the samples during storage, refrigerator blanks are maintained in the volatile sample refrigerators and analyzed weekly.

Analysts and technicians retrieve the sample container allocated to their analysis from the designated refrigerator and place them on carts, analyze the sample, and return the remaining sample or empty container to the refrigerator from which it originally came. All unused portions of samples, including empty sample containers, are returned to the secure sample control area until disposal.

Access to the laboratory is controlled such that sample storage need not be locked at all times unless a project specifically demands it. Samples are accessible to laboratory personnel only. Visitors to the laboratory are prohibited from entering the refrigerator and laboratory areas unless accompanied by an employee of TestAmerica.

23.5 Hazardous Samples and Foreign Soils

To minimize exposure to personnel and to avoid potential accidents, hazardous and foreign soil samples are stored in an isolated area designated for hazardous waste only. For any sample that is known to be hazardous at the time of receipt or, if after completion of analysis the result exceeds the acceptable regulatory levels, a Hazardous Sample Notice must be completed by the analyst. This form may be completed by Sample Control, Project Managers, or analysts and must be attached to the report. The sample itself is clearly marked with a red stamp, stamped on the sample label reading “HAZARDOUS” or “FOREIGN SOIL” and placed in a colored and/or marked bag to easily identify the sample. The date, log number, lab sample number, and the result or brief description of the hazard are all written on the Hazardous & Foreign Soil Sample Notice. A copy of the form must be included with the original COC and Work Order and the original must be given to the Sample Control Custodian. Analysts will notify Sample Control of any sample determined to be hazardous after completion of analysis by completing a Hazardous Sample Notice. All hazardous samples are either returned to the client or disposed of appropriately through a hazardous waste disposal firm that lab-packs all hazardous samples and removes them from the laboratory.

23.6 Sample Shipping

In the event that the laboratory needs to ship samples, the samples are placed in a cooler with enough ice to ensure the samples remain just above freezing and at or below 6.0°C during transit. The samples are carefully surrounded by packing material to avoid breakage (yet maintain appropriate temperature). A trip blank is enclosed for those samples requiring water/solid volatile organic analyses (see Note). The chain-of-custody form is signed by the sample control technician and attached to the shipping paperwork. Samples are generally shipped overnight express or hand-delivered by a TestAmerica courier to maintain sample integrity. All personnel involved with shipping and receiving samples must be trained to maintain the proper chain-of-custody documentation and to keep the samples intact and on ice. The Environmental, Health and Safety Manual contains additional shipping requirements.

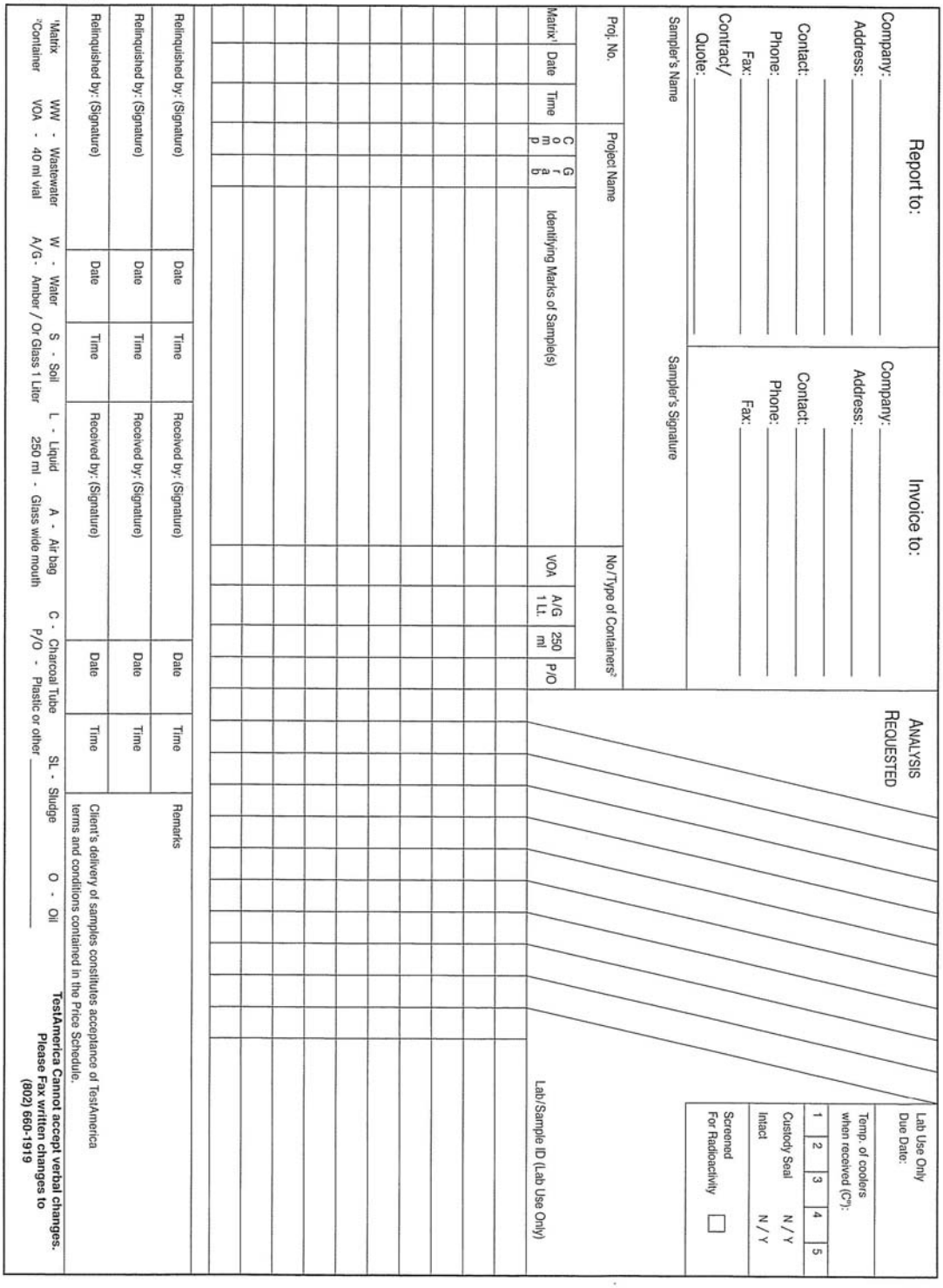
Note: If a client does not request trip blank analysis on the COC or other paperwork, the laboratory will not analyze the trip blanks that were supplied. However, in the interest of good client service, the laboratory will advise the client at the time of sample receipt that it was noted that they did not request analysis of the trip blank; and that the laboratory is providing the notification to verify that they are not inadvertently omitting a key part of regulatory compliance testing.

23.7 Sample Disposal

Samples should be retained for a minimum of 30 days after the project report is sent, however, provisions may be made for earlier disposal of samples once the holding time is exceeded. Some samples are required to be held for longer periods based on regulatory or client requirements (e.g., 60 days after project report is sent). The laboratory must follow the longer sample retention requirements where required by regulation or client agreement. Several possibilities for sample disposal exist: the sample may be consumed completely during analysis, the sample may be returned to the customer or location of sampling for disposal, or the sample may be disposed of in accordance with the laboratory's waste disposal procedures (SOP: BR-EH-001) All procedures in the laboratory Environmental, Health and Safety Manual are followed during disposal. Samples are normally maintained in the laboratory no longer than two months from receipt unless otherwise requested. Unused portions of samples found or suspected to be hazardous according to state or federal guidelines may be returned to the client upon completion of the analytical work.

If a sample is part of a known litigation, the affected legal authority, sample data user, and/or submitter of the sample must participate in the decision about the sample's disposal. All documentation and correspondence concerning the disposal decision process must be kept on file. Pertinent information includes the date of disposal, nature of disposal (such as sample depletion, hazardous waste facility disposal, return to client), names of individuals who conducted the arrangements and physically completed the task. The laboratory will remove or deface sample labels prior to disposal unless this is accomplished through the disposal method (e.g., samples are incinerated). A Waste Disposal Record should be completed.

Figure 23-1. Example: Chain of Custody (COC)



TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Burlington
30 Community Drive, Suite 11
South Burlington, VT 05403 Tel: 802 660 1990

CHAIN OF CUSTODY RECORD

TAL-8234(1007)

Report to: Company: Address: Contact: Phone: Fax: Contract/ Quote: Sampler's Name

Invoice to: Company: Address: Contact: Phone: Fax: Sampler's Signature

Analysis Requested

Lab Use Only Due Date:

Temp. of coolers when received (C°): 1 2 3 4 5

Custody Seal N / Y
Intact N / Y

Screened For Radioactivity ☐

Proj. No. Project Name

No./Type of Containers²

Matrix¹	Date	Time	Comp	Grab	Identifying Marks of Sample(s)	VOA	A/G 1 Lt.	250 ml	P/O	Lab/Sample ID (Lab Use Only)

Relinquished by: (Signature) Date Time Received by: (Signature) Date Time Remarks

Relinquished by: (Signature) Date Time Received by: (Signature) Date Time

Relinquished by: (Signature) Date Time Received by: (Signature) Date Time

Client's delivery of samples constitutes acceptance of TestAmerica terms and conditions contained in the Price Schedule.

TestAmerica Cannot accept verbal changes. Please Fax written changes to (802) 660-1919

¹Matrix: WW - Wastewater, W - Water, S - Soil, L - Liquid, A - Air bag, C - Charcoal Tube, SL - Sludge, O - Oil
²Container: VOA - 40 ml vial, A/G - Amber / Or Glass 1 Liter, 250 ml - Glass wide mouth, P/O - Plastic or other ____

Figure 23-2. Example: Sample Acceptance Policy

The receipt of samples is acknowledged on the chain of custody (COC) form with the signature and date/time of the sample custodian. The condition of samples upon receipt is documented on checklists designated for this purpose. Any deficiencies identified during sample receipt are recorded and communicated to the laboratory project manager (PM), who will contact the client and fully document any decision to proceed with analysis in the project record. Consultation with the client should be immediate and timely (next business day or as specified in the project plan). Correspondence records and/or records of conversations concerning the decision to proceed with analysis and/or the disposition of rejected samples is maintained in the project record, and should be maintained in association with the sample receipt checklist. All data associated with samples that did not meet the sample acceptance criteria must be qualified with a Non-Conformance Report (NCR) and/or noted in the project narrative that accompanies the final test report.

Sample receipt is considered deficient when the following conditions are observed:

- Shipping cooler and/or samples are received outside the temperature specification
- Sample bottles are received broken or leaking
- Samples are received beyond holding time
- Samples are received without the appropriate preservation
- Samples are not received in appropriate containers
- Chain of Custody does not match the samples received
- Chain of Custody was not received or is incomplete*
- Custody seals are broken
- Evidence of tampering with the cooler and/or samples
- Headspace in 40mL or 22 mL VOA vials
- Seepage of extraneous water or other material into the samples
- Inadequate sample volume
- Illegible, impermanent ink, or non-unique sample labeling
- One or more coolers missing from a multi parcel shipment
- Shipping container is damaged

**Complete documentation shall include sample identification, the location date/time of collection, collector's name, preservation type, sample type and any special remarks concerning the sample.*

Figure 23-3. Example: Cooler Receipt Form

TestAmerica Burlington
SAMPLE RECEIPT & LOG IN CHECKLIST

Client:	**Date Received:**	**Job #:**
Project #:	**Time Received:**	
PM:	**Received By:**	**Login#:**
Login Date:	**# Coolers Received:**	
	Samples Delivered By:	**ICOC Required? Y/N**
Initials:	⊐ Shipping Service	*If "Y", attach copy(s) of ICOC*
Signature:	⊐ Courier	
	⊐ Hand	

Receipt Info	**YES**	**NO**	**NA**	**COMMENTS**
There is *no* evidence to indicate tampering				
Custody seals are present and intact				
Custody seal numbers are present				
If yes, list custody seal numbers:				

IR Gun ID: **Correction Factor:** ° C

Thermal Preservation Type: ⊐ Wet Ice ⊐ Blue Ice ⊐ None ⊐ Other (specify)
Packing Material: ⊐ Bubble Wrap ⊐ Cardboard ⊐ Corrugated Paper ⊐ Shredded Paper ⊐ Styrofoam ⊐ Vermiculite ⊐ None

Cooler 1:	°C	Cooler 6	°C	Cooler 11	°C	Cooler 16	°C
Cooler 2:	°C	Cooler 7	°C	Cooler 12	°C	Cooler 17	°C
Cooler 3:	°C	Cooler 8	°C	Cooler 13	°C	Cooler 18	°C
Cooler 4:	°C	Cooler 9	°C	Cooler 14	°C	Cooler 19	°C
Cooler 5	°C	Cooler 10	°C	Cooler 15	°C	Cooler 20	°C

Unless otherwise documented, the recorded temperature readings are adjusted readings to account for the CF of the IR Gun
EPA Criteria: 0-6°C, except for air and geo samples which should be at ambient temperature and tissue samples, which may be frozen.
Some clients require thermal preservation criteria of 2-4°C or other such criteria. The PM must notify SM when alternate criteria is specified.
Comments:

Report Management-*Workshare (TALS Labs)*	**YES**	**NA**	**Initials**	**Date**
Workshare (TALS Labs)-Shipping and Receiving Documents scanned and attached to job.				
Email notification sent to job contact				
Report Management-*Login Review*	**YES**	**NA**	**Initials**	**Date**
Shipping and Receiving Documents: Scanned and attached to deliverable job folders.				
Project Manager-*Login Review*	**YES**		**Initials**	**Date**
Login Review Performed				
EDD Questions	**YES**	**NA**	**Initials**	**Date**
Applicable login/job questions answered				
Report Management-*Preliminary Deliverables*	**YES**	**NA**	**Initials**	**Date**
Lab Documents-Scanned and attached to appropriate job deliverables folder.				
Subcontract Data (if applicable)- Non-TALS Labs, 3rd Party Labs Scanned and attached to appropriate job deliverables folders				
Narrative-NCMs added, if present				
Preliminary Reports-run and assembled				
EDD(s)-run and created				
Project Manager	**YES**		**Initials**	**Date**
Final review and release completed				
Report Management-*Final Deliverables*	**YES**	**NA**	**Initials**	**Date**
Reports-Hardcopy printed (if requested), CD(s) burned				
Invoice-Approved in Invoice Desktop and printed (if hardcopy requested)				
Email-Report(s), EDD(s), and invoice (as requested)				
Delivery confirmed for report(s), EDD(s) and Invoice in TALS				

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SECTION 24. ASSURING THE QUALITY OF TEST RESULTS

24.1 Overview

In order to assure our clients of the validity of their data, the laboratory continuously evaluates the quality of the analytical process. The analytical process is controlled not only by instrument calibration as discussed in Section 20, but also by routine process quality control measurements (e.g. Blanks, Laboratory Control Samples (LCS), Matrix Spikes (MS), duplicates (DUP), surrogates, Internal Standards (IS)). These quality control checks are performed as required by the method or regulations to assess precision and accuracy. In addition to the routine process quality control samples, Proficiency Testing (PT) Samples (concentrations unknown to laboratory) are analyzed to help ensure laboratory performance.

24.2 Controls

Sample preparation or pre-treatment is commonly required before analysis. Typical preparation steps include homogenization, grinding, solvent extraction, sonication, acid digestion, distillation, reflux, evaporation, drying and ashing. During these pre-treatment steps, samples are arranged into discreet manageable groups referred to as preparation (prep) batches. Prep batches provide a means to control variability in sample treatment. Control samples are added to each prep batch to monitor method performance and are processed through the entire analytical procedure with investigative/field samples.

24.3 Negative Controls

Table 24-1. Example – Negative Controls

Control Type	Details
Method Blank (MB)	are used to assess preparation and analysis for possible contamination during the preparation and processing steps.
	The specific frequency of use for method blanks during the analytical sequence is defined in the specific standard operating procedure for each analysis. Generally it is 1 for each batch of samples; not to exceed 20 environmental samples.
	The method blank is prepared from a clean matrix similar to that of the associated samples that is free from target analytes (e.g., Reagent water, Ottawa sand, glass beads, etc.) and is processed along with and under the same conditions as the associated samples. The method blank goes through all of the steps of the process (including as necessary: filtration, clean-ups, etc.).
	Reanalyze or qualify associated sample results when the concentration of a targeted analyte in the blank is at or above the reporting limit as established by the method or by regulation, AND is greater than 1/10 of the amount measured in the sample.
Calibration Blanks	are prepared and analyzed along with calibration standards where applicable. They are prepared using the same reagents that are used to prepare the standards. In some analyses the calibration blank may be included in the calibration curve.
Instrument Blanks	are blank reagents or reagent water that may be processed during an analytical sequence in order to assess contamination in the analytical system. In general, instrument blanks are used to differentiate between contamination caused by the analytical system and that caused by the sample handling or sample prep process. Instrument blanks may also be inserted throughout the analytical sequence to minimize the effect of carryover from samples with high analyte content.

Table 24-1. Example – Negative Controls

Control Type	Details
Trip Blank [1]	are required to be submitted by the client with each shipment of samples requiring aqueous and solid volatiles analyses (or as specified in the client's project plan). Additionally, trip blanks may be prepared and analyzed for volatile analysis of air samples, when required by the client. A trip blank may be purchased (certified clean) or is prepared by the laboratory by filling a clean container with pure deionized water that has been purged to remove any volatile compounds. Appropriate preservatives are also added to the container. The trip blank is sent with the bottle order and is intended to reflect the environment that the containers are subjected to throughout shipping and handling and help identify possible sources if contamination is found. The field sampler returns the trip blank in the cooler with the field samples.
Field Blanks [1]	are sometimes used for specific projects by the field samplers. A field blank prepared in the field by filling a clean container with pure reagent water and appropriate preservative, if any, for the specific sampling activity being undertaken. (EPA OSWER)
Equipment Blanks [1]	are also sometimes created in the field for specific projects. An equipment blank is a sample of analyte-free media which has been used to rinse common sampling equipment to check effectiveness of decontamination procedures. (TNI)
Holding Blanks	also referred to as refrigerator or freezer blanks, are used to monitor the sample storage units for volatile organic compounds during the storage of VOA samples in the laboratory

[1] When known, these field QC samples should not be selected for matrix QC as it does not provide information on the behavior of the target compounds in the field samples. Usually, the client sample ID will provide information to identify the field blanks with labels such as "FB", "EB", or "TB."

Evaluation criteria and corrective action for these controls are defined in the specific standard operating procedure for each analysis.

24.4 Positive Controls

Control samples (e.g., QC indicators) are analyzed with each batch of samples to evaluate data based upon (1) Method Performance (Laboratory Control Sample (LCS) or Blank Spike (BS)), which entails both the preparation and measurement steps; and (2) Matrix Effects (Matrix Spike (MS) (Matrix spikes are not applicable to air) or Sample Duplicate (MD, DUP), which evaluates field sampling accuracy, precision, representativeness, interferences, and the effect of the matrix on the method performed. Each regulatory program and each method within those programs specify the control samples that are prepared and/or analyzed with a specific batch

Note that frequency of control samples vary with specific regulatory, methodology and project specific criteria. Complete details on method control samples are as listed in each analytical SOP.

24.4.1 Method Performance Control - Laboratory Control Sample (LCS)

The LCS measures the accuracy of the method in a blank matrix and assesses method performance independent of potential field sample matrix affects in a laboratory batch.

The LCS is prepared from a clean matrix similar to that of the associated samples that is free from target analytes (for example: Reagent water, Ottawa sand, glass beads, etc.) and is processed along with and under the same conditions as the associated samples. The LCS is spiked with verified known amounts of analytes or is made of a material containing known and verified amounts of analytes, taken through all preparation and analysis steps along with the field samples. Where there is no preparation taken for an analysis (such as in aqueous

volatiles), or when all samples and standards undergo the same preparation and analysis process (such as Phosphorus), a calibration verification standard is reported as the LCS. In some instances where there is no practical clean solid matrix available, aqueous LCS's may be processed for solid matrices; final results may be calculated as mg/kg or ug/kg, assuming 100% solids and a weight equivalent to the aliquot used for the corresponding field samples, to facilitate comparison with the field samples.

Certified pre-made reference material purchased from a NIST/A2LA accredited vendor may also be used for the LCS when the material represents the sample matrix or the analyte is not easily spiked (e.g. solid matrix LCS for metals, TDS, etc.).

The specific frequency of use for LCS during the analytical sequence is defined in the specific standard operating procedure for each analysis. It is generally 1 for each batch of samples; not to exceed 20 environmental samples.

If the mandated or requested test method, or project requirements, do not specify the spiking components, the laboratory shall spike all reportable components to be reported in the Laboratory Control Sample (and Matrix Spike) where applicable (e.g. no spike of pH). However, in cases where the components interfere with accurate assessment (such as simultaneously spiking chlordane, toxaphene and PCBs in Method 608), the test method has an extremely long list of components or components are incompatible, at a minimum, a representative number of the listed components (see below) shall be used to control the test method. The selected components of each spiking mix shall represent all chemistries, elution patterns and masses, permit specified analytes and other client requested components. However, the laboratory shall ensure that all reported components are used in the spike mixture within a two-year time period.

- For methods that have 1-10 target analytes, spike all components.
- For methods that include 11-20 target analytes, spike at least 10 or 80%, whichever is greater.
- For methods with more than 20 target analytes, spike at least 16 components.
- Exception: Due to analyte incompatibility in pesticides, Toxaphene and Chlordane are only spiked at client request based on specific project needs.
- Exception: Due to analyte incompatibility between the various PCB aroclors, aroclors 1016 and 1260 are used for spiking as they cover the range of all of the aroclors. Specific aroclors may be used by request on a project specific basis.

24.5 Sample Matrix Controls

Table 24-2. Sample Matrix Control

Control Type	Details	
Matrix Spikes (MS)	Use	used to assess the effect sample matrix of the spiked sample has on the precision and accuracy of the results generated by the method used;

Table 24-2. Sample Matrix Control

Control Type	Details	
	Typical Frequency [1]	At a minimum, with each matrix-specific batch of samples processed, an MS is carried through the complete analytical procedure. Unless specified by the client, samples used for spiking are randomly selected and rotated between different client projects.If the mandated or requested test method does not specify the spiking components, the laboratory shall spike all reportable components to be reported in the Laboratory Control Sample and Matrix Spike. Refer to the method SOP for complete details
	Description	essentially a sample fortified with a known amount of the test analyte(s).
Surrogate	Use	Measures method performance to sample matrix (organics only).
	Typical Frequency [1]	Are added to all samples, standards, and blanks, for all organic chromatography methods except when the matrix precludes its use or when a surrogate is not available. The recovery of the surrogates is compared to the acceptance limits for the specific method. Poor surrogate recovery may indicate a problem with sample composition and shall be reported, with data qualifiers, to the client whose sample produced poor recovery.
	Description	Are similar to matrix spikes except the analytes are compounds with properties that mimic the analyte of interest and are unlikely to be found in environment samples.
Duplicates[2]	Use	For a measure of analytical precision, with each matrix-specific batch of samples processed, a matrix duplicate (MD or DUP) sample, matrix spike duplicate (MSD), or LCS duplicate (LCSD) is carried through the complete analytical procedure.
	Typical Frequency [1]	Duplicate samples are usually analyzed with methods that do not require matrix spike analysis.
	Description	Performed by analyzing two aliquots of the same field sample independently or an additional LCS.
Internal Standards	Use	Are spiked into all environmental and quality control samples (including the initial calibration standards) to monitor the qualitative aspect of organic and some inorganic analytical measurements.
	Typical Frequency [1]	All organic and ICP methods as required by the analytical method.
	Description	Used to correct for matrix effects and to help troubleshoot variability in analytical response and are assessed after data acquisition. Possible sources of poor internal standard response are sample matrix, poor analytical technique or instrument performance.

[1] See the specific analytical SOP for type and frequency of sample matrix control samples.

[2] LCSD's are normally not performed except when regulatory agencies or client specifications require them. The recoveries for the spiked duplicate samples must meet the same laboratory established recovery limits as the accuracy QC samples. If an LCSD is analyzed both the LCS and LCSD must meet the same recovery criteria and be included in the final report. The precision measurement is reported as "Relative Percent Difference" (RPD). Poor precision between duplicates (except LCS/LCSD) may indicate non-homogeneous matrix or sampling.

24.6 Acceptance Criteria (Control Limits)

As mandated by the test method and regulation, each individual analyte in the LCS, MS, or Surrogate Spike is evaluated against the control limits published in the test method. Where there are no established acceptance criteria, the laboratory calculates in-house control limits with the use of control charts or, in some cases, utilizes client project specific control limits. When this occurs, the regulatory or project limits will supersede the laboratory's in-house limits.

Note: For methods, analytes and matrices with very limited data (e.g., unusual matrices not analyzed often), interim limits are established using available data or by analogy to similar methods or matrices.

Once control limits have been established, they are verified, reviewed, and updated when necessary unless the method requires more frequent updating. Control limits are established per method (as opposed to per instrument) regardless of the number of instruments utilized.

Laboratory generated % Recovery acceptance (control) limits are generally established by taking ± 3 Standard Deviations (99% confidence level) from the average recovery of a minimum of 20-30 data points (more points are preferred).

- Regardless of the calculated limit, the limit should be no tighter than the Calibration Verification (ICV/CCV). (Unless the analytical method specifies a tighter limit).

- In-house limits cannot be any wider than those mandated in a regulated analytical method. Client or contract required control limits are evaluated against the laboratory's statistically derived control limits to determine if the data quality objectives (DQOs) can be achieved. If laboratory control limits are not consistent with DQOs, then alternatives must be considered, such as method improvements or use of an alternate analytical method.

- The lowest acceptable recovery limit will be 10% (the analyte must be detectable and identifiable). Exception: The lowest acceptable recovery limit for Benzidine will be 5% and the analyte must be detectable and identifiable.

24.6.1 The lab must be able to generate a current listing of their control limits and track when the updates are performed. In addition, the laboratory must be able to recreate historical control limits.

24.6.2 A LCS that is within the acceptance criteria establishes that the analytical system is in control and is used to validate the process. Samples that are analyzed with an LCS with recoveries outside of the acceptance limits may be determined as out of control and should be reanalyzed if possible. If reanalysis is not possible, then the results for all affected analytes for samples within the same batch must be qualified when reported. The internal corrective action process (see Section 12) is also initiated if an LCS exceeds the acceptance limits. Sample results may be qualified and reported without reanalysis if:

- The analyte results are below the reporting limit and the LCS is above the upper control limit.

- If the analytical results are above the relevant regulatory limit and the LCS is below the lower control limit.

24.6.3 If the MS/MSDs do not meet acceptance limits, the MS/MSD and the associated spiked sample is reported with a qualifier for those analytes that do not meet limits. If obvious preparation errors are suspected, or if requested by the client, unacceptable MS/MSDs are reprocessed and reanalyzed to prove matrix interference. A more detailed discussion of acceptance criteria and corrective action can be found in the lab's method SOPs and in Section 12.

24.6.4 If a surrogate standard falls outside the acceptance limits, if there is not obvious chromatographic matrix interference, reanalyze the sample to confirm a possible matrix effect. If the recoveries confirm or there was obvious chromatographic interference, results are reported from the original analysis and a qualifier is added. If the reanalysis meets surrogate recovery criteria, the second run is reported (or both are reported if requested by the client).

24.7 Additonal Procedures to Assure Quality Control

The laboratory has written and approved method SOPs to assure the accuracy of the test method including calibration (see Section 20), use of certified reference materials (see Section 21) and use of PT samples (see Section 15).

A discussion regarding MDLs, Limit of Detection (LOD) and Limit of Quantitation (LOQ) can be found in Section 19.

- Use of formulae to reduce data is discussed in the method SOPs and in Section 20.
- Selection of appropriate reagents and standards is included in Section 9 and 21.
- A discussion on selectivity of the test is included in Section 5.
- Constant and consistent test conditions are discussed in Section 18.
- The laboratories sample acceptance policy is included in Section 23.

SECTION 25. REPORTING RESULTS

25.1 Overview

The results of each test are reported accurately, clearly, unambiguously, and objectively in accordance with State and Federal regulations as well as client requirements. Analytical results are issued in a format that is intended to satisfy customer and laboratory accreditation requirements as well as provide the end user with the information needed to properly evaluate the results. Where there is conflict between client requests and laboratory ethics or regulatory requirements, the laboratory's ethical and legal requirements are paramount, and the laboratory will work with the client during project set up to develop an acceptable solution. Refer to Section 7.

The format of each report type is specific to the client or regulatory program and is therefore not included in the QAM. The reporting specifications for CLP contract samples must comply with the specifications for CSF organization, preparation and review as specified in the SOW. Procedures for preparation of the CSF are provided in laboratory SOP BR-RM-001.

In cases where a client asks for simplified reports, there must be a written request from the client. There still must be enough information that would show any analyses that were out of conformance (QC out of limits) and there should be a reference to a full report that is made available to the client. Review of reported data is included in Section 19.

25.2 Test Reports

Analytical results are reported in a format that is satisfactory to the client and meets all requirements of applicable accrediting authorities and agencies. A variety of report formats are available to meet specific needs. The report is printed on laboratory letterhead, reviewed, and signed by the appropriate project manager. At a minimum, the standard laboratory report shall contain the following information:

25.2.1 A report title (e.g. Analytical Report For Samples) with a "sample results" column header.

25.2.2 Each report cover page printed on company letterhead, which includes the laboratory name, address and telephone number.

25.2.3 A unique identification of the report 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.

25.2.4 A copy of the chain of custody (COC).

- Any COCs involved with Subcontracting are included.

25.2.5 The name and address of client and a project name/number, if applicable.

25.2.6 Client project manager or other contact

25.2.7 Description and unambiguous identification of the tested sample(s) including the client identification code.

25.2.8 Date of receipt of sample, date and time of collection, and date(s) of test preparation and performance, and time of preparation or analysis if the required holding time for either activity is less than or equal to 72 hours.

25.2.9 Date reported or date of revision, if applicable.

25.2.10 Method of analysis including method code (EPA, Standard Methods, etc).

25.2.11 Practical quantitation limits or reporting limit.

25.2.12 Method detection limits (if requested)

25.2.13 Definition of Data qualifiers and reporting acronyms (e.g. ND).

25.2.14 Sample results.

25.2.15 QC data consisting of method blank, surrogate, LCS, and MS/MSD recoveries and control limits.

25.2.16 Condition of samples at receipt including temperature. This may be accomplished in a narrative or by attaching sample login sheets (Refer to Sec. 25.2.4 – Item 3 regarding additional addenda).

25.2.17 A statement to the effect that the results relate only to the items tested and the sample as received by the laboratory.

25.2.18 A signature and title of the person(s) accepting responsibility for the content of the report and date of issue. Signatories are appointed by the Lab Director.

25.2.19 When NELAC accreditation is required, the lab shall certify that the test results meet all requirements of TNI Standard or provide reasons and/or justification if they do not.

25.2.20 Where applicable, a narrative to the report that explains the issue(s) and corrective action(s) taken in the event that a specific accreditation or certification requirement was not met.

25.2.21 When soil samples are analyzed, a specific identification as to whether soils are reported on a "wet weight" or "dry weight" basis.

25.2.22 Appropriate laboratory certification number for the state of origin of the sample, if applicable.

25.2.23 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.

25.2.24 Any non-TestAmerica subcontracted analysis results are provided as a separate report on the official letterhead of the subcontractor. All TestAmerica subcontracting is clearly identified on the report as to which laboratory performed a specific analysis.

25.2.28 A clear statement notifying the client that non-accredited tests were performed and directing the client to the laboratory's accreditation certificates of approval shall be provided when non-accredited tests are included in the report.

Note: Refer to the Corporate SOP on Electronic Reporting and Signature Policy (No. CA-I-P-002) for details on internally applying electronic signatures of approval.

25.3 Reporting Level or Report Type

The laboratory routinely offers four levels of quality control reporting.

- Level I is a report with the features described in Section 25.2 above except QC summary information is not included.
- Level II is a Level I report plus QC summary information.
- Level III contains all the information supplied in Level II, but presented on CLP-like summary forms, and relevant calibration information. No raw data is provided.
- Level IV is the same as Level III with the addition of all raw supporting data.

The format of each report type is specific to the client or regulatory program and is therefore not included in the QAM. The reporting specifications for CLP contract samples must comply with the specifications for CSF organization, preparation and review as specified in the SOW. Procedures for preparation of the CSF are provided in laboratory SOP BR-RM-001.

25.3.1 Electronic Data Deliverables (EDDs)

EDDs are routinely offered as part of TestAmerica's services. TestAmerica Burlington offers a variety of EDD formats including Environmental Restoration Information Management System (ERPIMS), New Agency Standard (NAS), 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. Once the facility has committed to providing data in a specific

electronic format, the coding of the format may need to be performed. This coding is documented and validated. The validation of the code is retained by the IT staff coding the EDD.

EDDs shall be subject to a review to ensure their accuracy and completeness. If EDD generation is automated, review may be reduced to periodic screening if the laboratory can demonstrate that it can routinely generate that EDD without errors. Any revisions to the EDD format must be reviewed until it is demonstrated that it can routinely be generated without errors. If the EDD can be reproduced accurately and if all subsequent EDDs can be produced error-free, each EDD does not necessarily require a review.

25.4 Supplemental Information for Test

The lab identifies any unacceptable QC analyses or any other unusual circumstances or observations such as environmental conditions and any non-standard conditions that may have affected the quality of a result. This is typically in the form of a footnote or a qualifier and/or a narrative explaining the discrepancy in the front of the report.

Numeric results with values outside of the calibration range, either high or low are qualified as 'estimated'.

Where quality system requirements are not met, a statement of compliance/non-compliance with requirements and/or specifications is required, including identification of test results derived from any sample that did not meet sample acceptance requirements such as improper container, holding time, or temperature.

Where applicable, a statement on the estimated uncertainty of measurements; information on uncertainty is needed when a client's instructions so require.

Opinions and Interpretations - The test report contains objective information, and generally does not contain subjective information such as opinions and interpretations. If such information is required by the client, the Laboratory Director will determine if a response can be prepared. If so, the Laboratory Director will designate the appropriate member of the management team to prepare a response. The response will be fully documented, and reviewed by the Laboratory Director, before release to the client. There may be additional fees charged to the client at this time, as this is a non-routine function of the laboratory.

When opinions or interpretations are included in the report, the laboratory provides an explanation as to the basis upon which the opinions and interpretations have been made. Opinions and interpretations are clearly noted as such and where applicable, a comment should be added suggesting that the client verify the opinion or interpretation with their regulator.

25.5 Environmental Testing Obtained From Subcontractors

If the laboratory is not able to provide the client the requested analysis, the samples would be subcontracted following the procedures outlined in the Corporate SOP on Subcontracting (SOP No. CA-L-S-002).

Data reported from analyses performed by a subcontractor laboratory are clearly identified as such on the analytical report provided to the client. Results from a subcontract laboratory outside of TestAmerica are reported to the client on the subcontract laboratory's original report stationary and the report includes any accompanying documentation.

25.6 Client Confidentiality

In situations involving the transmission of environmental test results by telephone, facsimile or other electronic means, client confidentiality must be maintained.

TestAmerica will not intentionally divulge to any person (other than the Client or any other person designated by the Client in writing) any information regarding the services provided by TestAmerica or any information disclosed to TestAmerica by the Client. Furthermore, information known to be potentially endangering to national security or an entity's proprietary rights will not be released.

Note: This shall not apply to the extent that the information is required to be disclosed by TestAmerica under the compulsion of legal process. TestAmerica will, to the extent feasible, provide reasonable notice to the client before disclosing the information.

Note: Authorized representatives of an accrediting authority are permitted to make copies of any analyses or records relevant to the accreditation process, and copies may be removed from the laboratory for purposes of assessment.

25.6.1 Report deliverable formats are discussed with each new client. If a client requests that reports be faxed or e-mailed, the reports are faxed with a cover sheet or e-mailed with the following note that includes a confidentiality statement similar to the following:

This material is intended only for the use of the individual(s) or entity to whom it is addressed, and may contain information that is privileged and confidential. If you are not the intended recipient, or the employee or agent responsible for delivering this material to the intended recipient, you are hereby notified that any dissemination, distribution or copying of this communication is strictly prohibited. If you have received this communication in error, please notify us immediately by telephone at the 1-800-765-0980 (or for e-mails: please notify us immediately by e-mail or by phone (1-800-765-0980) and delete this material from any computer).

25.7 Format of Reports

The format of reports is designed to accommodate each type of environmental test carried out and to minimize the possibility of misunderstanding or misuse.

25.8 Amendments to Test Reports

Corrections, additions, or deletions to reports are only made when justification arises through supplemental documentation. Justification is documented using the laboratory's corrective action system (refer to Section 12).

The revised report is retained on the Archive data server, as is the original report. The revised report is stored in the Archive data server under the sample number followed by "R" ***[indicate your naming scheme]***. The revised report will have the word "revised" or "amended" next to the date rather than the word "reported".

When the report is re-issued, a notation of "report re-issue "is placed on the cover/signature page of the report *or at the top of the narrative page* with a brief explanation of reason for the re-issue and a reference back to the last final report generated. *For Example*: *Report was revised on 11/3/08 to include toluene in sample NQA1504 per client's request. This final report replaces the final report generated on 10/27/08 at 10:47am.*

25.9 Policies on Client Requests for Amendments

25.9.1 Policy on Data Omissions or Reporting Limit Increases

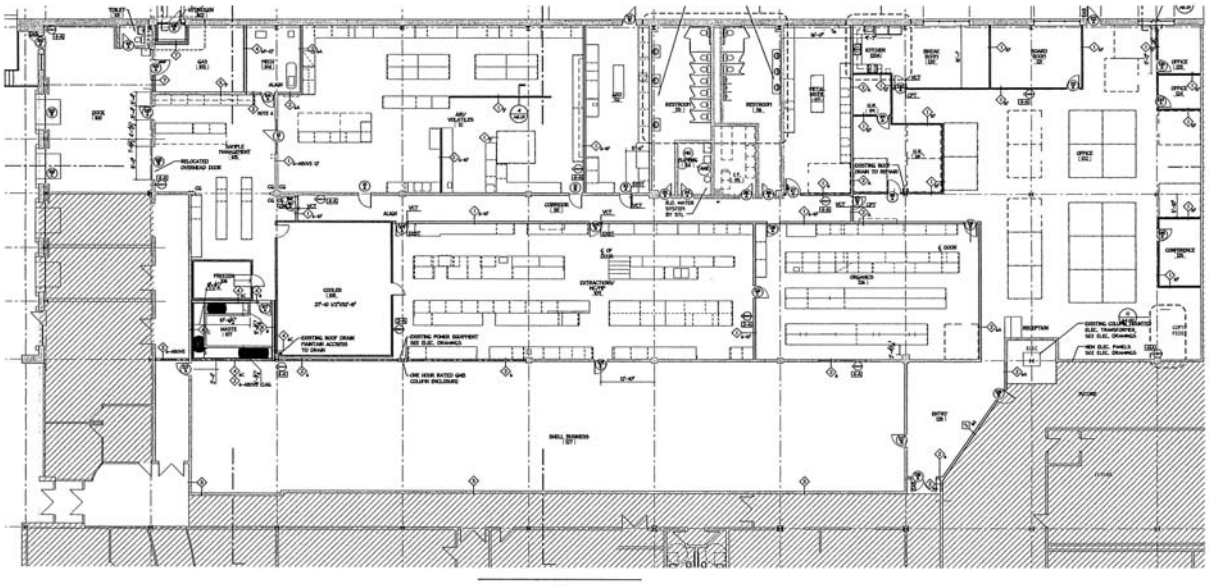
Fundamentally, our policy is simply to not omit previously reported results (including data qualifiers) or to not raise reporting limits and report sample results as ND. This policy has few exceptions. Exceptions are:

- Laboratory error.
- Sample identification is indeterminate (confusion between COC and sample labels).
- An incorrect analysis (not analyte) was requested (e.g., COC lists 8315 but client wanted 8310). A written request for the change is required.
- Incorrect limits reported based on regulatory requirements.
- The requested change has absolutely *no possible* impact on the interpretation of the analytical results and there is *no possibility* of the change being interpreted as misrepresentation by anyone inside or outside of our company.

25.9.2 Multiple Reports

TestAmerica does not issue multiple reports for the same work order where there is different information on each report (this does not refer to copies of the same report) unless required to meet regulatory needs and approved by QA.

Appendix 1. Laboratory Floor Plan



Appendix 2. Glossary/Acronyms (EL-V1M2 Sec. 3.1)

Glossary:

Acceptance Criteria: Specified limits placed on characteristics of an item, process, or service defined in requirement documents. (ASQC)

Accreditation: The process by which an agency or organization evaluates and recognizes a laboratory as meeting certain predetermined qualifications or standards, thereby accrediting the laboratory.

Accuracy: The degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components which are due to sampling and analytical operations; a data quality indicator. (QAMS)

Analyst: The designated individual who performs the "hands-on" analytical methods and associated techniques and who is the one responsible for applying required laboratory practices and other pertinent quality controls to meet the required level of quality.

Analytical Uncertainty: A subset of Measurement Uncertainty that includes all laboratory activities performed as part of the analysis. (TNI)

Assessment: The evaluation process used to measure or establish the performance, effectiveness, and conformance of an organization and/or its systems to defined criteria (to the standards and requirements of laboratory accreditation). (TNI)

Audit: A systematic and independent examination of facilities, equipment, personnel, training, procedures, record-keeping, data validation, data management, and reporting aspects of a system to determine whether QA/QC and technical activities are being conducted as planned and whether these activities will effectively achieve quality objectives. (TNI)

Batch: Environmental samples that are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents. A **preparation batch** is composed of one (1) to twenty (20) environmental samples of the same quality systems matrix, meeting the above mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be twenty-four (24) hours. An **analytical batch** is composed of prepared environmental samples (extracts, digestates or concentrates) which are analyzed together as a group. An analytical batch can include prepared samples originating from various quality system matrices and can exceed twenty (20) samples. (TNI)

Bias: The systematic or persistent distortion of a measurement process, which causes errors in one direction (i.e., the expected sample measurement is different from the sample's true value). (TNI)

Blank: A sample that has not been exposed to the analyzed sample stream in order to monitor contamination during sampling, transport, storage or analysis. The blank is subjected to the usual analytical and measurement process to establish a zero baseline or background value and is sometimes used to adjust or correct routine analytical results. (ASQC)

Calibration: A set of operations that establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument or measuring system, or values represented by a material measure or a reference material, and the corresponding values realized by standards. (TNI)

1) In calibration of support equipment the values realized by standards are established through the use of reference standards that are traceable to the International System of Units (SI).

2) In calibration according to methods, the values realized by standards are typically established through the use of Reference Materials that are either purchased by the laboratory with a certificate of analysis or purity, or prepared by the laboratory using support equipment that has been calibrated or verified to meet specifications.

Calibration Curve: The mathematical ~~r~~relationship between the known values, such as concentrations, of a series of calibration standards and their instrument response. (TNI)

Calibration Standard: A substance or reference material used to calibrate an instrument (QAMS)

Certified Reference Material (CRM): A reference material~~,~~ accompanied by a certificate, having a value, measurement uncertainty, and stated metrological traceability chain to a national metrology institute. (TNI)

Chain of Custody (COC) Form: Record that documents the possession of the samples from the time of collection to receipt in the laboratory. This record generally includes: the number and types of containers; the mode of collection; the collector; time of collection; preservation; and requested analyses. (TNI)

Compromised Samples: Those samples which are improperly sampled, insufficiently documented (chain of custody and other sample records and/or labels), improperly preserved, collected in improper containers, or exceeding holding times when delivered to a laboratory. Under normal conditions, compromised samples are not analyzed. If emergency situation require analysis, the results must be appropriately qualified.

Confidential Business Information (CBI): Information that an organization designates as having the potential of providing a competitor with inappropriate insight into its management, operation or products. and its representatives agree to safeguarding identified CBI and to maintain all information identified as such in full confidentiality.

Confirmation: Verification of the identity of a component through the use of an approach with a different scientific principle from the original method. These may include, but are not limited to Second Column Confirmation; Alternate wavelength; Derivatization; Mass spectral interpretation; Alternative detectors or Additional Cleanup procedures. (TNI)

Conformance: An affirmative indication or judgment that a product or service has met the requirements of the relevant specifications, contract, or regulation; also the state of meeting the requirements. (ANSI/ASQC E4-1994)

Correction: Actions necessary to correct or repair analysis specific non-conformances. The acceptance criteria for method specific QC and protocols as well as the associated corrective actions. The analyst will most frequently be the one to identify the need for this action as a result of calibration checks and QC sample analysis**.** No significant action is taken to change behavior, process or procedure.

Corrective Action: The action taken to eliminate the causes of an existing nonconformity, defect or other undesirable situation in order to prevent recurrence. (ISO 8402)

Data Audit: A qualitative and quantitative evaluation of the documentation and procedures associated with environmental measurements to verify that the resulting data re of acceptable quality (i.e., that they meet specified acceptance criteria).

Data Reduction: The process of transforming the number of data items by arithmetic or statistical calculations, standard curves, and concentration factors, and collation into a more useable form. (TNI)

Deficiency: An unauthorized deviation from acceptable procedures or practices, or a defect in an item. (ASQC)

Demonstration of Capability: A procedure to establish the ability of the analyst to generate analytical results of acceptable accuracy and precision. (TNI)

Document Control: The act of ensuring that documents (and revisions thereto) are proposed, reviewed for accuracy, approved for release by authorized personnel, distributed properly, and controlled to ensure use of the correct version at the location where the prescribed activity if performed. (ASQC)

Duplicate Analyses: The analyses or measurements of the variable of interest performed identically on two subsamples of the same sample. The results from duplicate analyses are used to evaluate analytical or measurement precision but not the precision of sampling, preservation or storage internal to the laboratory. (EPA-QAD)

Equipment Blank: Sample of analyte-free media which has been used to rinse common sampling equipment to check effectiveness of decontamination procedures.
External Standard Calibration: Calibrations for methods that do not utilize internal standards to compensate for changes in instrument conditions.

Field Blank: Blank prepared in the field by filing a clean container with pure de-ionized water and appropriate preservative, if any, for the specific sampling activity being undertaken (EPA OSWER)

Field of Accreditation: hose matrix, technology/method, and analyte combinations for which the NELAP accreditation body offers accreditation.

Holding Times: The maximum time that samples may be held prior to analyses and still be considered valid or not compromised. (40 CFR Part 136)

Internal Standard: A known amount of standard added to a test portion of a sample as a reference for evaluating and controlling the precision and bias of the applied analytical test method. (TNI)

Internal Standard Calibration: Calibrations for methods that utilize internal standards to compensate for changes in instrument conditions.

Instrument Blank: A clean sample (e.g., distilled water) processed through the instrumental steps of the measurement process; used to determine instrument contamination. (EPA-QAD)

Instrument Detection Limit (IDL): The minimum amount of a substance that can be measured with a specified degree of confidence that the amount is greater than zero using a specific instrument. The IDL is associated with the instrumental portion of a specific method only, and sample preparation steps are not considered in its derivation. The IDL is a statistical estimation at a specified confidence interval of the concentration at which the relative uncertainty is ± 100%. The IDL represents a range where qualitative detection occurs on a specific instrument. Quantitative results are not produced in this range.

Laboratory Control Sample (however named, such as laboratory fortified blank, spiked blank, or QC check sample): A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes, taken through all preparation and analysis steps of the procedure unless otherwise noted in a reference method. It is generally used to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or a portion of the measurement system.

An LCS shall be prepared at a minimum of 1 per batch of 20 or less samples per matrix type per sample extraction or preparation method except for analytes for which spiking solutions are not available such as

total suspended solids, total dissolved solids, total volatile solids, total solids, pH, color, odor, temperature, dissolved oxygen or turbidity. The results of these samples shall be used to determine batch acceptance.

Least Squares Regression (1st Order Curve): The least squares regression is a mathematical calculation of a straight line over two axes. The y axis represents the instrument response (or Response ratio) of a standard or sample and the x axis represents the concentration. The regression calculation will generate a correlation coefficient (r) that is a measure of the "goodness of fit" of the regression line to the data. A value of 1.00 indicates a perfect fit. In order to be used for quantitative purposes, r must be greater than or equal to 0.99 for organics and 0.995 for inorganics.

Limit(s) of Detection (LOD) [a.k.a., Method Detection Limit (MDL)]: A laboratory's estimate of the minimum amount of an analyte in a given matrix that an analytical process can reliably detect in their facility. (TNI)

LOD Verification [a.k.a., MDL Verification]: A processed QC sample in the matrix of interest, spiked with the analyte at no more than 3X the LOD for single analyte tests and 4X the LOD for multiple analyte tests and processed through the entire analytical procedure.

Limit(s) of Quantitation (LOQ) [a.k.a., Reporting Limit]: The minimum levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be reported with a specified degree of confidence. (TNI)

(QS) Matrix: The component or substrate that contains the analyte of interest. For purposes of batch and QC requirement determinations, the following matrix distinctions shall be used:

Aqueous: Any aqueous sample excluded from the definition of Drinking Water or Saline/Estuarine. Includes surface water, groundwater~~,~~ effluents, and TCLP or other extracts.

Drinking Water: Any aqueous sample that has been designated as a potable or potential potable water source.

Saline/Estuarine: Any aqueous sample from an ocean or estuary, or other salt water source such as the Great Salt Lake.

Non-Aqueous Liquid: Any organic liquid with <15% settleable solids.

Biological Tissue: Any sample of a biological origin such as fish tissue, shellfish, or plant material. Such samples shall be grouped according to origin.

Solids: Includes soils, sediments, sludges, and other matrices with >15% settleable solids.

Chemical Waste: A product or by-product of an industrial process that results in a matrix not previously defined.

Air & Emissions: Whole gas or vapor samples including those contained in flexible or rigid wall containers and the extracted concentrated analytes of interest from a gas or vapor that are collected with a sorbant tube, impinger solution, filter, or other device. (TNI)

Matrix Spike (spiked sample or fortified sample): A sample prepared, taken through all sample preparation and analytical steps of the procedure unless otherwise noted in a referenced method, by adding a known amount of target analyte to a specified amount of sample for which an independent test

result of target analyte concentration is available. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency.

Matrix Spike Duplicate (spiked sample or fortified sample duplicate): A replicate matrix spike prepared and analyzed to obtain a measure of the precision of the recovery for each analyte.

Method Blank: A sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses.

Method Detection Limit: The minimum concentration of a substance (an analyte) that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte. (40 CFR Part 136, Appendix B)

Negative Control: Measures taken to ensure that a test, its components, or the environment do not cause undesired effects, or produce incorrect test results.

Non-conformance: An indication, judgment, or state of not having met the requirements of the relevant specifications, contract, or regulation.

Performance Audit: The routine comparison of independently obtained qualitative and quantitative measurement system data with routinely obtained data in order to evaluate the proficiency of an analyst or laboratory.

Positive Control: Measures taken to ensure that a test and/or its components are working properly and producing correct or expected results from positive test subjects.

Precision: The degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves; a data quality indicator. Precision is usually expressed as standard deviation, variance or range, in either absolute or relative terms. (TNI)

Preservation: Any conditions under which a sample must be kept in order to maintain chemical and/or biological integrity prior to analysis. (TNI)

Proficiency Testing: A means of evaluating a laboratory's performance under controlled conditions relative to a given set of criteria through analysis of unknown samples provided by an external source. (TNI)

Proficiency Testing Program: The aggregate of providing rigorously controlled and standardized environmental samples to a laboratory for analysis, reporting of results, statistical evaluation of the results and the collective demographics and results summary of all participating laboratories. (TNI)

Proficiency Test Sample (PT): A sample, the composition of which is unknown to the laboratory and is provided to test whether the aboratory can produce analytical results within specified acceptance criteria. (TNI)

Quality Assurance: An integrated system of management activities involving planning, implementation, assessment, reporting and quality improvement to ensure that a process, item, ~~product~~ or service is of the type of quality needed and expected by the client. (TNI)

Quality Assurance [Project] Plan (QAPP): A formal document describing the detailed quality control procedures by which the quality requirements defined for the data and decisions pertaining to a specific project are to be achieved. (EAP-QAD)

Quality Control: The overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established by the customer; operational techniques and activities that are used to fulfill requirements for quality; also the system of activities and checks used to ensure that measurement systems are maintained within prescribed limits, providing protection against "out of control" conditions and ensuring that the results are of acceptable quality. (TNI)

Quality Control Sample: A sample used to assess the performance of all or a portion of the measurement system. One of any number of samples, such as Certified Reference Materials, a quality system matrix fortified by spiking, or actual samples fortified by spiking, intended to demonstrate that a measurement system or activity is in control. (TNI)

Quality Manual: A document stating the management policies, objectives, principles, organizational structure and authority, responsibilities, accountability, and implementation of an agency, organization, or laboratory, to ensure the quality of its product and the utility of its product to its users. (TNI)

Quality System: A structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for ensuring quality in its work processes, products (items), and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required QA and QC activities. (TNI)

Raw Data: The documentation generated during sampling and analysis. This documentation includes, but is not limited to, field notes, electronic data, magnetic tapes, untabulated sample results, QC sample results, print outs of chromatograms, instrument outputs, and handwritten records. (TNI)

Record Retention: The systematic collection, indexing and storing of documented information under secure conditions.

Reference Material: Material or substance one or more properties of which are sufficiently homogeneous and well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials. (TNI)

Reference Standard: Standard used for the calibration of working measurement standards in a given organization or a given location. (TNI)

Sampling: Activity related to obtaining a representative sample of the object of conformity assessment, according to a procedure.

Second Order Polynomial Curve (Quadratic): The 2nd order curves are a mathematical calculation of a slightly curved line over two axis. The y axis represents the instrument response (or Response ratio) of a standard or sample and the x axis represents the concentration. The 2nd order regression will generate a coefficient of determination (COD or r^2) that is a measure of the "goodness of fit" of the quadratic curvature the data. A value of 1.00 indicates a perfect fit. In order to be used for quantitative purposes, r^2 must be greater than or equal to 0.99.

Selectivity: The ability to analyze, distinguish, and determine a specific analyte or parameter from another component that may be a potential interferent or that may behave similarly to the target analyte or parameter within the measurement system. (TNI)

Sensitivity: The capability of a method or instrument to discriminate between measurement responses representing different levels (e.g., concentrations) of a variable of interest. (TNI)

Spike: A known mass of target analyte added to a blank, sample or sub-sample; used to determine recovery efficiency or for other quality control purposes.

Standard: The document describing the elements of laboratory accreditation that has been developed and established within the consensus principles of standard setting and meets the approval requirements of standard adoption organizations procedures and policies. (TNI)

Standard Operating Procedures (SOPs): A written document which details the method for an operation, analysis, or action, with thoroughly prescribed techniques and steps. SOPs are officially approved as the methods for performing certain routine or repetitive tasks. (TNI)

Storage Blank: A blank matrix stored with field samples of a similar matrix (volatiles only) that measures storage contribution to any source of contamination.

Surrogate: A substance with properties that mimic the analyte of interest. It is unlikely to be found in environment samples and is added to them for quality control purposes.

Surrogate compounds must be added to all samples, standards, and blanks, for all organic chromatography methods except when the matrix precludes its use or when a surrogate is not available. Poor surrogate recovery may indicate a problem with sample composition and shall be reported to the client whose sample produced poor recovery. (QAMS)

Systems Audit (also Technical Systems Audit): A thorough, systematic, qualitative on-site assessment of the facilities, equipment, personnel, training, procedures, record keeping, data validation, data management, and reporting aspects of a total measurement system. (EPA-QAD)

Technology: A specific arrangement of analytical instruments, detection systems, and/or preparation techniques.

Traceability: The ability to trace the history, application, or location of an entity by means of recorded identifications. In a calibration sense, traceability relates measuring equipment to national or international standards, primary standards, basic physical constants or properties, or reference materials. In a data collection sense, it relates calculations and data generated throughout the project back to the requirements for the quality of the project. (TNI)

Trip Blank: A blank matrix placed in a sealed container at the laboratory that is shipped, held unopened in the field, and returned to the laboratory in the shipping container with the field samples.

Uncertainty: A parameter associated with the result of a measurement that characterizes the dispersion of the value that could reasonably be attributed to the measured value.

Acronyms:

CAR – Corrective Action Report
CCV – Continuing Calibration Verification
CF – Calibration Factor
CFR – Code of Federal Regulations
COC – Chain of Custody
DOC – Demonstration of Capability
DQO – Data Quality Objectives
DUP - Duplicate
EHS – Environment, Health and Safety
EPA – Environmental Protection Agency
GC - Gas Chromatography
GC/MS - Gas Chromatography/Mass Spectrometry
HPLC - High Performance Liquid Chromatography
ICP - Inductively Coupled Plasma Atomic Emission Spectroscopy
ICP/MS – ICP/Mass Spectrometry
ICV – Initial Calibration Verification
IDL – Instrument Detection Limit
IH – Industrial Hygiene
IS – Internal Standard
LCS – Laboratory Control Sample
LCSD – Laboratory Control Sample Duplicate
LIMS – Laboratory Information Management System
LOD – Limit of Detection
LOQ – Limit of Quantitation
MDL – Method Detection Limit
MDLV – MDL Verification Check Standard
MRL – Method Reporting Limit Check Standard
MS – Matrix Spike
MSD – Matrix Spike Duplicate
MSDS - Material Safety Data Sheet
NELAC - National Environmental Laboratory Accreditation Conference
NELAP - National Environmental Laboratory Accreditation Program
PT – Performance Testing
TNI – The NELAC Institute
QAM – Quality Assurance Manual
QA/QC – Quality Assurance / Quality Control
QAPP – Quality Assurance Project Plan
RF – Response Factor
RPD – Relative Percent Difference
RSD – Relative Standard Deviation
SD – Standard Deviation
SOP – Standard Operating Procedure
TAT – Turn-Around-Time
VOA – Volatiles
VOC – Volatile Organic Compound

Appendix 3. Laboratory Certifications, Accreditations, Validations

TestAmerica Burlington maintains accreditation, certifications and approvals with numerous state and national entities. At the time of this QA Manual revision, the laboratory has accreditation/certification/licensing with the following organizations:

Lab ID	Program	Program Type	Authority
NA	Delaware DNREC		Delaware
ADE-1492	DoD ELAP	DoD	ACLASS
200610	NELAC	Secondary AB	New Hampshire
VT972	NELAC	Primary AB	New Jersey
10391	NELAC	Secondary AB	New York
68-00489	NELAC	Secondary AB	Pennsylvania
E87467	NELAC	Secondary AB	Florida
176292	NELAC	Secondary AB	Louisiana
PH-0751	State Program		Connecticut
VT00008	State Program		Maine
050-999-436	State Program		Minnesota
LAO00298	State Program		Rhode Island
VT-4000	State Program		Vermont
P330-11-00093	USDA		USDA

The certificates and parameter lists are available upon request from a laboratory representative. A complete list of analytical capabilities may be found on the company's web site, the laboratory's public server or from a representative of the laboratory.

Attachment D

Example Chain of Custodies

Chain of Custody Record

Connecticut
128 Long Hill Cross Road
Shelton, CT 06484
Tel: 203-929-8140
Fax: 203-929-8142

TAL-0015 (0508)

151209

Client	Project Manager	Date	Chain of Custody Number
GEI Consultants Inc.	Melissa Felter / Kim Bradley		18896

Address	Telephone Number (Area Code)/Fax Number/e-mail address	Field Telephone Number	Page / of
455 Winding Brook Dr.	860-368-5300 / mfelter@geiconsultants.com / kbradley@geiconsultants.com	860-917-0670	Page 1 of

City	State	Zip Code	Site Contact	Lab Contact
Glastonbury	CT	06033	Kim Bradley / Kari Weber	Pat McIssac

Project Name and Location (State)	Sample Disposal	Analysis (Attach list if more space is needed)
Gowanus Canal Brooklyn, NY	☐ Return To Client ☐ Disposal By Lab ☐ Archive For ____ Months (A fee may be assessed if samples are retained longer than 1 month)	

Contract/Purchase Order/Project No.
093010-2-1202

Field Sample I.D. (Containers for each sample may be combined on one line)	Collection Date	Collection Time	Matrix: Aqueous	Solid	Other	Containers & Preservatives: Unpres.	H_2SO_4	HNO_3	HCl	NaOH	ZnAc/NaOH	Other	SEE ATTACHED SLW Analytical	SEE ATTACHED SEDIMENT ANALYTICAL	SEE ATTACHED Pace Analytical	Comments
													X			
														X		
															X	

Turn Around Time Required (business days) Report / EDD Requirements

☐ 24 Hours ☐ 48 Hours ☐ 5 Days ☐ 10 Days ☐ 15 Days ☒ Other SEE Contact

State Regulatory QC Requirements

1. Relinquished By	Date	Time	1. Received By	Date	Time
2. Relinquished By	Date	Time	2. Received By	Date	Time
3. Received By	Date	Time	Cooler Temps	Passed Rad. Screen (Lab Use Only)	☐ Yes ☐ No

Comments

DISTRIBUTION: *WHITE - Stays with the Samples; CANARY - Returned to Client with Report; PINK - Field Copy*

Note: Deliverable Type → NYS ASP Cat B + EPA II EDD

EDD to datagroup@geiconsultants.com
Hard Copy to Lori Macinnon

CMS

Attachment E

Field Change Order Form

Field Modification Form
for
Paerdegat Basin , Sediment, Tissue and Porous Surface Sampling
GEI Consultants, Inc.

Date:

Document:

Activity:

Requested Modification:

Rationale:

Attachments:

Project Manager:

Attachment F

Project Manager and Data Validator Resumes

BARRY L. GIROUX, P.E., LEP
SENIOR PROJECT MANAGER

resume

Mr. Giroux is a principal environmental engineer with GEI. He has 30 years of environmental engineering experience, including consulting engineering, government regulatory, and contracting. Mr. Giroux's primary experience is in regard to hazardous and industrial waste remediation and management, including compliance with environmental regulations.

RELEVANT PROJECT EXPERIENCE

Shelly Ditch Removal Action Raybestos Products Company (Raybestos), Raytech Corp, Crawfordsville, IN. Project Manager for a time-critical removal action at the Shelly Ditch. The removal action was required pursuant to a Unilateral Administrative Order issued by the USEPA. The Order required the removal and proper disposal of soils containing elevated levels of polychlorinated biphenyls (PCB) and lead along a length of county drainage ditch extending in excess of 3,000 feet. Work included preparation of remedial actions plans and remedial designs for approval by the EPA, and oversight of the removal action including confirmation sampling, air monitoring, and general oversight of all contractor activities. A final closure report was prepared and submitted to EPA.

Occum Park Brownfield Redevelopment, The Norwich Community Development Corp. Inc., Norwich, CT. Project engineer and manager of PCB remediation activities, which were completed under the U.S. EPA risk-based standards in 40 CFR 761.61(c). GEI, under a CTDEP Voluntary Cleanup Program, developed a cleanup plan which capped certain waste to remain on site while removing other waste and soils containing PCBs. Regulatory alternatives allowed under the CTDEP Remediation Standard Regulations were utilized including an engineered control variance and environmental land use restriction (ELUR). In addition, GEI designed a municipal recreation facility at the site including play areas, fields, walkways and river access. GEI was responsible for remediation and construction oversight and preparation of all closure reports.

Facility Restoration, The United Illuminating Company, Bridgeport, CT. Project Manager for overall project management for decontamination and demolition of the former Steel Point electric generating facility located in Bridgeport, Connecticut and investigation and remediation of impacted soil. The eight-story, 95,000-square-foot facility occupied the 15-acre site. Abatement included asbestos, polychlorinated biphenyls, mercury, chemical containers, and contaminated building debris. Remedial action plans were coordinated with the City of Bridgeport's overall development plan for the Steel Point Peninsula which includes major waterfront commercial, retail,

EDUCATION
B.S., Civil Engineering, University of Connecticut

EXPERIENCE IN THE INDUSTRY
36 years

EXPERIENCE WITH GEI
21 years

REGISTRATIONS AND LICENSES
Licensed Environmental Professional, CT No. 139
Professional Engineer, CT No. 12395

CERTIFICATIONS
OSHA Supervisor Hazard Waste Operations and Emergency Response Training

GEI Consultants

and residential developments. Phase I through III investigations were completed and a "Phase One" remedial action plan was prepared and implemented. GEI was the LEP for this work, which was conducted under the CTDEP's voluntary remediation program. Remediation activities included excavation and off-site disposal of over 6000 cubic yards of soil containing petroleum hydrocarbons, polycyclic aromatic hydrocarbons and/or polychlorinated biphenyls. Work associated with removal included installation of sheet piles, construction of soil storage areas and treatment of dewatering waste waters.

Site Investigation and Remediation, Registered Environmental Consultant Program, Confidential Client, North Carolina, Ongoing. Project Manager for oversight of investigation and remediation activities being conducted under North Carolina's Registered Environmental Consultant program. GEI works for the corporate owner of the site and is responsible for peer review of activities conducted by a local consultant. Contaminant concerns at the site include chlorinated solvent in overburden and bedrock groundwater, and PCBs in a fill area. Remediation work, which was directly supervised by GEI, included the excavation and disposal of over 50 buried drums. Extensive investigations of the extent of solvents in groundwater (on and off site) and of the extent of PCBs in fill have been completed. Investigation methods have included conventional soil borings and groundwater monitoring wells in addition to a membrane interface probe survey.

Goffe Street Substation Closure, The United Illuminating Company (UI), New Haven, CT. Project manager of Phase I, II and III environmental site investigations of this electric substation parcel. All buildings and structures were demolished and the property was transferred. Work also included preparation of a remedial action plan, and plans and specifications for remediation of PCB and TPH impacted soil. PCB-impacted soil was remediated in accordance with the Remediation Standard Regulations and under the U.S. EPA performance-based remediation standards in 40 CFR 761.61(b).

Transfer Act and Compliance Order Site Investigation and Remediation, Sargent Manufacturing Company, New Haven, CT. Project Manager and LEP for investigation and remediation of this site. Architectural hardware is manufactured at the site. Areas of concern include former wastewater treatment lagoons, plating operations, a former drum storage area, a former drum disposal area, and miscellaneous petroleum release areas. GEI is presently overseeing operation and maintenance of the soil vapor extraction/air sparging and oil recovery treatment system.

Phase III Remedial Investigation of Former CT Coke Company Site, The United Illuminating Company (UI), New Haven, CT. Project Manager and licensed environmental professional (LEP) for Phase I, II, and III investigations at UI's retained portion of the former Connecticut Coke Company site. This 10-acre parcel is contaminated with coal tar, petroleum products, and ash. Investigations have been conducted to evaluate the site's environmental conditions relative to the Connecticut Remediation Standard Regulations. A Remedial Action Plan and a request for use of engineered controls has been prepared and submitted to the DEP.

Jet Fuel Remediation, Bradley International Airport, Connecticut Dept. of Transportation, Windsor Locks, CT. Project Manager regarding investigation and remediation of a jet fuel release at Bradley International Airport in Windsor Locks, Connecticut. The area of contamination was at the location where the a new terminal building was constructed. Work completed included supplemental investigations to better define the extent and degree of contamination and preparation of a technical memorandum recommending the preferred remedial alternative for the site. The remedial alternatives were presented to CTDEP and conceptually approved. Pilot-scale testing was conducted to evaluate the following technologies: high vacuum extraction for free product removal; soil vapor extraction; air sparging; and bioventing. The final remedy selected was an air sparging and soil vapor extraction system utilizing horizontal wells.

Steel Plant Closure and Remedial Design, Carpenter Technology Corporation, Bridgeport, CT. Project Manager for a facility closure and environmental assessment/remedial design for Carpenter Technology's former steel plant in Bridgeport, Connecticut. This project included an extensive field investigation to characterize the environmental conditions at the site; a health and environmental risk assessment for various development scenarios; and remedial design including contract plans and specifications (soil excavation/disposal and building dust cleanup), regulation compliance, and construction inspection. Extensive coordination was involved with the CTDEP regarding negotiating a Consent Agreement and successfully completing the remediation to ready the site for real estate development.

Consent Order and Transfer Act Compliance, Stanadyne Corporation, Windsor, CT. Project Manager for investigation and remediation activities being conducted under a Consent Order with CTDEP regarding transfer of this establishment. Responsibilities for investigation and remediation are divided between Stanadyne and the former owner. GEI is responsible for oversight of activities conducted by the former owner's consultant and for investigation and remediation of Stanadyne's environmental items. The facility has been a manufacturing facility since 1948. Over 120 site activities were investigated from which over 50 environmental items were identified for investigation. Conditions of note with regard to the Remediation Standard Regulations were identified at 39 environmental items.

Transfer Act Compliance, Corbin Russwin, Berlin, CT. Project Manager for investigation and remediation activities being conducted under the Transfer Act and RCRA Corrective Actions. Responsibilities for investigation and remediation are divided between Corbin Russwin and the former owner. GEI is responsible for oversight of activities conducted by the former owner's consultant that are required under the Transfer Act and for conducting actions required under RCRA or TSCA. The facility manufactures architectural hardware. There have been over 50 areas of concern identified at the site. Investigations have been required at most of these areas and remediation has been completed or is required at several of the areas. Remediation activities have included dual phase extraction, groundwater pump and treat, and excavation with off-site disposal.

Reflexite Investigation and Remediaion, Reflexite Corporation, New Britain, CT. Project Manager and LEP for investigation and remediation of this site at which hand tools were formerly manufactured. Work has included supplemental investigations and remediation of solvent contaminated soil located below the building floor. GEI prepared plans and specifications for the remediation work and supervised the remediation activities. Other smaller impacted areas were also remediation and post-remediation groundwater monitoring was completed. A sub-slab depressurization system was installed, to prevent vapor intrusion, an environmental land use restriction was established, and an LEP verification report is being prepared.

KeySpan MGP Services Program, National Grid, Brooklyn, NY. MGP Site Feasibility Study, Former Nassau Gas Works, Brooklyn, NY. Project Manager for preparation of feasibility study of remedial alternatives. The former MGP property is located on an approximately 13 acre parcel within the former Brooklyn Navy Yard. The MGP was operating by 1873 and ceased operations prior to 1935. The FS describes the development, screening, and detailed evaluation of remedial alternatives and was conducted in accordance with New York State Department of Environmental Conservation (NYSDEC) requirements.

Licensed Environmental Professional Verification, Bridgeport Energy LLC, Bridgeport, CT. Licensed Environmental Professional (LEP) for the investigation and verification of remediation for a former warehouse and illegal commercial hazardous waste storage facility. Documents prepared under Connecticut's voluntary remediation program included an environmental conditions assessment form (ECAF) and a parcel verification which verified that the site had been remediated in compliance with Connecticut's Remediation Standard Regulations (RSRs). The verification was not audited. This project included the review of remedial activities and several reports prepared by previous consultants and

supplemental groundwater and soil sampling and analysis. A request for approval of alternative cleanup criteria was prepared. The site was subsequently transferred several times and supplemental investigations and preparation of transfer act forms were completes.

On-Call Environmental Services, Connecticut Statewide, Connecticut Department of Public Works, Winsted, CT. Project Manager for Phase II site investigation under the Army's Installation Restoration Program at the Stratford Armory and Groton/New London Airport. Project manager for Phase I, II, and III investigations at the Seaside Regional Center in Waterford under the Connecticut Transfer Act. Mr. Giroux was the primary point of contact with CTDPW and managed all aspects (contractual and technical) of this contract.

Installation Restoration Study of the Naval Submarine Base, Department of the Navy, Groton, CT. Project Manager for work at the Naval Submarine Base in Groton, Connecticut for the United States Navy. This Superfund project included RI/FS investigations at four former waste disposal/release sites, extensive multimedia sampling, including biological and marine sampling and environmental impact assessment, and screening level investigations at nine additional potential waste disposal sites. Remedial designs were prepared at four sites, including closure design and hot spot removal at two landfill sites. Proposed Plan and Record of Decision (ROD) development were also included.

Voluntary Site Remediation, The United Illuminating Company, West Haven, CT. Project Manager and LEP for the voluntary remediation of a former warehouse and present electric substation site. Work included preparation of an environmental conditions assessment form, evaluation of the site's compliance with the Connecticut RSRs, supplemental investigations, post-remediation groundwater monitoring, and submittal of a verification to the DEP that the site had been investigated and remediated in compliance with the Remediation Standard Regulations. This verification was not audited.

On-Call Environmental Services, Connecticut Statewide, Connecticut Department of Transportation (ConnDOT). Project Manager for an on-call environmental services. The project included environmental compliance activities for ConnDOT facilities and environmental evaluations to determine the relative environmental risk associated with land uses in the vicinity of transportation projects; surficial, exploratory, site impact, water quality, and remedial investigations; remedial management planning; both groundwater and soil remedial design development; water supply rehabilitation, including water supply treatment, public supply connection, supply well replacement, and public water supply extension. Construction management tasks include compliance management, surveillance, and inspection.

Investigation and Remediation of UI's Former Skiff Street Service Center, Hamden, Connecticut, The United Illuminating Company. Project Manager and licensed environmental professional (LEP) for Phase III investigation, remedial action plan, and remediation of this petroleum and PCB-impacted site. Remediation included removal of PCB-impacted soil under EPA's self-implementing PCB-remediation waste regulations, and removal of petroleum-contaminated soils from a sheet piled excavation with pre-determined cut lines including permitting and discharge of construction dewatering wastewaters. Final verification that this site was made and accepted by the CTDEP.

Investigation of UI's Vehicle Maintenance Facility, Shelton, Connecticut, The United Illuminating Company. Project Manager and licensed environmental professional (LEP) for Phase I to III environmental site assessments under the Transfer Act. Work included preparation of an ECAF and Form III. Investigation of potential releases of hydraulic oil from vehicle lifts, surfical petroleum contamination, and historical urban fill were completed.

LORIE MACKINNON
DATA VALIDATOR

resume

Ms. MacKinnon is a data validator with 18 years of experience at GEI.

EXPERIENCE IN THE INDUSTRY
19 years

EXPERIENCE WITH GEI
19 years

EDUCATION
B.A., Chemistry, Boston University

RELEVANT PROJECT EXPERIENCE

Self-Employed Contractor, Data Validator. Performing data validation in accordance with the United States Environmental Protection Agency (EPA) Region I, Region II and Region IV, EPA National Functional Guidelines, and New Jersey Department of Environmental Protection (DEP) Guidelines for environmental consulting firms. Responsible for producing data validation reports and data spreadsheets.

Data Validator, GEI Consultants, Inc. Performing data validation in accordance with EPA Region I and Region II, EPA National Functional Guidelines, and New Jersey DEP Guidelines. Responsible for in-house review of all project data.

Inorganic Contract Laboratory Protocol (CLP) Coordinator. Responsible for CLP data management and data package review for the inorganic laboratory to ensure a high level of data quality.

Jacobs Engineering Group Inc. Performed data validation in accordance with Jacobs' modified Region I guidelines.

Independent Consultant. Performed methods development and validation for EPA Method 218.6, Hexavalent Chromium Analysis by High Performance Liquid Chromatography, and EPA Method 610, Polynuclear Aromatic Hydrocarbon Analysis by High Performance Liquid Chromatography. Developed standard operating procedures for both methods, allowing NET to offer these analytical procedures as routine services.

Quality Assurance Coordinator. Responsible for developing and overseeing the laboratory quality assurance and quality control practices to ensure that a high level of data quality is achieved. Responsible for the submission of performance evaluation samples from external regulating agencies and managing a program of internal performance evaluation audits for the Cambridge Division and subcontract laboratories. Acted as the primary contact for state and program-specific certification programs and, as such, was responsible for communicating all audit and PE sample results and corrective action responses.

Supervisor, Wet Chemistry Laboratory. Responsible for

training and performance of all laboratory technicians, as well as troubleshooting and instrument maintenance. Duties also included the scheduling of inorganic work in house, and reviewing and reporting all analytical results. Responsible for the preparation, analysis, and reporting of cyanide under EPA CLP protocol.

Project Manager. Responsibilities included defining the scope of work with a variety of industrial, engineering and governmental clients, developing price quotations, outlining the required quality control/quality assurance, arranging sampling and analytical schedules with the laboratory director and managers, and monitoring the project to its completion, including data review and report production.

Lead Project Chemist. Performed method development, validation, and residue analysis for several pesticide registration studies. Analyses included the use of gas chromatography and high-performance liquid chromatography.

Associate Scientist. Performed inorganic analyses on environmental and industrial samples. Analytical skills included quantitation of analytes by inductively coupled argon emission spectroscopy and atomic absorption spectroscopy under EPA CLP protocols.

Title: Volatile Organic Compounds by GC/MS
SW-846 8260B, SW-846 5030B, SW-846 5035 and SW-846 5035A

Approval Signatures:

William Cicero
Laboratory Director

Kirstin Daigle
QA Manager

Brad Chirgwin
Technical Manager

Kristine Dusablon
Department Manager

Dan Helfrich
EH&S Coordinator

Approval Date: September 7, 2012

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1.0 Scope and Application

This SOP describes the laboratory procedure for the determination of volatile organic compounds (VOCs) by GC/MS.

This SOP is applicable to the procedure for the determinative method. Sample preparation and screen procedures are described in laboratory SOP BR-MV-007.

1.1 Analytes, Matrix(s), and Reporting Limits

This procedure may be used for a variety of matrices including: water, soil, sediment, and TCLP leachates.

The laboratory's list of analytes that can be determined by this SOP is provided in Attachment 1 along with the compound's associated reporting limit (RL). The RLs listed represent those that can be achieved in a blank matrix at 100% dry weight. RLs associated with field samples will vary based on sample matrix, analyte concentration, co-extracted interferences and the percent moisture of sample. The RL for methanol extracts (MeOH) is based on a preparation factor of 5 g of sample to 10 mL of methanol.

2.0 Summary of Method

Compounds are introduced into the GC/MS system by purge-and-trap (SW-846 Method 5030) or closed-system purge-and-trap (SW-846 5035, SW-846 5035A). The VOCs are introduced directly to a capillary column where a temperature program is used to separate the analytes which are then detected with a mass spectrometer interfaced to the gas chromatograph (GC/MS).

This procedure is based on the following reference methods:

- SW-846 Method 8260B, Revision 2, December 1996.
- SW-846 Method 5030B, Revision 2, December 1996.
- SW-846 Method 5035, Revision 0, December 1996.
- SW-846 Method 5035A, Draft Revision 1, July 2002.

If the laboratory has modified its procedure from the reference method, a list of method modifications will be provided in Section 16.0.

3.0 Definitions

A list of terms and definitions are provided in Appendix A.

4.0 Interferences

Major contaminant sources are volatile materials in the laboratory and impurities in the inert purging gas and in the sorbent trap. The use of Teflon tubing, Teflon thread sealants, or flow controllers with rubber components in the purging device should be avoided since such materials out-gas organic compounds which will be concentrated in the trap during the purge operation. Analyses of laboratory reagent blanks provide information about the presence of contaminants. Subtracting blank values from sample results is not permitted.

Interfering contamination may occur when a sample containing low concentrations of volatile organic compounds is analyzed immediately after a sample containing relatively high concentrations of volatile organic compounds. The auto-sampler utilizes a single purge vessel that is automatically rinsed between analyses. After analysis of a sample containing high concentrations of volatile organic compounds, one or more laboratory reagent blanks may be analyzed to check for carry-over.

The analytical and sample storage area should be isolated from all atmospheric sources of methylene chloride; otherwise, random background levels will result. Since methylene chloride will permeate Teflon tubing, all GC carrier gas lines and purge gas plumbing should be constructed of stainless steel or copper tubing. Laboratory worker's clothing should be cleaned frequently since clothing previously exposed to methylene chloride fumes during common extraction procedures can contribute to sample contamination. Extraction laboratory personnel should not enter the volatile analytical laboratory.

Traces of ketones, methylene chloride, and some other organic solvents can be present even in the highest purity methanol. This is another potential source of contamination, and should be assessed before standards are prepared in the methanol.

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

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.

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

The following analytes have been tentatively classified as known or suspected human or mammalian carcinogens: benzene, carbon tetrachloride, 1,4-dichlorobenzene, 1,2-dichlorethane, hexachlorobutadiene, 1,1,2,2-tetrachloroethane, 1,1,2-trichloroethane, chloroform, 1,2-dibromoethane, tetrachloroethene, trichloroethene, and vinyl chloride.

5.2 Primary Materials Used

Table 2 lists those materials used in this procedure that have a serious or significant hazard rating along with the exposure limits and primary hazards associated with that material as identified in the MSDS. **NOTE: This list does not include all materials used in the method.** 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.

6.0 Equipment and Supplies

Catalog numbers listed in this SOP are subject to change. Analysts are instructed to ensure equipment used meets the specification of this SOP.

6.1 Miscellaneous

- 44 mL VOA Vials. ESS or equivalent.
- 1-5 mL Mini-Inert Vials with Teflon Lined Screw Caps. Restek brand or equivalent.
- Gas-Tight Syringe(s) 250 uL-10 mL, Hamilton or equivalent.

6.2 Purge and Trap

- Purge & trap Device: Tekmar LCS 2000, Tekmar Velocity, EST Encon Evolution, or equivalent.
- Autosampler: EST Archon, EST Centurion or equivalent.
- Trap: Supelco, VOCARB 3000 trap or equivalent

6.3 Instrumentation

- Gas Chromatograph: Hewlett-Packard 5890 Series II and 6890
- Mass Spectrometer: Hewlett-Packard 5971 MSD, Hewlett-Packard 5973 MSD
- Primary Column: Fused silica capillary column, 75 m x 0.53 mm x 3.0 um: J&W DB624 or equivalent. J&W DB624 25m x 0.200mm x 1.12um or equivalent

6.4 Software

- GC/MS Acquisition Platform - Hewlett-Packard ChemStation.
- Data Processing - Hewlett-Packard 9000-series computers, an HP9000 D250, HP 9000 K200 / HP-UX 10.20 and Target V3.5, TestAmerica Chrom and TestAmerica LIMS (TALS).

7.0 Reagents and Standards

7.1 Reagents

- Methanol (CH_3OH), Purge & Trap Quality: Company Approved Vendor: Mallinckrodt-Baker P&T Grade methanol or equivalent.

VOA-Free Reagent Water: Boil RO water for 1 hour then purge with helium.

7.2 Standards

Purchase stock standard solutions from commercial vendors and from these prepare calibration and working standards by diluting a known volume of stock standard in an appropriate solvent to the final volume needed to achieve the desired concentration. The recommended formulation for each standard used in this procedure is provided in Appendix B along with the recommended source materials, expiration dates and storage conditions.

8.0 Sample Collection, Preservation, Shipment and Storage

The laboratory does not perform sample collection so these procedures are not included in this SOP.

Listed below are the laboratory recommended minimum sample size for collection and the method required preservation and holding time requirements:

Matrix	Sample Container	Minimum Sample Size	Preservation	Holding Time	Reference
Water	Glass	40 mL (3)	See Note	See Table 2	SW-846
Soil	Various	150 g	See Note	See Table 2	SW-846

The laboratory requires a minimum sample volume of 3 x 40 mL vials for waters and 3 x 5.0 g aliquots for soils. The laboratory recommends that each water sample be collected in triplicate to ensure sufficient volume for screen analysis and pH measurement, and reserve. The container type for soils depends on the collection method used.

Note: The SW-846 methods include several different types of sample preservation. The most common preservation techniques are to acidify water samples to a pH <2 with hydrochloric acid (HCl) and to preserve soils with sodium bisulfate. Both matrices after collection should be cooled to 4± 2ºC and kept at this temperature until analysis. Adjusting the pH of a soil, sediment or solid waste sample may cause interferences and samples that contain carbonates should not be acidified due to effervescence which may cause a loss of VOCs. Some compounds, such as olefins, ketones, esters, ethers and sulfides may react under conditions of low pH and then may no longer represent the actual sample material. Acidification can also lead to losses of highly reactive compounds such as 2-chloroethylvinylether and acidification of certain soils with sodium bisulfate may produce a false positive for acetone. To counter these interferences, new techniques for preserving samples as described in SW-846 Method 5035A. A summary of the various preservation techniques used by the laboratory and associated holding times is provided Table 3 and also in laboratory SOP BR-MV-007. The actual preservation technique used for individual projects should be selected based on regulatory requirements and project data quality objectives.

Unless otherwise specified by client or regulatory program, after analysis, samples and extracts are retained for a minimum of 30 days after provision of the project report and then disposed of in accordance with applicable regulations.

9.0 Quality Control

9.1 Sample QC

The laboratory prepares the following quality control samples with each analytical window of samples.

QC Item	Frequency	Acceptance Criteria
Method Blank (MB)	1 in 20 or fewer samples	See Table 4
Laboratory Control Sample (LCS)	1 in 20 or fewer samples	See Table 4
Matrix Spike(s) (MS/MSD)	Client Request	See Table 4
Sample Duplicate	Client Request	See Table 4

The composition of the MB and the LCS are matched to the matrix of the samples for which they are associated. For instance, when soil samples are analyzed medium level, a MB and LCS comprised of methanol will be analyzed with the samples and these QC samples will be associated with the samples for reporting purposes.

Surrogate standards are added to all field and QC samples prior to analysis to assess the effect of the sample matrix on the accuracy of the method in the specific sample matrix.

Internal standards are added to all field and QC samples prior to analysis.

9.2 Instrument QC

The following instrument QC is performed:

QC Item	Frequency	Acceptance Criteria
Tune Standard (BFB)	Prior to calibration and every 12 hours	See Table 3
5- Point Initial Calibration (ICAL)	Prior to initial sample analysis; when ICV or CCV fail	See Table 4
Second Source Calibration Verification (ICV)	Once after each ICAL	See Table 4
Continuing Calibration Verification (CCV)	Daily, every 12 hours after BFB	See Table 4

10.0 Procedure

10.1 Instrument Operating Conditions

10.1.1 Archon Auto Sampler

Water and Medium Level Soils (MeOH): Program the autosampler to pull 5 mL of sample from each vial. The autosampler is designed to pierce the vial septa with the water side needle and pull the aliquot using vacuum after which the sample is transferred to the purge vessel. After each sample, the autosampler flushes the sample pathway with VOA free reagent water.

Low Level Soils: Program the autosampler to place the vial in position. When in position the autosampler adds 5 mL of VOA free water to the sample then preheats the sample to 40°C for 1 minute. The sample is purged with helium while simultaneously being mixed with a magnetic stir

bar. After each sample, the autosampler flushes the sample pathway with VOA free reagent water.

10.1.2 GC/MS

Set the GC/MS to acquire and store data over the mass range of 35-300 atomic mass units (amu) with a total cycle time (including scan overhead time) of one second as generated from a nominal ionization energy of 70 electron volts. Adjust the cycle time to measure five or more spectra during the elution of each GC peak. Use a multi-stage temperature ramp to separate the components of interest for this analysis.

A typical GC temperature program is described below:

Initial temperature:	40°C
Initial time:	4 min.
Ramp1:	7°C/min. to 100° C.
Ramp2:	4.2°C/min. to 120°C, hold for 0 min.
Ramp3:	28°C/min. to 220°C, hold for 2.7 min.
Carrier Gas:	Helium

The conditions listed above may be changed however once the operating conditions are established for the initial calibration, the same operating conditions must be used for the subsequent analysis of instrument performance check standards, QC and field samples.

10.2 Retention Time

Establish component retention times from the most recent calibration standard plus or minus 0.06 RRT units (RRT)

10.3 Instrument Calibration

10.3.1 Tune Standard

Prior to initial calibration (ICAL) and every 12 hours check the tuning of the instrument with analysis of the tune standard, 4-Bromofluorbenzene (BFB).

Prepare the BFB standard solution (25 ug/mL) using the formulation provided in Appendix B.

Manually inject 2 uL of the BFB solution into the GC to yield an on-column concentration of 50ng.

The data processing system acquires and averages three scans (apex scan, scan prior, and scan preceding) and performs background subtraction of the single scan prior to the elution of the BFB.

Evaluate the result. The BFB must meet the ion criteria given in Table 3. If criteria are not met, correct the problem and retune the instrument.

The official start time of the 12-hour analytical window is the time of the BFB injection. All samples must be injected within 12 hours of that time.

10.3.2 Initial Calibration (ICAL)

The instrument must be calibrated with a minimum of five calibration standards for each target analyte at concentrations that span the working range of the method. Repeat initial calibration whenever instrument operating conditions are changed, a new column is installed, when significant instrument maintenance has been performed, and when the result of the CCV indicate the calibration is no longer valid.

The laboratory performs two different calibration schemes for this test method. One calibration is used for water and methanol extracts; the other calibration is used for low level soils.

Prepare the calibration standards using the formulations provided in Appendix B.

Analyze the standards in a sequence using the instructions provided in Section 10.5.

Each of the following criteria must be met for each analyte that is to be reported from the calibration. If criteria are not met, the problem must be corrected and the initial calibration repeated. Samples may not be analyzed against a calibration curve that does not meet the following criteria. All calculations are performed by the data processing system, which is defaulted to RSD for quantification.

1) System Performance Check Compounds (SPCCs): The average RF must be $\geq$ 0.30 for Chlorobenzene and 1,1,2,2-tetarchloroethane and $\geq$ 0.10 for chloromethane, bromoform and 1,1-dichloroethane.

2) Calibration Check Compounds (CCCs): The %RSD must be $\leq$ 30% for: 1,1-Dichloroethene, Toluene, Chloroform, Ethylbenzene, 1,2-Dichloropropane, and Vinyl chloride.

3) The Relative Retention Time (RRT) for each analyte in each calibration standard must agree within 0.06 RRT units.

4) The RSD for each analyte in the calibration must be less than or equal to 15% in order to use the mean RF or quantification. If this criterion is not met, use linear or weighted linear regression for the analyte that did not meet RSD criterion. To use linear (or weighted linear) use the data processing system to generate a curve of concentration vs. response. The data system calculates the correlation coefficient. The correlation coefficient (r) must be $\geq$ 0.995. If (r) is not met, then troubleshoot to determine cause, correct the problem, and repeat initial calibration. Note that the use of linear regression requires a minimum of 5 calibration points. Refer to SW-846 Method 8000B or 8000C for linear regression calculations.

ICAL Criteria Exception(s):

- Individual analytes that do not meet ICAL criteria may be reported from the ICAL when the analyte is not included in the reporting list for individual samples. For example, if a client has a short list of target analytes requested for a set of samples and the calibration passes criteria for each analyte in the client list; the ICAL may be used for these project samples because the ICAL failures do not have an effect on the individual analytes requested. With this exception a TALS nonconformance memo (NCM) is not required.

- Individual analytes that fail ICAL criteria may be reported as estimated values during the time-frame in which corrective action is taking place. If this exception is used; document the ICAL failure for the individual analytes with an NCM. The NCM must be associated to the samples affected. In other words, initiate an NCM for each batch of samples associated to the ICAL

instead of an NCM associated to the ICAL batch. To clarify, samples affected means any sample in which the individual analyte that that did not meet ICAL criteria is reported regardless if the analyte is detected. The NCM will alert the project manager to identify the exception in the report narrative and to specify the results for these individual analytes are classified as estimated values. The internal comment tab of the NCM report should include the suspected cause for the ICAL failure and the corrective actions that are underway to correct the problem.

10.3.3 Second Source Calibration Verification (ICV)

Verify the accuracy of the initial calibration by analyzing a second source standard (ICV).

Prepare the ICV standard using the formulations provided in Appendix B. Analyze the ICV following the procedure specified in Section 10.5. Acquire the data and evaluate the result.

The percent recovery for each analyte included in the calibration must be within ± 25% of the expected value. If this criterion is not met, correct the problem and reanalyze the ICV. If the reanalysis of the ICV fails, remake the calibration standards and repeat the initial calibration.

ICV Criteria Exception:

- Individual analytes that fail ICV criteria may be reported as estimated values during the time-frame in which corrective action is taking place. If this exception is used; document the ICV failure for the individual analytes with an NCM. The NCM must be associated to the samples affected. In other words, initiate an NCM for each batch of samples associated to the ICV batch (which should be the same TALS batch as the ICAL) instead of an NCM associated to the batch that includes the ICV. To clarify, samples affected means any sample in which the individual analyte that that did not meet ICV criteria is reported regardless if the analyte is detected. The NCM will alert the project manager to identify the exception in the report narrative and to specify the results for these individual analyte(s) are classified as estimated values. The internal comment tab of the NCM report should include the suspected cause for the ICV failure and the corrective actions that are underway to correct the problem.

If after successful analysis of the ICV, time remains in the 12-hour analytical window samples may be analyzed without analysis of a continuing calibration verification standard (CCV); otherwise a CCV must be performed.

10.3.4 Troubleshooting:

- Chloromethane response can be low if the purge flow is too fast.
- Bromoform response can be low if the purge flow is too slow. Cold spots and/or active sites in the transfer lines may adversely affect response. Response of the quantification ion (m/z 173) is directly affected by the tuning of BFB at ions m/z 174/176. Increasing the m/z 174/176 ratio relative to m/z 95 may improve bromoform response.
- Contaminated transfer lines in purge-and-trap systems and/or active sites in the trap can degrade the response of Tetrachloroethane and 1,1-dichloroethane.
- 2-Chloroethylvinylether response can be drastically affected/suppressed by soil, foam, or other artifacts contaminating the inside of the soil purge needle. It is also susceptible to active sites/contamination anywhere in the helium path from the autosampler (soils) to the injection port on the GC.

- If the response of the later eluting compounds is low, especially with soils, the purge flow may have been reduced by an obstruction in the helium flow path.
- Poor chromatography and response of the gases are often the result of incorrect placement of the column head in the injection port and/or contamination of the first 6-10 inches of the column from samples and small pieces of injection port septum.
- Erratic response of various compounds and unstable calibrations can be the result of a worn out/contaminated purge trap. Variable matrices such as tissues, soils and moderately foamy samples can be the cause. Samples high in late eluting hydrocarbons or sulfur dioxide will also degrade the trap.

10.3.5 Continuing Calibration Verification (CCV)

Analyze a CCV each day prior to sample analysis and every 12 hours of analysis time. The 12-hour window is established from the injection time of the BFB.

Prepare the CCV standard(s) using the same source used to prepare the calibration standards at a concentration near the mid-level of your calibration range (Level 4). The recommended formulations for the CCV standards associated with each calibration scheme are provided in Appendix B. Analyze the CCV following the procedure specified in Section 10.5.

The data processing system acquires and calculates the RF and percent difference or drift for each target analyte and surrogate standard.

The following criteria must be met:

1) The average RF for the SPCCs must be $\geq$ 0.30 for Chlorobenze and 1,1,2,2-tetarchloroethane and $\geq$ 0.10 for chloromethane, bromoform and 1,1-dichloroethane.

2) The percent difference / drift for the CCCs must be ≤ 20%. If the CCC's are not included in the target analyte list, then the target analytes should be within criteria. The analytes that are CCCs are identified in Table 1.

3) The internal standard retention time must be ± 30 seconds from the RT of the midpoint standard in the ICAL and the extracted ion current profile (EICP) area must be within -50% to +100% of the midpoint standard in the ICAL.

If the above criteria are not met, repeat the analysis of the CCV once. If the second CCV meets criteria, continue with the analytical sequence. If it fails, evaluate the data to determine if one of the following conditions is met:

- If the CCV criteria are exceeded high, indicating a high bias, and the associated samples have non-detects for those analytes, the analytical data may be considered usable. In the absence of instructions otherwise, proceed with analysis.

- If the CCV criteria are exceeded low, indicating a low bias, analytical results may be reported if those results exceed the project's regulatory decision level. In other words, if the analytical results are sufficiently high to counter the low bias, results may be reported. Consult with the project manager to determine if the exception is allowable for each project.

If these conditions are not met or it is suspected that the failure is caused by instrument failure, perform corrective action. After corrective action is performed, recalibrate the instrument

10.4 Sample Preparation

These sections describe the sample preparation procedures performed immediately prior to instrument analysis. The procedure for sample handling, preservation checks and screen analysis is described in a separate SOP.

See Attachment 2 for spike and surrogate amounts.

Note: The laboratory adds surrogate and spike standards directly to the 44 mL vial. The laboratory's LIMS system TALS bases all calculations on a vial volume of 40 mLs. To ensure the calculations work properly, the laboratory must convert the spike amount added to compensate for the difference in volume and enter the converted spike amount into the TALS system. See the documents in Attachment 2 for more information.

Water:

1) Warm the samples to ambient temperature and inspect each vial to ensure it is hermetically sealed and does not contain air bubbles. If an air bubble is present, do not use the vial.

2) Check the screen results. If the screen data indicates a dilution is needed, prepare the dilution as follows: Partially fill a 44 mL vial with VOA-free water. Inject the proper amount of sample to the vial and adjust the volume to 44 mL with reagent water. The sample aliquots used for dilution preparation should not be less than 1 mL. Repeat this procedure as needed to achieve additional dilutions (serial dilutions).

3) To prepare the MB and LCS fill a 44 mL VOA vial with VOA-free reagent water.

4) Using a gas tight syringe add an appropriate volume of internal standard and surrogate solution to each vial through the septum of the vial.

5) Using a gas tight syringe add the appropriate volume of spike solution to the LCS and each MS/MSD.

MeOH Extracts:

1) Warm the samples to ambient temperature.

2) Check the screen results. If the screen data indicates a dilution is needed, prepare the dilution as follows: Fill a 44 mL vial with VOA-free water. Inject the proper amount of sample to the vial and adjust the volume. Repeat this procedure as needed to achieve additional dilutions (serial dilutions).

3) For each sample and MS/MSD, fill a 44 mL VOA vial with VOA free reagent water and transfer 880 uL of the extract to the vial.

4) To prepare the MB and LCS fill a 44 mL vial with VOA-free water and add 880 uL of methanol to the vial.

6) Using a microliter syringe add an appropriate volume of internal standard and surrogate solution to each vial through the septum of the vial.

7) Using a microliter syringe add the appropriate volume of spike solution to the LCS and each MS/MSD.

Soil (Sodium Bisulfate Preserved)

1) Warm the samples to ambient temperature.

2) Check the screen results. If the screen data indicates a dilution is needed, prepare samples for medium level analysis by following the procedure for MeOH Extracts.

3) To prepare the sodium bisulfate preserved MB and LCS add 5 g of Ottawa sand to a pre-preserved sodium bisulfate 44 mL vial then immediately reseal the vial with the screw cap and septum seal.

4) Using a microliter syringe add an appropriate volume of internal standard and surrogate solution to each vial through the septum of the vial.

5) Using a microliter syringe add the appropriate volume of spike solution to the LCS and each MS/MSD.

Soil (Frozen Water Preserved)

1) Warm the samples to ambient temperature, and inspect each vial to ensure it is intact and free of cracks.

2) To prepare the frozen water MB and LCS use a prepared 44ml vial with VOA free water and stir bar.

3) Using a microliter syringe add an appropriate volume of internal standard and surrogate solution to each vial through the septum of the vial.

4) Using a microliter syringe add the appropriate volume of spike solution to the LCS and each MS/MSD.

10.5 Sample Analysis

Arrange the vials in a sequence that begins with the instrument performance check samples followed by QC and field samples.

An example analytical sequence that includes initial calibration (ICAL) is provided below.

Injection Number	Lab Description
1	BFB
2	ICAL Level 1
3	ICAL Level 2
4	ICAL Level 3
5	ICAL Level 4

6	ICAL Level 5
7	ICAL Level 6
8	Cleaning Blank
9	ICV
10	LCS
11	Cleaning blank
12	Method Blank
13-X	samples

NOTE: Analyze a MB and the LCS every 20 samples.

Enter the sample ID's into the data acquisition program in the order the samples were placed in the autosampler and initiate the analytical sequence.

After analysis, check and record the pH of the vial analyzed. Record the pH in the instrument run log and in the TALS worksheet.

11.0 Calculations / Data Reduction

11.1 Qualitative Identification

The data processing system tentatively identifies target analytes by comparing the retention time of the peaks to the window set around the continuing calibration standard, and searches in that area for the primary ion and up to two secondary ions characteristic of the target analyte.

All tentative identifications made by the computer are reviewed and either accepted or rejected by the primary analyst. The identification made by the system is accepted when the following criteria are met:

- Compare the background subtracted mass spectrum for each analyte to the reference spectrum in the user-created database. All ions present above 10% relative abundance in the mass spectrum of the standard should be present in the mass spectrum of the sample component and their relative abundances should agree within 20%.For example, if an ion has a relative abundance of 30% in the standard spectrum, its abundance in the sample spectrum should be in the range of 10-50%. Some ions, particularly the molecular ion, are of special importance if a tentative identification is to be made, and should be evaluated even if they are below 10% relative abundance.

- The GC retention time for the target analyte should be within 0.06 RRT units of the daily CCV standard.

- When GC peaks obviously represent more than one sample component (i.e., broadened peak with shoulder(s) or valley between two or more maxima), select appropriate analyte spectra and background spectra by examining plots of characteristic ions for tentatively identified components. When analytes co-elute (i.e., only one GC peak is apparent), identification criteria can be met but each analyte spectrum will contain extraneous ions contributed by the coeluting compound. Because purgeable organic compounds are relatively small molecules and produce comparatively simple mass spectra, this is not a significant problem for most method analytes.

- Structural isomers that produce very similar mass spectra can be explicitly identified only if they have sufficiently different GC retention times. Acceptable resolution is achieved if the height of the valley between two peaks is less than 25% of the average height of the two peaks. Otherwise, structural isomers are identified as isomeric pairs. Two of the three isomeric xylenes (m,p) are examples of structural isomers that are not resolved on the capillary column. These groups of isomers will be reported as isomeric pairs.

Identification requires expert judgment when sample components are not resolved chromatographically and produce mass spectra containing ions contributed by more than one analyte. When GC peaks obviously represent more than one sample component (i.e., broadened peak with shoulder(s) or valley between two or more maxima), appropriate analyte spectra and background spectra can be selected by examining plots of characteristic ions for tentatively identified components. When analytes coelute (i.e., only one GC peak is apparent), the identification criteria can be met but each analyte spectrum will contain extraneous ions contributed by the coeluting compound. If the data system does not properly integrate a peak, perform manual integration. All manual integration must be performed and documented in accordance with laboratory SOP BR-QA-006 *Manual Integration*.

11.1.1 Tentatively Identified Compounds (TICs)

Evalute for and report TICs when requested for the project.

To evaluate for TICs: Perform the library search, and visually compare the sample spectra with the nearest library search and assign a tentative identification If the match is 85% or greater use the name generated by the library search program otherwise call it an unknown. The library search should not include peaks that are < 10% of the nearest non contaminated internal standard, target analytes, or peaks that elute earlier than 30 seconds before the first target analyte.

Use the following criteria to qualitatively identify these compounds:

- Relative intensities of ions greater than 10% of the most abundant ion in the reference spectrum should be present in the sample spectrum.

- The relative intensities of the major ions should agree within ± 20%.

- Molecular ions present in the reference spectrum should be present in the sample spectrum.

- Ions present in the sample spectrum but not in the reference spectrum should be reviewed for possible background contamination or presence of coeluting compounds.

Once identified, the concentration of TICs are calculated using an RF of 1.00.

11.2 Quantitative Identification

After a compound has been identified, the data system quantifies the on-column concentration of the target compound based on the integrated abundance of the characteristic ion from the EICP. If there is matrix interference with the primary ion, a secondary ion may be used for quantification by calculating a mean RF factor for that ion and using that ion to quantify the analyte in the sample. When secondary ion calculations are required, include this information in the non-conformance report and project narrative.

Final results are calculated in TALS.

When quantification from a secondary ion is performed, document the situation with a NCM to notify the PM for discussion in the project narrative.

11.3 Calculations

See Appendix C.

11.4 Data Review

11.4.1 Primary Review (Performed by Primary Analyst)

Review the chromatography and quantitation in the data processing system to confirm quantitative and qualitative identification of each target analyte.

Upload the data files to TALS. Enter batch editor information and add the standards and reagents to the TALS batch. Review the results against acceptance criteria. If acceptance criteria are not met, make arrangements to perform corrective action.

Check the results of samples analyzed immediately after high concentration samples for signs of carry-over. Reanalyze the sample if carry over is suspected.

Dilute and reanalyze samples whose results exceed the calibration range. The diluted analysis should result in a determination within the upper half of the calibration curve.

Set results to primary, secondary, acceptable or rejected as appropriate.

Verify corrective action was taken for all results not within acceptance criteria. If corrective action is not taken or was unsuccessful, record all instances where criteria are not met with a nonconformance memo (NCM). Be sure to provide explanation of your decision making in the internal comment section of the NCM. The internal comment section should list the reason the NCM is suspected, which action (if any) was taken and why and the outcome of the action taken.

Review project documents such as the Project Plan (PP), Project Memo or any other document/process used to communicate project requirements to ensure those project requirements were met. If project requirements were not met, immediately notify the project manager (PM) to determine an appropriate course of action.

Set the batch to 1st level review.

11.4.2 Secondary Review (Performed by Peer Reviewer)

Review the project documents such as the Project Plan (PP), Project Memo or any other document/process used to communicate project requirements and verify project requirements were met. If project requirements were not met, immediately notify the project manager (PM) to determine an appropriate course of action.

Review the TALS batch editor to verify information is complete. Review the batch to verify that the procedures in this SOP were followed. If discrepancy is found, resolve the discrepancy and verify any modifications to the SOP are documented and approved.

Spot-check 15% of samples in the batch to verify quantitative and qualitative identification.

If manual integrations were performed:

- Review each manual integration to verify that the integration is consistent and compliant with the requirements specified in laboratory SOP BR-QA-005.

- Check to ensure an appropriate technical reason code is provided for each manual integration. Acceptable technical reason codes are provided in laboratory SOP BR-QA-005.

- Generate a "before" and "after" chromatogram for every manual integration performed on an instrument performance check standard (Tune, ICAL, ICV, CCV), QC sample (MB, LCS) and for any manual integration performed on any surrogate or internal standard in any field sample.

- Generate the Manual Integration Summary Report. Document your review of manual integrations on the summary report and obtain any review signatures of integrations performed during secondary review as required.

  If the reviewer disagrees with the integration performed by the primary analyst, the secondary data reviewer should not change the integration. Instead, he/she should consult with the primary analyst that performed the integration and both the reviewer and the primary analyst should agree the integration should be changed. If consensus between the primary analyst and the peer reviewer cannot be achieved; both should consult with the Technical Manager or department management for resolution. Any changes to the integration should be performed by the primary analyst. If it is necessary for the secondary reviewer to perform the manual integration because the primary analyst is out of the office; the integration made by the peer reviewer must be reviewed by another peer reviewer or by department management to verify the integration was performed and documented in compliance to SOP BR-QA-005. If the original analyst that performed the integration is out of the office, the data reviewer may consult with the Department Manager (DM), Department Supervisor (DS) or the Technical Manager (TM) to verify the change he/she thinks is needed is warranted and should be made.

Verify that the performance criteria for the QC items listed in Table 1 were met. If the results do not fall within the established limits verify that corrective actions were performed. If corrective action was not performed; verify the reason is provided and that the situation is properly documented with an NCM. Set samples to 2nd level review.

Run the QC checker and fix any problems found. Run and review the deliverable. Fix any problems found. When complete set the method chain to lab complete and forward any paperwork to report/project management.

11.5 Data Reporting

Data reporting and creation of the data deliverable is performed by TALS using the formatters set by the project manager during project initiation.

Electronic and hardcopy data are maintained as described in laboratory SOP BR-QA-014 Laboratory Records.

11.0 Method Performance

12.1 Detection Limit (DL), Limit of Detection (LOD) & Limit of Quantitation (LOQ)

Perform a DL study and verification at initial method set-up and when there is a significant change in instrumentation or procedure that affects the sensitivity of the method. See SOP BR-QA-005 for the procedure and requirements.

12.2 Demonstration of Capabilities (DOC)

Perform a method demonstration of capability at initial set-up and any time there is a significant change in instrumentation or procedure.

12.3 Training Requirements

Any employee that performs any portion of the procedure described in this SOP must have documentation in their employee training file that they have read this version of this SOP.

Instrument analysts, prior to independent analysis of client samples, must also have documentation of demonstration of initial proficiency (IDOC) and annual on-going proficiency (ODOC) in their employee training files.

12.0 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 Safety Manual for "Waste Management and Pollution Prevention."

13.0 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 BR-EH-001.

The following waste streams are produced when this method is carried out.

- Aqueous Waste with pH between 4 and 9: Collect non-contaminated waste in a labeled 4 liter plastic satellite container. When satellite container is full, dispose the waste down the drain. Segregate any sample with a detect of target analyte for disposal by authorized personnel.

- Solvent Waste: Transfer to a labeled 4 liter glass satellite container kept in the fume hood. When the satellite container is full, notify the Hazardous Waste Coordinator who will arrange

for transport of the waste to the hazardous waste room or to the solvent waste drum located in the extraction laboratory.

- Solid Waste in VOA Vial: Collect the vials in labeled 5 gallon plastic satellite containers located under each instrument bench. When the satellite container is full, notify the Hazardous Waste Coordinator who will arrange for transport of the waste to the hazardous waste room.

- Expired Standards: Place in a plastic bags and transport to the hazardous waste room for subsequent disposal by authorized personnel.

14.0 Method Modifications

Modification Number	Method Reference	Modification
1	Method 5030B-8 Sec. 7.2.4.6.1	The laboratory prepares dilutions in 44 mL vials using gastight syringes or a 1-10 mL adjustable pipette.

15.0 References / Cross-References

- SW-846 Method 8260B, Revision 2, December 1996.
- SW-846 Method 5030B, Revision 2, December 1996.
- SW-846 Method 5035, Revision 0, December 1996.
- SW-846 Method 5035A, Draft Revision 1, July 2002.
- Laboratory SOP BR-QA-005
- Laboratory SOP BR-QA-011
- Laboratory SOP BR-LP-011
- Laboratory SOP BR-QA-014
- Laboratory Quality Assurance Manual (QAM)

16.0 Attachments

- Table 1: Primary Materials Used
- Table 2: Recommended Preservation Technique and Holding Tims
- Table 3: Tune Criteria
- Table 4: QC Summary and Recommended Corrective Action
- Appendix A: Terms and Definitions
- Appendix B: Standard Preparation Formulations
- Appendix C: Equations
- Attachment 1: Target List, RL, Limits and Supporting Information
- Attachment 2:

17.0 Revision History

BR-MV-006, Revision 9

- Updated Approval signatures
- Updated data review section to clarify responsibilities for each review function.

- Updated procedure for initial calibration to clarify criteria, when an exception may be allowed and requirements for the qualification of data.
- Updated control limits and replaced several tables in the prior version with tables now in Attachment 1 and Attachment 2.

BR-MV-006, Revision 8

- Updated Approval Signatures and Copyright
- Updated data review section to conform to laboratory SOP for data review and added LIMS procedures.
- Changed terms in method performance section from MDL to LOD and LOQ.
- Removed all references to DoD protocol.
- Removed Appendix E for marginal exceedance evaluation.

BR-MV-006, Revision 7

- This version of the SOP is a complete re-write from previous versions. All sections were significantly revised to be consistent with current practice and to incorporate purge and trap and autosampler conditions.

Table 1: Primary Materials Used

Material[1]	Hazards	Exposure Limit[2]	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] *Always add acid to water to prevent violent reactions.*
[2] *Exposure limit refers to the OSHA regulatory exposure limit.*

Table 2: Recommended Sample Preservation Technique and Holding Times

Matrix	Preservation[1]	Holding Time[2]	Reference
Water	Collect in HCl pre-preserved container and cool to 4± 2ºC until time of analysis.	If pH on laboratory receipt is <2, 14 days. If pH > 2, 7 days.	SW-846 5030B
Water	Cool to 4± 2ºC until time of analysis.	7 days	SW-846 5035A
Soil	Sample is cooled upon collection to 4± 2ºC for 48 hours or less. On laboratory receipt, the sample is extruded into a vial containing reagent water and sodium bisulfate and cooled to 4± 2ºC until analysis.	If samples are preserved within 48 hours, 14 days.	SW-846 5035
Soil	Sample is extruded into empty sealed vial and cooled to 4± 2ºC for 48 hours or less. On laboratory receipt, the sample is frozen on receipt to < -7ºC.	If samples are preserved within 48 hours, 14 days.	SW-846 5035A
Soil	Sample is extruded into empty sealed vial and cooled to 4± 2ºC for 48 hours or less. On laboratory receipt, the sample is preserved with methanol and cooled to 4± 2ºC until analysis.	If samples are preserved within 48 hours, 14 days.	SW-846 5035A
Soil	Sample is extruded into vial containing reagent water and cooled to 4± 2ºC for 48 hours or less. On laboratory receipt, the sample is frozen on receipt to < -7ºC.	If samples are preserved within 48 hours, 14 days.	SW-846 5035A

[1]Reactive compounds such as 2-chloroethylvinyl ether readily break down under acidic conditions and this compound will not be recovered during analysis in samples that are preserved.

[2]It is accepted industry practice to apply a 7 day hold-time for water samples that are insufficiently field-preserved to a pH <2 even though the SW-846 methods do not specifically include this allowance. Clarification from the EHSG MICE line indicates a 7 day holding time is considered acceptable for chemically unpreserved aqueous samples unless the aromatic constituents such as benzene, toluene, ethylbenzene, and xylenes (BTEX) are among the analytes of interest in which case acidification is required for biologically active samples because it has been demonstrated that losses can occur within four hours of sample collection.

Based on this clarification from the EHGS MICE line, when the laboratory receives samples that are not sufficiently preserved to a pH <2, the laboratory will check each subsequent vial received. If one of the vials is adequately preserved, the laboratory will apply a 14 day hold time and use that vial for analysis. If none of the vials are adequately preserved, the analyst will initiate a nonconformance report (NCR) and immediately notify the PM who will contact the client for further instruction. While awaiting client instruction, the laboratory will expedite analysis for to try to meet a 7 day holding time. The PM will include any client instruction to proceed with analysis in the project narrative.

Table 3: BFB Key Ions and Ion Abundance 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	50.0 percent to 120 percent of mass 95
175	5.0-9.0 percent of mass 174
176	95.0-101.0 percent of mass 174
177	5.0-9.0 percent of mass 176

Table 4: QC Summary, Frequency, Acceptance Criteria and Recommended Corrective Action

QC Item	Minimum Frequency	Acceptance Criteria	Recommended Corrective Action[1]
Tune Standard	Prior to calibration and every 12 hours during sample analysis	See Table 4	Reanalyze.
5- Point ICAL	Before sample analysis, when CCVs indicate calibration is no longer valid; after major instrument maintenance	1:SPCCs: See ICAL Section 2: CCCs: %RSD $\leq$ 30% and on of the following: • %RSD for each analyte: $\leq$ 15% • Linear Regression: r $\geq$ 0.995	Correct problem and repeat initial calibration.
ICV	After each initial calibration	%R (75-125)	Correct problem and verify second source standard. If that fails, repeat initial calibration.
CCV	Beginning of each 12-hour window, as established by a compliant BFB.	SPCCs: See CCV section CCCs: %D $\leq$ 20%	Re-analyze once, if still outside criteria perform corrective action, sequence can be re-started if two successive CCVs at different concentrations pass, otherwise repeat ICAL and all associated samples since last successful CCV, unless CCV is high and samples are non-detects.
MB	One per batch of 20 or fewer samples	< RL	Examine project DQO's and take appropriate corrective action, which may include re-analysis of MB and samples (if samples have been run), and/or non-conformance report (NCR). Corrective action must be documented on NCR. If there are no detects in samples, or if all detects are > 10 X MB level, reanalysis may not be required.
LCS	One per batch of 20 or fewer samples	See Attachment 1	Evaluate for marginal exceedance; examine project DQO's and take appropriate corrective action, which may include re-analysis of LCS and samples (if samples have been run), and/or non-conformance report (NCR). Corrective action must be documented on NCR. Flag all reported values outside of control limits.
MS/MSD SD	MS/MSD: Per extraction batch, DoD: project specific per extraction batch SD: Per client request	See Attachment 1	Evaluate data and determine if a matrix effect or analytical error is indicated. If analytical error, re-analyze. Flag all reported values outside of control limits.
Surrogate Standard	All field and QC samples	See Attachment 1	Evaluate data and determine if a matrix effect or analytical error is indicated. If analytical error, re-analyze. If matrix effect, review project DQOs to determine if a matrix effect must be confirmed by re-analysis. Flag all reported values outside of control limits.
Internal Standard	All field and QC samples	Area between 50-100% of area of daily calibration internal standard area	Same as above.

[1]*The recommended corrective action may include some or all of the items listed in this column. The corrective action taken may be dependent on project data quality objectives and/or analyst judgment but must be sufficient to ensure that data quality is known and documented. If corrective action is not taken or is not successful, data must be flagged with appropriate qualifiers.*

Appendix A: Terms and Definitions

Acceptance Criteria: specified limits placed on characteristics of an item, process or service defined in requirement documents.

Accuracy: the degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components which are due to sampling and analytical operations; a data quality indicator.

Analyte: The specific chemicals or components for which a sample is analyzed. (EPA Risk Assessment Guide for Superfund, OSHA Glossary).

Batch: environmental samples that are prepared and/or analyzed together with the same process, using the same lot(s) of reagents. A preparation/digestion batch is composed of one to 20 environmental samples of similar matrix, meeting the above criteria. An analytical batch is composed of prepared environmental samples (extracts, digestates and concentrates), which are analyzed together as a group.

Calibration: a set of operations that establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument or measuring system, or values represented by a material measure or a reference material and the corresponding values realized by the standards.

Calibration Curve: the graphical relationship between the known values or a series of calibration standards and their instrument response.

Calibration Standard: A substance or reference used to calibrate an instrument.

Continuing Calibration Verification (CCV): a single or multi-parameter calibration standard used to verify the stability of the method over time. Usually from the same source as the calibration curve.

Corrective Action: the action taken to eliminate the cause of an existing nonconformity, defect or other undesirable occurrence in order to prevent recurrence.

Data Qualifier: a letter designation or symbol appended to an analytical result used to convey information to the data user. (Laboratory)

Demonstration of Capability (DOC): procedure to establish the ability to generate acceptable accuracy and precision.

Holding Time: the maximum time that a sample may be held before preparation and/or analysis as promulgated by regulation or as specified in a test method.

Initial Calibration: Analysis of analytical standards for a series of different specified concentrations used to define the quantitative response, linearity and dynamic range of the instrument to target analytes.

Intermediate Standard: a solution made from one or more stock standards at a concentration between the stock and working standard. Intermediate standards may be certified stock standard solutions purchased from a vendor and are also known as secondary standards.

Laboratory Control Sample (LCS): a blank matrix spiked with a known amount of analyte(s) processed simultaneously with and under the same conditions as samples through all steps of the procedure.

Matrix Spike (MS): a field sample to which a known amount of target analyte(s) is added.

Matrix Spike Duplicate (MSD): a second replicate matrix spike

Method Blank (MB): a blank matrix processed simultaneously with and under the same conditions as samples through all steps of the procedure. Also known as the preparation blank (PB).

Method Detection Limit (MDL): the minimum amount of a substance that can be measured with a specified degree of confidence that the amount is greater than zero using a specific measurement system. The MDL is a statistical estimation at a specified confidence interval of the concentration at which relative uncertainty is ±100%. The MDL represents a range where qualitative detection occurs. Quantitative results are not produced in this range.

Non-conformance: an indication, judgment, or state of not having met the requirements of the relevant specification, contract or regulation.

Precision: the degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves.

Preservation: refrigeration and/or reagents added at the time of sample collection to maintain the chemical, physical, and/or biological integrity of the sample.

Quality Control Sample (QC): a sample used to assess the performance of all or a portion of the measurement system.

Reporting Limit (RL): the level to which data is reported for a specific test method and/or sample.

Stock Standard: a solution made with one or more neat standards usually with a high concentration. Also known as a primary standard. Stock standards may be certified solutions purchased from a vendor.

Surrogate: a substance with properties that mimic the analyte of interest but that are unlikely to be found in environmental samples.

Appendix B: Standard Preparation Tables

The standard formulations contained in this Appendix are recommended and are subject to change. If the concentration of the stock standard is different than those noted in this table, adjust the standard preparation formulation accordingly.

Prepare the standards using P&T grade methanol and Class A volumetric glassware. Store prepared standards at -10 to -20°C in amber glass mini-inert vials, except for the routine level water and medium level surrogate and internal standard solutions, which may be stored in volumetric flasks at 2-6°C. Assign the expiration date from the date prepared unless the expiration date of the parent components expires sooner in which case use the earliest expiration date.

Tune Standard (BFB) (25 ug/mL)

Parent Standard	Vendor	Stock Standard Concentration (ug/mL)	Volume Added (uL)	Final Volume (uL)	Final Concentration (ug/mL)
Bromofluorobenzene	Restek 30003	5000	125	25000	25

Expiration Date: 6 Month

Internal Standard (50 ug/mL)

Parent Standard	Vendor	Stock Standard Concentration (ug/mL)	Volume Added (uL)	Final Volume (uL)	Final Concentration (ug/mL)
Chlorobenzene-d5	Restek 50684	1000	1250	25000	50
1,4-Dichlorobenzene-d4					
Fluororbenzene					

Expiration Date: 1 Month

Surrogate Standard (50 ug/mL)

Parent Standard	Vendor	Stock Standard Concentration (ug/mL)	Volume Added (uL)	Final Volume (uL)	Final Concentration (ug/mL)
Bromofluorobenzene	Restek 53837	2000	625	25000	50
1,2-Dichlorobenzene-d_4					
1,2-Dichloroethane-d_4					
Toluene-d_8					

Expiration Date: 1 Month

Intermediate Calibration TBA (2500 ug/mL)

Parent Standard	Vendor	Stock Standard Concentration (ug/mL)	Volume Added (uL)	Final Volume (uL)	Final Concentration (ug/mL)
tert-Butyl Alcohol	Restek 30470	50,000	100	2000	2500

Expiration Date: 2 months

ICV/LCS TBA (2500 ug/mL)

Parent Standard	Vendor	Stock Standard Concentration (ug/mL)	Volume Added (uL)	Final Volume (uL)	Final Concentration (ug/mL)
tert-Butyl alcohol	Ultra Scientific CUS-10128	50,000	100	2000	2500

Expiration Date: 2 month

SOIL Intermediate Calibration Mix A – Gases (200 ug/mL)

Parent Standard	Vendor	Stock Standard Concentration (ug/mL)	Volume Added (uL)	Final Volume (uL)	Final Concentration (ug/mL)
Bromomethane	Restek 30042	2000	125	1250	200
Chloroethane		2000			200
Chloromethane		2000			200
Dichlorodifluoromethane		2000			200
Trichlorofluoromethane		2000			200
Vinyl Chloride		2000			200
2, Chloroethyl vinyl ether	Restek 30265	2000	125	1250	200

Expiration Date: 1 Week

SOIL Intermediate Calibration Mix B – Cal Mix (Mixed Concentration)

Parent Standard	Vendor	Stock Standard Concentration (ug/mL)	Volume Added (uL)	Final Volume (uL)	Final Concentration (ug/mL)
Bromofluorobenzene (SSTD)	Restek 53837	2000	400	4000	200
1,2-Dichlorobenzene-d_4 (SSTD)					200
1,2-Dichloroethane-d_4 (SSTD)					200
Toluene-d_8 (SSTD)					200
Vinyl acetate	Restek 30216	2000	400	4000	200
Methyl methacrylate	Restek 559530	2000	400	4000	200
Allyl chloride		2000			200
Acrylonitrile		2000			200
Ethyl methacrylate		2000			200
Benzene	Restek 30431	2000	400	4000	200
Bromobenzene		2000			200
Bromochloromethane		2000			200
Bromodichloromethane		2000			200
Bromoform		2000			200
n-butylbenzene		2000			200
sec-butylbenzene		2000			200
tert-butylbenzene		2000			200
Carbon tetrachloride		2000			200
Chlorobenzene		2000			200
Chloroform		2000			200
2-Chlorotoluene		2000			200
4-Chlorotoluene		2000			200
Dibromochloromethane		2000			200
1,2-Dibromo-3-chloropropane		2000			200
1,2-dibromoethane		2000			200
Dibromomethane		2000			200
1,2-dichlorobenzene		2000			200
1,3-dichlorobenzene		2000			200
1,4-dichlorobenzene		2000			200
1,1-dichloroethane		2000			200
1,2-dichloroethane		2000			200
1,1-dichloroethene		2000			200
cis-1,2-Dichloroethene		2000			200
trans-1,2-Dichloroethene		2000			200
1,2-Dichloropropane		2000			200
1,3-Dichloropropane		2000			200
2,2-Dichloropropane		2000			200
1,1-Dichloropropene		2000			200

cis-1,3-Dichloropropene		2000			200
trans-1,3-Dichloropropene					
Ethylbenzene		2000			200
Hexachlorobutadiene		2000			200
Isopropylbenzene		2000			200
4-Isopropyltoluene		2000			200
Methylene chloride		2000			200
Naphthalene		2000			200
n-Propylbenzene		2000			200
Styrene		2000			200
1,1,1,2-Tetrachloroethane		2000			200
1,1,2,2-Tetrachloroethane		2000			200
Tetrachloroethene		2000			200
Toluene		2000			200
1,2,3-Trichlorobenzene		2000			200
1,2,4-Trichlorobenzene		2000			200
1,1,1-Trichloroethane		2000			200
1,1,2-Trichloroethane		2000			200
Trichloroethene		2000			200
1,2,3-Trichloropropane		2000			200
1,2,4-Trimethylbenzene		2000			200
1,3,5-Trimethylbenzene		2000			200
m-Xylene		2000			200
o-Xylene		2000			200
p-Xylene		2000			200
1,4-Dioxane	Restek 56531	100,000	400	4000	10000
Isobutyl alcohol		100,000			10000
Tetrahydrofuran		18000			1800
Propionitrile		8000			800
trans-1,4-Dichloro-2-butene		2000			200
1,1,2-Trichlorotrifluoroethane (Freon TF)		2000			200
Chloroprene (2-Chloro-1,3-butadiene)		2000			200
Carbon disulfide		2000			200
Methacrylonitrile		2000			200
Methyl-tert-butyl ether		2000			200
Iodomethane (Methyl iodide)		2000			200
Methyl cyclohexane	Restek 563602	5000	160	4000	200
Cyclohexane		5000			200
Methyl acetate		5000			200

Expiration Date: 1 Month

SOIL Intermediate Calibration Mix C - Addeds (200 ug/mL)

Parent Standard	Vendor	Stock Standard Concentration (ug/mL)	Volume Added (uL)	Final Volume (uL)	Final Concentration (ug/mL)
2-Chloroethylvinylether	Restek 30265	2000	400	4000	200
Acrolein	Restek 30645	5000	160	4000	200
Acetone	Restek 30300	2000	400	4000	200
4-Methyl-2-pentanone					200
2-Butanone					200
Tetrahydrofuran					200
2-hexanone					200

Expiration Date: 1 Month

SOIL Intermediate ICV/LCS Mix A - Gases (200ug/mL)

Parent Standard	Vendor	Stock Standard Concentration (ug/mL)	Volume Added (uL)	Final Volume (uL)	Final Concentration (ug/mL)
Bromomethane	Accustandard M-502C-1	2000	31.2	1250	200
Chloroethane		2000			200
Chloromethane		2000			200
Dichlorodifluoromethane		2000			200
Trichlorofluoromethane		2000			200
Vinyl chloride		2000			200
2-Chloroethylvinylether	Ultra Scientific EPA-1016	5000	50	1250	200

Expiration Date: 1 week

SOIL Intermediate ICV/LCS Mix B – LCS Mix (Mixed Concentration)

Parent Standard	Vendor	Stock Standard Concentration (ug/mL)	Volume Added (uL)	Final Volume (uL)	Final Concentration (ug/mL)
Vinyl acetate	Ultra Scientific CUS 6019	2000	400	4000	200
Allyl chloride	Ultra Scientific CUS 8562	2000	400	4000	200
Methyl methacrylate					
Ethyl methacrylate					
Acrylonitrile	Ultra Scientific EPA 1002	5000	160	4000	200
Benzene	Ultra Scientific DWM-589N	2000	400	4000	200
Bromobenzene					
Bromochloromethane					
Bromodichloromethane					
Bromoform					
n-butylbenzene					
sec-butylbenzene					
tert-butylbenzene					
Carbon tetrachloride					
Chlorobenzene					
Chloroform					
2-Chlorotoluene					
4-Chlorotoluene					
Dibromochloromethane					
1,2-Dibromo-3-chloropropane					
1,2-Dibromoethane					
Dibromomethane					
1,2-Dichlorobenzene					
1,3-Dichlorobenzene					
1,4-Dichlorobenzene					
1,1-Dichloroethane					
1,2-Dichloroethane					
1,1-Dichloroethene					
cis-1,2-Dichloroethene					
trans-1,2-Dichloroethene					
1,2-Dichloropropane					
1,3-Dichloropropane					
2,2-Dichloropropane					
1,1-Dichloropropene					

cis-1,3-Dichloropropene					
trans-1,3-Dichloropropene					
Ethylbenzene					
Hexachlorobutadiene					
Isopropylbenzene					
4-Isopropyltoluene					
Methylene chloride					
Naphthalene					
n-Propylbenzene					
Styrene					
1,1,1,2-Tetrachloroethane					
1,1,2,2-Tetrachloroethane					
Tetrachloroethene					
Toluene					
1,2,3-Trichlorobenzene					
1,2,4-Trichlorobenzene					
1,1,1,-Trichloroethane					
1,1,2,-Trichloroethane					
Trichloroethene					
1,2,3-Trichloropropane					
1,2,4-Trimethylbenzene					
1,3,5-Trimethylbenzene					
o-xylene					
m-xylene					
p-xylene					
1,1,2-Trichlorotrifluoroethane (Freon TF)	Ultra Scientific CUS-9442	2000	400	4000	200
Iodomethane (Methyl iodide)		2000			200
Carbon disulfide		2000			200
MTBE		2000			200
Propionitrile		8000			800
Methacrylonitrile		2000			200
Isobutyl alcohol		100,000			10,000
Tetrahydrofuran		18,000			1800
1,4-dioxane		100,000			10,000
trans-1,4-Dichloro-2-butene		2000			200
Chloroprene(2-chloro-1,3-butadiene)		2000			200
Methyl cyclohexane	Ultra Scientific CUS-10269	5000	160	4000	200
Cyclohexane		5000			200
Methyl acetate		5000			200

Expiration Date: 1 Month

SOIL Intermediate ICV/LCS Mix C - Addeds (200ug/mL)

Parent Standard	Vendor	Stock Standard Concentration (ug/mL)	Volume Added (uL)	Final Volume (uL)	Final Concentration (ug/mL)
Acrolein	Ultra Scientific CUS 9748	2000	400	4000	200
Acetone	Accustandard S-4352-R1	2000	400	4000	200
2-Butanone					200
4-Methyl-2-pentanone					200
Tetrahydrofuran					200
2-Hexanone					200

Expiration Date: 1 Month

WATER Intermediate Calibration Mix A – Gases (50 ug/mL)

Parent Standard	Vendor	Stock Standard Concentration (ug/mL)	Volume Added (uL)	Final Volume (uL)	Final Concentration (ug/mL)
Bromomethane	Restek 30042	2000	31.2	1250	50
Chloroethane		2000			50
Chloromethane		2000			50
Dichlorodifluoromethane		2000			50
Trichlorofluoromethane		2000			50
Vinyl Chloride		2000			50
2-Chloroethylvinylether	Restek 30265	2000	31.2	1250	50

Expiration Date: 1 Week

WATER Intermediate Calibration Mix B – Cal Mix (Mixed Concentration (ug/mL)

Parent Standard	Vendor	Stock Standard Concentration (ug/mL)	Volume Added (uL)	Final Volume (uL)	Final Concentration (ug/mL)
Bromofluorobenzene (SSTD)	Restek 53837	2000	110	4400	50
1,2-Dichlorobenzene-d_4 (SSTD)					50
1,2-Dichloroethane-d_4 (SSTD)					50
Toluene-d_8 (SSTD)					50
Vinyl Acetate	Restek 30216	2000	110	4400	50
Methyl methacrylate	Restek 559530	2000	110	4400	50
Allyl chloride		2000			50
Acrylonitrile		2000			50
Ethyl methacrylate		2000			50
Benzene	Restek 30431	2000	110	4400	50
Bromobenzene		2000			50
Bromochloromethane		2000			50
Bromodichloromethane		2000			50
Bromoform		2000			50
n-Butylbenzene		2000			50
sec-Butylbenzene		2000			50
tert-Butylbenzene		2000			50
Carbon tetrachloride		2000			50
Chlorobenzene		2000			50
Chloroform		2000			50
2-Chlorotoluene		2000			50
4-Chlorotoluene		2000			50
Dibromochloromethane		2000			50
1,2-Dibromo-3-chloropropane		2000			50
1,2-Dibromoethane		2000			50
Dibromomethane		2000			50
1,2-Dichlorobenzene		2000			50
1,3-Dichlorobenzene		2000			50
1,4-Dichlorobenzene		2000			50
1,1-Dichloroethane		2000			50
1,2-Dichloroethane		2000			50
1,1-Dichloroethene		2000			50
cis-1,2-Dichloroethene		2000			50
trans-1,2-Dichloroethene		2000			50
1,2-Dichloropropane		2000			50
1,3-Dichloropropane		2000			50
2,2-Dichloropropane		2000			50
1,1-Dichloropropene		2000			50

cis-1,3-Dichloropropene		2000			50
trans-1,3-Dichloropropene		2000			50
Ethylbenzene		2000			50
Hexachlorobutadiene		2000			50
Isopropylbenzene		2000			50
4-Isopropyltoluene		2000			50
Methylene chloride		2000			50
Naphthalene		2000			50
n-Propylbenzene		2000			50
Styrene		2000			50
1,1,1,2-Tetrachloroethane		2000			50
1,1,2,2-Tetrachloroethane		2000			50
Tetrachloroethene		2000			50
Toluene		2000			50
1,2,3-Trichlorobenzene		2000			50
1,2,4-Trichlorobenzene		2000			50
1,1,1-Trichloroethane		2000			50
1,1,2-Trichloroethane		2000			50
Trichloroethene		2000			50
1,2,3-Trichloropropane		2000			50
1,2,4-Trimethylbenzene		2000			50
1,3,5-Trimethylbenzene		2000			50
m-Xylene		2000			50
o-Xylene		2000			50
p-Xylene		2000			50
1,4-Dioxane	Restek 56531	100,000	110	4400	2500
Isobutyl alcohol		100,000			2500
Tetrahydrofuran		18,000			450
Propionitrile		8000			200
trans-1,4-Dichloro-2-butene		2000			50
1,1,2-Trichlorotrifluoroethane (Freon TF)		2000			50
Chloroprene (2-Chloro-1,3-butadiene)		2000			50
Carbon disulfide		2000			50
Methacrylonitrile		2000			50
Methyl-tert-butyl ether		2000			50
Iodomethane (Methyl Iodide)		2000			50
Cyclohexane	Restek 563602	5000	44	4400	50
Methylcyclohexane		5000			50
Methyl acetate		5000			50

Expiration Date: 1 Month

WATER Intermediate Calibration MixC - Addeds (250 ug/mL)

Parent Standard	Vendor	Stock Standard Concentration (ug/mL)	Volume Added (uL)	Final Volume (uL)	Final Concentration (ug/mL)
Acrolein	Restek 30645	5000	220	4400	250
Acetone	Restek 30300	2000	550	4400	250
4-Methyl-2-pentanone		2000			250
2-hexanone		2000			250
Tetrahydrofuran		2000			250
2-butanone		2000			250

Expiration Date: 1 Month

Water Intermediate ICV/LCS Mix B – LCS Mix (Mixed Concentration ug/mL)

Parent Standard	Vendor	Stock Standard Concentration (ug/mL)	Volume Added (uL)	Final Volume (uL)	Final Concentration (ug/mL)
Vinyl acetate	Ultra Scientific CUS-6019	2000	110	4400	50
Acrylonitrile	Ultra Scientific EPA-1002	5000	44	4400	50
Methyl methacrylate	Ultra Scientific CUS-8562	2000	110	4400	50
Allyl chloride		2000			50
Ethyl methacrylate		2000			50
Benzene	Ultra Scientific DWM-589N	2000	110	4400	50
Bromobenzene		2000			50
Bromochloromethane		2000			50
Bromodichloromethane		2000			50
Bromoform		2000			50
n-Butylbenzene		2000			50
sec-Butylbenzene		2000			50
tert-Butylbenzene		2000			50
Carbon tetrachloride		2000			50
Chlorobenzene		2000			50
Chloroform		2000			50
2-Chlorotoluene		2000			50
4-Chlorotoluene		2000			50
Dibromochloromethane		2000			50
1,2-Dibromo-3-chloropropane		2000			50
1,2-Dibromoethane		2000			50
Dibromomethane		2000			50
1,2-Dichlorobenzene		2000			50
1,3-Dichlorobenzene		2000			50
1,4-Dichlorobenzene		2000			50
1,1-Dichloroethane		2000			50
1,2-Dichloroethane		2000			50
1,1-Dichloroethene		2000			50
cis-1,2-Dichloroethene		2000			50
trans-1,2-Dichloroethene		2000			50
1,2-Dichloropropane		2000			50
1,3-Dichloropropane		2000			50
2,2-Dichloropropane		2000			50
1,1-Dichloropropene		2000			50
cis-1,3-Dichloropropene		2000			50
trans-1,3-Dichloropropene		2000			50
Ethylbenzene		2000			50
Hexachlorobutadiene		2000			50
Isopropylbenzene		2000			50
4-Isopropyltoluene		2000			50
Methylene chloride		2000			50
Naphthalene		2000			50
n-Propylbenzene		2000			50
Styrene		2000			50
1,1,1,2-Tetrachloroethane		2000			50
1,1,2,2-Tetrachloroethane		2000			50
Tetrachloroethene		2000			50
Toluene		2000			50
1,2,3-Trichlorobenzene		2000			50
1,2,4-Trichlorobenzene		2000			50
1,1,1-Trichloroethane		2000			50
1,1,2-Trichloroethane		2000			50

Trichloroethene		2000			50
1,2,3-Trichloropropane		2000			50
1,2,4-Trimethylbenzene		2000			50
1,3,5-Trimethylbenzene		2000			50
m-Xylene		2000			50
o-Xylene		2000			50
p-Xylene		2000			50
1,4-Dioxane	Ultra Scientific CUS-9442	100,000	110	4400	2500
Isobutyl alcohol		100,000			2500
Tetrahydrofuran		18,000			450
Propionitrile		8000			200
trans-1,4-Dichloro-2-butene		2000			50
1,1,2-Trichlorotrifluoroethane (Freon TF)		2000			50
Chloroprene (2-Chloro-1,3-butadiene)		2000			50
Carbon disulfide		2000			50
Methacrylonitrile		2000			50
Methyl-tert-butyl ether		2000			50
Iodomethane (Methyl iodide)		2000			50
Cyclohexane	Restek 563602	5000	44	4400	50
Methylcyclohexane	Restek 563602	5000	44	4400	50
Methyl acetate	Restek 563602	5000	44	4400	50

Expiration Date: 1 Month

Water Intermediate ICV/LCS Mix C - Addeds (Mixed ug/mL)

Parent Standard	Vendor	Stock Standard Concentration (ug/mL)	Volume Added (uL)	Final Volume (uL)	Final Concentration (ug/mL)
Acrolein	Ultra Scientific CUS-9748	10,000	110	4400	250
Acetone	Accustandard S-4352-R1	2000	550	4400	250
4-Methyl-2-pentanone (MIBK)		2000			250
2-hexanone		2000			250
Tetrahydrofuran		2000			250
2-butanone (MEK)		2000			250

Expiration Date: 1 Month

Water Intermediate ICV/LCS Mix – A Gases (50 ug/mL)

Parent Standard	Vendor	Stock Standard Concentration (ug/mL)	Volume Added (uL)	Final Volume (uL)	Final Concentration (ug/mL)
Bromomethane	Accustandard M-502C-01	2000	31.2	1250	50
Chloroethane		2000			50
Chloromethane		2000			50
Dichlorodifluoromethane		2000			50
Trichlorofluoromethane		2000			50
Vinyl Chloride		2000			50
2-Chloroethylvinylether	Ultra Scientific CUS-1016	5000	12.5	1250	50

Expiration Date: 1 Week

Appendix C: Equations

Response Factor (RFx) = $\dfrac{\text{Area}_x \text{ X Concentration}_{is}}{\text{Area}_{is} \text{ X Concentration}_x}$

Where: x=compound, is = Internal Standard

Relative Retention Time (RRT) = $\dfrac{\text{Retention Time}_x}{\text{Retention Time}_{is}}$

Where: x=compound, is = Internal Standard

Mean Response Factor ($\overline{RF}$) = $\dfrac{\sum_{i=1}^{n} RF_i}{n}$

where: n = number of calibration levels

Standard Deviation of the Response Factor (SD) = $\sqrt{\dfrac{\sum_{i=1}^{n}\left(RF_i - \overline{RF}\right)2}{n-1}}$

where: n = number of calibration levels

Percent Relative Standard Deviation (RSD) of the Response = $\dfrac{SD}{\overline{RF}} \times 100\%$

Percent Difference (%D) = $\dfrac{RF_v - \overline{RF}}{\overline{RF}} \times 100\%$

where: RF_v = Response Factor from the Continuing Calibration Verification (CCV)

Percent Drift = $\dfrac{\text{Calculated Concentration – Theoretical Concentration}}{\text{Theoretical Concentration}}$ X 100%

Percent Recovery (%R) = $\frac{C_s}{C_n} \times 100\%$

where: C_s = Concentration of the Spiked Field or QC Sample
C_n = Nominal Concentration of Spike Added

Percent Recovery (%R) for MS/MSD = $\frac{C_s - C_u}{C_n} \times 100\%$

where: C_s = Concentration of the Spiked Sample
C_u = Concentration of the Unspiked Sample
C_n = Nominal Concentration of Spike Added

Relative Percent Difference (%RPD) = $\frac{C_1 - C_2}{\left(\frac{C_1 + C_2}{2}\right)} \times 100\%$

where: C_1 = Measured Concentration of First Sample
C_2 = Measured Concentration of Second Sample

Sample Concentration

Water

$$C_X = \frac{A_x \times C_{is}}{A_{is} \times \text{Mean RF}} \times DF$$

Solids

$$C_X = \frac{A_x \times C_{is}}{A_{is} \times \text{Mean RF} \times \text{Percent Solids}} \times DF$$

Where

C_x = Concentration of compound (µg/L)
A_{is} = Area of quantification ion for associated internal standard.
A_x = Area of quantification ion for compound.
C_{is} = Concentration of associated internal standard (µg/L).
DF = Dilution Factor.
Mean RF = Mean Response Factor from initial calibration, or 1 for a tentatively identified compound

ATTACHMENT 1: SW-846 8260B Method Information

The tables associated to Attachment 1 summarize the laboratory's established RL for each matrix along with the in-house control limits for accuracy and precision, internal standard associations, characteristic ions used for quantitation and minimum response factor criteria for each analyte.

The RL's provided in these tables are those that can be achieved in a blank water or soil matrix using the routine extraction volume / mass of sample specified in the laboratory SOP for these matrices. These RLs are always adjusted for field samples based on actual sample amount used, final extract volume, percent moisture (solids) and dilutions.

The information provided in these tables is entered in the laboratory's management information system (LIMS) called TALS and is kept current by the local TALS system administrator. The values in TALS are the values used by the laboratory's data processing systems to evaluate and report data. The information presented in these tables is pulled from TALS and current as of the effective date of this SOP but is subject to change. Updates to these tables are made with each SOP revision. For the most current information, refer to the method, equipment and ICAL limit groups maintained in the TALS database.

Attachment 1: SW846 8260B Method Information (BR-MV-006)

Type	Analytes	CAS #	RL			Control Limits (%R)						Precision
			Water	Soil	MeOH	Water		Low Soil		MeOH[1]		RPD
			(ug/L)	(ug/Kg)	(ug/Kg)	Lower	Upper	Lower	Upper	Lower	Upper	≤
Analyte	1,1,1,2-Tetrachloroethane	630-20-6	1.0	5.0	100	80	120	75	120	80	120	30
Analyte	1,1,1-Trichloroethane	71-55-6	1.0	5.0	100	75	120	70	120	75	120	30
Analyte	1,1,2,2-Tetrachloroethane	79-34-5	1.0	5.0	100	80	125	75	120	80	125	30
Analyte	1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	1.0	5.0	100	70	120	65	120	70	120	30
Analyte	1,1,2-Trichloroethane	79-00-5	1.0	5.0	100	80	125	75	120	80	125	30
Analyte	1,1-Dichloroethane	75-34-3	1.0	5.0	100	80	120	70	120	80	120	30
Analyte	1,1-Dichloroethene	75-35-4	1.0	5.0	100	80	120	80	120	80	120	30
Analyte	1,1-Dichloropropene	563-58-6	1.0	5.0	100	80	125	75	120	80	125	30
Analyte	1,2,3-Trichlorobenzene	87-61-6	1.0	5.0	100	80	120	80	125	80	120	30
Analyte	1,2,3-Trichloropropane	96-18-4	1.0	5.0	100	80	120	70	120	80	120	30
Analyte	1,2,4-Trichlorobenzene	120-82-1	1.0	5.0	100	80	120	80	125	80	120	30
Analyte	1,2,4-Trimethylbenzene	95-63-6	1.0	5.0	100	80	120	80	125	80	120	30
Analyte	1,2-Dibromo-3-Chloropropane	96-12-8	1.0	5.0	100	70	120	70	120	70	120	30
Analyte	1,2-Dichlorobenzene	95-50-1	1.0	5.0	100	80	125	80	125	80	125	30
Analyte	1,2-Dichloroethane	107-06-2	1.0	5.0	100	70	120	70	120	70	120	30
Summary Analyte	1,2-Dichloroethene, Total	540-59-0	1.0	5.0	100	80	125	75	125	80	125	30
Analyte	1,2-Dichloropropane	78-87-5	1.0	5.0	100	80	125	75	120	80	125	30
Analyte	1,3,5-Trimethylbenzene	108-67-8	1.0	5.0	100	80	120	80	125	80	120	30
Analyte	1,3-Dichlorobenzene	541-73-1	1.0	5.0	100	80	125	80	125	80	125	30
Analyte	1,3-Dichloropropane	142-28-9	1.0	5.0	100	80	125	75	120	80	125	30
Analyte	1,4-Dichlorobenzene	106-46-7	1.0	5.0	100	80	125	80	120	80	125	30
Analyte	1,4-Dioxane	123-91-1	50	250	5000	75	140	75	120	75	140	30
Analyte	2,2-Dichloropropane	594-20-7	1.0	5.0	100	80	120	75	120	80	120	30
Analyte	2-Butanone (MEK)	78-93-3	5.0	10	500	60	170	60	130	60	170	30
Analyte	2-Chloro-1,3-butadiene	126-99-8	1.0	5.0	100	70	120	80	120	70	120	30
Analyte	2-Chloroethyl vinyl ether	110-75-8	1.0	5.0	100	80	125	55	120	80	125	30
Analyte	2-Chlorotoluene	95-49-8	1.0	5.0	100	80	125	80	125	80	125	30
Analyte	2-Hexanone	591-78-6	1.0	5.0	500	75	150	80	120	75	150	30
Analyte	2-Methyl-2-propanol	75-65-0	50	50	5000	80	120	80	120	80	120	30
Analyte	3-Chloro-1-propene	107-05-1	1.0	5.0	100	80	130	80	125	80	130	30
Analyte	4-Chlorotoluene	106-43-4	1.0	5.0	100	80	125	80	125	80	125	30
Analyte	4-Isopropyltoluene	99-87-6	1.0	5.0	100	75	120	75	120	75	120	30
Analyte	4-Methyl-2-pentanone (MIBK)	108-10-1	5.0	5.0	500	80	125	75	130	80	125	30
Analyte	Acetone	67-64-1	5.0	5.0	500	15	200	70	120	15	200	30
Analyte	Acrolein	107-02-8	1.0	5.0	100	45	135	75	120	45	135	30

Attachment 1: SW846 8260B Method Information (BR-MV-006)

Type	Analytes	CAS #	RL			Control Limits (%R)						Precision
			Water	Soil	MeOH	Water		Low Soil		MeOH[1]		RPD
			(ug/L)	(ug/Kg)	(ug/Kg)	Lower	Upper	Lower	Upper	Lower	Upper	≤
Analyte	Acrylonitrile	107-13-1	1.0	5.0	100	75	140	80	120	75	140	30
Analyte	Benzene	71-43-2	1.0	5.0	100	80	125	75	125	80	125	30
Analyte	Bromobenzene	108-86-1	1.0	5.0	100	80	125	75	120	80	125	30
Analyte	Bromoform	75-25-2	1.0	5.0	100	80	120	75	120	80	120	30
Analyte	Bromomethane[2]	74-83-9	1.0	5.0	100	60	120	60	120	40	120	30
Analyte	Carbon disulfide	75-15-0	1.0	5.0	100	80	120	65	120	80	120	30
Analyte	Carbon tetrachloride	56-23-5	1.0	5.0	100	75	120	70	120	75	120	30
Analyte	Chlorobenzene	108-90-7	1.0	5.0	100	80	120	80	125	80	120	30
Analyte	Chlorobromomethane	74-97-5	1.0	5.0	100	80	130	75	120	80	130	30
Analyte	Chlorodibromomethane	124-48-1	1.0	5.0	100	80	125	75	120	80	125	30
Analyte	Chloroethane	75-00-3	1.0	5.0	100	80	130	75	120	40	120	30
Analyte	Chloroform	67-66-3	1.0	5.0	100	75	120	80	120	75	120	30
Analyte	Chloromethane	74-87-3	1.0	5.0	100	65	120	65	120	65	120	30
Analyte	cis-1,2-Dichloroethene	156-59-2	1.0	5.0	100	80	125	75	120	80	125	30
Analyte	cis-1,3-Dichloropropene	10061-01-5	1.0	5.0	100	80	125	80	120	80	125	30
Analyte	Cyclohexane	110-82-7	1.0	5.0	100	80	120	70	120	80	120	30
Analyte	Dibromomethane	74-95-3	1.0	5.0	100	75	120	75	120	75	120	30
Analyte	Dichlorobromomethane	75-27-4	1.0	5.0	100	80	120	75	120	80	120	30
Analyte	Dichlorodifluoromethane	75-71-8	1.0	5.0	100	35	125	55	120	35	125	30
Analyte	Ethyl ether[2]	60-29-7	1.0	5.0	5	40	120	40	120	40	120	30
Analyte	Ethyl methacrylate	97-63-2	1.0	5.0	100	80	125	75	120	80	125	30
Analyte	Ethylbenzene	100-41-4	1.0	5.0	100	80	125	80	125	80	125	30
Analyte	Ethylene Dibromide	106-93-4	1.0	5.0	100	80	120	75	120	80	120	30
Analyte	Hexachlorobutadiene	87-68-3	1.0	5.0	100	75	120	80	130	75	120	30
Analyte	Iodomethane	74-88-4	1.0	5.0	100	45	150	55	125	45	150	30
Analyte	Isobutyl alcohol	78-83-1	50	250	5000	80	130	75	130	80	130	30
Analyte	Isopropyl ether[2]	108-20-3	1.0	5.0	100	40	120	40	120	40	120	30
Analyte	Isopropylbenzene	98-82-8	1.0	5.0	100	80	120	80	125	80	120	30
Analyte	Methacrylonitrile	126-98-7	1.0	5.0	100	80	120	80	120	80	120	30
Analyte	Methyl acetate	79-20-9	1.0	5.0	100	70	120	65	120	70	120	30
Analyte	Methyl methacrylate	80-62-6	1.0	5.0	100	80	125	75	120	80	125	30
Analyte	Methyl tert-butyl ether	1634-04-4	1.0	5.0	100	80	120	70	120	80	120	30
Analyte	Methylcyclohexane	108-87-2	1.0	5.0	100	80	120	75	120	80	120	30
Analyte	Methylene Chloride	75-09-2	1.0	5.0	100	80	120	75	120	80	120	30
Analyte	m-Xylene & p-Xylene	179601-23-1	1.0	5.0	100	80	125	80	125	80	125	30

Attachment 1: SW846 8260B Method Information (BR-MV-006)

Type	Analytes	CAS #	RL			Control Limits (%R)						Precision
			Water	Soil	MeOH	Water		Low Soil		MeOH[1]		RPD
			(ug/L)	(ug/Kg)	(ug/Kg)	Lower	Upper	Lower	Upper	Lower	Upper	≤
Analyte	Naphthalene	91-20-3	1.0	5.0	100	80	130	80	120	80	130	30
Analyte	n-Butylbenzene	104-51-8	1.0	5.0	100	80	120	80	125	80	120	30
Analyte	N-Propylbenzene	103-65-1	1.0	5.0	100	80	120	80	125	80	120	30
Analyte	o-Xylene	95-47-6	1.0	5.0	100	80	120	80	125	80	120	30
Analyte	Propionitrile	107-12-0	4.0	20	400	80	135	80	120	80	135	30
Analyte	sec-Butylbenzene	135-98-8	1.0	5.0	100	80	120	80	125	80	120	30
Analyte	Styrene	100-42-5	1.0	5.0	100	80	120	80	125	80	120	30
Analyte	Tert-amyl methyl ether[2]	994-05-8	1.0	5.0	100	40	120	40	120	40	120	30
Analyte	Tert-butyl ethyl ether[2]	637-92-3	1.0	5.0	100	40	120	40	120	40	120	30
Analyte	tert-Butylbenzene	98-06-6	1.0	5.0	100	75	120	75	120	75	120	30
Analyte	Tetrachloroethene	127-18-4	1.0	5.0	100	80	120	80	125	80	120	30
Analyte	Tetrahydrofuran	109-99-9	14	50.0	1400	80	120	75	120	80	120	30
Analyte	Toluene	108-88-3	1.0	5.0	100	80	120	80	125	80	120	30
Analyte	trans-1,2-Dichloroethene	156-60-5	1.0	5.0	100	80	125	75	125	80	125	30
Analyte	trans-1,3-Dichloropropene	10061-02-6	1.0	5.0	100	80	120	75	120	80	120	30
Analyte	trans-1,4-Dichloro-2-butene	110-57-6	1.0	5.0	100	75	135	80	125	75	135	30
Analyte	Trichloroethene	79-01-6	1.0	5.0	100	75	120	75	120	75	120	30
Analyte	Trichlorofluoromethane	75-69-4	1.0	5.0	100	75	120	65	120	40	120	30
Analyte	Vinyl acetate	108-05-4	1.0	5.0	100	80	200	80	185	80	200	30
Analyte	Vinyl chloride	75-01-4	1.0	5.0	100	80	130	75	120	80	130	30
Summary Analyte	Xylenes, Total	1330-20-7	1.0	5.0	100	80	120	80	125	80	120	30
ISTD 1	Fluorobenzene	462-06-6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ISTD 2	Chlorobenzene-d5	3114-55-4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ISTD 3	1,4-Dichlorobenzene-d4	3855-82-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Surrogate	1,2-Dichlorobenzene-d4	2199-69-1	NA	NA	NA	75	120	20	185	75	120	NA
Surrogate	1,2-Dichloroethane-d4 (Surr)	17060-07-0	NA	NA	NA	80	120	35	145	80	120	NA
Surrogate	4-BromoISTD1	460-00-4	NA	NA	NA	80	125	30	200	80	125	NA
Surrogate	Toluene-d8 (Surr)	2037-26-5	NA	NA	NA	80	120	40	175	80	120	NA

[1] *Water limits are used until sufficient number of points (30) are available to set in-house control limits. Some compounds are default limits based on known performance.*

2 *Default limits set until sufficient data points (30) available to set in-house limits.*

Attachment 1: SW846 8260B Method Information (BR-MV-006)

Type	Analytes	CAS #	Internal Standard Association	Characterisitc Ion			Minimum Response Factor
				Primary	Secondary	Tertiary	
Analyte	1,1,1,2-Tetrachloroethane	630-20-6	ISTD2	131	133	117	
Analyte	1,1,1-Trichloroethane	71-55-6	ISTD1	97	99	61	
Analyte	1,1,2,2-Tetrachloroethane	79-34-5	ISTD3	83	85	131	0.300
Analyte	1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	ISTD1	151	101	153	
Analyte	1,1,2-Trichloroethane	79-00-5	ISTD2	83	97	61	
Analyte	1,1-Dichloroethane	75-34-3	ISTD1	63	65	83	0.100
Analyte	1,1-Dichloroethene	75-35-4	ISTD1	96	61	98	
Analyte	1,1-Dichloropropene	563-58-6	ISTD1	75	110	77	
Analyte	1,2,3-Trichlorobenzene	87-61-6	ISTD3	180	145	109	
Analyte	1,2,3-Trichloropropane	96-18-4	ISTD3	75	110	61	
Analyte	1,2,4-Trichlorobenzene	120-82-1	ISTD3	180	182	145	
Analyte	1,2,4-Trimethylbenzene	95-63-6	ISTD1	105	120	77	
Analyte	1,2-Dibromo-3-Chloropropane	96-12-8	ISTD3	157	155	75	
Analyte	1,2-Dichlorobenzene	95-50-1	ISTD1	146	111	75	
Analyte	1,2-Dichloroethane	107-06-2	ISTD1	62	64	98	
Summary Analyte	1,2-Dichloroethene, Total	540-59-0	ISTD1	NA	NA	NA	
Analyte	1,2-Dichloropropane	78-87-5	ISTD1	63	76	41	
Analyte	1,3,5-Trimethylbenzene	108-67-8	ISTD3	105	120	91	
Analyte	1,3-Dichlorobenzene	541-73-1	ISTD3	146	111	75	
Analyte	1,3-Dichloropropane	142-28-9	ISTD2	76	41	49	
Analyte	1,4-Dichlorobenzene	106-46-7	ISTD3	146	111	75	
Analyte	1,4-Dioxane	123-91-1	ISTD1	88	58		
Analyte	2,2-Dichloropropane	594-20-7	ISTD1	77	97	61	
Analyte	2-Butanone (MEK)	78-93-3	ISTD1	72	43	57	
Analyte	2-Chloro-1,3-butadiene	126-99-8	ISTD1	53	88	51	
Analyte	2-Chloroethyl vinyl ether	110-75-8	ISTD1	63	106	43	
Analyte	2-Chlorotoluene	95-49-8	ISTD3	91	126	75	
Analyte	2-Hexanone	591-78-6	ISTD2	43	58	85	
Analyte	2-Methyl-2-propanol	75-65-0	ISTD1	59	57	41	
Analyte	3-Chloro-1-propene	107-05-1	ISTD3	76	41	39	
Analyte	4-Chlorotoluene	106-43-4	ISTD3	91	126		
Analyte	4-Isopropyltoluene	99-87-6	ISTD3	119	91	134	
Analyte	4-Methyl-2-pentanone (MIBK)	108-10-1	ISTD1	43	58	85	
Analyte	Acetone	67-64-1	ISTD1	58	43		
Analyte	Acrolein	107-02-8	ISTD1	56	55		

Attachment 1: SW846 8260B Method Information (BR-MV-006)

Type	Analytes	CAS #	Internal Standard Association	Characterisitc Ion			Minimum Response Factor
				Primary	Secondary	Tertiary	
Analyte	Acrylonitrile	107-13-1	ISTD1	53	52	51	
Analyte	Benzene	71-43-2	ISTD1	78	77		
Analyte	Bromobenzene	108-86-1	ISTD3	156	77	158	
Analyte	Bromoform	75-25-2	ISTD2	173	175	171	0.100
Analyte	Bromomethane[2]	74-83-9	ISTD1	94	96		
Analyte	Carbon disulfide	75-15-0	ISTD1	76	78		
Analyte	Carbon tetrachloride	56-23-5	ISTD1	117	119	82	
Analyte	Chlorobenzene	108-90-7	ISTD2	112	77	50	0.300
Analyte	Chlorobromomethane	74-97-5	ISTD1	130	49	128	
Analyte	Chlorodibromomethane	124-48-1	ISTD1	129	127	79	
Analyte	Chloroethane	75-00-3	ISTD1	64	49	66	
Analyte	Chloroform	67-66-3	ISTD1	83	85		
Analyte	Chloromethane	74-87-3	ISTD1	50	52		0.100
Analyte	cis-1,2-Dichloroethene	156-59-2	ISTD1	61	96	98	
Analyte	cis-1,3-Dichloropropene	10061-01-5	ISTD1	75	110	39	
Analyte	Cyclohexane	110-82-7	ISTD1	84	56	69	
Analyte	Dibromomethane	74-95-3	ISTD2	93	174	81	
Analyte	Dichlorobromomethane	75-27-4	ISTD1	83	85	47	
Analyte	Dichlorodifluoromethane	75-71-8	ISTD1	75	71	8	
Analyte	Ethyl ether[2]	60-29-7	ISTD1	60	29	7	
Analyte	Ethyl methacrylate	97-63-2	ISTD1	97	63	2	
Analyte	Ethylbenzene	100-41-4	ISTD2	100	41	4	
Analyte	Ethylene Dibromide	106-93-4	ISTD1	106	93	4	
Analyte	Hexachlorobutadiene	87-68-3	ISTD3	225	190	118	
Analyte	Iodomethane	74-88-4	ISTD1	142	127		
Analyte	Isobutyl alcohol	78-83-1	ISTD1	43	41	42	
Analyte	Isopropyl ether[2]	108-20-3	ISTD1	45	87	59	
Analyte	Isopropylbenzene	98-82-8	ISTD3	105	120	77	
Analyte	Methacrylonitrile	126-98-7	ISTD1	67	52	41	
Analyte	Methyl acetate	79-20-9	ISTD1	43	74	59	
Analyte	Methyl methacrylate	80-62-6	ISTD2	69	41	100	
Analyte	Methyl tert-butyl ether	1634-04-4	ISTD1	73	43		
Analyte	Methylcyclohexane	108-87-2	ISTD1	83	55	98	
Analyte	Methylene Chloride	75-09-2	ISTD1	84	49	86	
Analyte	m-Xylene & p-Xylene	179601-23-1	ISTD2	91	106	77	

Attachment 1: SW846 8260B Method Information (BR-MV-006)

Type	Analytes	CAS #	Internal Standard Association	Characterisitc Ion			Minimum Response Factor
				Primary	Secondary	Tertiary	
Analyte	Naphthalene	91-20-3	ISTD3	128			
Analyte	n-Butylbenzene	104-51-8	ISTD3	91	92	134	
Analyte	N-Propylbenzene	103-65-1	ISTD3	91	120	65	
Analyte	o-Xylene	95-47-6	ISTD1	91	106	77	
Analyte	Propionitrile	107-12-0	ISTD1	54	53		
Analyte	sec-Butylbenzene	135-98-8	ISTD3	105	134	91	
Analyte	Styrene	100-42-5	ISTD2	104	78	51	
Analyte	Tert-amyl methyl ether[2]	994-05-8	ISTD1	73	55	87	
Analyte	Tert-butyl ethyl ether[2]	637-92-3	ISTD1	59	87	57	
Analyte	tert-Butylbenzene	98-06-6	ISTD3	119	91	134	
Analyte	Tetrachloroethene	127-18-4	ISTD2	164	131	166	
Analyte	Tetrahydrofuran	109-99-9	ISTD1	42	71	72	
Analyte	Toluene	108-88-3	ISTD2	92	91	65	
Analyte	trans-1,2-Dichloroethene	156-60-5	ISTD1	96	61	98	
Analyte	trans-1,3-Dichloropropene	10061-02-6	ISTD2	75	110	49	
Analyte	trans-1,4-Dichloro-2-butene	110-57-6	ISTD3	53	89	124	
Analyte	Trichloroethene	79-01-6	ISTD1	132	95	60	
Analyte	Trichlorofluoromethane	75-69-4	ISTD1	101	103		
Analyte	Vinyl acetate	108-05-4	ISTD1	43	86		
Analyte	Vinyl chloride	75-01-4	ISTD1	62	64		
Summary Analyte	Xylenes, Total	1330-20-7	ISTD2	NA	NA	NA	
ISTD 1	Fluorobenzene	462-06-6	NA	NA	NA	NA	NA
ISTD 2	Chlorobenzene-d5	3114-55-4	NA	NA	NA	NA	NA
ISTD 3	1,4-Dichlorobenzene-d4	3855-82-1	NA	NA	NA	NA	NA
Surrogate	1,2-Dichlorobenzene-d4	2199-69-1	ISTD3	152	115	154	
Surrogate	1,2-Dichloroethane-d4 (Surr)	17060-07-0	ISTD1	65	102		
Surrogate	4-BromoISTD1	460-00-4	ISTD3	95	174	176	
Surrogate	Toluene-d8 (Surr)	2037-26-5	ISTD2	98	70	100	

[1] *Water limits are used until sufficient number of points (30) are available to s*

2 *Default limits set until sufficient data points (30) available to set in-house lin*

ATTACHMENT 2: Preparation Information Tables.

The forms attached to this SOP are copies of document controlled forms used in the laboratory.

Calibration, QC and Sample Preparation Information

8260B Water (Prepared in 44 mL VOA Vial) - Use for Water and Medium Level Soil (MeOH)

Instructions: Add the amount, type and concentration of spiking solution listed in this table to a prepared 44 mL VOA vial.

SOP Reference: BR-MV-006

		Spiking Solutions							
		Routine						Non-Routine	
	Standard:	524/8260	524/8260	8260	8260	TBA_1	TBA_1	Freon-123A	Freon-123A
	Type:	ISTD	SSTD	Cal Mix, Gases, & Addeds	LCS Mix, Gases, & Addeds	Cal	LCS	Cal	LCS
Sample Type	**Conconcentration$_2$**	**50 ug/mL**	**50 ug/mL**	**50 /250 ug/mL**	**50/250 ug/mL**	**2500 ug/mL**	**2500 ug/mL**	**50 ug/mL**	**25 ug/mL**
Level 1	**1 ug/L**	22 uL		0.9 uL		0.9 uL		0.9 uL	
Level 2	**5 ug/L**	22 uL		4.4 uL		1.8 uL		4.4 uL	
Level 3	**10 ug/L**	22 uL		8.8 uL		3.6 uL		8.8 uL	
Level 4 /CCV	**25 ug/L**	22 uL		**22 uL**		**8.8 uL**		**22 uL**	
Level 5	**50 ug/L**	22 uL		44 uL		17.6 uL		44 uL	
Level 6	**100 ug/L**	22 uL		88 uL		35.2 uL		88 uL	
ICV and LCS	**25 ug/L**	22 uL	22 uL		22 uL		8.8 uL		22 uL
MS / MSD	**25 ug/L**	22 uL	22 uL		22 uL		8.8 uL		22 uL
Samples & MB	**NA**	22 uL	22 uL						

1: tert-Butyl Alcohol

2: TBA concentration 20 fold greater, except Cal 1 which is 50 fold greater and Cal 3 which is 25 fold greater.

TALS Amounts: *TALS bases calculations on a VOA vial volume of 40 mL. The lab adds spikes and surrogates directly to 44 mL VOA vials. To compensate for the difference, the amount added in TALS must be an adjusted value. The conversion factor for 5 mL purge is 8.8 (Volume of VOA Vial / Purge Volume) or 44/5 = 8.8. To calculate the amount added for TALS, divide the actual volume added by 8.8. For example, 22 uL of SSTD is added to each sample, but the volume of surrogate added is entered into the TALS worksheet as 2.5 uL.*

Calibration, QC, and Sample Preparation Summary

8260B Soil (Prepared in 44 ml VOA Vial / 5 mL) Sample Volume)

Instructions: Add the amount, type and concentration of spiking solution listed in this table to a prepared 44 mL VOA vials and enter these amounts into the reagent worksheet in the TALS analysis batch.

SOP Reference: BR-MV-006

		Routine							
		524/8260 ISTD	**524/8260 SSTD**	**8260 Cal Mix & Gases**	**8260 Cal Addeds**	**8260 LCS Mix & Gases**	**8260 LCS Addeds**	**TBA_1**	**TBA_1 LCS**
	Concentration$_2$	**50 ug/mL**	**50 ug/mL**	**200 ug/mL**	**200 ug/mL**	**200 ug/mL**	**200 ug/mL**	**2500 ug/mL**	**2500 ug/mL**
Cal 1_3	**5 ug/L**	44 mL		1.1 uL	1.1 uL			0.9 uL	
Cal 2_3	**10 ug/L**	44 mL		2.2 uL	5.5 uL			1.8 uL	
Cal 3_3	**25 ug/L**	44 mL		5.5 uL	11 uL			3.6 uL	
Cal 4/CCV	**50 ug/L**	**5 uL**		**1.2 uL**	**3.1 uL**			**1 uL**	
Cal 5	**100 ug/L**	5 uL		2.5 uL	6.2 uL			2 uL	
Cal 6	**200 ug/L**	5 uL		5 uL	12.5 uL			4 uL	
ICV or LCS	**50 ug/L**	5 uL	5 uL			1.2 uL	3.1 uL		1 uL
MS / MSD	**50 ug/L**	5 uL	5 uL			1.2 uL	3.1 uL		1 uL
Samples & Blank	NA	5 uL	5 uL						

1: tert-Butyl Alcohol

2: TBA concentration 10 fold greater.

3: Prepared in 44 mL VOA vial.

TALS Amounts: *TALS bases calculations on a VOA vial volume of 40 mL. The lab adds spikes and surrogates directly to 44 mL VOA vials for some of the standards. To compensate for the difference, the amount added in TALS must be an adjusted value when the standards are added to 44 mL vials.. The conversion factor for 5 mL purge is 8.8 (Volume of VOA Vial / Purge Volume) or 44/5 = 8.8. To calculate the amount added for TALS, divide the actual volume added by 8.8. For example, 44 mL of ISTD is added to the 44 mL VOA vial. To determine the volume of ISTD to enter into the TALS Batch worksheet, divide 44 by 8.8, which equals 5. Enter 5 mL in the TALS worksheet.*

Title: VOA Sample Preservation & Screen Analysis Procedure

Approval Signatures:

William Cicero
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Approval Date: August 2, 2012

Facility Distribution No. Electronic **Distributed To: Facility Intranet**

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1.0 Scope and Application

This SOP describes the laboratory's procedure used to laboratory preserve and screen field samples scheduled for analysis by SW-846 8260.

1.1 Analytes, Matrix(s), and Reporting Limits

This procedure is used for waters and soils.

This procedure is a preparation procedure. The list of analytes included in the screen analysis are provided in Table 1.

2.0 Summary of Method

Soil samples are preserved on receipt using the preservation technique specified by the project manager (PM). Samples may be screened prior to analysis to estimate appropriate dilution factors for sample analysis and to distinguish between samples that require high concentration analysis.

Sample preservation procedures are based on the following reference methods:

- SW-846 Method 5030B, 5035 and 5035A.

The screen procedure is a laboratory developed method.

3.0 Definitions

- Screen: A term used to describe a test procedure that is designed to provide semiquantitative or range-finding results.

A complete list of common laboratory terms and definitions is provided in Appendix A.

4.0 Interferences

Contamination by carryover can occur whenever high-level and low-level samples are sequentially analyzed. To reduce carryover, whenever an unusually concentrated sample is encountered, it should be followed by analysis of reagent water.

Prior to and after sample analysis, the instrument system is demonstrated to be free of interferences by the analysis of an instrument blank.

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

Sodium bisulfate creates sulfuric acid when mixed with water.

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

There are areas of high voltage in the gas chromatograph. 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

Table 2 lists those materials used in this procedure that have a serious or significant hazard rating along with the exposure limits and primary hazards associated with that material as identified in the MSDS. **NOTE: This list does not include all materials used in the method.** 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.

6.0 Equipment and Supplies

6.1 Preservation

- 40 mL VOA Vials
- Wide-Range pH Paper: Fisher Brand or equivalent.

6.2 Screen Analysis

- HP5890 GC with ECD and FID
- Tekmar 7000 Headspace Sampler; Tekmar 7050 Autosampler.
- PC, ChromPerfect Software with DT2408 A/D board.
- 20 mL crimp top vials with Teflon lined septa and aluminum caps.
- Gastight Syringe 10-100 uL, Hamilton or equivalent.
- Gastight Syringe 0-1000 uL, Hamilton or equivalent.
-

7.0 Reagents and Standards

7.1 Reagents

Methanol (CH_3OH), Purge & Trap quality: Company approved vendor.

VOA-Free Reagent Water: Boil water that has been filtered through the laboratory RO system for one hour, then purge with helium for a minimum of one hour.

7.2 Standards

Purchase stock standard solutions from commercial vendors and from these prepare calibration and working standards by diluting a known volume of stock standard in an appropriate solvent to

the final volume needed to achieve the desired concentration. The recommended formulation for each standard used in this procedure is provided in Appendix B along with the recommended source materials, expiration dates and storage conditions.

8.0 Sample Collection, Preservation, Shipment and Storage

The laboratory does not perform sample collection so these procedures are not included in this SOP. Sampling requirements for volatile organic samples by the SW-846 methods are provided in SW-846 Chapter 4, Section 4.1.2.

Holding Times:

- The holding time for preserved water samples is 14 days from date of collection and 7 days from date of collection for unpreserved samples. See Section 10.1.1 for more information.

- The holding time for soils stored at 4°±2 is 48 hours from time of collection to time of preservation. After preservation, the holding time is extended to 14 days from time of sample collection.

9.0 Quality Control

Not applicable.

10.0 Procedure

10.1 Sample Preservation

Water Samples (SW-846 Method 5030A)

Check the preservation of water samples after analysis using the same vial used for analysis.

To check preservation dip a piece of wide-range pH paper into the spent vial. Record the measurement on the instrument run log and in the TALS batch. The pH of the field-preserved sample must be <2. If it is not, initiate a nonconformance memo (NCM) in TALS and send a TALS email from the NCM module to the PM. The PM should contact their client to alert them of the situation and request further instruction.

It is industry standard to apply a 7 day holding time to samples that are not preserved to a pH <2.However the SW-846 reference method does not include this provision. A company representative contacted the EHSG MICE line and received the following clarification:

From: *mice@cpmx.mail.saic.com [mailto:mice@cpmx.mail.saic.com]* ***On Behalf Of*** *EHSG MICE* ***Sent:*** *Monday, February 06, 2006 11:38 AM* ***Cc:*** *EHSG MICE* ***Subject:*** *RE: Holding Time for unpreserved Volatiles*

Thank you for your inquiry. In the recently published Method 5030C, which is the aqueous purge-and-trap preparation method for Method 8260, it is noted that: "depending on the desired class of target analytes sample preservation may or may not be necessary and the analytical holding time will be based on whether a preservative is present. The user is then referred to Method 5035A, Appendix A for the most current OSW volatiles sample collection, preservation, and storage guidance. Under the Method 5035A guidance, a 7 day holding time would be considered acceptable for chemically unpreserved aqueous samples,

however, please note if the aromatic constituents such as benzene, toluene, ethylbenzene, and xylenes (BTEX) are among the analytes of interest, acidification is required for biologically active samples because it has been demonstrated that losses can occur within four hours of sample collection.
We hope this information helps!

Based on the response from the EHGS MICE line, the following explanation should be included in the project narrative when the sample used for analysis was not properly preserved to a pH < 2.

"The volatile organic analyses were performed on a sample that was not adequately field preserved to a pH less than 2. Unless there is biological activity in the sample there would be no impact on the sample data if it is analyzed within 7 days. Per EPA Methods Information Communication Exchange (MICE), in the case of where there is biological activity in the sample, the aromatic compounds (BTEX) may exhibit a low bias regardless of how quickly it is analyzed. Since the laboratory does not have knowledge of biological activity in submitted samples, the samples are qualified to indicate the lack of proper acid preservation."

Soil Samples (SW-846 5035)

Sodium Bisulfate Field Preservation: Low concentration samples are collected and preserved in the field in vials that contain preservative solution and stored on ice for shipment to the laboratory. On receipt in the laboratory the samples are put in refrigerated storage areas kept at a temperature of 4°C ±2 until time of analysis.

Methanol Field Preservation: When samples are known to contain volatiles at concentrations high enough that dilution will not preclude obtaining results within the calibration range, samples may be collected into vials that contain purge and trap grade methanol. After collection, samples are placed on ice for shipment to the laboratory. On receipt in the laboratory the samples are put in refrigerated storage areas kept at a temperature of 4°C ±2 until time of analysis.

Samples preserved in methanol are not analyzed by the closed system purge and trap technique specified in reference method SW-846 5035. Thus the method reference is applicable to the preservation technique only.

Unpreserved Soils: EnCore™ Samplers or similar devices: Samples collected in these samples are chemically unpreserved at the time of collection but are thermally preserved on ice for shipment to the laboratory. Samples collected in these devices must be transferred within 48 hours of collection or analyzed within 48 hours from time of collection.

Extrude the sample from the Encore sampling devices into pre-preserved 44 mL vials that contains 5 mL of VOA free-reagent water and a magnetic stir bar. ***Preservation must be complete within 48 hours of sample collection.*** Prepare 2 vials for each samples. Store the preserved samples at a temperature of +/- 4°C until time of analysis.

Soil Samples (SW-846 5035A)

Frozen Field Preservation: Samples are collected in VOA vials and frozen in the field to < -7°C until thawed for analysis.

Frozen Water Preservation: Samples are collected in VOA vials and stored on ice at 4°C ±2 for 48 hours or less for shipment to the laboratory then frozen on laboratory receipt, within 48 hours from time of collection, to < -7°C until thawed for analysis.

Methanol Preservation (Lab): Samples are collected in VOA vials and stored on ice at 4°C ±2 for 48 hours or less for shipment to the laboratory then preserved with methanol within 48 hours from time of collection. The methanol is added by opening the vial and adding 10ml MeOH with an adjustable mechanical pipette.

Methanol Preservation (Field): Samples are transferred from the coring device into a VOA vial that contains methanol then shipped and stored at 4°C ±2 until time of analysis.

Sodium Bisulfate Preservation (Field): Samples are collected from a coring device into a vial pre-preserved with sodium bisulfate, then cooled and kept at 4°C ±2 until time of analysis.

Reagent Water/ Freezing: Samples are collected from a coring device into a VOA vial that contains reagent water, the vial is turned on its side and the contents are immediately frozen to < -7°C until thawed for analysis. Alternatively, samples may be stored cooled to 4°C ±2 for 48 hours or less for shipment to the laboratory then frozen on laboratory receipt (within 48 hours of time of collection) to < -7°C until thawed for analysis.

EnCore™ Samplers or similar devices: Samples are collected in coring device and the device is refrigerated or frozen for shipment to the laboratory. On laboratory receipt, sample is extruded into prepared VOA vials. Preservation must occur within 48 hours of time of collection.

Soil Samples Bulk Samples

Since jars and vials cannot be opened without comprising the integrity o f the sample the allowance for the collection of unpreserved samples in containers other than air-tight coring device containers has been removed from SW-846 methods 5035 and 5035A except for sample amounts that will be used solely for dry weight determination or screen analysis.

However the laboratory does on occasion receive samples collected unpreserved in bulk jars for samples analysis. Below are preservation options for bulk samples:

- Frozen Water: Transfer 5 g of sample to a 44 mL vial that contains 5 mL of VOA-free water and a magnetic stir bar. Record the sample weight in TALS. Store the preserved samples at a temperature of -15°C (+/-5) until time of analysis. Sample vials must be stored on their side (not upright) in order to prevent breakage.

- Methanol: Transfer 5 g of sample into a pre-preserved 44 mL vial that contains 10 mL of methanol. Store the preserved samples at a temperature of 4°C (+/-2) until time of analysis.

- Sodium Bisulfate: Transfer 5 go of sample into a pre-preserved sodium bisulfate vial. Store the preserved samples at a temperature of 4°C (+/-2) until time of analysis.

10.2 Screen Analysis

Instrument Operating Conditions

Recommended Operating Conditions:

Headspace Sampler Tekmar 7000 (100 uL Loop) / Tekmar 7050 Autosampler

Description	Condition
Platen Equilibrium Time	0.1 min
Platen Temperature	60°C
Loop Temperature	150°C
Line Temperature	160°C
Sample Equilibrium Time	41 min
Mixer	On
Mix Time	0.1 min
Mix Power Level	3
Stabilize Time	0.1 min
Pressurize Time	0.25 min
Pressure Equilibrium Time	0.05 min
Loop Fill Time	0.25 min
Loop Equilibrium Time	0.05 min
Inject Time	1.0 min
GC Cycle Time	10 min

Gas Chromatograph HP5890 GC

Description	Condition
Column	J&W DB-624 30m x 0.53mmID x 3u film Catalog Number 125-1334.
Carrier Gas	Hydrogen at 5psi
Temperature Program	40 for 0.50 min. Ramp to 90 at 16 min, no hold ramp to 170 at 30 min, no final hold.
Detector A	ECD at 280 with 60ml/min P5 makeup gas
Detector B.	FID at 280 with 300ml/min Air and 30ml/min H2

The column eluent is split between the FID and ECD at a ratio of approximately 19:1 using a press-fit glass Y with varying lengths of uncoated fused silica capillary column going to each detector. The split ratio is approximately proportional to the length ratio of the two lines.

Instrument Calibration

Calibrate the instrument with nine calibration standards using a minimum of five points for each detector. For the FID, some of the lower points (cal levels 1-3) may not be usable due to low sensitivity especially for the chlorinated compounds. For the ECD some of the upper level points (cal levels 7-9) may not be used due to detector saturation of the heavily chlorinated compounds, which occurs at over 800,000 area counts. Remove lower calibration levels from the ICAL if there is not enough sensitivity to make a positive identification. Remove higher calibration levels when detector saturation occurs. A minimum of 5 points is suggested but as reagent blank and a single calibration point is acceptable because the screen procedure is semiquantiative.

Prepare the calibration standards using the formulations provided in Appendix B. Analyze the standards using the procedure described under analytical sequence.

Use the following calibration curve fit options:

- FID: 1 over concentration squared weighted Least Squares Fit linear regression.
- ECD: Ln/Ln transformed linear regression (a.k.a. Power Fit Curve).

The data processing system calculates the Calibration Factor (CF), mean CF and Relative Standard Deviation (%RSD) for each analyte on both columns to verify system performance.

Calibrate the screen instrument as needed.

Each day prior to screen analysis, analyze two CCVs at different concentrations to verify the calibration relationship is sound.

To prepare the CCV standards: Add 2.5 mL of VOA free water to two separate 20 mL headspace vials. Add 5 uL of CAL Mix B to one vial and 5 uL of CAL Mix C to the other. Analyze the standards using the procedure described under analytical sequence.

Sample Preparation

Waters

1) Rinse a 1000 uL gastight syringe with VOA-free water.

2) Prepare a 20 mL headspace vial for each sample. Label the vial with the LAB ID and add 2.0 mL of VOA-free water to each vial.

3) Draw 200 uL of air into the gastight syringe, insert the syringe into a sample container and inject the air into the sample container through the septum.

4) Draw 500 uL of sample into the gastight syringe and inject the sample into its designated headspace vial.

5) Add 2.0 uL of surrogate solution to the sample then cap and crimp the vial.

Soils

1) Using a 100 uL gastight syringe, transfer 50 uL of methanol extract to a 20 mL headspace vial that contains 2.5 mL of VOA-free water.

2) Add 2.0 uL of surrogate solution and crimp the vial tightly.

Analytical Sequence

Arrange the instrument blanks, standards, and screen aliquots sequentially in the autosampler tray. Enter the blank, standard, and sample information into the sequence table in the ChromPerfect software. An example analytical sequence that includes calibration is given below. When ICAL is not performed, the analytical sequence begins with an instrument blank followed by CCV1 (Level 4), CCV2 (Level 6) and another instrument blank.

Injection Number	Lab Description
1	Instrument blank
2	ICAL Level 1
3	ICAL Level 2
4	ICAL Level 3

5	ICAL Level 4
6	ICAL Level 5
7	ICAL Level 6
8	ICAL Level 7
9	ICAL Level 8
10	ICAL Level 9
11	Instrument blank
12-X	Samples

Begin the sequence and acquire the data.

11.0 Calculations / Data Reduction

11.1 Sample Concentration

$$C_S = DF(mX + b)$$

Where:
C_S = Concentration in the sample
DF = Dilution Factor
m = Slope of the line
X = Area response of target constituent
b = y-intercept of the line

11.2 Data Review

Review the analyte concentration for each sample and record the concentration of the analyte with the greatest concentration on the screen worksheet. A response over 800,000 units for any analyte indicates saturation of the detector, and a dilution screen analysis must be performed.
6
Review the percent recovery of the surrogate to verify adequate sample transfer.

Review for saturation or bad injection and repeat the screen procedure if necessary.

When screen is complete, forward the screen data to the instrument analysts.

12.0 Method Performance

12.1 Method Detection Limit Study (MDL)

This is a screening procedure, MDL study is not applicable.

12.2 Demonstration of Capabilities (DOC)

This is a screening procedure, DOC is not applicable.

12.3 Training Requirements

Any employee that performs any portion of the procedure described in this SOP must have

documentation in their employee training file that they have read this version of this SOP.

13.0 Pollution Control and Waste Management

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 Safety Manual for "Waste Management and Pollution Prevention."

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 BR-EH-001. The following waste streams are produced when this method is carried out:

- Aqueous Waste-Satellite Container: 5 Gallon Plastic Bucket.
- Solid Waste-Satellite Container: 5 Gallon Plastic Bucket.
- Solvent Waste-Satellite Container: 1 Liter amber.

Where reasonably feasible, technological changes have been implemented to minimize the production of hazardous waste and minimize potential source of pollution to the environment.

Hazardous waste generated by this procedure is accumulated in satellite containers located in the work area. The satellite containers are labeled "Hazardous Waste" along with the type of waste category generated. Authorized personnel routinely transfer the contents of the satellite containers to the hazardous waste storage room for future disposal in accordance with Federal, State and Local regulations. The procedures for waste management are further given in laboratory SOP BR-EH-001 *Hazardous Waste*.

14.0 References / Cross-References

- SW-846 5030B, Purge and Trap for Aqueous Samples, Revision 2, December 1996.
- SW-846 5035 Closed-System Purge and Trap and Extraction for Volatile Organics in Soil and Waste Samples, Revision 0, 1996.
- SW-846 5035A, Closed-System Purge and Trap and Extraction for Volatile Organics in Soil and Waste Samples, Revision 1, July 1992.
- Laboratory SOP BR-EH-001

15.0 Method Modifications

None

16.0 Attachments

Table 1: Screen Analyte List
Table 2: Primary Materials Used

Appendix A: Terms and Definitions
Appendix B: Standard Preparation Formulations

17.0 Revision History

BR-MV-007 Revision 6:

- Title Page: Updated approval signatures
- Section 10: Changed format of this section, added more options from 5035A. Separated bulk samples into its own section and removed method reference for bulk samples.
- Tables: Updated formulations and added formulations missing from prior version.

BR-MV-007 Revision 5:

- Title Page: Name of SOP was changed from LM-MV-3810 to LM-MV-Screen
- Title Page: Updated approval signatures.
- All Sections: Entire SOP was re-written to reflect current practice.

Table 1: Screen List

Compound	CAS
Pentane	109-66-0
Freon 113	76-13-1
Methylene Chloride	75-09-2
Methyl-t-Butyl Ether	1634-04-4
1,1-Dichloroethane	75-34-3
cis 1,2-Dichloroethene	156-59-2
Chloroform	67-66-3
1,1,1 Trichloroethane	71-55-6
Carbon Tetrachloride	56-23-5
Benzene	71-43-2
Trichloroethene	79-01-6
Bromodichloromethane	75-27-4
Octane (C8)	111-65-9
Toluene	108-88-3
1,1,2 Trichloroethane	79-00-5
Tetrachloroethene	127-18-4
Dibromochloromethane	124-48-1
Chlorobenzene	108-90-7
Ethyl Benzene	100-41-4
meta Xylene para Xylene	108-38-3 106-42-3
Ortho Xylene	95-47-6
Decane (C10)	124-18-5
Bromoform	75-25-2
1,3 Dichlorobenzene	541-73-1
1,4 Dichlorobenzene	106-46-7
1,2 Dichlorobenzene	95-50-1

Dodecane	112-40-3
a,a,a Trifluorotoluene	98-08-8
Bromofluorobenzene	460-00-4

Table 2: Primary Materials Used (Method 5030, 5035)

Material (1)	Hazards	Exposure Limit (2)	Signs and symptoms of exposure
Hydrochloric Acid	Corrosive Poison	5 ppm-Ceiling	Inhalation of vapors can cause coughing, choking, inflammation of the nose, throat, and upper respiratory tract, and in severe cases, pulmonary edema, circulatory failure, and death. Can cause redness, pain, and severe skin burns. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
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 – Always add acid to water to prevent violent reactions.			
2 – Exposure limit refers to the OSHA regulatory exposure limit.			

Appendix A: Terms and Definitions

Analyte: The specific chemicals or components for which a sample is analyzed. (EPA Risk Assessment Guide for Superfund, OSHA Glossary).

Calibration: a set of operations that establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument or measuring system, or values represented by a material measure or a reference material and the corresponding values realized by the standards.

Calibration Curve: the graphical relationship between the known values or a series of calibration standards and their instrument response.

Calibration Standard: A substance or reference used to calibrate an instrument.

Continuing Calibration Verification (CCV): a single or multi-parameter calibration standard used to verify the stability of the method over time. Usually from the same source as the calibration curve.

Holding Time: the maximum time that a sample may be held before preparation and/or analysis as promulgated by regulation or as specified in a test method.

Initial Calibration: Analysis of analytical standards for a series of different specified concentrations used to define the quantitative response, linearity and dynamic range of the instrument to target analytes.

Preservation: refrigeration and/or reagents added at the time of sample collection to maintain the chemical, physical, and/or biological integrity of the sample.

Stock Standard: a solution made with one or more neat standards usually with a high concentration. Also known as a primary standard. Stock standards may be certified solutions purchased from a vendor.

Surrogate: a substance with properties that mimic the analyte of interest but that are unlikely to be found in environmental samples.

Appendix B: Standard Preparation Formulations

Unless otherwise specified, prepare the standards in methanol and assign an expiration date of 6 months from date of preparation unless the parent standards expire sooner. In which case, use the earliest expiration date. Store in the freezer at a temperature of -15°C ±5.

Surrogate Intermediate Standard (5000 ug/mL)

Stock Standard	Vendor	Standard Concentration (ug/mL)	Volume Added (mL)	Final Volume (mL)	Final Concentration (ug/mL)
a,a,a-Trifluorotoluene	Restek #30083	10,000	1	2.0	5,000
4-Bromofluorobenzene	Restek #30082	10,000	1	2.0	5,000

Screen Surrogate Working Standard (500 ug/mL)

Parent Standard	Vendor	Stock Standard Concentration (ug/mL)	Volume Added (uL)	Final Volume (mL)	Final Concentration (ug/mL)
Surrogate Intermediate Standard	Laboratory Prepared	5,000	100	1.0	500

Working Calibration Standards

Standard Name	Parent Standard	Vendor	Volume Added (uL)	Final Volume (mL)
Calibration Mix C	Custom VOA Screen Standard (D)	Ultra Scientific 13716	100	1
Calibration Mix B	Calibration Mix C	Laboratory Prepared	100	1
Calibration Mix A	Calibration Mix B	Laboratory Prepared	100	1

Concentration of Components in Calibration Stock Standard Solutions

Component	Concentration (ug/mL)			
	D	C	B	A
Pentane	1000	100	10	1
Freon 113	3000	300	30	3
Methylene Chloride	4000	400	40	4
Methyl-t-Butyl Ether	2000	200	20	2
1,1-Dichloroethane	2000	200	20	2
cis 1,2-Dichloroethene	2000	200	20	2
Chloroform	4000	400	40	4
1,1,1 Trichloroethane	2000	200	20	2
Carbon Tetrachloride	500	50	5	0.5
Benzene	667	66.7	6.67	0.667
Trichloroethene	1000	100	10	1
Bromodichloromethane	1000	100	10	1
Octane (C8)	500	50	5	0.5
Toluene	500	50	5	0.5
1,1,2 Trichloroethane	4000	400	40	4
Tetrachloroethene	667	66.7	6.67	0.667
Dibromochloromethane	2000	200	20	2
Chlorobenzene	667	66.7	6.67	0.667
Ethyl Benzene	500	50	5	0.5
Meta -xylene	250	25	2.5	0.25
Para-xylene	250	25	2.5	0.25
Ortho Xylene	500	50	5	0.5
Decane (C10)	500	50	5	0.5
Bromoform	4000	400	40	4
1,3 Dichlorobenzene	1000	100	10	1
1,4 Dichlorobenzene	1000	100	10	1
1,2 Dichlorobenzene	1000	100	10	1
Dodecane (C12)	500	50	5	0.5
a,a,a Trifluorotoluene	1000	100	10	1
Bromofluorobenzene	1000	100	10	1

Calibration Working Standards Formulation

Level	Parent Standard	Volume Added (uL)	Reagent Water (mL)
Level 1	Mix A	2.0	2.5
Level 2	Mix A	5.0	2.5
Level 3	Mix B	2.0	2.5
Level 4	Mix B	5.0	2.5
Level 5	Mix C	2.0	2.5
Level 6	Mix C	5.0	2.5
Level 7	Mix D	2.0	2.5
Level 8	Mix D	5.0	2.5
Level 9	Mix D	10.0	2.5

Final Concentration in Each Calibration Level (ug/L)

Component	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7	Level 8	Level 9
Pentane	0.80	2.0	8.0	20	80	200	800	2000	4000
Freon 113	2.4	6.0	24	60	240	600	2400	6000	12000
Methylene Chloride	3.2	8.0	32	80	320	800	3200	8000	16000
Methyl-t-Butyl Ether	1.6	4.0	16	40	160	400	1600	4000	8000
1,1-Dichloroethane	1.6	4.0	16	40	160	400	1600	4000	8000
cis 1,2-Dichloroethene	1.6	4.0	16	40	160	400	1600	4000	8000
Chloroform	3.2	8.0	32	80	320	800	3200	8000	16000
1,1,1 Trichloroethane	1.6	4.0	16	40	160	400	1600	4000	8000
Carbon Tetrachloride	0.4	1.0	4.0	10	40	100	400	1000	2000
Benzene	0.53	1.3	5.3	13	53	130	530	1300	2600
Trichloroethene	1.6	4.0	16	40	160	400	1600	4000	8000
Bromodichloromethane	0.8	2.0	8.0	20	80	200	800	2000	4000
Octane (C8)	0.40	10	4.0	10	40	100	400	1000	2000
Toluene	0.40	1.0	4.0	10	40	100	400	1000	2000
1,1,2 Trichloroethane	3.2	8.0	32	80	320	800	3200	8000	16000
Tetrachloroethene	0.53	1.3	5.3	13	53	130	530	1300	2600
Dibromochloromethane	1.6	4.0	16	40	160	400	1600	4000	8000
Chlorobenzene	0.53	1.3	5.3	13	53	130	530	1300	2600
Ethyl Benzene	0.40	1.0	4.0	10	40	100	400	1000	2000
m -xylene	0.20	0.50	2.0	2.0	20	50	200	500	1000
p-xylene	0.20	0.50	2.0	2.0	20	50	200	500	1000
o-Xylene	0.40	1.0	4.0	10	40	100	400	1000	2000
Decane (C10)	0.40	1.0	4.0	10	40	100	400	1000	2000
Bromoform	3.2	8.0	32	80	320	800	3200	8000	16000
1,3 Dichlorobenzene	0.8	2.0	8.0	20	80	200	800	2000	4000
1,4 Dichlorobenzene	0.8	2.0	8.0	20	80	200	800	2000	4000
1,2 Dichlorobenzene	0.8	2.0	8.0	20	80	200	800	2000	4000
Dodecane (C12)	0.40	1.0	4.0	10	40	100	400	1000	2000
a,a,a Trifluorotoluene	0.80	2.0	8.0	20	80	200	800	2000	4000
Bromofluorobenzene	0.80	2.0	8.0	20	80	200	800	2000	4000

Health and Safety Plan

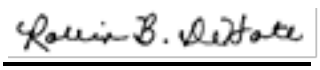
Paerdegat Basin – National Grid

Brooklyn, NY

GEI Consultants, Inc.
455 Winding Brook Drive
Suite 201
Glastonbury, CT 06033

October 2012
Revised February 14, 2013

Barry Giroux
Project Manager



Robin B. DeHate, Ph.D.
Corporate Health and Safety Officer

Table of Contents

1. Background

1.1 General

Engineer GEI Consultants, Inc. (GEI)
455 Winding Brook Drive
Suite 201
Glastonbury, CT 06033

Project Name Paerdegat Basin – National Grid
Brooklyn, NY

This Health and Safety Plan (HASP) establishes policies and procedures to protect GEI personnel from the potential hazards posed by activities at Paerdegat Basin in Brooklyn, New York (see the map in **Appendix A** – Site-Specific Information).

Reading of and adherence to the HASP is required of all on-site GEI personnel. Subcontractors for this project will be required to develop their own HASP for protection of their employees, but at a minimum must adhere to applicable requirements set forth in this HASP. Additionally, federal, state and local representatives may be required to sign and adhere to this HASP, depending on the nature of their presence on site during activities conducted by GEI.

The plan identifies measures to minimize accidents and injuries, which may result from project activities, emergencies, or during adverse weather conditions. Activities performed under this HASP will comply with applicable parts of OSHA Regulations, primarily 29 Code of Federal Regulations (CFR) Parts 1910 and 1926.

Included in Appendix A is a route to the nearest medical facility to the site with directions and contact information. Appendix B is the Hazard Communication Program. Appendix C details the signs, symptoms, care and procedures to both heat and cold stress. And included in Appendix D are the GEI standard operating procedures (SOPs) that apply to this project. . Material safety data sheets specific to chemicals that may be encountered while working at the site are included in Appendix E. Appendix F is a blank incident report form.

1.2 Project Description

The project involves the release of a polychlorinated biphenyl (PCB)-contaminated liquid to Paerdegat Basin on Jamaica Bay in Brooklyn, NY. A gas condensate release was

caused when a contractor was abandoning a 24" transmission line with flowable fill/concrete. The concrete displaced the condensate liquids from the line and caused a release through a standpipe that pooled on the ground surface and ultimately discharged to the adjacent water body. Reported release volume to the waterway was approximately 1,400 gallons.

The primary objectives of the project are to conduct a presence/absence assessment of Aroclor 1242 in the area surrounding Paerdegat Basin (here as referred to as the Site). Aroclor 1242 was previously documented by analysis as the only Aroclor (a commercial mixture of PCBs) in the condensate liquid released. Therefore, the approach would be to investigate whether Aroclor 1242 is detected in any media, and to assess whether further analyses are required.

If Aroclor 1242 is detected, a congener analyses will be conducted as part of a forensic comparison of the sample media to the source sample. Sample media include: soils, shallow sediments (0 – 6 inches), and biota (crabs, fish, mussels, and potentially additional benthic invertebrates depending on organisms collected).

1.3 Chemical Hazards

The characteristics of compounds at the Site are discussed below in the following subsections for informational purposes. Adherence to the safety and health guidelines in this HASP should reduce the potential for exposure to the compounds discussed below.

1.3.1 Volatile Organic Compounds (VOCs)

Volatile organic chemicals (VOCs), such as benzene, toluene, ethyl benzene, and xylene (BTEX) may be present within Jamaica Bay sediments and potentially within subsurface soils adjacent to Paerdegat Basin and Jamaica Bay. In some cases, the chemical components may be present in non-aqueous phase liquids (NAPL) such as fuels, oils, or tar within sediments and within subsurface soils adjacent to the Bay. These compounds generally have a depressant effect on the central nervous system (CNS), may cause chronic liver and kidney damage, and some are suspected human carcinogens. Benzene is a known human carcinogen. Acute exposure may include headache, dizziness, nausea, and skin and eye irritation. The primary route of exposure to VOCs is through inhalation and therefore air monitoring and respiratory protection is the primary control against exposure to VOCs. Air monitoring will be completed as specified in Section 8.0 to minimize airborne exposures. Exposure through direct contact is possible and will be minimized through the use of PPE as prescribed in Section 9.0.

1.3.2 Oil Products

Petroleum products that may have been associated with the gas condensate spill contain semi-volatile organic compounds (SVOCs). SVOCs consist of a mixture of

acenaphthene, acenaphthylene, anthracene, benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, benzo(e)pyrene, benzo(g,h,i)perylene, chrysene, dibenz(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, 2-methyl naphthalene, naphthalene, phenanthrene, phenols, and pyrene.

Petroleum products such as those listed above may cause contact dermatitis. Direct contact can be irritating to the skin and produce itching, burning, swelling and redness. Direct contact or exposure to the vapors may be irritating to the eyes. Conjunctivitis may result from prolonged exposure. Coal tar is considered to be very toxic, if ingested. High levels of exposure to coal tar, though not anticipated during work activities conducted during this project, may increase the risk of cancer including lung, kidney, and skin cancer. Naphthalene is also an eye and skin irritant and can cause nausea, headache, fever anemia, liver damage, vomiting convulsions, and coma. Poisoning may occur by ingestion of large doses, inhalation, or skin absorption.

The major route of exposure of SVOCs during work activities to be conducted at this Site is through direct contact. Exposure is most likely when handling sediment, soil, and water samples. Exposure through direct contact is possible and will be minimized through the use of PPE as prescribed in Section 9.0. Inhalation of SVOCs may occur when the soil is disturbed causing respirable and nuisance dust particles to become airborne or through the volatilization of naphthalene. Air monitoring will be completed as specified in Section 7.0 to minimize airborne exposures.

1.3.2 Heavy Metals

Paerdegat Basin and Jamaica Bay soils and sediments may contain elevated levels of metals including: arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, thallium, and zinc; typical of industrialized urban estuaries.

As with SVOCs, the primary route of metal exposure is through inhalation of dust particles when soils or sediments are disturbed and become airborne. The primary route of exposure is through inhalation of dust particles when subsurface soils are disturbed and become airborne. Air monitoring will be completed as specified in Section 7.0 to minimize airborne exposures during subsurface soil investigations.

1.3.3 Asbestos-Containing Materials

Asbestos containing materials (ACM) can be present at investigation sites in the form of demolition debris, ACM pipe insulation, and asbestos cement pipe. Chronic exposure to asbestos may cause asbestosis and mesothelioma. The primary route of exposure for asbestos is inhalation during the disturbance and/or removal of asbestos from the pipe insulation and cement pipes. Any ACM encountered within sediments will be saturated with water and will likely not be friable and thus should not be a concern for inhalation.

Asbestos is strictly regulated under OSHA 29 CFR 1910.1001/1926.1101. Employees that may be potentially exposed to ACM must participate in a medical surveillance program, have specific training in the hazards and controls of exposure to asbestos and wear respirators with high efficiency particulate (HEPA) filters. All work must be conducted in demarcated regulated areas to minimize the amount of people within the exposure area. Employers must conduct air sampling and provide signs and labels regarding the presence of asbestos.

1.3.4 Polychlorinated Biphenyls

The gas condensate released into Paerdegat Basin is known to contain polychlorinated biphenyls (PCBs) which may be encountered during sampling activities. PCBs have historically been used from a number of sources including, but not limited to; electrical systems, hydraulic oils, lubricants, cutting oils, printers ink, and asphalt. Exposure to PCBs can occur through unbroken skin without immediate pain or irritation. Acute affects of PCB exposure can include eye, skin, nose, and throat irritation. Chronic effects of PCB exposure can include skin swelling and redness, gastro-intestinal disturbances, and neurological effects such as headache, dizziness, nervousness and numbness of extremities. PCBs are probable human carcinogens that can cause liver cancer. PCBs can accumulate in fatty tissues and result in health effects after the initial exposure has occurred. The primary route of exposure for PCBs is inhalation, dermal contact, and ingestion.

1.3.5 Hydrogen Sulfide

Hydrogen sulfide is a by associated with the breakdown of sewage by bacteria. Exposure to lower concentrations can result in eye irritation, a sore throat and cough, shortness of breath, and fluid in the lungs. These symptoms usually go away in a few weeks. Long-term, low-level exposure may result in fatigue, loss of appetite, headaches, irritability, poor memory, and dizziness. Breathing very high levels (>800 ppm) of hydrogen sulfide can cause death within just a few breaths. The primary route of exposure is through inhalation, and therefore respiratory protection is the primary control against exposure to hydrogen sulfide.

1.3.6 Evaluation of Organic Vapor Exposure

Air monitoring reduces the risk of overexposure by indicating when action levels have been exceeded and when PPE must be upgraded or changed. Action levels for volatile organic compounds and associated contingency plans for the work zone are discussed within Section 7.0 of this Health and Safety Plan.

Exposure to organic vapors shall be evaluated and/or controlled by:

- Monitoring air concentrations for organic vapors in the breathing zone with a photo-ionization detector (PID) or a flame ionizing detector (FID)
- When possible, engineering control measures will be utilized to suppress the volatile organic vapors. Engineering methods can include utilizing a fan to promote air circulation, utilizing volatile suppressant foam, providing artificial ground cover, or covering up the impacted material with a tarp to mitigate volatile odors.
- When volatile suppression engineering controls are not effective and organic vapor meters indicate concentrations above the action levels, then appropriate respiratory protection (i.e. air purifying respirator with organic vapor cartridge) will be employed.

1.4 Physical Hazards

1.4.1 Fire and Explosion

All activities shall conform with all applicable state, federal, and local regulations pertaining to fire and explosion prevention procedures. A fire extinguisher will be located on the boat and in the work zone on land. All fires should be reported to 911 emergency services. In the event of an emergency, staff should attempt to disconnect the power supply to the systems, however if a fire is present staff should immediately evacuate the system and contact 911. Section 12.0 contains specific information related to fire response on the boat.

1.4.2 Cold Stress

During the winter months, workers may be exposed to the hazards of working in cold environments. Potential hazards in cold environments include frostbite, trench foot or immersion foot, hypothermia as well as slippery surfaces, brittle equipment, and poor judgment. Additionally, exposure to ocean water during the cold season can result in cold stress and hypothermia. The procedures to be followed regarding the avoidance of cold stress are provided in **Appendix C** - Cold Stress Guidelines.

1.4.3 Heat Stress

Heat stress is a significant potential hazard, which is greatly exacerbated with the use of PPE in hot environments. The potential hazards of working in hot environments include dehydration, cramps, heat rash, heat exhaustion, and heat stroke. A heat stress prevention program will be implemented when ambient temperatures exceed 70ºF for personnel wearing chemical protective clothing. The procedures to be followed are provided in **Appendix C**- Heat Stress Guidelines.

1.4.4 Noise

Noise is a potential hazard associated with the operation of heavy equipment (i.e. winch), pumps and generators. Site workers who will perform suspected or established high noise tasks and operations for short durations (less than 1-hour) shall wear hearing protection. If deemed necessary by the Site Safety Officer (SSO), the Corporate Health & Safety Officer (CHSO) will be consulted on the need for additional hearing protection for site activities. Other workers who do not need to be in proximity of the noise should distance themselves from the equipment generating the noise.

1.4.5 Slips, Trips, and Falls

Project work will pose slip, trip and fall hazards due to potential slippery surfaces on the boat deck. GEI employees will wear proper footwear (i.e. boots or shoes with appropriate traction for slippery surfaces) and will employ good work practice and housekeeping procedures to minimize the potential for slips, trips, and falls.

1.4.6 Manual Lifting

Manual lifting of objects and equipment may be required. Failure to follow proper lifting technique can result in back injuries and strains. Site workers should use power equipment (winch)to lift heavy loads whenever possible and should evaluate loads before trying to lift them (i.e., they should be able to easily tip the load and then return it to its original position). Carrying heavy loads with a buddy and proper lifting techniques include: 1) make sure footing is solid; 2) make back straight with no curving or slouching; 3) center body over feet; 4) grasp the object firmly and as close to your body as possible; 5) lift with legs; and 6) turn with your feet, don't twist.

1.4.7 Sun Exposure

Employees are encouraged to liberally apply sunscreen, with a minimum sun protection factor (SPF) of 15, when working outdoors to avoid sunburn and potential skin cancer, which is associated with excessive sun exposure to unprotected skin. Additionally, employees should wear safety glasses that offer protection from UVA/UVB rays.

1.4.8 Boat Safety

Location of boarding will occur at the Midget Squadron marina located at Brooklyn, New York.

For retrieving a person overboard see Section 12.0. The boat will be equipped with an ABC rated fire extinguisher(s).

Emergency procedures for fire and man overboard will be reviewed on the first day of operations and any time a change of personnel occurs.

Utility Clearance in the Project Area

New York requires that Dig Safe Systems, Inc (Dig Safe) be notified at least three (3) full work days prior to initiation of any subsurface work. The Subcontractor will contact New York 811 Dig Safe (1-800-272-4480) to request a mark-out of subsurface utilities that may be present in the Project Area prior to probing sediments. Work will not begin until the required utility clearances have been performed.

Public utility clearance organizations typically do not mark-out underground utility lines that are located on private property. As such, GEI must exercise due diligence and try to identify the location of any private utilities that may be buried within the Project Area. GEI will fulfill this requirement in several ways, including:

- Obtaining as-built drawings for the areas being investigated from the property owners; and
- Visually reviewing each proposed sediment sampling location with the property owner or knowledgeable site representative.

Due to the limitations associated with utility mark-outs, GEI and/or the subcontractors' staff may meet with utility owners to determine if they have any underground lines located in the Project Area. This information will be reviewed by GEI. If it is determined that underground utilities are located in the sediment sampling areas, the sampling locations will be changed so that no utilities are struck during the proposed investigation.

Working on Water

This project presents unique hazards to the GEI personnel when compared to land-based investigation programs. Special attention has been given to the topic of marine safety in this HASP, including the scheduling of a pre-mobilization strategy meeting between GEI and the marine subcontractors to develop the specific safety and emergency communications protocols (based on actual site conditions) to address the hazards of working on the water.

Boat Deck

The boat or drilling platform itself presents slip, trip, and fall hazards to GEI personnel due to the accumulation of water on the deck and the accumulation of equipment which inevitably occurs during work from a boat. To the extent possible, accumulated water should be removed from the boat or barge deck to avoid this hazard. If possible, anti-slip matting should be placed on the decks as an additional precaution.

Good Housekeeping

Maintaining a work environment that is free from accumulated debris is the key to preventing slip, trip and fall hazards at construction sites. Essential elements of good housekeeping on each boat or drilling barge include:

- Orderly placement of materials, tools, and equipment;
- Placing trash receptacles at appropriate locations for the disposal of miscellaneous rubbish;
- Prompt removal and secure storage of items that are not needed to perform the immediate task at hand; and
- Awareness on the part of all employees to walk around, not over or on, equipment that may be stored in the work area.

Boat Capacity

The survey boat shall not be loaded beyond the maximum capacity (number of passengers or the total weight of passengers and gear) as specified on the manufactures capacity plate affixed to the vessel. In addition, consideration will be applied to down rate this capacity (at the discretion of the Boat Captain) so that there is sufficient room, freeboard, and stability to safely perform the intended task given the prevailing weather and river conditions. All equipment shall be properly loaded and secured to prevent shifting and to limit tripping hazards. All personnel shall be evenly distributed on-board and will be instructed to remain seated at all times and wear a personal flotation device (PFD) while the vessel or barge is underway or being moved to the drilling areas.

Personal Flotation Devices

All GEI employees working on the water, near the water's edge, or at any other time where there exists the possibility of falling into the water are required to wear a USCG-approved personal flotation device. When selecting the appropriate type and style of PFD, the type of activity being conducted and the required mobility of the user must be considered, because some activities may require a PFD which is less restrictive.

GEI employees will be required to wear a USCG-approved Type III PFD or a Type V work vest. Although not as effective as a Type I in turning an unconscious wearer face-up in the water, these vests are generally less bulky and restrictive, and are typically the PFDs of choice in a marine work environment. The use of inflatable PFDs is discouraged due to questionable reliability and maintenance requirements.

Prior to and after each use, each PFD shall be inspected for defects which would alter their strength or buoyancy. Defective units shall not be used. In situations where the water temperature has fallen below 50˚F, a USCG-approved Mustang flotation suit shall be worn in place of the Type III or Type V PFD work vest.

Emergency Equipment

All GEI personnel working on boat(s) that are owned/operated by others should be informed of the locations of all on-board safety equipment including first-aid kit, fire extinguishers, throw-ring, marine radio or other suitable communications equipment as applicable to the specific boat being used. Additionally, all GEI personnel shall be instructed as to their individual roles and responsibilities in the event of an on-board emergency (loss of operator, medical emergency, man overboard) prior to the start of any on-water work.

1.5 Biological Hazards

During the course of the project, there is a potential for workers to come into contact with biological hazards such as animals, insects and plants. Workers will be instructed in hazard recognition, health hazards, and control measures during site-specific training.

1.5.1 Animals

During the conduct of site operations, wild animals such as stray dogs or cats, raccoons, and mice may be encountered. Workers shall use discretion and avoid all contact with wild animals.

1.5.2 Marine/Freshwater Organisms

Staff working with surface waters and handling aquatic organisms may experience aquatic dermatitis as a result of exposure to a number of organisms. According to the Suffolk County Health Services Department, aquatic dermatitis "is a skin manifestation, such as a rash or eruption, contracted by bathing in surface waters. A variety of marine and freshwater organisms can be involved, including larval forms of parasitic flatworms, sea anemone or other coelenterate larvae, larval forms of crabs, and jellyfish. The most common conditions reported in Suffolk County waters include "swimmers itch", "sea-bathers eruption" (often referred to as "sea-lice"), and jellyfish envenomations (stings)." While staff will not be entering water to conduct work, exposure is possible due to sampling activities. Staff should also take care when handling any aquatic organisms to avoid injury from claws, spines, teeth etc. Protective gloves should be worn to avoid injury and a PFD will be worn anytime an employee is near water to collect aquatic organisms.

1.5.3 Insects

Insects, including bees, wasps, hornets, and spiders, may be present at the Site making the chance of a bite possible. Some individuals may have a severe allergic reaction to an insect bite or sting that can result in a life threatening condition. Any individuals who have been bitten or stung by an insect should notify the SSO. The following is a list of preventive measures:

- Apply insect repellent prior to performing any field work and as often as needed throughout the work shift
- Wear proper protective clothing (work boots, socks and light colored pants)
- When walking in wooded areas, avoid contact with bushes, tall grass, or brush as much as possible
- Field personnel who may have insect allergies should have bee sting allergy medication on site and should provide this information to the SSO prior to commencing work

1.5.3.1 Lyme Disease

Lyme disease is caused by infection from a deer tick that carries a spirochete. During the painless tick bite, the spirochete may be transmitted into the bloodstream often after feeding on the host for 12 to 24 hours. The ticks that cause the disease are often no bigger than a poppy seed or a comma in newsprint. The peak months for human infection are from May to September.

Symptoms appear in three stages. First symptoms usually appear from 2 days to a few weeks after a person is bitten by an infected tick. Symptoms usually consist of a ring-like red rash on the skin where the tick was attached. The rash is often bulls-eye like with red on the outside and clear in the center. The rash may be warm, itchy, tender, and/or "doughy." Unfortunately, this rash appears in only 60 to 80% of infected persons. An infected person also has flu-like symptoms of a stiff neck, chills, fever, sore throat, headache, fatigue and joint pain. These symptoms often disappear after a few weeks. The second stage symptoms, which occur weeks to months later include meningitis, severe headache, drooping of the muscles on the face, called Bell's Pals, encephalitis, numbness, withdrawal and lethargy. These symptoms may last for several weeks to several months. Third stage symptoms, which occur months or years later include arthritis, heart problems, and loss of memory. The third stage symptoms may mimic multiple sclerosis and Alzheimer's disease.

It is recommended that personnel check themselves when in areas that could harbor deer ticks, wear light color clothing and visually check themselves and their buddy when coming from wooded or vegetated areas. If a tick is found biting an individual, the SSO should be contacted immediately. The tick can be removed by pulling gently at the head with tweezers. If tweezers are not available, cover your fingers (e.g. tissue paper) and use to grasp the tick. It is important to grasp the tick as close to the site of attachment and use a firm steady pull to remove it. Wash hands immediately after with soap and water. The affected area should then be disinfected with an antiseptic wipe. All mouth parts must be removed from the skin. If the tick is removed with breaking off the mouth parts, an irritation or infection may occur. Also, the organism that is causing the disease can

still enter the body through the skin. The employee will be offered the option for medical treatment by a physician, which typically involves antibiotics. If personnel feel sick or have signs similar to those above, they should notify the SSO immediately.

Treatment with antibiotics is effective and recovery is usually complete. In the first stage antibiotics are usually given orally. Second and third stage treatment, however is prolonged and recovery may take longer. Antibiotic treatment is usually provided intravenously for second and third stage Lyme disease.

1.5.3.2 West Nile Virus

West Nile Virus (WNV) is a mosquito-borne infection transmitted through the bite of an infected mosquito. The symptoms of WNV can be asymptomatic (no symptoms) or in more serious cases can lead to West Nile fever. West Nile Fever can include fever, headache, tiredness, body ache, an occasional rash on the trunk of the body, and swollen lymph glands, In severe cases, people have developed West Nile encephalitis or meningitis which symptoms include fever, headache, neck stiffness, tremors, coma and in some cases death. The incubation period for the disease is usually 2 to 15 days. The symptoms can range from a few days to several weeks.

Since the initial outbreak in 1999, the virus has spread rapidly throughout New York State. There are about 65 different species of mosquitoes in New York State, but only a small percentage has been associated with the WNV. Most mosquitoes are not infected and the chance of infection from a mosquito bite of an on-site worker is very small. All residents of areas where virus activity has been identified are at risk of getting WNV, but those of the highest risk for becoming seriously ill from WNV are people are over 50 and individuals with some immunocompromised person (transplant patients).

The following precautions will be used to help reduce the risk of mosquito bites:

- Reduce mosquito-breeding areas by making sure wheelbarrows, buckets, and other containers are turned upside down when not used so that they do not collect standing water.
- Wear shoes, long pants with bottoms tucked into boots or socks, and a long-sleeved shirt when outdoors for long periods of time, or when many mosquitoes are most active (between dawn and dusk).
- Use mosquito repellant according to the manufacturer's directions when outdoors for long periods of time and when mosquitoes are most active.

1.5.4 Plants

The potential for contact with poisonous plants exists when performing field work in undeveloped and wooded areas. Poison ivy, sumac, and oak may be present on site.

Poison ivy can be found as vines on tree trunks or as upright bushes. Poison ivy consists of three leaflets with notched edges. Two leaflets form a pair on opposite sides of the stalk, and the third leaflet stands by itself at the tip. Poison ivy is red in the early spring and turns shiny green later in the spring. Poison sumac can be present in the form of a flat-topped shrub or tree. It has fern-like leaves, which are velvety dark green on top and pale underneath. The branches of immature trees have a velvety "down." Poison sumac has white, "hairy" berry clusters. Poison oak can be present as a sparingly branched shrub. Poison oak is similar to poison ivy in that it has the same leaflet configuration; however, the leaves have slightly deeper notches. Prophylactic application of Tecnu may prevent the occurrence of exposure symptoms. Post exposure over the counter products are available and should be identified at the local pharmacy. Susceptible individuals should be identified to the PM.

Contact with poison ivy, sumac, or oak may lead to a skin rash, characterized by reddened, itchy, blistering skin which needs first aid treatment. If a field worker believes they have contacted one of these plants, immediately wash skin thoroughly with soap and water, taking care not to touch your face or other body parts.

1.5.6 Sewage and Bacterial Impacted Sediments

Paerdegat Basin has served as a combined sewer overflow and consequently has received untreated sanitary sewage from numerous outfalls. Decomposed sewage will potentially be encountered within sediments. Bacteria associated with sewage and can cause illness if ingested or through direct contact. Personal protective equipment as specified in Section 6.0 will be worn to minimize potential exposures. Personnel will use decontamination procedures identified in Section 10.0.

HAZARD ANALYSIS Activity: Mobilization		
Task	**Potential Hazard**	**Control Measure**
Boarding and launching the boat, placing miscellaneous equipment on vessel. [Vessel will be floating at the pier]	Crushing of limbs between pier and hard objects Drowning Slip/Trip/Fall Submerged objects in water	Keep limbs from between trailer, and vessel. Follow safe work practices, US Coast Guard Safe Boating Practices, and wear flotation vest. Keep traffic areas on boat free of slip/trip/fall hazards. Be familiar with the basin configuration and conditions of the surrounding marine area.
Boat mobilization / Landing at dock	Crushing of limbs between the vessel and the dock, drowning.	Keep limbs inboard. Wear flotation vest.
Activity: Soil and Sediment Sampling Activities		
Task	**Potential Hazard**	**Control Measure**
Moving vessel to exploration locations; set up vessel to sample by	Interaction with other boat traffic. Drowning.	Wear flotation vest. Follow USCG Safe Boating Practices.

lowering anchors.		
Sampling	Contact w/equipment, especially moving parts. Overhead hazard (rods).	Stay alert and maintain suitable clearance from moving and overhead equipment. Do not wear loose clothing, jewelry, or equipment, which could get caught by moving equipment. Inspect equipment daily. Train all personnel on use of emergency shutoff switches.
	Weather related equipment hazards (slippage in rain, lightning).	Cease operations prior to and during electrical storms. Cease operations if equipment cannot be operated safely under wet conditions.
	Slip/trip/fall.	Keep trafficked areas on boat or barge free of slip/trip/fall hazards.
	Drowning.	Wear flotation vest.
	Loud noise (outboard motor, generator, VC sampler).	Use hearing protection during the operation of equipment that produces loud noise.
	Contact with contaminated sediments.	Wear protective coveralls (e.g. Tyvek®) with shoe covers, butyl rubber gloves, safety glasses and face shield when handling samples. Dispose of gloves after sampling. If exposed to the sediments or surface waters of the basin, wash the exposed skin immediately with anti-bacterial wipes/ gel and wash with soap and water. Personal protective equipment will be decontaminated and disposed of in general accordance with Section 10 of this HASP.
	Cuts or abrasions	Wear Kevlar or leather gloves over butyl rubber gloves.
	Loud noise (generator).	Use hearing protection if working near the generator. Stage generator away from work area.
	Weather related equipment hazards (slippage in rain, lightning).	Cease operations prior to and during electrical storms. Cease operations if equipment cannot be operated safely under wet conditions.
	Loud noise (outboard motor, generator).	Use hearing protection during the operation of equipment that produces loud noise.
	Contaminant contact.	Wear protective coveralls (e.g. Tyvek®) with shoe covers, nitrile gloves, safety glasses and face shield when handling samples. Dispose of gloves after sampling. If exposed to the sediments or surface waters of the canal, wash the exposed skin immediately with anti-bacterial wipes/ gel and wash with soap and water. Personal protective equipment will be decontaminated and disposed of in general accordance with Section 10 of this HASP.
Lift and secure anchors.	Heavy lifting. Slip/Trip/Fall.	Use proper lifting technique. Stay alert to

Relocate to next exploration location.	Drowning.	moving or overhead equipment. Keep trafficked areas on boat or barge free of slip/trip/fall hazards. Wear flotation vest Anchoring equipment and boat deck will be rinsed to remove accumulated sediments prior to demobilization from the canal at the end of the day.
Activity: Biota Sampling Activities		
Collection of aquatic organisms	Cuts or abrasions. Drowning	Wear Kevlar or leather gloves over butyl rubber gloves. Wear flotation vest

2. Statement of Safety and Health Policy

GEI is committed to providing a safe and healthy work environment for its employees. To maintain a safe work environment, GEI has established an organizational structure and a Corporate Health and Safety Program to promote the following objectives:

- Reduce the risk of injury, illness, and loss of life to GEI employees.
- Maintain compliance with federal, state, and other applicable safety regulations; and
- Minimize GEI employees' work exposure to potential physical, chemical, and biological hazards.

3. Key Project Personnel/Responsibilities and Lines of Authority

GEI Personnel		
Barry Giroux	Project Manager (PM)	Office: (860) 368-5340 Mobile: (860) 608-9723 bgiroux@geiconsultants.com
Kimberly Bradley	Field Leader/Site Safety Officer (SSO)	Office: (860) 368-5414 Mobile: (860) 917-0670 kbradley@geiconsultants.com
Robin DeHate	Corporate Health and Safety Officer (CHSO)	Office: (813) 774-6564 Mobile: (813) 323-6220 rdehate@geiconsultants.com
Steve Hawkins	Regional Health and Safety Officer (RHSO)	Office: (860) 368-5348 Mobile: (860) 916-4167 shawkins@geiconsultants.com

Lines of Authority will be as follows:

On site – GEI will have responsibility for safety of its employees during the work performed at the site. GEI's field representative will have a cell phone available to contact the appropriate local authorities, in the event of an emergency. The field leader will be available for communication with the SSO and PM and with representatives from National Grid and NYSDEC (if necessary). The field leader (FL) and/or SSO may change due to the nature of work being conducted on site.

All GEI employees have the authority to stop work activities if an unanticipated hazard is encountered or a potential unsafe condition is observed. The GEI employee should contact the Corporate Health and Safety Officer and the Project Manager to discuss the stop work conditions and potential control methods that can be implemented.

3.1 Project Manager (PM)

Responsibilities of the PM include the following:

- Verifies implementation of the HASP
- Conducts periodic inspections and documents these in the field book
- Participates in incident investigations
- Verifies the HASP has all of the required approvals before any site work is conducted

- Verifies that National Grid site manager is informed of project changes, which require modifications of the HASP
- Has overall responsibility for project health and safety
- Acts as the primary point of contact with National Grid for site related activities and coordination with non-project related site operations
- Overseeing of performance of project tasks as outlined in the scope of work
- Plans field work using appropriate safe procedures and equipment
- Verifies and documents current training and medical monitoring clearance for GEI project staff

3.2 Corporate Health and Safety Officer (CHSO)

The CHSO is a qualified health and safety professional with experience in hazardous waste site remediation activities. Responsibilities of the CHSO include the following:

- Provides support for the development and approval of the HASP
- Serves as the primary contact to review health and safety matters that may arise
- Approves revised or new safety protocols for field operations
- Coordinates revisions of this HASP with field personnel
- Coordinates upgrading or downgrading of PPE with the site manager
- Leads the investigation of all accidents/incidents
- Provide the necessary training of GEI field crews in accordance with OSHA regulations and provides proof of training to the SSO prior to GEI personnel entering the site

3.3 Site Safety Officer (SSO)

Responsibilities of the SSO include the following:

- Verifies that the HASP is implemented and that all health and safety activities identified in the HASP are conducted and/or implemented
- Verifies that field work is scheduled with adequate personnel and equipment resources to complete the job safely and enforces site health and safety rules
- Verifies that adequate communications between field crews and emergency response personnel is maintained during emergency situations
- Verifies that field site personnel are adequately trained and qualified to work at the site and that proper PPE is utilized by field teams
- Report all accidents/incidents to the CHSO and PM
- Stop work if necessary
- Identifies operational changes which require modifications to the HASP and ensures that the procedure modifications are implemented and documented through changes to the HASP, with CHSO approval
- Determines upgrades or downgrades of PPE based on site conditions and/or real-time monitoring results with CHSO approval

- Reports to the CHSO and provides summaries of field operations and progress

3.4 Field Leader (FL)

The FR is responsible for carrying out field work on a daily, weekly, monthly, quarterly, or as-needed basis. Responsibilities of the FR include:

- Conducts routine safety inspection of the work area
- Documenting occurrences of unsafe activity and what actions were taken to rectify the situation
- Reports any unsafe or potentially hazardous conditions to the SSO and PM
- Maintains familiarity of the information, instructions, and emergency response actions contained in the HASP
- Complies with rules, regulations and procedures set forth in the HASP
- Prevents admittance to work site by unauthorized personnel
- Inspects all tools and equipment, including PPE, prior to use and documents inspection on the daily safety meeting form or in the appropriate field book
- Ensures that monitoring instruments are calibrated
- Stops work if necessary.

5. Emergency Contact List

Emergency Phone List
Paerdegat Basin Site

Medical Emergencies

Emergency Medical Services (NYC Fire Department)	
Emergency	911
All other communications	(718) 999-2000
Nearest Emergency Room (Brookdale University Hospital and Medical Center)	(718) 240-5000

Fire and Rescue Emergencies

Emergency	1911
All other communications	(718) 999-2000

Police Emergencies

NYC Police Department (69th Precinct 9720 Foster Avenue)	
Emergency	911
All other communications	311
Switchboard	(718) 834-3211

Utility Emergencies

Electric (Con Edison)	(800) 752-6633
Water/Sewer (NYC Dept of Environmental Protection)	(718) 699-9811
Natural Gas (National Grid)	(718) 643-4050
National Grid Site Contacts	
William Ryan - Project Manager	(516)-545-2586
Underground Utilities (New York City One Call Center)	(800) 272-4480

Spill Incident

New York State Department of Environmental Conservation	(800)-457-7362
National Response Center	(800) 424-8802

National Information Centers

Chemtrec	(800) 424-9300
Poison Control Center	(800) 222-1222

6. Training Program

6.1 HAZWOPER Training

In accordance with 29 CFR 1910.120, hazardous waste site workers shall, at the time of job assignment, have received a minimum of 40 hours of initial health and safety training for hazardous waste site operations unless otherwise noted in the above reference. At a minimum, the training shall have consisted of instruction in the topics outlined in the standard. Personnel who have not met the requirements for initial training shall not be allowed to work in any site activities in which they may be exposed to hazards (chemical or physical). Proof of training shall be submitted to the SSO prior to the start of field activities.

6.2 Annual Eight-Hour Refresher Training

Annual eight-hour refresher training will be required of all hazardous waste site field personnel in order to maintain their qualifications for fieldwork. The training will cover a review of 29 CFR 1910.120 requirements and related company programs and procedures. Proof of current 8-hour refresher training shall be submitted to the SSO prior to the start of field activities.

6.3 Supervisor Training

Personnel acting in a supervisory capacity shall have received 8 hours of instruction in addition to the initial 40 hours training.

6.4 Site Safety Officer (SSO)

The SSO shall have completed the following training and work experience prior to the commencement of site activities:

- One year of construction experience
- 40-Hour Hazardous Materials training course

Training specific to work activities (i.e., excavation and trenching activities, lock out/tag out, etc).

6.5 Project Specific Safety Training

A project safety briefing, given by the Project Manager and/or the SSO, will serve to familiarize on-site personnel with the procedures, requirements, and the provisions of this HASP, and any applicable GEI H&S SOP. Prior to commencement of field activities, the SSO will ensure all field personnel assigned to the project will have completed training that will specifically address the activities, procedures, monitoring, and equipment used in the site operations. It will include site and facility layout, hazards and emergency

services at the Site and will highlight all provisions contained within this HASP. This training will also allow field workers to clarify anything they do not understand and to reinforce their responsibilities regarding safety and operations for their particular activity. This training will be documented on the Project Safety Briefing form. The signed form will be forwarded to the Health and Safety Committee at Health&SafetyCommittee@geiconsultants.com. In addition, all GEI personnel shall sign the plan to document that they understand the hazards and control measures presented and agree to comply with the procedures established in the HASP Personnel that have not received site-specific training will not be allowed on site.

6.6 On-Site Safety Briefings

Project personnel and visitors will be given health and safety briefings daily by the SSO to assist site personnel in safely conducting work activities. The briefings will include information on new operations to be conducted, changes in work practices or changes in the site's environmental conditions, as well as periodic reinforcement of previously discussed topics. The briefings will also provide a forum to facilitate conformance with safety requirements and to identify performance deficiencies related to safety during daily activities or as a result of safety inspections. The meetings will also be an opportunity to periodically update the crews on monitoring results. These briefings will be documented on the GEI Daily Safety Briefing form.

6.7 First Aid and CPR

The SSO will identify individuals certified in first aid and CPR, or identify individuals for such training in order to ensure that emergency medical treatment is available during field activities. The training will be consistent with the requirements of the American Red Cross Association and will include training on blood borne pathogens.

6.8 Hazard Communication

Hazard communication training will be provided in accordance with the requirements contained in the Hazard Communication Program in Section 12.0.

6.9 Boat Operator Training

Vessel operators will have attended a recognized boat operator-training program

7. Work Zone Monitoring

Monitoring shall be performed to identify and quantify airborne levels of hazardous substances and safety and health hazards in order to determine the appropriate level of worker protection needed on site.

GEI will conduct work zone monitoring for GEI employees. GEI will monitor and document daily site conditions and operations on National Grid's behalf.

GEI will provide the following equipment for health and safety monitoring of its personnel:

- Photo-ionization Detector (PID), or Flame Ionization Detector (FID),
- Particulate Meter (PM-10 capable)
- Dräger Chip Measurement System (CMS) (or equivalent instrument)

The air monitoring action levels and contingency plan presented within the Table 7-1 below will be implemented by GEI.
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TABLE 7-1: Work Zone Air Monitoring Action Levels

Air Monitoring Instrument	Monitoring Location	Action Level	Site Action
PID/FID	Breathing Zone	1.0 ppm	Use Dräger Chip Measurement System (CMS) tube for benzene or to verify if concentration is benzene.
PID/FID	Breathing Zone	0 - 50 ppm	No respiratory protection is required
		50 - 100 ppm	Stop work, withdrawal from work area, institute engineering controls, if levels persist Upgrade to Level C
		> 100 ppm	Stop work, withdraw from work area; notify SSO & CHSO

TABLE 7-1: Work Zone Air Monitoring Action Levels			
Air Monitoring Instrument	**Monitoring Location**	**Action Level**	**Site Action**
Particulate Meter [Soil Investigation only]	Work Zone	150 ug/m^3	Implement work practices to reduce/minimize airborne dust generation, e.g., spray/misting of soil with water

8. Incident Reporting

GEI will report incidents involving GEI personnel or subcontractor personnel, such as lost time injuries, injuries requiring medical attention, near miss incidents, fires, fatalities, accidents involving the public, and property damage. The report shall be made to the GEI PM verbally within 2 hours of the incident. The PM will immediately inform the CHSO, the Director of Human Resources and a project-specific National Grid representative for the incident. An Incident Report Form (see **Appendix D**) will be completed and submitted to the CHSO within 24 hours.

National Grid requires immediate notification of any incident involving injury, illness, or property damage. **A draft Incident Report must be submitted within 6 hours of the incident.**

9. Personal Protective Equipment

The PPE specified in the Table 6-1 represents PPE selection required by 29 CFR 1910.132, and is based on the AHA of Section 4.

The PPE program addresses elements, such as PPE selection based on site hazards, use and limitations, donning and doffing procedures, maintenance and storage, decontamination and disposal, training and proper fitting, inspection procedures prior to / during / and after use, evaluation of the effectiveness of the PPE program, and limitations during temperature extremes, heat stress, and other appropriate medical considerations.

A summary of PPE for each level of protection is as follows:

Table 6-1 Personal Protective Equipment Selection

Safety Equipment	Level A	Level B	Level C	Level D
Tyvek® suit or work overalls				•
Hard hats with splash shields or safety glasses			•	•
Steel-toe boots with over boots			•	•
Chemical-resistant gloves as appropriate for work being performed and materials handled			•	•
Half- or full-face respirators with organic/HEPA cartridges as approved by the SSO			•	
Tyvek® splash-resistant suit			•	
Chemical-resistant clothing		•		
Pressure-demand, full-face SCBA or pressure-demand supplied air respirator with escape SCBA	•	•		
Inner and outer chemical-resistant gloves	•	•		
Chemical-resistant safety boots or shoes	•	•		
Two-way radio	•	•		
Fully encapsulating chemical-resistant suit	•			
Personal Floatation Device				•

PPE requirements for the project consist of Level D. A PFD will also be worn when working on the boat or near water. Butyl rubber gloves and safety glasses will be worn when handling soils/sediments potentially impacted with PCBs. If presence of PCBs in soil is confirmed a full-face respirator with organic vapor cartridges will be worn.

OSHA Requirements for PPE

Should any additional PPE be required during the course of this field investigation, it must meet the following OSHA standards (as applicable):

Type of Protection	Regulation	Source
Eye and Face	29 CFR 1910.133	ANSI Z87.1 1968
Respiratory	29 CFR 1910.134	ANSI Z88.1 1980
Head	29 CFR 1910.135	ANSI Z89.1 1969
Foot	29 CFR 1910.136	ANSI Z41.1 1999 or ASTM F-2412-2005, and ASTM F-2413-2005

CRF = Code of Federal Regulations
ANSI = American National Standards Institute
ASTM = American Society For Testing and Materials

For most work conducted at the Site, Level D PPE will include the items highlighted above in Table 6-1.

Use of Level A or Level B PPE is not anticipated. If conditions indicating the need for Level A or Level B PPE are encountered, personnel will leave the work zone and this HASP will be revised with oversight of the CHSO, GEI personnel will not re-enter the work zone until conditions allow.

Table 6-2 describes the anticipated task-specific PPE. For activities not covered by Table 6-2, SSO/CHSO will revise the hazard assessment and select the PPE using the information provided in Appendix E.

PPE Abbreviations

HEAD PROTECTION HH = Hard Hat HEARING PROTECTION EP = ear plugs	EYE/FACE PROTECTION APR = Full Face Air Purifying Respirator with HEPA filter and organic vapor cartridge or Particulate half face respirator PFS =Plastic Face shield SG = ANSI approved safety glasses with side shields	RESPIRATORY PROTECTION Level D = No respiratory protection required Level C = Full face air purifying respirator with approved cartridges Level B = Full face air supplied respirator with escape bottle
HAND PROTECTION LWG = Leather Work Gloves Nit = Nitrile Gloves Kev = Kevlar Gloves BR = Butyl rubber	BODY PROTECTION Poly = Polyethylene coated Tyvek® coveralls or apron WC = Work clothes PFD=Personal Flotation Device (USCG)	FOOT PROTECTION OB = Over boot STB = Leather work boots with steel toe

Table 9.1-PERSONAL PROTECTIVE EQUIPMENT SELECTION

TASK	HEAD	EYE/ FACE	FEET	HANDS	BODY	HEARING	RESPIRATOR
Mobilization/Demobilization							
Mobilization/ demobilization of equipment and supplies	HH as needed	SG as needed	STB	LWG as needed	WC	EP as needed	Level D
Establishment of site security, work zones and staging area	HH as needed	SG as needed	STB	LWG as needed	WC	EP as needed	Level D
Soil and Sediment Investigation Activities							
Sample Collection	HH	SG, PFS, APR as needed	STB, OB	BR	WC, Poly. PFD	EP as needed	Level D initially, Level C-with organic vapor cartridges If action levels exceeded (see Section 7 of HASP)
Sample Pickup/Transfer	HH as needed	SG as needed	STB	LWG as needed	WC, PFD	EP as needed	Level D
Sample Packing and Shipping	HH as needed	SG as needed	STB	LWG and Nit as needed	WC	EP as needed	Level D
Waste Handling	HH	SG	STB, OB as needed	LWG and BR as needed	WC, Poly as needed	EP as needed	Level D initially, Level C with organic vapor cartridges-If action levels exceeded (see Section 7 of HASP)
Biota Collection							
Organism Collection	HH	SG as needed	STB	BR	WC, PFD, Poly as needed	EP as needed	Level D

10. Decontamination Procedures

PPE help prevent the wearer from becoming contaminated or inhaling contaminants, and good work practices help reduce contamination on protective clothing, instruments, and equipment. Even with these safeguards, contamination may occur. Harmful materials can be transferred to clean areas, exposing unprotected personnel. To prevent such occurrences, the following contamination reduction and decontamination procedures have been developed.

10.1 Minimization of Contact with Contaminants

During completion of all site activities, personnel should attempt to minimize the degree of contact with contaminated materials. This involves a conscientious effort to keep "clean" during site activities. All personnel should minimize kneeling, splash generation, and other physical contact with contamination. This may ultimately minimize the degree of decontamination required and the generation of waste materials from site operations.

10.2 Personnel Decontamination

Personnel hygiene, coupled with diligent decontamination, will significantly reduce the potential for exposure. Consideration will be given to prevailing wind directions so that the decontamination line, the support zone, and contamination reduction zone (CRZ) exit is upwind from the exclusion zone (EZ) and the first station of the decontamination line. Decontamination will be performed by removing all PPE used in EZ and placing in drums/trash cans at CRZ. Disinfecting hand wipes shall be available for wiping hands and face. For Level D Decontamination, personnel should wash and rinse gloves, and use anti bacterial wipes/ gel and wash and rinse hands and face with potable water.

For Level C Decontamination, personnel should wash and rinse gloves and over boots, remove boot covers, remove outer gloves, remove Poly-coated suit, wash inner gloves, remove respirator, rinse inner gloves, remove inner gloves and wash and rinse hands and face.

If exposed to the sediments or surface waters of the canal, wash the exposed skin immediately with anti-bacterial wipes/ gel and wash with soap and water.

10.3 Emergency Decontamination

If circumstances dictate that contaminated clothing cannot be readily removed, then remove gross contamination; wrap injured personnel with clean garments/blankets to avoid contaminating other personnel or transporting equipment. If the injured person can be moved, he/she will be moved to the exclusion zone boundary and decontaminated by site personnel as described above before emergency responders handle the victim. If the person cannot be moved because of the extent of the injury (a back or neck injury) provisions shall be made to ensure that

emergency response personnel will be able to respond to victim without being exposed to potentially hazardous atmospheric conditions. The only time an injured person should be removed is if the worker's life is threatened to a greater degree than if he/she is left in the spot where the accident occurred. If emergency response personnel have to enter hazardous conditions to respond to victim this should communicated when the emergency call is made and responders can come prepared in appropriate PPE. If the potential for inhalation hazards exist, such as with an open excavation, this area will be covered with plastic sheeting, or similar controls, to eliminate any potential inhalation hazards. All emergency personnel are to be immediately informed of the injured person's condition, potential contaminants, and provided with all pertinent chemical data.

10.4 Hand Held Equipment Decontamination

Hand held equipment includes all monitoring instruments, samples, hand tools, sampling equipment (including the PONAR sampler) and notebooks. The hand held equipment is dropped at the first decontamination station to be decontaminated by one of the decontamination team members. These items must be decontaminated or discarded as waste prior to removal from the exclusion zone.

To aid in decontamination, monitoring instruments can be sealed in plastic bags or wrapped in polyethylene. This will also protect the instruments against contaminants. The instruments will be wiped clean using antibacterial wipes and paper towels if contamination is visually evident.

Decontamination procedures for sampling equipment, hand tools, etc., shall include the use of steam cleaning or a detergent wash, as appropriate for the site conditions. A dilute solution of bleach (approximately 10% solution) will be used first and will be followed by the standard decontamination procedures presented in the Work Plan. After the detergent wash and water rinse each piece of equipment that could potentially be contaminated by PCBs shall be rinsed or swabbed with hexane to meet the applicable decontamination standards in 40 CFR 761.79(c). Hexane is an approved performance-based organic decontamination fluid (PODF) under the self-implementing decontamination standards in 40 CFR 761.79(c). All liquids generated in the decontamination will be stored at a secure location identified by National Grid in lined rolls or drums and then disposed of at an approved facility in accordance with federal, state and local regulations. Personnel performing this task will wear the proper PPE as prescribed in Section 9.

10.5 Heavy Equipment Decontamination

Decontamination of chemically contaminated heavy equipment will be accomplished using high -pressure steam or dry decontaminated with brushes and shovels. Decontamination shall take place on a decontamination pad and all liquids used in the decontamination procedure will be collected. Equipment brought into an exclusion zone will be treated as contaminated, and will be decontaminated prior to removal. All liquids used in the decontamination procedure will be stored at a secure location identified by National Grid in lined rolls or drums and then disposed

of at an approved facility in accordance with federal, state and local regulations. Personnel performing this task will wear the proper PPE as prescribed in Section 9.

11. Medical Support

In case of minor injuries, on site care shall be administered with the Site first aid kit.
For serious injuries, call 911 and request emergency medical assistance. Seriously injured persons should not be moved, unless they are in immediate danger.

Section 5.0 and **Appendix A** contain detailed emergency information, including directions to the nearest hospital, and a list of emergency services and their telephone numbers. GEI field personnel will carry a cellular telephone.

12. Supplemental Contingency Plan Procedures

12.1 Hazard Communication Plan

GEI personnel have received hazard communication training as part of their annual HAZWOPER refresher training. All hazardous materials used on the Site will be properly labeled, stored, and handled. MSDS will be available to on-site staff.

12.2 Fire

In the event of a fire at sea, the captain and SSO will adhere to the following:

- at the first sign of smoke, determine your situation and notify boats in the area that you might have a problem. Do not wait as you may lose your radio.
- Move any crew and passengers to a safe area of the vessel
- Cut off the air supply to the fire (i.e. close hatches, doors, windows, etc.)
- Maneuver the vessel to minimize the effect of wind on the fire
- If unable to control the fire, IMMEDIATELY notify the Coast Guard and any other vessels in the area. YOU HAVE A MAYDAY SITUATION.

Crew and other staff members will:

- Immediately use portable CO2 fire extinguishers at the base of the flames for flammable liquid or grease fires, or water for ordinary combustibles
- Halon and Dry Chemical fire extinguishers may be used for flammable liquid, grease or electrical fires

If applicable, notification of evacuation will be made to the GEI PM and the CHSO. The field representative will account for GEI personnel and subcontractor personnel and report their status to the PM.

The subcontractor will have fire extinguishers on board the boat.

12.3 Person Overboard

If someone falls overboard, the remaining personnel on the vessel will:

- Immediately throw anything that floats overboard to mark the position of the person
- Throw a life ring (Type IV PFD) overboard as close to the person as possible
- Notify the captain “Man Overboard” and on which side of the vessel
- Post a lookout to keep the person in sight. This person should try to make their way to the captain to assist him in bringing the vessel to the person in the water.
- Maneuver the vessel to pick up the person in the water. When the captain has the person in sight, he will release the deckhand to rig the rescue ladder.

- Have the life ring with line attached ready to throw near the person so they may be pulled to the boat
- Notify boats in the area by radio on that you have a person in the water
- Have a crew member attach a safety line to themselves and stand by to go in the water ONLY IF NECESSARY
- If the person is not located immediately, radio the Coast Guard and other vessels in the area
- Continue search until relieved by the Coast Guard

12.4 Severe Weather

The contingency plan for severe weather includes reviewing the expected weather to determine if severe weather is in the forecast. Severe weather includes high winds over 30 mph, heavy rains or snow squalls, thunderstorms, hurricanes, lightning storms, or wave action that makes boating unsafe. If severe weather is approaching, the decision to return to a pier or secure location at the shore of the creek will be made in a manner as to allow adequate time for the boat to return and all personnel to evacuate. The location where the boat will dock is to be determined by its location in the creek and the severity of the weather. The person in command of the vessel will make the final decision regarding movement of the boat. All equipment will be lashed securely to the deck of the boat and all personnel will evacuate the boat to a place of safety. The vessel captain will make the final decision for actions taken due to changing weather conditions.

The captain is responsible for:

- Closing all watertight and weather-tight doors, hatches and windows to prevent taking on water
- Keeping bilges dry to prevent loss of stability
- Keeping any passengers seated and evenly distributed
- Clearing all deck drains and securing lines from washing overboard

12.5 Abandon Ship

The captain and SSO:

- NEVER abandon ship unless actually forced to do so
- In the event the vessel has to be abandoned the captain and SSO will insure that nearby boats and the Coast Guard have been contacted with the locations
- Crew members will assist any passengers and instruct them in what to do with respect to donning life jackets
- Life jackets are distributed throughout the vessel in plain view
- Life rings are on the side of the pilot house of the steel boat
- If near or after dark, attach water lights to rafts and life rings

12.6 Spills or Material Release

If a hazardous waste spill or material release occurs, the SSO or their representative will immediately assess the magnitude and potential seriousness of the spill or release based on the following.

- MSDS, if applicable, for the material spilled or released
- Source of the release or spillage of hazardous material
- An estimate of the quantity released and the rate at which it is being released
- The direction in which the spill or air release is moving
- Personnel who may be or may have been in contact with the material, or air release, and possible injury or sickness as a result
- Potential for fire and/or explosion resulting from the situation; and
- Estimates of area under influence of release.

If the spill or release is determined to be within the on-site emergency response capabilities, the SSO will ensure implementation of the necessary remedial action. If the release is beyond the capabilities of the site personnel, all personnel will be evacuated from the immediate area and the local fire department will be contacted. The SSO will notify the PM, the CHSO and the National Grid PM.

12.7 Alcohol and Drug Abuse Prevention

Alcohol and drugs will not be allowed on the work site. Project personnel under the influence of alcohol or drugs will not be allowed to enter the site.

Health and Safety Plan Sign-Off

All GEI personnel conducting site activities must read this Health and Safety Plan, be familiar with its requirements, and agree to its implementation.

Once the Health and Safety Plan has been read, complete this sign-off sheet, and return it to the Project Manager.

Site Name:
Paerdegat Basin Oil Spill – National Grid

Activity:

- Surface Sediment Sampling
- Porous Surface Sampling
- Surface Water Sampling
- Biota Sampling

I have received and read the Health and Safety Plan, been briefed on it, and agree to its implementation.

Name:	Signature:	Date:
Name:	Signature:	Date:
Name:	Signature:	Date:
Name:	Signature:	Date:
Name:	Signature:	Date:
Name:	Signature:	Date:
Name:	Signature:	Date:
Name:	Signature:	Date:
Name:	Signature:	Date:
Name:	Signature:	Date:

APPENDIX A

Site-Specific Information

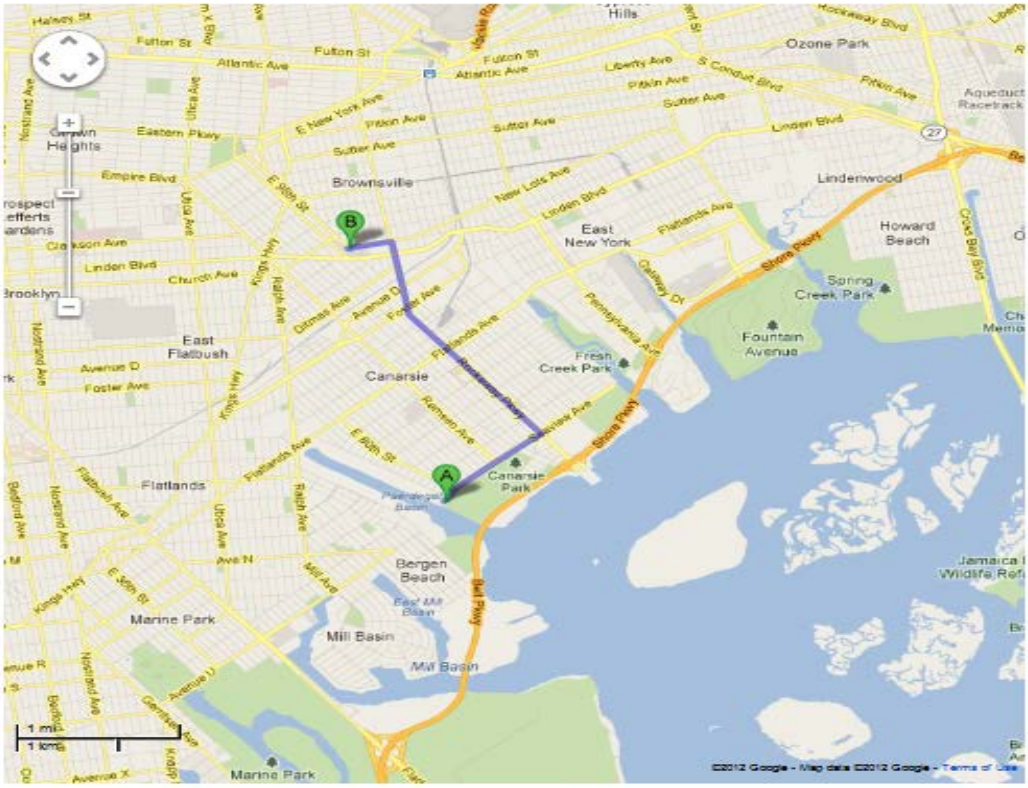
HOSPITAL ROUTE MAP
Brookdale University Hospital and Medical Center
One Brookdale Plaza, Brooklyn, New York 11212
718-240-5000

Google

Directions to Brookdale Hospital
Brookdale Plaza, New York, NY 11212
3.0 mi – about 9 mins

You can enter notes here.

Save trees. Go green!
Download Google Maps on your phone at google.com/gmm



A **Midget Squadron Yacht Club**
Foot Of Seaview Ave , Brooklyn, NY 11236, 11236 - (718) 251-9823

1.	Head **northeast** on **Seaview Ave** toward **E 80th St** About 2 mins	go 0.8 mi total 0.8 mi
2.	Turn left onto **Rockaway Pkwy** About 3 mins	go 1.3 mi total 2.1 mi
3.	Slight right onto **Rockaway Ave** About 2 mins	go 0.6 mi total 2.7 mi
4.	Turn left onto **Hegeman Ave** About 1 min	go 0.3 mi total 3.0 mi
5.	Turn left onto **E 98th St** Destination will be on the right	go 75 ft total 3.0 mi

B **Brookdale Hospital**
Brookdale Plaza, New York, NY 11212

These directions are for planning purposes only. You may find that construction projects, traffic, weather, or other events may cause conditions to differ from the map results, and you should plan your route accordingly. You must obey all signs or notices regarding your route.
Map data ©2012 Google

Directions weren't right? Please find your route on maps.google.com and click "Report a problem" at the bottom left.

APPENDIX B

Hazard Communication Program

1.0 POLICY AND PURPOSE

It is the policy of the Consultant to furnish employees with a working environment safe from recognized hazards. This program is designed to provide the Consultant compliance with OSHA's Federal Hazard Communication Standard (29 CFR 1910.1200 and 1926.59).

The Consultant Hazard Communication (HAZCOM) Program has been compiled to provide guidelines for assisting this corporation in meeting the requirements of OSHA's Hazard Communication Standard. This program addresses the evaluation of potential Consultant workplace hazards and communication of pertinent hazard information to Consultant employees.

The **CONTRACTOR** must develop a HAZCOM for **CONTRACTOR** employees and **SUBCONTRACTORs**.

Although most **CONTRACTOR** field projects do not involve the use of hazardous substances, it is imperative that all hazardous materials be managed in accordance with this program. This applies to any usage of hazardous materials regardless of volume. The Contractor shall generate a list of chemicals that are anticipated to be used during work activities.

2.0 SCOPE

In accordance with 29 CFR 1910.1200 and 1926.59, this program applies to any potentially hazardous chemical which is known to be present in the workplace in such a manner that employees may potentially be exposed under normal conditions of use. This program also addresses chemicals that may be constituents of waste that may be encountered on a typical Consultant job site.

3.0 LOCATION OF WRITTEN PROGRAM

A complete original of this written program is located with the Consultant Corporate Health and Safety Specialist (CHSS) and with each Consultant Office/Branch Manager.

4.0 RESPONSIBILITIES

Overall coordination and implementation of Consultant HAZCOM Program is the responsibility of the CHSS. Any questions, comments, or suggestions relating to Consultant HAZCOM Program should be directed to the CHSS.

The following subsections delineate the responsibilities of personnel as required for successful implementation of this program.

Corporate Health and Safety Specialist (CHSS)

The CHSS shall:

- Develop and oversee implementation of the written HAZCOM Program
- At a minimum, determine that field personnel engaged in hazardous waste operations receive OSHA 40-hour Health and Safety Training, 24-hour supervised on-the-job training, 8-hour Supervisory Training, and annual 8-hour Retraining as required by OSHA (29 CFR 1910.120 and 29 CFR 1926.65)

Office/Branch Managers

The Office/Branch Managers shall:

- Determine that all new employees at their office/branch receive training in accordance with the HAZCOM Program within 30 days of hire or prior to performing field work (whichever is sooner)
- Maintain at the office/branch an inventory of Material Safety Data Sheets (MSDSs) as available for all hazardous materials with which employees have the potential of coming into contact while on the job
- Determine that MSDSs are made readily available for employee review upon request by the employee
- Determine that label and warning protocol for hazardous materials is complied with

Supervisors (Project Mangers and/or Field Team Leaders)

Supervisors shall:

- Develop and oversee completeness of site-specific HASPs for their projects
- Implement the hazard communication programs and HASPs for their projects
- Determine that field personnel are familiar with the HAZCOM Program regarding chemical use and potential chemical exposures in the field
- Determine that employees working on their project sites are familiar with site-specific HASPs and perform in compliance with the requirements of those HASPs.

Employee

It is the employee's responsibility to:

- Read the HAZCOM procedure within 30 days of employment by the Consultant or prior to performing field work for CONSULTANT (whichever is sooner)
- Gain familiarization with MSDSs of those hazardous materials which they use or may be exposed to
- Utilize information and measures as learned from the HAZCOM Program, including associated training and professional experiences, to protect themselves from adverse exposure to hazardous materials

5.0 PROGRAM REQUIREMENTS

Material Safety Data Sheets (MSDSs) and Chemical List

Complete sets of MSDSs for chemicals specific to each office/branch are maintained by the Consultant Office/Branch Manager and made readily available for review upon request by any employee.

A list of chemicals potentially used/encountered by Consultant personnel at offices/branches involved in hazardous waste operations is provided in Table 11-1. Note that Table 11-1 is not necessarily complete.

MSDSs are available for the listed chemicals described below.

- MSDSs for chemicals that are typically used for decontamination and/or sample preservation are compiled. Supplies of these chemicals are generally kept in Consultant field equipment storerooms.
- MSDSs for chemicals and materials that may be encountered on typical Consultant job sites are compiled. These MSDSs are typically included in site-specific Health and Safety Plans. MSDSs should be reviewed prior to performing fieldwork on those sites.
- MSDSs for chemicals used for Photo ionization detector (PID) soil gas instrument and standards are compiled. These chemicals are generally kept in small quantities to be used only by soil gas instrument technical personnel.

In addition, the consultant maintains an a comprehensive collection of MSDSs as printed by Genium Publishing Corporation and as obtained from manufacturers of products received at Consultants office are available for use by employees by request to the CHSS. This MSDS collection is updated periodically.

TABLE 11-1
CHEMICAL LIST

DECONTAMINATION AND/OR PRESERVATION CHEMICALS (Field/Storeroom Personnel)

Chemical	*Amount Stored	Location
Acetone	20 liters	Field Equipment Room Flammable Storage Cabinet
Acetonitrile	4 liters	Field Equipment Room Flammable Storage Cabinet
1-Butanol (n-Butyl Alcohol)	0.5 liter	Field Equipment Room Flammable Storage Cabinet
Hexane	20 liters	Field Equipment Room Flammable Storage Cabinet
Hydrochloric Acid	0.5 liter	Field Equipment Room Corrosive Storage Cabinet
Methanol	40 liters	Field Equipment Room Flammable Storage Cabinet
Nitric Acid	15 liters	Field Equipment Room Corrosive Storage Cabinet
Sodium Hydroxide	1 kg	Field Equipment Room Corrosive Storage Cabinet (separated from acids)
Sulfuric Acid	0.5 liter	Field Equipment Room Corrosive Storage Cabinet

CHEMICALS POTENTIALLY ENCOUNTERED ON TYPICAL JOB SITES

Chemical
Benzene
Coal Tar Creosote
Coal Tar Pitch
Cresol
Cyanide
1,1-Dichloroethylene
1,2-Dichloroethylene (both isomers)
Ethyl benzene
Gasoline
Naphtha (Coal Tar)
Naphthalene and related PAHs
Pentachlorophenol
Perchloroethylene
Polychlorinated Biphenyls
Styrene
1,1,2,2-Tetrachloroethane
Tetraethyl Lead
Toluene

DECONTAMINATION AND/OR PRESERVATION CHEMICALS (Field/Storeroom Personnel)

Chemical	*Amount Stored	Location
1,1,1-Trichloroethane (methyl chloroform)		
Trichloroethylene		
Xylene		

**SOIL GAS STANDARD CHEMICALS (used by soil gas personnel only)

Chemical	*Amount Stored	Location
Stored for Occasional or Potential Future Use		
Benzene	10 grams	Field Equipment Room Refrigerator
1,1-Dichloroethylene	10 grams	Field Equipment Room Refrigerator
1,2-Dichloroethylene (both isomers)	14 grams	Field Equipment Room Refrigerator
Ethyl benzene	10 grams	Field Equipment Room Refrigerator
Perchloroethylene	10 grams	Field Equipment Room Refrigerator
Toluene	10 grams	Field Equipment Room Refrigerator
Trichloroethylene	10 grams	Field Equipment Room Refrigerator
Xylenes (o, m, & p)	6 grams	Field Equipment Room Refrigerator
Bromodichloromethane	1 gram	Field Equipment Room Refrigerator
Bromoform	5 grams	Field Equipment Room Refrigerator

**SOIL GAS STANDARD CHEMICALS (used by soil gas personnel only)

Chemical	*Amount Stored	Location
Stored for Occasional or Potential Future Use		
2-Chloroethyl vinyl ether	5 grams	Field Equipment Room Refrigerator
Dibromochloromethane	1 gram	Field Equipment Room Refrigerator
1,4-Dichlorobenzene	5 grams	Field Equipment Room Refrigerator
1,2-Dichloropropane	5 grams	Field Equipment Room Refrigerator
1,3-Dichloropropene	2 grams	Field Equipment Room Refrigerator
Styrene	2 grams	Field Equipment Room Refrigerator
1,1,2,2-Tetrachloroethane	2 grams	Field Equipment Room Refrigerator
1,1,1-Trichloroethane	2 grams	Field Equipment Room Refrigerator
1,1,2-Trichloroethane	5 grams	Field Equipment Room Refrigerator
Trichlorofluoromethane	5 grams	Field Equipment Room Refrigerator
1,2,4-Trimethylbenzene	2 grams	Field Equipment Room Refrigerator

* Amounts stored are based on typical field equipment room inventory (Colchester Office). Actual amounts may vary depending on facility location and project requirements.

** Soil gas standard chemicals are used for field testing/calibration of soil gas, field, analytical equipment.

LABELS AND WARNINGS

The Consultant labeling system for containers of hazardous materials is as follows:

- Containers are labeled, tagged, or marked in a legible fashion, with the identity of the hazardous materials contained therein.
- Containers are labeled, tagged, or marked in a legible fashion with the appropriate hazard warnings. This warning may be of any type of message, words, pictures or symbols that convey the hazards of the chemical.
- All required container labels, tags and/or markings are legible.
- Labels are affixed to the container itself (vs. lid). Note that lids may also be labeled, but not in lieu of container labeling.

The Consultant field equipment room maintenance technician is responsible that the Consultant labeling system is complied with at his/her office location. Project Managers and Field Team Leaders are responsible for determining that the Consultant labeling system is complied with for the field portion of their projects.

TRAINING

The Consultant Office/Branch Manager is responsible for determining that the HAZCOM Training Program is complied by personnel employed at their office/branch.

The Consultant's HAZCOM Program training requirements are listed below:

- Newly hired employees who may use or be exposed to hazardous materials will be required to familiarize themselves with the HAZCOM Program, and with the MSDSs associated with their job function.
- Selected employees will be required to attend a HAZCOM Program classroom training session. Training shall provide information on:
    - The physical and health hazards of the chemicals in the work area
    - Methods and observations that may be used to detect the presence or release of a hazardous chemical in the work area
    - Measures employees can take to protect themselves from these hazards
    - The details of the HAZCOM Program, including an explanation of MSDSs and CONSULTANTs container labeling system

- As required to achieve compliance with OSHA 1910.120 and 1926.65, technical staff engaged in hazardous waste operations will be provided with OSHA 40-hour HAZWOPER safety training, 24 hours of on-the-job training, and annual 8-hour HAZWOPER refresher courses.

6.0 MULTI-EMPLOYER WORK PLACES

The Consultant is obligated to provide the identity of any hazardous materials/conditions to other employers sharing the same workplace whose employees may be exposed. Likewise, all employers sharing the same workplace with the Consultant shall be obligated to identify all hazardous materials/conditions to which employees may be exposed. The employer sharing space with the Consultant will be required by the Consultant Project Manager to:

- Determine that a mutual exchange of this information occurs, and that health and safety hazards are minimized
- Provide to project employees, as part of the subcontractor HASP, MSDSs of identified hazardous materials to which they may be exposed
- Conform in full to the requirements of 29 CFR 1910.1200 and 29 CFR 1926.59, applicable HASPs, and established work procedures

These obligations may be accomplished via the exchange of written HAZCOM Programs, project HASPs, or MSDSs as appropriate.

7.0 BIENNIAL REVIEW

This program will be formally reviewed by the Consultant CHSS and company management on a biennial basis or more frequently if the CHSS deems it necessary to promote personnel safety. The program will be revised as necessary for continuing compliance with the OSHA Federal Hazard Communication Standard.

APPENDIX C

Cold Stress and Heat Stress Guidelines

Cold Stress Guidelines

	Symptoms	What to do
Mild Hypothermia	• Body Temp 98-90°F • Shivering • Lack of coordination, stumbling, fumbling hands • Slurred speech • Memory loss • Pale, cold skin	• Move to warm area • Stay active • Remove wet clothes and replace with dry clothes or blankets • Cover the head • Drink warm (not hot) sugary drink
Moderate Hypothermia	• Body temp 90-86°F • Shivering stops • Unable to walk or stand • Confused irrational	• All of the above, plus: • Call 911 • Cover all extremities completely • Place very warm objects, such as hot packs on the victim's head, neck, chest and groin
Severe Hypothermia	• Body temp 86-78°F • Severe muscle stiffness • Very sleepy or unconscious • Ice cold skin • Death	• Call 911 • Treat victim very gently • Do not attempt to re-warm
Frostbite	• Cold, tingling, stinging or aching feeling in the frostbitten area, followed by numbness • Skin color turns red, then purple, then white or very pale skin • Cold to the touch • Blisters in severe cases	• Call 911 • Do not rub the area • Wrap in soft cloth • If help is delayed, immerse in warm, not hot, water
Trench Foot	• Tingling, itching or burning sensation • Blisters	• Soak feet in warm water, then wrap with dry cloth bandages • Drink a warm sugary drink

HEAT STRESS GUIDELINES			
Form	Signs & Symptoms	Care	Prevention[3]
Heat Rash	Tiny red vesicles in affected skin area. If the area is extensive, sweating can be impaired.	Apply mild lotions and cleanse the affected area.	Cool resting and sleeping areas to permit skin to dry between heat exposures
Heat Cramps	Spasm, muscular pain (cramps) in stomach area and extremities (arms and legs).	Provide replacement fluids with minerals (salt) such as Gatorade.	Adequate salt intake with meals[1] ACCLIMATIZATION[2]
Heat Exhaustion	Profuse sweating, cool (clammy) moist skin, dizziness, confusion, pale skin color, faint, rapid shallow breathing, headache, weakness, muscle cramps.	Remove from heat, sit or lie down, rest, replace lost water with electrolyte replacement fluids (water, Gatorade) take frequent sips of liquids in amounts greater than required to satisfy thirst.	ACCLIMATIZATION[2] Adequate salt intake with meals[1] only during early part of heat season. Ample water intake, frequently during the day
Heat Stroke	HOT Dry Skin. Sweating has stopped. Mental confusion, dizziness, nausea, severe headache, collapse, delirium, coma.	HEAT STROKE IS A MEDICAL EMERGENCY - Remove from heat. - COOL THE BODY AS RAPIDLY AS POSSIBLE by immersing in cold (or cool) water, or splash with water and fan. Call for Emergency Assistance. Observe for signs of shock.	ACCLIMATIZATION[2] Initially moderate workload in heat (8 to 14 days). Monitor worker's activities.

Footnotes:

1.) American diets are normally high in salt, sufficient to aid acclimatization. However, during the early part of the heat season, (May, June), one extra shake of salt during one to two meals per day may help, so long as this is permitted by your physician. Check with your personal physician.

2.) ACCLIMATIZATION - The process of adapting to heat is indicated by worker's ability to perform hot jobs less fluid loss, lower concentrations of salt loss in sweat, and a reduced core (body) temperature and heart rate.

3.) Method to Achieve Acclimatization - Moderate work or exercise in hot temperatures during early part of heat season. Adequate salt (mineral) and water intake. Gradually increasing work time in hot temperatures. Avoid alcohol. Normally takes 8 to 14 days to achieve acclimatization. Lost rapidly, if removed from strenuous work (or exercise) in hot temperature for more than approximately five days.

APPENDIX D

Health and Safety Standard Operating Procedures (SOPs)

STANDARD OPERATING PROCEDURES
SOP NO. HS-003 Container Management

1.1 Objective

This SOP has been developed to minimize the potential for injuries to GEI employees performing container and drum handling and sampling, through proper use of engineering and administrative controls and education.

1.2 General

Hazardous substances and contaminated liquids and other residues will be handled, transported, labeled, and disposed of in accordance with this paragraph. Drums and containers will meet the appropriate DOT, OSHA, and EPA regulations for the wastes that they contain.

Site operations will be organized to minimize the amount of drum or container movement. Prior to movement of drums or containers, all employees exposed to the transfer operation will be notified of the potential hazards associated with the contents of the drums or containers. Unlabeled drums and containers will be considered to contain hazardous substances and handled accordingly until the contents are positively identified and labeled.

U.S. Department of Transportation specified salvage drums or containers and suitable quantities of proper absorbent will be kept available and used in areas where spills, leaks, or ruptures may occur. Where spills may occur, a spill containment program, which may be part of the health and safety plan, will be implemented to contain and isolate the entire volume of the hazardous substance being transferred. Fire extinguishing equipment meeting the requirements of 29 CFR Part 1910, Subpart L, will be on hand and ready for use to control incipient fires.

1.3 Opening Drums and Containers

The following procedures will be followed in areas where drums or containers are being opened:

- Employees not actually involved in opening drums or containers will be kept a safe distance from the drums or containers being opened.

- If employees must work near or adjacent to drums or containers being opened, a suitable shield that does not interfere with the work operation will be placed between the employee and the drums or containers being opened to protect the employee in case of accidental release.

- GEI employees will not handle or attempt to open bulging containers. Employees will not stand upon or work from drums or containers. GEI will contract with a hazardous waste company to handle, manage, and dispose of a bulging drum.

1.4 Material Handling Equipment

Material handling equipment used to transfer drums and containers will be selected, positioned, and operated to minimize sources of ignition.

1.5 Radioactive Wastes

GEI does not routinely handle or manage radioactive waste. If required to do so for a project, procedures will be approved by the Corporate Health and Safety Officer (CHSO) and Regional Health and Safety Officer (RHSO).

1.6 Shock-sensitive Wastes

GEI employees will not handle shock-sensitive waste. Shock-sensitive waste or chemicals may explode with friction, movement or heat. Some chemicals are shock-sensitive by nature, others become shock-sensitive through drying, decomposition, or slow reactions with oxygen, nitrogen, or the container. Some chemicals that are, or can, become shock-sensitive will have that hazard noted in the MSDS.

- Drums and containers containing packaged laboratory wastes will be considered to contain shock-sensitive or explosive materials until they have been characterized. *Caution: Shipping of shock-sensitive wastes may be prohibited under U.S. Department of Transportation regulations. Shippers will refer to 49 CFR 173.21 and 173.50.*

1.7 Laboratory Waste Packs

GEI employees will not handle or open laboratory waste packs.

1.8 Sampling of Drum and Container Contents

Sampling of containers and drums will be done in accordance with a site-specific sampling plan that will be developed in conjunction with a site-specific health and safety plan.

1.9 Shipping and Transport

Drums and containers will be identified and classified prior to packaging for shipment. Drum or container staging areas will be kept to a minimum number as approved by the client to safely identify and classify materials and prepare them for transport. Staging areas will be provided with adequate access and egress routes. Bulking of hazardous

wastes will be permitted only after a thorough characterization of the materials has been completed and approved by the Client.

1.10 Tank and Vault Procedures

GEI employees do not routinely sample vaults and tanks. Entry procedures will be coordinated and approved by the CHSO and RHSO.

1.11 Limitations

None

1.12 References

OSHA 1910.120 Hazardous Waste Operations and Emergency Response (j) Handling of Drums and Containers.

1.13 Attachments

GEI – Weekly Facility/Hazardous Waste Inspection Checklist.

1.14 Contact

GEI Corporate Health and Safety Officer
GEI Mid-West Regional Health and Safety Officer
GEI Atlantic Regional Health and Safety Officer
GEI New England Regional Health and Safety Officer
GEI Western Regional Region Health and Safety Officer

STANDARD OPERATING PROCEDURE
HS-004 Driver Safety

1.1 Objective

GEI values the safety of its employees, both on and while traveling to and from worksites. Accordingly, GEI has implemented a Save Driving Program to encourage safe driving habits and promote the ongoing safety of our staff and the communities where we work. For more information, refer to the Operation of Vehicles section of GEI's Employee Handbook.

More than 41,000 people lose their lives in motor vehicle crashes each year and over two million more suffer disabling injuries. This standard operating procedure provides requirements and recommendations to minimize the potential risks while operating or riding in a motor vehicle.

1.2 General Requirements

GEI employees will adhere to the following requirements when operating a vehicle while conducting business on behalf of GEI. These requirements apply to GEI owned, rental, and personal vehicles used to conduct GEI business:

- Employees must maintain a valid and current driver's license.
- All employees using a personal vehicle for work-related travel must have proper insurance coverage that meets the requirements in the state in which they reside.
- Employees must wear their safety belt at all times while in a moving vehicle.
- Vehicle accidents will be reported within two hours of their occurrence to their supervisor and a written Accident Report form will be submitted within 24 hours.
- Vehicles will be properly maintained and safely operated.
- Employees will follow safe driving behaviors, which include limiting distractions such as manipulating radios or other equipment that may cause a distraction. Employees are not to exceed the posted speed limit and should always maintain a safe distance between other vehicles.
- When parking a vehicle at a job site, the employee should position the vehicle in a manner to reduce or eliminate the need to operate the vehicle in reverse. A safety cone will be placed at the rear of the vehicle after parking the vehicle and be removed prior to moving the vehicle. This procedure makes the employee aware of other vehicles, equipment, and structures within the backup radius of the vehicle.

When driving a rental vehicle or GEI vehicle that you are unfamiliar with orient yourself to the vehicle by:

- Walking around the vehicle.
- Becoming familiar with the size of the vehicle.
- Adjusting all mirrors (rear and side).
- Becoming familiar with dashboard and steering controls.
- Locating the turn signals, windshield wipers, lights, emergency flashers, and the heating, air conditioning, and defrost controls.

1.3 Driving Defensively

Driving defensively means not only taking responsibility for yourself and your actions but also keeping an eye on "the other guy." Good defensive drivers may be able to anticipate what the other driver will do next. GEI recommends the following guidelines to help reduce your risks on the road.

Do not start the engine without securing each passenger in the vehicle. Safety belts save thousands of lives each year!

- Remember that driving too fast or too slow can increase the likelihood of a collision.
- Be alert! If you notice that a car is straddling the center line, weaving, making wide turns, stopping abruptly or responding slowly to traffic signals, the driver may be impaired or using a cellular telephone.
- Avoid an impaired driver by turning right at the nearest corner or exiting at the nearest exit. If it appears that an oncoming car is crossing into your lane, pull over to the roadside, sound the horn and flash your lights.
- Notify the police immediately after seeing a motorist who is driving suspiciously.
- Follow the rules of the road. Do not contest the "right of way" or try to race another car during a merge. Be respectful of other motorists.
- Do not follow too closely. GEI employees should use a "three-second following distance" or a "three-second plus following distance."
- While driving be cautious, aware, and responsible.

1.4 Cellular Phone Use and Other Distractions

Refer to the HR policy on use of cellular telephones while operating a vehicle on company business.

1.5 Drugs and Alcohol

The use of drugs or alcohol is prohibited when driving any vehicle on GEI business. Alcohol is a factor in almost half of all fatal motor vehicle crashes.

1.6 Adverse Driving Conditions

1.6.1 Driving at Night

Traffic death rates are three times greater at night than during the day. Driving at night is more of a challenge than many people think and is also more dangerous. Why is night driving so dangerous? One obvious answer is the darkness. Ninety percent of a driver's reaction depends on vision, and vision is severely limited at night. Depth perception, color recognition, and peripheral vision are all compromised after sundown.

Another factor adding danger to night or early morning driving is fatigue. Drowsiness makes driving more difficult by dulling concentration and slowing reaction time.

Fortunately, there are effective measures to minimize these after-dark dangers by preparing your car and following special guidelines while you drive. They include:

- Have your headlights properly aimed. Misaimed headlights blind other drivers and reduce your ability to see the road.
- Do not drink and drive. Alcohol severely impairs your driving ability and acts as a depressant. Just one drink can induce fatigue.
- Avoid smoking when you drive. Smoke's nicotine and carbon monoxide hamper night vision.
- If there is any doubt, turn your headlights on. Lights will not help you see better in early twilight, but they will make it easier for other drivers to see you. Being seen is as important as seeing.
- Do not overdrive your headlights. You should be able to stop inside the illuminated area. If you do not, you create a blind crash area in front of your vehicle.
- If an oncoming vehicle does not lower beams from high to low, avoid glare by watching the right edge of the road and using it as a steering guide.
- Make frequent stops for light snacks and exercise. If you are too tired to drive, stop and get some rest.

Observe night driving safety as soon as the sun goes down. ***Twilight is one of the most difficult times to drive, because your eyes are constantly changing to adapt to the growing darkness!***

1.6.2 Snow/Freezing Conditions

Sometimes, it is impossible to avoid driving in wintry weather conditions. When snow and ice are present, be prepared by following these winter driving safety tips.

1.6.2.1 Prepare the Vehicle Before a Snowstorm

- Check under the hood and take a look at the vehicles cooling system. Make sure the vehicle contains adequate antifreeze and the hoses are in good condition.

- Test heaters and defrosters ahead of time to make sure they are in good working condition.
- Test your windshield wipers and check the condition of your wiper blades. If wipers leave streaks on your windshields, replace the blades.
- It is recommended that a washer/antifreeze solution is used during winter conditions.
- Check all your lights and periodically clear them of snow and dirt.
- Car batteries need extra power in cold conditions. Make sure the battery's terminals are clean and cables are secure.
- Fill up. Keep your gas tank at least half full in the winter to help avoid gas line freeze up.

1.6.2.2 Driving During and After a Snowstorm

- Wear sunglasses. You might want to keep a pair in the car just in case the sun is reflecting off the snow.
- Be aware of blind spots created by snow banks.
- Be extra cautious of pedestrians and other vehicles in intersections.
- Allow extra time for braking and increase the distance between you and the car ahead of you.
- Reduce your speed and do not exceed the posted limit.
- If you start to lose traction, do not panic. Take your foot off the gas and gradually reduce your speed. Accelerate slowly once you feel traction is regained.
- If you start to skid, steer in the direction of the skid. Remember, steering can be more important than braking on slippery roads.

1.6.3 Driving In the Rain

Losing control of your car on wet pavement is a frightening experience. Unfortunately, it can happen unless you take preventive measures.

- You can prevent skids by driving slowly and carefully, especially on curves.
- Steer and brake with a light touch.
- When you need to stop or slow, do not brake hard or lock the wheels and risk a skid.
- Maintain mild pressure on the brake pedal.

If you do find yourself in a skid, remain calm, ease your foot off the gas, and carefully steer in the direction you want the front of the car to go. For cars without anti-lock brakes, avoid using your brakes. This procedure, known as "steering into the skid," will bring the back end of your car in line with the front. If your car has ABS, brake firmly as you "steer into the skid."

While skids on wet pavement may be frightening, hydroplaning can be even worse. Hydroplaning happens when the water in front of your tires builds up faster than your car's weight can push it out of the way. The water pressure causes your car to rise up and slide on a thin layer of water between your tires and the road. At this point, your car can be completely out of contact with the road, and you are in danger of skidding or drifting out of your lane, or even off the road.

To avoid hydroplaning, keep the tires properly inflated and maintain good tread on the tires. If tires need to be replaced, notify the branch manager or their designee. Slow down when roads are wet, and stay away from puddles. Try to drive in the tire tracks left by the cars in front of you. If you find yourself hydroplaning, do not brake or turn suddenly. This could throw your car into a skid. Ease your foot off the gas until the car slows and you can feel the road again. If you need to brake, do it gently with light pumping actions. If your car has anti-lock brakes, then brake normally; the car's computer will mimic a pumping action, when necessary.

A defensive driver adjusts his or her speed to the wet road conditions in time to avoid having to use any of these measures.

1.6.4 Off Road

If operation of a vehicle is required off publicly or privately maintained roads or in situations where four-wheel-drive vehicles are required, the appropriate vehicle for the situation will be used. Operators of vehicles being used in these situations will be trained on the use and limitations of the vehicle while operating in off-road situations.

1.7 Driver Training

All GEI employees are required to complete the on-line Driver Training modules. Employees will complete the quiz at the end of each module and forward the training certificate to the Regional Health and Safety Officer.

1.8 Sources

National Safety Council
Oklahoma Safety Council
GEI Consultants, Inc. Employee Handbook

1.9 Contact

GEI Corporate Health and Safety Officer
GEI Mid-West Regional Health and Safety Officer
GEI Atlantic Regional Health and Safety Officer
GEI New England Regional Health and Safety Officer
GEI Western Regional Region Health and Safety Officer

STANDARD OPERATING PROCEDURES

HS-007 General Safety Requirements

1.1 General Health and Safety Training

GEI requires all employees to complete Health and Safety Training on an annual basis. Project employees must have completed, at a minimum, GEI's General 4-Hour Health and Safety Training or when required, HAZWOPER training before beginning any on-site work. In addition, all field staff must be current in First Aid and CPR Training. Further Health and Safety training requirements can be found in Section 2 of the GEI Health and Safety Manual. In addition, all site-specific safety training will be completed before beginning work on each project site.

1.2 Tailgate Meetings

Health and Safety tailgate meetings will be conducted by the GEI Project Manager or site safety officer (SSO), and be recorded in the GEI field book or in the GEI briefing log. All GEI staff on site will sign the meeting log to indicate attendance.

1.3 Health and Safety Plans (HASP)

GEI projects must have a HASP before beginning any work. GEI HASP templates are located on the Health and Safety page on the GEI intranet. Specific requirements for HASPs are located in Section 7 of GEI's Health and Safety Manual. After the HASP has been completed, it must be sent to the Corporate Health and Safety Officer (CHSO) and the Regional Health and Safety Officer (RHSO) for review. All project employees must read the HASP and sign the signature page to document that they have read, understood, and will comply with the requirements of the HASP. The site-specific HASP must be kept on-site at all times.

1.4 Personal Protective Equipment (PPE)

Project-specific PPE will be identified in the HASP based on the hazards present during work tasks. All required PPE must be worn on the project site. More information regarding PPE is located in Section 6 of GEI's Health and Safety Manual.

1.5 Fire Protection and Prevention

The work site should be kept clear of flammable materials and debris. GEI field personnel should know where all fire extinguishers are located, and be familiar in the use of the extinguisher. Information on the correct use of a fire extinguisher is included in

GEI's general health and safety training. Call 911(or other number identified in the project HASP) in the event of a fire.

1.6 Accident/Incident Reporting

The following accident reporting procedures must be followed:

- Seek medical attention.
- Notify your supervisor.
- Notify CHSO and Human Resources (HR) within two hours of the accident/incident.
- Complete Accident Reporting Form (found on the Health and Safety page of the GEI Intranet) within **24 hours** and send to CHSO and HR. Refer to Section 8 of the GEI Health and Safety Manual for more information.

1.7 Near Miss Reporting

GEI employees will complete a near-miss reporting form if a hazardous or unsafe condition or near miss is observed. The near-miss reporting form is located on the Health and Safety page of the GEI Intranet. Refer to Section 8 of the GEI Health and Safety Manual for more information.

1.8 Housekeeping

Work areas, passages, and stairs will be kept clear of debris. All debris will be removed from the project site at regular intervals.

1.9 Illumination

Project sites will be illuminated either with natural or artificial illumination, in compliance with OSHA regulations.

1.10 Sanitation

Hand-washing is an essential form of protection from chemical and biological exposures and illness. GEI employees should wash their hands after performing work tasks and regularly throughout the day. If soap and water are not available, hand sanitizers and/or wipes should be used.

1.11 Machinery, Tools, Material, and Equipment

Machinery, tools, material, and equipment will be kept in good repair and will be inspected by a competent person. Any unsafe equipment will be identified as unsafe by

tagging or locking the controls to render them inoperable or will be physically removed from the site.

1.12 Vehicles

GEI's motor vehicles will be in good working order. Brakes, tires, head lights, and tail lights will be inspected prior to initial use and regularly during extended use by the vehicle operator. If a need for repair is discovered, the operator should contact the branch manager or their designee responsible for the scheduling of such repair to make arrangements for the repair. Each GEI-owned vehicle will have a fire extinguisher and first aid kit. Additional fire extinguishers and first aid kits are kept in each GEI office for use in personal or rental vehicles.

1.13 Heavy Equipment

GEI employees will keep a line of sight between them and heavy equipment operators. If a GEI employee needs to communicate with heavy equipment operators, they will use hand signals or direct communication with the operator. GEI employees should never operate or climb on heavy equipment. GEI employees should not approach heavy equipment while it is in operation. GEI personnel should not use cellular telephones when working near operating equipment. For more information regarding heavy equipment, refer to GEI's Heavy Equipment SOP.

1.14 Contact

GEI Corporate Health and Safety Officer
GEI Mid-West Regional Health and Safety Officer
GEI Atlantic Regional Health and Safety Officer
GEI New England Regional Health and Safety Officer
GEI Western Regional Region Health and Safety Officer

STANDARD OPERATING PROCEDURES

SOP No. HS-008 Hand and Power Tools

1.1 Objective

The purpose of this SOP is to minimize the potential for injuries to GEI employees when using hand and power tools.

1.2 General Requirements

1.2.1 Condition of Tools

All hand and power tools and similar equipment, whether furnished by GEI or the employee, will be maintained in a safe condition.

1.2.2 Guarding

When power tools are designed to accommodate guards, they will be equipped with such guards prior to, and at all times during, use. All guards will be in good condition and be adequate to provide protection to the employee.

1.2.3 Personal Protective Equipment

Employees using hand or power tools and exposed to the hazard of falling, flying, abrasive, and splashing objects will be provided with the personal protective equipment (PPE) necessary to protect them from the hazard. All employees will wear work gloves and safety glasses at a minimum. In addition, face shields and hearing protection may be required.

1.3 Hand Tools

GEI does not issue or permit the use of unsafe hand tools.

1.3.1 Power-operated Hand Tools

1.3.1.1 Electric power-operated

Electric power operated tools will either be double-insulated type or grounded according to Occupational Safety and Health Administration (OSHA) regulations.

1.3.1.2 Pneumatic Power Tools

Pneumatic power tools will be properly maintained and operated according to the manufacturer's safe operating procedures.

1.3.1.3 Fuel Powered Tools

Fuel powered tools will be stopped while being refueled, serviced, or maintained, and fuel will be transported, handled, and stored in accordance with federal regulations.

1.3.1.4 Hydraulic Power Tools

The fluid used in hydraulic powered tools will be fire-resistant and approved under Schedule 30 of the U.S. Bureau of Mines, Department of the Interior, and will retain its operating characteristics at the most extreme temperatures to which it will be exposed.

1.3.1.5 Powder-actuated Tools

Only employees who have been trained in the operation of the particular tool in use will be allowed to operate a power-actuated tool.

1.3.2 Abrasive Wheels and Tools

1.3.2.1 Power

Grinding machines will be supplied with sufficient power to maintain the spindle speed at safe levels under all conditions of normal operations.

1.3.2.2 Guarding

Grinding machines will be equipped with safety guards in conformance with the requirements of the American National Standards Institute (ANSI) B7.1-1970.

1.3.3 Woodworking Tools

1.3.3.1 Disconnect Switches

Fixed power driven woodworking tools will be provided with a disconnect switch that can either be locked or tagged in the off position.

1.3.3.2 Speeds

The operating speed will be etched or otherwise permanently marked on all circular saws over 20 inches in diameter or operating at over 10,000 peripheral feet per minute. Saws will not be operated at a speed other than that marked on the blade.

1.3.3.3 Self-feed

Automatic feeding devices will be installed on machines whenever the nature of the work will permit. Feeder attachments will have the feed rolls or other moving parts covered or guarded so as to protect the operator from hazardous points.

1.3.3.4 Guarding

Portable, power-driven circular saws will be equipped with guards above and below the base plate or shoe.

1.3.3.5 Personal Protective Equipment

Personal protective equipment will conform to OSHA and ANSI standards.

1.3.3.6 Other Requirements

Woodworking tools and machinery will meet other applicable requirements of ANSI 01.1-1961, Safety Code for Woodworking Machinery.

1.3.4 Jacks – Lever and Ratchet, Screw, and Hydraulic

1.3.4.1 General Requirements

The manufacturer's rated capacity will be legibly marked on all jacks and will not be exceeded. All jacks will have a positive stop to prevent over-travel.

1.3.4.2 Blocking

When the working area does not have a solid working surface and it is necessary to provide a firm foundation, the base of the jack will be blocked or cribbed.

1.3.4.3 Operation and Maintenance

Hydraulic jacks exposed to freezing temperatures will be supplied with adequate antifreeze liquid. Jacks will be properly lubricated at regular intervals. Jacks will be thoroughly inspected, if necessary, based upon the service conditions. Repair or replacement parts will be examined for possible defects. Jacks that are out of order will be tagged accordingly, and will not be used until repairs are made. Parts subjected to wear will be inspected on a regular basis and repaired or replaced as needed.

1.4 References

OSHA Standards for the Construction Industry, Subpart I

1.5 Contact

GEI Corporate Health and Safety Officer
GEI Atlantic Regional Health and Safety Officer
GEI New England Regional Health and Safety Officer
GEI Mid-West Regional Health and Safety Officer
GEI Western Regional Health and Safety Officer

STANDARD OPERATING PROCEDURES

SOP NO. HS-009 Hazard Identification and Management

1.1 Objective

The purpose of this SOP is to outline the steps GEI personnel will take to identify potential hazards on site, the risks associated with these hazards, and the proper engineering controls, work practices, and personal protective equipment (PPE) to use to minimize the associated risks.

1.2 Hazard Identification

An initial identification of hazards should be done based on a review of available documents, including lists of chemicals used on site, analytical data from soil, surface water, groundwater, air, spill history, site history, equipment on site, maps, photos, and a preliminary survey.

1.3 Risk Identification

Once the presence and concentrations of specific hazardous substances and health hazards have been established, the risks associated with these substances will be identified. GEI employees and GEI subcontractors who will be working on the site will be informed of any risks that have been identified.

Risks to consider include, but are not limited to:

- Potential exposures exceeding the permissible exposure limits and published exposure levels.
- Potential Immediately to Life and Health (IDLH) Concentrations.
- Potential Skin Absorption and Irritation Sources.
- Potential Eye Irritation Sources.
- Potential hazardous atmospheres, including oxygen deficiency and fire and explosion hazards.

1.4 Engineering Controls, Work Practices, and Personal Protective Equipment for Employee Protection

Engineering controls, work practices, and PPE for substances regulated in OSHA Subpart Z (Toxic and Hazardous Substances) will be implemented in accordance with this section to protect employees from exposure to hazardous substances and safety and health hazards.

1.4.1 Engineering Controls, Work Practices, and Personal Protective Equipment for Substances Regulated in Subparts G (Occupational Health and Environment Control) and Subpart Z (Toxic and Hazardous Substances)

Engineering controls and work practices will be instituted to reduce and maintain employee exposure at or below the permissible exposure limits for substances regulated by 29 CFR Part 1910, to the extent required by Subpart Z, except to the extent that such controls and practices are not feasible.

Engineering controls that may be feasible include the use of pressurized cabs or control booths on equipment, and/or the use of remotely operated material handling equipment. Work practices that may be feasible include removing all non-essential employees from potential exposure during opening of drums, wetting down dusty operations, and locating employees upwind of possible hazards.

If engineering controls and work practices are not feasible, or not required, any reasonable combination of engineering controls, work practices, and PPE will be used to reduce and maintain at or below the permissible exposure limits or dose limits for substances regulated by 29 CFR Part 1910, Subpart Z.

GEI will not implement a schedule of employee rotation as a means of compliance with permissible exposure limits or dose limits except when there is no other feasible way of complying with the airborne or dermal dose limits for ionizing radiation.

The provisions of 29 CFR, subpart G, Occupational Health and Environment control, will be followed.

1.4.2 Engineering Controls, Work Practices, and Personal Protective Equipment for Substances Not Regulated in Subparts G and Subparts Z

An appropriate combination of engineering controls, work practices, and personal protective equipment will be used to reduce and maintain employee exposure to or below published exposure levels for hazardous substances and health hazards not regulated by 29 CFR Part 1910, Subparts G and Subparts Z. GEI will use published literature and MSDS' as a guide in making the determination of what level of protection is appropriate for hazardous substances and health hazards for which there is no permissible exposure limit or published exposure limit.

1.4.3 Decontamination Procedure

Decontamination procedure(s) will be developed, communicated to employees, and implemented before any employees or equipment enter areas on site where potential for exposure to hazardous substances exists. Procedures will be developed to minimize

employee contact with hazardous substances or with equipment that has contacted hazardous substances.

All GEI employees leaving a contaminated area will be properly decontaminated; all contaminated clothing and equipment leaving a contaminated area will be properly disposed of or decontaminated.

Decontamination procedures will be monitored by the site safety officer to determine their effectiveness. When such procedures are found to be ineffective, the site safety officer will contact the CHSO and appropriate steps will be taken to correct any deficiencies.

1.4.3.1 Location

Decontamination will be performed in geographical areas that will minimize the exposure to employees, equipment, and the environment.

1.4.3.2 Equipment and Solvents

All equipment and solvents used for decontamination will be decontaminated or disposed of properly.

1.4.3.3 Personal Protective Clothing and Equipment

Protective clothing and equipment will be decontaminated, cleaned, laundered, maintained or replaced as needed to maintain their effectiveness.

Employees whose clothing becomes wetted with hazardous substances will immediately remove that clothing and proceed to shower. The clothing will be disposed of or decontaminated before it is removed from the work zone.

1.4.3.4 Commercial Laundries or Cleaning Establishments

Commercial laundries or cleaning establishments that decontaminate protective clothing or equipment will be informed of the potentially harmful effects of exposures to hazardous substances.

1.4.3.5 Showers and Changing Rooms

Where the decontamination procedure indicates a need for regular showers and change rooms outside of a contaminated area, they will be provided and meet the requirements of 29 CFR 1910.141 (Sanitation). If temperature conditions prevent the effective use of water, then other effective means for cleansing will be provided and used.

1.5 Limitations

None

1.6 References

OSHA 1910.120 Hazardous Waste Operations and Emergency Response
OSHA 1910 Subpart G Occupational Health and Environment Control
OSHA 1910 Subpart Z Toxic and Hazardous Substances
OSHA 1910.141 General Environmental Controls - Sanitation

1.7 Contact

GEI Corporate Health and Safety Officer
GEI Mid-West Regional Health and Safety Officer
GEI Atlantic Regional Health and Safety Officer
GEI New England Regional Health and Safety Officer
GEI Western Regional Region Health and Safety Officer

STANDARD OPERATING PROCEDURES
SOP No. HS-010 Inclement Weather

1.1 Objective

Inclement weather can affect work activities and pose safety hazards to employees working in these conditions. The following guidelines will be followed when weather conditions become a safety concern.

1.2 Execution

All employees will be aware of local weather conditions and monitor any advisories issued by the National Weather Service and other local reporting services. Depending on location and season, storms are capable of producing heavy rain, floods, extreme temperatures, high wind conditions, lighting, tornados, and/or snowfall.

1.2.1 Heavy Rain

If working or driving in a storm use extreme caution and turn your lights on when the rainfall becomes heavy. Employees should be aware of the following:

- Heavy rain causes visibility issues, especially when driving.
- Surfaces and tools become slippery.
- If you are working in the rain and your clothes become wet there is a risk of hypothermia when exposed to winds, even in warm temperatures.
- If the storms are going to produce thunder and/or lightning, leave the work area immediately and move to a safe area.
- Use your best judgment to determine if the rainfall becomes too heavy to continue working safely.

1.2.2 Lightning

Lightning can strike as far as 10 miles from the area where it is raining. That's about the distance you can hear thunder. **If you can hear thunder, you are within striking distance. Seek safe shelter immediately.** This can be within a building or vehicle. Wait 30 minutes after the last clap of thunder or flash of lightning before going outside again.

1.2.3 Flooding

Flooding may occur as a result of heavy rain in a short period of time. Flooding can be particularly acute in canyon areas where dry creek beds can turn into raging rivers from rainfall in distant or higher elevation areas. Be aware of this and your surroundings and move to a safe place if you begin to see any signs that flooding may occur. Do not

attempt to drive through areas or streets that are flooded. Seek alternate routes. Be particularly cautious at night when flooded areas are difficult to see. Urban flooding can stop traffic and increase the potential for traffic accidents and being trapped in vehicles.

1.2.4 Extreme Temperatures

Work activities may take place in extreme heat or cold. Be prepared if these conditions are anticipated. Have the correct personal protective equipment (PPE) available, exercise proper fluid intake, and take breaks to complete work and prevent heat and cold stress. For more information about these conditions see the heat stress and cold stress programs found in GEI's Health and Safety Manual.

1.2.5 High Wind and Tornados

Tropical storms are described as storms with sustained winds ranging from 39 to 73 miles per hour (mph) and hurricanes produce sustained winds that exceed 74 mph. When winds approach 40 mph (gale force winds) twigs begin to break off of trees and vehicles will veer off of the road. When winds approach **40 mph** or the GEI employee feels unsafe based on the activities being performed, work is to be stopped and you should seek shelter as soon as possible. Blowing or falling debris and overhanging limbs/signs can be a significant hazard. Avoid driving in these conditions; 70 percent of injuries during hurricanes are a result of vehicle accidents. Note that tall or elevated equipment will have manufacturer's safe operating wind speeds defined that could be less than 40 mph, the operator's manual should be consulted prior to operation of the equipment.

A tornado is a violent, dangerous, rotating column of air that is in contact with both the surface of the earth and a cumulonimbus cloud or, in rare cases, the base of a cumulus cloud. The Fujita Scale is used to rate the intensity of a tornado by examining the damage caused by the tornado after it has passed over a man-made structure. Based on the Fujita Scale or F-Scale Numbers begin at F0: 40-72 mph and go to F6: 319-379 mph (F6 is generally theoretical). Nearly three-fourths of all tornados are on the weak F0-F1 scale with just over two-thirds of deaths resulting from the violent F4-F5 tornados. All tornado wind speeds exceed the 40 mph stop work speed, shelter should be taken immediately if a tornado is seen. If a tornado siren is sounded move immediately to safety indoors and then move to a windowless interior space, basement, stair well etc., or designated fall-out shelter if available. Windows should not be opened before an oncoming tornado, keep the building envelope closed to the extent possible. If there is no shelter available seat belt yourself into your stationary vehicle or seek a depression or low spot on the land surface.

1.2.6 Snowfall and Ice Conditions

Working in the winter months will result in activities taking place during periods of snowfall or icy conditions. If you are working during or after snow has fallen, dress appropriately for the conditions. Snow and ice can cause working surfaces to become

slippery; clear snow and ice from all work areas to prevent slip hazards. Use caution when performing any snow or ice removal activities to prevent injuries. Driving in snowy and icy conditions is also hazardous. Reduce speed and use caution if you must drive in these conditions.

If the weather conditions deteriorate and you do not feel safe working in these conditions, stop work, move to a safe indoor location, and contact your Project Manager to let them know the weather and work status and your location.

1.3 Limitations

- Follow safety procedures as defined in the site-specific health and safety plan (HASP) at all times.
- Protection from working in extreme weather conditions can best be accomplished if the conditions are anticipated. Monitor local weather conditions prior to starting work.

1.4 References

Center for Disease Control and Prevention – Natural Disasters and Severe Weather
http://www.bt.cdc.gov/disasters/
National Lightning Safety Institute
NOAA, National Weather Service
Office of Climate, Water, and Weather Services

1.5 Attachment

None

1.6 Contact

GEI Corporate Health and Safety Officer
GEI Mid-West Regional Health and Safety Officer
GEI Atlantic Regional Health and Safety Officer
GEI New England Regional Health and Safety Officer
GEI Western Regional Region Health and Safety Officer

STANDARD OPERATING PROCEDURES
HS-017 Water Safety

1.1 Objective

The purpose of this SOP is to ensure the safe deployment and return of GEI personnel during field activities while aboard a boat or when working near water.

1.2 Execution

Boat safety practices will be conducted in general accordance with guidance provided in the United States Army Corps of Engineers (USACE) Safety and Health Requirements Manual (EM) 385-1-1. Personnel will board the boat at specified locations to be determined and agreed upon prior to field deployment. The following safety practices will be adhered to:

- Boats operated by GEI will comply with Coast Guard regulations.
- Every GEI employee will wear a Type III Personal Flotation Device (PFDs) at all times when aboard any boat except when that boat is equipped with a fully enclosed cabin and the employee is inside. Boats must also, at a minimum, have Coast Guard approved PFDs on board for each person and at least one throwable flotation device, such as a seat cushion.
- For every boating activity, a trip plan must be communicated to someone in a position to take appropriate action when the GEI employee is overdue.
- For every trip requiring more than one day, daily communications with an appropriate base must be maintained.
- The consumption of alcoholic beverages and the use of illegal drugs will not be permitted at any time aboard boats on which GEI employees are present.
- All employees working on a boat will monitor the weather, incorporating, as appropriate, National Oceanic and Atmospheric Administration (NOAA) marine weather broadcasts and other local commercial weather forecasting services as may be available.
- For retrieving a person overboard, the boat operator will throw a life ring and line, and use a ladder attached to the boat or the boat step transom to allow the person to climb out of the water. The boat will be equipped with an ABC rated fire extinguisher(s) and a life ring attached to approximately 90 feet of rope.
- Emergency procedures for fire, person overboard, and capsizing will be reviewed on the first day of operations and any time a change of personnel occurs.

1.3 Working Near Water

OSHA Construction Industry Standards (1926) state: "employees working over or near water, **where the danger of drowning exists**, will be provided a Coast Guard-approved PFD." OSHA General Industry Standards (1910) do not address working over or near water. Therefore, GEI uses the OSHA Construction Standard for all employees and all tasks to ensure protection in all operations. A site-specific health and safety plan (HASP) is required to be completed and signed by all GEI employees that may be working over or near water before the work may begin.

The following procedures and safety devices will be provided for and used by employees at locations where the danger of drowning exists and when employees are not protected by passive fall protection systems such as railings, nets, safety belts, or other applicable provisions:

- **Personal Flotation Devices (PFD).** Employees will be required to wear U. S. Coast Guard approved personal flotation devices that are marked or labeled Type I PFD, Type II PFD, or Type III PFD, or a U.S. Coast Guard approved Type V PFD that is marked or labeled for use as a work vest for commercial use or for use on vessels. GEI employees will inspect buoyant work vests or life preservers for defects that could alter their strength or buoyancy prior to, and after, each use. Defective units will not be used and will be marked as defective and properly disposed.

- **Ring Buoys.** U. S. Coast Guard approved 30-inch ring buoys with at least 150 feet of 600 pound capacity line will be readily available for emergency rescue operations. Distance between ring buoys will not exceed 150 feet.

These requirements can be superseded by the use of 100 percent fall protection. If an employee cannot fall into the water as a result of use of active or passive fall protection, there is no danger of drowning and a PFD is not required. For example, where an employee is working on a steep slope and could fall into water, a PFD is required.

1.4 Procedures

Safety lines that prevent employees from reaching the water eliminate the danger of drowning, and negate the need for a PFD. The same is true when working on a barge or floating platform with an approved railing system.

Employees working over or near water where the distance to the water is greater than the length of the lanyard (and by virtue of safety devices no danger of drowning exists), are not required to comply with requirements for working in proximity to water. If the distance between the water surface and the employee is less than the length of the lanyard and thus will allow entry into the water, the OSHA standard is relevant. Employees who exit the basket of the aerial lift to a location that is over or near water, (and the danger of drowning as a result of a fall exists), and do not maintain 100 percent fall protection,

must wear a PFD. When GEI employees are working over or adjacent to water, the client will provide at least one lifesaving skiff to be immediately available for potential rescue purposes.

Employees will not work alone, where practical, in situations where a drowning hazard exists.

1.5 Training

Training will be conducted for employees unfamiliar with the use of safety equipment and PPE required by this SOP. Employees working over or near water will be trained in their responsibilities and the safe work practices associated with working on or near water.

1.6 Limitations

None

1.7 References

United States Army Corps of Engineers, Safety and Health Requirements Manual (EM), 385-1-1.November 3, 2003 – Section 19 Floating Plant and Marine Activities

1.8 Attachments

None

1.9 Contact

GEI Corporate Health and Safety Officer
GEI Mid-West Regional Health and Safety Officer
GEI Atlantic Regional Health and Safety Officer
GEI New England Regional Health and Safety Officer
GEI Western Regional Region Health and Safety Officer

1.10 Revision Dates

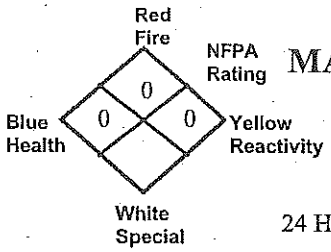
November 2010
May 2011

APPENDIX E

Material Safety Data Sheets (MSDSs)

04-3224
04-3210
S-70112

Alconox ®



MATERIAL SAFETY DATA SHEET

Alconox, Inc.
30 Glenn Street
White Plains, NY 10603

24 Hour Emergency Number – Chem-Tel (800) 255-3924

I. IDENTIFICATION

Product Name (as appears on label)	ALCONOX
CAS Registry Number:	Not Applicable
Effective Date:	January 1, 2001
Chemical Family:	Anionic Powdered Detergent
Manufacturer Catalog Numbers for sizes	1104, 1125, 1150, 1101, 1103 and 1112

II. HAZARDOUS INGREDIENTS/IDENTITY INFORMATION

There are no hazardous ingredients in ALCONOX as defined by the OSHA Standard and Hazardous Substance List 29 CFR 1910 Subpart Z.

III. PHYSICAL/CHEMICAL CHARACTERISTICS

Boiling Point (F):	Not Applicable
Vapor Pressure (mm Hg):	Not Applicable
Vapor Density (AIR=1):	Not Applicable
Specific Gravity (Water=1):	Not Applicable
Melting Point:	Not Applicable
Evaporation Rate (Butyl Acetate=1):	Not Applicable
Solubility in Water:	Appreciable-Soluble to 10% at ambient conditions
Appearance:	White powder interspersed with cream colored flakes.
pH:	9.5 (1%)

IV. FIRE AND EXPLOSION DATA

Flash Point (Method Used):	None
Flammable Limits:	LEL: No Data UEL: No Data
Extinguishing Media:	Water, dry chemical, CO_2, foam
Special Fire fighting Procedures:	Self-contained positive pressure breathing apparatus and protective clothing should be worn when fighting fires involving chemicals.
Unusual Fire and Explosion Hazards:	None

V. REACTIVITY DATA

Stability:	Stable
Hazardous Polymerization:	Will not occur
Incompatibility (Materials to Avoid):	None
Hazardous Decomposition or Byproducts:	May release CO_2 on burning

VI. HEALTH HAZARD DATA

Route(s) of Entry:	Inhalation? Yes Skin? No Ingestion? Yes
Health Hazards (Acute and Chronic):	Inhalation of powder may prove locally irritating to mucous membranes. Ingestion may cause discomfort and/or diarrhea. Eye contact may prove irritating.
Carcinogenicity:	NTP? No IARC Monographs? No OSHA Regulated? No
Signs and Symptoms of Exposure:	Exposure may irritate mucous membranes. May cause sneezing.
Medical Conditions Generally Aggravated by Exposure:	Not established. Unnecessary exposure to this product or any industrial chemical should be avoided. Respiratory conditions may be aggravated by powder.
Emergency and First Aid Procedures:	Eyes: Immediately flush eyes with water for at least 15 minutes. Call a physician. Skin: Flush with plenty of water. Ingestion: Drink large quantities of water or milk. Do not induce vomiting. If vomiting occurs administer fluids. See a physician for discomfort.

VII. PRECAUTIONS FOR SAFE HANDLING AND USE

Steps to be Taken if Material is Released or Spilled:	Material foams profusely. Recover as much as possible and flush remainder to sewer. Material is biodegradable.
Waste Disposal Method:	Small quantities may be disposed of in sewer. Large quantities should be disposed of in accordance with local ordinances for detergent products.
Precautions to be Taken in Storing and Handling:	Material should be stored in a dry area to prevent caking.
Other Precautions:	No special requirements other than the good industrial hygiene and safety practices employed with any industrial chemical.

VIII. CONTROL MEASURES

Respiratory Protection (Specify Type):	Dust mask - Recommended
Ventilation:	Local Exhaust-Normal Special-Not Required Mechanical-Not Required Other-Not Required
Protective Gloves:	Impervious gloves are useful but not required.
Eye Protection:	Goggles are recommended when handling solutions.
Other Protective Clothing or Equipment:	None
Work/Hygienic Practices:	No special practices required

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**** MATERIAL SAFETY DATA SHEET ****

Methanol
14280

**** SECTION 1 - CHEMICAL PRODUCT AND COMPANY IDENTIFICATION ****

MSDS Name: Methanol
Catalog Numbers:
, S75959, S75965, S75965A, S75965HPLC, S75965SPEC, A408-1, A408-4, A408SK-4 A411-20, A411-4, A412-1, A412-20, A412-200, A412-200LC, A412-4, A412-4LC, A412-500, A412-500LC, A412CU1300, A412FB115, A412FB19, A412FB200, A412FB50, A412J500, A412P-4, A412P-4LC, A412POP19, A412POP200, A412POP50, A412POPB19, A412POPB200, A412POPB50, A412RE115, A412RE19, A412RE200, A412RE50, A412RS115, A412RS200, A412RS28, A412RS50, A412SK-4, A412SS-115, A412SS-19, A412SS-200, A413-20, A413-200, A413-4, A413-500, A433F-1GAL, A433P-4, A433P1GAL, A433S-20, A433S-200, A433S-4, A434-20, A450-4, A452-1, A452-4, A452-4LC, A452J1, A452NB219, A452POP19, A452POP200, A452POP28, A452POP50, A452POPN19, A452RS-115, A452RS-19, A452RS-200, A452RS-28, A452RS-50, A452SK-1, A452SK-4, A452SS-115, A452SS-19, A452SS-200, A452SS-50, A453-1, A453-1LC, A453-500, A453J1, A454-1, A454-1LC, A454-4, A454-4LC, A454POP19, A454POP200, A454POP50, A454RS-115, A454RS-19, A454RS-200, A454RS-28, A454RS-50, A454SS-19, A454SS-28, A454SS-50, A455-1, A455POP19, A455POP200, A455POP50, A455SS19, A455SS200, A455SS50, A457-4, A935-4, A935FB200, A935POPB200, A935RB200, A936-1, A936-4, A947-4, A947-4LC, A947POP19, A947POP200, A947POP50, A947RS-115, A947RS-200, A947RS-28, A947SS-115, A947SS-19, A947SS-200, A947SS-28, A947SS-50, BP1105-1, BP1105-4, BP1105POP19, BP1105POP20, BP1105POP50, BP1105RS19, BP1105SS19, BP1105SS28, BP1105SS50, BP2618100, HC400 1GAL, NC9633361, NC9766429, NC9780216, NC9905242, NC9941388, NC9942270, NC9964975, NC9979250, SC95-1, SW2-1, TIA9474, TIA947P200L
Synonyms:
Carbinol; Methyl alcohol; Methyl hydroxide; Monohydroxymethane; Wood alcohol; Wood naptha; Wood spirits; Columbian spirits; Methanol.
Company Identification: Fisher Scientific
1 Reagent Lane
Fairlawn, NJ 07410
For information, call: 201-796-7100
Emergency Number: 201-796-7100
For CHEMTREC assistance, call: 800-424-9300
For International CHEMTREC assistance, call: 703-527-3887

**** SECTION 2 - COMPOSITION, INFORMATION ON INGREDIENTS ****

CAS#	Chemical Name	%	EINECS#
67-56-1	Methanol	>99.0	200-659-6

Hazard Symbols: T F
Risk Phrases: 11 23/24/25 39/23/24/25

**** SECTION 3 - HAZARDS IDENTIFICATION ****

EMERGENCY OVERVIEW
Appearance: clear, colorless liquid. Flash Point: 11 deg C.
Danger! Flammable liquid and vapor. Causes respiratory tract irritation. May cause central nervous system depression. Poison! Cannot be made non-poisonous. Causes eye and skin irritation. May be fatal or cause blindness if swallowed. Harmful if swallowed, inhaled, or absorbed through the skin. Vapor harmful.
Target Organs: Eyes, nervous system, optic nerve.

Potential Health Effects
Eye:
Methanol is a mild to moderate eye irritant. Inhalation, ingestion or skin absorption of methanol can cause significant disturbances in vision, including blindness.
Skin:
Causes moderate skin irritation. Harmful if absorbed through the skin. Prolonged and/or repeated contact may cause defatting of the skin and dermatitis. Methanol can be absorbed through the skin, producing systemic effects that include visual disturbances.
Ingestion:
Harmful if swallowed. May be fatal or cause blindness if swallowed. Aspiration hazard. May cause systemic toxicity with acidosis. May cause central nervous system depression, characterized by excitement, followed by headache, dizziness, drowsiness, and nausea. Advanced stages may cause collapse, unconsciousness, coma and possible death due to respiratory failure.
Inhalation:
Methanol is toxic and can very readily form extremely high vapor concentrations at room temperature. Inhalation is the most common route of occupational exposure. At first, methanol causes CNS depression with nausea, headache, vomiting, dizziness and incoordination. A time period with no obvious symptoms follows (typically 8-24 hrs). This latent period is followed by metabolic acidosis and severe visual effects which may include reduced reactivity and/or increased sensitivity to light, blurred, double

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and/or snowy vision, and blindness. Depending on the severity of exposure and the promptness of treatment, survivors may recover completely or may have permanent blindness, vision disturbances and/or nervous system effects.
Chronic:
Prolonged or repeated skin contact may cause dermatitis. Chronic exposure may cause effects similar to those of acute exposure. Methanol is only very slowly eliminated from the body. Because of this slow elimination, methanol should be regarded as a cumulative poison. Though a single exposure may cause no effect, daily exposures may result in the accumulation of a harmful amount. Methanol has produced fetotoxicity in rats and teratogenicity in mice exposed by inhalation to high concentrations that did not produce significant maternal toxicity.

**** SECTION 4 - FIRST AID MEASURES ****

Eyes:
In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical aid.
Skin:
In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Get medical aid immediately. Wash clothing before reuse.
Ingestion:
Potential for aspiration if swallowed. Get medical aid immediately. Do not induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person.
Inhalation:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical aid.
Notes to Physician:
Effects may be delayed.
Antidote:
Ethanol may inhibit methanol metabolism.

**** SECTION 5 - FIRE FIGHTING MEASURES ****

General Information:
Containers can build up pressure if exposed to heat and/or fire. As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear. During a fire, irritating and highly toxic gases may be generated by thermal decomposition or combustion. Use water spray to keep fire-exposed containers cool. Water may be ineffective. Material is lighter than water and a fire may be spread by the use of water. Flammable liquid and vapor. Vapors are heavier than air and may travel to a source of ignition and flash back. Vapors can spread along the ground and collect in low or confined areas.
Extinguishing Media:
For small fires, use dry chemical, carbon dioxide, water spray or alcohol-resistant foam. Water may be ineffective. For large fires, use water spray, fog or alcohol-resistant foam. Do NOT use straight streams of water.
Autoignition Temperature:464 deg C (867.20 deg F)
Flash Point: 11 deg C (51.80 deg F)
Explosion Limits, lower:6.0 vol %
Explosion Limits, upper:36.00 vol %
NFPA Rating: (estimated) Health: 1; Flammability: 3; Instability: 0

**** SECTION 6 - ACCIDENTAL RELEASE MEASURES ****

General Information: Use proper personal protective equipment as indicated in Section 8.
Spills/Leaks:
Absorb spill with inert material (e.g. vermiculite, sand or earth), then place in suitable container. Use water spray to disperse the gas/vapor. Remove all sources of ignition. Provide ventilation. A vapor suppressing foam may be used to reduce vapors. Water spray may reduce vapor but may not prevent ignition in closed spaces.

**** SECTION 7 - HANDLING and STORAGE ****

Handling:
Wash thoroughly after handling. Remove contaminated clothing and wash before reuse. Ground and bond containers when transferring material. Avoid contact with eyes, skin, and clothing. Empty containers retain product residue, (liquid and/or vapor), and can be dangerous. Keep container tightly closed. Do not ingest or inhale. Do not pressurize, cut, weld, braze, solder, drill, grind, or expose empty containers to heat, sparks or open flames. Use only with adequate ventilation. Keep away from heat, sparks and flame. Avoid use in confined spaces. Avoid breathing vapor or mist.
Storage:
Keep away from heat, sparks, and flame. Keep away from sources of ignition. Store in a cool, dry, well-ventilated area away from incompatible substances. Flammables-area. Keep containers tightly closed.

**** SECTION 8 - EXPOSURE CONTROLS, PERSONAL PROTECTION ****

Engineering Controls:
Use explosion-proof ventilation equipment. Facilities storing or utilizing this material should be equipped with an eyewash facility and a safety shower. Use adequate general or local exhaust ventilation to keep airborne concentrations below the permissible exposure limits.

Exposure Limits

Chemical Name	ACGIH	NIOSH	OSHA - Final PELs
Methanol	200 ppm; 250 ppm STEL; skin - potential for cutaneous absorption	200 ppm TWA; 260 mg/m3 TWA 6000 ppm IDLH	200 ppm TWA; 260 mg/m3 TWA

OSHA Vacated PELs:
Methanol:
200 ppm TWA; 260 mg/m3 TWA

Personal Protective Equipment

Eyes:
Wear chemical goggles.
Skin:
Wear appropriate protective gloves to prevent skin exposure.
Clothing:
Wear appropriate protective clothing to prevent skin exposure.
Respirators:
A respiratory protection program that meets OSHA's 29 CFR 1910.134 and ANSI Z88.2 requirements or European Standard EN 149 must be followed whenever workplace conditions warrant a respirator's use.

**** SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES ****

Physical State:	Liquid
Color:	clear, colorless
Odor:	alcohol-like - weak odor
pH:	Not available.
Vapor Pressure:	127 mm Hg @ 25 deg C
Vapor Density:	1.11 (Air=1)
Evaporation Rate:	5.2 (Ether=1)
Viscosity:	0.55 cP 20 deg C
Boiling Point:	64.7 deg C @ 760 mm Hg
Freezing/Melting Point:	-98 deg C
Decomposition Temperature:	Not available.
Solubility in water:	miscible
Specific Gravity/Density:	.7910 g/cm3 @ 20&C
Molecular Formula:	CH4O
Molecular Weight:	32.04

**** SECTION 10 - STABILITY AND REACTIVITY ****

Chemical Stability:
Stable under normal temperatures and pressures.
Conditions to Avoid:
High temperatures, ignition sources, confined spaces.
Incompatibilities with Other Materials:
Strong oxidizing agents, strong acids, powdered aluminum, powdered magnesium.
Hazardous Decomposition Products:
Carbon monoxide, irritating and toxic fumes and gases, carbon dioxide, formaldehyde.
Hazardous Polymerization: Will not occur.

**** SECTION 11 - TOXICOLOGICAL INFORMATION ****

RTECS#:
CAS# 67-56-1: PC1400000
LD50/LC50:
CAS# 67-56-1: Draize test, rabbit, eye: 40 mg Moderate; Draize test, rabbit, eye: 100 mg/24H Moderate; Draize test, rabbit, skin: 20 mg/24H Moderate; Inhalation, rabbit: LC50 = 81000 mg/m3/14H; Inhalation, rat: LC50 = 64000 ppm/4H; Oral, mouse: LD50 = 7300 mg/kg; Oral, rabbit: LD50 = 14200 mg/kg; Oral, rat: LD50 = 5600 mg/kg; Skin, rabbit: LD50 = 15800 mg/kg.
Human LDLo Oral: 143 mg/kg.
Inhalation; 300 ppm caused visual field changes & headache.
LDLo Skin: 393 mg/kg.
experimental animals than humans, because most animal species metabolize methanol differently. Non-primate species do not ordinarily show symptoms of metabolic acidosis or the visual effects

which have been observed in primates and humans.
Carcinogenicity:
Methanol -
Not listed by ACGIH, IARC, NIOSH, NTP, or OSHA.
Epidemiology:
No data available.
Teratogenicity:
There is no human information available. Methanol is considered to be a potential developmental hazard based on animal data. In animal experiments, methanol has caused fetotoxic or teratogenic effects without maternal toxicity.
Reproductive Effects:
See actual entry in RTECS for complete information.
Neurotoxicity:
ACGIH cites neuropathy, vision and CNS under TLV basis.
Mutagenicity:
See actual entry in RTECS for complete information.
Other Studies:
No data available.

**** SECTION 12 - ECOLOGICAL INFORMATION ****

Ecotoxicity:
Fish: Fathead Minnow: 29.4 g/L; 96 Hr; LC50 (unspecified)Fish: Goldfish: 250 ppm; 11 Hr; resulted in deathFish: Rainbow trout: 8000 mg/L; 48 Hr; LC50 (unspecified)Fish: Rainbow trout: LC50 = 13-68 mg/L; 96 Hr.; 12 degrees CFish: Fathead Minnow: LC50 = 29400 mg/L; 96 Hr.; 25 degrees C, pH 7.63Fish: Rainbow trout: LC50 = 8000 mg/L; 48 Hr.; UnspecifiedBacteria: Phytobacterium phosphoreum: EC50 = 51,000-320,000 mg/L; 30 minutes; Microtox test

**** SECTION 13 - DISPOSAL CONSIDERATIONS ****

Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste.
US EPA guidelines for the classification determination are listed in 40 CFR Parts 261.3. Additionally, waste generators must consult state and local hazardous waste regulations to ensure complete and accurate classification.
RCRA P-Series: None listed.
RCRA U-Series: CAS# 67-56-1: waste number U154 (Ignitable waste).

**** SECTION 14 - TRANSPORT INFORMATION ****

US DOT
Shipping Name: METHANOL
Hazard Class: 3
UN Number: UN1230
Packing Group: II
Canadian TDG
Shipping Name: METHANOL
Hazard Class: 3.61
UN Number: UN1230
Other Information: FLASHPOINT 11 C

**** SECTION 15 - REGULATORY INFORMATION ****

US FEDERAL
TSCA
CAS# 67-56-1 is listed on the TSCA inventory.
Health & Safety Reporting List
None of the chemicals are on the Health & Safety Reporting List.
Chemical Test Rules
None of the chemicals in this product are under a Chemical Test Rule.
Section 12b
None of the chemicals are listed under TSCA Section 12b.
TSCA Significant New Use Rule
None of the chemicals in this material have a SNUR under TSCA.
SARA
CERCLA Hazardous Substances and corresponding RQs
CAS# 67-56-1: 5000 lb final RQ; 2270 kg final RQ
SARA Section 302 Extremely Hazardous Substances
None of the chemicals in this product have a TPQ.
SARA Codes
CAS # 67-56-1: acute, flammable.
Section 313
This material contains Methanol (CAS# 67-56-1, 99.0%),which is subject to the reporting requirements of Section 313 of SARA Title III and 40 CFR Part 372.
Clean Air Act:
CAS# 67-56-1 is listed as a hazardous air pollutant (HAP).
This material does not contain any Class 1 Ozone depletors.
This material does not contain any Class 2 Ozone depletors.
Clean Water Act:
None of the chemicals in this product are listed as Hazardous Substances under the CWA.
None of the chemicals in this product are listed as Priority Pollutants under the CWA.

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None of the chemicals in this product are listed as Toxic Pollutants under the CWA.

OSHA:

None of the chemicals in this product are considered highly hazardous by OSHA.

STATE

Methanol can be found on the following state right to know lists: California, New Jersey, Pennsylvania, Minnesota, Massachusetts.

California No Significant Risk Level:

None of the chemicals in this product are listed.

European/International Regulations

European Labeling in Accordance with EC Directives

Hazard Symbols: T F

Risk Phrases:

R 11 Highly flammable.
R 23/24/25 Toxic by inhalation, in contact with skin and if swallowed.
R 39/23/24/25 Toxic : danger of very serious irreversible effects through inhalation, in contact with skin and if swallowed.

Safety Phrases:

S 7 Keep container tightly closed.
S 16 Keep away from sources of ignition - No smoking.
S 36/37 Wear suitable protective clothing and gloves.
S 45 In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).

WGK (Water Danger/Protection)

CAS# 67-56-1: 1

United Kingdom Occupational Exposure Limits

CAS# 67-56-1: OES-United Kingdom, TWA 200 ppm TWA; 266 mg/m3 TWA
CAS# 67-56-1: OES-United Kingdom, STEL 250 ppm STEL; 333 mg/m3 STEL

United Kingdom Maximum Exposure Limits

Canada

CAS# 67-56-1 is listed on Canada's DSL List.
This product has a WHMIS classification of B2, D1B, D2B.
CAS# 67-56-1 is listed on Canada's Ingredient Disclosure List.

Exposure Limits

CAS# 67-56-1: OEL-ARAB Republic of Egypt:TWA 200 ppm (260 mg/m3);Skin

**** SECTION 16 - ADDITIONAL INFORMATION ****

MSDS Creation Date: 7/21/1999 Revision #11 Date: 10/21/2002

The information above is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantability or any other warranty, express or implied, with respect to such information, and we assume no liability resulting from its use. Users should make their own investigations to determine the suitability of the information for their particular purposes. In no way shall the company be liable for any claims, losses, or damages of any third party or for lost profits or any special, indirect, incidental, consequential or exemplary damages, howsoever arising, even if the company has been advised of the possibility of such damages.

MATERIAL SAFETY DATA SHEET: CRYSTAL SIMPLE GREEN®

I. PRODUCT & COMPANY INFORMATION

PRODUCT NAME: CRYSTAL SIMPLE GREEN®

OTHER NAMES: CRYSTAL SIMPLE GREEN® - SPECIALIZED CLEANER / DEGREASER
SIMPLE GREEN SAFETY TOWELS (fluid only)

COMPANY NAME: SUNSHINE MAKERS, INC.
15922 Pacific Coast Highway
Huntington Harbour, CA 92649 USA
Telephone: 800-228-0709 • 562-795-6000
Fax: 562-592-3034
Website: www.simplegreen.com

Version No. 4006
Issue Date: January 2002

For 24-hour emergency, call Chem-Tel, Inc.: 800-255-3924

USE OF PRODUCT: A specialized cleaner and degreaser for use in the industrial and institutional workplace..

II. INGREDIENT INFORMATION

The only ingredient of Crystal Simple Green® with established exposure limits is undiluted 2-butoxyethanol (<6%) (Butyl Cellosolve; CAS No. 111-76-2): the OSHA PEL and ACGIH TLV is 25 ppm (skin). Note, however, that Butyl Cellosolve is only one of the raw material ingredients that undergo processing and dilution during the manufacture of Crystal Simple Green®. Upon completion of the manufacturing process, Crystal Simple Green® does not possess the occupational health risks associated with exposure to undiluted Butyl Cellosolve. Verification of this is contained in the independent test results detailed under "Toxicological Information" on Page 3 of this MSDS.

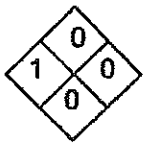
The Butyl Cellosolve in Crystal Simple Green® is part of a chemical category (glycol ethers) regulated by the Emergency Planning and Community Right-to-Know Act (SARA, Title III, section 313); therefore, a reporting requirement exists. Based upon chemical analysis, Crystal Simple Green® contains no known EPA priority pollutants, heavy metals, or chemicals listed under RCRA, CERCLA, or CWA. Analysis by TCLP (Toxicity Characteristic Leaching Procedure) according to RCRA revealed no toxic organic or inorganic constituents.

All components of Crystal Simple Green® are listed on the TSCA Chemical Substance Inventory.

III. HAZARDS IDENTIFICATION

UN Number: Not required
Dangerous Goods Class: Nonhazardous

Hazard Rating (NFPA/HMIS)
Health = 1* Reactivity = 0
Fire = 0 Special = 0



Rating Scale
0 = minimal 1 = slight
2 = moderate 3 = serious
4 = severe

*Mild eye irritant, non-mutagenic and non-carcinogenic. **None of the ingredients in Crystal Simple Green® are regulated or listed as potential cancer agents by Federal OSHA, NTP, or IARC.**

IV. FIRST AID MEASURES

SYMPTOMS OF OVEREXPOSURE AND FIRST AID TREATMENT

Eye contact: Reddening may develop. Immediately rinse the eye with large quantities of cool water; continue 10-15 minutes or until the material has been removed; be sure to remove contact lenses, if present, and to lift upper and lower lids during rinsing. Get medical attention if irritation persists.

Skin contact: Minimal effects, if any; rinse skin with water, rinse shoes and launder clothing before reuse. Reversible reddening may occur in some dermal-sensitive users; thoroughly rinse area and get medical attention if reaction persists.

Swallowing: Essentially non-toxic. Give several glasses of water to dilute; do not induce vomiting. If stomach upset occurs, consult physician.

Inhalation: Non-toxic. Exposures to concentrate-mist may cause mild irritation of nasal passages or throat; remove to fresh air. Get medical attention if irritation persists.

V. FIRE FIGHTING MEASURES

Crystal Simple Green® is stable, not flammable, and will not burn.

Flash Point/Auto-Ignition:	Not flammable.
Flammability Limits:	Not flammable.
Extinguishing Media:	Not flammable/nonexplosive. No special procedures required.
Special Fire Fighting Procedures:	None required.

VI. ACCIDENTAL RELEASE MEASURES

Recover usable material by convenient method; residual may be removed by wipe or wet mop. If necessary, unrecoverable material may be washed to drain with large quantities of water.

VII. HANDLING, STORAGE & TRANSPORT INFORMATION

No special precautions are required. **This product is non-hazardous for storage and transport according to the U.S. Department of Transportation Regulations.** Crystal Simple Green® requires no special labeling or placarding to meet U.S. Department of Transportation requirements.

UN Number:	Not required
Dangerous Goods Class:	Nonhazardous

VIII. EXPOSURE CONTROLS

Exposure Limits: The Crystal Simple Green® formulation presents no health hazards to the user when used according to label directions for its intended purposes. Mild skin and eye irritation is possible (please see Eye contact and Skin contact in Section IV.).

Ventilation: No special ventilation is required during use. Large-scale uses indoors should provide an increased rate of air exchange.

Human Health Effects or Risks from Exposure: Adverse effects on human health are not expected from Crystal Simple Green®, based upon twenty years of use of Simple Green without reported adverse health incidence in diverse population groups, including extensive use by inmates of U.S. Federal prisons in cleaning operations.

Crystal Simple Green® is a mild eye irritant; mucous membranes may become irritated by concentrate-mist.

Crystal Simple Green® is not likely to irritate the skin in the majority of users. Repeated daily application to the skin without rinsing, or continuous contact of Crystal Simple Green® on the skin may lead to temporary, but reversible, irritation.

Medical Conditions Aggravated by Exposure: No aggravation of existing medical conditions is expected; dermal-sensitive users may react to dermal contact by Crystal Simple Green®.

IX. PERSONAL PROTECTION

Precautionary Measures: No special requirements under normal use conditions.
Eye Protection: Caution, including reasonable eye protection, should always be used to avoid eye contact where splashing may occur.
Skin Protection: No special precautions required; rinse completely from skin after contact.
Respiratory Protection: No special precautions required except during large-scale spray applications where spray mist levels are high.
Work and Hygienic Practices: Wash or rinse hands before touching eyes or contact lenses. Follow standard hygienic practices for handling cleaning agents.

X. PHYSICAL AND CHEMICAL PROPERTIES

Appearance/odor::	Clear liquid	Vapor Pressure:	18 mm Hg @ 20 °C; 23.5 mm Hg @ 26 °C
Specific Gravity:	1.020	Vapor Density:	1.3 (air = 1)
pH of concentrate:	9.35	Density:	8.5 lbs./gallon
Evaporation:	>1 (butyl acetate = 1)		
Boiling Point:	100.6 °C (212 °F)		
Freezing Point:	-9 °C (16 °F) If product freezes, it will reconstitute without loss of efficacy when brought back to room temperature and agitated.		

VOC Composite Partial Pressure: 0 mm Hg @ 20 °C
Volatile Organic Compounds (VOCs): 0 g/L per ASTM Method D-2369. Per California AQMD's VOC test method, product must be diluted at least 2 parts of water to 1 part Crystal Simple Green® in order to meet SCAQMD Rule 1171 & Rule 1122 and BAAQMD Regulation 8-16 VOC requirements for solvent cleaning operations.
Water Solubility: Completely soluble in water.
Detection: Crystal Simple Green® has a characteristic odor that is not indicative of any hazardous situation.

XI. STABILITY AND REACTIVITY INFORMATION

Nonreactive. Crystal Simple Green® is stable, even under fire conditions, and will not react with water or oxidizers. Hazardous polymerization will not occur.

XII. TOXICOLOGICAL INFORMATION

The information and conclusions cited in this section are based on data and testing of Simple Green®. The data are directly applicable to Crystal Simple Green® because, except for the fragrance and dyes which have been removed, it contains the same ingredients as Simple Green®.

Nonhuman Toxicity

Acute Mortality Studies:
Oral LD_{50} (rat): >5.0 g/kg body weight // Dermal LD_{50} (rabbit): >2.0 g/kg body weight

Dermal Irritation: Only mild, but reversible, irritation was found in a standard 72-hr test on rabbits. A value of 0.2 (non-irritating) was found on a scale of 8.

Eye Irritation: With or without rinsing with water, the irritation scores in rabbits at 24 hours did not exceed 15 (mild irritant) on a scale of 110.

Subchronic dermal effects: No adverse effects, except reversible dermal irritation, were found in rabbits exposed to Simple Green® (up to 2.0 g/kg/day for 13 weeks) applied to the skin of 25 males and 25 females. Only female body weight gain was affected. Detailed microscopic examination of all major tissues showed no adverse changes.

Fertility Assessment by Continuous Breeding: The Simple Green® formulation had no adverse effect on fertility and reproduction in CD-1 mice with continuous administration for 18 weeks, and had no adverse effect on the reproductive performance of their offspring.

XIII. BIODEGRADABILITY AND ENVIRONMENTAL TOXICITY INFORMATION

Biodegradability:
Like Simple Green®, Crystal Simple Green® is readily decomposed by naturally occurring microorganisms. The biological oxygen demand (BOD), as a percentage of the chemical oxygen demand (COD), after 4, 7, and 11 days was 56%, 60%, and 70%, respectively. Per OECD Closed Bottle Test, Crystal Simple Green® meets OECD and EPA recommendations for ready biodegradability.

In a standard biodegradation test with soils from three different countries, Butyl Cellosolve reached 50% degradation in 6 to 23 days, depending upon soil type, and exceeded the rate of degradation for glucose, which was used as a control for comparison.

Environmental Toxicity Information:
Crystal Simple Green® is considered practically non-toxic per EPA's aquatic toxicity scale.

XIV. DISPOSAL CONSIDERATIONS

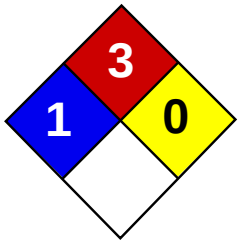
Crystal Simple Green® is fully water soluble and biodegradable and will not harm sewage-treatment microorganisms if disposal by sewer or drain is necessary. Dispose of in accordance with all applicable local, state, and federal laws.

XV. OTHER INFORMATION

Containers:	Crystal Simple Green® residues can be completely removed by rinsing with water; the container may be recycled or applied to other uses.
Contact Point:	Sunshine Makers, Inc., Research and Development Division: 562-795-6000.

***** NOTICE *****

All information appearing herein is based upon data obtained by the manufacturer and recognized technical sources. Judgments as to the suitability of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of this information, Sunshine Makers, Inc. or its distributors extends no warranties, makes no representations and assumes no responsibility as to the suitability of such information for application to purchaser's intended purposes or for consequences of its use.



Material Safety Data Sheet
Hexanes MSDS

Section 1: Chemical Product and Company Identification

Product Name: Hexanes

Catalog Codes: SLH2335, SLH2032

CAS#: 110-54-3

RTECS: MN9275000

TSCA: TSCA 8(b) inventory: Hexane

CI#: Not applicable.

Synonym:

Chemical Name: Hexane

Chemical Formula: C6-H14

Contact Information:

Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396

US Sales: **1-800-901-7247**
International Sales: **1-281-441-4400**

Order Online: ScienceLab.com

CHEMTREC (24HR Emergency Telephone), call:
1-800-424-9300

International CHEMTREC, call: 1-703-527-3887

For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
Hexanes	110-54-3	98.5-99.9

Toxicological Data on Ingredients: Hexane: ORAL (LD50): Acute: 25000 mg/kg [Rat].

Section 3: Hazards Identification

Potential Acute Health Effects:
Hazardous in case of skin contact (permeator), of ingestion, of inhalation. Slightly hazardous in case of skin contact (irritant), of eye contact (irritant).

Potential Chronic Health Effects:
CARCINOGENIC EFFECTS: Not available. MUTAGENIC EFFECTS: Mutagenic for bacteria and/or yeast. TERATOGENIC EFFECTS: Not available. DEVELOPMENTAL TOXICITY: Not available. The substance may be toxic to peripheral nervous system, skin, central nervous system (CNS). Repeated or prolonged exposure to the substance can produce target organs damage.

Section 4: First Aid Measures

Eye Contact:

Check for and remove any contact lenses. Immediately flush eyes with running water for at least 15 minutes, keeping eyelids open. Get medical attention if irritation occurs.

Skin Contact: Wash with soap and water. Cover the irritated skin with an emollient. Get medical attention if irritation develops.

Serious Skin Contact:
Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek medical attention.

Inhalation:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention if symptoms appear.

Serious Inhalation:
Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek medical attention.

Ingestion:
Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention if symptoms appear.

Serious Ingestion: Not available.

Section 5: Fire and Explosion Data

Flammability of the Product: Flammable.

Auto-Ignition Temperature: 225°C (437°F)

Flash Points: CLOSED CUP: -22.5°C (-8.5°F). (TAG)

Flammable Limits: LOWER: 1.15% UPPER: 7.5%

Products of Combustion: These products are carbon oxides (CO, CO2).

Fire Hazards in Presence of Various Substances:
Highly flammable in presence of open flames and sparks, of heat. Non-flammable in presence of shocks.

Explosion Hazards in Presence of Various Substances:
Risks of explosion of the product in presence of mechanical impact: Not available. Risks of explosion of the product in presence of static discharge: Not available.

Fire Fighting Media and Instructions:
Flammable liquid, insoluble in water. SMALL FIRE: Use DRY chemical powder. LARGE FIRE: Use water spray or fog.

Special Remarks on Fire Hazards:
Extremely flammable liquid and vapor. Vapor may cause flash fire.

Special Remarks on Explosion Hazards: Not available.

Section 6: Accidental Release Measures

Small Spill: Absorb with an inert material and put the spilled material in an appropriate waste disposal.

Large Spill:
Flammable liquid, insoluble in water. Keep away from heat. Keep away from sources of ignition. Stop leak if without risk. Absorb with DRY earth, sand or other non-combustible material. Do not get water inside container. Do not touch spilled material. Prevent entry into sewers, basements or confined areas; dike if needed. Call for assistance on disposal. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

Section 7: Handling and Storage

Precautions:
Keep locked up.. Keep away from heat. Keep away from sources of ignition. Ground all equipment containing material. Do not ingest. Do not breathe gas/fumes/ vapor/spray. Avoid contact with skin. Wear suitable protective clothing. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Keep away from incompatibles such as oxidizing agents.

Storage:
Store in a segregated and approved area. Keep container in a cool, well-ventilated area. Keep container tightly closed and sealed until ready for use. Avoid all possible sources of ignition (spark or flame).

Section 8: Exposure Controls/Personal Protection

Engineering Controls:
Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapors below their respective threshold limit value. Ensure that eyewash stations and safety showers are proximal to the work-station location.

Personal Protection:
Safety glasses. Lab coat. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Gloves (impervious).

Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Vapor respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits:
TWA: 500 (ppm) from OSHA (PEL) [United States] Inhalation TWA: 1800 (mg/m3) from OSHA (PEL) [United States] Inhalation TWA: 176 (mg/m3) from ACGIH (TLV) [United States] SKIN TWA: 50 (ppm) from ACGIH (TLV) [United States] SKIN TWA: 500 STEL: 1000 (ppm) from ACGIH (TLV) [United States] Inhalation TWA: 1760 STEL: 3500 (mg/m3) from ACGIH (TLV) [United States] Inhalation Consult local authorities for acceptable exposure limits.

Section 9: Physical and Chemical Properties

Physical state and appearance: Liquid.

Odor: Gasoline-like or petroleum-like (Slight.)

Taste: Not available.

Molecular Weight: 86.18g/mole

Color: Clear Colorless.

pH (1% soln/water): Not applicable.

Boiling Point: 68°C (154.4°F)

Melting Point: -95°C (-139°F)

Critical Temperature: Not available.

Specific Gravity: 0.66 (Water = 1)

Vapor Pressure: 17.3 kPa (@ 20°C)

Vapor Density: 2.97 (Air = 1)

Volatility: Not available.

Odor Threshold: 130 ppm

Water/Oil Dist. Coeff.: The product is more soluble in oil; log(oil/water) = 3.9

Ionicity (in Water): Not available.

Dispersion Properties: See solubility in water, diethyl ether, acetone.

Solubility:
Soluble in diethyl ether, acetone. Insoluble in cold water, hot water.

Section 10: Stability and Reactivity Data

Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability: Heat, ingnition sources, incompatibles.

Incompatibility with various substances: Reactive with oxidizing agents.

Corrosivity: Not available.

Special Remarks on Reactivity: Hexane can react vigorously with strong oxidizers (e.g. chlorine, bromine, fluorine)

Special Remarks on Corrosivity: Not available.

Polymerization: Will not occur.

Section 11: Toxicological Information

Routes of Entry: Absorbed through skin. Dermal contact. Inhalation. Ingestion.

Toxicity to Animals:
WARNING: THE LC50 VALUES HEREUNDER ARE ESTIMATED ON THE BASIS OF A 4-HOUR EXPOSURE. Acute oral toxicity (LD50): 25000 mg/kg [Rat]. Acute toxicity of the gas (LC50): 48000 ppm 4 hours [Rat].

Chronic Effects on Humans:
MUTAGENIC EFFECTS: Mutagenic for bacteria and/or yeast. May cause damage to the following organs: peripheral nervous system, skin, central nervous system (CNS).

Other Toxic Effects on Humans:
Very hazardous in case of ingestion, of inhalation. Hazardous in case of skin contact (permeator). Slightly hazardous in case of skin contact (irritant).

Special Remarks on Toxicity to Animals: Not available.

Special Remarks on Chronic Effects on Humans:
May cause adverse reproductive effects based on animal data. May be tumorigenic based on animal data. May affect genetic material. Passes through the placental barrier in animal.

Special Remarks on other Toxic Effects on Humans:
Acute Potential Health Effects: Skin: May cause mild skin irritation. It can be absorbed through the skin in harmful amounts. Eyes: May cause mild eye irritation. Inhalation: May be harmful if inhaled. Inhalation of vapors may cause respiratory tract irritation. Overexposure may affect, brain, spinal cord, behavior/central and peripheral nervous systems (lightheadness, dizziness, hallucinations, paralysis, blurred vision, memory loss, headache, euphoria, general anesthetic, muscle weakness, numbness of the extremeties, asphyxia, unconciousness and possible death), metabolism, respiration, blood, cardiovascular system, gastrointestinal system (nausea) Ingestion: May be harmful if swallowed. May cause gastrointestinal tract irritation with abdominal pain and nausea. May also affect the liver, blood, brain, peripheral and central nervous systems. Symptoms of over exposure by ingestion are similar to that of overexposure by inhalation.

Section 12: Ecological Information

Ecotoxicity: Not available.

BOD5 and COD: Not available.

Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The product itself and its products of degradation are not toxic.

Special Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

Waste Disposal:
Waste must be disposed of in accordance with federal, state and local environmental control regulations.

Section 14: Transport Information

DOT Classification: CLASS 3: Flammable liquid.

Identification: : Hexane UNNA: 1208 PG: II

Special Provisions for Transport: Not available.

Section 15: Other Regulatory Information

Federal and State Regulations:
Connecticut hazardous material survey.: Hexanes Illinois toxic substances disclosure to employee act: Hexanes Illinois chemical safety act: Hexanes New York release reporting list: Hexanes Rhode Island RTK hazardous substances: Hexanes Pennsylvania RTK: Hexanes Florida: Hexanes Minnesota: Hexanes Massachusetts RTK: Hexanes Massachusetts spill list: Hexanes New Jersey: Hexanes New Jersey spill list: Hexanes Louisiana spill reporting: Hexanes TSCA 8(b) inventory: Hexanes SARA 313 toxic chemical notification and release reporting: Hexanes CERCLA: Hazardous substances.: Hexanes: 5000 lbs. (2268 kg)

Other Regulations:
OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200). EINECS: This product is on the European Inventory of Existing Commercial Chemical Substances.

Other Classifications:

WHMIS (Canada):
CLASS B-2: Flammable liquid with a flash point lower than 37.8°C (100°F). CLASS D-2B: Material causing other toxic effects (TOXIC).

DSCL (EEC):
R11- Highly flammable. R20- Harmful by inhalation. R38- Irritating to skin. R51/53- Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment. R62- Possible risk of impaired fertility. R65- Harmful: may cause lung damage if swallowed. R67- Vapors may cause drowsiness or dizziness. S9- Keep container in a well-ventilated place. S16- Keep away from sources of ignition - No smoking. S29- Do not empty into drains. S33- Take precautionary measures against static discharges. S36/37- Wear suitable protective clothing and gloves. S61- Avoid release to the environment. Refer to special instructions/Safety data sheets. S62- If swallowed, do not induce vomiting: seek medical advice immediately and show this

HMIS (U.S.A.):

Health Hazard: 2

Fire Hazard: 3

Reactivity: 0

Personal Protection: g

National Fire Protection Association (U.S.A.):

Health: 1

Flammability: 3

Reactivity: 0

Specific hazard:

Protective Equipment:
Gloves (impervious). Lab coat. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate. Safety glasses.

Section 16: Other Information

References: Not available.

Other Special Considerations: Not available.

Created: 10/10/2005 08:19 PM

Last Updated: 06/09/2012 12:00 PM

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APPENDIX F

Incident Reporting

INCIDENT REPORT FORM

Please attach photographs relating to the incident if possible.

Report No. _____

Site: _____ Project No. _____

Location: _____

Date of Report: _____ Preparer's Name: _____

Name and Address of Injured: _____

Date of Birth _____ Date of Hire: _____ Title/Classification: _____

Division/Department _____ Date of Accident _____ Time: _____

Accident Category: ___ Motor Vehicle ___ Property Damage ___ Fire
___ Chemical Exposure ___ Near Miss ___ Other

Severity of Injury or Illness: ____ Non-disabling ___ Disabling
____ Medical Treatment ___ Fatality

Amount of Damage: $_____ Property Damaged: _____

Estimated Number of Days Away from Job: _____

Nature of Injury or Illness: _____

CLASSIFICATION OF INJURY:

____ Fractures	____ Heat Burns	____ Cold Exposure
____ Dislocations	____ Chemical Burns	____ Frostbite
____ Sprains	____ Radiation Burns	____ Heat Stroke
____ Abrasions	____ Bruises	____ Heat Exhaustion
____ Lacerations	____ Blisters	____ Concussion
____ Punctures	____ Toxic Respiratory Exposure	____ Faint/Dizziness
____ Bites	____ Toxic Ingestions	____ Toxic Respiratory
____ Toxic Ingestions	____ Dermal Allergy	

Part of Body Affected: _____

Degree of Disability: _____

Date Medical Care Was Received: _____

Where Medical Care Was Received: _____

Address (if off site): _____

Causative agent most directly related to accident (object substance, material, machinery, equipment conditions):

_____

_____

Was weather a factor? _____

Unsafe mechanical/physical/environmental condition at time of accident (be specific):

_____

Unsafe act by injured and/or others contributing to the accident (be specific, must be answered):

Personal factors (improper attitude, lack of knowledge or skill, slow reaction, fatigue):

Level of personal protection equipment required in Site Safety Plan: _____

Modifications: _____

Was injured using required equipment? _____

If not, how did actual equipment use differ from plan? _____

What can be done to prevent a recurrence of this type of accident (modification of machine; mechanical guards; correct environment training):

Detailed narrative description (how did accident occur, why; objects, equipment, tools used, circumstance assigned duties) (be specific):

(Use separate sheet as required)

Witnesses to accident _____

Signature of Preparer _____

Signature of Site Leader _____