FINAL
QUALITY ASSURANCE PROJECT PLAN

Stratford Army Engine Plant Tidal Flats Feasibility Study
Stratford, Connecticut

Contract No.: W912WJ-15-D-0003
Delivery Order No.: 0003

***Prepared* for:**

New England District
U.S. Army Corps of Engineers
696 Virginia Road
Concord, MA 01742-2751

Prepared by:

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511 Congress Street, Suite 200
Portland, Maine 04101

Project No. 3616176064

Revision 1

Final

January 10, 2018

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ACRONYMS

ADR	Automated Data Review
AES	atomic emission spectroscopy
Amec Foster Wheeler	Amec Foster Wheeler Environment & Infrastructure, Inc.
ASTM	American Society for Testing and Materials
bgs	Below Ground Surface
CA	Corrective Action
CCB	Continuing Calibration Blank
CCV	Continuing Calibration Verification
°C	Degrees Celsius
CENAE	United States Army Corps of Engineers, New England District
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CIH	Certified Industrial Hygienist
COB	Close of Business
COC	Chain-of-Custody
CQM	Certified Quality Manager
CSP	Certified Safety Professional
CT DEEP	Connecticut Department of Energy and Environmental Protection
CVAA	Cold Vapor Atomic Absorption Spectroscopy
CVAF	Cold Vapor Atomic Fluorescence
DP	Duplicate
DQI	Data Quality Indicator
ECD	Electron Capture Detector
EDD	Electronic Data Deliverable
EQAPP	Electronic Quality Assurance Project Plan
FDR	Field Data Record
FID	Flame Ionization Detector
FOL	Field Operations Lead
FS	Feasibility Study
FSP	Field Sampling Plan
GC	Gas Chromatography
GFAA	Graphite Furnace/Atomic Absorption
GC/MS	Gas Chromatograph/Mass Spectrometer
GPC	Gel Permeation Chromatography

HAZWOPER	Hazardous Waste Operations and Emergency Response
ICAL	Initial Calibration
ICB	Initial Calibration Blank
ICP/MS	Inductively Coupled Plasma Mass Spectroscopy
ICV	Initial Calibration Verification
ID	Identification
LCS	Laboratory Control Sample
LK	Lloyd Kahn
LOD	Level of Detection
LOQ	Level of Quantitation
MDL	Method Detection Limit
µg/kg	micrograms per kilogram
MS	Matrix Spike
MSD	Matrix Spike Duplicate
NA	Not Applicable
NTCRA	Non-time Critical Removal Action
NELAP	National Environmental Laboratory Accreditation Program
No.	Number
OPSEC	Operations Security Training
OSHA	Occupational Safety and Health Administration
oz.	Ounce
PCB	Polychlorinated Biphenyl
PDQO	Project Data Quality Objective
PM	Project Manager
ppm	parts per million
PQL	Project Quantitation Limit
PRG	Project Remediation Goal
PWS	Performance Work Statement
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
QL	Quantitation Limit
QSM	Quality Systems Manual
%R	Percent Recovery
RADBS	Relational Access Data Base
RCRA	Resource Conservation and Recovery Act
RL	Reporting Limit
RPD	Relative Percent Difference

RSD	Relative Standard Deviation
SAEP	Stratford Army Engine Plant
SB	Soil Boring
SD	Sediment Sample
SEDD	Staged Electronic Data Deliverable
SOP	Standard Operating Procedure
SPCC	System Performance Check Compounds
SPLP	Synthetic Precipitation Leaching Procedure
SS	Surface Soil
SSHP	Site Safety and Health Plan
SVOC	Semi-Volatile Organic Compounds
SW	Surface Water
TAL	Target Analyte List
TBD	To Be Determined
TCLP	Toxic Characteristic Leaching Procedure
TED	Technical Environmental Database
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbon
TSA	Technical Systems Audit
UFP-QAPP	Uniform Federal Policy for Quality Assurance Project Plans
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound

1.0 INTRODUCTION

This Quality Assurance Project Plan (QAPP) has been prepared for the Stratford Army Engine Plant (SAEP) Feasibility Study (FS), (Project) in Stratford, Connecticut (**Figure 1-1**), on behalf of United States Army Corps of Engineers (USACE), New England District (herein referred to as CENAE) by Amec Foster Wheeler.

The QAPP has been prepared in conjunction with the Field Sampling Plan (FSP) (Amec Foster Wheeler, 2018) for the Project, and is consistent with the requirements identified in Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP). The FSP (Amec Foster Wheeler, 2018), defines the overall objectives of the investigation, outlines the tasks to be completed, and provides protocols to be followed while conducting the investigation. The Site-Specific Safety and Health Plan (SSHP) (Amec Foster Wheeler, 2017) defines the health and safety protocols and considerations associated with the Project. Together, these three documents define the organization, investigation objectives, health and safety plan elements, and specific quality assurance/quality control (QA/QC) procedures that will be implemented for this Project.

The QAPP describes the applicable analytical methods and measurements, QA/QC protocols, and data assessment procedures for data evaluation and the identification (ID) of any data limitations. The scope of this QAPP is limited to investigation activities specified in the FSP (Amec Foster Wheeler, 2018). Proposed additions or changes to the requirements in the approved QAPP will be documented in a QAPP revision and submitted for review and approval.

The Project, referred to as Area of Concern 52 (AOC 52) Facility Outfalls 001 through 007, and associated Tidal Flats, is identified as Resource Conservation and Recovery Act (RCRA) Stewardship Permit, United States Environmental Protection Agency (USEPA) ID No. CTD001181502, Permit No. DEP/HWM/CS-134-003. The Project is located east of Main Street and north of Sniffens Lane, in Stratford, Connecticut (**Figure 1-1**). Additional information regarding the Project and the FS activities is provided in the FSP (Amec Foster Wheeler, 2018).

2.0 PROJECT MANAGEMENT AND OBJECTIVES

Worksheet #1 Title and Approval Page

Site Name/Project Name: Stratford Army Engine Plant
Site Location: 550 South Main Street, Stratford, Fairfield County, Connecticut

Document Title: Quality Assurance Project Plan

Lead Organization: CENAE

Preparer's Name and Organizational Affiliation: Wolfgang Calicchio, Amec Foster Wheeler

Preparer's Address, Telephone No., and E-mail Address: 511 Congress Street, Suite 200, Portland, ME 04101/207-775-5401 ext. 3466/wolfgang.calicchio@amecfw.com

Preparation Date (Day/Month/Year): May 17, 2017

Investigative Organization's Project Manager (PM)/Date: J. Roderick Pendleton
Signature
Printed Name/Organization: Rod Pendleton/Amec Foster Wheeler

Investigative Organization's Project QA Officer/Date: Tony Delano
Signature
Printed Name/Organization: Tony Delano/Amec Foster Wheeler

Lead Organization's PM/Date: ______________________________
Signature
Printed Name/Organization: Ellen Iorio/CENAE

Approval Signatures/Date: ______________________________
Signature
Printed Name/Title: ______________________________

Approval Authority: ______________________________

Other Approval Signatures/Date: ______________________________
Signature
Printed Name/Title: ______________________________

Worksheet #2 QAPP Identifying Information

Site Name/Project Name: Stratford Army Engine Plant Tidal Flats – Feasibility Study	**Title:** Quality Assurance Project Plan
Site Location: 550 South Main Street, Stratford, Fairfield County, Connecticut	**Revision Number:** 0 (Draft)
Site Number/Code: EPA #CTD001181502	**Revision Date:**
Operable Unit: All Sites	
Contractor Name: Amec Foster Wheeler, Environment & Infrastructure, Inc.	
Contractor Number: N/A	
Contract Title: N/A	
Work Assignment Number: W912WJ-15-D-003	

1. **Identify regulatory program:** Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

2. **Identify approval entity:** CENAE

3. **The QAPP is (select one):** ☐Generic ✓Project Specific

4. **List dates of scoping sessions that were held:** February 21, 2017 site visit at SAEP facility with CENAE, and a February 22, 2017 meeting with CENAE and Connecticut Department of Energy and Environmental (CT DEEP). The provisions for the scope of this work and level of effort are established based on these meetings and the following documents:

   - CENAE Revised Performance Work Statement (PWS) 28 February 2017
   - Amec Foster Wheeler Final Proposal for Revised PWS March 02, 2017
   - Project Status Meeting at CENAE May 1, 2017

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

Title	Approval Date
Not Applicable	Not Applicable

6. **List organizational partners (stakeholders) and connection with lead organization:**

   - CENAE – Client
   - Amec Foster Wheeler Environment & Infrastructure, Inc. – Contractor
   - Town of Stratford Connecticut – Representing the affected community
   - CT DEEP – Regulatory oversight
   - USEPA Region 1 – Regulatory oversight

7. List data users:

- Amec Foster Wheeler
- USACE – New England District (CENAE)

8. 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 exclusions below:

All elements included - not applicable.

Worksheet #2 QAPP Identifying Information

Required QAPP Element(s) and Corresponding QAPP Section(s)	Required Information	Crosswalk to Related Documents
2.0 Project Management and Objectives		
2.1 Project Management and Objectives	- Title and Approval Page	Worksheet #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	- Table of Contents - QAPP Identifying Information	The Table of Contents is provided following the QAPP cover page. Worksheet #2 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	- Distribution List - Project Personnel Sign-Off Sheet	Worksheet #3 Distribution List and Worksheet #4 Project Personnel Sign-Off
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	- Project Organizational Chart - Communication Pathways - Personnel Responsibilities and Qualifications Table - Special Personnel Training Requirements Table	Worksheet #5 Project Organization Chart, Worksheet #6 Communication Pathways, Worksheet #7 Personnel Responsibilities and Qualifications, and Worksheet #8 Special Personnel Training Requirements
2.5 Project Planning/Problem Definition 2.5.1 Project Planning (Scoping) 2.5.2 Problem Definition, Site History, and Background	- Project Planning Session Documentation (including Data Needs tables) - Project Scoping Session Participants Sheet - Problem Definition, Site History, and Background - Site Maps (historical and present)	Worksheet #9 Project Team Planning Sessions Participants Sheet and Worksheet #10 Problem Definition for Project Data Quality Objectives Site history and more details can be found in the Sediment Endpoints Report, 2017.

Worksheet #2 QAPP Identifying Information

Required QAPP Element(s) and Corresponding QAPP Section(s)	Required Information	Crosswalk to Related Documents
2.6 Project Data Quality Objectives (PDQOs) and Measurement Performance Criteria 2.6.1 Development of Project Quality Objectives Using the Systematic Planning Process 2.6.2 Measurement Performance Criteria	- Site-Specific PDQOs - Measurement Performance Criteria Table	Worksheet #11 Project Quality Objectives/Systematic Planning Process Statements and Worksheet #12 Measurement Performance Criteria for Project Analytes Details concerning the project objectives can be found in the Performance Work Statement, February 28, 2017 and the Amec Foster Wheeler Proposal, March 02, 2017
2.7 Secondary Data Evaluation	- Sources of Secondary Data and Information - Secondary Data Criteria and Limitations Table	Worksheet #13 Secondary Data Criteria and Limitations
2.8 Project Overview and Schedule 2.8.1 Project Overview 2.8.2 Project Schedule	- Summary of Project Tasks - Reference Limits and Evaluation Table - Project Schedule/Timeline Table	Worksheet #14 Summary of Project Tasks, Worksheets #15-1 through 15-9 Reference Limits and Evaluation for specific monitoring activities and Worksheet #16 Project Schedule/Timeline
3.0 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	- Sampling Design and Rationale - Sample Location Map - Sampling Locations and Methods/Standard Operating Procedure (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	Worksheet #17 Sampling Design and Rationale, Worksheet #18 Sampling Locations and Methods/SOP Requirements for the project (see Appendix A and Appendix B), Worksheet #19 Analytical SOP Requirements (see Appendix B), Worksheet #20 Field Quality Control Sample Summary Table, Worksheet #21 Project Sampling SOP References Table and Worksheet #22 Field Equipment Calibration, Maintenance, Testing and Inspection

Worksheet #2 QAPP Identifying Information

Required QAPP Element(s) and Corresponding QAPP Section(s)	**Required Information**	**Crosswalk to Related Documents**
Procedures 3.2 Analytical Tasks 3.2.1 Analytical SOPs 3.2.2 Analytical Instrument Calibration Procedures 3.2.3 Analytical Instrument and Equipment Maintenance, Testing, and Inspection Procedures 3.2.4 Analytical Supply Inspection and Acceptance Procedures	- Analytical SOPs - Analytical SOP References Table - Analytical Instrument Calibration Table - Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table	Worksheet #23 Analytical SOP References, Worksheet #24 Analytical Instrument Calibration, and Worksheet #25 Analytical Instrument and Equipment Maintenance, Testing, and Inspection Analytical SOPs can be found in Appendix B.
3.3 Sample Collection Documentation, Handling, Tracking, and Custody Procedures 3.3.1 Sample Collection Documentation 3.3.2 Sample Handling and Tracking System 3.3.3 Sample Custody	- Sample Collection Documentation Handling, Tracking, and Custody SOPs - Sample Container Identification - Sample Handling Flow Diagram - Example Chain-of-Custody Form and Seal	Worksheet #26 Sample Handling System and Worksheet #27 Sample Custody Requirements More details concerning the field sampling procedures can be found in Appendix A and Appendix B). An example of the Chain-of-Custody (COC) form can be found in Appendix D
3.4 Quality Control Samples 3.4.1 Sampling Quality Control Samples 3.4.2 Analytical Quality Control Samples	- QC Samples Table - Screening/Confirmatory Analysis Decision Tree	Worksheets #28 presents QC sample information for project analytes
3.5 Data Management Tasks 3.5.1 Project Documentation and Records 3.5.2 Data Package Deliverables 3.5.3 Data Reporting Formats 3.5.4 Data Handling and Management 3.5.5 Data Tracking and Control	- Project Documents and Records Table - Analytical Services Table - Data Management SOPs	Worksheet #29 Project Documents and Records and Worksheet #30 Analytical Services See Worksheet #14 for the Data management Plan
4.0 Assessment/Oversight		
4.1 Assessments and Response Actions 4.1.1 Planned Assessments 4.1.2 Assessment Findings and Corrective Action Responses	- Assessments and Response Actions - Planned Project Assessments Table - Audit Checklists - Assessment Findings and Corrective Action Responses Table	Worksheet #31 Planned Project Assessments and Worksheet #32 Assessment Findings and Corrective Action Responses
4.2 QA Management Reports	- QA Management Reports Table	Worksheet #33 QA Management Reports
4.3 Final Project Report		

Worksheet #2 QAPP Identifying Information

Required QAPP Element(s) and Corresponding QAPP Section(s)	Required Information	Crosswalk to Related Documents
5.0 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	- Verification (Step I) Process Table - Validation (Steps IIa and IIb) Process Table - Validation (Steps IIa and IIb) Summary Table - Usability Assessment	Worksheet #34 Verification (Step I) Process, Worksheet #35 Validation (Steps IIa and IIb) Process, Worksheet #36 Validation (Steps IIa and IIb) Summary, and Worksheet #37 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	None	NA

Worksheet #3 Distribution List

Worksheet #3 Distribution List

QAPP Recipients	Title	Organization	Telephone Number	Mobile Number	E-mail Address
Ellen Iorio	PM	CENAE	978-318-8194		ellen. iorio@usace.army.mil
James Kelly	Technical Lead Engineer	CENAE	978-318-8227	Redacted - Privacy Act	james.a.kelly@usace.army.mil
Jeffrey Pickett	Program Manager	Amec Foster Wheeler	207-828-3661	Redacted - Privacy Act	jeffrey.pickett@amecfw.com
Rod Pendleton	PM	Amec Foster Wheeler	207-828-3605	Redacted - Privacy Act	rod.pendleton@amecfw.com
Tony Delano	Associate Engineer	Amec Foster Wheeler	978-392-5319	Redacted - Privacy Act	tony.delano@amecfw.com
Rebecca Brosnan	Project Scientist	Amec Foster Wheeler	207-828-2635		rebacca.brosnan@amecfw.com
Michael Lounsbury	Field Operations Lead (FOL)	Amec Foster Wheeler	207-828-3537		michael.lounsbury@amecfw.com
Wolfgang Calicchio	Project Chemist	Amec Foster Wheeler	207-828-3466	Redacted - Privacy Act	wolfgang.calicchio@amecfw.com
Karen Furey	Project Administrator	Amec Foster Wheeler	207-828-3464		karen.furey@amecfw.com
Maria Peters	Project Accountant	Amec Foster Wheeler	610-877-6128		maria.peters@amecfw.com
Russ Foster	QA Manager	Envirosystems, Inc.	603-926-3345		rfoster@envirosystems.com
Kirk Cram	PM	EnviroSytems, Inc. Laboratory	603-926-3345		kcram@envirosystems.com

Worksheet #4 Project Personnel Sign-Off Sheet

Worksheet #4 Project Personnel Sign-Off Sheet

Organization: CENAE

Project Personnel	Title	Telephone Number	Signature	Date QAPP Read
Ellen Iorio	PM	978-318-8194		
James Kelly	Technical Lead Engineer	978-318-8227		

Organization: Amec Foster Wheeler Environment & Infrastructure, Inc.

Project Personnel	Title	Telephone Number	Signature	Date QAPP Read
Jeffrey Pickett	Program Manager	207-828-3661		August 4, 2017
Rod Pendleton	PM	207-828-3605	J. Roderick Pendleton	August 3, 2017
Tony Delano	Engineering Study Lead	978-392-/5319	Tony	August 4, 2017
Wolf Calicchio	Project Chemist	207-828-3466		August 4, 2017
Michael Lounsbury	Field Operations Lead	207-828-3537		August 4, 2017
Binks Colby-George	Project Data Manager	207-828-3650		August 4, 2017

Worksheet #4 Project Personnel Sign-Off Sheet

Organization: EnviroSystems, Inc.

Project Personnel	Title	Telephone Number	Signature	Date QAPP Read
Kirk Cram	Laboratory PM	603-926-3345		
Russ Foster	Laboratory Quality Assurance Officer	603-926-3345		

Worksheet #4 Project Personnel Sign-Off Sheet

Organization: Kemron Environmental Services, Inc.

Project Personnel	Title	Telephone Number	Signature	Date QAPP Read
Tommy Jordan	PM	404-636-0928		

Worksheet #4 Project Personnel Sign-Off Sheet

Organization: TG&B Marine

Project Personnel	Title	Telephone Number	Signature	Date QAPP Read
Mark Avakian	PM	508-326-3686		

Worksheet #5 Project Organizational Chart

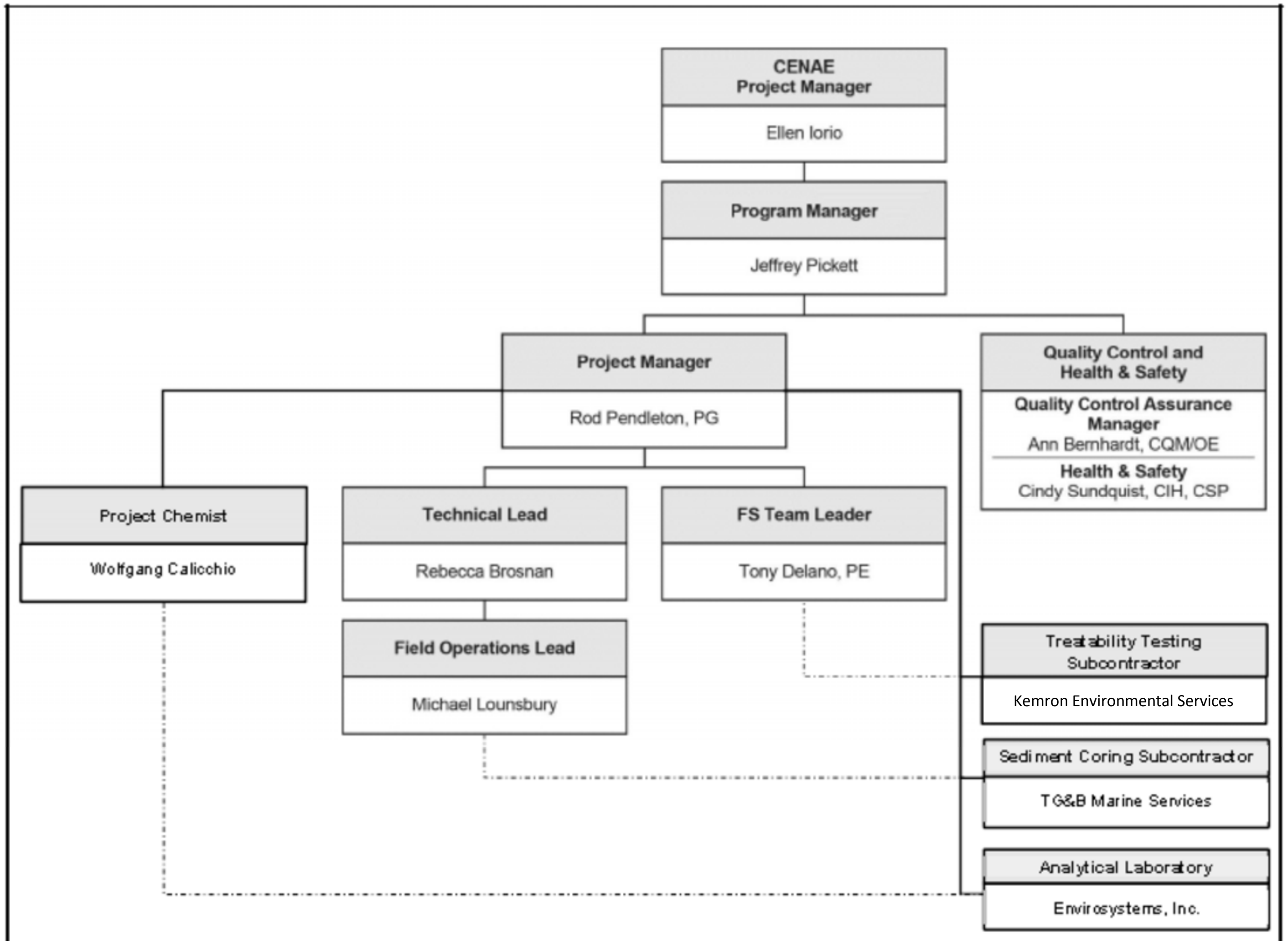

FIGURE 3-1
PROJECT ORGANIZATIONAL CHART

Worksheet #6 Communication Pathways

Worksheet #6 Communication Pathways

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathways, etc.)
Client	CENAE PM	Ellen Iorio	978-318-8433	As client, will coordinate overall scope of the project, with authority regarding all decisions
Manage all Project Phases	Amec Foster Wheeler PM	Rod Pendleton	207-828-3605/ Redacted - Privacy Act	Will serve as Amec Foster Wheeler liaison to CENAE Notify CENAE of field-related problems that may impact progress, data, or other Project objectives by phone or email by Close of Business (COB) the next business day.
Daily Field Progress Reports	FOL	Michael Lounsbury	207-828-3537	Mike will provide daily progress reports to Rod Pendleton by phone or e-mail by the end of each day.
QAPP Amendments	CENAE Technical Lead	James Kelly	978-318-8227	Any major changes to the QAPP must be approved by James Kelly before the changes can be implemented.
QAPP changes in the field	FOL	Michael Lounsbury	207-828-3537	Mike will notify Rod Pendleton and William Colby-George by phone of changes to QAPP made in the field and the reasons prior to changes being implemented.
QAPP/Sample discrepancies	Project Chemist	Wolf Calicchio	207-828-3537	Wolf will notify Rod Pendleton and William Colby-George of any QA/QC issues with project field samples by phone as soon as discrepancy is identified.

Worksheet #6 Communication Pathways

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathways, etc.)
Sample discrepancies	Project Database Manager	William Colby-George	207-828-3650	William will report all QA/QC issues with project field samples to analytical laboratory by phone or e-mail by COB the next day (day after samples were submitted).
Lab Data QA Issues	Laboratory QA Manager	Russ Foster	603-926-3345	The analytical laboratory PM will notify Wolf Calicchio and Rod Pendleton of all QA/QC issues with project field samples as soon as issues are identified.
Field and Analytical Corrective Actions	Amec Foster Wheeler Quality Assurance Officer and Database Manager	Wolf Calicchio and Rod Pendleton	207-828-3466 / 207-828-3605	The need for corrective action for field and analytical issues will be determined by Wolf Calicchio and Rod Pendleton.
Release of Analytical Data to Amec Foster Wheeler	Laboratory PM	Kirk Cram	603-926-3345	No analytical data will be released until the data has been processed in Automated Data Review (ADR.NET) and the corrective actions taken as appropriate.
Data Reviewer/Release of Analytical Data for Project Reports	Amec Foster Wheeler	William Colby-George	207-828-3650	William will perform data verification using ADR.NET and confirm the data is of useable quality.

Worksheet #7 Personnel Responsibilities and Qualifications Tables

Worksheet #7 Personnel Responsibilities and Qualification Table

Name	Title	Organizational Affiliation	Responsibilities	Education and Experience Qualifications
Ellen Iorio	PM	CENAE	Responsible for the overall management of FS • Responsible for leading activities designed to meet objectives of the FS tasks; • Responsible for providing review and approval of deliverables; and • Responsible for approval of project documents and reports.	Designated as the CENAE Project Site Manager
Jeffrey Pickett	Program Manager	Amec Foster Wheeler	• Manage the overall quality of the project; and • Ensure that the necessary resources are made available to the Amec Foster Wheeler PM for execution of the work.	Designated Amec Foster Wheeler Program Manager
James Kelly	Technical Lead	CENAE	• Responsible for communication with Amec Foster Wheeler PM regarding project status, schedule, changes to scope of work; • Responsible for review of work products from Amec Foster Wheeler's work; and • Reports directly to CENAE.	

Worksheet #7 Personnel Responsibilities and Qualification Table

Name	Title	Organizational Affiliation	Responsibilities	Education and Experience Qualifications
Rod Pendleton	PM	Amec Foster Wheeler	Oversees all aspects of the project and responds to CENAE PM. Mr. Pendleton is responsible for technical, financial, and scheduling matters, and serves as the main contact with the CENAE. He is also responsible for: • Adhering to project plans and obtaining approvals for any changes to these plans; • Reviewing and approving all sampling procedures; • Assigning duties to and orienting project staff to the specific needs and requirements of the project; • Serving as the focus for coordination of project field task activities, communications, reports, and technical reviews, and other support functions; • Coordinating field and office activities with the Project Database Manager and the Project FOL; • Monitoring schedules for field, analytical, and data review activities associated with the field sampling program; • Implementing recommendations made by the Project Database Manager; • Initiating corrective actions; • Reviewing and approving deliverables prepared for submission to CENAE in fulfillment of Amec Foster Wheeler requirements under the PWS; and • Maintaining the project file.	Designated Amec Foster Wheeler PM Professional Geologist

Worksheet #7 Personnel Responsibilities and Qualification Table

Name	Title	Organizational Affiliation	Responsibilities	Education and Experience Qualifications
Tony Delano	Feasibility Study – Professional Engineer/Technical Engineering	Amec Foster Wheeler	As FS Technical Lead, Mr. Delano is responsible for providing senior technical guidance and direction during the FS including: • Leading the FS and cost estimating; • Providing technical oversight of project deliverables during their preparation; • Reviewing and approving Amec Foster Wheeler deliverables in conjunction with the PM; and • Delivering project work and deliverables that meet the project objectives.	Professional Engineer
Michael Lounsbury	Project FOL	Amec Foster Wheeler	Amec Foster Wheeler's Michael Lounsbury is the Project Field Operations Leader for the FS tasks. As a field lead, Mr. Lounsbury is responsible for leading the field activities in accordance with the FSP and QAPP to meet the objectives of the FS tasks, and is the communication link between the field team, subcontractors, Amec Foster Wheeler FS Technical Leads, and Amec Foster Wheeler PM. As field lead, Mr. Lounsbury is responsible for: • Reviewing and understanding the FSP and the QAPP prior to commencement of field activities at the Project; • Implementing the FSP and QAPP; • Coordinating field activities with Amec Foster Wheeler and subcontractor field staff to make staff aware of the overall project objectives, specific project activities to be accomplished, and specific sampling and analysis requirements for each task to be performed; • Assigning specific duties to field team members and training field staff as necessary; • Ensuring site security and access; • Coordinating calibration of all field instruments to be used for measurement of field parameters using certified calibration standards and gases and proper recording of the results; • Overseeing field work to verify proper procedures are followed during data collection;	Designated Amec Foster Wheeler Project FOL

Worksheet #7 Personnel Responsibilities and Qualification Table

Name	Title	Organizational Affiliation	Responsibilities	Education and Experience Qualifications
			• Creating and maintaining the Project field logbook; • Creating, distributing, and tracking of all other field logbooks; • Using, reviewing, and filing Field Data Records (FDRs); • Mobilizing and demobilizing the field team and subcontractors; • Resolving any logistical problems that could potentially hinder field activities, such as equipment malfunctions or availability, personnel scheduling, or weather-dependent working conditions; • Implementing field QC including issuance and tracking of measurement and test equipment; supervision of the proper labeling, handling, storage, and shipping of samples including chain-of-custody procedures and control of field documentation; • Reviewing FDRs at the completion of each day's sampling event to determine if the sampling event has been recorded properly, and if the required information is present and recorded accurately; • Confirming that the planned sampling task has been completed in accordance with the FSP to include the number and location of samples, the field measurements, and requested laboratory analyses; • interpreting data acquired during field work; and • Supporting FS report preparation.	
Ann Bernhardt	Quality Control/Assurance Manager	Amec Foster Wheeler	• Corporate Quality Control Officer	Amec Foster Wheeler, CQM
Cynthia Sundquist	Health & Safety Manager	Amec Foster Wheeler	• Corporate Health and Safety	Amec Foster Wheeler, CIH, CSP

Worksheet #7 Personnel Responsibilities and Qualification Table

Name	Title	Organizational Affiliation	Responsibilities	Education and Experience Qualifications
William Colby-George	Project Database Manager	Amec Foster Wheeler	As the Amec Foster Wheeler Project Database Manager, Mr. Colby-George is responsible for establishing and maintaining the project database, and overseeing the data reduction and review process. He will work closely with the contracted Laboratory PM to track and complete the data review and reduction process by: • Developing and obtaining approval for the comprehensive ADR library files for the project; • Processing the contract laboratory's Staged Electronic Data Deliverables (SEDD) through ADR Software; • Coordinating with the contract laboratory to correct errors and re-submit files as necessary; • Loading files into the Amec Foster Wheeler copy of USACE Relational Access Database (RADBS); • Posting the ADR files A1 through A6, a database file from the RADBS, and associated field data, to the USACE ftp site (or equivalent); • Loading the standard ADR output files into Amec Foster Wheeler's Technical Environmental Database (TED) to facilitate report table generation and data validation. Standardized procedures are used to capture and load other types of project data (e.g., field parameter data); • Creating summary tables and processing other data requests from the TED.	Professional Geologist
Karen Furey	Project Administrator	Amec Foster Wheeler	• Assists with the development of Project deliverables.	

Worksheet #7 Personnel Responsibilities and Qualification Table

Name	Title	Organizational Affiliation	Responsibilities	Education and Experience Qualifications
Russ Foster	Laboratory Manager	EnviroSytems, Inc.	The Laboratory Manager is ultimately responsible for the data produced by the laboratory including: • Implementing and adhering to the QA and corporate policies and procedures within the laboratory; • Approving laboratory SOPs; • Maintaining adequate staffing; and • Implementing internal/external audit findings and corrective actions.	
Kirk Cram	Laboratory PM	EnviroSytems, Inc.	As the Laboratory PM, TBD is the primary point of contact between the laboratory and Amec Foster Wheeler. TBD is responsible for: • Establishing a project file and analytical requirements; • Communicating project requirements to TBD laboratory personnel; • Keeping the laboratory and Amec Foster Wheeler informed of project status; • Monitoring, reviewing, and evaluating the progress and performance of projects; • Reporting Amec Foster Wheeler inquiries involving data quality issues or data acceptability to the EnviroSytems Laboratory QA Manager and to the affected laboratory staff; and • Reviewing project data packages for completeness and compliance to Project requirements and Amec Foster Wheeler needs.	

Worksheet #7 Personnel Responsibilities and Qualification Table

Name	**Title**	**Organizational Affiliation**	**Responsibilities**	**Education and Experience Qualifications**
Russ Foster	Laboratory QA Manager	EnviroSytems, Inc.	The Laboratory QA Manager reports directly to the Laboratory Manager. As the EnviroSytems Laboratory QA Manager, Mr. Russ Foster is responsible for: • Approving laboratory SOPs; • Maintaining quality within the laboratory; • Supervising and providing guidance and training to laboratory staff; • Implementing internal/external audit findings and corrective actions; • Addressing all client inquiries involving data quality issues; • Performing QA audits and assessments; • Tracking external and internal findings of QA audits; and • Coordinating laboratory certification and accreditation programs.	
Tommy Jordan	PM	Kemron Environmental Services, Inc.	• Provides dewatering services and technical input of the sediment dewatering results for the development of the tidal flat sediments treatability FS. As the Kemron Environmental Services, Inc. lead, Mr. Jordan will conduct the bench scale treatability tests and is responsible for ensuring that his employees understand their responsibilities in completing their tasks in accordance with the Project FSP, QAPP, and applicable SOPs. Mr. Jordan reports bench testing issues to the Amec Foster Wheeler Project FS Technical Lead (Tony Delano).	

Worksheet #8 Special Personnel Training Requirements Table

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 Activities	40-hour Hazardous Waste Operations and Emergency Response with 8-hour Annual Refresher	OSHA Certified Training Professionals	NA	Field operations personnel	Amec Foster Wheeler personnel	Amec Foster Wheeler project offices
Data Management	Operations Security Training (OPSEC)	Center for Development of Security Excellence	TBD	Data Managers	Amec Foster Wheeler personnel	Amec Foster Wheeler project offices
Administration	OPSEC	Center for Development of Security Excellence	TBD	Administrative Assistant	Amec Foster Wheeler personnel	Amec Foster Wheeler project offices
Performing data management and verification using ADR.NET	ADR Course Workshop. Focuses on review and management of analytical data.	Laboratory Data Consultants, Inc.	NA	Data Managers	Amec Foster Wheeler personnel	Amec Foster Wheeler project offices
Performing data management and verification using ADR.NET	ADR Course Workshop. Focuses on review and management of analytical data.	Laboratory Data Consultants, Inc.	NA	Analytical Laboratory	Envirosystems, Inc.	Appendix F
Analytical Chemistry	National Environmental Laboratory Accreditation Program (NELAP) and CT DEEP Accreditation	NELAP Accrediting State and CTDEEP	NA	Analytical Laboratory	Envirosystems, Inc.	Appendix F

Worksheet #9 Project Scoping Session Participants Sheet

Worksheet #9 Project Scoping Session Participants Sheet

Project Name: Stratford Army Engine Plant – Feasibility Study **Projected Date(s) of Sampling:** 2017 **PM:** Rod Pendleton	**Site Name:** Stratford Army Engine Plant Tidal Flats **Site Location:** Stratford, Connecticut

Date of Session: January 25, 2016
Scoping Session Purpose: Introduction of stakeholders.

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Ellen Iorio	PM	CENAE	978-318-8194	ellen.iorio@usace.army.mil	PM
James Kelly	Technical Lead	CENAE	978-318-8227	james.a.kelly@usace.army.mil	Technical Lead
Jeff Pickett	Program Manager	Amec Foster Wheeler	207-775-5401	Jeffrey.Pickett@amecfw.com	Program Manager
Rod Pendleton	PM	Amec Foster Wheeler	207-775-5401	rod.pendleton@amecfw.com	PM

Comments/Decisions: Discuss objectives for Stratford Army Engine Plant Tidal Flats - Feasibility Study.

Discussion Topics:

1) Remedial Alternatives
2) Use of Nell’s Island existing data as background reference for Polychlorinated Biphenyls (PCBs) and mercury.
3) Development of Project Remediation Goals, and finalization of Sediment Remediation Endpoints Report
4) Use of treated sediments as upland fill material.

Action Items:

1) Obtain acceptance of background Project Remediation Goals for PCBs and mercury from CT DEEP.
2) Provide meeting minutes to CENAE and CT DEEP

Worksheet #10 Conceptual Site Model

Worksheet #10 Conceptual Site Model

The problem to be addressed by the project: - Delineate PCB, metals, and mercury contamination in the Tidal Flat sediments. - Characterize the physical properties of the Tidal Flat sediments to evaluate potential remedies. - Evaluate effectiveness of proposed sediment removal technologies - Evaluate required sediment processing (dewatering, stabilization, and water treatment) to allow use of sediments as fill material in the upland property re-development or as material to be disposed of off-site, and reporting of results.
Background information: *An on-site chemical waste treatment plant operated to treat waste generated at the facility, and released effluent to the Housatonic River under a National Pollutant Discharge Elimination System permit. Lagoons on the Site were regulated under RCRA, and were closed under RCRA in the 1980s. The facility was cited in 1983 for violating the Toxic Substances Control Act regarding reporting of PCB-containing transformers. The Site was owned by the United States (U.S.) Air Force until 1976, when ownership was transferred to the U.S. Army (EPA, 2016), (see reports listed in Worksheet #13).*
Sources of known or suspected hazardous waste: *Former manufacturing activities at Stratford Army Engine Plant, Stratford, CT.*
Known or suspected contaminants or classes of contaminants: *PCBs, inorganic mercury, arsenic, cadmium, copper, chromium, lead, nickel, silver, and zinc*
Primary release mechanism: *On-site chemical waste treatment and storm-water discharge to the Tidal Flats through Facility outfalls OF-001 through OF-007.*
Secondary contaminant migration: *Hydrodynamic processes have caused migration of contaminated sediments in the estuary.*
Fate and transport considerations: *Total PCBs exceeding 1.0* parts per million *(ppm), and mercury concentrations greater than the proposed background value of 0.55 ppm, are generally co-located with samples having an ERM-Q > 0.5. The 5-6 and 7-8 foot below ground surface (bgs) data indicate no criteria exceeded, with the exception of a 7-8 foot bgs Total PCB concentration > 1.0 ppm along the Dike near outfalls OF-002 & OF-003.*
Potential receptors and exposure pathways: *Biota living in and/or ingesting prey species from the lower estuary of the Housatonic River; humans ingesting these biota.*
Land use considerations: *The Housatonic River Estuary is a complex and dynamic system that includes various habitats and various levels of contamination.*

Worksheet #10 Conceptual Site Model

Key physical aspects of the site: *The Tidal Flats area is approximately 5,000 feet upstream of the mouth of the Housatonic River, where the river enters Long Island Sound. The Tidal Flats are classified as estuarine and marine wetlands, and consist of fine-grained sediments exposed twice daily during low tide. The sediment is soft and deep, and walking more than a few feet out onto the Tidal Flats is not possible without sinking to depths above the knee. Maximum water depth in the Tidal Flats area is approximately five feet at high tide, but only two to three feet deep near the Dike boundary adjacent to the Tidal Flats.*

The sediments are un-vegetated, with the exception of the northern portion supporting limited emergent vegetation. A Causeway extends from the upland SAEP facility toward the river channel and divides the Tidal Flats into two areas. The Causeway was constructed over the Tidal Flats in 1929 to provide access to the river channel. A stone jetty borders the Tidal Flats on the northeast, separating the Tidal Flats from the river. The jetty was built in 1932 to divert effluent from the Stratford Sewage Treatment Plant, which is located immediately upstream from the Tidal Flats. Numerous outfalls formerly released liquid waste streams from SAEP industrial operations to the Tidal Flats. Several of the outfalls currently function to pump storm water and groundwater infiltration from the SAEP facility.

Current interpretation of nature and extent of contamination to the extent that it will influence project-specific decision-making: *Data from previous Tidal Flats area investigations indicate a general decrease in metals and PCB concentrations with depth, with the exception being the area around the tip of the Causeway, as well as the outer fringes of the Tidal Flats adjacent to the stone jetty and toward the Housatonic River channel. The additional data collected in 2015 at the outer limits of the Tidal Flats support prior interpretations that there may be source(s) of contamination, which are not associated with the SAEP facility, transported to the Tidal Flats by the Housatonic River. This interpretation is supported by average ERM-Q, total PCB, and mercury distributions in the 2-3 and 3-4 foot bgs sample intervals.*

Data gaps and uncertainties associated with the Conceptual Site Model: *Data gaps to be addressed by this Tidal Flats Feasibility Study include:*

- *Sediment samples will be collected from locations proposed on FSP Figures 4-1 and 4-2, to delineate PCB “hot spots” with concentrations of greater than or equal to 50 ppm and to delineate PCB concentrations between 4 and 8 feet bgs near Outfalls 001, 002, 003, 004, and 007.*
- *Sediment samples are proposed at approximately 12 locations near Outfalls 001, 002, 003, 004, and 007, from four 1-foot intervals between 4 and 8 feet bgs, for a total of 48 samples. The proposed 1-foot sample intervals are 4-5’, 5-6’, 6-7’, and 7-8’. The purpose of these samples is to evaluate PCB concentrations at depth around outfall locations, which are suspected sources of PCBs to the Tidal Flats. Proposed sample locations are shown on FSP Figure 4-2.*

Worksheet #11 Project Quality Objectives /Systematic Planning Process Statements

Worksheet #11 Project Quality Objectives /Systematic Planning Process Statements

Who will use the data? *CENAE, Amec Foster Wheeler, their subcontractors, and stakeholder agencies will use the data.*

What will the data be used for? *The sampling objectives are to supplement the usable, existing Project data collected to date to support development of the FS. The proposed sampling will fill data gaps and allow for remedial footprints to be refined, both horizontally and vertically. In addition, the sampling aims to provide the data required to perform treatability studies to evaluate the potential for re-using dredged material as fill on-site. Sampling is proposed as follows:*

1. *Perform sediment sampling and analyses in the Tidal Flats to further delineate PCBs at depth near the historic discharge outfalls, as well as around Total PCB concentrations above 50 ppm*
2. *Collect sediment from the Tidal Flats to conduct bench-scale treatability studies in support of the FS*

The data collected from the sampling activities, in conjunction with previously collected data, will be used to support the development of an FS Report for removal and treatment/disposal of contaminated sediments in the Tidal Flats and Outfall 008 Drainage Ditch.

What type of data are needed? (target analytes, analytical groups, field screening, on-site analytical or off-site laboratory techniques, sampling techniques). *Analytical data from sediment, surface water, and elutriate water will be collected from on-site areas. Samples will be analyzed for PCB Homologs, and Aroclors, mercury, and total metals to include arsenic, cadmium, chromium, copper, lead, nickel, and zinc, total organic carbon, grain size, moisture content, solids, content, Atterberg Limits, bulk and dry density, and specific gravity. Sampling scope for media and planned analyses are described in the FSP.*

How "good" do the data need to be in order to support the environmental decision? *The quality of data needed to achieve the project quality objectives is described using data quality indicator goals (precision, accuracy, representativeness, comparability, completeness, selectivity, and sensitivity) required of each analytical parameter used for each media sampled. The limits set on each of these items are referred to as measurement performance criteria and are defined in Worksheets 12, 15, 24, and 35. Measurement performance have been established for each parameter to ensure the data are sound, highly defensible, and with low enough quantitation limits to support human health evaluations. With the exception of samples analyzed for waste disposal characteristics, data quality will be evaluated to the same level for all FS activities. Disposal characteristic samples will not include duplicates and matrix spikes.*

How much data are needed?

Sampling Objective	Solid/Aqueous	Analysis	Laboratory Analytical Methods	Estimated Number of Samples
PCB Delineation	Solid	PCB Homologs	EPA Method 680 Mod	110
Treatability Testing (includes total number of analyses proposed for the five options/phases of treatability testing)	Solid	PCB Homologs	Extraction: EPA Method 3570 Analysis: EPA Method 680 Mod	11
	Solid	Metals + mercury	EPA Method 6020/245.7	11
	Solid	SPLP PCB Homologs	SW 846 1312/680 Mod	20
	Solid	SPLP Metals	SW 846 1312/6020	20
	Aqueous	Metals + mercury	EPA Method 6020/245.7	23
	Aqueous	PCB Homologs	Extraction: EPA Method 3510C Analysis: EPA Method 680 Mod	23
Off-Site Disposal Characterization	Solid	TCLP VOCs, SVOCs, pesticides, herbicides, metals	SW-846 Method 1311 leachate prep, followed by aqueous analysis by 8260, 8270, 8081, 6020, 245.7, 8151A	1
	Solid	Total Petroleum Hydrocarbons and PCB Homologs	Method 8015, 680 Mod	1
	Solid	Hazardous Waste Parameters, Ignitability, Corrosivity, Reactivity	SW-846 1030, 9045, 9010, 9038	1
On-site Re-use/Dredged Materials Characterization	Solid	SPLP PCB Homologs	SW-846 1312 leachate prep, followed by aqueous analysis by EPA Method 680 Mod	5
	Solid	SPLP Metals	SW 846 1312/6020	5

Worksheet #11 Project Quality Objectives /Systematic Planning Process Statements

	Solid	Atterberg Limits	American Society for Testing and Materials (ASTM) D4318	10
	Solid	Total Organic Carbon	Lloyd Kahn	10
	Solid	Grain Size	ASTM D6913 (ASTM D422 withdrawn) w/ hydrometer (ASTM D7928)	10
	Solid	Percent Solids	EPA Method 160.3	10
	Solid	Water Content	ASTM 2216	10
	Solid	Specific Gravity of Solids	ASTM D854	10
	Solid	Bulk and Dry Density	ASTM D653	10
Dredging Resuspension Testing (Elutriate)	Aqueous	Elutriate Metals[1]	Inland Testing Manual/EPA Method 6020/245.7	3
	Aqueous	Elutriate PCB Aroclors and Homologs	Inland Testing Manual/EPA Method 8082A and 680 Mod	3

Where, when, and how should the data be collected/generated? *Sediment, surface water, and elutriate* samples will be collected as follows:

1. Sediment sampling and analyses in the Tidal Flats to further delineate:
   a. concentrations of PCBs from 0-2 feet below ground surface (bgs) at locations where total PCBs have been detected at concentrations exceeding 50 ppm; and
   b. concentrations of PCBs at depths between 4 and 8 feet bgs near the historic wastewater outfalls which discharged to the Tidal Flats west of the Causeway.
2. Collect samples from the Tidal Flats to conduct bench-scale treatability studies to:
   a. evaluate sediment dewatering, flocculation, stabilization, disposal characteristics, elutriate characteristics, and geotechnical properties; and
   b. evaluate water generated by dewatering sediments for treatability with various technologies aimed at reducing PCBs and metals concentrations.

Data will be collected under the following schedule:

Event	Date
Initiate Treatability Sediment Sampling in the Tidal Flats	8/2/2017
Initiate Sediment PCB Delineation Coring	10/17/2017
Completion of Treatability Testing	12/31/2017
Analyses of Sediment PCB Delineation Samples completed	12/31/2017
Data Validation of Sediment PCB Delineation Samples completed	1/30/2018
Draft FS Report due to CENAE	1/30/2018
Draft Final FS Report due to CT DEEP and USEPA	3/21/2018
Final FS Report due to CENAE, CT DEEP, and USEPA	4/26/2018

Sample collection to support data *generated* will be done *in accordance with* the FSP and the procedures described in the Field Sampling SOPs listed in Worksheet # 21. Analytical results to support data generated will be done in accordance with the procedures described in the Analytical References Worksheet #23.

Worksheet #11 Project Quality Objectives /Systematic Planning Process Statements

Who will collect and generate the data? *Amec Foster Wheeler will collect the environmental samples. Samples will be analyzed by Envirosystems, Inc. located in Hampton, NH. Field and laboratory data will be managed and reported by Amec Foster Wheeler.*
How will the data be reported? *The analytical laboratories will provide a report stored either on a CD or their website. Results will be validated and entered into an electronic database as described in Worksheet #14.*
How will the data be archived? *Amec Foster Wheeler will maintain the validated analytical results in their TED for final submission to the USACE Environmental Restoration Information System. Reviewed ADR files (containing validated SEDD data) will also be imported into the USACE RADBS.*

Worksheet #12   Measurement Performance Criteria Table

A summary of analytical methods that will be used during the Feasibility Study is included in Table 1.

Table 1 – Summary of Analytical Methods

Analytical Parameter	Analytical Method	Sediment	Surface Water
PCB Homologs	Solids Extraction: EPA Method 3570 Aqueous Extraction: EPA Method 3510C Sample Analysis: EPA Method 680 Mod	X	X
PCB Aroclors	Solids Extraction: EPA Method 3570 Aqueous Extraction: EPA Method 3510C Sample Analysis: SW-846 8082A	X	X
TAL Metals	SW-846 6020 Inductively Coupled Plasma Mass Spectroscopy (ICP-MS)	X	X
Mercury, total	245.7	X	X
Grain Size	American Society for Testing and Materials (ASTM) D6913 w/ Hydrometer (ASTM D7928)	X	
Total Organic Carbon	Lloyd Kahn	X	
Water Content	ASTM 2216	X	
Percent Solids	EPA 160.3	X	
Atterberg Limits	ASTM D4318	X	
Bulk and Dry Density	ASTM D653	X	
Specific Gravity of Solids	ASTM D854	X	
Elutriate Prep	Inland Testing Manual	X	
Elutriate PCB Homologs	SW-846 680 Modified/Inland Testing Manual	X	
Elutriate PCB Aroclors	SW-846 8082A Modified/Inland Testing Manual	X	
Elutriate TAL Metals	SW-846 6020 (ICP-MS) /Inland Testing Manual	X	
Elutriate Mercury, total	SW-846 245.7/Inland Testing Manual	X	
Synthetic Precipitation Leaching Procedure (SPLP)	SW-846 1312	X	
SPLP PCB Homologs	SW-846 1312/680 Modified	X	
SPLP PCB Aroclors	SW-846 1312/8082A Modified	X	
SPLP TAL Metals	SW-846 1312/6020 (ICP-MS)	X	
SPLP Mercury, total	SW-846 1312	X	
Toxic Characteristic Leaching Procedure (TCLP)	SW-846 1311	X	
TCLP TAL Metals	SW-846 1311/6020 (ICP-MS)	X	
TCLP Mercury, total	SW-846 1311//245.7	X	
TCLP VOCs	SW-846 1311/8260	X	
TCLP SVOC	SW-846 1311/8270	X	
TCLP Pesticides	SW-846 1311/8081	X	

Analytical Parameter	Analytical Method	Sediment	Surface Water
TCLP Herbicides	SW-846 1311/8151A	X	
Total Petroleum Hydrocarbons	SW-846 8015	X	
Ignitability	SW-846 1030	X	
Corrosivity	SW-846 9045	X	
Reactivity	SW-846 9010/9038	X	

VOCs- Volatile Organic Compounds
SVOC –Semi-volatile Organic Compounds
PCBs – Polychlorinated biphenyls

Table 2 Project Analytical QC Limits

Analytical Parameter	Analytical Method	QC Test	Water %R	Water RPD	Solid %R	Soil RPD
PCB Homologs	SW-846 680 Modified	Laboratory Control Sample (LCS)	40-140		40-140	
		Matrix Spike/ Matrix Spike Duplicate (MS/MSD)	40-140	50	40-140	50
		Surrogates	30-150		30-150	
		Field Duplicates		30		50
PCB Aroclors	SW-846 8082A	LCS	40-140		40-140	
		MS/MSD	40-140	50	40-140	50
		Surrogates	30-150		30-150	
		Field Duplicates		30		50
TAL Metals	SW-846 6020A 245.7	LCS	80-120		80-120	
		MS/MSD	75-125	50	75-125	50
		Lab Duplicates		20		35
		Field Duplicates		30		50
Total Organic Carbon	Lloyd Kahn	LCS			75-125	
		MS/MSD			75-125	50
		Lab Duplicates				25
		Field Duplicates				50
Grain Size	ASTM D6913 w/ Hydrometer (ASTM D7928)	Field Duplicates				50

RPD - Relative Percent Difference
%R – Percent Recovery

Worksheet #12 Measurement Performance Criteria Table

Matrix	Sediment
Analytical Group	PCB Homologs
Concentration Level	Low/Medium/High

Sampling Procedure[1]	**Analytical Method/SOP**[2]	**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)**
S-1	EPA 680 modified / L-1, L-7	Precision – Overall	RPD ≤ 50 when positive results for both samples are ≥ 5x reporting limit (RL); For analytes detected < 5x the RL the absolute difference between sample concentrations must be ≤4x the RL.	Field Duplicates	S & A
		Accuracy/ Precision	Percent Recoveries 40-140 RPD ≤50%	MS/MSD	A
		Accuracy	Percent Recoveries 30-150	Surrogate Spike	A
		Accuracy/ Precision	Percent Recoveries 40-140 RPD ≤20%	LCS/LCSD	A
		Accuracy/ Contamination	No target analyte >½ quantitation limit (QL).	Method Blank	A
		Accuracy/ Contamination	Evaluate possible carryover	Instrument blank	A
		Accuracy/ Contamination	No target compounds > QL.	Field Equipment Blank	S

Worksheet #12 Measurement Performance Criteria Table

Matrix	Sediment
Analytical Group	PCB Homologs
Concentration Level	Low/Medium/High

Sampling Procedure^1	**Analytical Method/SOP^2**	**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)**
		Sensitivity	Method Detection Limits (MDLs) and QLs are analyte-specific. See Worksheet #15 and the Project Target Analyte Reporting Limit, Blank Contamination, and Lab & Field Duplicate RPD Criteria produced from the Project E-QAPP and contained in Appendix E of this QAPP.	MDL Study	A
S-1	SW-846 8082A/L-2, L-7	Precision-Overall	RPD ≤50% when detects for both field duplicate samples are ≥ QL.	Field Duplicate	S & A
		Accuracy/ Precision	Percent Recoveries 40-140 RPD ≤50%	MS/MSD	A
		Accuracy	Percent Recoveries 30-150	Surrogate Spike	A
		Accuracy/ Precision	Percent Recoveries 40-140 RPD ≤20%	LCS/LCSD	A
		Accuracy/ Contamination	No target analyte >½ QL.	Method Blank	A

Worksheet #12 Measurement Performance Criteria Table

Matrix	Sediment
Analytical Group	PCB Homologs
Concentration Level	Low/Medium/High

Sampling Procedure[1]	**Analytical Method/SOP**[2]	**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)**
		Accuracy/ Contamination	Evaluate possible carryover	Instrument blank	A
		Accuracy/ Contamination	No target compounds > QL.	Field Equipment Blank	S
		Sensitivity	MDLs and QLs are analyte-specific. See Worksheet #15 and the Project Target Analyte Reporting Limit, Blank Contamination, and Lab & Field Duplicate RPD Criteria produced from the Project E-QAPP and contained in Appendix E of this QAPP.	MDL Study	A
		Completeness	100% laboratory analysis of submitted samples. > 90% results accepted.	Data Completeness Check	S & A

Worksheet #12 Measurement Performance Criteria Table

Matrix	Sediment
Analytical Group	Metals
Concentration Level	Low/Medium/High

Sampling Procedure[1]	Analytical Method/SOP[2]	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)
S-1	SW-846 6020A/L-10	Precision-Overall	RPD ≤50% when detects for both field duplicate samples are ≥ QL.	Field Duplicate	S & A
		Accuracy and Precision	RPD ≤35% when detects for both laboratory duplicate samples are ≥ QL.	Laboratory Duplicate	A
		Accuracy/ Precision	Percent Recoveries 75-125 RPD ≤50%	MS/MSD	A
		Accuracy/ Precision	Percent Recoveries 75-125 RPD ≤35%	LCS/LCSD	A
		Accuracy/ Contamination	No target analyte >½ QL.	Method Blank	A
		Accuracy/ Contamination	No target compounds > QL.	Instrument blank	A
		Accuracy/ Contamination	No target compounds > QL.	Field Equipment Blank	S
		Sensitivity	MDLs and QLs are analyte-specific. See Worksheet #15 and the *Project Target Analyte Reporting Limit, Blank Contamination, and Lab & Field Duplicate RPD Criteria* in Appendix E of this QAPP.	MDL Study	A

Worksheet #12 Measurement Performance Criteria Table

Matrix	Sediment
Analytical Group	Total Mercury
Concentration Level	Low/Medium/High

Sampling Procedure[1]	**Analytical Method/SOP**[2]	**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)**
S-1	USEPA 245.7/L-8	Precision-Overall	RPD ≤50% when detects for both field duplicate samples are ≥ QL.	Field Duplicate	S & A
		Accuracy and Precision	RPD ≤35% when detects for both laboratory duplicate samples are ≥ QL.	Laboratory Duplicate	A
		Accuracy/ Precision	Percent Recoveries 75-125 RPD ≤50%	MS/MSD	A
		Accuracy/ Precision	Percent Recoveries 75-125 RPD ≤35%	LCS/LCSD	A
		Accuracy/ Contamination	No target analyte >½ QL.	Method Blank	A
		Accuracy/ Contamination	No target compounds > QL.	Instrument blank	A
		Accuracy/ Contamination	No target compounds > QL.	Field Equipment Blank	S
		Sensitivity	MDLs and QLs are analyte-specific. See Worksheet #15 and the *Project Target Analyte Reporting Limit, Blank Contamination, and Lab & Field Duplicate RPD Criteria* in Appendix E of this QAPP.	MDL Study	A

Worksheet #12 Measurement Performance Criteria Table

Matrix	Sediment
Analytical Group	Total Organic Compound (TOC)
Concentration Level	Medium

Sampling Procedure[1]	**Analytical Method/SOP[2]**	**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)**
S-1	Lloyd Kahn / L-12	Precision - Overall	RPD ≤ 50 when positive results for both samples are ≥ 5x RL; For analytes detected < 5x the RL the absolute difference between sample concentrations must be ≤4x the RL.	Field Duplicates	S & A
		Accuracy/Precision - Laboratory	RPD ≤ 25 if results are ≥ 5x RL	Laboratory Duplicates	A
		Accuracy/Precision - Laboratory	Percent recoveries 75 – 125, RPDs ≤ 25	Matrix Spike/Matrix Spike Duplicate	A
		Accuracy/Bias	Percent recoveries 75 – 125	Laboratory Control Sample	A
		Accuracy/Bias - Contamination	< RL	Initial Calibration blanks, Continuing Calibration Blanks, Preparation Blanks, and Equipment Blanks	S & A
		Completeness	Field 90%, Laboratory 95%	Data Completeness Check	S & A
		Sensitivity	MDL/RL evaluated versus project action limits. See Worksheet #15	MDL Study	A

Worksheet #12 Measurement Performance Criteria Table

Matrix	Surface Water
Analytical Group	PCB Homologs
Concentration Level	Low/Medium/High

Sampling Procedure[1]	**Analytical Method/SOP**[2]	**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)**
S-2	EPA 680 modified / L-1, L-3	Precision - Overall	RPD ≤ 30 when positive results for both samples are ≥ 5x reporting limit (RL); For analytes detected < 5x the RL the absolute difference between sample concentrations must be ≤4x the RL.	Field Duplicates	S & A
		Accuracy/ Precision	Percent Recoveries 40-140 RPD ≤50%	MS/MSD	A
		Accuracy	Percent Recoveries 30-150	Surrogate Spike	A
		Accuracy/ Precision	Percent Recoveries 40-140 RPD ≤20%	LCS/LCSD	A
		Accuracy/ Contamination	No target analyte >½ QL.	Method Blank	A
		Accuracy/ Contamination	Evaluate possible carryover	Instrument blank	A
		Accuracy/ Contamination	No target compounds > QL.	Field Equipment Blank	S

Worksheet #12 Measurement Performance Criteria Table

Matrix	Surface Water
Analytical Group	PCB Homologs
Concentration Level	Low/Medium/High

Sampling Procedure[1]	**Analytical Method/SOP**[2]	**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)**
		Sensitivity	MDLs and QLs are analyte-specific. See Worksheet #15 and the Project Target Analyte Reporting Limit, Blank Contamination, and Lab & Field Duplicate RPD Criteria produced from the Project E-QAPP and contained in Appendix E of this QAPP.	MDL Study	A
		Completeness	100% laboratory analysis of submitted samples. > 90% results accepted.	Data Completeness Check	S & A

Worksheet #12 Measurement Performance Criteria Table

Matrix	Sediment
Analytical Group	PCB Aroclors
Concentration Level	Low/Medium/High

Sampling Procedure[1]	**Analytical Method/SOP**[2]	**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)**
S-2	SW-846 8082A/L-2, L-3	Precision-Overall	RPD ≤30% when detects for both field duplicate samples are ≥ QL.	Field Duplicate	S & A
		Accuracy/ Precision	Percent Recoveries 40-140 RPD ≤50%	MS/MSD	A
		Accuracy	Percent Recoveries 30-150	Surrogate Spike	A
		Accuracy/ Precision	Percent Recoveries 40-140 RPD ≤20%	LCS/LCSD	A
		Accuracy/ Contamination	No target analyte >½ QL.	Method Blank	A
		Accuracy/ Contamination	Evaluate possible carryover	Instrument blank	A
		Accuracy/ Contamination	No target compounds > QL.	Field Equipment Blank	S
		Sensitivity	MDLs and QLs are analyte-specific. See Worksheet #15 and the Project Target Analyte Reporting Limit, Blank Contamination, and Lab & Field Duplicate RPD Criteria produced from the Project E-QAPP and contained in Appendix E of this QAPP.	MDL Study	A

Worksheet #12 Measurement Performance Criteria Table

Matrix	Sediment
Analytical Group	PCB Aroclors
Concentration Level	Low/Medium/High

Sampling Procedure[1]	**Analytical Method/SOP[2]**	**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)**
		Completeness	100% laboratory analysis of submitted samples. > 90% results accepted.	Data Completeness Check	S & A

Worksheet #12 Measurement Performance Criteria Table

Matrix	Sediment
Analytical Group	Grain size with Hydrometer
Concentration Level	NA

Sampling Procedure[1]	Analytical Method/SOP[2]	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)
S-1	ASTM D422 / L-XX	Precision - Overall	RPD $\leq$ 50	Field Duplicates	S & A
		Completeness	Field 90%, Laboratory 95%	Data Completeness Check	S & A

Worksheet #12 Measurement Performance Criteria Table

Matrix	Surface Water
Analytical Group	Metals
Concentration Level	Low/Medium/High

Sampling Procedure[1]	**Analytical Method/SOP**[2]	**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)**
S-2	SW-846 6020A/L-10, L-11, L-21, L-23	Precision-Overall	RPD ≤30% when detects for both field duplicate samples are ≥ QL.	Field Duplicate	S & A
		Accuracy and Precision	RPD ≤25% when detects for both laboratory duplicate samples are ≥ QL.	Laboratory Duplicate	A
		Accuracy/ Precision	Percent Recoveries 75-125 RPD ≤50%	MS/MSD	A
		Accuracy/ Precision	Percent Recoveries 75-125 RPD ≤35%	LCS/LCSD	A
		Accuracy/ Contamination	No target analyte >½ QL.	Method Blank	A
		Accuracy/ Contamination	No target compounds > QL.	Instrument blank	A
		Accuracy/ Contamination	No target compounds > QL.	Field Equipment Blank	S
		Sensitivity	MDLs and QLs are analyte-specific. See Worksheet #15 and the *Project Target Analyte Reporting Limit, Blank Contamination, and Lab & Field Duplicate RPD Criteria* in Appendix E of this QAPP.	MDL Study	A

Worksheet #12 Measurement Performance Criteria Table

Matrix	Surface Water
Analytical Group	Total Mercury
Concentration Level	Low/Medium/High

Sampling Procedure[1]	**Analytical Method/SOP**[2]	**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)**
S-2	USEPA 245.7/L-9	Precision-Overall	RPD ≤30% when detects for both field duplicate samples are ≥ QL.	Field Duplicate	S & A
		Accuracy and Precision	RPD ≤20% when detects for both laboratory duplicate samples are ≥ QL.	Laboratory Duplicate	A
		Accuracy/ Precision	Percent Recoveries 75-125 RPD ≤50%	MS/MSD	A
		Accuracy/ Precision	Percent Recoveries 75-125 RPD ≤35%	LCS/LCSD	A
		Accuracy/ Contamination	No target analyte >½ QL.	Method Blank	A
		Accuracy/ Contamination	No target compounds > QL.	Instrument blank	A
		Accuracy/ Contamination	No target compounds > QL.	Field Equipment Blank	S
		Sensitivity	MDLs and QLs are analyte-specific. See Worksheet #15 and the *Project Target Analyte Reporting Limit, Blank Contamination, and Lab & Field Duplicate RPD Criteria* in Appendix E of this QAPP.	MDL Study	A

Worksheet #13 Secondary Data Criteria and Limitations Table

Worksheet #13 Secondary Data Criteria and Limitations Table

Secondary Data	Data Source (Originating Organization, Report Title, and Date)	Data Generator(s) (Originating Org., Data Types, Data Generation/ Collection Dates)	How Data Will Be Used	Limitations on Data Use
Sediment	Metal Concentrations in the Sediment of the Lower Housatonic River, Thesis Report, December 2008	Joshua Conklin, Southern Connecticut State University, metals in sediments	Conceptual Site Model, Understanding Remedial Alternatives	None
Sediment	Geotechnical Investigation Summary Causeway Non-Time Critical Removal Action Design, December 2000	Harding ESE Non-time Critical Removal Action (NTCRA) Design for the Causeway at SAEP	Understanding sediment characteristics	None
Sediment	Phases I and II-100% Design-Final Causeway Non-Time Critical Removal Action Design, August 2001	Harding ESE NTCRA 100% Design for the Causeway at SAEP	Understanding sediment characteristics	None
Sediment	Feasibility Study Raymark Industries, Inc. Superfund Site, Operable Unit (OU) 3, June 2016	Nobis Engineering, evaluation of remedial alternatives	Understanding Remedial Alternatives	None
Sediment, Surface Water	Raymark Industries, Inc. Superfund Site Record of Decision for Final Remedy at OU2, Final Source Control Actions at OU3, OU4, OU6 and Modification to the OU1 Remedy, September 2016	USEPA-New England Region 1	Conceptual Site Model, Understanding Remedial Alternatives	None

Worksheet #14   Summary of Project Tasks

Worksheet #14 Summary of Project Tasks

Sampling Tasks:

- Sampling tasks are described in the following task-specific work plans or work orders:
    - Sediment samples in the 0-2 foot depth interval will be collected to delineate PCB concentrations greater than or equal to 50 ppm. A total of 23 sediment cores are proposed around three locations in the Tidal Flats where PCBs > 50 mg/kg have been historically detected, with samples collected from each sediment core from the 0-1 and 1-2 foot depth intervals. Sediment samples will be collected using Piston-Vibracore® techniques, and each sampled depth interval (46 total samples) will be homogenized prior to containerization and submittal to the analytical laboratory for analysis of total PCB Homologs. 18 additional contingency cores that will be collected over the 0-2’ depth interval and processed in the same manner as the first 23 cores. However, the samples will be held frozen at the laboratory pending analytical results from the first 35 cores. If there are detections of total PCBs greater than 50 ppm in the samples from the original 23 cores, then the adjacent contingency core sample(s) will be analyzed to further delineate the extent of total PCBs at concentrations greater than 50 ppm.
    - Additional sediment cores will be collected from the depth interval between 4 and 8 feet near the facility outfalls at locations specified in Figure 4-2. There has been one instance of total PCBs detected over this depth interval to the north of Outfall OF-002 at a depth of 7-8 feet. CT DEEP has requested that the depth interval between 4 and 8 feet be evaluated for total PCB Homologs and mercury near Outfalls OF-001, -002, -003, -004, and -007. A total of 12 sediment cores are proposed around these outfalls, with samples collected from each sediment core from the 4-5, 5-6, 6-7, and 7-8 foot depth intervals. Sediment samples will be collected using Piston-Vibracore® techniques, and each sampled depth interval (48 total samples) will be homogenized prior to containerization and submittal to the analytical laboratory for analysis of total PCB Homologs.
    - Sediment samples from four areas within the Tidal Flats will be collected for assessment with bench-scale treatability testing. Sediment sample collection is proposed with the purpose of evaluating the required treatment for sediment for on-site consolidation, off-site disposal and for dewatering fluids generated during sediment processing. The sediment sample locations were selected from areas with higher concentrations of PCBs, metals, and mercury, and from hydrodynamically diverse areas of the site (shallow vs. deep water, near shore vs. near river, near outfalls, and opposites sides of the causeway) to ensure collection of sediments from potentially differing depositional environments (e.g., representation of variability in sediment grain size). These areas have been selected to ensure that sediments that are potentially more difficult to dewater are tested, so that water treatment performance can be adequately assessed. In addition, areas were selected to provide vertical representation of sediment characteristics for proposed dredging depths. Samples will be analyzed for treatability, off-site disposal characterization, Synthetic Precipitation Leaching Procedure (SPLP) PCBs and metals, effluent characteristics for dredged material (effluent elutriate test), and geotechnical analyses.
    - Surface water samples will be collected to support the bench-scale treatability testing. One 55-gallon sample will be collected as make-up water for treatability studies (Area 1), and three 5-gallon samples will be collected as makeup water for corresponding sediment for elutriate analysis (Areas 1, 6, and 8).

Analysis Tasks:

- Sediment samples will be analyzed by Envirosystems, Inc. for low level PCB homologs, mercury and metals, total organic carbon, and percent solids.
- Sediment samples will be analyzed by Envirosystems for grain size, water content, Atterberg Limits, bulk and

Worksheet #14 Summary of Project Tasks

dry density, and specific gravity of solids.

- Elutriate samples will be analyzed Envirosystems, Inc. for low level PCB homologs, mercury and metals.
- Sediment SPLP precipitates will be analyzed by Envirosystems, Inc. for low level PCB homologs, mercury and metals.
- Sediments will be analyzed for hazardous waste characteristics by Envirosystems, Inc. for disposal offsite.
- Surface water samples will be analyzed by Envirosystems, Inc. for low level PCB homologs, mercury, and metals.

Quality Control Tasks: The quality control (QC) samples are described in Worksheet #20. Field instrument testing is described in Worksheet #22.

Secondary Data: See Worksheet #13.

Data Management Tasks:

Both the contract laboratory and Amec Foster Wheeler will obtain the most recent version (ADR.NET) of the USACE ADR software. Amec Foster Wheeler will develop comprehensive ADR library files (i.e., Electronic Quality Assurance Project Plan or EQAPP) for analytical methods to be used on the project. The library files will be submitted to CENAE for approval prior to field sampling. Approved library files will be used by the subcontract laboratory and Amec Foster Wheeler to check the laboratory electronic data deliverables (EDDs) for compliance, and the ADR module will be used to perform applicable data validation reviews. ADR validation actions will be reviewed/verified by the Amec Foster Wheeler project chemist. Final results will be provided to CENAE and be entered into RADBS. Final results will also be entered into the Amec Foster Wheeler TED data management system for use in preparing the FS report and subsequent documents.

The data management plan has five elements: 1) sample designation system, 2) field activities, 3) sample tracking and management, 4) data management system, and 5) document control.

1. *Sample Designation System:* Samples collected during Site activities shall be assigned unique sample ID numbers. These numbers are necessary to identify and track each of the samples collected for analysis during completion of the project. In addition, the sample ID numbers shall be used to identify analytical results received from field activities or laboratory, and to report data in the SAEP Tidal Flats - Feasibility Study Report.

Sample IDs for previously collected samples will be included in the database as they were originally identified. No changes will be made to sample IDs for previously collected samples. The following text describes the sample designations for future sampling. It should be noted that both environmental samples and QA/QC samples will be collected and submitted for laboratory analysis. The QA/QC samples will include field duplicates, matrix spikes and matrix spike duplicates, and field QC blank samples (field blanks and equipment rinsate blanks). Blank samples will have sample IDs that identify the type of equipment that was used, the date (DDMMYY), the sample matrix, and _QC. Blank samples will not contain any location ID. See Sampling SOPs S-1 and S-2.

In general, sample IDs will identify, in the following order, the sample type, the horizontal sample locator, the sample depth interval, and a QA/QC designation (for samples submitted as field duplicates or matrix spike analysis). With the exception of blank samples, each sample ID will contain the sample location. Future samples collected at previously sampled locations will be identified using the established sampling location.

Sediment and Surface Water Sample Nomenclature - Sample Type-Horizontal Sample Locator-Sample Depth Interval

Sample Type (2 to 3 digits)

SD – Sediment sample
SW – Surface water sample
EB – Equipment rinsate blank
EL - Elutriate

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BL – QC Blank

Sample Program Designator
PCB – PCB Delineation Sampling
T – Treatability Testing Sampling

Horizontal Sample Locator (3 digits)
Example 001
0's are used as placeholders for numbers with less than 3 digits
010
001

Sample Depth Interval in feet
Examples 0001- 0' to 1' bgs
0812 = 8' to 12' bgs

Sample Modifiers (2 to 3 digits, if needed)
DP – Duplicate Sample
MS – Matrix Spike
MSD – Matrix Spike Duplicate
EB – Equipment Blank
TB – Trip Blank
SB – Source Blank

Example Field Sample IDs:

- A sediment sample collected for PCB delineation from sample location 037, from the depth interval 7-8' bgs would be identified as "SDPCB0370708".

A duplicate sediment sample collected for PCB delineation from sample location 015, from the depth interval 1-2' bgs would be identified as "SDPCB0150102DUP".

- An MS sample for a treatability study sediment core from area 03 with a location ID number of 029 collected from a depth interval of 3-4' bgs would be identified as "SDT030290304MS".

2. *Field Activities:* Site and field Logbooks will be used to document procedures performed by field personnel. The site logbook and field logbooks provide a daily hand written account of all field activities. Logbooks are hardcover books that are permanently bound. All entries are made in permanent black or blue ink, and corrections are made with a single line with the author initials and date. Each page of the logbook will be dated and signed by the person completing the log. Partially completed pages will have a line drawn through the unused portion at the end of each day, and will be signed and dated.

The cover of each logbook will be entitled with the project name "Stratford Army Engine Plant Tidal Flats – Feasibility Study", the name of the firm completing the logbook, the logbook type (i.e., Site Logbook or sequentially numbered Field Logbook), and the date the logbook was started. The Site Logbook will contain a comprehensive listing of all field logbooks created for the project.

Site Logbook:

The site logbook is a record of all site activities completed for each day or operation. Entries are made daily to document the important activities of that day. The FOL, or designee, will complete the site logbook. At a minimum, the site logbook will contain the following information:

- a list of all field logbooks created for the project;
- names, titles, and affiliations of all project related personnel present at the site during each day of operation;
- a brief summary of all activities completed for each day of operation;
- a listing of any changes made to established work plan or QAPP procedures;

Worksheet #14 Summary of Project Tasks

- a summary of any problems encountered during the day including a description of corrective actions and impacts on the project; and
- record of health and safety issues.

Field Logbooks:

The Amec Foster Wheeler field team will follow Amec Foster Wheeler's SOP S-8, Use of Field Logbooks. This SOP is included in Appendix A.

Field logbooks will provide the means of recording the chronology of data collection activities performed during the investigation. As such, entries will be described in as much detail as possible so that a particular situation could be reconstructed without reliance on memory.

Field logbooks will be bound field survey books or notebooks. Logbooks will be stored in the project files when not in use. Each logbook will be identified by the project-specific document number. All logbooks will be water resistant and have sequentially numbered pages.

The cover of each logbook will contain the following:

- the logbook number
- project name and number
- site name and location
- project start date
- end date

Entries into the logbook will contain a variety of information. At the beginning of each entry, the date, start time, weather, and names of all sampling team members present will be entered. Each page of the logbook will be signed and dated by the person making the entry. All entries will be made in permanent ink, signed, and dated and no erasures or obliterations will be made. If an incorrect entry is made, the information will be crossed out with a single strike mark which is signed and dated by the sampler. The correction shall be written adjacent to the error.

Field activities will be fully documented. Upon receipt of the field logbook for a particular activity, the designated person recording the notes will begin recording notes on a new page. The person recording the notes will sign the top of the new page and indicate the date, time, and weather conditions, prior to recording information about the field activity. The field logbook will document all Field Data Record forms that are used during investigation activities. When the designated person recording the notes either relinquishes the field logbook to another team member or turns the book in at the end of the day, the person relinquishing the field logbook will affix a signature and date to the bottom of the last page used. If the page is not complete, a diagonal line will be struck across the blank portion of the page. Information included in the logbook or associated field data record forms will include, but may not be limited to:

- description and chronology of activities, including entry and exit times
- names of all people involved in sampling activities and organizational affiliations
- level of personal protection used
- any changes made to planned protocol
- names of visitors to the site during sampling and reason for their visit
- sample location and sample identification codes for collected analytical samples
- dates (month/day/year) and times (military) of sample collection
- measurement equipment identification (model/manufacturer) and calibration information (if not recorded on a FDR)
- field monitoring instrument results (if not recorded on a FDR)
- site observations (if not recorded on a FDR)
- sample collection methods and equipment (if not recorded on a FDR)
- sample collection date and time (if not recorded on a FDR)
- sample depths (if not recorded on a FDR)

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- whether grab or composite sample collected (if not recorded on a FDR)
- sample description (color, odor, texture, etc.) (if not recorded on a FDR)
- tests or analyses to be performed (if not recorded on a FDR)
- sample preservation and storage conditions (if not recorded on a FDR)
- equipment decontamination procedures (if not recorded on an FDR)
- QC sample collection,
- unusual observations
- record of photographs
- sketches or diagrams
- signature of person recording the information

Field logbooks will be reviewed daily by the Amec Foster Wheeler FOL.

Field Data Record Forms:

Field data records will be used to record sample collection information in real time during field activities. A complete set of Field Data Records is provided in Appendix B of the QAPP. These forms are designed to capture data from each type of field activity that is completed during the FS. Field personnel are instructed to utilize these forms during the field activities for which each form was designed.

- Daily Tailgate Health and Safety Log
- Field Activity Log
- Equipment Calibration and Tracking Log
- Surface Water Sampling Log
- Sediment Sampling Log
- Daily Float Plan

All documentation will be recorded on paper forms in permanent ink. Corrections to errors in documentation or recorded calculations will be made by first striking out the error with a single line so as not to obliterate the original entry. Then the replacement entry or value will be inserted where appropriate. The person originating the change will initial and date each separate change. All revisions, deletions, and changes will be made in indelible ink.

Photographs:

Field personnel will be instructed to photo-document field activities when possible. Examples of items that may require photographic documentation include:

- general site topography
- sampling locations
- existing monitoring locations
- physical appearance of environmental samples
- physical appearance of sediment and surface water

A field logbook entry or Photograph Log will be used to record the date, time, and description (caption) of photographs taken at the site. Digital photographs will be downloaded from the camera and photographic files saved on the Amec Foster Wheeler/USACE_SAEP_FS project drive.

Equipment Calibration Log:

A FDR form will be used to record which instruments were calibrated each day (identified by manufacturer, model number and serial number), the individual who performed the calibration, and any notes regarding the maintenance of the instrument.

Health and Safety Log:

A Site Logbook entry will be used to record any Health and Safety issues that arise during field activities. Any

Worksheet #14 Summary of Project Tasks

injuries, illnesses, use of first aid supplies, use of personal protective equipment (for levels A, B or C only, if needed), or possible work-related symptoms will be recorded in the log together with the date, the name(s) of the affected individual(s), and a description of the incident. The designated HSO and FOL will be responsible for these entries.

<u>Field QC Sample Record:</u>

During field sampling investigations, the FOL will maintain a record of all field QC samples that are generated. Field QC samples include QC blanks (field blanks and equipment blanks), field duplicates, and MS/MSD samples. This record will be provided to the project chemist for use during data validation.

<u>Field Documentation Management System:</u>

The Amec Foster Wheeler FOL will maintain an inventory of all logbooks used during the program and will be responsible for ensuring that they are archived in the project files following the completion of the investigation.

Completed FDRs will be maintained by the Amec Foster Wheeler FOL during the duration of the program and will be archived in the project files following completion of the sampling effort.

3. **Sample Tracking and Management**: This section documents the procedures that will be followed to identify and track samples collected in the field, samples delivered or shipped to a fixed laboratory for analysis, and sample transfer throughout the laboratory.

A computerized sample tracking program will used to ensure that all relevant sample information is recorded accurately and completely at each stage of the sample handling process. The sample tracking program will be the primary method used to record sample collection information and print individual bottle labels. This program can also be used to generate a COC. An example of the computer-generated COC is presented in Field Sample Tracking System SOP (S-6), included in Appendix A. Sample collection information is entered into the sample tracking database by the field sampler or designated sample manager at the time of sample generation. Information from the sample including sample ID, location ID, date collected, analytical methods, containers and preservatives, and sampler name is captured in the field and downloaded directly into an Access database. An electronic COC can be generated directly from the database and sent to the laboratory. Sample Delivery Groups (SDGs) may be identified in the sample tracking process and information on QC samples, QC blanks, matrix spikes, and field duplicates will also be tracked. Electronic sample collection information can be exported from the sample tracking program to Excel for reporting purposes.

The goal of each COC record is the same: to document the identification, source, contents, condition, date/time and parties involved in each sample's collection and transfer. Labels are created for every bottle needed for a sample. Bottles are then checked out to the sample team that collects the sample. When the team returns with the collected sample(s), the samples are recorded as "checked in" to the sample tracking program by the sample administrators. When the sample administrator ships the samples to the lab, the samples are recorded as "shipped" in the same sample tracking program and a hardcopy COC is produced for signature. Date and time data are recorded at every key step. An SDG report is also available to check the progress of the SDG and associated QC samples.

The sample tracking data is directly loaded into the Amec Foster Wheeler Technical Environmental Database (TED) to provide a summary of samples, analytical parameters, and sample collection dates. This summary is used to track the project schedule and sample analysis and reporting status. The data base is also used to track sample data reporting by off-site laboratories and verify completeness of the data deliverables.

4. **Data Management System**: Data from field activities and measurements may be entered into the TED data base and used during site assessments. The contract laboratory will submit Stage 2a EDDs to Amec Foster Wheeler using the Staged Electronic Data Deliverables (SEDD) format (i.e., xml format files) by Sample Delivery Group (SDG). The contract laboratory will ensure that SEDD files are checked using the Contract Compliance Screening (CSS) tool contained in the laboratory version of the ADR software. The laboratory shall prepare a separate non-conformance report addressing and explaining any items identified by the CSS tool. SEDD files will be submitted on CD along with the hardcopy data package and will also include a transmittal letter ensuring that the SEDD files are error free and in agreement with hard copy data packages.

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Upon receipt of the laboratory SEDDs, Amec Foster Wheeler will process the files through the consultant version of the ADR.net software. The reviewed files are exported from ADR.net. Error free files are then loaded into a contractor's copy of USACE RADBS. Any errors identified in the SEDD at any point in this process will be corrected by the subcontract laboratory, at their cost, and resubmitted through the process identified above.

Data Entry and Verification: Data entry performed by Amec Foster Wheeler or its contractors will be proofed for accuracy. Verification will be carried out either by proofing printout or database records against the original data.

Data Transformation and Reduction: Data generated through field activities or by the subcontract laboratory, will be reduced and validated prior to reporting. Measurements and sample collection information will be transcribed directly into the field logbook or onto standardized forms. If errors are made, results will be legibly crossed out, initialed and dated by the person recording the data, and corrected in a space adjacent to the original (erroneous) entry. Periodic reviews of the field records by the Amec Foster Wheeler FOL will ensure that:

- logbooks and standardized forms have been filled out completely and that the information recorded accurately reflects the activities that were performed;
- records are legible and in accordance with good record keeping procedures, i.e., entries are signed and dated, data are not obliterated, changes are initialed, dated, and explained;
- sample collection, handling, preservation, and storage procedures were conducted in accordance with the protocols described in the QAPP, and that any deviations were documented and approved by the appropriate personnel; and
- analytical instrumentation will be calibrated and operated in accordance with the procedures specified in the QAPP.

Laboratory Audits: No laboratory audits by Amec Foster Wheeler are currently planned, but will be considered.

Internal laboratory audits are conducted periodically by the Laboratory QA Manager. As part of the audit, the overall performance of the laboratory staff is evaluated and compared to performance criteria outlined in the laboratory QA manual and SOPs. Results of the audits are summarized and issued to each department supervisor, laboratory manager, and laboratory director.

As a participant in state and federal certification programs, the laboratory is audited by representatives of the regulatory agency issuing certification, in addition to the laboratory's internal audits. Audits are usually conducted annually and focus on laboratory conformance to the specific program protocols for which the laboratory is seeking certification. The auditor reviews sampling handling and tracking documentation, analytical methodologies, analytical supportive documentation and final reports. The audit findings are formerly documented and submitted to the laboratory for corrective action, if necessary.

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

Field Procedures: If, during field work, a condition is observed by the field crew that would have an adverse effect on data quality, corrective action will be taken so as not to repeat this condition. Condition identification, cause and corrective action implemented by the Field Task Manager or a designee will be documented on a corrective action form and reported to the appropriate.

Worksheet #15 Reference Limits and Evaluation Table

Table 3 – Summary of Reference Limits and Evaluation Table

Worksheet #	Analytical Group and Matrix
15-1	PCB Homologs (Low/Medium/High Level), EPA 680 modified, Sediment
15-2	PCB Aroclors (Low/Medium/High Level), SW-846 8082A, Sediment
15-3	Metals (Low/Medium/High Level), SW-846 6020A, Sediment
15-4	Total Mercury (Low/Medium/High Level), USEPA 245.7, Sediment
15-5	TOC (Low/Medium/High level), Lloyd Kahn, Sediment
15-6	PCB Homologs (Low/Medium/High Level), EPA 680 modified, Surface Water/Elutriate
15-7	PCB Aroclors (Low/Medium/High Level), SW-846 8082A, Surface Water/Elutriate
15-8	Metals (Low/Medium/High Level), SW-846 6020A, Surface Water/Elutriate
15-9	Total Mercury (Low/Medium/High Level), USEPA 245.7, Surface Water/Elutriate

Note: MDLs presented in Table 15 Worksheets are current but should be considered as representative. These limits are updated annually by the laboratories. Amec Foster Wheeler will review updated limits as necessary to ensure that they support the quantitation limits presented in this QAPP.

Worksheet #15-1 Reference Limits and Evaluation Table

Medium/Matrix: *Sediment*
Matrix Code: *SD*
Analytical Parameter: *PCB Homologs*
Concentration Level: *Low/Medium/High*
Fixed Laboratory Method/SOP: *680 modified/L-1*

CAS Number	Analyte	Project Action Limit		Project Quantitation Limit (mg/kg)	Achievable Laboratory Limits		
		Project Remediation Goal (PRG) (mg/kg)	PRG Reference		Level of Quantitation (LOQ) (mg/kg)	Level of Detection (LOD) (mg/kg)	MDL (mg/kg)
27323-18-8	Monochlorobiphenyl	0.0598	TEC[1]	0.01	0.01	0.01	0.01
25512-42-9	Dichlorobiphenyl	0.0598	TEC[1]	0.01	0.01	0.01	0.01
25323-68-6	Trichlorobiphenyl	0.0598	TEC[1]	0.01	0.01	0.01	0.01
26914-33-0	Tetrachlorobiphenyl	0.0598	TEC[1]	0.01	0.01	0.01	0.01
25429-29-2	Pentachlorobiphenyl	0.0598	TEC[1]	0.01	0.01	0.01	0.01
26601-64-9	Hexachlorobiphenyl	0.0598	TEC[1]	0.01	0.01	0.01	0.01
28655-71-2	Heptachlorobiphenyl	0.0598	TEC[1]	0.01	0.01	0.01	0.01
55722-26-4	Octachlorobiphenyl	0.0598	TEC[1]	0.01	0.01	0.01	0.01
53742-07-7	Nonachlorobiphenyl	0.0598	TEC[1]	0.01	0.01	0.01	0.01
2051-24-3	Decachlorobiphenyl	0.0598	TEC[1]	0.01	0.01	0.01	0.01

1: Consensus Based Threshold Effect Concentration, “Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Systems”, MacDonald, Ingersoll, Berger, January 13, 2000.

µg/kg - micrograms per kilogram

Worksheet #15-2 Reference Limits and Evaluation Table

Medium/Matrix: *Sediment*
Matrix Code: *SD*
Analytical Parameter: *PCB Aroclors*
Concentration Level: *Low/Medium/High*
Fixed Laboratory Method/SOP: 8082A/L-2, L-7

		Project Action Limit			Achievable Laboratory Limits		
CAS Number	Analyte	PRG (mg/kg)	PRG Reference	Project Quantitation Limit (mg/kg)	LOQ (mg/kg)	LOD (mg/kg)	MDL (mg/kg)
12674-11-2	Aroclor 1016	0.0598	TEC[1]	0.02	0.02	0.01	0.01
11104-28-2	Aroclor 1221	0.0598	TEC[1]	0.02	0.02	0.01	0.01
11141-16-5	Aroclor 1232	0.0598	TEC[1]	0.02	0.02	0.01	0.01
53469-21-9	Aroclor 1242	0.0598	TEC[1]	0.02	0.02	0.01	0.01
12672-29-6	Aroclor 1248	0.0598	TEC[1]	0.02	0.02	0.01	0.01
11097-69-1	Aroclor 1254	0.0598	TEC[1]	0.02	0.02	0.01	0.01
11096-82-5	Aroclor 1260	0.0598	TEC[1]	0.02	0.02	0.01	0.01
37324-23-5	Aroclor 1262	0.0598	TEC[1]	0.02	0.02	0.01	0.01
11100-14-4	Aroclor 1268	0.0598	TEC[1]	0.02	0.02	0.01	0.01

1: Consensus Based Threshold Effect Concentration, “Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Systems”, MacDonald, Ingersoll, Berger, January 13, 2000.

Worksheet #15-3 Reference Limits and Evaluation Table

Medium/Matrix: *Sediment*
Matrix Code: *SD*
Analytical Parameter: *Metals*
Concentration Level: *Low/Medium/High*
Fixed Laboratory Method/SOP: 6020/L-10,L-11

CAS Number	Analyte	Project Action Limit		Project Quantitation Limit (mg/kg)	Achievable Laboratory Limits		
		PRG (mg/kg)	PRG Reference		LOQ (mg/kg)	LOD (mg/kg)	MDL (mg/kg)
7440-38-2	Arsenic	9.79	TEC[1]	10	0.01	0.01	0.009
7440-43-9	Cadmium	0.99	TEC[1]	0.5	0.01	0.01	0.003
7440-47-3	Chromium	43.4	TEC[1]	10	0.01	0.01	0.005
7440-50-8	Copper	31.6	TEC[1]	10	0.01	0.01	0.008
7439-92-1	Lead	35.8	TEC[1]	1	0.01	0.01	0.004
7440-02-0	Nickel	22.7	TEC[1]	1	0.01	0.01	0.014
7440-22-4	Silver			0.1	0.01	0.01	0.003
7440-66-6	Zinc	121	TEC[1]	10	0.01	0.01	0.030

1: Consensus Based Threshold Effect Concentration, “Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Systems”, MacDonald, Ingersoll, Berger, January 13, 2000.

Worksheet #15-4 Reference Limits and Evaluation Table

Medium/Matrix: *Sediment*
Matrix Code: *SD*
Analytical Parameter: Total Mercury
Concentration Level: *Low/Medium/High*
Fixed Laboratory Method/SOP: 245.7/L-8

CAS Number	Analyte	Project Action Limit		Project Quantitation Limit (mg/kg)	Achievable Laboratory Limits		
		PRG (mg/kg)	PRG Reference		LOQ (mg/kg)	LOD (mg/kg)	MDL (mg/kg)
7439-97-6	Mercury	0.18	TEC[1]	0.1	0.001	0.001	0.00016

1: Consensus Based Threshold Effect Concentration, “Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Systems”, MacDonald, Ingersoll, Berger, January 13, 2000.

Worksheet #15-5 Reference Limits and Evaluation Table

Medium/Matrix: *Sediment*
Matrix Code: *SD*
Analytical Parameter: Total Organic Carbon
Concentration Level: *Low/Medium/High*
Fixed Laboratory Method/SOP: Lloyd Kahn/L-12

CAS Number	Analyte	Project Action Limit		Project Quantitation Limit (mg/kg)	Achievable Laboratory Limits		
		PRG (mg/kg)	PRG Reference		LOQ (mg/kg)	LOD (mg/kg)	MDL (mg/kg)
7440-44-0	TOC	NA	NA		2500	1700	228

NA – Not applicable

Worksheet #15-6 Reference Limits and Evaluation Table

Medium/Matrix: *Surface Water/Elutriate*
Matrix Code: *SW/EL*
Analytical Parameter: *PCB Homologs*
Concentration Level: *Low/Medium/High*
Fixed Laboratory Method/SOP: *680 modified/L-1, L-3, L-14*

CAS Number	Analyte	Project Action Limit		Project Quantitation Limit (µg/l)	Achievable Laboratory Limits		
		PRG (µg/l)	PRG Reference		LOQ (µg/l)	LOD (µg/l)	DL (µg/l)
27323-18-8	Monochlorobiphenyl	0.03	CT SA & SB Chronic[1]	0.03	0.03	0.03	0.03
25512-42-9	Dichlorobiphenyl	0.03	CT SA & SB Chronic[1]	0.03	0.03	0.03	0.03
25323-68-6	Trichlorobiphenyl	0.03	CT SA & SB Chronic[1]	0.03	0.03	0.03	0.03
26914-33-0	Tetrachlorobiphenyl	0.03	CT SA & SB Chronic[1]	0.03	0.03	0.03	0.03
25429-29-2	Pentachlorobiphenyl	0.03	CT SA & SB Chronic[1]	0.03	0.03	0.03	0.03
26601-64-9	Hexachlorobiphenyl	0.03	CT SA & SB Chronic[1]	0.03	0.03	0.03	0.03
28655-71-2	Heptachlorobiphenyl	0.03	CT SA & SB Chronic[1]	0.03	0.03	0.03	0.03
55722-26-4	Octachlorobiphenyl	0.03	CT SA & SB Chronic[1]	0.03	0.03	0.03	0.03
53742-07-7	Nonachlorobiphenyl	0.03	CT SA & SB Chronic[1]	0.03	0.03	0.03	0.03
2051-24-3	Decachlorobiphenyl	0.03	CT SA & SB Chronic[1]	0.03	0.03	0.03	0.03
	Total PCBs						

1: Department of Energy and Environmental Protection, “Connecticut Water Quality Standards”, Saltwater Classes SA and SB Chronic, Table 3; Secretary of the State file number 6139, October 10, 2013.

Worksheet #15-7 Reference Limits and Evaluation Table

Medium/Matrix: *Surface Water/Elutriate*
Matrix Code: *SW/EL*
Analytical Parameter: *PCB Aroclors*
Concentration Level: *Low/Medium/High*
Fixed Laboratory Method/SOP: 8082A/L-2, L-3, L-14

	Project Action Limit			Achievable Laboratory Limits		
Analyte	PRG (µg/l)	PRG Reference	Project Quantitation Limit (µg/l)	LOQ (µg/l)	LOD (µg/l)	MDL (µg/l)
Aroclor 1016	0.03	CT SA & SB Chronic[1]	0.1	0.1	0.04	0.05
Aroclor 1221	0.03	CT SA & SB Chronic[1]	0.1	NA	NA	0.05
Aroclor 1232	0.03	CT SA & SB Chronic[1]	0.1	NA	NA	0.05
Aroclor 1242	0.03	CT SA & SB Chronic[1]	0.1	NA	NA	0.05
Aroclor 1248	0.03	CT SA & SB Chronic[1]	0.1	NA	NA	0.05
Aroclor 1254	0.03	CT SA & SB Chronic[1]	0.1	NA	NA	0.05
Aroclor 1260	0.03	CT SA & SB Chronic[1]	0.1	0.1	0.04	0.05

1: Department of Energy and Environmental Protection, “Connecticut Water Quality Standards”, Saltwater Classes SA and SB Chronic, Table 3; Secretary of the State file number 6139, October 10, 2013.

NA – Not applicable

Worksheet #15-8 Reference Limits and Evaluation Table

Medium/Matrix: *Surface Water/Elutriate*
Matrix Code: *SW/EL*
Analytical Parameter: *Metals*
Concentration Level: *Low/Medium/High*
Fixed Laboratory Method/SOP: 6020/L-10, L-11

		Project Action Limit			Achievable Laboratory Limits		
CAS Number	Analyte	PRG (µg/l)	PRG Reference	Project Quantitation Limit (µg/l)	LOQ (µg/l)	LOD (µg/l)	MDL (µg/l)
7440-38-2	Arsenic	36	CT SA & SB Chronic[1]	10	0.5	0.1	0.036
7440-43-9	Cadmium	8.8	CT SA & SB Chronic[1]	0.5	0.1	0.05	0.012
7440-47-3	Chromium	50	CT SA & SB Chronic[1]	10	0.5	0.2	0.044
7440-50-8	Copper	3.1	CT SA & SB Chronic[1]	0.5	0.5	0.1	0.034
7439-92-1	Lead	8.1	CT SA & SB Chronic[1]	1	0.5	0.1	0.015
7440-02-0	Nickel	8.2	CT SA & SB Chronic[1]	1	0.5	0.2	0.062
7440-22-4	Silver	1.9	CT SA & SB Chronic[1]	0.1	0.1	0.05	0.021
7440-66-6	Zinc	81	CT SA & SB Chronic[1]	10	1	0.5	0.23

1: Department of Energy and Environmental Protection, “Connecticut Water Quality Standards”, Saltwater Classes SA and SB Chronic, Table 3; Secretary of the State file number 6139, October 10, 2013.

Worksheet #15-9 Reference Limits and Evaluation Table

Medium/Matrix: *Surface Water/Elutriate*
Matrix Code: *SW/EL*
Analytical Parameter: Total Mercury
Concentration Level: *Low/Medium/High*
Fixed Laboratory Method/SOP: 245.7/L-9

CAS Number	Analyte	Project Action Limit		Project Quantitation Limit (µg/l)	Achievable Laboratory Limits		
		PRG (µg/l)	PRG Reference		LOQ (µg/l)	LOD (µg/l)	DL (µg/l)
7439-97-6	Mercury	1.8	CT SA & SB Chronic[1]	0.1	0.01	0.005	0.001

[1] Department of Energy and Environmental Protection, "Connecticut Water Quality Standards", Saltwater Classes SA and SB Chronic, Table 3; Secretary of the State file number 6139, October 10, 2013.

Worksheet #15-10 Reference Limits and Evaluation Table

Medium/Matrix: *TCLP/SPLP*
Matrix Code: *AQ*
Analytical Parameter: *PCB Aroclors*
Concentration Level: *Low/Medium/High*
Fixed Laboratory Method/SOP: 8082A/L-2, L-21, L-23

Analyte	Project Action Limit		Project Quantitation Limit (µg/l)	Achievable Laboratory Limits		
	PRG (µg/l)	PRG Reference		LOQ (µg/l)	LOD (µg/l)	DL (µg/l)
Aroclor 1016	0.03	CT SA & SB Chronic[1]	0.1	0.1	0.04	0.05
Aroclor 1221	0.03	CT SA & SB Chronic[1]	0.1	NA	NA	0.05
Aroclor 1232	0.03	CT SA & SB Chronic[1]	0.1	NA	NA	0.05
Aroclor 1242	0.03	CT SA & SB Chronic[1]	0.1	NA	NA	0.05
Aroclor 1248	0.03	CT SA & SB Chronic[1]	0.1	NA	NA	0.05
Aroclor 1254	0.03	CT SA & SB Chronic[1]	0.1	NA	NA	0.05
Aroclor 1260	0.03	CT SA & SB Chronic[1]	0.1	0.1	0.04	0.05
Aroclor 1262	0.03	CT SA & SB Chronic[1]	0.1	0.1	0.04	0.05
Aroclor 1268	0.03	CT SA & SB Chronic[1]	0.1	0.1	0.04	0.05

1: Department of Energy and Environmental Protection, “Connecticut Water Quality Standards”, Saltwater Classes SA and SB Chronic, Table 3; Secretary of the State file number 6139, October 10, 2013.

NA – Not applicable

Worksheet #15-11 Reference Limits and Evaluation Table

Medium/Matrix: *TCLP/SPLP*
Matrix Code: *AQ*
Analytical Parameter: *Metals*
Concentration Level: *Low/Medium/High*
Fixed Laboratory Method/SOP: 6020/L-10, L-21, L-23

CAS Number	Analyte	Project Action Limit		Project Quantitation Limit (µg/l)	Achievable Laboratory Limits		
		PRG (µg/l)	PRG Reference		LOQ (µg/l)	LOD (µg/l)	DL (µg/l)
7440-38-2	Arsenic	69	CT SA & SB Chronic[1]	10	0.5	0.1	0.036
7440-43-9	Cadmium	40	CT SA & SB Chronic[1]	0.5	0.1	0.05	0.012
7440-47-3	Chromium	50	CT GWPC GA[2]	10	0.5	0.2	0.044
7440-50-8	Copper	4.8	CT SA & SB Chronic[1]	0.5	0.5	0.1	0.034
7439-92-1	Lead	210	CT SA & SB Chronic[1]	1	0.5	0.1	0.015
7440-02-0	Nickel	74	CT SA & SB Chronic[1]	1	0.5	0.2	0.062
7440-22-4	Silver	1.9	CT SA & SB Chronic[1]	0.1	0.1	0.05	0.021
7440-66-6	Zinc	90	CT SA & SB Chronic[1]	10	1	0.5	0.23

1: Department of Energy and Environmental Protection, “Connecticut Water Quality Standards”, Saltwater Classes SA and SB Chronic, Table 3; Secretary of the State file number 6139, October 10, 2013.

2: Regulation of Connecticut State Agencies, Department of Environmental Protection, “Remediation Standard”, Title 22a. Environmental Protection, Inclusive Section 22a-133k-3, Ground-water remediation standards. Revised August 9, 2017.

Worksheet #15-12 Reference Limits and Evaluation Table

Medium/Matrix: *TCLP/SPLP*
Matrix Code: *AQ*
Analytical Parameter: Total Mercury
Concentration Level: *Low/Medium/High*
Fixed Laboratory Method/SOP: 245.7/L-9, L-21, L-23

CAS Number	Analyte	Project Action Limit		Project Quantitation Limit (µg/l)	Achievable Laboratory Limits		
		PRG (µg/l)	PRG Reference		LOQ (µg/l)	LOD (µg/l)	DL (µg/l)
7439-97-6	Mercury	1.8	CT SA & SB Chronic[1]	0.1	0.01	0.005	0.001

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[1] 1: Department of Energy and Environmental Protection, “Connecticut Water Quality Standards”, Saltwater Classes SA and SB Chronic, Table 3; Secretary of the State file number 6139, October 10, 2013.

Worksheet #16 Project Schedule Timeline Table

Date	Activity
June 2017	Work plans submitted to CENAE for approval
July/August 2017	Sediment and Surface Water Sampling for Treatability Testing
October 2017	PCB & Mercury Characterization Sampling
January 2018	Treatability Testing Results Available
January 2018	Draft Feasibility Study Report issued to CENAE
February 2018	Technical Memorandum - 2017 Tidal Flats PCB & Mercury Characterization
March 2018	Draft Final Feasibility Study Report issued to CT DEEP and USEPA
April 2018	Final Feasibility Study Report

Worksheet #17 Sampling Design and Rationale

Worksheet #17 Sampling Design and Rationale

The sampling design and rationale are presented in the FSP and summarized in the paragraphs below.

For the delineation of PCBs > 50 ppm in the 0-2 foot depth interval sediments, the proposed sampling design is based on a 50-foot square grid with samples collected around the historical data point > 50ppm. Contingency samples will also be collected by stepping out another 50 feet for collection, but these samples will be held for analysis until the results of the inner, 50-foot samples results are available for assessment. The rationale for this design is based on work at other USEPA Region 1 oversight projects where a 50-foot grid has been deemed acceptable for PCB delineation. See Figure 4-1 of the FSP for proposed exploration locations.

For the delineation of PCBs > 50 ppm in the 4-8 foot depth interval sediments, the proposed sampling design is also based on a 50-foot square grid with samples collected around the historical data point at 7-8 feet bgs > 50ppm. The rationale for this design is based on the same principles as above for the 0-2 foot depth interval, and takes into account the existing PCB data near the outfall areas to be sampled. See Figure 4-2 of the FSP for proposed exploration locations.

For the treatability sampling, four areas of the Tidal Flats were selected for obtaining sediments and surface water to conduct the bench-scale tests. The four Areas (1,4,6,8) are presented on Figure 4-3 of the FSP and the rationale for selection of these areas is based on their PCB, metals, and mercury concentrations, as well as diversity of hydrodynamic environment:

	Rationale for Selection of Treatability Testing Sample Locations			
Tidal Flats Area	**Elevated PCB Concentrations**	**Elevated Metals Concentrations**	**Elevated Hg Concentrations**	**Representative Area/Hydrodynamic conditions**
01	X	X	X	West side of Causeway; deeper water
04	X	X		Near outfalls; shallow water
06		X		East side of Causeway, shallow water
08	X	X		Near outfalls; shallow water

The following table presents the # samples anticipated in the delineation of PCBs and treatability testing:

Sampling Objective	Solid/Aqueous	Analysis	Laboratory Analytical Method	Estimated Number of Samples
PCB & Mercury Characterization	Solid	PCB Homologs	EPA Method 680 Mod	118
	Solid	Mercury	EPA Method 245.7	
Treatability Testing (includes total number of analyses proposed for the five options/phases of treatability testing)	Solid	PCB Homologs	EPA Method 680 Mod	11
	Solid	Metals + mercury	EPA Method 6020/245.7	11
	Solid	SPLP PCB Homologs	SW 846 1312/680 Mod	20
	Solid	SPLP Metals	SW 846 1312/6020	20
	Aqueous	Metals + mercury	EPA Method 6020/245.7	23
	Aqueous	PCB Homologs	EPA Method 680 Mod	23
Off-Site Disposal Characterization	Solid	TCLP VOCs, SVOCs, pesticides, herbicides, metals	SW-846 1311 leachate prep, followed by aqueous analysis by 8260, 8270, 8081, 6020, 245.7, 8151A	1
	Solid	Total Petroleum Hydrocarbons and PCB Aroclors	Method 8015/8082A Mod	1
	Solid	Hazardous Waste Parameters, Ignitability, Corrosivity, Reactivity	SW-846 1030, 9045, 9010, 9038	1
On-site Re-use/Dredged Materials Characterization	Solid	SPLP PCB Homologs	SW-846 1312 leachate prep, followed by aqueous analysis by EPA Method 680 Mod	5
	Solid	SPLP Metals	SW 846 1312/6020	5
	Solid	Atterberg Limits	American Society for Testing and Materials (ASTM) D4318	10
	Solid	Total Organic Carbon	Lloyd Kahn	10

Worksheet #17 Sampling Design and Rationale

	Solid	Grain Size	ASTM D6913 (ASTM D422 withdrawn) w/ hydrometer (ASTM D7928)	10
	Solid	Percent Solids	EPA Method 160.3	10
	Solid	Water Content	ASTM 2216	10
	Solid	Specific Gravity of Solids	ASTM D854	10
	Solid	Bulk and Dry Density	ASTM D653	10
Dredging Resuspension Testing (Elutriate)	Aqueous	Elutriate Metals[1]	Inland Testing Manual/EPA Method 6020/245.7	3
	Aqueous	Elutriate PCB Homologs	Inland Testing Manual/EPA Method 680 Mod	3

See Figures 4-1 through 4-3 of the FSP for proposed sampling locations.

Worksheet #18 Sampling Locations and Methods/SOP Requirements Table

PCB Delineation Sampling (0-2')

						Analytical Sample Quantities	
Proposed Location ID	**Contingency Boring**	**Easting**	**Northing**	**Sample Depth Intervals (ft)**	**Proposed Sample IDs**	**Total PCB Homologs (Method 680)**	**Mercury (Method 245.7)**
SD-PCB-001		898122	624350	0-1 1-2	SDPCB0010001 SDPCB0010102	1 1	
SD-PCB-002		898167	624327	0-1 1-2	SDPCB0020001 SDPCB0020102	1 1	
SD-PCB-003		898212	624305	0-1 1-2	SDPCB0030001 SDPCB0030102	1 1	
SD-PCB-004		898100	624305	0-1 1-2	SDPCB0040001 SDPCB0040102	1 1	
SD-PCB-005		898145	624283	0-1 1-2	SDPCB0050001 SDPCB0050102	1 1	
SD-PCB-006		898189	624261	0-1 1-2	SDPCB0060001 SDPCB0060102	1 1	
SD-PCB-007		898078	624260	0-1 1-2	SDPCB0070001 SDPCB0070102	1 1	
SD-PCB-008		898122	624238	0-1 1-2	SDPCB0080001 SDPCB0080102	1 1	
SD-PCB-009	x	898256	624283	0-1 1-2	SDPCB0090001 SDPCB0090102	0 0	

SD-PCB-010	x	898234	624350	0-1 1-2	SDPCB0100001 SDPCB0100102	0 0	
SD-PCB-011	x	898189	624372	0-1 1-2	SDPCB0110001 SDPCB0110112	0 0	
SD-PCB-012	x	898144	624395	0-1 1-2	SDPCB0120001 SDPCB0120102	0 0	
SD-PCB-013	x	898077	624372	0-1 1-2	SDPCB0130001 SDPCB0130102	0 0	
SD-PCB-014	x	898055	624327	0-1 1-2	SDPCB0140001 SDPCB0140102	0 0	
SD-PCB-101		897295	623989	0-1 1-2	SDPCB1010001 SDPCB1010102	1 1	
SD-PCB-102		897340	623967	0-1 1-2	SDPCB1020001 SDPCB1020102	1 1	
SD-PCB-103		897385	623945	0-1 1-2	SDPCB1030001 SDPCB1030102	1 1	
SD-PCB-104		897273	623944	0-1 1-2	SDPCB1040001 SDPCB1040102	1 1	
SD-PCB-105		897318	623922	0-1 1-2	SDPCB1050001 SDPCB1050102	1 1	
SD-PCB-106		897363	623900	0-1 1-2	SDPCB1060001 SDPCB1060102	1 1	
SD-PCB-107		897251	623899	0-1 1-2	SDPCB1070001 SDPCB1070102	1 1	
SD-PCB-108		897296	623877	0-1 1-2	SDPCB1080001 SDPCB1080102	1 1	

SD-PCB-109		897341	623855	0-1 1-2	SDPCB1090001 SDPCB1090102	1 1	
SD-PCB-110	x	897317	623810	0-1 1-2	SDPCB1100001 SDPCB1100102	0 0	
SD-PCB-111	x	897385	623834	0-1 1-2	SDPCB1110001 SDPCB1110102	0 0	
SD-PCB-112	x	897407	623877	0-1 1-2	SDPCB1120001 SDPCB1120102	0 0	
SD-PCB-113	x	897429	623921	0-1 1-2	SDPCB1130001 SDPCB1130102	0 0	
SD-PCB-114	x	897406	623990	0-1 1-2	SDPCB1140001 SDPCB01140102	0 0	
SD-PCB-115	x	897249	624012	0-1 1-2	SDPCB1150001 SDPCB1150102	0 0	
SD-PCB-116	x	897226	623967	0-1 1-2	SDPCB1160001 SDPCB1160102	0 0	
SD-PCB-117	x	897204	623922	0-1 1-2	SDPCB1170001 SDPCB1170102	0 0	
SD-PCB-201		897096	623852	0-1 1-2	SDPCB2010001 SDPCB2010102	1 1	
SD-PCB-202		897141	623830	0-1 1-2	SDPCB2020001 SDPCB2020102	1 1	
SD-PCB-203		897186	623808	0-1 1-2	SDPCB2030001 SDPCB2030102	1 1	
SD-PCB-204		897074	623807	0-1 1-2	SDPCB2040001 SDPCB2040102	1 1	

SD-PCB-205		897119	623785	0-1 1-2	SDPCB2050001 SDPCB2050102	1 1	
SD-PCB-206		897164	623763	0-1 1-2	SDPCB2060001 SDPCB2060102	1 1	
SD-PCB-207	x	897208	623741	0-1 1-2	SDPCB2070001 SDPCB2070102	0 0	
SD-PCB-208	x	897231	623786	0-1 1-2	SDPCB2080001 SDPCB2080102	0 0	
SD-PCB-209	x	897163	623875	0-1 1-2	SDPCB2090001 SDPCB2090102	0 0	
SD-PCB-210	x	897051	623874	0-1 1-2	SDPCB2100001 SDPCB2100102	0 0	

Subtotal Field Sample Analyses:	46
Field Duplicate Analyses (10%):	5
MS/MSD Analyses (5%):	3
Total Analytical Samples:	54

PCB and MercuryDelineation Sampling (4-8')

Proposed Location ID	Easting	Northing	Sample Depth Intervals (ft)	Proposed Sample IDs	Analytical Sample Quantities	
					Total PCB Homologs (Method 680)	Mercury (Method 245.7)

Proposed Location ID	Easting	Northing	Sample Depth Intervals (ft)	Proposed Sample IDs	Total PCB Homologs (Method 680)	Mercury (Method 245.7)
SD-PCB-201	897096	623852	4-5 5-6 6-7 7-8	SDPCB2010405 SDPCB2010506 SDPCB2010607 SDPCB2010708	1 1 1 1	1 1 1 1
SD-PCB-205	897119	623785	4-5 5-6 6-7 7-8	SDPCB2050405 SDPCB2050506 SDPCB2050607 SDPCB2050708	1 1 1 1	1 1 1 1
SD-PCB-206	897164	623763	4-5 5-6 6-7 7-8	SDPCB2060405 SDPCB2060506 SDPCB2060607 SDPCB2060708	1 1 1 1	1 1 1 1
SD-PCB-210	897051	623874	4-5 5-6 6-7 7-8	SDPCB2100405 SDPCB2100506 SDPCB2100607 SDPCB2100708	1 1 1 1	1 1 1 1
SD-PCB-300	897253	623719	4-5 5-6 6-7 7-8	SDPCB3000405 SDPCB3000506 SDPCB3000607 SDPCB3000708	1 1 1 1	1 1 1 1

Proposed Location ID	Easting	Northing	Sample Depth Intervals (ft)	Proposed Sample IDs	Total PCB Homologs (Method 680)	Mercury (Method 245.7)
SD-PCB-301	897275	623764	4-5	SDPCB3010405	1	1
			5-6	SDPCB3010506	1	1
			6-7	SDPCB3010607	1	1
			7-8	SDPCB3010708	1	1
SD-PCB-302	897320	623741	4-5	SDPCB3020405	1	1
			5-6	SDPCB3020506	1	1
			6-7	SDPCB3020607	1	1
			7-8	SDPCB3020708	1	1
SD-PCB-303	897365	623719	4-5	SDPCB3030405	1	1
			5-6	SDPCB3030506	1	1
			6-7	SDPCB3030607	1	1
			7-8	SDPCB3030708	1	1
SD-PCB-304	897343	623674	4-5	SDPCB3043045	1	1
			5-6	SDPCB3040506	1	1
			6-7	SDPCB3040607	1	1
			7-8	SDPCB3040708	1	1
SD-PCB-400	896603	624095	4-5	SDPCB4000405	1	1
			5-6	SDPCB4000506	1	1
			6-7	SDPCB4000607	1	1
			7-8	SDPCB4000708	1	1

Proposed Location ID	Easting	Northing	Sample Depth Intervals (ft)	Proposed Sample IDs	Total PCB Homologs (Method 680)	Mercury (Method 245.7)
SD-PCB-401	896625	624140	4-5	SDPCB4010405	1	1
			5-6	SDPCB4010506	1	1
			6-7	SDPCB4010607	1	1
			7-8	SDPCB4010708	1	1
SD-PCB-402	896670	624118	4-5	SDPCB4020405	1	1
			5-6	SDPCB4020506	1	1
			6-7	SDPCB4020607	1	1
			7-8	SDPCB4020708	1	1
				Subtotal Field Sample Analyses:	48	48
				Field Duplicate Analyses (10%):	5	5
				MS/MSD Analyses (5%):	3	3
				Total Analytical Samples:	56	56

Notes:

1) Coordinates are North American Datum 1983 Connecticut State Plane

Treatability Study Samples

Number of Samples Per Analysis

	Proposed Sample ID	Matrix	Depth Interval (ft)	Treatability[1,2]	Off-Site Waste Disposal[1,2]	SPLP[3]	Elutriate[4]	Geotechnical[5]
01	SDT01COMP001	sediment	0-4	1	1			1
	SDT01COMP002	sediment	0-4				1	
	SDT010180002	sediment	0-2			1		
	SDT010180204	sediment	2-4			1		
	SDT010190001	sediment	0-1					1
	SDT010190001	sediment	1-2					1
	SDT010190001	sediment	2-4					1
04	SDT04COMP001	sediment	0-2	1	1			1
	SDT040500002	sediment	0-2			1		
	SDT040510001	sediment	0-1					1
	SDT040510102	sediment	1-2					1
06	SDT06COMP003	sediment	0-4				1	1
	SDT060540004	sediment	0-4			1		
	SDT060550001	sediment	0-1					1
	SDT060550102	sediment	1-2					1
	SDT060550204	sediment	2-4					1
08	SDT08COMP001	sediment	0-2	1	1			1
	SDT08COMP004	sediment	0-2				1	
	SDT080800004	sediment	0-4			1		
	SDT080810001	sediment	0-1					1
	SDT080810102	sediment	1-2					1

Notes:

1. All treatability cores will be composited together to create a single sample volume of 40 gallons to be submitted for treatability analyses and off-site waste disposal characterization parameters. Prior to combining cores from different areas, samples the area composite for geotechnical parameters to assess variability across the site.

2. Parameters include Volatile Organic Compounds (VOCs), Semi-VOCs, Polychlorinated Biphenyls (PCBs) [homologs], metals,
and TPH. Offsite disposal includes: TCLP (VOCs, SVOCs, Pesticides, Herbicides, metals), ignitability, corrosivity, reactivity.
3. SPLP parameters include PCBs (homologs and Aroclors) and metals arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu),
lead (Pb), nickel (Ni), silver (Ag), zinc (Zn), and mercury (Hg).
4. Elutriate analysis is aqueous and includes PCBs (Aroclors and Homologs) and metals (As, Cd, Cr, Cu, Pb, Ni, Ag, Zn, Hg only)
6. Geotechnical parameters include Atterberg limits, TOC, grain size, percent solids/moisture content, water content, bulk and dry density, specific gravity of solids.

Worksheet #19   Analytical SOP Requirements Table

Matrix	Analytical Group	Concentration Level	Analytical and Preparation Method/SOP Reference (1)	Sample Volume Required	Containers (number, size, and type)	Shipping	Holding Time To Preservation	Preservative	Storage	Maximum Holding Time To Prep And Analysis
SED	PCB Homologs	Low/Medium/High	SW-846 680 modified/L-1, L-7	1 Liter (L.), combined[1]	One Amber Glass Teflon Lined	Cool, ≤ 6ºC	immediate	Cool, ≤ 6ºC	In a cooler on ice	14 Days to extraction; 40 days to analysis
SED	PCB Aroclors	Low/Medium/High	SW-846 8082A /L-2, L-7	1 L.	One Amber Glass Teflon Lined	Cool, ≤ 6ºC	immediate	Cool, ≤ 6ºC	In a cooler on ice	14 Days to extraction; 40 days to analysis
SED	Total TAL Metals	Low/Medium/High	SW-846 6020/L-10, L-11	1 Liter (L.), combined[1]	One Amber Glass Teflon Lined	Cool, ≤ 6ºC	immediate	Cool, ≤ 6ºC	In a cooler on ice	180 days to analysis
SED	Total Mercury	Low/Medium/High	EPA 245.7/L-8	1 Liter (L.), combined[1]	One Amber Glass Teflon Lined	Cool, ≤ 6ºC	immediate	Cool, ≤ 6ºC	In a cooler on ice	28 days to analysis
SED	Total Organic Carbon	Low/Medium/High	Lloyd Kahn/L-12	1 Liter (L.), combined[1]	One Amber Glass Teflon Lined	Cool, ≤ 6ºC	immediate	Cool, ≤ 6ºC	In a cooler on ice	28 days to analysis
SED	Grain Size	N/A	ASTM D422 w/Hydrometer/L-XX	16 oz., combined[2]	One Amber Glass Teflon Lined	Cool, ≤ 6ºC	immediate	Cool, ≤ 6ºC	In a cooler on ice	180 days to analysis
SED	Water Content	N/A	ASTM 2216/L-13	16 oz., combined[3]	One Amber Glass Teflon Lined	Cool, ≤ 6ºC	immediate	Cool, ≤ 6ºC	In a cooler on ice	As soon as possible
SED	Percent Solids	N/A	EAP 160.3/L-13	16 oz., combined[3]	One Amber Glass Teflon Lined	Cool, ≤ 6ºC	immediate	Cool, ≤ 6ºC	In a cooler on ice	As soon as possible
SED	Atterberg Limits	N/A	ASTM D4318/L-XX	16 oz., combined[2]	One Amber Glass Teflon Lined	Cool, ≤ 6ºC	immediate	Cool, ≤ 6ºC	In a cooler on ice	180 days to analysis

Worksheet #19 Analytical SOP Requirements Table

Matrix	Analytical Group	Concentration Level	Analytical and Preparation Method/SOP Reference (1)	Sample Volume Required	Containers (number, size, and type)	Shipping	Holding Time To Preservation	Preservative	Storage	Maximum Holding Time To Prep And Analysis
SED	Bulk and Dry Density	N/A	ASTM D653	16 oz., combined[2]	One Amber Glass Teflon Lined	Cool, ≤ 6ºC	immediate	Cool, ≤ 6ºC	In a cooler on ice	180 days to analysis
SED	Specific Gravity of Solids	N/A	ASTM D854	16 oz.	One Amber Glass Teflon Lined	Cool, ≤ 6ºC	immediate	Cool, ≤ 6ºC	In a cooler on ice	14 days
SED	Elutriate Prep	N/A	Inland Testing Manual/L-14	5 gallons	One plastic bucket	Cool, ≤ 6ºC	immediate	Cool, ≤ 6ºC	In a cooler on ice	7 days
SED	Toxic Characteristic Leaching Procedure	Low/Medium/High	SW-846 1311/L-23	16 oz.	One Amber Glass Teflon Lined	Cool, ≤ 6ºC	immediate	Cool, ≤ 6ºC	In a cooler on ice	14 days
SED	Synthetic Precipitate Leaching Procedure	Low/Medium/High	SW-846 1312/L-21	16 oz.	One Amber Glass Teflon Lined	Cool, ≤ 6ºC	immediate	Cool, ≤ 6ºC	In a cooler on ice	14 days
SED	Ignitability	N/A	SW-846 1030/L-15			Cool, ≤ 6ºC	immediate	Cool, ≤ 6ºC	In a cooler on ice	
SED	Corrosivity	N/A	SW-846 9045/L-22			Cool, ≤ 6ºC	immediate	Cool, ≤ 6ºC	In a cooler on ice	
SED	Reactivity	N/A	SW-846 9010/9030/L-16/L-17			Cool, ≤ 6ºC	immediate	Cool, ≤ 6ºC	In a cooler on ice	
SED	Total Petroleum Hydrocarbons	Low/Medium/High	SW-846 8015/L-29			Cool, ≤ 6ºC	immediate	Cool, ≤ 6ºC	In a cooler on ice	

Worksheet #19 Analytical SOP Requirements Table

Matrix	Analytical Group	Concentration Level	Analytical and Preparation Method/SOP Reference (1)	Sample Volume Required	Containers (number, size, and type)	Shipping	Holding Time To Preservation	Preservative	Storage	Maximum Holding Time To Prep And Analysis
SW, EL	PCB Homologs	Low/Medium/High	SW-846 680 modified/L-1, L-3, L-14	2 x 1 liter	Two Amber Glass Teflon Lined	Cool, ≤ 6°C	immediate	Cool, ≤ 6°C	In a cooler on ice	7 Days to extraction; 40 days to analysis
SW, EL	PCB Aroclors	Low/Medium/High	SW-846 8082A /L-2, L-3, L-14	2 x 1 liter	Two Amber Glass Teflon Lined	Cool, ≤ 6°C	immediate	Cool, ≤ 6°C	In a cooler on ice	7 Days to extraction; 40 days to analysis
SW, EL	Total TAL Metals	Low/Medium/High	SW-846 6020/L-10, L-11, L-14	9 oz.	One Glass Teflon Lined	Cool, ≤ 6°C	immediate	Cool, ≤ 6°C	In a cooler on ice	180 days to analysis
EL	PCB Homologs	Low/Medium/High	SW-846 680 modified/L-1, L-8, L-9, L-10, L-22	10 gallons, combined [4]	Two Plastic Buckets	Cool, ≤ 6°C	immediate	Cool, ≤ 6°C	In a cooler on ice	7 Days to extraction; 40 days to analysis
EL	Total TAL Metals	Low/Medium/High	SW-846 6020/L-10, L-11, L-14	10 gallons , combined [4]	One Glass Teflon Lined	Cool, ≤ 6°C	immediate	Cool, ≤ 6°C	In a cooler on ice	180 days to analysis
EL	Total Mercury	Low/Medium/High	USEPA 245.7/L-9, L-14	10 gallons , combined [4]	One Glass Teflon Lined	Cool, ≤ 6°C	immediate	Cool, ≤ 6°C	In a cooler on ice	28 days to analysis

[1] Total TAL metals, PCB Homologs, Total Organic Carbon, and mercury analyses combined in one 1 Liter (L) jar

[2] Grain size, Atterberg Limits, Bulk and Dry Density analyses combined in one 16 oz. jar

[3] Water content and percent solids combined in one 16 oz. jar

[4] Water Total TAL metals, PCB Homologs, and mercury elutriate analyses combined in two 5 gallon buckets

Worksheet #20 Field Quality Control Sample Summary Table

Worksheet #20 Field Quality Control Sample Summary Table

Matrix	Analytical Group	Concentration Level	Analytical and Preparation SOP Reference[1]	No. of Samples	No. of Field Duplicate Pairs	No. of MS /MSD	No. of Field Blanks	No. of Equip. Blanks	No. of PT Samples	Total No. of Samples to Lab*
SED	PCB Homologs	Low/Medium/High	SW-846 680 modified/L-1, L-7	129	10%	5%	None	2 per sampling event	0	TBD
SED	PCB Aroclors	Low/Medium/High	SW-846 8082A /L-2, L-23	1	NA	NA	None	None	0	1
SED	Total TAL Metals	Low/Medium/High	SW-846 6020/L-10, L-11	35	10%	5%	None	2 per sampling event	0	TBD
SED	Total Mercury	Low/Medium/High	USEPA 245.7/L-8	35	10%	5%	None	2 per sampling event	0	TBD
SED	Total Petroleum Hydrocarbons	Low/Medium/High	SW-846 8015/L-29	1	NA	NA	None	None	0	1
SED	Ignitability	NA	SW-846 1030/L-15	1	NA	NA	None	None	0	1
SED	Corrosivity	NA	SW-846 9045/L-22	1	NA	NA	None	None	0	1
SED	Reactivity	NA	ASTM 4500/L-16, L-17	1	NA	NA	None	None	0	1
SED	Total Organic Carbon	Low/Medium/High	Lloyd Kahn/L-12	10	NA	NA	None	None	0	TBD
SED	Grain Size	N/A	ASTM D422 w/Hydrometer/L-XX	10	NA	NA	None	None	0	TBD
SED	Water Content	N/A	ASTM 2216/L-13	10	NA	NA	None	None	0	TBD
SED	Percent Solids	N/A	USEPA 160.3/L-13	10	NA	NA	None	None	0	TBD
SED	Atterberg Limits	N/A	ASTM D4318/L-XX	10	NA	NA	None	None	0	TBD

Worksheet #20 Field Quality Control Sample Summary Table

Matrix	**Analytical Group**	**Concentration Level**	**Analytical and Preparation SOP Reference**[1]	**No. of Samples**	**No. of Field Duplicate Pairs**	**No. of MS /MSD**	**No. of Field Blanks**	**No. of Equip. Blanks**	**No. of PT Samples**	**Total No. of Samples to Lab***
SED	Bulk and Dry Density	N/A	ASTM D653/L-XX	10	NA	NA	None	None	0	TBD
SED	Specific Gravity of Solids	N/A	ASTM D854/L-XX	10	NA	NA	None	None	0	TBD
SED	Elutriate Prep	N/A	Inland Testing Manual/L-22	10	NA	NA	None	None	0	TBD
SED	Toxic Characteristic Leaching Procedure[2]	Low/Medium/High	SW-846 1311/L-23	1	NA	NA	None	None	0	TBD
SED	Synthetic Precipitate Leaching Procedure	Low/Medium/High	SW-846 1312/L-22	45	NA	NA	None	None	0	TBD
SW	PCB Homologs	Low/Medium/High	SW-846 680 modified/L-1, L-3, L-14	31	10%	5%	None	None	0	TBD
SW	Total TAL Metals	Low/Medium/High	SW-846 6020/L-10, L-13	31	10%	5%	None	None	0	TBD
SW	Total Mercury	Low/Medium/High	USEPA 245.7/L-9	31	10%	5%	None	None	0	TBD

[1] Specify the appropriate reference letter or number from the Analytical SOP References table (Worksheet #23)
[2] Parameters for analysis include: VOC, SVOCs, RCRA Metals, Pesticides, and Herbicides

NA = Not applicable

Worksheet #21 Project Sampling SOP References Table

Worksheet #21 Project Sampling SOP References Table

Reference Number	Title, Revision Date and/or Number	Originating Organization	Equipment Type	Modified for Project Work? (Check if yes)	Comments
S-1	SOP No. S-1, Sediment Sampling	Amec Foster Wheeler	Field Logbooks	N	None
S-2	SOP No. S-2, Surface Water Sampling	Amec Foster Wheeler	Direct Method, Peristaltic	N	None
S-3	SOP No. S-3, Calibration of Field Instruments for Water Quality Parameters.	Amec Foster Wheeler	Water quality parameter meter, turbidity meter	N	None
S-4	SOP No. S-4, Decontamination of Field Equipment	Amec Foster Wheeler	Liquinox, alconox, deionized water, scrub brushes, wash basins, aluminum foil, polyethylene sheeting	N	None
S-5	SOP No. S-5, Sample Chain of Custody Procedure	Amec Foster Wheeler	Chains of custody, custody seals, sample labels	N	None
S-6	SOP No. 6, Field Sample Tracking System	Amec Foster Wheeler	Computer and field records	N	None
S-7	SOP No. S-7, Sample Packaging and Shipment	Amec Foster Wheeler	Coolers, plastic bags, packing tape, strapping tape, bubble wrap, ice, chains of custody	N	None
S-8	SOP No. S-8, Use of Field Logbooks	Amec Foster Wheeler	Field Logbooks	N	None

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

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

Field Equipment	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference[1]
Multimeter	Yes	As Necessary	Yes	Yes	Daily	Per Manufacturer calibration specifications	Attempt re-calibration; Replace	FOL, Field Technician	S-3
Submersible 12v Pump	NA	NA	Operation	Visual Inspection for defective parts	Each pump prior to use	No visually defective parts, pump is operable, conformance to manufacturer standards	Repair, replace parts; use backup pump.	FOL, Field Technician	S-4
	NA	Cleaning	NA	NA	Each pump prior to use	No visually dirty parts	Re-clean	FOL, Field Technician	S-4

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

Worksheet #23 Analytical SOP References Table

Worksheet #23 Analytical SOP References Table

Reference Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work?
L-1	PCB Homologs in Solids	Definitive	Organics	Gas Chromatograph/Mass Spectrometer (GC/MS)	EnviroSytems, Inc.	N
L-2	Analysis of Pesticides and PCBs in Extracts of Soil & Water	Definitive	Organics	GC/ Electron Capture Detector (ECD)	EnviroSytems, Inc.	N
L-5	Extraction of Pesticides and PCBs in Aqueous Samples	Definitive	Organics	GC/ Electron Capture Detector (ECD)	EnviroSytems, Inc.	N
L-6	Analysis of Volatile Organics by GCMS	Definitive	Organics	GC/MS	EnviroSytems, Inc.	N
L-7	Semi-volatile Compounds by GCMS	Definitive	Organics	GC/MS	EnviroSytems, Inc.	N
L-8	Extraction of Pentachlorophenol and other ABNs in Aqueous Sample	Definitive	Organics	GC/MS	EnviroSytems, Inc.	N
L-9	Sediment Extraction for Organic Compounds	Definitive	Organics	GC/MS, GC/ECD	EnviroSytems, Inc.	N
L-8	Mercury by AF Sed or Tissue	Definitive	Inorganics	Cold Vapor Atomic Fluorescence (CVAF)	EnviroSytems, Inc.	N
L-9	Mercury by Cold Vapor AF	Definitive	Inorganics	Cold Vapor Atomic Fluorescence (CVAF)	EnviroSytems, Inc.	N
L-12	Determination of Trace Metals By ICP-MS Analysis	Definitive	Inorganics	ICP-MS	EnviroSytems, Inc.	N
L-13	Sample Preparation; Trace Metals Digestion	Definitive	Inorganics		EnviroSytems, Inc.	N
L-14	Total Organic Carbon in Soil and Sediment by Lloyd Kahn	Definitive	Inorganics	Carbon Analyzer	EnviroSytems, Inc.	N
L-15	Percent Moisture in Solid Samples	Definitive		Gravimetric	EnviroSytems, Inc.	N

Worksheet #23 Analytical SOP References Table

Reference Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work?
L-16	Modified Elutriate Solution Preparation Method	Definitive	Organic/Inorganic	NA	EnviroSytems, Inc.	N
L-17	Ignitability of Solids	Definitive	Physical	NA	EnviroSytems, Inc.	N
L-18	Total Cyanide	Definitive	Inorganics	Spectrophotometer	EnviroSytems, Inc.	N
L-19	Sulfide Analysis	Definitive	Physical	Spectrophotometer	EnviroSytems, Inc.	N
L-20	Synthetic Precipitate Leaching Procedure	Definitive	Organic/Inorganic	NA	EnviroSytems, Inc.	N
L-22	Soil pH Measurement	Definitive	Inorganics	pH Meter	EnviroSystems, Inc.	N
L-23	Toxicity Characteristic Leaching Procedure	Definitive	Organic/Inorganic	NA	EnviroSystems, Inc.	N
L-24	Particle Size Analysis	Definitive	Inorganics	Gravimetric	EnviroSystems, Inc.	N
L-25	Plasticity of Soils	Definitive	Inorganics	NA	EnviroSystems, Inc.	N
L-26	Sieve Analysis	Definitive	Inorganics	NA	EnviroSystems, Inc.	N
L-27	Modified Elutriate Solution Preparation	Definitive	Organic/Inorganic	NA	EnviroSystems, Inc.	N
L-28	Preparation of Samples for Chlorinated Herbicides	Definitive	Organics	GC/ Electron Capture Detector (ECD)	EnviroSystems, Inc.	N
L-29	TPH – Diesel Range Organics	Definitive	Organics	GC/Flame Ionization Detector (FID)	EnviroSystems, Inc.	N

[1] Biota samples with minimal sample volume may require a reduced sample volume outside the SOP.

Worksheet #24 Analytical Instrument Calibration Table

Worksheet #24 Analytical Instrument Calibration Table

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference[1]
GC/MS for 680 modified	Instrument performance check (tune).	Prior to initial calibration and calibration verification	Acceptance limits specified in method	Re-tune instrument per manufacturers specifications	Analyst	L-1
	Initial Calibration (ICAL)	Prior to analysis of samples, 6 points for all analytes.	Ave. response factor for system performance check compounds (SPCCs) ≥0.3, Relative Standard Deviation (RSD) for SPCCs ≤30%	Correct problem then repeat ICAL		
	Calibration verification	Daily before any sample analysis and every 12 hours	Average RF for SPCCs ≥0.30, percent difference ≤20	Reanalyze and qualify data		
GC-ECD for 8082A	ICAL continued	Prior to sample analysis	Midpoint calibration of Aroclors 1221 and 1232; if targets are detected, 6-point calibration is performed.	Correct problem then repeat ICAL	Analyst	L-2
	Second source initial calibration verification (ICV)	One after each ICAL	All project analytes within ±20% of true value.	Correct problem and verify second source standard. Rerun second source verification. If that fails, correct problem and repeat ICAL.		
	Continuing Calibration Check compounds	Daily before any sample analysis and every 12 hours	All project analytes within ±20% of expected value from the ICAL	Reanalyze and qualify data		

Worksheet #24 Analytical Instrument Calibration Table

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference[1]
ICP-MS for 6020A	Instrument Tune	Prior to ICAL	Mass calibration ≤0.1 amu from true value; resolution <0.9 amu full width at 10% peak height; for stability, RSD ≤5% for at least four replicate analyses.	Re-tune instrument per manufacturers specifications	Analyst	L-10
	ICAL minimum one high standard and a calibration blank.	Daily prior to sample analysis.	If more than one calibration standard is used, r ≥0.995.	Correct problem and repeat calibration.		
ICP-MS for 6020A	Second source calibration verification (ICV)	One after each ICAL	All project analytes within ±10% of true value.	Correct problem and verify second source standard. Rerun second source verification. If that fails, correct problem and repeat ICAL.	Analyst	L-10
	Continuing Calibration Verification (CCV)	After every 10 samples and at the end of the analysis sequence.	within ±10% of true value	Reanalyze and qualify data		
CVAF for 245.7	6 points plus a calibration blank.	Daily or per batch prior to sample analysis.	≥0.995.	Correct problem and repeat calibration.	Analyst	L-8, L-9
	Second source calibration verification (ICV)	One after each ICAL	All project analytes within ±10% of true value.	Correct problem and verify second source standard. Rerun second source verification. If that fails, correct problem and repeat ICAL.		
	CCV	After every 10 samples and at the end of the analysis sequence.	within ±10% of true value	Reanalyze and qualify data		

Worksheet #24 Analytical Instrument Calibration Table

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference[1]
Carbon Analyzer (TOC-LK)	5 points plus a calibration blank.	Daily prior to sample analysis.	r ≥0.995.	Correct problem and repeat calibration.	Analyst	L-12
	Second source calibration verification (ICV)	One after each ICAL	All project analytes within ±20% of true value.	Correct problem and verify second source standard. Rerun second source verification. If that fails, correct problem and repeat ICAL.		
	CCV	After every 10 samples and at the end of the analysis sequence.	within ±20% of true value	Reanalyze and qualify data		
Analytical Balance for gravimetric analyses	2-point calibration	Daily prior to sample analysis	within ±10% of true value	Correct problem and repeat calibration.	Analyst	L-13

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

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

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference[1]
GC/MS (680 Modified)	Replace pump oil as needed Change gas line dryers as needed Perform ion source cleaning and filament replacement as needed Replace injection port liner weekly or as needed Clip column Replace gas chromatography (GC) column as needed Manual tuning Replace electron multiplier Check that gas supply is sufficient and delivery pressure is adequate Bake out lines and column	Daily performance and QC recovery	Sensitivity and background check	Daily, prior to analysis	See SOP L-1	Inspect system, correct problem, rerun calibration and affected samples	Analyst	L-1

[1] Refer to the Analytical SOP References table (Worksheet #23).

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

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference[1]
GC/ECD (8082A)	Change gas line dryers as needed Replace injection port liner weekly or as needed Clip column Replace gas chromatography (GC) column as needed Check that gas supply is sufficient and delivery pressure is adequate Bake out lines and column Thermally clean detector Wipe test Change gas line dryers as needed Replace injection port liner weekly or as needed	Daily performance and QC recovery	Sensitivity and background check	Daily, prior to analysis	See SOP L-2	Inspect system, correct problem, rerun calibration and affected samples	Analyst	L-2

[1] Refer to the Analytical SOP References table (Worksheet_#23).

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

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference[1]
ICP/MS (6020A)	Replace pump oil as needed Perform ion source cleaning and filament replacement Replace electron multiplier Change capillary and pump tubing Check liquid argon tank Replace and realign plasma torch Clean nebulizer and spray chamber	Daily performance and QC recovery	Sensitivity and background check	Daily, prior to analysis	See SOP L-3	Inspect system, correct problem, rerun calibration and affected samples	Analyst	L-10
CVAF (245.7)	Replace tubing, inspect sample introduction system	Daily performance and QC recovery	Sensitivity and background check	Daily, prior to analysis	See SOP – L-4	Inspect system, correct problem, rerun calibration and affected samples	Analyst	L-8, L-9
Carbon Analyzer (TOC-LK)	Change columns	Blank and analytical standards	Gases, column	Daily, prior to analysis	See SOP L-6	Inspect system, correct problem, rerun calibration and affected samples	Analyst	L-12

[1] Refer to the Analytical SOP References table (Worksheet #23).

Worksheet #26 Sample Handling System

Worksheet #26 Sample Handling System

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): Amec Foster Wheeler
Sample Packaging (Personnel/Organization): FOL / Amec Foster Wheeler.
Coordination of Shipment (Personnel/Organization): FOL / Amec Foster Wheeler
Type of Shipment/Carrier: Samples/EnviroSytems Courier or Fed Ex/UPS
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): Various / EnviroSytems
Sample Custody and Storage (Personnel/Organization): Various / EnviroSytems
Sample Preparation (Personnel/Organization): Various / EnviroSytems
Sample Determinative Analysis (Personnel/Organization): Various / EnviroSytems
SAMPLE ARCHIVING
Field Sample Storage (No. of days from sample collection): 90
Sample Extract/Digestate Storage (No. of days from extraction/digestion): 90
SAMPLE DISPOSAL
Personnel/Organization: Various / EnviroSytems
Number of Days from Analysis: 60

Worksheet #27 Sample Custody Requirements

Worksheet #27 Sample Custody Requirements

Field Sample Custody Procedures (sample collection, packaging, shipment, and delivery to laboratory):

Sample Collection:

- During sample collection procedures, the assigned field sampler will be aware of custody requirements and maintain secure custody of all equipment and containers used in the collection of samples.
- Pre-printed labels will be provided for each sample. Labels will include the following: Site project number, Sample Location, unique field sample ID, sample number, analysis to be performed, and preservative.
- The assigned field sampler will record date and time of collection on the sample labels.
- The field sampler will securely affix the sample label to the container with clear packing tape.
- Check the cap on the sample container to confirm that it is properly sealed.
- Complete Field data record (FDR) and field notebook entries for each sample collected.
- FDR and field notebook entries will include the following: Site project number, Sample Location, unique field sample ID, sample number, analysis to be performed, preservative, sampling equipment type used for sample collection, sample equipment operational settings (purge rate, refill/discharge rate, pressure settings, etc.), any anomalies or observations encountered regarding sample collection conditions (e.g. drastic turbidity changes, sample color, sampling equipment issues/changes, weather conditions), start and end time, and any observed sample odors.
- The field sampler will maintain continuous custody of samples until delivery of samples to the laboratory.
- The field sampler or FOL will initiate a COC and complete the COC form with the required sampling information (sample ID, data and time of collection, parameters for analysis, preservation codes, and any observed conditions). Note: If the sampler relinquishes the samples to field personnel other than the FOL, the sampler will complete the chain-of-custody prior to this transfer. The appropriate personnel will sign and date the chain-of-custody form to document the sample custody transfer.
- The field sampler will place the collected sample into a sample cooler with bagged ice.
- The appropriate personnel will sign and date the chain-of-custody form to document the sample custody transfer.
- The field sampler will record relinquishing the samples in their assigned field notebook.

Worksheet #27 Sample Custody Requirements

Samples will be packaged for shipment as outlined following:

- Use indelible ink only, no pencil (a ball point pen is best). Corrections are made by drawing a single line through the error, and dating and initialing the strike through (erasures and obliterations are not allowed). Enter the correct information.
- Using strapping tape, secure the outside drain plug at the bottom of the cooler.
- Place one or two layers of bubble wrap on the bottom of the cooler.
- Wrap sample containers in bubble wrap and place into the cooler(s).
- Double bag ice in zipper-type plastics bags and place on top of the samples, filling the remaining space within the cooler.
- If shipping the sample cooler to a laboratory, record the airbill number on the COC, sign, date and time on the COC.
- Place the signed COC in a zipper-type plastic bag and tape to the inside cover of the sample cooler.
- Seal the sample cooler by wrapping both ends with strapping tape and tape around the lid seal.
- Sign and date two custody seals, when using an overnight shipper and place across the lid seal at opposing ends/sides of the sample cooler. Place a strip of clear tape across each custody seal affixed to the sample cooler.
- Upon transfer of the cooler to the shipping company, call the receiving laboratory representative and provide them information regarding the sample shipment including number of sample coolers, project name, and airbill number for tracking purposes.
- If the sample cooler is to be picked up by a designated laboratory courier, maintain custody of sample cooler(s) in a secure location until the courier arrives.
- Review the COC with the designated courier, sign, data and time the COC relinquishing to the courier.
- Have the courier sign, date and time the COC acknowledging receipt of the sample cooler.
- Obtain a copy of the signed COC from the courier.
- The designated courier will maintain secure custody of the sample cooler(s) for delivery to the laboratory the same day of receipt of the sample cooler(s).
- If delivering the sample cooler(s) directly to the laboratory during demobilization, the sample cooler(s) will be maintained in a secure location during the demobilization.
- Laboratory sample receiving personnel will sign, date and time the COC acknowledging receipt of sample cooler(s).
- FOL will obtain a copy of the signed COC.

Worksheet #27 Sample Custody Requirements

Laboratory Sample Custody Procedures (receipt of samples, archiving, disposal):

Samples will be received and logged in by a designated sample custodian or his/her designee. Upon sample receipt, the sample custodian will

- examine the shipping containers to verify that the custody seal, if present, is intact;
- examine all sample containers for damage;
- determine if the temperature required for the requested testing program has been maintained during shipment and document the temperature on the chain-of-custody or sample login records;
- compare samples received against those listed on the chain-of-custody or traffic report;
- verify that sample holding times have not been exceeded;
- examine all shipping records for accuracy and completeness;
- determine sample pH (if applicable) and record on chain-of-custody or sample login forms;
- aliquots which require acidification will be checked with pH paper and recorded on the chain-of-custody or sample login forms.
- sign and date the chain-of-custody or traffic report immediately (if shipment is accepted) and attach the air bill;
- note any problems associated with the coolers and/or samples on the cooler receipt form and notify the Laboratory PM, who will be responsible for contacting the Amec Foster Wheeler Lead Chemist or Amec Foster Wheeler PM;
- attach laboratory sample container labels with unique laboratory identification and test; and
- place the samples in the proper laboratory storage.

Following receipt, samples will be logged in per the following procedure:

- The samples will be entered into the laboratory tracking system. At a minimum, the following information will be entered: project name or identification, unique sample numbers (both client and internal laboratory), type of sample, required tests, date and time of laboratory receipt of samples, and field identification provided by field personnel.
- The Laboratory PM will be notified of sample arrival.
- The completed chain-of-custody or traffic report, air bills, and any additional documentation will be placed in the final evidence file.

Worksheet #27 Sample Custody Requirements

Sample Identification Procedures: Samples collected during Site activities shall be assigned unique sample identification (ID) numbers. These numbers are necessary to identify and track each of the samples collected for analysis during completion of the project. In addition, the sample ID numbers shall be used to identify and retrieve the analytical results received from the laboratory, as well as other data related to the sample.

Sample IDs for previously collected samples will be included in the database as they were originally identified. No changes will be made to sample IDs for previously collected samples. The following text describes the sample designations for future sampling. It should be noted that both environmental samples and QA/QC samples will be collected and submitted for laboratory analysis. The QA/QC samples will include field duplicates, matrix spikes and matrix spike duplicates, and field QC blank samples (field blanks and equipment rinsate blanks). Blank samples will have sample IDs that identify the sample as a specific type of blank (rinsate, field, etc.). Blank samples will not contain any location ID.

In general, sample IDs will identify, in the following order, Location ID, the date, the medium sampled, and a QA/QC designation (for samples submitted as field duplicates, for matrix spike analysis). In addition, for sediment samples, the depth interval for the sample will also be included in the sample ID. Multiple samples (surface water samples collected over time, for example) at a given location will all have the same sample ID, but they will be identified uniquely by the combination of the sample ID and sample date. With the exception of blank samples, each sample ID will contain the sample location.

The sample ID code is not limited to a specific number of digits, except for practical limitations in listing the sample ID in report tables. Sample IDs will be assigned as described in Worksheet #14.

Chain-of-custody Procedures: Completed COC forms are required for all samples to be analyzed. COC forms will be initiated by the field sampling crew in the field. The COC will contain the unique sample identification, sample date and time, sample description, sample type, preservation (if any), and analyses required. The original COC form will accompany the samples to the laboratory. Copies of the COC will be made prior to shipment (or multiple copy forms will be used) for field documentation. The COC forms will remain with the samples at all times. The samples and signed COC forms will remain in the possession of the sampling crew until the samples are delivered to the express carrier (e.g. Federal Express), transferred to the designated laboratory courier, hand delivered to the permanent laboratory, or placed in secure storage.

Sample labels will be completed for each sample using waterproof ink. The labels will include the information listed in Worksheet #14. The completed sample labels will be affixed to each sample bottle and covered with clear tape.

Worksheet #28 QC Samples Tables

Worksheet #	Analytical Group and Matrix
28-1	PCB Homologs (Low/Medium/High Level) EPA 680 Modified, Sediment
28-2	PCB Aroclors (Low/Medium/High Level) SW-846 8082A, Sediment
28-3	TAL Metals (Low/Medium/High Level), SW-846 6020A, Sediment
28-4	Total Mercury (Low/Medium/High Level), EPA 245.7, Sediment
28-5	TOC – Lloyd Kahn, Sediment
28-6	Grain Size and Hydrometer
28-7	PCB Homologs (Low/Medium/High Level) EPA 680 Modified, Surface Water/Elutriate
28-8	PCB Aroclors (Low/Medium/High Level) SW-846 8082A, Surface Water/Elutriate
28-9	TAL Metals (Low/Medium/High Level), SW-846 6020A, Surface Water/Elutriate
28-10	Total Mercury (Low/Medium/High Level), EPA 245.7, Surface Water/Elutriate

Worksheet #28-1 QC Samples Table

Matrix:	Sediment	**Sampling SOP:**	S-1	**Field Sampling Organization:**		Amec Foster Wheeler
Analytical Group:	PCB Homologs	**Analytical Method/ SOP Reference:**	EPA 680 modified / L-1	**Analytical Organization:**		EnviroSytems, Inc.
Concentration Level:	Low/Medium/High	**Sampler's Name:**	TBD	**No. of Sample Locations:**		TBD
QC Sample	**Frequency/ Number**	**Method/ SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
ICAL: 6 points plus a calibration blank.	Daily prior to sample analysis.	If more than one calibration standard is used, r ≥0.995.	Correct problem and repeat calibration.	Analyst and Data Validator	Accuracy/Bias and Precision	Linear least squares regression r≥0.995
Second source calibration verification (ICV)	One after each ICAL	All project analytes within ±10% of true value.	Correct problem and verify second source standard. Rerun second source verification. If that fails, correct problem and repeat ICAL.	Analyst and Data Validator	Accuracy/Bias and Precision	All project analytes within ±10% of true value.
CCV	After every 10 samples and at the end of the analysis sequence.	±20% of true value	Reanalyze and qualify data	Analyst and Data Validator	Accuracy/Bias and Precision	±20% of true value
Equipment Blank	One per processing area (boat/shore)	< RL	Qualify data	Data Validator	Accuracy/Bias-Contamination	< RL
Method Blank	One per extraction batch of 20 or fewer samples.	Less than RL	Investigate source of contamination, re-digest and reanalyze all associated samples if sample concentration ≥RL.	Analyst and Data Validator	Accuracy/Bias-Contamination	Assess action levels and qualify sample results < action levels as not-detected.

Worksheet #28-1 QC Samples Table

Matrix:	Sediment	**Sampling SOP:**	S-1	**Field Sampling Organization:**	Amec Foster Wheeler
Analytical Group:	PCB Homologs	**Analytical Method/ SOP Reference:**	EPA 680 modified / L-1	**Analytical Organization:**	EnviroSytems, Inc.
Concentration Level:	Low/Medium/High	**Sampler's Name:**	TBD	**No. of Sample Locations:**	TBD

QC Sample	Frequency/ Number	Method/ SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Calibration Blank	Internal calibration blank (ICB): immediately after ICV Continuing Calibration Blank (CCB): every 10 samples immediately after CCV	< RL	Re-clean, retest, reanalyze, and/or qualify data	Analyst and Data Validator	Accuracy/Bias-Contamination	Assess action levels and qualify sample results < action levels as not-detected.
Cooler Temperature Blank	1 per sample cooler	≤ 6°C	Resample and/or qualify data	FOL and Data Validator	Accuracy/Bias-Preservation	≤ 6°C
Field Duplicate	One per 10	NA	Qualify data	Data Validator	Accuracy/Bias	RPD ≤50 when positive results for both samples are ≥5x RL For analytes detected < 5x the RL the absolute difference between sample concentrations must be ≤4x the RL.
Surrogates	3 per sample	Percent recovery 30-150	Qualify data	Analyst and Data Validator	Accuracy/Bias	Percent recoveries 30-150
Laboratory Matrix Spike	One per prep batch or matrix	Percent recovery 40-140	Qualify data	Analyst and Data Validator	Accuracy/Bias	Percent recoveries 40-140
Matrix Spike Duplicates	One per prep batch or matrix	Percent recovery 40-140, RPD ≤50	Qualify data	Analyst and Data Validator	Accuracy/Bias	Percent recoveries 40-140, RPD ≤50.
LCS	One per batch	Percent recoveries 40-140	Determine cause of problem, reanalyze, and/or qualify data	Analyst and Data Validator	Accuracy/bias	Percent recoveries 40-140

Worksheet #28-2 QC Samples Table

Matrix:	Sediment	**Sampling SOP:**	S-1	**Field Sampling Organization:**		Amec Foster Wheeler
Analytical Group:	PCB Aroclors	**Analytical Method/ SOP Reference:**	SW-846 8082A / L-2	**Analytical Organization:**		EnviroSystems, Inc.
Concentration Level:	Low/Medium/High	**Sampler's Name:**	TBD	**No. of Sample Locations:**		TBD
QC Sample	**Frequency/ Number**	**Method/ SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
ICAL: 6 points plus a calibration blank.	Daily prior to sample analysis.	If more than one calibration standard is used, r ≥0.995.	Correct problem and repeat calibration.	Analyst and Data Validator	Accuracy/Bias and Precision	Linear least squares regression r≥0.995
Second source calibration verification (ICV)	One after each ICAL	All project analytes within ±10% of true value.	Correct problem and verify second source standard. Rerun second source verification. If that fails, correct problem and repeat ICAL.	Analyst and Data Validator	Accuracy/Bias and Precision	All project analytes within ±10% of true value.
CCV	After every 10 samples and at the end of the analysis sequence.	±20% of true value	Reanalyze and qualify data	Analyst and Data Validator	Accuracy/Bias and Precision	±20% of true value
Equipment Blank	One per processing area (boat/shore)	< RL	Qualify data	Data Validator	Accuracy/Bias-Contamination	< RL
Method Blank	One per extraction batch of 20 or fewer samples.	Less than RL	Investigate source of contamination, re-digest and reanalyze all associated samples if sample concentration ≥RL.	Analyst and Data Validator	Accuracy/Bias-Contamination	Assess action levels and qualify sample results < action levels as not-detected.
Calibration Blank	ICB: immediately after ICV CCB: every 10 samples immediately after CCV	< RL	Re-clean, retest, reanalyze, and/or qualify data	Analyst and Data Validator	Accuracy/Bias-Contamination	Assess action levels and qualify sample results < action levels as not-detected.

Worksheet #28-2 QC Samples Table

Matrix:	Sediment	**Sampling SOP:**	S-1	**Field Sampling Organization:**	Amec Foster Wheeler
Analytical Group:	PCB Aroclors	**Analytical Method/ SOP Reference:**	SW-846 8082A / L-2	**Analytical Organization:**	EnviroSystems, Inc.
Concentration Level:	Low/Medium/High	**Sampler's Name:**	TBD	**No. of Sample Locations:**	TBD

QC Sample	**Frequency/ Number**	**Method/ SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
Cooler Temperature Blank	1 per sample cooler	≤ 6°C	Resample and/or qualify data	FOL and Data Validator	Accuracy/Bias-Preservation	≤ 6°C
Field Duplicate	One per 10	NA	Qualify data	Data Validator	Accuracy/Bias	RPD ≤50 when positive results for both samples are ≥5x RL For analytes detected < 5x the RL the absolute difference between sample concentrations must be ≤4x the RL.
Surrogates	3 per sample	Percent recovery 30-150	Qualify data	Analyst and Data Validator	Accuracy/Bias	Percent recoveries 30-150
Laboratory Matrix Spike	One per prep batch or matrix	Percent recovery 40-140	Qualify data	Analyst and Data Validator	Accuracy/Bias	Percent recoveries 40-140
Matrix Spike Duplicates	One per prep batch or matrix	Percent recovery 40-140, RPD ≤50	Qualify data	Analyst and Data Validator	Accuracy/Bias	Percent recoveries 40-140, RPD ≤50.
LCS	One per batch	Percent recoveries 40-140	Determine cause of problem, reanalyze, and/or qualify data	Analyst and Data Validator	Accuracy/bias	Percent recoveries 40-140

Worksheet #28-3 QC Samples Table

Matrix:	Sediment	**Sampling SOP:**	S-1	**Field Sampling Organization:**	Amec Foster Wheeler
Analytical Group:	TAL Metals	**Analytical Method/ SOP Reference:**	SW-846 6020A / L-3	**Analytical Organization:**	EnviroSystems, Inc.
Concentration Level:	Low/Medium/High	**Sampler's Name:**	TBD	**No. of Sample Locations:**	TBD

QC Sample	Frequency/ Number	Method/ SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
5 points plus a calibration blank.	Daily prior to sample analysis.	RSD ≤ 15%	Correct problem and repeat calibration.	Analyst and Data Validator	Accuracy/Bias and Precision	RSD ≤ 15%
Second source calibration verification (ICV)	One after each ICAL	77-123% Recovery	Correct problem and verify second source standard. Rerun second source verification. If that fails, correct problem and repeat ICAL.	Analyst and Data Validator	Accuracy/Bias and Precision	77-123% Recovery
CCV	After every 10 samples and at the end of the analysis sequence.	77-123% Recovery	Recalibrate instrument and reanalyze samples from last acceptable CCV or analyze two additional CCVs. If either of the two CCV fails, the analysis is terminated, the instrument is recalibrated and the previous 10 samples are reanalyzed.	Analyst and Data Validator	Accuracy/Bias and Precision	77-123% Recovery
Project Quantitation Limit (PQL) Standard	Every ICAL	±25% of true value	Correct problem and reanalyze.	Analyst and Data Validator	Accuracy/Bias	Percent recovery 75-125
Equipment Blank	One per processing area (boat/shore)	< RL	Qualify data	Data Validator	Accuracy/Bias - Contamination	Assess action levels and qualify sample results < action levels as not-detected.
Method Blank	One per preparation batch	< RL	Re-clean, retest, reanalyze, and/or qualify data	Analyst and Data Validator	Accuracy/Bias - Contamination	Assess action levels and qualify sample results < action levels as not-detected.

Worksheet #28-3 QC Samples Table

Matrix:	Sediment	**Sampling SOP:**	S-1	**Field Sampling Organization:**	Amec Foster Wheeler
Analytical Group:	TAL Metals	**Analytical Method/ SOP Reference:**	SW-846 6020A / L-3	**Analytical Organization:**	EnviroSystems, Inc.
Concentration Level:	Low/Medium/High	**Sampler's Name:**	TBD	**No. of Sample Locations:**	TBD

QC Sample	Frequency/ Number	Method/ SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Calibration Blanks	ICB: immediately after ICV CCB: every 10 samples immediately after CCV	< RL	Re-clean, retest, reanalyze, and/or qualify data	Analyst and Data Validator	Accuracy/Bias - Contamination	Assess action levels and qualify sample results < action levels as not-detected.
Cooler Temperature Blank	1 per sample cooler	Frozen; If frozen is not possible, then chilled ≤ 4ºC.	Resample and/or qualify data	FOL and Data Validator	Accuracy/Bias -Preservation	Frozen; If frozen is not possible, then chilled ≤ 4ºC.
Field Duplicate	One per 10	NA	Qualify data	Data Validator	Accuracy/Bias	RPD ≤50 when positive results for both samples are ≥5x RL For analytes detected < 5x the RL the absolute difference between sample concentrations must be ≤4x the RL.
Laboratory Duplicate	One per batch	SOP = RPD < 35	Qualify data	Data Validator	Precision	RPD < 35 if results ≥ 5x RL
Laboratory Matrix Spike	One per 10 samples per matrix	Percent recovery 75-125	Qualify data	Analyst and Data Validator	Accuracy/Bias	Percent recoveries 75-125
Matrix Spike Duplicates	One per 10 samples per matrix	Percent recovery 75-125, RPD ≤50	Qualify data	Analyst and Data Validator	Accuracy/Bias	Percent recoveries 75-125, RPD ≤50
LCS	One per batch	Percent recoveries 80-120	Determine cause of problem, reanalyze, and/or qualify data	Analyst and Data Validator	Accuracy/bias	Percent recoveries 80-120
Ongoing Precision and Recovery (OPR)	Beginning and end of each analytical batch, or at the end of each 12-hour shift	Percent recovery 77-123	Determine cause of problem, reanalyze, and/or qualify data	Analyst and Data Validator	Accuracy/Bias	Percent recovery 77-123

Worksheet #28-4 QC Samples Table

Matrix:	Sediment	**Sampling SOP:**	S-1	**Field Sampling Organization:**	Amec Foster Wheeler
Analytical Group:	Total Mercury	**Analytical Method/ SOP Reference:**	SW-846 245.7 / L-5	**Analytical Organization:**	EnviroSystems, Inc.
Concentration Level:	Low/Medium/High	**Sampler's Name:**	TBD	**No. of Sample Locations:**	TBD

QC Sample	Frequency/ Number	Method/ SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
5 points plus a calibration blank.	Daily prior to sample analysis.	RSD ≤ 15%	Correct problem and repeat calibration.	Analyst and Data Validator	Accuracy/Bias and Precision	RSD ≤ 15%
Second source calibration verification (ICV)	One after each ICAL	77-123% Recovery	Correct problem and verify second source standard. Rerun second source verification. If that fails, correct problem and repeat ICAL.	Analyst and Data Validator	Accuracy/Bias and Precision	77-123% Recovery
CCV	After every 10 samples and at the end of the analysis sequence.	77-123% Recovery	Recalibrate instrument and reanalyze samples from last acceptable CCV or analyze two additional CCVs. If either of the two CCV fails, the analysis is terminated, the instrument is recalibrated and the previous 10 samples are reanalyzed.	Analyst and Data Validator	Accuracy/Bias and Precision	77-123% Recovery
PQL Standard	Every ICAL	±25% of true value	Correct problem and reanalyze.	Analyst and Data Validator	Accuracy/Bias	Percent recovery 75-125
Equipment Blank	One per processing area (boat/shore)	< RL	Qualify data	Data Validator	Accuracy/Bias - Contamination	Assess action levels and qualify sample results < action levels as not-detected.
Method Blank	One per preparation batch	< RL	Re-clean, retest, reanalyze, and/or qualify data	Analyst and Data Validator	Accuracy/Bias - Contamination	Assess action levels and qualify sample results < action levels as not-detected.
Calibration Blanks	ICB: immediately after ICV CCB: every 10 samples immediately after CCV	< RL	Re-clean, retest, reanalyze, and/or qualify data	Analyst and Data Validator	Accuracy/Bias - Contamination	Assess action levels and qualify sample results < action levels as not-detected.

Worksheet #28-4 QC Samples Table

Matrix:	Sediment	**Sampling SOP:**	S-1	**Field Sampling Organization:**	Amec Foster Wheeler
Analytical Group:	Total Mercury	**Analytical Method/ SOP Reference:**	SW-846 245.7 / L-5	**Analytical Organization:**	EnviroSystems, Inc.
Concentration Level:	Low/Medium/High	**Sampler's Name:**	TBD	**No. of Sample Locations:**	TBD

QC Sample	Frequency/ Number	Method/ SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Cooler Temperature Blank	1 per sample cooler	Frozen; If frozen is not possible, then chilled ≤ 4ºC.	Resample and/or qualify data	FOL and Data Validator	Accuracy/Bias -Preservation	Frozen; If frozen is not possible, then chilled ≤ 4ºC.
Field Duplicate	One per 10	NA	Qualify data	Data Validator	Accuracy/Bias	RPD ≤50 when positive results for both samples are ≥5x RL For analytes detected < 5x the RL the absolute difference between sample concentrations must be ≤4x the RL.
Laboratory Duplicate	One per batch	SOP = RPD < 35	Qualify data	Data Validator	Precision	RPD < 35 if results ≥ 5x RL
Laboratory Matrix Spike	One per 10 samples per matrix	Percent recovery 75-125	Qualify data	Analyst and Data Validator	Accuracy/Bias	Percent recoveries 75-125
Matrix Spike Duplicates	One per 10 samples per matrix	Percent recovery 75-125, RPD ≤50	Qualify data	Analyst and Data Validator	Accuracy/Bias	Percent recoveries 75-125, RPD ≤50
LCS	One per batch	Percent recoveries 80-120	Determine cause of problem, reanalyze, and/or qualify data	Analyst and Data Validator	Accuracy/bias	Percent recoveries 80-120
Ongoing Precision and Recovery (OPR)	Beginning and end of each analytical batch, or at the end of each 12-hour shift	Percent recovery 77-123	Determine cause of problem, reanalyze, and/or qualify data	Analyst and Data Validator	Accuracy/Bias	Percent recovery 77-123

Worksheet #28-5 QC Samples Table

Matrix:	Sediment	**Sampling SOP:**	S-1	**Field Sampling Organization:**	Amec Foster Wheeler
Analytical Group:	TOC	**Analytical Method/ SOP Reference:**	Lloyd Kahn / L-6	**Analytical Organization:**	EnviroSystems, Inc.
Concentration Level:	Low/Medium/High	**Sampler's Name:**	TBD	**No. of Sample Locations:**	TBD

QC Sample	**Frequency/ Number**	**Method/ SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
ICAL: 5 points plus a calibration blank.	Daily prior to sample analysis.	If more than one calibration standard is used, r ≥0.995.	Correct problem and repeat calibration.	Analyst and Data Validator	Accuracy/Bias and Precision	Linear least squares regression r≥0.995
Second source calibration verification (ICV)	One after each ICAL	All project analytes within ±20% of true value.	Correct problem and verify second source standard. Rerun second source verification. If that fails, correct problem and repeat ICAL.	Analyst and Data Validator	Accuracy/Bias and Precision	All project analytes within ±20% of true value.
High level Calibration Verification	One after each ICAL	±20% of true value	Correct problem and verify standard. Rerun, if that fails, correct problem and repeat ICAL.	Analyst and Data Validator	Accuracy/Bias and Precision	±20% of true value
CCV	After every 10 samples and at the end of the analysis sequence.	±20% of true value	Reanalyze and qualify data	Analyst and Data Validator	Accuracy/Bias and Precision	±20% of true value
Method Blank	One per preparation batch	< RL	Re-clean, retest, reanalyze, and/or qualify data	Analyst and Data Validator	Accuracy/Bias-Contamination	Assess action levels and qualify sample results < action levels as not-detected.
Calibration Blank	ICB: immediately after ICV CCB: every 10 samples immediately after CCV	< RL	Re-clean, retest, reanalyze, and/or qualify data	Analyst and Data Validator	Accuracy/Bias-Contamination	Assess action levels and qualify sample results < action levels as not-detected.

Worksheet #28-5 QC Samples Table

Matrix:	Sediment	**Sampling SOP:**	S-1	**Field Sampling Organization:**		Amec Foster Wheeler
Analytical Group:	TOC	**Analytical Method/ SOP Reference:**	Lloyd Kahn / L-6	**Analytical Organization:**		EnviroSystems, Inc.
Concentration Level:	Low/Medium/High	**Sampler's Name:**	TBD	**No. of Sample Locations:**		TBD
QC Sample	**Frequency/ Number**	**Method/ SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
Cooler Temperature Blank	1 per sample cooler	≤ 6°C	Resample and/or qualify data	FOL and Data Validator	Accuracy/Bias-Preservation	≤ 6°C
Field Duplicate	One per 10	NA	Qualify data	Data Validator	Accuracy/Bias	RPD ≤50 when positive results for both samples are ≥5x RL For analytes detected < 5x the RL the absolute difference between sample concentrations must be ≤4x the RL.
Laboratory Duplicate	One per batch	NA	Qualify data	Data Validator	Precision	RPD < 25 if results ≥ 5x QL
Laboratory Matrix Spike	One per prep batch or matrix	Percent recovery 75-125	Qualify data	Analyst and Data Validator	Accuracy/Bias	Percent recoveries 75-125
Matrix Spike Duplicates	One per prep batch or matrix	Percent recovery 75-125, RPD ≤25	Qualify data	Analyst and Data Validator	Accuracy/Bias	Percent recoveries 75-125, RPD ≤25
LCS	One per batch	Percent recoveries 75-125	Determine cause of problem, reanalyze, and/or qualify data	Analyst and Data Validator	Accuracy/bias	Percent recoveries 75-125

Worksheet #28-6 QC Samples Table

Matrix:	Sediment	**Sampling SOP:**	S-1	**Field Sampling Organization:**		Amec Foster Wheeler
Analytical Group:	Grain size with Hydrometer	**Analytical Method/SOP Reference:**	ASTM D422, D421 / L-15, L-16	**Analytical Organization:**		EnviroSystems, Inc.
Concentration Level:	NA	**Sampler's Name:**	TBD	**No. of Sample Locations:**		TBD
QC Sample	**Frequency/ Number**	**Method/ SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
Field Duplicate	One per 10	NA	Qualify data	Data Validator	Accuracy/Bias	RPD ≤50 when positive results for both samples are ≥5x RL For analytes detected < 5x the RL the absolute difference between sample concentrations must be ≤4x the RL.

Worksheet #28-7 QC Samples Table

Matrix:	Surface Water/Elutriate	**Sampling SOP:**	S-2	**Field Sampling Organization:**		Amec Foster Wheeler
Analytical Group:	PCB Homologs	**Analytical Method/ SOP Reference:**	EPA 680 modified / L-1	**Analytical Organization:**		EnviroSystems, Inc.
Concentration Level:	Low/Medium/High	**Sampler's Name:**	TBD	**No. of Sample Locations:**		TBD
QC Sample	**Frequency/ Number**	**Method/ SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
ICAL: 6 points plus a calibration blank.	Daily prior to sample analysis.	If more than one calibration standard is used, r ≥0.995.	Correct problem and repeat calibration.	Analyst and Data Validator	Accuracy/Bias and Precision	Linear least squares regression r≥0.995

Worksheet #28-7 QC Samples Table

Matrix:	Surface Water/Elutriate	**Sampling SOP:**	S-2	**Field Sampling Organization:**	Amec Foster Wheeler
Analytical Group:	PCB Homologs	**Analytical Method/ SOP Reference:**	EPA 680 modified / L-1	**Analytical Organization:**	EnviroSystems, Inc.
Concentration Level:	Low/Medium/High	**Sampler's Name:**	TBD	**No. of Sample Locations:**	TBD

QC Sample	Frequency/ Number	Method/ SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Second source calibration verification (ICV)	One after each ICAL	All project analytes within ±10% of true value.	Correct problem and verify second source standard. Rerun second source verification. If that fails, correct problem and repeat ICAL.	Analyst and Data Validator	Accuracy/Bias and Precision	All project analytes within ±10% of true value.
CCV	After every 10 samples and at the end of the analysis sequence.	±20% of true value	Reanalyze and qualify data	Analyst and Data Validator	Accuracy/Bias and Precision	±20% of true value
Equipment Blank	One per processing area (boat/shore)	< RL	Qualify data	Data Validator	Accuracy/Bias-Contamination	< RL
Method Blank	One per extraction batch of 20 or fewer samples.	Less than RL	Investigate source of contamination, re-digest and reanalyze all associated samples if sample concentration ≥RL.	Analyst and Data Validator	Accuracy/Bias-Contamination	Assess action levels and qualify sample results < action levels as not-detected.
Calibration Blank	ICB: immediately after ICV CCB: every 10 samples immediately after CCV	< RL	Re-clean, retest, reanalyze, and/or qualify data	Analyst and Data Validator	Accuracy/Bias-Contamination	Assess action levels and qualify sample results < action levels as not-detected.
Cooler Temperature Blank	1 per sample cooler	≤ 6°C	Resample and/or qualify data	FOL and Data Validator	Accuracy/Bias-Preservation	≤ 6°C

Worksheet #28-7 QC Samples Table

Matrix:	Surface Water/Elutriate	**Sampling SOP:**	S-2	**Field Sampling Organization:**	Amec Foster Wheeler
Analytical Group:	PCB Homologs	**Analytical Method/ SOP Reference:**	EPA 680 modified / L-1	**Analytical Organization:**	EnviroSystems, Inc.
Concentration Level:	Low/Medium/High	**Sampler's Name:**	TBD	**No. of Sample Locations:**	TBD

QC Sample	Frequency/ Number	Method/ SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Field Duplicate	One per 10	NA	Qualify data	Data Validator	Accuracy/Bias	RPD ≤30 when positive results for both samples are ≥5x RL For analytes detected < 5x the RL the absolute difference between sample concentrations must be ≤4x the RL.
Surrogates	3 per sample	Percent recovery 30-150	Qualify data	Analyst and Data Validator	Accuracy/Bias	Percent recoveries 30-150
Laboratory Matrix Spike	One per prep batch or matrix	Percent recovery 40-140	Qualify data	Analyst and Data Validator	Accuracy/Bias	Percent recoveries 40-140
Matrix Spike Duplicates	One per prep batch or matrix	Percent recovery 40-140, RPD ≤50	Qualify data	Analyst and Data Validator	Accuracy/Bias	Percent recoveries 40-140, RPD ≤50.
LCS	One per batch	Percent recoveries 40-140	Determine cause of problem, reanalyze, and/or qualify data	Analyst and Data Validator	Accuracy/bias	Percent recoveries 40-140

Worksheet #28-8 QC Samples Table

Matrix:	Surface Water/Elutriate	**Sampling SOP:**	S-2	**Field Sampling Organization:**	Amec Foster Wheeler
Analytical Group:	PCB Aroclors	**Analytical Method/ SOP Reference:**	SW-846 8082A / L-2	**Analytical Organization:**	EnviroSystems, Inc.
Concentration Level:	Low/Medium/High	**Sampler's Name:**	TBD	**No. of Sample Locations:**	TBD

QC Sample	Frequency/ Number	Method/ SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
ICAL: 6 points plus a calibration blank.	Daily prior to sample analysis.	If more than one calibration standard is used, r ≥0.995.	Correct problem and repeat calibration.	Analyst and Data Validator	Accuracy/Bias and Precision	Linear least squares regression r≥0.995
Second source calibration verification (ICV)	One after each ICAL	All project analytes within ±10% of true value.	Correct problem and verify second source standard. Rerun second source verification. If that fails, correct problem and repeat ICAL.	Analyst and Data Validator	Accuracy/Bias and Precision	All project analytes within ±10% of true value.
CCV	After every 10 samples and at the end of the analysis sequence.	±20% of true value	Reanalyze and qualify data	Analyst and Data Validator	Accuracy/Bias and Precision	±20% of true value
Equipment Blank	One per processing area (boat/shore)	< RL	Qualify data	Data Validator	Accuracy/Bias-Contamination	< RL
Method Blank	One per extraction batch of 20 or fewer samples.	Less than RL	Investigate source of contamination, re-digest and reanalyze all associated samples if sample concentration ≥RL.	Analyst and Data Validator	Accuracy/Bias-Contamination	Assess action levels and qualify sample results < action levels as not-detected.
Calibration Blank	ICB: immediately after ICV CCB: every 10 samples immediately after CCV	< RL	Re-clean, retest, reanalyze, and/or qualify data	Analyst and Data Validator	Accuracy/Bias-Contamination	Assess action levels and qualify sample results < action levels as not-detected.

Worksheet #28-8 QC Samples Table

Matrix:	Surface Water/Elutriate	**Sampling SOP:**	S-2	**Field Sampling Organization:**	Amec Foster Wheeler
Analytical Group:	PCB Aroclors	**Analytical Method/ SOP Reference:**	SW-846 8082A / L-2	**Analytical Organization:**	EnviroSystems, Inc.
Concentration Level:	Low/Medium/High	**Sampler's Name:**	TBD	**No. of Sample Locations:**	TBD

QC Sample	Frequency/ Number	Method/ SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Cooler Temperature Blank	1 per sample cooler	≤ 6°C	Resample and/or qualify data	FOL and Data Validator	Accuracy/Bias-Preservation	≤ 6°C
Field Duplicate	One per 10	NA	Qualify data	Data Validator	Accuracy/Bias	RPD ≤30 when positive results for both samples are ≥5x RL For analytes detected < 5x the RL the absolute difference between sample concentrations must be ≤4x the RL.
Surrogates	3 per sample	Percent recovery 30-150	Qualify data	Analyst and Data Validator	Accuracy/Bias	Percent recoveries 30-150
Laboratory Matrix Spike	One per prep batch or matrix	Percent recovery 40-140	Qualify data	Analyst and Data Validator	Accuracy/Bias	Percent recoveries 40-140
Matrix Spike Duplicates	One per prep batch or matrix	Percent recovery 40-140, RPD ≤50	Qualify data	Analyst and Data Validator	Accuracy/Bias	Percent recoveries 40-140, RPD ≤50.
LCS	One per batch	Percent recoveries 40-140	Determine cause of problem, reanalyze, and/or qualify data	Analyst and Data Validator	Accuracy/bias	Percent recoveries 40-140

Worksheet #28-9 QC Samples Table

Matrix:	Surface Water Elutriate	**Sampling SOP:**	S-2	**Field Sampling Organization:**	Amec Foster Wheeler
Analytical Group:	TAL Metals	**Analytical Method/ SOP Reference:**	SW-846 6020A / L-3	**Analytical Organization:**	EnviroSystems, Inc.
Concentration Level:	Low/Medium/High	**Sampler's Name:**	TBD	**No. of Sample Locations:**	TBD

QC Sample	Frequency/ Number	Method/ SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
5 points plus a calibration blank.	Daily prior to sample analysis.	RSD ≤ 15%	Correct problem and repeat calibration.	Analyst and Data Validator	Accuracy/Bias and Precision	RSD ≤ 15%
Second source calibration verification (ICV)	One after each ICAL	77-123% Recovery	Correct problem and verify second source standard. Rerun second source verification. If that fails, correct problem and repeat ICAL.	Analyst and Data Validator	Accuracy/Bias and Precision	77-123% Recovery
CCV	After every 10 samples and at the end of the analysis sequence.	77-123% Recovery	Recalibrate instrument and reanalyze samples from last acceptable CCV or analyze two additional CCVs. If either of the two CCV fails, the analysis is terminated, the instrument is recalibrated and the previous 10 samples are reanalyzed.	Analyst and Data Validator	Accuracy/Bias and Precision	77-123% Recovery
PQL Standard	Every ICAL	±25% of true value	Correct problem and reanalyze.	Analyst and Data Validator	Accuracy/Bias	Percent recovery 75-125
Equipment Blank	One per processing area (boat/shore)	< RL	Qualify data	Data Validator	Accuracy/Bias - Contamination	Assess action levels and qualify sample results < action levels as not-detected.
Method Blank	One per preparation batch	< RL	Re-clean, retest, reanalyze, and/or qualify data	Analyst and Data Validator	Accuracy/Bias - Contamination	Assess action levels and qualify sample results < action levels as not-detected.
Calibration Blanks	ICB: immediately after ICV CCB: every 10 samples immediately after CCV	< RL	Re-clean, retest, reanalyze, and/or qualify data	Analyst and Data Validator	Accuracy/Bias - Contamination	Assess action levels and qualify sample results < action levels as not-detected.

Worksheet #28-9 QC Samples Table

Matrix:	Surface Water Elutriate	**Sampling SOP:**	S-2	**Field Sampling Organization:**	Amec Foster Wheeler
Analytical Group:	TAL Metals	**Analytical Method/ SOP Reference:**	SW-846 6020A / L-3	**Analytical Organization:**	EnviroSystems, Inc.
Concentration Level:	Low/Medium/High	**Sampler's Name:**	TBD	**No. of Sample Locations:**	TBD

QC Sample	Frequency/ Number	Method/ SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Cooler Temperature Blank	1 per sample cooler	Frozen; If frozen is not possible, then chilled ≤ 4ºC.	Resample and/or qualify data	FOL and Data Validator	Accuracy/Bias -Preservation	Frozen; If frozen is not possible, then chilled ≤ 4ºC.
Field Duplicate	One per 10	NA	Qualify data	Data Validator	Accuracy/Bias	RPD ≤30 when positive results for both samples are ≥5x RL For analytes detected < 5x the RL the absolute difference between sample concentrations must be ≤4x the RL.
Laboratory Duplicate	One per batch	SOP = RPD < 20	Qualify data	Data Validator	Precision	RPD < 20 if results ≥ 5x RL
Laboratory Matrix Spike	One per 10 samples per matrix	Percent recovery 75-125	Qualify data	Analyst and Data Validator	Accuracy/Bias	Percent recoveries 75-125
Matrix Spike Duplicates	One per 10 samples per matrix	Percent recovery 75-125, RPD ≤50	Qualify data	Analyst and Data Validator	Accuracy/Bias	Percent recoveries 75-125, RPD ≤50
LCS	One per batch	Percent recoveries 80-120	Determine cause of problem, reanalyze, and/or qualify data	Analyst and Data Validator	Accuracy/bias	Percent recoveries 80-120
Ongoing Precision and Recovery (OPR)	Beginning and end of each analytical batch, or at the end of each 12-hour shift	Percent recovery 77-123	Determine cause of problem, reanalyze, and/or qualify data	Analyst and Data Validator	Accuracy/Bias	Percent recovery 77-123

Worksheet #28-10 QC Samples Table

Matrix:	Surface Water/Elutriate	**Sampling SOP:**	S-1	**Field Sampling Organization:**	Amec Foster Wheeler
Analytical Group:	Total Mercury	**Analytical Method/ SOP Reference:**	SW-846 245.7 / L-5	**Analytical Organization:**	EnviroSystems, Inc.
Concentration Level:	Low/Medium/High	**Sampler's Name:**	TBD	**No. of Sample Locations:**	TBD

QC Sample	Frequency/ Number	Method/ SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
5 points plus a calibration blank.	Daily prior to sample analysis.	RSD ≤ 15%	Correct problem and repeat calibration.	Analyst and Data Validator	Accuracy/Bias and Precision	RSD ≤ 15%
Second source calibration verification (ICV)	One after each ICAL	77-123% Recovery	Correct problem and verify second source standard. Rerun second source verification. If that fails, correct problem and repeat ICAL.	Analyst and Data Validator	Accuracy/Bias and Precision	77-123% Recovery
CCV	After every 10 samples and at the end of the analysis sequence.	77-123% Recovery	Recalibrate instrument and reanalyze samples from last acceptable CCV or analyze two additional CCVs. If either of the two CCV fails, the analysis is terminated, the instrument is recalibrated and the previous 10 samples are reanalyzed.	Analyst and Data Validator	Accuracy/Bias and Precision	77-123% Recovery
PQL Standard	Every ICAL	±25% of true value	Correct problem and reanalyze.	Analyst and Data Validator	Accuracy/Bias	Percent recovery 75-125
Equipment Blank	One per processing area (boat/shore)	< RL	Qualify data	Data Validator	Accuracy/Bias - Contamination	Assess action levels and qualify sample results < action levels as not-detected.
Method Blank	One per preparation batch	< RL	Re-clean, retest, reanalyze, and/or qualify data	Analyst and Data Validator	Accuracy/Bias - Contamination	Assess action levels and qualify sample results < action levels as not-detected.
Calibration Blanks	ICB: immediately after ICV CCB: every 10 samples immediately after CCV	< RL	Re-clean, retest, reanalyze, and/or qualify data	Analyst and Data Validator	Accuracy/Bias - Contamination	Assess action levels and qualify sample results < action levels as not-detected.

Worksheet #28-10 QC Samples Table

Matrix:	Surface Water/Elutriate	**Sampling SOP:**	S-1	**Field Sampling Organization:**	Amec Foster Wheeler
Analytical Group:	Total Mercury	**Analytical Method/ SOP Reference:**	SW-846 245.7 / L-5	**Analytical Organization:**	EnviroSystems, Inc.
Concentration Level:	Low/Medium/High	**Sampler's Name:**	TBD	**No. of Sample Locations:**	TBD

QC Sample	**Frequency/ Number**	**Method/ SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
Cooler Temperature Blank	1 per sample cooler	Frozen; If frozen is not possible, then chilled ≤ 4ºC.	Resample and/or qualify data	FOL and Data Validator	Accuracy/Bias -Preservation	Frozen; If frozen is not possible, then chilled ≤ 4ºC.
Field Duplicate	One per 10	NA	Qualify data	Data Validator	Accuracy/Bias	RPD ≤30 when positive results for both samples are ≥5x RL For analytes detected < 5x the RL the absolute difference between sample concentrations must be ≤4x the RL.
Laboratory Duplicate	One per batch	SOP = RPD < 20	Qualify data	Data Validator	Precision	RPD < 20 if results ≥ 5x RL
Laboratory Matrix Spike	One per 10 samples per matrix	Percent recovery 75-125	Qualify data	Analyst and Data Validator	Accuracy/Bias	Percent recoveries 75-125
Matrix Spike Duplicates	One per 10 samples per matrix	Percent recovery 75-125, RPD ≤50	Qualify data	Analyst and Data Validator	Accuracy/Bias	Percent recoveries 75-125, RPD ≤50
LCS	One per batch	Percent recoveries 80-120	Determine cause of problem, reanalyze, and/or qualify data	Analyst and Data Validator	Accuracy/bias	Percent recoveries 80-120
Ongoing Precision and Recovery (OPR)	Beginning and end of each analytical batch, or at the end of each 12-hour shift	Percent recovery 77-123	Determine cause of problem, reanalyze, and/or qualify data	Analyst and Data Validator	Accuracy/Bias	Percent recovery 77-123

Worksheet #29 Project Documents and Records Table

Worksheet #29 Project Documents and Records Table

Sample Collection Documents and Records	On-site Analysis Documents and Records	Off-site Analysis Documents and Records	Data Assessment Documents and Records	Other
Field Logbooks	Equipment Calibration Logs	Sample Receipt, Custody and Tracking Records	Field Sampling Audit Checklists	
COC Records	Equipment Maintenance, Testing and Inspection Logs	Standard Traceability Logs	Data Validation Reports	
Shipping Bills	Field Activity Forms	Equipment Calibration Summary	Corrective Action Forms (if needed)	
FDRs	Field logbooks	Sample Preparation Logs	Lab Audit Report (if performed)	
Sample Tracking Program	Calibration Standard Certificates	Instrument Logs - Run Logs		
Corrective Action Reports (if needed)	FDRs	Equipment Maintenance, Testing and Inspection Logs		
Sample Container Certificates		Corrective Action Forms (if needed)		
		Sample and QC Sample Results Reports		
		Instrument Printout (raw data) for field samples, standards, QC checks and QC samples		
		Telephone Logs		
		MDL Study Records		
		Email		

Worksheet #30 Analytical Services Table

Worksheet #30 Analytical Services Table

Matrix	Analytical Group	Concentration Level	Sample Location/ID Numbers	Analytical SOP	Data Package Turnaround Time	Laboratory/Organization (Name and Address, Contact Person and Telephone Number)	Backup Laboratory/Organization (Name and Address, Contact Person and Telephone Number
SD/SW/EL	PCB Homologs (EPA 680 Modified)	All	See FS Work Plan/FSP and task work plans	See Worksheet #23	21 Calendar Days	EnviroSytems, Inc. 1 Lafayette Road Hampton, NH 03842 Tel. 603-926-3345 rfoster@envirosystems.com	
SD/SW/EL	PCB Aroclors (SW-846 8082A)	All	See FS Work Plan/FSP and task work plans	See Worksheet #23	21 Calendar Days	EnviroSytems, Inc. 1 Lafayette Road Hampton, NH 03842 Tel. 603-926-3345 rfoster@envirosystems.com	
SD/SW/EL	TAL Metals (SW-846 6020A)	All	See FS Work Plan/FSP and task work plans	See Worksheet #23	21 Calendar Days	EnviroSytems, Inc. 1 Lafayette Road Hampton, NH 03842 Tel. 603-926-3345 rfoster@envirosystems.com	
SD	Total Mercury (SW-846 245.7)	All	See FS Work Plan/FSP and task work plans	See Worksheet #23	21 Calendar Days	EnviroSytems, Inc. 1 Lafayette Road Hampton, NH 03842 Tel. 603-926-3345 rfoster@envirosystems.com	
SD	Total Organic Carbon (Lloyd Kahn)	All	See FS Work Plan/FSP and task work plans	See Worksheet #23	21 Calendar Days	EnviroSytems, Inc. 1 Lafayette Road Hampton, NH 03842 Tel. 603-926-3345 rfoster@envirosystems.com	
SD	Grain Size and Organic Mater	All	See FS Work Plan/FSP and task work plans	See Worksheet #23	21 Calendar Days	EnviroSytems, Inc. 1 Lafayette Road Hampton, NH 03842 Tel. 603-926-3345 rfoster@envirosystems.com	

Worksheet #30 Analytical Services Table

Matrix	**Analytical Group**	**Concentration Level**	**Sample Location/ID Numbers**	**Analytical SOP**	**Data Package Turnaround Time**	**Laboratory/Organization (Name and Address, Contact Person and Telephone Number)**	**Backup Laboratory/Organization (Name and Address, Contact Person and Telephone Number**
SW	Total Mercury (SW-846 245.7)	All	See FS Work Plan/FSP and task work plans	See Worksheet #23	21 Calendar Days	EnviroSytems, Inc. 1 Lafayette Road Hampton, NH 03842 Tel. 603-926-3345 rfoster@envirosystems.com	

Work plans/work orders are identified in Worksheet 14 and Worksheet 18.

Worksheet #31   Planned Project Assessments Table

Worksheet #31 Planned Project Assessments Table

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)
Readiness Review	Initially at startup	Internal	Amec Foster Wheeler	Tony Delano, Engineering Study Lead Amec Foster Wheeler	Michael Lounsbury, FOL Amec Foster Wheeler	Tony Delano, Engineering Study Lead Amec Foster Wheeler	Rod Pendleton, PM Amec Foster Wheeler
Field Sampling Technical Systems Audit	At startup sampling	Internal	Amec Foster Wheeler	Tony Delano, Engineering Study Lead Amec Foster Wheeler	Michael Lounsbury, FOL Amec Foster Wheeler	Tony Delano, Engineering Study Lead Amec Foster Wheeler	Rod Pendleton, PM Amec Foster Wheeler
Laboratory Performance	Upon receipt of initial analytical data	Internal	Amec Foster Wheeler	Wolfgang Calicchio, Project Chemist Amec Foster Wheeler	EnviroSytems, Laboratory Manager EnviroSytems, Inc.	Catie Sasso, QA Manager, EnviroSytems, Inc.	Anne Bernhardt, QA Manager Amec Foster Wheeler
Management Review	Interim Management Review following site mobilization. Final management review upon completion of field work.	Internal	Amec Foster Wheeler	Rod Pendleton, PM Amec Foster Wheeler	Tony Delano, Engineering Study Lead Amec Foster Wheeler Rebecca Brosnan Investigation Technical Lead Amec Foster Wheeler	Rod Pendleton, PM Amec Foster Wheeler	Jeffrey Pickett, Program Manager Amec Foster Wheeler
Field Health and Safety Systems Audit (if required)	Initially at startup	Internal	Amec Foster Wheeler	Tony Delano, Engineering Study Lead Amec Foster Wheeler	Michael Lounsbury, Field Operation Lead Amec Foster Wheeler	Rod Pendleton, PM Amec Foster Wheeler	Kendra Bavor, Health and Safety Amec Foster Wheeler

Worksheet #32 Assessment Findings and Corrective Action Responses

Worksheet #32 Assessment Findings and Corrective Action Responses

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (Name, Title, Organization)	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response (Name, Title, Org.)	Timeframe for Response
Readiness Review	Memorandum	Rebecca Brosnan, Investigation Team Lead Amec Foster Wheeler	72 hours after audit	Memorandum	Rod Pendleton, PM Amec Foster Wheeler	48 hours after notification
Field Sampling Technical Systems Audit	Memorandum	Michael Lounsbury, Amec Foster Wheeler	Verbal within 24 hrs to CENAE	Memorandum	Rod Pendleton, PM Amec Foster Wheeler	48 hours after notification
Laboratory Performance	Written Audit Report	TBD, QA Manager Amec Foster Wheeler	One week after audit	Corrective Action Report	Catie Sasso, QA Manager Amec Foster Wheeler	48 hours after notification
Management Review	Memorandum	Jeffrey Pickett, Program Manager Amec Foster Wheeler	One week after audit	Memorandum	Jeffrey Pickett, Program Manager Amec Foster Wheeler	48 hours after notification
Field Health and Safety Systems Audit (if required)	Memorandum	Rod Pendleton, PM Amec Foster Wheeler	Verbal within 24 hrs to CENAE	Memorandum	Kendra Bavor, Health and Safety Amec Foster Wheeler	48 hours after notification

Worksheet #33 QA Management Reports Table

Worksheet #33 QA Management Reports Table

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)
Verbal Status Report	Weekly	At the end of every day of field activities	Michael Lounsbury, Field Operation Lead Amec Foster Wheeler	Rod Pendleton, PM Amec Foster Wheeler
Verbal or Written Status Report	As necessary	As necessary	Rod Pendleton, PM Amec Foster Wheeler	Ellen Iorio, CENAE PM
Corrective Action Report	As necessary	As necessary	TBD, Project QA Manager and Project Chemist Amec Foster Wheeler	Rod Pendleton, PM Amec Foster Wheeler
Field Sampling Technical Systems Audit Report	One at startup of sampling	Within 2-3 days of audit	Michael Lounsbury, Field Operation Lead Amec Foster Wheeler	Rod Pendleton, PM Amec Foster Wheeler
Data Usability Assessment	One after all data generated and validated	TBD	TBD, Project QA Manager and Wolfgang Calicchio Project Chemist Amec Foster Wheeler	Rod Pendleton, PM Amec Foster Wheeler
Final Project Report	One after Tidal Flats - Feasibility Study completed	TBD	Tony Delano, Engineering Study Leader Amec Foster Wheeler	Ellen Iorio, CENAE PM

Worksheet #34   Verification (Step I) Process Table

Worksheet #34 Verification (Step I) Process Table

Verification Input	Description	Internal/ External	Responsible for Verification (Name, Organization)
COCs and Shipping Forms	Chain-of-Custody forms and shipping documentation will be reviewed to verify completeness in accordance with QAPP requirements and verified against the packed sample coolers for which they represent. When everything checks out, a copy of the COC will be retained in the site file, and the original and remaining copies will be taped inside the cooler for shipment.	Internal	Michael Lounsbury, Field Operation Lead Amec Foster Wheeler
Field Logbooks and FDRs	Field records will be reviewed daily to ensure notes are accurate, all necessary calibration information has been documented, and applicable FDR forms are complete.	Internal	Michael Lounsbury, Field Operation Lead Amec Foster Wheeler
Audit Reports	Upon report completion, a copy of all audit reports will be placed in the project file. If corrective actions are required, a copy of the documented corrective action taken will be attached to the appropriate audit report in the site file. Audit reports will be reviewed internally to ensure that all appropriate corrective actions have been taken and that corrective action reports are attached. If corrective actions have not been taken, the FOL will be notified to ensure action is taken.	Internal	Rod Pendleton, PM Amec Foster Wheeler
Laboratory Data Packages*	All laboratory data packages will be verified internally by the laboratory performing the work for completeness prior to submittal.	Internal	Catie Sasso, QA Manager, EnviroSytems, Inc.
Laboratory Data Packages	All final laboratory data packages will be verified for content upon receipt.	External	TBD, Project QA Manager and Wolfgang Calicchio, Project Chemist Amec Foster Wheeler
Data Validation	All lab data reports will be technically reviewed for accuracy and completeness. Data validation is completed as specified in this QAPP.	Internal	TBD, Project QA Manager and Project Chemist Amec Foster Wheeler
Data Validation Reports	All data validation reports will be reviewed for completeness and technical content.	Internal	TBD, Project QA Manager and Wolfgang Calicchio Project Chemist Amec Foster Wheeler

*Requires a signature after review has been completed.

Worksheet #35 Validation (Steps IIa and IIb) Process Table

Worksheet #35 Validation (Steps IIa and IIb) Process Table

Step IIa/IIb	Validation Input	Description	Responsible for Validation (Name, Organization)
IIa	Sampling Methods and Procedures	Establish that required sampling methods were used and that any deviations were noted. Provide that the sampling procedures and field measurements met performance criteria and that any deviations were documented.	Michael Lounsbury, Field Operation Lead Amec Foster Wheeler, Catie Sasso, EnviroSytems, Project QA Officer and Project Chemist, Amec Foster Wheeler
IIa	Analytical Method and Procedures	Establish that required analytical methods were used and that any deviations were noted. The laboratory will provide that QC samples met performance criteria and that any deviations were documented in the report.	Catie Sasso, EnviroSytems, Laboratory QA Manager, EnviroSytems, Inc.; Alex Mackinnon, EnviroSytems, Project QA Officer and Project Chemist, Amec Foster Wheeler
IIb	Documentation of QAPP QC Sample Results	Establish that all QAPP required QC samples were collected and analyzed.	Catie Sasso, EnviroSytems, Project QA Officer and Wolfgang Calicchio, Project Chemist, Amec Foster Wheeler
IIb	Project Quantitation Limits	Determine that the project quantitation limits, outlined in the QAPP, were achieved.	Catie Sasso, EnviroSytems, Project QA Officer and Wolfgang Calicchio, Project Chemist, Amec Foster Wheeler
IIb	Performance Criteria	Evaluate QC data associated with the samples designated in Worksheet #36 against project specific performance criteria established in the QAPP and laboratory Quality Assurance Manual (QAM).	Catie Sasso, EnviroSytems, Project QA Officer and Wolfgang Calicchio, Project Chemist, Amec Foster Wheeler
IIb	Validation Report	Summarize data verification and validation components included in the Performance Review. Include final, qualified data and explanation of all qualifiers.	Catie Sasso, EnviroSytems, Project QA Officer and Wolfgang Calicchio, Project Chemist, Amec Foster Wheeler

Worksheet #36 Validation (Steps IIa and IIb) Summary Table

Worksheet #36 Validation (Steps IIa and IIb) Summary Table

Step IIa/IIb	Matrix	Analytical Group	Concentration Level	Validation Criteria	Data Validator (title and organizational affiliation)
IIa and IIb	Sediment	Organics, Inorganics	Low, medium, high	Stage 2B Validation 90% of data and Stage 3 Validation 10% of data following EPA New England Environmental Data Review Elements and Superfund Specific Guidance/Procedures, acceptance criteria as presented in Worksheets #12 and reporting limits as presented in Worksheets # 15, and applicable methods	Catie Sasso, EnviroSytems, Project QA Officer and Wolfgang Calicchio, Project Chemist, Amec Foster Wheeler
IIa and IIb	Surface Water / Elutriate	Organics, Inorganics	Low, medium, high	Stage 2B Validation 90% of data and Stage 3 Validation 10% of data following EPA New England Environmental Data Review Elements and Superfund Specific Guidance/Procedures, acceptance criteria as presented in Worksheets #12 and reporting limits as presented in Worksheets # 15, and applicable methods	Catie Sasso, EnviroSytems, Project QA Officer and Wolfgang Calicchio, Project Chemist, Amec Foster Wheeler

Worksheet #37 Usability Assessment

Worksheet #37 Usability Assessment

Summarize the usability assessment process and all procedures, including interim steps and any statistics, equations, and computer algorithms that will be used:

DATA USABILITY

Prior to completing the SAEP Tidal Flats - Feasibility Study an assessment will be completed to determine if validated laboratory data collected during the investigation are consistent with the project quality objectives established for the project. The assessment of data usability will be completed at the end of each major sample collection event. The assessment will include a review of any field program issues, sample collection issues, field measurement issues, or laboratory data quality issues that were identified during the field sampling event and subsequent data review process. A data usability report (or subsection of the SAEP Tidal Flats - Feasibility Study) will be completed that provides a discussion of field sampling problems that prevented collection of all samples, or other situations where data that were specified in work plans were not obtained. Evaluation of the parameters will be completed during data validation and chemistry reviews. Data may be qualified as estimated and potentially biased during data validation. Some result may be rejected based on the guidelines and QC results. Interpretations of the limitations on the use of the data, and the significance of data gaps will be included in the Data Usability Assessment.

PRECISION

The RPD between spike and spike duplicate, or sample and sample duplicate, is calculated to compare to precision objectives. Spike and laboratory duplicates will be used to assess analytical precision and the field duplicates will be used to assess project precision. The RPD will be calculated according to the following formula:

$$RPD = \frac{(Amount\ \ in\ Sample\ \ 1 - Amount\ \ in\ Sample\ \ 2)}{0.5\,(Amount\ \ in\ Sample\ \ 1 + Amount\ \ in\ Sample\ \ 2)}\,x\,100$$

The impact of analytical imprecision, project imprecision, and overall imprecision (when both analytical and project precision tests show problems) on data usability will be assessed. If the precision results yield data which are not usable, the Data Usability Assessment will identify how this problem will be resolved and the potential need for re-sampling will be discussed in the final project report.

ACCURACY

If field or laboratory contamination exists, the impact on the data will be evaluated during the Data Usability Assessment. The direction of bias for contamination will be identified.

Worksheet #37 Usability Assessment

to assess the accuracy of the analytical procedures, LCS and MS/MSD samples will be utilized. The increase in concentration of the analyte observed in the spiked sample, due to the addition of a known quantity of the analyte, compared to the reported value of the same analyte in the unspiked sample, determines %R.

Accuracy is similarly assessed by determining %Rs for surrogate compounds added to each field and QC sample to be analyzed for organic parameters. Accuracy for air analyses will be further assessed through determination of %Rs for Performance Evaluation (PEs) samples and calibration results. If the Data Validation Reports indicate contamination and/or analytical biases, the impact on the data will be assessed.

%R for MS/MSD results will be determined according to the following equation:

$$\%R = \frac{(Amount\ in\ Spiked\ Sample - Amount\ in\ Sample)}{Known\ Amount\ Added} x100$$

%R for LCSs and surrogate compound results will be determined according to the following equation:

$$\%R = \frac{Experiment\ al\ Concentrat\ ion}{Known\ \ Amount\ \ Added} x100$$

Overall contamination and accuracy/bias will be reviewed for each matrix and analytical parameter. The Data Usability Assessment will include any limitations on the use of the data, if it is limited to a particular matrix, SDG, parameter, or laboratory. If the accuracy results yield data which are not usable, the Data Usability Assessment will identify how this problem will be resolved and the potential need for resampling will be discussed in the final project report.

REPRESENTATIVENESS

Overall sample representativeness will be evaluated for each matrix and analytical parameter using duplicate and QC blank results. The Data Usability Assessment will include any limitations on the use of the data, if limited to a particular matrix, SDG, parameter, or laboratory. If the results of the evaluation of representativeness yield data which are not usable, the Data Usability Assessment will identify how this problem will be resolved and the potential need for resampling will be discussed in the final project report.

Worksheet #37 Usability Assessment

SENSITIVITY AND QUANTITATION LIMITS

Method and instrument sensitivity will be evaluated through the use of MDL studies for all analyses. MDLs will be provided to Amec Foster Wheeler by the laboratories. Amec Foster Wheeler will evaluate the MDLs to ensure the laboratories can meet required project quantitation limits presented in Worksheet #15.

Overall sensitivity will be reviewed for each matrix and analytical parameter. The impact on the lack of sensitivity or the reporting of higher quantitation limits by the laboratory will be assessed. The Data Usability Assessment will include any limitations on the use of the data, if limited to a particular matrix, SDG, parameter, or laboratory. If the evaluation of sensitivity identifies data which do not meet goals in this QAPP, the Data Usability Assessment will identify how this problem will be resolved and the potential need for resampling will be discussed in the final project report.

COMPLETENESS

Completeness is the ratio of the number of valid sample results to the total number of samples analyzed or processed. Following completion of the testing, the percent completeness will be calculated by the following equation:

$$Completeness = \frac{(number\ of\ valid\ measurements)}{(number\ of\ measurements\ planned)}\ x\,100$$

Overall completeness will be reviewed for each matrix and analytical parameter. The Data Usability Assessment will identify samples (or results) that are include in the project scope (Work plan), but not obtained. The impact of missing data will be assessed in the Phase III - Engineering Study.

Describe the evaluative procedures used to assess overall measurement error associated with the project: The field and laboratory data collected during this investigation will be used to achieve the objectives identified in Worksheet #11 of this QAPP. The QC results associated with each analytical parameter for each matrix will be compared to the objectives presented in this QAPP during the data validation task described in Worksheet #36. Data generated in association with QC results meeting the stated acceptance criteria (i.e., data determined to be valid) will be considered usable for decision-making purposes. Data associated with QC results not meeting acceptance criteria will be qualified during validation and limitations on use of these results will be identified in validation reports and the Phase III - Engineering Study.

In addition, the data obtained will be both qualitatively and quantitatively assessed on a project-wide, matrix-specific, and parameter-specific basis. Results of the measurement error assessments will be applied against the site as a whole; any conclusions will be documented in the final report.

Worksheet #37 Usability Assessment

Data generated in association with QC results not meeting the stated acceptance criteria may still be considered usable for decision-making purposes, ending on certain factors. This assessment will be performed by the Amec Foster Wheeler PM, in conjunction with the Amec Foster Wheeler Project Chemist, and the results presented and discussed in detail in the final report. Factors to be considered in this assessment of field and laboratory data will include, but not necessarily be limited to, the following:

- conformance to the field methodologies and SOPs proposed in the QAPP;
- conformance to the EPA methods referenced in the QAPP;
- adherence to proposed sampling strategy;
- presence of elevated detection limits due to matrix interferences or contaminants present at high concentrations;
- presence of analytes not expected to be present;
- conformance to validation protocols included in the QAPP for laboratory data;
- unusable data sets (qualified as “R”) based on the data validation results;
- data sets identified as usable for limited purposes (qualified as “J”) based on the data validation results;
- effect of qualifiers applied as a result of data validation on the ability to achieve the project objectives;
- status of all issues requiring corrective action, as presented in the QA reports to management;
- effect of nonconformance (procedures or requirements) on project objectives; and
- adequacy of the data in meeting the project objectives.

Identify the personnel responsible for performing the usability assessment: This assessment will be performed by the Amec Foster Wheeler PM, in conjunction with the Amec Foster Wheeler Project Chemist, and the results presented and discussed in detail in the final report.

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: Internal Assessments

Technical system audits (TSAs) of both field and laboratory activities may be conducted to verify that sampling and analysis are performed in accordance with the procedures established in the QAPP.

Field Sampling TSAs

A system audit of field activities including sampling and field measurements will be conducted and documented by the Field Investigation Team Leader (or their designee) at the start of the sampling. The purpose of this audit is to verify that all established procedures are being followed as planned and documented and to allow for timely corrective action, reducing the impact of the nonconformance. The audit will ensure that all personnel have read the QAPP and have signed Worksheet #4. The audit will cover field sampling records, field measurement results, field

Worksheet #37 Usability Assessment

instrument operation and calibration records, sample collection, preservation, handling, and packaging procedures, adherence to QA procedures, personnel training, sampling procedures, decontamination procedures, corrective action procedures, and chain-of-custody, etc. Follow-up surveillance will be conducted by the FOL to verify that QA procedures are maintained throughout the investigation.

Upon completion of the audit, the Field Investigation Team Leader will prepare a written audit report, which summarizes the audit findings, identifies deficiencies, and recommends corrective actions. In addition, a verbal debriefing will also be given to the FOL and PM at the time of the audit. The written report will be submitted to the Amec Foster Wheeler PM, who will be responsible for ensuring that corrective measures are implemented.

Fixed Laboratory TSAs

Prior to the start of the sampling program, the Amec Foster Wheeler QA Officer will host a kick-off meeting with the Lab Manager from EnviroSytems to review the QAPP and the Sampling and Analysis Program. A laboratory audit is not planned at this time unless it is deemed necessary.

To access overall laboratory QA, the Amec Foster Wheeler QA Officer will obtain at least one audit report for EnviroSytems from a government certification agency that had been completed within the previous year. This audit report will be reviewed to assess laboratory audit issues and verify that any necessary corrective actions have been completed. Audits may be conducted by the Amec Foster Wheeler QA Officer or by a designated qualified individual under the direction of the Amec Foster Wheeler QA Officer if data quality concerns regarding laboratory performance arise. If a laboratory audit is deemed necessary, the fixed laboratory TSA will include a review of the following areas:

- QA organization and procedures (including the Laboratory QA Plan);
- personnel training and qualifications;
- facility security;
- sample log-in procedures;
- sample storage facilities;
- analyst technique
- adherence to referenced analytical methods and the QAPP;
- compliance with QA/QC objectives;
- equipment, instrumentation and supplies kept on reserve;
- instrument calibration and maintenance;
- data recording, reduction, review, and reporting; and
- cleanliness and housekeeping.

Worksheet #37 Usability Assessment

Preliminary results of the TSA will be discussed with the Laboratory Manager, Laboratory PM, and Laboratory QA Manager during a verbal debriefing held at the facility. Assessment findings will be documented and reported as described below.

Data Validation TSA

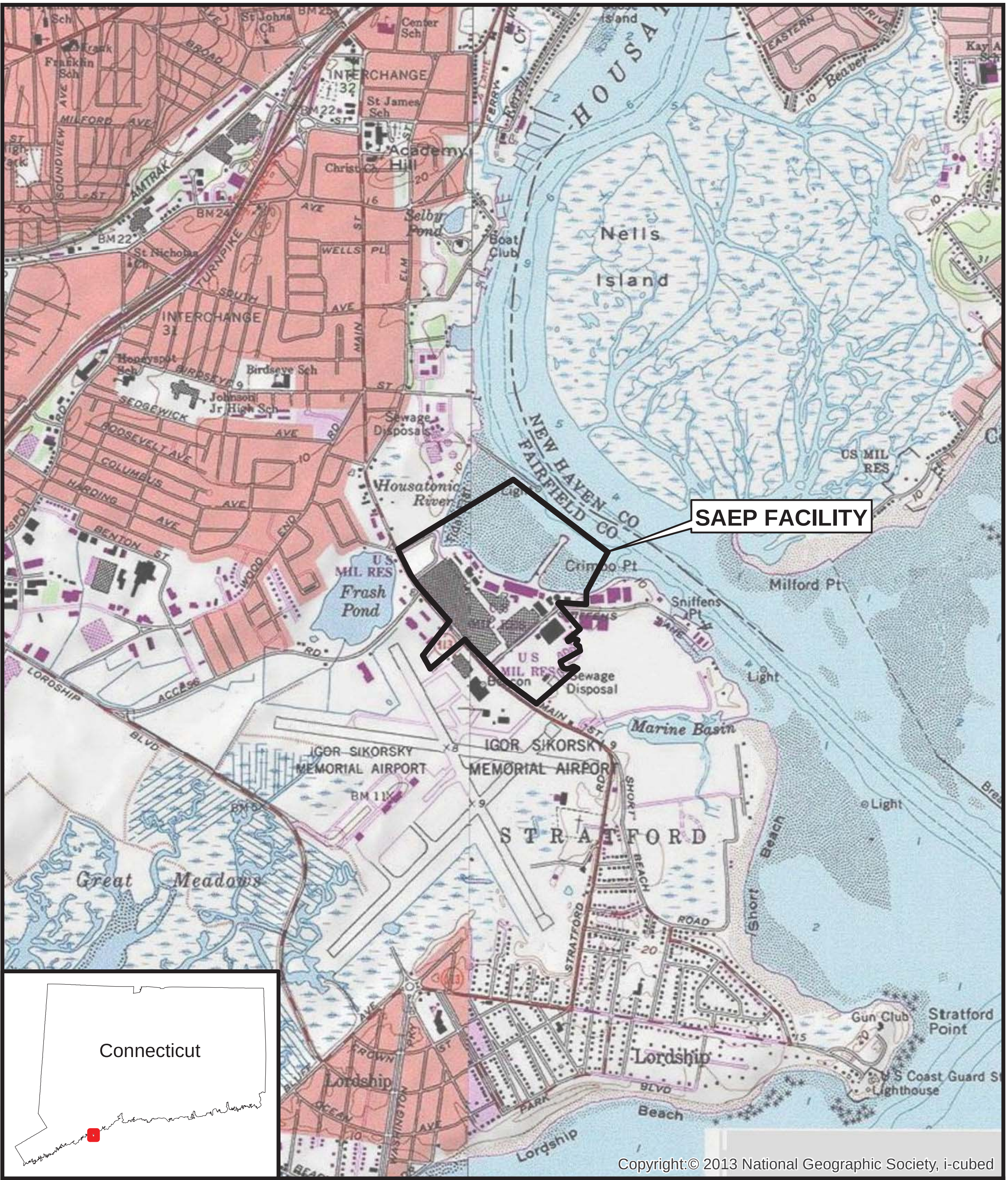
A review of the complete Data Validation Report will be conducted by the Amec Foster Wheeler QA Officer. This review will include a review of the reported data validation actions and observations, and a review of the Data Validation Report to ensure that all required components are present. This review will also ensure that the most recent version of the DOD Quality Systems Manual (QSM) guidelines were followed and that all measurement performance criteria were met or evaluated.

3.0 REFERENCES

Amec Foster Wheeler, 2017. Site-Specific Safety and Health Plan, Stratford Army Engine Plant, Stratford, Connecticut. June 2017.

Amec Foster Wheeler, 2018. Final Field Sampling Plan, Stratford Army Engine Plant, Stratford, Connecticut. January 10, 2018.

FIGURES



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0 1,000 2,000 Feet

Prepared/Date: BRP 06/06/17

Checked/Date: RB 06/06/17

Figure 1-1
Facility Location

Stratford Army Engine Plant
Stratford, Connecticut

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APPENDICES

APPENDIX A

FIELD SAMPLING SOPs

SOP No. S-1

AMEC FOSTER WHEELER ENVIRONMENT & INFRASTRUCTURE, INC.
STANDARD OPERATING PROCEDURE

SEDIMENT SAMPLING

SEDIMENT SAMPLING

PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide a standardized method for collecting sediment samples with a Piston VibraCore® coring device. This SOP may be used by employees of Amec Foster Wheeler, or contractors and subcontractors supporting the Stratford Army Engine Plant Feasibility Study. Deviations from the procedures outlined in this document must be approved by the Project Manager or Field Operations Leader prior to initiation of the sampling activity.

The methodologies discussed in this SOP are applicable to the sampling of sediment in both flowing and standing water. For the purposes of this procedure, sediments are those mineral and organic materials situated beneath an aqueous layer.

RESPONSIBILITIES

The Field Operation Leader (FOL) may be an Amec Foster Wheeler employee or contractor who is responsible for overseeing the sediment sampling activities. The FOL is also responsible for checking all work performed and verifying that the work satisfies the specific tasks outlined by this SOP and the Project Plan. It is the responsibility of the FOL to communicate with the Field Personnel regarding specific collection objectives and anticipated situations that require any deviation from the Project Plan. It is also the responsibility of the FOL to communicate the need for any deviations from the Project Plan with the appropriate personnel (Project Manager or Field Investigation Leader).

Field personnel performing sediment sampling are responsible for adhering to the applicable tasks outlined in this procedure while collecting samples.

EQUIPMENT

- Sample coring device **-** used for collecting continuous sediment cores above or below the water surface.
- Stainless steel hand tools - trowel, large spoon, or similar had tool for collection of sediment samples (above water).
- Collection containers - 4-oz., 8-oz., and one-quart wide mouth amber glass jars with Teflon lined lids.
- Gloves - for personal protection and to prevent cross-contamination of samples. May be plastic or latex, disposable, powderless.
- Field Clothing and Personal Protective Equipment - as specified in the Health and Safety Plan.
- Field notebook -a bound book used to record progress of sampling effort and record any problems and field observations during sampling. Alternatively, an electronic tablet device with pre-loaded forms for electronic data entry may be used.
- Field Data Record - to record and track samples collected at the site. An example form is provided in Appendix A of the FSP.

- Permanent marking pen - used to mark sample jars/lids, coring tubes, and for documentation of field logbooks and data sheets.
- Stainless steel lab spoon **-** or equivalent. Used for homogenizing sediment samples.
- Stainless steel bucket **-** used for compositing samples; must have 10 - 12 liter capacity.
- Trash bags - used to dispose of gloves and any other non-hazardous waste generated during sampling.

METHOD SUMMARY

Sediment samples wil be collected with a Piston VibraCore® coring device. The procedure for collecting sediment samples with a Piston VibraCore® coring device is described below.

GEOGRAPHIC POSITIONING

To navigate to the target sampling locations, a Differential Global Positioning System (DGPS) with real-time monitoring of the most recent coordinates will be used. If using a boat, the marine sampling vessel will deploy a three-point anchor or double-tie to docks to maintain its position. Once the vessel is secured, Amec Foster Wheeler scientists will record its position in the field log, measure the water depth with a weighted fiberglass tape, and then correct the water depth to mean lower low water (MLLW) using National Oceanic and Atmospheric Administration (NOAA) tide tables and bathymetric data.

The target navigational accuracy is ±3 meters (m). The Field Operations Leader may change sampling location(s) because of the presence of debris blocking access to core positions, poor recovery after several attempts, or other unforeseen situations. If such situations arise, the Field Operations Leader will decide where to relocate the sampling location(s) within the proposed sampling area and document the reasons for the change.

VIBRACORE SAMPLE COLLECTION PROCEDURE

Each sampling location must be recorded on the FDR (FSP Appendix A) prior to collecting the sample. All sampling equipment must be decontaminated prior to use, as well as between sample locations. Decontamination procedures are presented in SOP S-4. VibraCore® technicians will deploy the VibraCore® used for sediment sample collection. The VibraCore® uses a 3-4-inch-diameter aluminum tube connected to a stainless steel cutter. To prevent cross-contamination between stations, a new polyethylene liner is placed in the VibraCore® barrel prior to each sampling attempt. The VibraCore® and tube, as well as the piston, are lowered by a hydraulic winch and vibrated until penetration to project depth is achieved. Core penetration depth is calculated with a tape measure attached to the VibraCore® head, and the distance from where the tape is attached to the VibraCore® head will be added to the length from that point to the core cutter. After the VibraCore® is turned off, the sediment core is returned to the boat's deck for eventual transport to shore. The actual length of the sediment in the tube will be determined to assess the amount of compaction that occurred during collection. VibraCore® penetration accuracy will be ± 0.5 ft.

Sampling with a vibratory corer is divided into four steps: intrusion, extraction, core sampling, and packaging. The following procedure describes the use of a VibraCore to collect subsurface sediments.

Intrusion. The vibrator head should be attached near the top of the unsharpened end of the core barrel prior to initiating the coring procedure. After a coring location has been determined, the core pipe will be vertically positioned. The piston will be lowered within the tube to the sediment surface. The core barrel will initially sink into the sediment by its own weight, giving the barrel stability. Once the vibrator head engine is started, the pipe will begin to penetrate the sediment.

Extraction. After removing the vibrator head, the remaining pipe is cut off with a hacksaw approximately 2 feet above the ground surface. The distance to the sediment surface inside and outside of the pipe is measured to determine the amount of compaction. The pipe is then filled with water and a gas-main sealer plug is inserted and tightened to prevent loss of sediment from the core pipe when it is removed.

A tripod is assembled and placed over the intruded pipe. Two come-alongs are fastened to the eye-bolts on the tripod head and to a rope securely fastened to the core pipe. The core is guided through the core pipe slot in the tripod head and then rested against the tripod head to prevent falling over during extraction. When the core is completely out of the sediment, the come-alongs are removed and the core pipe slot is opened by pulling on the cord that moves the spring-loaded slot gate. The core barrel is placed vertically, to prevent disturbance of the core, and transported to the field laboratory.

VibraCore® Recovery Calculation. VibraCore® drilling methods commonly recover less subsurface material than expected when compared with penetration depth. This lack of full recovery can often be attributed to loss of loose sediment from the bottom of the core barrel or to sediment compaction within the core barrel, which occurs as the VibraCore® encounters materials of varying densities. To calculate percent recovery, determine the length of sediment retrieved divided by the length of the core penetration. The criteria for core acceptance is a percent recovery of at least 75%. If recovery is less than 75%, the core will be rejected and another core attempted. A maximum of three cores will be attempted at any one location.

Core Sampling. Core sampling will occur in the field laboratory. Sediment samples will be removed from the core by splitting the core lengthwise. Splitting the core lengthwise is preferred since it allows direct observation of the sediment structure, bedding, lithologies and other features. Samples can be collected from one half of the core and the other half can be preserved for future studies or sampling, if necessary. The following steps present the methodology of collecting discrete depth interval samples form sediment cores:

- Put on safety goggles and work gloves.
- Prepare sample containers with pre-printed labels, if necessary.
- Place the core within two table clamps, one close to either end of the table, with the up direction to the left.
- Lay out a measuring tape with increments of tenths of feet.
- Cut the liner lengthwise with a box knife made specifically for the task.
- Turn core 180°, make a second cut lengthwise along the core tube.
- Cut a length of fishing line using a knife or razor blade.
- Insert the fishing line on one end of the core and run the line, with each end of the line on either side of the cut, down the length of the core.
- Place an ID card near the core and measuring tape along its length.

- Carefully photograph the core with most of the viewfinder taken up by the core.
- Mark the core into 0.5 foot sections.
- Record description of the sediment core on the Sediment Core Log (see FSP Appendix A)
- For analytical samples, remove core intervals with a stainless steel spatula/knife in accordance with the FSP and homogenize in a stainless steel bowl.
- Fill containers, prepare chain of custody form, and place containers on ice at 4 degrees C.
- If there is remaining sediment volume, containerize for disposition.

Packaging. If the core is to be homogenized at the treatability laboratory, the extracted core is cut in the field using a hacksaw. Plastic caps held securely with duct tape will be used to cap the core liner. Each core section must be carefully labeled, indicating the top and bottom, with a waterproof marker. Alternatively, the cores may be cut open using the procedure above and place d in 5-gallon pails for transport to the treatability laboratory

HEALTH AND SAFETY

All field personnel must wear protective clothing and equipment as specified in the Health and Safety Plan. When sampling from waterbodies, physical hazards must be identified, and adequate precautions must be taken to ensure the safety of the sampling team. The team member collecting the samples should stay away from the edge of the waterbody, where bank failure may cause loss of balance. When collecting samples near the edge of waterbodies, personnel must wear a lifeline. All sampling personnel must wear personal flotation devices (life vests). If sampling from a boat, appropriate protective measures must be implemented.

SAMPLE CONTAINERS AND LABELING

Following the sample collection procedures outlined above, sediment is homogenized using a spoon and/or electric drill and stainless steel paddle, and mixing bowl or bucket. Following homogenization, a portion is removed and transferred into appropriate sample containers (see QAPP for appropriate containers).

Sample labeling will occur as prescribed below:

1. Place a pre-printed label onto the sample collection container.
2. Sign and date the sample label.
3. This procedure will be repeated for each sample collected using clean sample containers and unique sample ID numbers.

All samples will be stored on ice (4°C) in a secured cooler or refrigerator. Samples will be shipped under chain-of-custody, protected with suitable resilient packing material to reduce shock, vibration, and disturbance.

SITE CLEAN-UP

Excess sediment not included in the sample, if any, should be containerized for disposition.

Throw all used wipes and gloves into the trash bags and take with you to dispose of at the field office.

RECORD KEEPING AND QUALITY CONTROL

Field personnel should collect the number and type of quality control sample as described in the Quality Assurance Project Plan. In addition, a field notebook should be maintained by each individual or team that is collecting samples, as described in the QAPP. Each sample should have an ID number affixed to the outside of the collection container. Deviations from this sampling plan should be noted in the field notebook, as necessary.

DECONTAMINATION

Because decontamination procedures are time consuming, having a quantity of pre-cleaned sampling tools available is recommended. All sampling equipment must be decontaminated prior to reuse as prescribed in the FSP and detailed in the QAPP SOP No. S-4, Decontamination of Field Equipment.

REFERENCES

Amec Foster Wheeler, 2016a. Field Sampling Plan; Penobscot River Phase III Engineering Study – Penobscot River, Maine. July 2016.

Amec Foster Wheeler, 2016b. Quality Assurance Project Plan; Penobscot River Phase III Engineering Study – Penobscot River, Maine. July 2016.

- END OF PROCEDURE -

SOP No. S-4

AMEC FOSTER WHEELER ENVIRONMENT & INFRASTRUCTURE, INC.
STANDARD OPERATING PROCEDURE

SURFACE WATER SAMPLING

SURFACE WATER SAMPLING

OBJECTIVES

The purpose of this procedure is to describe the methods for surface water sampling. It describes the procedures and equipment to be used to obtain representative surface water samples that are capable of producing accurate quantification of water quality.

SCOPE AND APPLICABILITY

This procedure is intended for the collection of surface water samples to support site investigations as required by the scope of work.

RESPONSIBILITIES

The Field Operations Leader is responsible for ensuring that surface water samples are collected in accordance with this SOP and any other site-specific or project specific planning documents.

The Field Personnel are responsible for understanding and implementing this SOP during all field activities, as well as obtaining the appropriate field logbooks, forms and records necessary to complete the field activities.

The Site Safety and Health Officer (SSHO) is responsible for overseeing the health and safety of employees and for stopping work if necessary to fix unsafe conditions observed in the field.

DEFINITIONS

Surface water samples: Samples of water collected from streams, ponds, rivers, lakes, tidal waters, or other impoundments open to the atmosphere.

REQUIRED MATERIALS

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

- Maps/plot plan
- Safety equipment and personal protective equipment
- Tape Measure
- Paper towels
- Global positioning system (GPS)
- Clean latex or nitrile gloves
- Waders/Hip Waders
- Sampling device (e.g. submersible pump)
- Tubing
- Decontamination equipment/supplies
- Water quality monitoring equipment (e.g. pH/conductivity/dissolved oxygen meter)

- Sample Containers/preservatives
- Sample Labels
- Field Notebooks/logbooks
- Field data record
- Chain of Custody Forms

PROCEDURES

A variety of sampling methods and equipment are available for the collection of surface water samples because of the varied conditions and locations where samples may be collected.

Sampling Equipment

The objective of surface water sampling is to evaluate the surface water quality. There is a variety of equipment available for surface water sampling. Because each site may contain varied surface water conditions, collection of a representative sample may be difficult. In general, a sampling device will include the following characteristics:

- Be constructed of disposable or non-reactive material (e.g. Teflon, glass, or stainless steel); and
- Be designed to maintain sample integrity and to provide the desired level of quality in achieving desired analytical results.

For the SAEP FS sampling, a submersible 12-volt Whale® pump will be used to obtain the required volumes.

Decontamination

The primary purpose of equipment decontamination is to prevent the potential of cross-contamination within the samples collected. The same Whale® pump will be used for collection of all surface water samples. Prior to collection of each sample, the Whale® pump will be purged for one minute prior to collection of the sample. The tubing used to pump the water to the surface will be changed between sample locations

Surface water samples will be collected directly into 5-gallon pails and decontamination is not required, as shared sampling equipment does not come into contact with the water sample, and new sampling containers are used at each sampling location.

Sampling Methods

General

The specific sampling method utilized will depend on the accessibility to, the size, and the depth of the water body, as well as the type of samples being collected. In most ambient water quality studies, grab samples will be collected. However, the objectives of the study will dictate the sampling method. General cautions for sampling are as follows:

- When conducting surface water sampling in water bodies influenced by tidal effects, conduct the sampling on the outgoing tide.

- When using water craft, take samples near the bow, away and upwind from any outboard engine. Orient watercraft so that bow is positioned in the upstream direction.
- When wading, collect samples upstream from the body.
- Avoid disturbing sediments in immediate area of sample location.
- Collect water samples prior to taking sediment samples when obtaining both from the same site.
- Sampling near structures may not provide representative data because of unnatural flow patterns.
- Collect surface water samples from downstream towards upstream.

Submersible Pump

Gathering surface water samples with the assistance of a submersible pump is another commonly used sampling technique. In this method the sample is drawn through heavy-walled, weighted tubing and pumped directly into the sample container. New tubing will be used at each sample location and disposed of after use. The peristaltic sampling system allows the operator to extend the sample tubing into the liquid body to sample from depth. Submersible pumps are available with a range of power sources. For field use, the battery operated units have proven most convenient and very reliable.

Perform the following procedures when sampling with a submersible pump:

1. Prepare the submersible Whale® pump in accordance with manufacturer's instructions. Prior to use, be sure battery is fully charged prior to entering the field.
2. Change the food grade tubing between sample locations to avoid cross-contamination. This action requires maintaining a sufficiently large stock of tubing material to avoid having to decontaminate the tubing in the field.
3. Attach a weight to the tubing line immediately above the pump.
4. Measure the depth of water above the sediment surface.
5. Gently lower the pump intake to a depth of 1 foot above the sediment surface. Avoid unnecessary agitation (aeration) of the liquid to be sampled and bottom sediments.
6. Run the pump until no air bubbles are noted in the discharge, and continue to run for one additional minute.
7. Discharge water shall be released downstream from sampling area during sampling event.
8. Following one minute of pump purging, begin collecting surface water in 5-gallon plastic food-grade pail.
9. Immediately following the termination of sampling, lower a calibrated multimeter into the sample container, and let the meter equilibrate to the surrounding surface water.
10. Collect field parameters and record on FDR.

QUALITY ASSURANCE/QUALITY CONTROL

Quality assurance activities which apply to the implementation of these procedures are located in the site QAPP, including the collection of required quality control samples such as field duplicates, field blanks and equipment blanks. In addition, the following general procedures apply:

- All data must be documented on field data records or within site logbooks.
- All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment calibration activities must occur prior to sampling/operation and they must be documented.

Descriptions of any deviations and the reason for deviations from the site QAPP or this SOP should be noted in the field notebook, as necessary. In addition, the logbook should track pertinent sample collection information such as:

- Sample date/time;
- Personnel;
- Weather conditions;
- Sample identification information; and
- Visible staining or other indications of non-homogeneous conditions.

- END OF PROCEDURE -

SOP No. S-3

AMEC ENVIRONMENT AND INFRASTRUCTURE, INC. STANDARD OPERATING PROCEDURE

CALIBRATION OF FIELD INSTRUMENTS FOR WATER QUALITY PARAMETERS

STANDARD OPERATING PROCEDURE

CALIBRATION OF FIELD INSTRUMENTS FOR WATER QUALITY PARAMETERS

1.0 SCOPE AND APPLICABILITY

The purpose of this standard operating procedure (SOP) is to provide a framework for calibrating field instruments used to measure water quality parameters for groundwater and surface water. Water quality instruments addressed in this SOP include those that measure temperature, pH, dissolved oxygen (DO), conductivity/specific conductance, oxidation-reduction potential (ORP), and turbidity. Manufacturer manuals are included in the Quality Assurance Project Plan (QAPP) appendices (MACTEC, 2008). This SOP is written for instruments that utilize multiple probes for temperature, pH, DO, conductivity/specific conductance, ORP, and turbidity. This SOP refers to instrumentation and outlines calibration procedures consistent with those discussed in U.S. Environmental Protection Agency (USEPA) Region I Standard Operating Procedure, Draft Calibration of Field Instruments, June 3, 1998.

For groundwater monitoring during well development and/or purging prior to sample collection, the multiple probe instrument must be equipped with a flow-through cell, and the display/logger or computer display screen should be large enough to simultaneously display the readouts of each probe in the instrument. Turbidity is measured using a separate instrument because turbidity cannot be measured accurately in a flow-through cell.

2.0 SUMMARY OF METHOD

All monitoring instruments must be calibrated before they are used to measure environmental samples. Most instruments will require at least two standards to bracket the expected measurement range, one standard less than the expected value and one higher. At a minimum, calibration must be performed at the beginning of each sampling day prior to sample collection. Site-specific plans should be consulted for required calibration frequency. Note: Part of the instrument preparation and initial calibration is performed prior to the field event.

This SOP requires that the manufacturer's instruction manual (including the instrument specifications) accompany the instrument into the field.

3.0 DEFINITIONS

SOP Standard Operating Procedure pH Potential of Hydrogen ORP Oxidation-Reduction Potential NIST National Institute of Standards and Technology C Celsius mg Milligram L Liter DO Dissolved Oxygen mm Millimeter NTU Nephelometric Turbidity Unit PPE Personal Protective Equipment Sonde Device that holds the measuring probes SU Standard Units µg Microgram

4.0 HEALTH & SAFETY WARNINGS

AMEC Environment and Infrastructure, Inc. (AMEC) employees will be on site when implementing this SOP. Therefore, AMEC personnel shall follow the site-specific Health & Safety Plan (HASP). AMEC personnel will use the appropriate level of personal protective equipment (PPE), which includes the following:

1) hardhat; 2) safely boots (steel toe/steel shank); 3) safety glasses; and 4) chemical resistant gloves. Implementing this SOP will require the use of calibration solutions. The following health and safety precautions must be taken with the pH, conductivity, and ORP solutions: Avoid inhalation, skin and eye contact or ingestion.

Maintenance of the instruments will require the use of liquid cleaners. Although these substances are not hazardous materials, AMEC will appropriately handle and store them at times in accordance with manufacturer's instructions.

5.0 CAUTIONS & POTENTIAL PROBLEMS

Prior to calibration all instrument probes must be cleaned according to the manufacturer's instructions. Failure to perform this step (proper maintenance) can lead to erroneous measurements.
Prior to using calibration standards, check all expiration dates.
Use a ring stand and clamp to secure the sonde in an upright position. This will prevent the sonde from falling over and damaging the probes.

The volume of the calibration solutions must be sufficient to cover both the probe being calibrated and the temperature sensor (see manufacturer's instructions for additional information).
While calibrating or performing sample measurements, make sure there are no air bubbles lodged between the probe and the probe guard.

DO content in water is measured using a membrane electrode. The DO probe's membrane and electrolyte solution should be replaced prior to the sampling period. Failure to perform this step may lead to erratic and or erroneous measurements. If the probe reading shows the error message "value out of range", the instrument probe must be recalibrated.

6.0 PERSONNEL QUALIFICATIONS

Since this SOP will be implemented at sites or in work areas that entail potential exposure to toxic chemicals or hazardous environments, all AMEC personnel must be adequately trained.
Before implementing this SOP alone, AMEC personnel must be trained in these procedures by a senior staff member with experience operating the equipment. In addition, all personnel utilizing this SOP must have completed the following:

- 40-hour OSHA training;
- 8-hour annual refresher training; and
- On-site training.

In addition to the 40-hour initial OSHA; training (and annual 8-hour refresher training), all AMEC field staff will complete 24 hours of supervised field experience that contribute toward the 24-hour field supervised requirement in compliance with OSHA regulation: 29 CFR 1910.120(e)(4).

7.0 EQUIPMENT AND SUPPLIES

The following equipment should be used when calibrating water quality parameter measuring equipment. Site-specific conditions may warrant the use of additional items or deletion of items from this list.

- Appropriate level of personal protection
  Water quality meter capable of measuring pH, temperature, DO, specific conductivity, and ORP (e.g., YSI 600XL, or equivalent)
- Turbidity Meter (e.g., LaMotte 2020, or equivalent)
- Distilled water
- Deionized water
- Flow-through cell
- Ring stand with clamp
- Paper towels
- Soft tissue (e.g., Kimwipes)
- Cuvette
- pH buffer solutions (4, 7, 10 SU)
- Conductivity solution (100, 1000 µmhos)
- Zobell solution
- Turbidity standards (0.5, 20 NTU)
- Zero DO solution (0.0 milligrams per liter [mg/L])
- DO membrane kit (electrolyte solution, membranes)
- NIST thermometer (0.01 C accuracy)
- Small glass or polyethylene jars to hold the calibration standards (4-8 oz.)
- Calibration Logbook
- Field Instrument Calibration Field Data Record (See FSP Appendix A)
- Cup or spray bottle for the distilled water

8.0 PROCEDURES

The probe readings for pH, dissolved oxygen, and specific conductance are automatically corrected for temperature by the instrument. Communications to the instrument (programming and displaying the measurement files) are performed using a display/logger or a computer. Information sent to the instrument is entered through the keypad on the display/logger or computer. It is desirable that the display/logger or computer have data storage capabilities. If the instrument does not have a keypad, follow the manufacturer's instructions for entering information into the instrument.

- Program the multi-probe instrument so that the following parameters to be measured will be displayed: temperature, pH, percent DO, mg/L dissolved oxygen, conductivity, specific conductance, and ORP.
- For instrument probes that rely on the temperature sensor (pH, DO, conductivity/specific conductance, and ORP), each temperature sensor needs to be checked for accuracy against a thermometer that is traceable to the National Institute of Standards and Technology (NIST). Before any instrument is calibrated or used to perform environmental measurements, the instrument must stabilize (warm-up) according to manufacturer's instructions.

Temperature Most instrument manuals state that calibration of the temperature sensor is not required, but this SOP requires that the temperature sensor be checked to verify its accuracy. This accuracy check is performed at least once per year and the accuracy check date/information is kept with the instrument. If the accuracy check date/information is not included with the instrument or the last check was performed over a year prior to the date of use, it is recommended that the temperature sensor accuracy be checked at the beginning of the sampling event. If the instrument contains multiple temperature sensors, each sensor must be checked.

VERIFICATION PROCEDURE

1. Allow a container filled with water to equilibrate to ambient temperature.
2. Place a NIST -traceable thermometer and the instrument's temperature sensor into the water and wait approximately five minutes for both temperature readings to stabilize.
3. Compare the two measurements. The instrument's temperature sensor must agree with the NIST -traceable thermometer measurement within the accuracy of the sensor (usually to +/-15°C). If the measurements do not agree, the instrument may not be working properly and the manufacturer needs to be consulted.

Dissolved Oxygen DO is the volume of oxygen that is dissolved in water and is measured using a membrane electrode. The DO probe's membrane and electrolyte solution should be replaced prior to the sampling period. Failure to perform this step may lead to erratic or erroneous measurements.

CALIBRATION PROCEDURE

1. Gently dry the temperature sensor according to manufacturer's instructions.
2. Place a wet sponge or a wet paper towel on the bottom of the DO calibration container that comes with the instrument.
3. Place the DO probe in the container without the probe coming in contact with the wet sponge or paper towel. The probe must fit loosely in the container to ensure it is vented to the atmosphere.
4. Allow the confined air to become saturated with water vapor (saturation occurs in approximately 10 to 15 minutes). During this time, turn on the instrument to allow the

6. DO probe to warm up. Select monitoring/run mode. Check temperature readings. Readings must stabilize before continuing to the next step.
4. Select calibration mode; then select "DO%".
5. Enter the local barometric pressure (usually in mm of mercury) for the sampling location into the instrument. This measurement can be determined from an on-site barometer. Do not use barometric pressure obtained from the local weather services unless the pressure is corrected for the elevation of the sampling location and unless this is the only source of barometric data. [Note: inches of mercury times 25.4 mm/inch mercury equals mm of mercury].
6. The instrument should indicate that the calibration is in progress. After calibration, the instrument should display percent saturated DO. Check the reading against the Temperature Atmospheric Pressure table in Attachment A. For example, if the barometric pressure is 752 mm Hg at an elevation of 278 feet, the percent saturation value after calibration should be 99%.
7. While the probe is still in the calibration cup, select monitoring/run mode. Compare the DO mg/L reading to the Oxygen Solubility at Indicated Pressure chart in Attachment B. For example, if the barometric pressure is 750 mm Hg and the temperature inside the calibration cup is 20°C, the DO mg/L reading should be 8.94 mg/L. If they do not agree to the accuracy of the instrument (usually ±0.2 mg/L), repeat calibration. If this does not work, change the membrane and electrolyte solution and repeat calibration.
8. Remove the probe from the container, rinse it with distilled water, pat it dry with a towel and place it into a 0.0 mg/L DO Standard. The standard must be filled to the top of its container and the DO probe must fit snugly into the standard's container (no headspace). Check temperature readings. They must stabilize before continuing.
9. Wait until the "mg/L DO" readings have stabilized. The instrument should read < 0.5 mg/L or to the accuracy of the instrument (usually ± 0.2 mg/L) within 30 seconds. If the instrument cannot reach this value, it will be necessary to clean the probe and change the membrane and electrolyte solution. If this does not work, prepare a new

0.0 mg/L standard. If these measures do not work, contact the manufacturer.

<u>pH (electrometric)</u>

The pH is the measure of the degree of the acidity or alkalinity of a solution as measured on a scale of 0 to 14. The pH of a sample is determined electrometrically using a glass electrode. All pH measurements are in standard units (SU).

Choose the appropriate buffered standards that will bracket the expected values at the sampling locations. For groundwater, the pH will usually be close to seven. Three standards are needed for the calibration: one close to seven, one at least two pH units below seven and the other at least two pH units above seven. For those instruments that will not accept three standards, the instrument will need to be recalibrated if the water sample's pH is outside the range defined by the two standards used in the initial calibration.

CALIBRATION PROCEDURE

1. Allow the buffered standards to equilibrate to the ambient temperature.
2. Fill calibration containers with the buffered standards so each standard will cover the pH probe and temperature sensor.
3. Remove the cover of the probe, rinse in a cup filled with distilled water or use a spray bottle, and blot dry with soft tissue.
4. Select monitoring/run mode. Immerse probe in the initial buffered standard (e.g., pH 7) and allow at least 1 minute for temperature equilibration before proceeding.
5. Enter the buffered standard value (7) into the pH calibration menu of the instrument. Allow the pH reading to stabilize for approximately 30 seconds and if the reading does not change, finish the calibration. The reading should remain within the manufacturer’s specifications; if it changes, recalibrate. If readings continue to fluctuate or readings do not stabilize after recalibration, consult the manufacturer.
6. Remove probe from the initial buffered standard, rinse in a cup filled with distilled water or use a spray bottle, and blot dry with soft tissue.
7. Immerse probe into the second buffered standard (e.g., pH 4). Repeat step 5 substituting "4" into the pH calibration menu instead of “7”.
8. Remove probe from the second buffered standard, rinse in a cup filled with distilled water or use a spray bottle, and blot dry with soft tissue. If the instrument only accepts two standards the calibration is complete. Proceed to step 11. Otherwise continue with step 9.
9. Immerse probe m third buffered standard (e.g., pH 10). Repeat step 5, substituting "10" into the pH calibration menu instead of "7".
10. Remove probe from the third buffered standard, rinse in a cup filled with distilled water or use a spray bottle, and blot dry with soft tissue.
11. Select monitoring/run mode, if not already selected. To ensure that the initial buffered calibration standard (e.g., pH 7) has not changed, immerse the probe into the initial standard. Wait for the reading to stabilize. The reading should read the initial standard value (e.g., 7) within the manufacturer's specifications. If not, re-calibrate the instrument. If re-calibration does not help, the calibration range may be too great. Reduce calibration range by using standards that are closer together.

<u>Specific Conductance</u> Conductivity is used to measure the ability of an aqueous solution to conduct an electrical current. Specific conductance is the conductivity value corrected to 25°C. Calibrating an instrument for specific conductance automatically calibrates the instrument for conductivity, and vice-versa.

Most instruments are calibrated against a single standard which is near, but below the specific conductance of the environmental samples. A second standard which is above the environmental sample specific conductance is used to check the linearity of the instrument in the range of measurements.

CALIBRATION PROCEDURE

1. Allow the calibration standard to equilibrate to the ambient temperature.
2. Remove probe from its storage container, rinse the probe with a small amount of the conductivity/specific conductance standard (discard the rinsate), and place the probe into the conductivity/specific conductance standard. Gently move the probe up and down in the solution to remove any air bubbles from the sensor. Allow the probe to sit in the solution for at least l minute for temperature equilibration before proceeding.
3. Select calibration mode.
4. Select Specific Conductance from the Calibration menu. Enter the calibration value of the solution (mS/cm at 25°C) and continue. Allow the Specific Conductance reading to stabilize for approximately 30 seconds and finish the calibration. The reading should remain within manufacturer's specifications. If it does not, recalibrate. If readings continue to change after recalibration, consult the manufacturer.
5. Remove probe from the standard, rinse the probe with a small amount of the second conductivity/specific conductance standard (discard the rinsate), and place the probe into the second conductivity/specific conductance standard. The second standard will serve to verify the linearity of the instrument. Read the specific conductance value from the instrument and compare the value to the specific conductance on the standard. The two values should agree within the specifications of the instrument. If they do not agree, re-calibrate. If readings do not compare, then the second standard may be outside the linear range of the instrument. Use a standard that is closer, but above the first standard and repeat the verification. If values still do not compare, try cleaning the probe or consult the manufacturer.

NOTE: These procedures should only be used for instruments that are capable of automatically correcting specific conductance for temperature (to 25°C). For instruments that cannot calibrate for specific conductance, follow the procedures in the instrument's manual for conductivity calibration. If calibrating for conductivity instead of specific conductance, the solutions conductivity value must be corrected for the temperature that the sensor is reading.

<u>Oxidation-Reduction Potential</u> The ORP is the electrometric difference measured in a solution between an inert indicator electrode and a suitable reference electrode. The electrometric difference is measured in millivolts (mV) and is temperature dependent.

CALIBRATION OR VERIFICATION PROCEDURE

1. Allow the calibration standard (a.Zobell Solution) to equilibrate to ambient temperature.
2. Remove the cover of the probe and place it into the standard.
3. Select monitoring/run mode.
4. While stirring the standard, wait for the probe temperature to stabilize, and then read the temperature.
5. Look up the mV value at this temperature from the mV versus temperature correction table found in Attachment C. It may be necessary to interpolate mV values between temperatures. Select “calibration mode”, then "ORP". Enter the temperature corrected ORP value and calibrate the instrument.
6. Select monitoring/run mode. The reading should remain unchanged within manufacturer's specifications. If it changes, recalibrate. If readings continue to change after calibration, consult manufacturer.

7. If the instrument instruction manual states the instrument is factory calibrated, then verify the factory calibration against the standard. If reading does not agree within the specification of the instrument, the instrument will need to be re-calibrated by the manufacturer.

Turbidity Turbidity refers to how clear the water is and is a measure of relative sample clarity. The greater the amount of total suspended solids in the water, the higher the measured turbidity. The turbidity method is based upon a comparison of intensity of light scattered by a sample under defined conditions with the intensity of light scattered by a standard reference suspension. A turbidity meter is a nephelometer with a visible light source for illuminating the sample and one or more photoelectric detectors placed ninety degrees to the path of the light source.
Some instruments will only accept one standard. For these instruments, the standards will serve as check points.

CALIBRATION PROCEDURES

1. If the standard cuvette is not sealed, rinse a cuvette with deionized water. Shake the cuvette to remove as much water as possible. Do not wipe the inside of the cuvette because lint from the wipe may remain in the cuvette. Add the standard to the cuvette.
2. Before performing the calibration procedure, make sure the cuvettes are not scratched and the outside surfaces are dry, free from fingerprints and dust. If the cuvette is scratched or dirty, discard or clean the cuvette, respectively.
3. Zero the instrument by using either a zero or 0.02 NTU standard. A zero standard (approximately 0 NTU) can be prepared by passing distilled water through a 0.45 micron pore size membrane filter.
4. Using a standard at I NTU, calibrate according to manufacturer's instructions or verify calibration if instrument will not accept a second standard. If verifying, the instrument should read the standard value to within the specifications of the instrument. If the instrument has a range of scales, check each range that will be used during the sampling event with a standard that falls within that range.
5. Using a standard at 10 NTU, calibrate according to manufacturer's instruction or verify calibration if instrument does not accept a third standard. If verifying, the instrument should read the standard value to within the specifications of the instrument.

Note: If only performing a two-point calibration (depending on project requirements), the 0.02 NTU and 10 NTU standard should be used.

9.0 DATA MANAGEMENT AND RECORDS MANAGEMENT

Prior to calibrating, the field equipment and calibration standard information should be recorded on a separate Field Instrument Calibration Field Data Record (See FSP Appendix C). For field equipment, the information recorded should include the make, model number and the serial number of the instrument. \ Each instrument can be assigned an identification number which can be referenced in future field notes or when filling out the Field Instrument Calibration Field Data Record.

For calibration standards, the information recorded should include the manufacturer, expiration date, true value, and standard description such as lot number. Each calibration standard can also be assigned an identification number which can be referenced in future field notes or when filling out the Field Instrument Calibration Log.

All standards should be initialed and dated when opened.
At a minimum, the log must include the instrument information described above, calibration standard information described above, calibration date and time, and the instrument calibration results.

10.0 REFERENCES

MACTEC, 2007. “Quality Assurance Project Plan”; Olin Chemical Superfund Site; Date – to be determined.

USEPA Region I, June 3, 1998. Standard Operating Procedure, Draft Calibration of Field Instruments.

USEPA Region I, July 30, 1996. Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples for Monitoring Wells.

SOP No. S-4

AMEC ENVIRONMENT AND INFRASTRUCTURE, INC. STANDARD OPERATING PROCEDURE

DECONTAMINATION OF FIELD EQUIPMENT

STANDARD OPERATING PROCEDURE

DECONTAMINATION OF FIELD EQUIPMENT

1.0 SCOPE AND APPLICABILITY

This Standard Operating Procedure (SOP) describes the methods to be used for the decontamination of all field equipment which becomes potentially contaminated during a sample collection task. The equipment may include split-spoons, bailers, trowels, shovels, hand-augers, or any other type of equipment used during field activities.

Decontamination is performed as a quality assurance measure and a safety precaution. It prevents cross-contamination between samples and also helps to maintain a clean working environment for the safety of all field personnel.

Decontamination is mainly achieved by rinsing with liquids which may include: soap and/or detergent solutions, tap-water, deionized water, acid solutions, and methanol. Equipment will be allowed to air dry after being cleaned or may be wiped dry with clean cloths or paper towels if immediate re-use is needed. The frequency of equipment use dictates that most decontamination be accomplished at each sampling site, between collection points. Waste products produced by the decontamination procedures, such as waste liquids, solids, rags, gloves, etc. must be collected and disposed of properly. All decontamination materials and wastes should be stored in a central location so as to maintain control over the quantity of materials used and/or produced throughout the study.

2.0 RESPONSIBILITIES

It is the primary responsibility of the project Field Operations Leader and field samplers to assure that the proper decontamination procedures are followed and that all waste materials produced by decontamination are properly stored and disposed of.

It is the responsibility of the project safety officer to draft and enforce safety measures which provide the best protection for all persons involved directly with sampling and/or decontamination.

t is the responsibility of any subcontractors (i.e., drilling contractors) to follow the proper designated decontamination procedures that are stated in their contracts and outlined in the Project Health and Safety Plan.

It is the responsibility of all personnel involved with sample collection or decontamination to maintain a clean working environment and to ensure that any contaminants are not negligently introduced to the environment.

3.0 EQUIPMENT AND MATERIALS

3.1 Cleaning Liquids

Cleaning materials may include tap (potable) water, deionized water, and soap and/or detergent solutions, nitric acid solutions, and methanol. For the site, only deionized water and liquinox will be used unless specified in the FSP for a specific sampling location.

3.2 Personal Safety Gear

Personal protective equipment (PPE) will be defined in Project Health and Safety Plan.

3.3 Paper Towels

3.4 Disposable Gloves

3.5 Waste Storage Containers

Drums, boxes, plastic bags

3.6 Cleaning Containers

Plastic buckets, galvanized steel pail

3.7 Cleaning Brushes

3.8 Stainless Steel Spray Bottles

4.0 PROCEDURES

4.1 General Approach

4.1.1

All equipment that comes in contact with the media that is sampled should be included in the decontamination process.

4.1.2

The standard procedures listed in the following section can be considered the procedure for full field decontamination. If different or more elaborate procedures are required for a specific task, they will be spelled out in the FSP. Such variations in decontamination may include following all, just part, or an expanded scope of the decontamination procedure stated herein.

4.2 Soil Sampling Equipment

4.2.1

Remove any solid particles from the equipment or material by brushing and then rinsing with clean water. This initial step is performed to remove gross contamination.

4.2.2

Wash equipment with a soap or detergent solution and brush.

4.2.3

Rinse with tap-water.

4.2.4

Rinse with deionized water.

4.2.5

Repeat entire procedure or any parts of the procedure if necessary.

4.2.6

If sampling equipment is to be used immediately at another location, wrap the equipment in aluminum foil and store in a safe place.

4.3 Submersible Pump Decontamination Procedures

This procedure will be used to decontaminate submersible pumps (if used) and pump tubing between groundwater sample collection points and at the end of each day of use. For wells where dedicated tubing is being used, no decontamination of the tubing is needed. The dedicated tubing will be placed back into the monitoring well and only the pump will be decontaminated as described in the following subsections. The following materials will be used:

- plastic-nalgene or PVC upright cylinder
- 5-10 gallon plastic water storage containers
- Deionized water
- Stainless steel spray bottle
- Paper towels

4.3.1

During decontamination the submersible pump will be placed on a clean surface (sheet of plastic) or held away from ground.

4.3.2

Clean the upright plastic-nalgene/PVC cylinder as described above in Section 4.2.

4.3.3

Decontaminate the outer surface of the submersible pump and the entire tubing using a potable water rinse followed by a deionized water rinse.

4.3.4

Place the submersible pump upright in the cylinder and fill the cylinder with potable water.

4.3.5

Activate the pump in the forward mode withdrawing water from the cylinder.

4.3.6

Continue pumping until the water in the cylinder is pumped down and air is drawn through the pump. If tubing is being decontaminated, continue pumping water through the pump until the tubing is full and overflowing. Continue pumping a volume of water that is twice the volume needed to fill the tubing and run the pump to dryness. At this time air pockets will be observed in the discharge line. Shut off the pump immediately.

4.3.7

Using the water remaining in the cylinder, rinse the sealed portion of the power cord and discharge tube by pouring the water carefully over the coiled lines.

4.3.8

Repeat steps 4.3.4 through 4.3.7 using deionized water. Pump or drain all the remaining water from the tubing.

4.3.9

When reaching the next monitoring well place the pump in the well casing and wipe dry both the power and discharge lines with a clean paper towel as the pump is lowered.

5.0 REFERENCES

U.S. Environmental Protection Agency (USEPA), January, 1986. "Decontamination Techniques for Mobile Response Equipment Used at Waste Sites (State-of-the-Art Survey)." EPA/600/52-85/105.

USEPA, March, 1985. "Guide for Decontaminating Buildings, Structures, and Equipment at Superfund Sites." EPA/600/2 85/028.

SOP No. S-5

AMEC ENVIRONMENT AND INFRASTRUCTURE, INC. STANDARD OPERATING PROCEDURE

SAMPLE CHAIN OF CUSTODY PROCEDURE

STANDARD OPERATING PROCEDURE

SAMPLE CHAIN OF CUSTODY PROCEDURE

1.0 INTRODUCTION

This SOP describes chain of custody procedures to be followed whenever collecting environmental samples. This SOP is referenced in all SOPs for environmental sample collection.

2.0 CROSS-REFERENCES

- ASTM D4840-95: Guide for Sampling Chain-of-Custody Procedures
- U.S. EPA Region 4 "Environmental Investigations Standard Operating Procedures and Quality Assurance Manual," May 1996 Including 1997 Revisions
- Site-specific Health and Safety Plan

3.0 MATERIALS

3.1 Documentation

- Work Plan
- Field Data Records (FDR)
- Chain-of-custody forms
- Sample labels
- Field logbook
- Permanent marker
- Lab contact information
- Chain-of-Custody Form

4.0 PREPARATION

Review Work Plan to identify samples to be collected, analyses to be performed, laboratory performing the analyses, and any other project specific-objectives of the sampling program. Review sample collection SOPs for media being sampled.

5.0 SAMPLE LABELING

Enter in the log book and label each sample container with the following information: a) CRREL project number b) Date and time of collection c) Sample location d) Sample number

e) Analysis to be performed f) Sampler's initials g) Preservative
If using field sample tracking system labels will be generated and printed by the field sample coordinator.

6.0 CHAIN OF CUSTODY

6.1 Definition

EPA provides the following definition of chain-of-custody:
“A sample is considered to be in your custody if any of the following criteria are met:

- The sample is in your possession or is in your view after being in your possession;
- The sample was in your possession and then locked up or sealed to prevent tampering; or
- You have placed the sample in a secured area.”

6.2 Purpose

"The chain-of-custody form is functionally similar to a packing slip that accompanies a shipment of goods. The chain-of-custody form includes a chain-of-custody record located at the bottom of the form. The form is used as physical evidence of sample custody. EPA guidelines specify that official custody of samples must be maintained and documented from the time of collection until the time the samples are introduced as evidence in the event of litigation. The sampler is responsible for the care and custody of the sample until sample shipment."

6.3 Documentation

6.3.1

After samples are collected and labeled, fill out the chain-of-custody form. Examples of computer generated COC forms and hand written laboratory COC forms that may be used are presented in Attachment A of this SOP. The sampler becomes the initial sample custodian.

6.3.2

Chain-of-custody forms must be completed for every shipment of samples to an analytical laboratory.

6.3.3

Use indelible ink only, no pencil (a ball point pen is best). Make corrections by drawing a line through and initialing and dating the error, then enter the correct information. Erasures are not allowed.

6.3.4

A separate chain-of-custody form must accompany each cooler for each shipment. Place the original COC form in a zipper-type plastic bag in the cooler with the samples. The chain-of-custody forms must address all samples in that sample shipment. If multiple coolers are shipped a copy of the COC should accompany each cooler. This practice maintains the chain-of-custody for all samples in case of mis-shipment.

6.4 Transfer of Custody

6.4.1

When transferring the possession of samples, the individuals relinquishing and receiving custody will sign, date, and note the time on the record. Persons receiving the custody of a sample group are responsible for confirming the accuracy of the COC with regard to the number and type of sample containers for which they are accepting responsibility.

6.4.2

When samples are to be shipped to an analytical facility by commercial delivery service, the samples will be relinquished to the courier in sealed containers, and, if practicable, the shipment number will be noted on the COC form. When samples are transferred by commercial delivery service, a copy of the shipping documentation will serve as the COC record for the delivery service's role in the chain of custody.

6.4.3

The sample custodian relinquishing custody to a facility or agency will request the signature of a representative of the appropriate party acknowledging receipt of the samples. If a representative is unavailable or refuses to sign, this will be noted in the "Received by" space on the COC. When appropriate, the custody record will contain a statement that the samples were delivered to the designated location at the designated time.

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ESI Job No: 4552

CHAIN OF CUSTODY DOCUMENTATION

Client:	Contact:	Project Name:	Page of
Report to:	Address:	Project Number:	
Invoice to:	Address:	Project Manager:	
Voice:	Fax:	email:	P.O. No: Quote No:

Protocol: RCRA SDWA NPDES USCOE Other

Lab Number (assigned by lab)	Your Field ID: (must agree with container)	Date Sampled	Time Sampled	Sampled By	Grab or composit (G/C)	Container Size (ml.)	Container Type (P/G/T)	Field Preservation	Matrix S=Solid W=Water	Filter N=Not needed F=Done in field L=Lab to do	Analyses Requested\ Special Instructions:

Relinquished By:	Date:	Time:	Received By:	Date:	Time:
Relinquished By:	Date:	Time:	Received at Lab By:	Date:	Time:

Comments:

Sample Delivery Group No:	Page of

COC Doc No:

SOP No. S-6

AMEC ENVIRONMENT AND INFRASTRUCTURE, INC. STANDARD OPERATING PROCEDURE

FIELD SAMPLE TRACKING SYSTEM

STANDARD OPERATING PROCEDURE

FIELD SAMPLE TRACKING SYSTEM

1.0 SCOPE AND APPLICATION

This purpose of this standard operating procedure (SOP) is to outline the steps associated with computerized field sample tracking of analytical samples collected during remedial investigations. This SOP includes computerized procedures applicable to tracking samples from label production through shipping samples to the lab with a completed Chain of Custody (COC). Specific steps and details are described for the primary tasks of initial sample creation, label production, post sample collection data entry and creation of COC for shipping to lab.

Additional manual sample tracking procedures and chain of custody forms may be utilized during investigations. These procedures only address those tasks that will use the computerized sample tracking program.

2.0 EQUIPMENT AND SUPPLIES

- PC Computer with Windows
- MS Access 97 or greater (2002 preferred)
- Copy of the MACTEC Field Sample Tracking Program
- Printer
- Avery 5260 Labels

3.0 METHOD SUMMARY: FIELD SAMPLE TRACKING PROGRAM OVERVIEW

To start the Field Sample Tracking Program double-click the Field Sample Tracking Program shortcut on your computer desktop. This will start Access and load the Field Sample Tracking Program. When it starts you will see the main form you will use for creating labels and tracking samples (see figure 1). From here you can add new samples, add methods to samples, print labels, track the status of samples, print COCs and Analysis Request Forms (ARFs) and assign samples to a Sample Delivery Group (SDG). The upper area of the form contains information about the sample such as by whom, when and where it was collected. Below the sample information is a box containing the analysis method information for the sample. Each analysis will have a method name, status, bottle information SDG and fraction. **The status field is used to track where in the sample collecting and shipping process the analysis is located**. It will change at every step of the sample tracking process.

You can also move through the samples using the form navigation buttons at the bottom of the form. The left and right arrows will jump you one sample forward or backward and the arrows with a line will take you to the first or last sample, respectively. The arrow with an asterisk is the Add New Sample Button, which will be used later. There are also 2 buttons that allow you to quickly navigate the samples if you know the Field Sample Identification (ID) or the sample number.

To jump to a sample if you know the Field Sample ID, enter it in the text box next to the Go To Field Sample ID button (or select it from the drop down) and press the button. Note that this will take you to the first occurrence of the field Sample ID, if it happens to be listed more than once.
To jump to a sample if you know the Sample Number, enter it in the text box next to the Go To Sample Number button (or select it from the drop down) and press the button.

To the right of the sample information is a box containing radio selection buttons, two buttons labeled “Selected” and “All” and two buttons with arrows. The two buttons with arrows can be used to move to the next sample forward or backward in the list. The radio selection and the “Selected” and “All” buttons are used to change the status field for a method. Their use will be explained in the following sections.

4.0 PROCEDURE

4.1 Initial Sample Creation

This step can be done for the majority of the samples using the sample information found in the task specific work plans. Individual samples can be created as necessary (see figure 1).

- Press the Add New Sample Button
- Enter the Field Sample ID, Location ID and Sample Date if known.
- Select Sample Team, QC Code, Matrix and Media from drop down selections
- Add new methods (see add new methods section)

Underline spaces may be used if sample depth is a part of the Field Sample ID, but is unknown at the time of the sample creation. The correct Field Sample ID can be entered after the sample is collected.
After the sample is created, the analytical methods needed are added. The Field Sample Tracking Program method list is dependant on Matrix, so make sure Matrix has been selected before adding methods to a sample.

- Press the Add New Methods Button – this will open a selection form (see figure 2).
- Select methods to add to the sample by checking the box to the left of method name.
- When you have selected all methods you wish to add, press the Add Methods Button.

You will return to the Field Sample Tracking Screen and the added methods will now be in the method box. Their status is initially set to “NEW”.

4.2 Label Production

Methods that will have labels printed need to have a status of “PRINT”. For methods with a Status of “NEW” use the following recipe:

- Navigate to a sample you wish to print labels for.
- Set the Radio button in the upper left box to “Print”.
- If you wish to print labels for all methods for the sample, press the All Button.
- If you wish to print less than all of the methods, check the box next to the method name you wish to print. When you have selected the methods you wish to print, press the Selected button.

Repeat this process for all samples that you wish to print labels for.
In addition, you can manually change the status to “PRINT” for any method by using the drop down selector in the status field. This may be done to reprint labels that have already been printed before.
When you have finished identifying all of the methods that need to print labels, press the Close and Print Labels Button.

Press the Print Labels and Return to Main Form Button that appears. A preview of the labels to be printed will appear for your review. If it looks satisfactory, press the print icon and close the preview. The labels will start printing on the printer containing the Avery 5260 Labels. If the print preview on the screen is not satisfactory, just close the preview.

A Message box with the Choice “Change PRINT Status of Analyses” will appear. Choose the CHANGE button if you samples have printed to your satisfaction. This will change the method status to “PRINTED”. If you choose “KEEP” the status will remain at “PRINT” and the methods will show up in the next batch of labels. Use this option if you find an error in your preview, experience a printer error, or just wanted to print a test page of labels.

4.3 Post Sampling Data Entry

After a sample is collected in the field, it needs to be recorded as “Checked in to the Office” (or field trailer or where ever the field tracking computer is being operated).
For methods with a Status of “PRINTED” use the following recipe:

- Navigate to a sample you wish to check in.
- Enter information about sample date and time in the sample collection section.
- Enter information about sample depth, if appropriate.
- Set the Radio button in the upper right box to “Check-in to Office”.
- If you wish to check in all methods for the sample, press the “All” Button.
- If you wish to check in less than all of the methods, check the box next to the method name you wish to check in. When you have selected the methods you wish to check in, press the “Selected” button.
- Edit the In field of a method if less than the number of required bottles has returned – if necessary (due to bottle breakage, less than enough sample material).

Repeat this process for all samples that you wish to check in. In addition, you can manually change the status to “IN LAB” using the drop down selector in the status field.

4.4 Off-Site Laboratory Samples

Sample containers will be weighed by the off-site laboratory sample manager immediately upon receipt at the off-site laboratory. The sample manager will record the container identification number and post-sampling container weight on the chain of custody. A trip blank will accompany each shipment of samples to the off-site laboratory. The trip blank will consist of a sample container with methanol prepared by the off-site laboratory for the same analytical method as the field samples.

4.5 COC Production and Sample Shipping

For methods with a Status of “IN LAB” use the following recipe:

- Navigate to a sample you wish to ship to a lab.
- Set the Radio button in the upper right box to “Send to Lab”.
- If you wish to ship all methods for the sample, press the “All” Button.
- If you wish to ship less than all of the methods, check the box next to the method name you wish to ship. When you have selected the methods you wish to ship, press the “Selected” button.

Repeat this process for all samples that you wish to ship to a lab.

In addition, you can manually change the status to “SHIP” using the drop down selector in the status field.

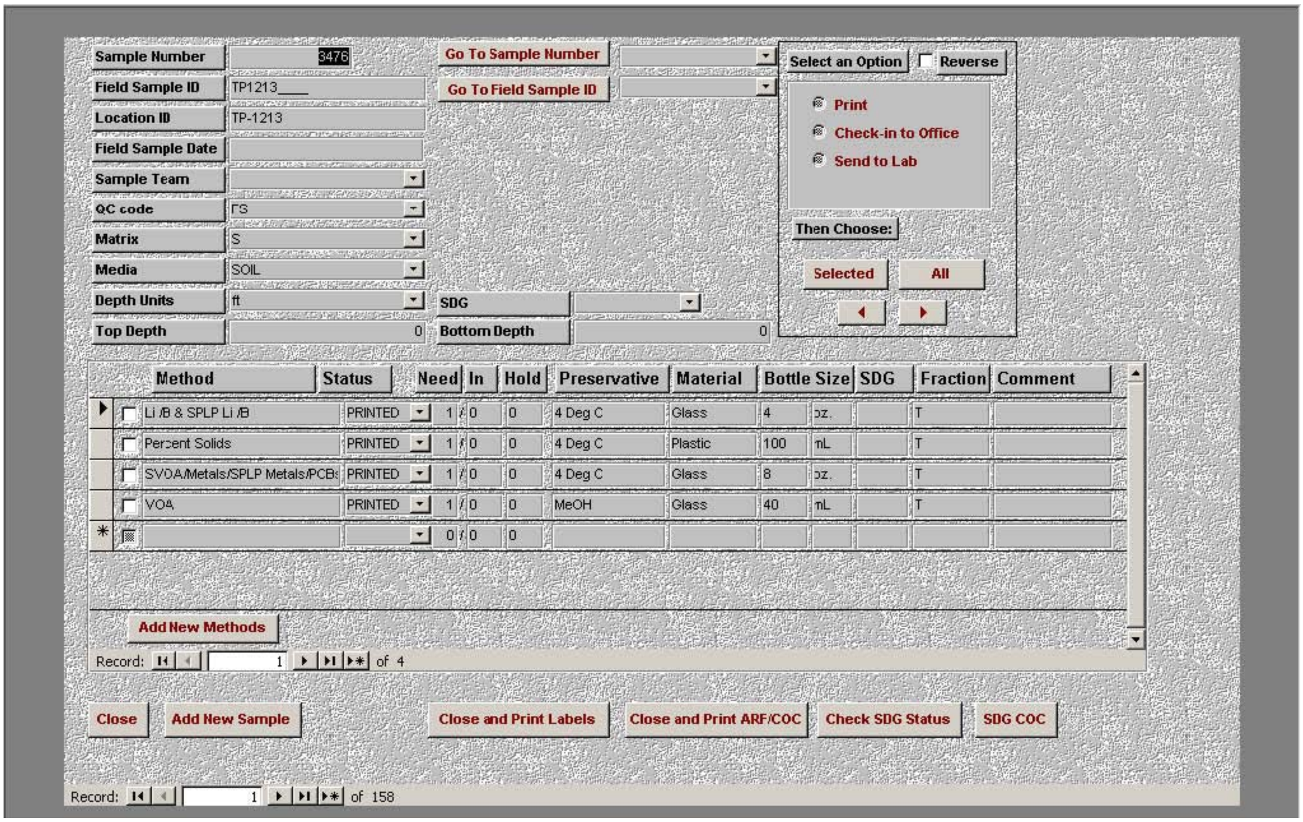
When you have finished identifying all of the methods that need to be shipped to a lab, press the Close and Print ARF/COC Button.

Press the Print COC/ARF and Return to Main Form Button that appears. A preview of the COC/ARF to be printed will appear for your review. If it looks satisfactory, press the print icon and close the preview (see figure 3 for an example of a printed COC). If not satisfactory, just close the preview.

A Message box with the Choice “Change Status of Analyses from SHIP to SHIPPED” will appear. Choose the CHANGE button if you samples have printed to your satisfaction. This will change the method status to “SHIPPED”. If you choose “KEEP” the status will remain at “SHIP” and the methods will show up in the next batch of COC/ARF to ship. Use this option if you find an error in your preview or just wanted to print a COC/ARF test page.

5.0 FIGURES

Figure 1



Sample Number	3476
Field Sample ID	TP1213____
Location ID	TP-1213
Field Sample Date	
Sample Team	
QC code	FS
Matrix	S
Media	SOIL
Depth Units	ft
Top Depth	0
SDG	
Bottom Depth	0

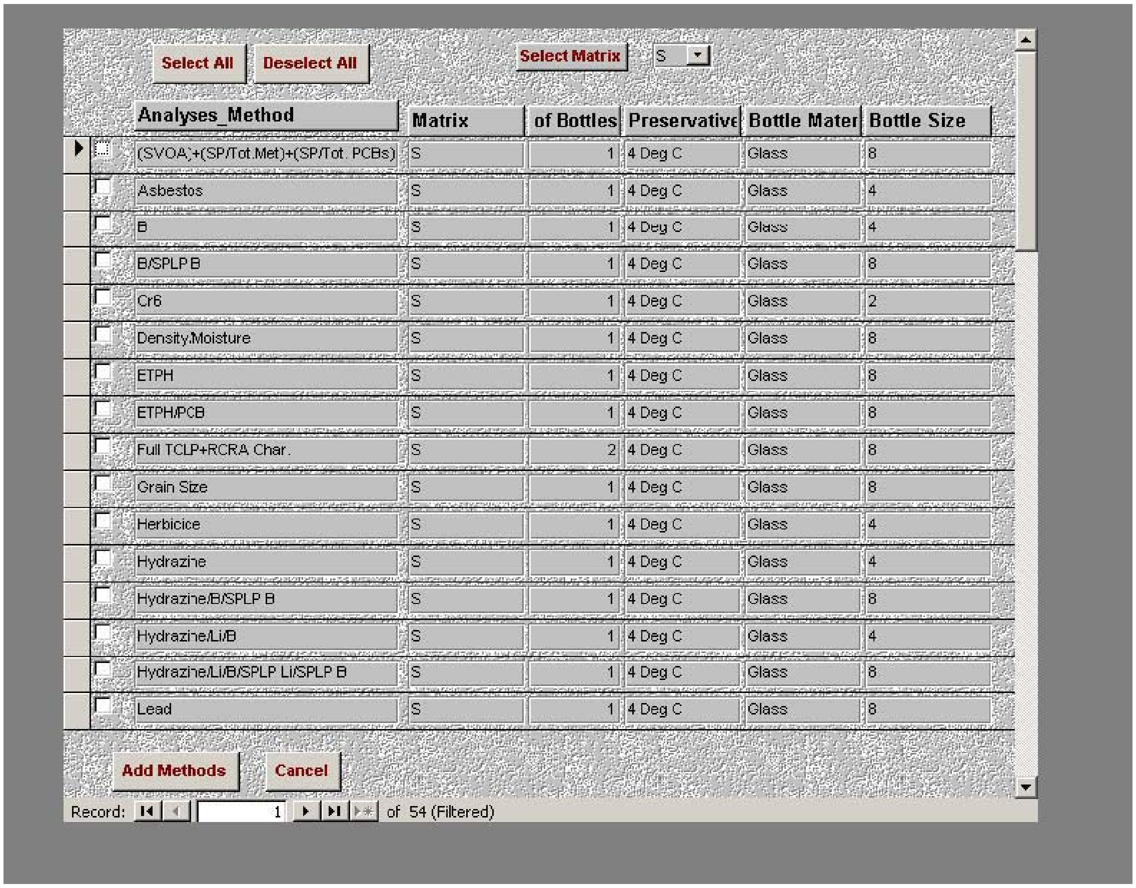
Select an Option ☐ Reverse

○ Print
○ Check-in to Office
○ Send to Lab

	Method	Status	Need	In	Hold	Preservative	Material	Bottle Size		SDG	Fraction	Comment
☐	Li /B & SPLP Li /B	PRINTED	1	0	0	4 Deg C	Glass	4	oz.		T	
☐	Percent Solids	PRINTED	1	0	0	4 Deg C	Plastic	100	mL		T	
☐	SVOA/Metals/SPLP Metals/PCBs	PRINTED	1	0	0	4 Deg C	Glass	8	oz.		T	
☐	VOA	PRINTED	1	0	0	MeOH	Glass	40	mL		T	
*			0	0	0							

Record: 1 of 4

Record: 1 of 158



	Analyses_Method	Matrix	of Bottles	Preservative	Bottle Mater	Bottle Size
☐	(SVOA;+(SP/Tot.Met)+(SP/Tot. PCBs)	S	1	4 Deg C	Glass	8
☐	Asbestos	S	1	4 Deg C	Glass	4
☐	B	S	1	4 Deg C	Glass	4
☐	B/SPLP B	S	1	4 Deg C	Glass	8
☐	Cr6	S	1	4 Deg C	Glass	2
☐	Density.Moisture	S	1	4 Deg C	Glass	8
☐	ETPH	S	1	4 Deg C	Glass	8
☐	ETPH/PCB	S	1	4 Deg C	Glass	8
☐	Full TCLP+RCRA Char.	S	2	4 Deg C	Glass	8
☐	Grain Size	S	1	4 Deg C	Glass	8
☐	Herbicice	S	1	4 Deg C	Glass	4
☐	Hydrazine	S	1	4 Deg C	Glass	4
☐	Hydrazine/B/SPLP B	S	1	4 Deg C	Glass	8
☐	Hydrazine/Li/B	S	1	4 Deg C	Glass	4
☐	Hydrazine/Li/B/SPLP Li/SPLP B	S	1	4 Deg C	Glass	8
☐	Lead	S	1	4 Deg C	Glass	8

Figure 2

SOP No. S-7

AMEC ENVIRONMENT AND INFRASTURE, INC. STANDARD OPERATING PROCEDURE

SAMPLE PACKAGING AND SHIPMENT

STANDARD OPERATING PROCEDURE

SAMPLE PACKAGING AND SHIPMENT

1.0 SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) establishes methodologies for shipping samples collected during environmental field investigation/remediation activities. This SOP applies to all environmental samples including drinking water, groundwater, surface water samples, soil, and sediment samples, and treatment plant samples.

2.0 DEFINITIONS

Shipper's Declaration – A paper document describing the contents of a shipment.

2.0 HEALTH AND SAFETY WARNINGS

Shippers of dangerous goods should take all precautions to eliminate any hazards associated with the goods being shipped. The shipper should consult the most-recent version of the International Air Transportation Association (IATA) regulations regarding shipment of dangerous goods.

3.0 PERSONNEL QUALIFICATIONS

Any person designated as a shipper of dangerous goods shall be trained in the U.S. Department of Transportation Hazardous Materials Regulations, which must be renewed every two years.
Shipment of environmental samples does not require specialized training; however, a familiarity with the regulations and the materials being shipped is considered beneficial.

4.0 EQUIPMENT AND SUPPLIES

Consult the most-recent version of the IATA regulations for a listing of proper shipping materials.

- Cooler -Samples -Labels -Ink pen
- Packing materials (bubble wrap) to prevent breakage, absorb leakage, and insulate samples.
- Polyethylene zip-type baggies large enough to contain the largest sample bottles.
- Custody seals if shipped through Federal Express (FEDEX) or similar shipping vendor.
- Large plastic trash bag to act as containment for the packing materials.

6.0 PROCEDURES

1. Be certain that all containers are sufficiently tight, preserved, and labeled correctly. Sediment samples should be allowed to settle for a minimum of 2 hrs prior to shipping to the laboratory. The sample manger should look closely at all sediment samples to see if a clear water layer forms above the sediment. Any water layer should be decanted from the sample jar prior to shipping to the laboratory.
2. Clean the exterior of each sample container such that no gross contamination remains.
3. Complete the Chain of Custody (COC) as described SOP S-9. When the COC form is completed, verify that bottle labels, analytical fractions, and bottle numbers match what is written on the COC form.
4. Wrap sample containers in bubble wrap. Zip-type plastic baggies may be used as additional containment.

5. Line the cooler with the trash bag and add a layer of packing material. If the cooler has a drain, close and seal to prevent leakage of water from melting ice.
6. Place sample containers into the cooler, and pack them sufficiently to prevent them from shifting during shipment.
7. Place ice-filled zip-type bags on samples such that all samples are contacted by the ice. Place sufficient ice to retain the sample temperature between 2 and 6 degrees C. Place a temperature blank in with the samples.
8. Fill the remaining space in the cooler with packing material and close and secure the top of the trash bag.
9. On the chain of custody, sign in the relinquished by box and add in the subsequent received by box the name of the courier/carrier and the air bill No. (if applicable).
10. Place the COC into a plastic bag and tape it to the inside top of the cooler.
11. Close the cooler and tape the cooler shut with strapping tape or similar high-strength shipping tape.
12. If more than one cooler is being shipped under the same COC, copies of the COC should be placed into each additional cooler in the same manner as the original COC.
13. If shipped through FEDEX or other shipping vendor, apply custody seals to the cooler such that the seals must be broken in order to open the cooler.
14. Apply “UP Arrows” in the appropriate direction on at least opposing sides of the cooler exterior, or indicate on top “this side up”.
15. Add the appropriate shipping address labels to the cooler along with a return address to the cooler. If more than one cooler is being shipped, add “one of ____” to the label so that the recipient is aware that more than one cooler should be received.

7.0 DATA AND RECORDS MANAGEMENT

A copy of the COC shall be retained by the shipper until the completed laboratory data package is received. In addition, a copy of the air bill shall also be retained for validation/custody purposes and also for payment.

8.0 REFERENCES

AMEC Environment and Infrastructure, Inc. Standard Operating Procedure for Chain of Custody S-9 Code of Federal Regulations 40 CFR Part 261.4(d) Samples. Dangerous Goods Regulations, IATA, Most-Current Version.

SOP No. S-8

AMEC ENVIRONMENT AND INFRASTRUCTURE, INC. STANDARD OPERATING PROCEDURE

USE OF FIELD LOGBOOKS

STANDARD OPERATING PROCEDURE

USE OF FIELD LOGBOOKS

1.0 SCOPE AND APPLICABILITY

The use of a Site Logbook and Field Logbook provides a daily record of significant events, observations, and measurements during field investigations. A site logbook is the master log for recording activities during an investigation. Field logbooks provide data and observations which will enable field personnel to reconstruct field project events. Sufficient data and observations should be logged in the field logbook to enable reconstruction of field events and to provide sufficient evidence in the event of legal proceedings.

2.0 RESPONSIBILITIES

It is the responsibility of the Field Operation Leader (FOL) to maintain centralized daily log book records of all significant field events, observations, and measurements during field investigations. All members of the field team are responsible for maintaining complete records of their actions, observations, etc. in their log books and providing this information to the team leader at the end of each day. If observations and measurements are taken in an area where the field log book may become contaminated or if the field personnel are spread over a large area, separate waterproof bound and numbered field log books may be maintained. Logbook entries should be signed and dated at the completion of each task or at the end of each day. Individual field log books are retained by the field team members until the logbook is filled or the completion of the project, at which time, possession of the log books is transferred to the FOL or project manager.

Errant field entries shall have a single line drawn through them and the correct data entered above it. All corrections shall be initialed and dated by the appropriate field personnel. Individual pages should never be removed from bound logbooks.

3.0 EQUIPMENT DESCRIPTIONS

A waterproof, bound field notebook and indelible ink pen are the standard field equipment.

4.0 PROCEDURES

The title page of each logbook will contain the following:

- The logbook number
- Project name and project number
- Site name (Cold Regions Research Engineering Laboratory) and address (72 Lyme Road, Hanover, NH 03755)
- Logbook start date

The site logbook and field logbooks provide a daily hand written account of all field activities. All entries are made in permanent black or blue ink, and corrections are made with a single line with the author initials and date. Each page of the logbook will be dated and signed by the person completing the log. Partially completed pages will have a line drawn through the unused portion at the end of each day.
<u>Site Logbook</u> The site logbook is a record of all major tasks completed for each day or operation. Entries are made each day. The FOL responsible for on-site field operations will complete the site logbook. At a

minimum the site logbook will contain the following information:

- A list of all field logbooks created for the project;
- Names and titles of all project related personnel present at the site during each day of operation;
- A brief summary of all activities completed for each day of operation;
- A listing of any changes made to established SI/RI program procedures; and,
- A summary of any problems encountered during the day including a description of corrective actions and impacts on the project.
- Field Logbook Field logbooks are daily records of field task activities that are entered in real time by the on-site field technicians and scientists. The following information is entered into the field logbooks:
- The date and time of each entry. The daily log should begin with weather conditions and the names and organizations of personnel performing the documented task;
- A summary of important tasks or subtasks completed during the day;
- A description of any field tests completed in association with the daily task;
- A description of any samples collected including documentation of any quality control samples that were prepared (rinse blanks, duplicates, matrix spikes, split samples);
- Documentation of equipment maintenance and decontamination activities; and,
- A summary of any problems encountered during the day including a description of corrective actions and impacts on the daily task.

APPENDIX B

FIELD DATA RECORDS

DAILY PROJECT SAFETY AND HEALTH INSPECTION CHECKLIST

Project: Stratford Army Engine Plant, Stratford, Connecticut

Project Number: 3616176064 **Project Manager:** Rod Pendleton

Prepared by: ______________________________

Names of Amec Foster Wheeler employees on project: ______________________________

Amec Foster Wheeler Subcontractors and their employees' Names on project:

____

____

____

____

Y	N	N/A		Comments
			Inspect Initial Start up of the project, when tasks change or new workers come to the project.	
☐	☐	☐	1) Are emergency phone numbers posted?	
☐	☐	☐	2) Are directions to the nearest emergency medical care posted?	
☐	☐	☐	3) Is there a SSHP at the Project?	
☐	☐	☐	a. Is it current?	
☐	☐	☐	b. Does it address all know/suspected hazards?	
☐	☐	☐	c. Is it approved?	
☐	☐	☐	4) Have applicable workers received 40-hour initial training? (24-hours training for contractors is acceptable)	
☐	☐	☐	5) Have all applicable workers received refresher training within the past year?	
☐	☐	☐	6) Are all applicable workers in the medical monitoring program?	
☐	☐	☐	a. Are they current in their physicals?	
☐	☐	☐	7) Is there a charged fire extinguisher on Project?	
☐	☐	☐	8) Is there an eyewash on Project?	
☐	☐	☐	a. Solution not expired?	
☐	☐	☐	9) Is there a first aid kit on project?	
☐	☐	☐	a. Adequately stocked?	

AMEC FOSTER WHEELER DAILY TAILGATE SAFETY MEETING CHECKLIST

I have participated in the daily safety meeting discussing the topics indicated on the reverse and fully understand my responsibility for complying with all health and safety requirements. I have had the opportunity to have my questions on project health and safety issues and procedures answered.

Employee Name	**Employee Signature**	**Date**

Name and Signature of person conducting training Date:

SUMMARY OF DAILY ACTIVITIES

Site Name:	Stratford Army Engine Plant	**Project Number:**	3616176064
Technician Name:		**Date and Time:**	

Personnel Onsite:

Weather Conditions:

Description of Daily Activities and Events:

List Samples Collected:

Deviation from Plans:

Visitors on Site:	**Important Telephone Calls / Photos Taken:**	**Technician Signature:**
		Technician Name (print)**:**

QA/QC'd by:

QA/QC Date:

FIELD INSTRUMENTATION CALIBRATION RECORD

PROJECT Stratford Army Engine Plant DATE ____ TIME ____

CREW ID OR TASK ID ____ JOB NUMBER 3616176064

SAMPLER SIGNATURE ______________________________CHECKED BY____________

EQUIPMENT CALIBRATION

MANF & MODEL NO.______________

UNIT ID NO.________________

		INITIAL CALIBRATION		SECONDARY CALIBRATION (see note 3)		
		STANDARD VALUE	METER VALUE	STANDARD VALUE	METER VALUE	ACCEPTANCE CRITERIA **
pH	units					+/- 10% of standard
Redox	+/- mV					see note 1
Conductivity	mS/cm					+/- 10% of standard
DO	mg/L *					+/- 10% of standard
Thermometer Temperature	deg. C					+/- 2.0 deg. C
TURBIDITY METER TYPE__________ MODEL NO.__________	NTU (low)					within 0.5 NTU of the standard
UNIT ID NO.__________	NTU (high)					+/- 10% of standard
PHOTOIONIZATION METER TYPE__________	Background ppmv					within 5 ppmv of Zero
MODEL NO.__________ UNIT ID NO.__________	Span Gas ppmv					+/- 10% of standard
OTHER METER TYPE__________ MODEL NO.__________ UNIT ID NO.__________						see note 2

Check One

☐ Equipment calibrated within the Acceptance Criteria specified for each of the parameters listed above.

☐ Equipment (not) calibrated within the Acceptance Criteria specified for each of the parameters listed above (see notes below).

MATERIALS RECORD

Deionized Water Source: ____________________

PID SPAN Gas: Lot ____________________

PID Zero Gas: Lot ____________________

Other : ____________________

Source and Lot Number

pH ____________________

ORP ____________________

Conductivity ____________________

Turbidity ____________________

Other ____________________

NOTES:

* = Indicate in notes section what was used as the DO standard (i.e., based on saturation at room temperature)

** = If the meter reading is not within acceptance criteria, clean or replace probe and re-calibrate, or use a different meter if available. If project requirements necessitate use of the instrument, clearly document on all data sheets and log book entries that the parameter was not calibrated to the acceptance criteria.

1 = meter must read within specified range of the Zobell solution.

2 = specify acceptance criteria in the Notes section

3 = secondary calibration to be completed should instrument drift be suspected during field day

EQUIPMENT BLANK SAMPLING RECORD

PROJECT NAME Stratford Army Engine Plant	**SAMPLE LOCATION**	**PROJECT NO** 3616176064

Rinsate Blank Sample I.D.:	
Date/Time:	
DI Water Source:	
Equipment Used:	

Sample I.D.s associated with above Rinsate Blank	Comment

Created By: BPW
Checked By:

amec foster wheeler

Stratford Army Engine Plant - Feasibility Study

SEDIMENT CORE and DISCRETE SAMPLE LOG

Site: Stratford Army Engine Plant **Project No.:** 3616176064 **Logger:**
Sub: **WO:** **Crew:**
Date: **Time :** **Vessel:**

Coordinates: **Easting** **Northing**

Sampling Station:

Weather/Conditions: Traffic: Water Temp:

Measured Water Depth (ft):
Core Liner tube length (ft):
Core Penetration (ft) Core Recovery (ft):
Calculated Percent Recovery:

Coring Notes:

Interval	Sample ID	Description (Odor, Color, Type, etc.)	Notes
0-1'			
1-2'			
3-4'			
4-5'			
5-6'			
6-7'			
7-8'			

Number of containers:					Equipment Sampler Type
Type of container:	40 ml VOA	Amber Jar	Plastic bag	other	Capacity

Live Organisms present	Y	N
Oil-Like Present	Y	N
Odor Present	Y	N
Debris Present	Y	N

Photo Numbers

Comments

SURFACE WATER SAMPLING RECORD

Amec Foster Wheeler
511 Congress Street
Suite 200
Portland, Maine 04101

PROJECT NAME Stratford Army Engine Plant	**SAMPLE LOCATION**	**DATE**
PROJECT NUMBER 3616176064	**START TIME**	**END TIME**
SAMPLE ID	**SAMPLE TIME**	**PAGE** **of**
Lat.	**Long.**	

SURFACE WATER DATA

WATER DEPTH AT SAMPLE LOCATION ________ FT.

DEPTH OF SAMPLE BELOW WATER SURFACE ________ FT.

SAMPLING FLOW RATE ________ ML/MIN

TIDE DIRECTION ☐ INCOMING ☐ OUTGOING

FIELD SKETCH ☐ YES ☐ NO

TOTAL PURGE VOLUME ________ ML

WATER QUALITY PARAMETERS:

TEMPERATURE ________ ^{o}C
SPEC. COND. ________ mS/cm
PH ________ pH Units
ORP ________ mV
TURBIDITY ________ NTUs
DO ________ mg/L
SALINITY ________ ppt

EQUIPMENT USED:

- ☐ BEAKER
- ☐ BOTTLE
- ☐ PACS BOMB
- ☒ PUMP Peristaltic Pump (Geopump)
- ☐ FILTER ________
- ☐ 5 ft of lab precleaned 1/4 " Teflon Tubing
- ☐ 3 ft of lab precleaned Masterflex Tubing

TYPE OF SURFACE WATER:

- ☐ STREAM
- ☐ RIVER
- ☐ LAKE
- ☐ POND
- ☐ SEEP
- ☒ TIDAL FLATS
- ☐ ________

☐ FIELD DUPLICATE COLLECTED
DUP. ID ________
TIME ________

☐ MATRIX SPIKE COLLECTED
MS ID ________
TIME ________

☐ MATRIX SPIKE DUPLICATE COLLECTED
MSD ID ________
TIME ________

DECON FLUIDS USED

- ☐ ALL USED
- ☐ LIQUINOX/DI H_2O SOLUTION
- ☐ DEIONIZED WATER
- ☐ POTABLE WATER
- ☐ NITRIC ACID
- ☐ HEXANE
- ☐ ETHYL ALCOHOL
- ☐ N/A ________

SAMPLING EQUIPMENT

WATER QUALITY METER MODEL NO. ________ UNIT ID NO. ________
TURBIDITY METER MODEL NO. ________ UNIT ID NO. ________

ANALYTICAL PARAMETERS

	PARAMETER	METHOD NUMBER	PRESERVATION METHOD	VOLUME REQUIRED	SAMPLE COLLECTED
☐					
☐					
☐					
☐					
☐					
☐					
☐					

NOTES/SKETCH

Note:

Sampler Signature: Print Name:

Checked By: Date:

APPENDIX C

LABORATORY QUALITY ASSURANCE MANUALS PLANS AND STANDARD OPERATING PROCEDURES

Redacted - Confidential Business Information

Redacted - Confidential Business Information

Redacted - Confidential Business Information

Redacted - Confidential Business Information

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Technical Information

Reference Number:	ASTM D422
Test Method Title:	Test Method for Particle Size Analysis of Soils
Test Property:	Grain Size Analysis
Test Specimen Size:	Passing #10 sieve: 115 g sandy soils, 65 g silty or clayey soils Retained on #10 sieve: see test standard (based on largest particle size)
Number of Test Specimens:	1 representative sample obtained by quartering, mixing or splitting
Test Equipment:	Hydrometer (ASTM) Sedimentation Cylinder Stirring Apparatus (blender) Dispersion Cup Drying containers Balance readable to 0.01 gram for material passing #10 sieve or 0.1% of mass for material retained on #10 sieve Thermometer readable to 0.5 ºC Various sieves 250 mL beaker Drying oven capable of maintaining a temperature of 110 ± 5 ºC Dispersing agent mixture (40 g/L of Sodium Hexametaphosphate solution) Mechanical sieve shaker Distilled Water Spray Bottle Wash pan

Standard Operating Procedure

Sampling

1. Collect a representative sample and perform a moisture content test in accordance with ASTM D 2216.

2. Collect another representative sample to be used for the particle size analysis. Base specimen size on test standard (based on largest particle size). Record specimen wet weight.

Splitting / Washing sample on #200 sieve

3. Add 125 ml of dispersing agent into sample container. Stir well and allow to soak for at least 16 hours.

4. Rinse sample into dispersion cup and use stirring apparatus (blender) to further disperse sample for 1 minute.

5. Wash the test specimen from the dispersion cup, using distilled water, over the No. 200 sieve into a container. Be sure to collect all washings in the container. Use only 800 ml of distilled water for the washing operation.

6. Transfer the portion retained on the No. 200 into a tare and place in a drying oven.

7. Wash the minus No. 200 sieve material into a Sedimentation cylinder.

Sieve analysis of portion retained on #200 sieve

8. Separate the portion retained on #200 sieve into a series of fractions using various sieve sizes ranging from 3 inch to #200. Set up in mechanical shaker and shake for 10 minutes. Determine the mass retained on each sieve by weighing and recording mass to nearest 0.1 % of sample mass.

Hydrometer analysis of portion passing #200 sieve

9. Add distilled water to the1000 mL point. Place a rubber stopper over the open end and turn the cylinder upside down and back for a period of 1 minute (should be 60 turns per minute). Set the cylinder down, remove stopper and wash any adhering soil into the cylinder. Begin to take and record hydrometer readings at the following intervals: 2, 5, 15, 30, 60, 120, 240, and approximately 1440 minutes. After each reading, the temperature of the solution should be recorded.

10. Calculations: Use initial moisture content and initial wet weight of test specimen to calculate initial dry weight of test specimen. Use reporting software to enter data and calculate % passing and retained for each sieve size and hydrometer readings.

11. Report: sample identification, sample description, percentage passing or retained on each sieve fraction (tabular and graphical).

Technical Information

Reference Number:	ASTM D4318
Test Method Title:	Standard Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils
Test Property:	Plasticity of soils
Test Specimen Size:	150-200 grams of material passing the #40 sieve 100 grams of as received soil for Moisture Content Determination
Number of Test Specimens:	1 (representative sample obtained by quartering, mixing or splitting)
Test Equipment:	Liquid limit device Flat grooving tool Drying containers Balance readable to 0.01 gram with 500 gram capacity Ground glass plate Spatula #40 sieve Wash bottle Distilled Water Drying oven capable of maintaining 110 ± 5 °C Drying Plate/vacuum pump apparatus Soil Blender with mixing cup

Standard Operating Procedure

The Atterberg Limit Test requires the As Received Moisture content determination to be reported. If no other assigned testing requires the As Received Moisture content determination, follow ASTM D 2216 and obtain the result for the sample.

GTX requires a daily IRM check of the equipment to include, but is not limited to: the wear of the grooving tool, the drop height of the Liquid Limit device cup and the wear spot on the base under the cup at the point of impact of the Liquid Limit device. Do not use equipment that is not comply with the IRM tolerances, found on the IRM log.

SAMPLE PREPARTION (wet method)

1. If sample has little or no material retained on the #40 sieve, prepare specimen of 150-200 g by mixing thoroughly with distilled water on glass plate or mixing dish using a spatula. If desired, soak the material in a mixing/storage dish with a small amount of water to soften the material before the start of mixing. Adjust the water content of the soil and mix again to bring to a consistency that would require between 25-35 blows. Remove >#40 sieve material by hand if small percentage is present. If water has been added to specimen place in a covered dish and allow to cure for a minimum of 16 hours.

2. If large percentage of >#40 sieve material is present, obtain a large enough specimen which will contain 150-200 g of material passing the #40 sieve. Place specimen in mixing cup and cover with distilled water. Mix into slurry, pass specimen through a #40 sieve and discard >#40 material. Reduce the amount of water using the drying plate/vacuum pump apparatus. Do not allow sample to over dry. Dry until sample is at a consistency that would require between 25-30 blows. Water has been added to the specimen so place in a covered dish and allow to cure for a minimum of 16 hours.

SAMPLE PREPARATION (dry method)

1. If sample is received dry, pass the material through a #40 sieve, and adjust the moisture content and mix thoroughly to bring the soil to a consistency that would require between 25-35 blows. Place specimen in a covered dish and allow to cure for a minimum of 16 hours.

LIQUID LIMIT DETERMINIATION (multipoint method)

1. Before starting test, remix thoroughly in its dish adjusting the water content slightly, as necessary.

2. Fill the liquid limit cup even with front rim, to a depth that allows a full height cut with grooving tool. Keep the unused material covered with a wet towel in the mixing dish.

3. Form a groove in the soil from the highest point to the lowest point on the rim of the cup using the beveled edge facing forward of the grooving tool. Keep the tool perpendicular to cup from back to front by using an arc type motion. If the groove cannot be made in one stroke without tearing the soil, cut the groove in layers a little deeper with each cut, without tearing the soil.

4. Inspect the underside of the Liquid Limit Device, making sure the underside of the cup and base are clean. Lift and drop the cup at a rate of 1.9-2.1 drops per second until the two halves of the soil pat come in contact at the bottom of the groove along a distance of 0.5 inch. The base of the machine shall not be held with a hand while the crank is being turned. Record number of blows required. Take approximately 10 g of material from the closed area, perpendicular to the groove and place into a pre-weighed drying container. Measure and record mass to nearest 0.01 g. Cover the container.

5. Remove balance of material from cup and remix with soil in dish. Clean the cup.

6. By wetting the remaining material, adjust the blow counts so a distribution of blow counts is obtained. One point between 35 and 25 blows, another point between 20 and 30 blows, and a third point between 25 and 15 blows. For each point repeat steps 1 through 6.

PLASTIC LIMIT DETERMINATION

1. Obtain about 20 grams of soil prepared for the Liquid Limit test and dry by blotting with paper towels until it can be rolled without sticking to the glass plate.

2. To determine plastic limit, roll three to four threads of 1.5-2.0 grams of material down to a 1/8 inch diameter for a total sample weight of at least 6 grams.

3. Roll the material on a glass plate with the palm of your hand until a thread of uniform diameter of 1/8 inch is obtained (80-90 strokes per minute). This should take no longer than 2 minutes.

4. Ball up and repeat step 3 again. Repeat until 1/8 inch diameter cannot be obtained (thread crumbles under the pressure required for rolling). The only requirement for continuing is that the threads are able to be reformed into a ball and rolled out again.

5. Gather portions of the crumbled thread together and place into a pre-weighed container. Measure and record mass to nearest 0.01 g.

6. Repeat steps 2 through 5 one more time.

7. Dry all materials to a constant mass in oven with the temperature required for the material type being tested. Weigh again to the nearest 0.01 g.

8. Calculate the plasticity index as follows:

   PI = LL-PL

   where:
   PI = Plasticity Index
   LL = Liquid Limit
   PL = Plastic Limit

9. If either the liquid limit or plastic limit could not be determined, or if the plastic limit is equal to or greater than the liquid limit, report the soil as non-plastic.

10. Report: sample identification, as received moisture content, sample preparation procedure, liquid limit, plastic limit and plasticity index to the nearest whole number, and non-plastic if applicable.

Technical Information

Reference Number:	ASTM D6913
Test Method Title:	Standard Test Methods for Particle-Size Distribution Gradation) of Soils Using Sieve Analysis
Test Property:	Grain Size Analysis for samples with all material passing a No. 4 sieve.
Test Specimen Size:	Depends on test samples maximum particle size. See ASTM D6913 Table 2 below. Specimen size is generally on the order of 50 to 500 g.

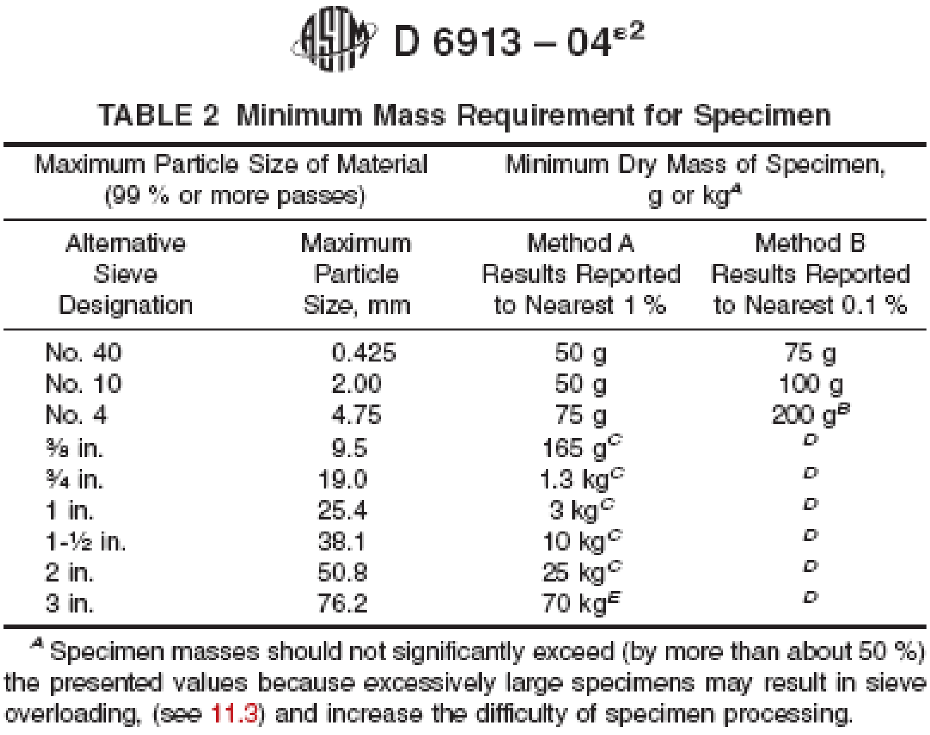

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TABLE 2 Minimum Mass Requirement for Specimen

Maximum Particle Size of Material (99 % or more passes)		Minimum Dry Mass of Specimen, g or kg[A]	
Alternative Sieve Designation	Maximum Particle Size, mm	Method A Results Reported to Nearest 1 %	Method B Results Reported to Nearest 0.1 %
No. 40	0.425	50 g	75 g
No. 10	2.00	50 g	100 g
No. 4	4.75	75 g	200 g[B]
⅜ in.	9.5	165 g[C]	[D]
¾ in.	19.0	1.3 kg[C]	[D]
1 in.	25.4	3 kg[C]	[D]
1-½ in.	38.1	10 kg[C]	[D]
2 in.	50.8	25 kg[C]	[D]
3 in.	76.2	70 kg[E]	[D]

[A] Specimen masses should not significantly exceed (by more than about 50 %) the presented values because excessively large specimens may result in sieve overloading, (see 11.3) and increase the difficulty of specimen processing.

Number of Test Specimens:	1 representative sample obtained by quartering, mixing or splitting

Test Equipment:	Fine Sieve Set: 3/8 in., No. 4, No. 10, No. 20, No. 40, No. 60, No.100, No. 140, No.200 Washing Sieve, No. 200 (75-µm) Washing Sink with Spray Nozzle Mechanical Sieve Shaker Balances (readable to 0.01 g) Drying Oven 110° ± 5 ° C Sample and Specimen Containers Sieve Brushes Wash bottle Spatula Stirring Rod

Optional Items
Splitter/Riffle Box or Quartering equipment
Mortar and Rubber-Covered Pestle (for breaking up aggregations of dried soil.)
Low Temperature Drying Oven not to exceed 60°C
Sodium hexametaphosphate dispersant solution:
  Make a solution by using 40 g of sodium hexametaphosphate and 1,000 g distilled, deionized, or demineralized water

Standard Operating Procedure

ASTM D6913 Method B – Single Sieve Set Sieving (Use for samples containing **no** particles larger than a #4 sieve.)

Sample Preperation:

1. Confirm that the sample contains no plus No. 4 material.

2. Record the weight of an empty tare.

3. If the sample is large, collect a 100–200 g representative sub-sample of and place it in the tare weighed in step 2 above. For smaller samples, place the entire sample in the weighed tare from set 2 above. This sample will be used as a moisture content sample and the sieve test sub-specimen. Record the wet weight of the [sub-specimen + tare] and oven dry at 110° ± 5 ° C.

Sieve Test:

1. Record the weight of the [oven-dried sub-specimen + tare] dried in Sample Preperation step 3 above.

2. Disperse the dried sub-specimen by soaking in water for at least 5 minutes before washing. Difficult samples can be dispersed using a sodium hexametaphosphate solution and/or an ultrasonic bath.

3. Wash the dispersed specimen on a #200 wash sieve, using tap water. Collect the wash water and dispose of the fine soil properly. Do not let the fines run down the drain.

The material in the wash sieve may be lightly manipulated by hand, to facilitate the washing, taking care not to lose any of the soil. Do not exert any downward pressure on the wash sieve as this may damage the sieve.

Fine material can clog the screen. Care should be taken not to let the wash sieve fill with too much water when clogging occurs. Prevent clogging by lightly tapping the sides of the sieve with your hand or tapping on the bottom of the screen with a fingertip.

4. Transfer the washed +200 in. fraction of soil back into the same tare and oven dry at $110^{\circ} \pm 5^{\circ}$ C.

5. Sieve the dried specimen using the standard fine sieve set, which includes the following sieve sizes:

   No. 4, No. 10, No. 20, No. 40, No. 60, No.100, No. 140, No.200

   Additional screens may be added as requested by the client.

6. Shake the sieve sample for a minimum 10 minutes. (The “Standard Shaking Period” is verified annually based on the procedure in ASTM D 6913.)

7. Avoid overloading individual sieves. Refer to ASTM Table 3 below for maximum sieve loading. If necessary, shake overloaded sieves in multiple batches.

8. Cumulatively record the weights of the oven-dried material retained on each of the fine sieves. Place the material, sieve by sieve, into a tared weighing container and record the cumulative weight. At least one sieve in the sieving process shall have 100 percent passing.

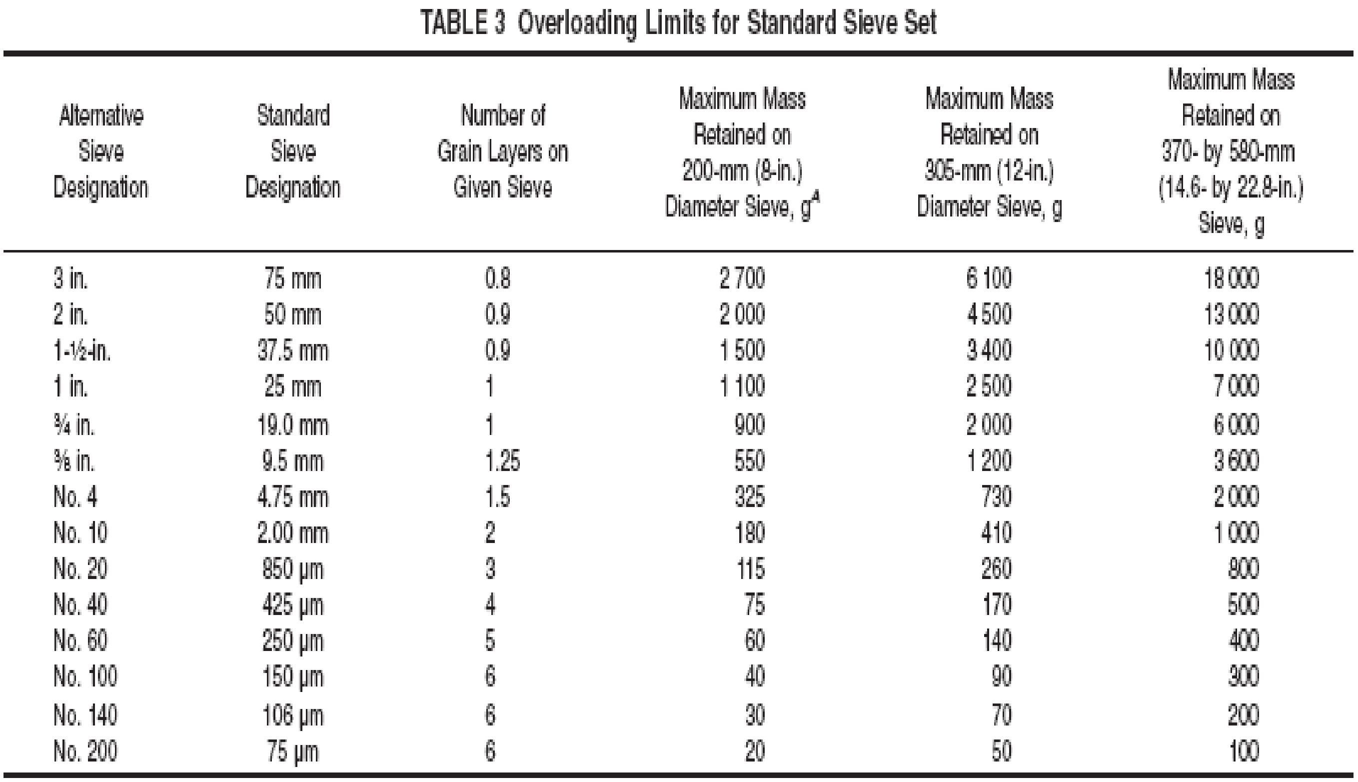

TABLE 3 Overloading Limits for Standard Sieve Set

Alternative Sieve Designation	Standard Sieve Designation	Number of Grain Layers on Given Sieve	Maximum Mass Retained on 200-mm (8-in.) Diameter Sieve, g[A]	Maximum Mass Retained on 305-mm (12-in.) Diameter Sieve, g	Maximum Mass Retained on 370- by 580-mm (14.6- by 22.8-in.) Sieve, g
3 in.	75 mm	0.8	2 700	6 100	18 000
2 in.	50 mm	0.9	2 000	4 500	13 000
1-½-in.	37.5 mm	0.9	1 500	3 400	10 000
1 in.	25 mm	1	1 100	2 500	7 000
¾ in.	19.0 mm	1	900	2 000	6 000
⅜ in.	9.5 mm	1.25	550	1 200	3 600
No. 4	4.75 mm	1.5	325	730	2 000
No. 10	2.00 mm	2	180	410	1 000
No. 20	850 µm	3	115	260	800
No. 40	425 µm	4	75	170	500
No. 60	250 µm	5	60	140	400
No. 100	150 µm	6	40	90	300
No. 140	106 µm	6	30	70	200
No. 200	75 µm	6	20	50	100

Calculations:

1. Use initial moisture content and initial wet weight of test specimen to calculate initial dry weight of test specimen. Use reporting software to enter data and calculate % passing and retained for each sieve size.

Report:

1. The datasheet shall include the following:

    - Project identification, boring number, sample number, depth,
    - Visual classification of the soil being tested
    - Test method used (Method A)
    - Sample preparation - moist, air dried, or oven dried, etc.
    - Any material excluded from the specimen.
    - Indicate that composite sieving was used and the size of the designated separating sieve.
    - If material is retained on the designated separating sieve size in finer sieve set, then document that the percent retained does not exceed 2 % criterion.
    - Indicate if the ultrasonic bath or shaking apparatus or both were used during the dispersion process.

- Any prior testing performed on specimen
- All mass measurements.
- Tabulation of percent passing for each sieve to 0.1%.

2. The report shall include the following:

- Project identification, boring number, sample number, depth,
- Classification or visual classification of the soil being tested
- Any material excluded from the specimen.
- Any prior testing performed on specimen
- A graph of the percent passing versus log of particle size in mm

ASTM Comments:

Some materials that are not soils, but are made up of particles may be tested using this method.

This test method is ***not*** applicable for the following soils:

1. Soils containing fibrous peat that will change in particle size during the drying, washing, or sieving procedure.
2. Soils containing extraneous matter, such as organic solvents, oil, asphalt, wood fragments, or similar items. Such extraneous matter can affect the washing and sieving procedures.
3. Materials that contain cementitious components, such as cement, fly ash, lime, or other stabilization admixtures.

This test method may **not** produce consistent test results within and between laboratories for the following soils:

1. Friable soils in which the sieving processes change the gradation of the soil. Typical examples of these soils are some residual soils, most weathered shales and some weakly cemented soils such as hardpan, caliche or coquina.
2. Soils that will not readily disperse such as glauconitic clays or some dried plastic clays.

To test these soils, this test method must be adapted, or altered, and these alterations documented.

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Preparation of Samples for Chlorinated Herbicides Analysis by GC.

Reference Methods: **EPA 8151A,** SW-846, Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, EPA SW-846, Update III, 1996.

MA BWSC-CAM Section VC, Quality Control Requirements and Performance Standards for SW-846 Method 8151A, for the Massachusetts Contingency Plan (MCP). Revision 1, July1, 2010.

EPA Method 3550C SW-846, Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, EPA SW-846, Update III, February 2007.

1. Scope and Application

Matrices: Aqueous, soil and waste.

Definitions: See Alpha Laboratories Quality Manual Appendix A

Specifically, Method 8151A may be used to determine the following compounds:

Parameter	CAS No.[a]
2,4-D [1, 2, 3]	94-75-7
2,4-DB	94-82-6
2,4,5-TP (silvex) [1, 2, 3]	93-72-1
2,4,5-T [1, 2]	93-76-5
Dalapon	75-99-0
Dicamba	1918-00-9
Dichloroprop	120-36-5
Dinoseb	88-85-7
MCPA	94-74-6
MCPP	93-65-2

[a] Chemical Abstract Service Registry Number

[1] RCRA List

[2] APA List

[3] TCLP List

Method 8151A is a capillary gas chromatographic (GC) method for determining certain chlorinated acid herbicides and related compounds in aqueous, soil and waste matrices.

Because these compounds are produced and used in various forms (i.e., acid, salt, ester, etc.), Method 8151A describes a hydrolysis step that can be used to convert herbicide esters into the acid form prior to analysis. Herbicide esters generally have a half-life of less than one week in soil.

Refer to the analytical SOP for list of compounds reported by this method.

The data report packages present the documentation of any method modification related to the samples tested. Depending upon the nature of the modification and the extent of intended use, the laboratory may be required to demonstrate that the modifications will produce equivalent results for the matrix. Approval of all method modifications is by one of the following laboratory personnel before performing the modification: Area Supervisor, Laboratory Services Manager, Laboratory Director, or Quality Assurance Officer.

This method is restricted to use by or under the supervision of an experienced analyst. Only experienced analysts should be allowed to work with diazomethane due to the potential hazards associated with its use (explosive, carcinogenic).

2. Summary of Method

Method 8151A provides extraction, derivatization, and gas chromatographic conditions for the analysis of chlorinated acid herbicides in water, soil, and waste samples. The hydrolysis of esters is also described.

Water, soil, and waste samples are extracted with diethyl ether and then methylized with diazomethane. The derivatives are determined by gas chromatography with an electron capture detector (GC/ECD).

2.1 Method Modifications from Reference

-Extraction of high concentration samples uses ultrasonic extraction, rather than waste dilution.

3. Reporting Limits

Reporting Limit information may be found in the various determinative method SOPs.

4. Interferences

4.1 Refer to Method 8000 for instrumental interferences.

4.2 Method interferences may be caused by contaminants in solvents, reagents, glassware, and other sample processing hardware that lead to discrete artifacts or elevated baselines in gas chromatograms. All these materials must be routinely demonstrated to be free from interferences under the conditions of the analysis, by analyzing reagent blanks.

4.2.1 Glassware must be scrupulously cleaned. Clean each piece of glassware as soon as possible after use by rinsing it with the last solvent used in it. This should be followed by detergent washing with hot water and rinses with tap water, then with organic-free reagent water. Glassware should be solvent-rinsed with acetone and pesticide-quality hexane. After rinsing and drying, glassware should be sealed and stored in a clean environment to prevent any accumulation of dust or other contaminants. Store glassware inverted or capped with aluminum foil. Immediately prior to use, glassware should be rinsed with the next solvent to be used.

4.2.2 The use of high purity reagents and solvents helps to minimize interference problems.

4.3 Matrix interferences may be caused by contaminants that are co extracted from the sample. The extent of matrix interferences will vary considerably from waste to waste, depending upon the nature and diversity of the waste being sampled.

4.4 Organic acids, especially chlorinated acids, cause the most direct interference with the determination by methylation. Phenols, including chlorophenols, may also interfere with this procedure.

4.5 Alkaline hydrolysis and subsequent extraction of the basic solution removes many chlorinated hydrocarbons and phthalate esters that might otherwise interfere with the electron capture analysis. However, hydrolysis may result in the loss of dinoseb and the formation of aldol condensation products if any residual acetone remains from the extraction of solids.

4.6 The herbicides, being strong organic acids, react readily with alkaline substances and may be lost during analysis. Therefore, glassware must be acid-rinsed and then rinsed to constant pH with organic-free reagent water. Sodium sulfate must be acidified.

4.7 Sample extracts must be dry prior to methylation otherwise poor recoveries will be obtained.

5. Safety

The toxicity or carcinogenicity of each reagent and standard used in this method is not fully established; however, each chemical compound should be treated as a potential health hazard. From this viewpoint, exposure to these chemicals must be reduced to the lowest possible level by whatever means available. A reference file of material data handling sheets is available to all personnel involved in the chemical analysis. Additional references to laboratory safety are available in the Chemical Hygiene Plan.

All personnel handling environmental samples known to contain or to have been in contact with municipal waste must follow safety practices for handling known disease causative agents.

5.1 Lab coats, safety glasses, and gloves must be worn when handling supplies, samples, extracts, standards or solvents, and when washing glassware.

5.2 All extract concentration steps must be performed in extraction hoods. All solvent and extract transfers must also be handled in a hood.

5.3 All expired stock standards, working standards, and spent sample extracts must be placed into the waste bucket in the laboratory for future disposal by the Hazardous Waste Manager. The container must be properly labeled with hazard warning labels indicating the container contents.

5.4 Bottles containing flammable solvents must be stored in the flammables cabinet or in the vented cabinets found under the hoods. All ether bottles are to be checked for peroxide immediately upon opening.

5.5 All waste solvents must be transferred to the satellite waste storage containers located in the extraction laboratory. Separate containers are provided for chlorinated and non-chlorinated solvents and must be used accordingly. Under no circumstances are solvents to be poured down the sink drains.

5.6 Inspect all glassware prior to use. Do not use any glassware that is chipped or cracked if it could present a safety hazard. Damaged glassware is put aside for repair; otherwise the piece is discarded.

5.7 **CAUTION:** Diazomethane is a carcinogen and can explode under certain conditions. Diazomethane generation is only to be performed by or under the supervision of experienced analyst. Record the diazomethane generation in the Diazomethane Generation Logbook.

5.8 All Field Samples must be opened and handled in a hood.

6. Sample Collection, Preservation, Shipping and Handling

6.1 Sample Collection

Aqueous samples are collected in two one-liter amber glass containers. Soil samples are collected in 8oz. glass jars or equivalent.

6.2 Sample Preservation

Both aqueous and soil/solid samples are stored in refrigerators to maintain a temperature of 2 – 6 °C.

6.3 Sample Shipping

See applicable Sample Custody SOP.

6.4 Sample Handling

Both aqueous and soil/solid samples and extracts are stored under refrigeration (2 – 6 ºC) and protected from light. Aqueous samples must be extracted within 7 days from the time of collection; soil samples, within 14 days from collection. Sample extracts must be analyzed within 40 days following extraction.

Samples are removed from the Custody Sample Refrigerators by the analyst just prior to sample extraction. The analyst must take custody of the samples by signing them out via the LIMS.

Aqueous Samples: Visually inspect the samples prior to starting the extraction process. Typically the entire contents of the 1L amber jar are used for extraction.

Soil/Sediment Samples: When possible, samples must be homogenized prior to removing the sample from the soil jar.

After the sample or sample aliquot is removed, the samples or empty sample containers are returned to Sample Custody. Custody of the samples is transferred back by signing them back in utilizing the LIMS. If there is any sample remaining, place the sample back in its appropriate refrigerator. If the entire sample volume was used, change the status of the container in the LIMS to “EMPTY”, and discard the empty container.

7. Equipment and Supplies

7.1 Disposable Borosilicate Glass Pipets: 10mL, graduated

7.2 **Kuderna-Danish (K-D) apparatus:** Note, all Herbicide glassware is denoted with a green “dot”.

7.2.1 **Concentrator Tube:** 25mL graduated. A ground glass stopper is used to prevent evaporation of extracts.

7.2.2 **Evaporation Flask:** 500mL. Attach to concentrator tube with springs, clamps, or equivalent.

7.2.3 **Snyder Column:** Three-ball macro.

7.2.4 **Snyder Column:** three-ball Micro.

7.3 Beaker: 400mL, 2000 mL, 500 mL; thick-walled.

7.4 Powder Funnel: 75mm diameter, glass or metal.

7.5 Separatory Funnel: 2L, glass or Teflon, with polytetrafluorothylene (PTFE) stopcock.

7.6 Centrifuge Bottle: 500mL, Pyrex® 1260 or equivalent.

7.7 Erlenmeyer Flasks: 500mL, 1000mL and 2000mL.

7.8 Pipet: Pasteur, glass, disposable (140mm x 5mm ID).

7.9 Vials: 22mL, glass, with PTFE-lined screw caps.

7.10 Filter Paper: 15cm diameter (Whatman No. 1 or equivalent).

7.11 Acidified Glass Wool: Phosphoric treated.

7.12 Boiling Chips: Solvent-extracted with methylene chloride, approximately 10/40 mesh (silicone carbide or equivalent).

7.13 S-EVAP Water Bath with Solvent Collection Capability: Heated. Capable of temperature control (0.1ºC). Baths are located in a hood. Baths are equipped with chilled water condensers for solvent collection.

7.14 Balance: Analytical, capable of accurately weighing to 0.01g.

7.15 Centrifuge: Fisher Scientific Centrifuge.

7.16 Round, Flat- Bottomed Boiling Flasks: 250mL.

7.17 Ultrasonic Extraction System: A horn-type device equipped with a titanium tip, or a device that will give equivalent performance. The disrupter has minimum power wattage of 300 watts, with pulsing capability. A device designed to reduce the cavitation sound is recommended. Follow the manufacturer's instructions for preparing the disrupter for extraction of samples. Use a ¾" horn for most samples.

7.18 Sonabox: Used with the above disrupter for decreasing cavitation sound (Heat Systems – Ultrasonics, Inc., Model 432B or equivalent).

7.19 pH Paper: Wide range, multibanded.

7.20 Syringes: 1.0mL for adding Surrogate/Spikes

7.21 Spatulas: Stainless steel and Teflon

7.22 KI Paper Strips: 0.05mg/L residual chlorine sensitivity

7.23 Brady labeling system: Thermal label generator**.**

7.24 Peroxide Test Strips

7.25 Diazold Generation kit: various distillation glassware, hot plate, Thermometer, chiller.

7.26 Porcelain Dish

7.27 Vortex

7.28 Buchner Setup: Buchner Funnel attached to 2000mL Erlenmeyer flask with Vacuum Spigot. Spigot is attached to a vacuum pump with 3/8" tubing.

7.29 Bottle Top Dispenser.

7.30 N-EVAP: Organomation; utilized for micro blow down**.**

7.31 Water Bath

7.32 Graduated Cylinders: 25, 50, 250 and 1000 mL, class "A".

8. Standards and Reagents

Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

NOTE: Store the standard solutions (stock, composite, calibration, internal, and surrogate) at 4±2 °C in Teflon(R)-sealed containers in the dark. When a large volume of standard is prepared, aliquots of that lot are stored in individual small vials. All stock standard solutions must be replaced after one year or sooner if routine QC tests indicate a problem. All other standard solutions must be replaced after six months or sooner if routine QC indicates a problem.

8.1 Reagent water: All references to water in this method refer to reagent water from Alpha's DI water treatment system.

8.2 Sodium hydroxide solution (25%), NaOH: Dissolve 245g of NaOH pellets in organic-free reagent water and dilute to 1000mL. Store at room temperature. Expires one year after date of preparation.

8.3 Potassium hydroxide solution (37%), KOH: Dissolve 370g of potassium hydroxide pellets in organic-free reagent water and dilute to 1000mL. Store at room temperature. Expires one year from date of preparation.

8.4 Sodium sulfate (granular, acidified, anhydrous), $NaSO_4$: Purify sulfate by heating at 400ºC for 4 hours in a shallow tray. Acidify by pouring 3500-4000g of sodium sulfate in a porcelain bowl, saturate with ether. Add 18-20mL concentrated H_2SO_4. Add aliquots of the ether saturated sulfate to Buchner setup. When sulfate is dry, test the pH by mixing 1g of acidified sodium sulfate with 5mL of reagent water. The pH must be less than 4. Transfer remaining solid to a 2.5-Liter glass jar. Expires after 24 hours.

8.5 Solvents: All solvents are pesticide quality or equivalent

8.5.1 Methylene chloride, CH_2Cl_2. No expiration date listed.

8.5.2 Acetone, CH_3COCH_3. No expiration date listed.

8.5.3 Methanol, CH_3OH. No expiration date listed. Store in a refrigerator.

8.5.4 Diethyl ether: Each bottle of ether must be verified to be free of peroxides as indicated on test strips. Dip test strip (Section 7.24) into the ether and compare the strip to the color chart on the strip container. If peroxides are present, the bottle of ether cannot be used. Expires 6 months after opening.

8.5.5 **Hexane, C_6H_{14}.** No expiration date listed.

8.5.6 **Isooctane 2,2,4-Trimethylpentane:** Store in refrigerator.

8.5.7 **Benzene.** No expiration date listed.

8.5.8 **BF3 Methanol.** No expiration date listed. Store in a refrigerator.

8.5.9 **Ethanol (200 Proof, Spectrophotometric grade).** No expiration date listed. Store in refrigerator.

8.5.10 **1:1 Acetone/Methylene Chloride:** Using a graduated cylinder, measure 2 liters of acetone and transfer into a 4-liter glass bottle. Using a graduated cylinder, add 2 liters of methylene chloride into the same 4-liter bottle. Mix.

8.6 Diazomethane Solution: see Section 10.3.8. Expires 2-days after generation. Store in a freezer.

8.7 Silicic Acid H_2SiO_5: 100-mesh powder, store at room temperature in a desiccator.

8.8 Sulfuric Acid, H_2SO_4, 12N: Dilute 334mL of concentrated sulfuric acid to 1000mL. No expiration date listed. Stored at room temperature.

8.9 Sodium Chloride, NaCl: Purified by baking for 30 minutes at 400 °C.

8.10 10% Nitric Acid Solution: purchased direct from vendors. No expiration date listed.

8.11 Spiking Solution: The preparation and expiration dates of these solutions are described in the analytical SOP's.

8.12 Sulfuric Acid: Concentrated. Expiration date is listed on the reagent bottle.

8.13 Sodium Thiosulfate Crystals ($Na_2S_2O_3$): J.T. Baker; 5-Hydrate crystal.

9. Quality Control

The laboratory must maintain records to document the quality of data that is generated. Ongoing data quality checks are compared with established performance criteria to determine if the results of analyses meet the performance characteristics of the method.

9.1 Blank(s)

A matrix-specific extraction blank is performed with each extraction batch of 20 or fewer samples, according to the extraction SOPs. The extraction blank must not contain any of the reportable analytes at or above the reporting limit. If any reportable analytes are detected in the blank, the entire extraction batch is suspect and re-extraction of all associated samples is required.

9.2 Laboratory Control Sample (LCS)/ LCS Duplicate (LCSD)

LCS samples are measured aliquots of clean matrix (typically sodium sulfate for soil extractions, DI Water for Liquids) that are spiked with a solution containing known amounts of target compounds, in addition to the surrogate solution. The LCS is carried through all stages of the sample extraction, concentration, and cleanup procedures. LCS samples serve as batch specific quantitative checks of the extraction. An LCS is extracted with each batch of 20 or less samples.

9.3 Initial Calibration Verification (ICV)

Not applicable.

9.4 Continuing Calibration Verification (CCV)

Not applicable.

9.5 Matrix Spike (MS)/Matrix Spike Duplicate (MSD)

MS and MSDs are field samples spiked with a known quantity of the target analyte(s). They are prepared by taking additional sample aliquots, and adding the appropriate amounts of surrogate and spiking solutions. The MS/MSD are carried through all stages of the sample extraction, concentration, and cleanup procedures. MS samples serve as a measure of extraction accuracy, by allowing the comparison of the found amount(s) of target analyte(s) with the spiked amount(s). An MS/MSD set also allows for the calculation of the extraction precision, by comparing the results of the two samples.

For samples with a state of origin of New Jersey, a MS and MSD/DUP must be extracted for every twenty samples within a 24hr period.

9.6 Laboratory Duplicate

Duplicates are laboratory selected replicate samples, prepared by taking an additional sample aliquot of a sample. The duplicate is carried through all stages of the sample extraction, concentration, and cleanup procedures. Duplicates serve as a measure of the extraction precision, by comparing the results of the sample and duplicate.

For samples with a state of origin of New Jersey, a MS and MSD/DUP must be extracted for every twenty samples within a 24hr period.

9.7 Method-specific Quality Control Samples

9.7.1 Surrogates

All extracted samples and associated QC are spiked with surrogates at the levels listed in the analytical SOP. The laboratory must evaluate surrogate recovery data from individual samples and QC samples versus the surrogate control limits for both columns listed in the analytical SOP. If the surrogate limits are not met, the extract should be reanalyzed to determine if the failure was due to an instrument problem. If the criteria are still not met, the affected samples should be re-extracted to confirm that the failure was due to sample matrix. If matrix effect is confirmed, this must be noted on a narrative sheet for inclusion in the client report.

9.8 Method Sequence

Refer to Section 10.

10. Procedure

10.1 Equipment Set-up

All extraction information is recorded by the chemist performing the work in the ELN (Electronic Lab Notebook) see WI/2517. In addition to recording the extraction, concentration, clean-up and vialing information, the analyst must note the matrix “type” along with any observations, deviations from the procedure, or difficulties encountered with the samples in the comment section of the logbook.

10.2 Initial Calibration

Not applicable.

10.3 Equipment Operation and Sample Processing

10.3.1 Extraction of High Concentration Waste Samples:

All glassware must be cleaned following the procedure described in the Glassware Cleaning SOP (SOP/1953). In addition, the glassware and separatory funnels must be rinsed with acetone and methylene chloride. Prior to use, all glassware must be rinsed with 10% Nitric Acid solution followed by a reagent water rinse.

10.3.1.1 Weigh 5.0g of homogenized sample and extract via Ultrasonic Extraction (see 10.3.2).

10.3.2 Extraction of Soil, Sediment, and Other Solid Samples:

All glassware must be cleaned following the procedure described in the Glassware Cleaning SOP (SOP/1953). In addition, the glassware and separatory funnels must be rinsed with acetone and methylene chloride. Prior to use, all glassware must be rinsed with 10% Nitric Acid Solution followed by a reagent water rinse.

10.3.2.1 Ultrasonic Extraction:

10.3.2.1.1 Before beginning the extraction process, each soil or sediment sample should be visually inspected. If a sample contains a significant amount of standing water, the analyst must contact the Log-In Department or the Project Manager to determine if the water is to be considered part of the sample. If the water is not to be homogenized with the solid material, decant and discard the water layer. Record this in the Electronic Laboratory Notebook.

Any artifacts (rocks, leaves, sticks, or similar materials) are not typically considered part of the soil sample and should not be included. If necessary, transfer these artifacts to another container prior to homogenizing the sample. Note the presence of sample artifacts in the Electronic Laboratory Notebook. Gummy, fibrous, or oily materials not amenable to grinding should be cut, shredded, or otherwise reduced in size to allow mixing and maximum exposure of the sample surfaces for extraction. The addition of acidified anhydrous sodium sulfate to the sample may make the mixture amenable to grinding. Record the sample matrix “type/description” in the comments section of the ELN using the Sample Matrix Description spreadsheet.

10.3.2.1.2 Weigh 30.0g of homogenized sample into a 400mL glass beaker and place the label containing the sample number onto the beaker (See WI/2421). Add acidified sodium sulfate and mix well until the sample is free-flowing. Adjust the pH to < 2 with 2mL of concentrated sulfuric acid and stir with a telfon spatula. Spike the LCS, LCSD, MS, and MSD samples with 1mL working LCS/MS solution and dot the label with a sharpie. Spike the samples and associated QC samples with 1mL working surrogate solution and dot the label with a sharpie.

10.3.2.1.3 Check the Qsonica sonicator settings to ensure the proper program is selected (See Appendix 1). Add 100mL of methylene chloride/acetone (1:1 v/v) to the beaker(s) containing the samples. Set the mode to “Pulse”, and the amplification to 50%. Make sure the horn is submerged 0.5 - 1 inch below the surface of the solvent level and extract the sample for 3 minutes. Allow the solids to settle once extraction is complete. Filter the solvent layer through a powder funnel containing glass wool and acidified sodium sulfate, into a KD Setup (see Section7.2).

10.3.2.1.4 Repeat Section 10.3.2.1.3 twice more, using 100mL Methylene Chloride as the extraction solvent. Decant the Methylene Chloride and collect into the KD Apparatus between sonication cycles. Rinse the sample beaker with approximately 25mL of Methylene Chloride and collect in the KD Apparatus.

10.3.2.1.5 Set the water bath temperature to 75 °C.

10.3.2.1.6 Attach a Snyder Column to the KD apparatus and place on the S-EVAP. Attach the chilled water condenser to the top of the Snyder Column. At the proper rate of distillation, the balls in the column will actively chatter, but the chambers will not flood with solvent. The solvent will drain and be collected in the Waste Drum.

10.3.2.1.7 When the volume of solvent reaches approximately 30mL, remove the chilled water condenser from the Snyder Column. Immediately remove the KD apparatus from the S-EVAP and allow to cool.

10.3.2.1.8 **CAUTION:** The presence of residual acetone will result in the formation of aldol condensation products which will cause GC interference.

10.3.3 Hydrolysis of Soil, Solid, and Sediment Samples:

10.3.3.1 Add 8mL of 37% KOH and 30mL of DI water to the KD flask apparatus containing the approximate 30mL extract. Mix the sample for approximately one minute by swirling the KD flask. Using forceps, dip the pH strip into the sample and check the pH. Samples need to be at a pH of 12 or greater. Add more KOH until the pH of 12 or greater is achieved.

10.3.3.1.1 Set the water bath temperature to 60 °C. Add the KD apparatus (samples) to the water bath.

10.3.3.2 Reflux the mixture for 90 minutes.

10.3.3.3 Remove the flasks from the water bath and let them cool for 15 minutes.

10.3.4 Clean Up and Back Extraction of Soil, Sediment, and Other Solid Extracts

10.3.4.1 Transfer the hydrolyzed aqueous solution to a pre-rinsed and appropriately labeled (see WI2421) 2L separatory funnel and transfer the label from the KD flask to the corresponding 250 mL Round Bottom flask. Rinse the KD apparatus with 100 mLs of DCM and transfer to the labeled Separatory funnel. Place the cap onto the Separatory funnel and vent. After venting place the Separatory funnel on the auto-shakers. Set the shakers for 2 minutes of shaking at 170 rpms.

NOTE: Methylene Chloride creates excessive pressure very rapidly, therefore initial venting should be done immediately after the separatory funnel has been sealed and shaken once. The separatory funnel should be vented into a hood to avoid analyst exposure to solvent vapors.

10.3.4.2 Let the layers settle for ten minutes. Using a 2Liter Polypropylene beaker, collect and discard the Methylene Chloride phase (bottom layer) into the waste receptacle. If sample is cloudy, decant the Methylene Chloride layer into 60mL centrifuge tubes and centrifuge to separate. Decant the water layer back into the Separatory Funnel and discard the Methylene Chloride layer into the waste receptacle.

10.3.4.3 At this point, the (basic) aqueous solution contains the herbicide salts.

10.3.4.4 Adjust the pH of the solution to < 2 with 4mL of 12N sulfuric acid. Additional acid may be added to achieve a pH <2. Using the bottle top dispenser, add 40mL of ether to the separatory funnel and place on the separatory funnel shaker. Extract for two minutes. Allow the layers to separate for 10 minutes. Check the pH to confirm it is within the appropriate range, and then carefully drain the aqueous sample (bottom layer) into a 250mL Round Bottom Flask. Drain the Ether phase (top layer) directly into a 250mL Round Bottom Flask containing 40 grams of Acidified Sodium Sulfate. Swirl the ether extract for approximately 30 seconds.

10.3.4.5 Pour the aqueous sample back into the appropriately labeled separatory funnel. Rinse the 250mL Round Bottom flask with 20mL diethyl ether. Pour the ether into the separatory funnel containing the aqueous sample and extract for two minutes on the separatory funnel shaker. After 10 minutes, carefully drain the aqueous sample (bottom layer) into a same(labeled) 250mL Round Bottom Flask. Drain the Ether phase (top layer) into the same(labeled) 250mL Round Bottom Flask containing the acidified sodium sulfate.

10.3.4.6 Repeat extraction process (Section 10.3.4.5) one more time until the aqueous sample has been extracted a total of three times. All aqueous sample must be transferred to the satellite waste storage containers located in the extraction lab

10.3.4.7 After extracting, the samples need to sit for a minimum of 2 hours on the acidified sodium. This step is critical to remove any trace amount of moisture from the ether extract. If the sodium sulfate is not free flowing when the flask is swirled, this indicates the sodium sulfate has bonded with the water. Add more acidified sulfate until free flowing. Proceed to Section 10.3.7 for methylation or refrigerate sample until ready to proceed.

10.3.5 Preparation of Aqueous Samples:

All glassware must be cleaned following the procedure described in the Glassware Cleaning SOP (SOP/1953). In addition, the glassware and separatory funnels must be rinsed with Acetone, DCM, and Hexane prior to use. Prior to use, all glassware must be rinsed with 10% Nitric Acid Solution followed by a reagent water rinse.

10.3.5.1 Hydrolysis of Aqueous Samples

10.3.5.1.1 Carefully examine the sample prior to beginning the extraction process. The sample should be single-phase, with minimal or no sediment or solid material present. If this is not the case, contact a Department Supervisor to determine how the sample should be handled. The Supervisor may need to contact the project manager to determine how the Client would like the sample to be handled. Record all observations and/or deviations from the routine extraction procedure in the Electronic Laboratory Notebook.

10.3.5.1.2 Each sample and associated QC must be checked for residual chlorine prior to any pH adjustments. Invert the sample several times to ensure that sample is well mixed, then dip one KI test strip into the sample for 10 seconds with a gentle constant back and forth motion. After 30 seconds, refer to the chart on the KI strip container; if chlorine is detected at a level less than 0.1mg/L extraction may begin. If chlorine is detected at a level greater than or equal to 0.1mg/L, add sodium thiosulfate to the entire sample volume, mix and re-check until the chlorine level is less than 0.1mg/L.

10.3.5.1.3 Measure 1L of DI water each for the Blank, LCS and LCSD using a class A graduated cylinder. Using a permanent marker, mark the volume level of each sample on the outside of each sample bottle for later sample volume measurement. For TCLP Extraction, measure 200mL of the TCLP Extract using a Graduated Cylinder and transfer into a labeled Separatory funnel. The TCLP QC will consist of TCLP Fluid.

10.3.5.1.3.1 If high analyte concentrations are known to be present, a smaller sample volume may be taken and diluted to 1L with reagent water, provided prior authorization is obtained from the Client or the Client Services Representative.

10.3.5.1.3.2 On occasion, smaller sample volumes may be provided by the Client. If the sample volume is less than 750mL, add reagent water to reach a final volume of 1000mL and record this action in the ELN.

10.3.5.1.4 Once the sample volumes are marked, transfer the sample volume to be extracted into the separatory funnel.

10.3.5.1.5 Add 1mL of spike to the LCS, LCSD, MS, and MSD and mark the sep. funnel with a sharpie marker; also add 1mL surrogate to all samples and QC and mark the sep. funnel with a sharpie marker. For TCLP Extraction 0.5mL of Spike and Surrogate is added.

10.3.5.1.6 Add 50g of NaCl for every 200mL (i.e. 250g for a 1000mL sample) of sample to all samples and QC samples. Shake samples until the NaCl is dissolved.

10.3.5.1.7 Add 17mL of 25% NaOH to all samples and QC samples. For TCLP samples use 5mL of 25% NaOH to all samples and QC samples. Swirl to mix the NaOH throughout the sample and check the pH. The pH must be > 12. Using forceps, dip the pH strip into the sample and check the pH. Add additional 25% NaOH if necessary to pH>12.

10.3.5.1.8 Let the sample sit for 90 minutes, swirling occasionally.

10.3.6 Clean-Up and Extraction of Aqueous Samples

10.3.6.1 Add 100mL of methylene chloride into the separatory funnel. If the sample was transferred directly from the sample bottle, refill the bottle with water to the mark made in Section 10.3.5.1.3. Using a graduated cylinder, measure and record the volume of sample that was in the original sample container in the ELN.

10.3.6.2 Seal the separatory funnel and vented (see below). After all samples are ready load the funnels onto the auto-shakers and run the shakers for 2 minutes at 170 rpm.

NOTE: Methylene Chloride creates excessive pressure very rapidly, therefore initial venting should be done immediately after the separatory funnel has been sealed and shaken once. The separatory funnel should be vented into a hood to avoid analyst exposure to solvent vapors.

10.3.6.3 Allow the methylene chloride layer to separate from the water phase for a minimum of 10 minutes. If the emulsion interface between the layers is more than one-third the size of the solvent layer, the analyst must employ mechanical techniques to complete the phase separation. The optimum technique depends on the sample and may include stirring, filtration of the emulsion through glass wool, centrifugation, addition of sodium chloride, or other.

10.3.6.4 Discard the methylene chloride phase into the waste receptacle. The sample is now ready for extraction.

10.3.6.5 Adjust the pH of the samples and QC samples to be < 2 with 17mL of 12N H_2SO_4 for samples and 5mL for TCLP samples. Swirl the samples to mix the acid throughout the samples and test the pH using pH strips to ensure that it is < 2 before proceeding. Additional acid can be added if needed to achieve the desired pH.

10.3.6.6 Using the bottle top dispenser, pump 120mL of Diethyl Ether into the separatory funnel. Seal the funnel and shake for 2 minutes using the auto-shakers.

10.3.6.7 Allow the ether layer to separate out from the water phase for a minimum of 10 minutes (ether takes a while to separate from water because it is partly soluble in water). Refer to section 10.3.6.3 if an emulsion forms. Carefully drain the aqueous phase (bottom layer) into a 2L Erlenmeyer flask. Drain the Ether phase (top layer) into a 500mL Erlenmeyer flask containing 100 grams of acidified sodium sulfate.

10.3.6.8 Decant water sample back into labeled 2-Liter Separatory funnel. Using the bottle top dispenser add 60mL of diethyl ether to each Separatory Funnel, place on the shaker and extract for two minutes.

10.3.6.9 Repeat Sections 10.3.6.7 and 10.3.6.8 again until the sample has been extracted a total of 3 times.

10.3.6.10 After extracting, the samples need to sit for a minimum of 2 hours on the acidified sodium sulfate. This step is critical to remove any trace amount of moisture from the ether extract. If the sodium sulfate is not free flowing when the flask is swirled, this indicates the sodium sulfate has bonded with the water. Add more acidified sulfate until free flowing. For Herb TCLP extraction, go to Section 10.3.9 for concentration and methylation.

10.3.6.11 The extract is ready for concentration. Proceed to Section 10.3.7 for methylation.

10.3.7 Soil and Liquid Concentration and Methylation. For TCLP Samples proceed to Section 10.3.9.

10.3.7.1 Set the S-EVAP temperature to 65 °C.

10.3.7.2 Assemble a KD apparatus and add 1 boiling stone. Transfer the extract through an Acidified sodium sulfate funnel containing approximately 20g or acidified sodium sulfate, into the labeled KD apparatus.

10.3.7.2.1 Rinse the flask that contained the extract with approximately 20mL of Ether and pour this rinseate into the KD flask. Repeat this step to ensure a qualitative transfer, a total of up to three times.

10.3.7.2.2 Attach a Snyder Column to the KD apparatus and place on the 65C, S-EVAP. Attach the chilled water condenser to the top of the Snyder Column. At the proper rate of concentration, the balls in the column will actively chatter, but the chambers will not flood with solvent.

10.3.7.2.3 When the volume of ether reaches approximately 10-15mL, remove the chilled water condenser from the Snyder Column. Immediately remove the KD apparatus from the S-EVAP and allow to cool. After the sample is cool, disassemble the concentrator tube from the KD Flask and transfer the sample label to the concentrator tube.

10.3.7.3 Set the N-EVAP bath temperature to 35°C and the nitrogen flow so the nitrogen causes a slight dimple in the sample. Place Concentrator tube on the N-EVAP and reduce the sample volume to 0.5mL. Once the sample volume is at 0.5mL, remove the tubes from the N-EVAP.

10.3.7.4 Add 0.5mL of Methanol to the extract, bringing the sample extract to 1.0 mL,

10.3.7.5 Add 1mL of Isooctane, bringing the sample extract to 2.0 mL,

10.3.7.6 Add 2.0mL of Diethyl Ether to the extract, bringing the sample extract to 4.0mL.

10.3.7.7 Slowly add 2mL of Diazomethane. Vortex the extract to mix well and let them sit for 15 minutes. The extracts should bubble slightly. Refer to Section 10.3.8 for the procedure to generate Diazomethane.

10.3.7.8 After 15minutes add approximately 10mg of Silicic Acid and vortex to remove any residual diazomethane. Once the yellow color of the diazomethane has disappeared, adjust the sample volume to 10mL with hexane and vortex for 1 minute.

10.3.7.9 The extract is now ready for vialing, Refer to WI 3827 and 2426 for further vialing instructions.

10.3.8 Diazomethane Generation by Distillation

CAUTION: Diazomethane is a carcinogen and can explode under certain conditions. Diazomethane generation is only to be performed by or under the supervision of experienced analyst. Record the diazomethane generation in the Diazomethane Generation Logbook.

10.3.8.1 Assemble the diazomethane reaction glassware in the diazomethane generation hood as shown in Figure 1. Attach the condenser to the clamps. Add approximately 250mL of water to the 500mL beaker. Turn on the heating mantle to heat the water. Using a thermometer heat the water to 60 C. Do not exceed 60 C. You will need to regulate the water temp using hot water and ice cubes. Adjust the heating mantle between 165C and 200C to maintain the 60 C. The Distilling flask will need to be submerged in the water.

Caution: If the temperature of the reaction exceeds 138 °C, an explosion could occur.

10.3.8.2 Attach the chiller hoses to the condenser. The water needs to enter the lower end of the condenser and exit the top. Attach the elbow joint to the condenser. Attach the 100ml receiving round bottom flask to the elbow joint. The receiving round bottom (receiving) flask must be resting in a beaker, surrounded by ice. The ice needs to cover the entire flask.

10.3.8.3 On a piece of filter paper, weigh out 10 grams of Potassium Hydroxide pellets and transfer to a 250 mL distilling flask. Using a 25mL graduated cylinder, add 16 mL of DI water and swirl flask until Potassium Hydroxide dissolves then place the flask in the ice to cool.

10.3.8.4 Add 19 mL of Ethanol (200 proof) to the 25mL graduated cylinder. Add 1 mL of DI water to the graduated cylinder. Transfer to distilling flask.

10.3.8.5 Attach the distilling flask to the distilling apparatus.

10.3.8.6 Attach the 125 mL separatory funnel to the top of the distilling flask.

10.3.8.7 Using filter paper weigh out 10 grams of Diazald and transfer it into the separatory funnel. Using a bottle top dispenser add 90 mL of Ethyl Ether to the funnel and shake until the Diazald dissolves.

10.3.8.8 Check all connections to assure a tight fit.

10.3.8.9 Begin dripping the Diazald solution into the distilling flask containing the potassium hydroxide and ethanol mixture. The distilling flask is positioned in a beaker of 60C water while sitting on the hot plate The entire diazald solution should drip into the distillation flask. As this distillation takes place, the diazomethane solution condenses into the receiving flask. Distill the entire volume of diazald solution into the receiving flask until the distilling flask is no longer yellow in color.

10.3.8.10 At this point the receiving flask contains the diazomethane solution. This will generate about 80 mLs of dark yellow diazomethane solution. The reagents can be increased or decreased proportionally for greater or lesser amounts of diazomethane. Transfer the diazomethane solution into 60mL Voa vials and store in the freezer. Solution can only be retained for two days.

10.3.9 TCLP Concentration and Methylation

10.3.9.1 Set the water bath temperature to 65°C.

10.3.9.2 Assemble a KD apparatus and 1 boiling stone. Transfer the extract through a Acidified sodium sulfate funnel containing approximately 20g or acidified sodium sulfate, into the labeled KD apparatus

10.3.9.3 Rinse the flask that contained the extract with approximately 20mL of Ether and pour this rinseate into the KD flask. Repeat this step to ensure a qualitative transfer, a total of up to three times

10.3.9.4 Attach a Snyder Column to the KD apparatus and place on the 65 C, S-EVAP. Attach the chilled water condenser to the top of the Snyder Column. At the proper rate of distillation, the balls in the column will actively chatter, but the chambers will not flood with solvent.

10.3.9.5 Allow the sample extract volume to reduce to 30mL. Remove the condenser and add 15mL of benzene to the top of the Snyder column transfer to the 95C bath. Attach the chilled water condenser. Remove the

KD apparatus from the water bath once the sample volume has been reduced to about 10-15mL. Wipe the outside of the flask and its lower ground glass joint with a paper towel to remove any moisture from the outside of the glassware. Allow sample to cool for 5 minutes. Disassemble the KD apparatus and transfer the sample label onto the concentrator tube.

10.3.9.6 Set the N-EVAP bath temperature to 65°C and the nitrogen flow so the nitrogen causes a slight dimple in the sample. Place the Concentrator tubes on the N-EVAP and reduce the sample volume to 5mL using the graduations on the concentrator tube.

10.3.9.7 Bring the sample extracts to exactly 5mL in the Concentrator tube by adding benzene as necessary.

10.3.9.8 Add 2mL BF3 methanol to each sample and QC sample extract.

10.3.9.9 Set the water bath temperature to 60°C. Place a microsnyder column on each Concentrator Tube. Place each Concentrator tube into the water bath. Reflux each sample and QC sample extract on the water bath for 15 minutes. Samples should just barely boil.

10.3.9.10 Remove the samples from the water bath and add 5mL reagent water. Cap each Concentrator tube and vortex for 5 – 10 seconds until water mixes with the sample extract. Allow 2 hours for water to separate from the ether solution before vialing (see WI 3827 and WI 2426 for vialing instructions). The sample may also be transferred to a 20mL vial and centrifuged from 5 minutes @ 5000RPM to separate. After vialing the extract is archived.

10.4 Continuing Calibration

Not applicable.

10.5 Preventive Maintenance

10.5.1 Balances

10.5.1.1 All balances are calibrated and serviced every six months by an instrument service company. All service records are kept on file.

10.5.1.2 Keep balances clean. Brush off any sample spills immediately. Keep the balance doors closed and the balance turned off when not in use.

10.5.2 Water Bath

10.5.2.1 The water bath should be kept full at all times. Add reagent water as necessary.

10.5.2.2 Keep unit clean. Avoid solvent spills on or around unit. Clean periodically with a damp cloth.

10.5.3 Automatic Shaker

10.5.3.1 The Automatic Shaker should be lubricated according to the manufacturer’s instructions.

11. Data Evaluation, Calculations and Reporting

Refer to the analytical method SOP.

12. Contingencies for Handling Out-of-Control Data or Unacceptable Data

Refer to analytical method SOP.

13. Method Performance

13.1 Method Detection Limit Study (MDL) / Limit of Detection Study (LOD) / Limit of Quantitation (LOQ)

The laboratory follows the procedure to determine the MDL, LOD, and/or LOQ as outlined in Alpha SOP1732. These studies performed by the laboratory are maintained on file for review.

13.2 Demonstration of Capability Studies

Refer to Alpha SOP 1739 for further information regarding IDC/DOC Generation.

13.2.1 Initial (IDC)

The analyst must make an initial, one-time, demonstration of the ability to generate acceptable accuracy and precision with this method, prior to the processing of any samples.

13.2.2 Continuing (DOC)

The analyst must make a continuing, annual, demonstration of the ability to generate acceptable accuracy and precision with this method.

14. Pollution Prevention and Waste Management

Refer to Alpha's Chemical Hygiene Plan and Waste Management and Disposal SOP for further pollution prevention and waste management information.

15. Referenced Documents

Chemical Hygiene Plan

WI/2421 Labeling and Generating Work Groups and Batches

WI/2517 LIMS Electronic Laboratory Notebook Procedure

WI/2423 GC Mass Spec Extract Vialing Procedure

WI/2426 GC Extract Vialing Procedure

WI/3827 Extract Vialing Procedure

SOP/1732 DL/LOD/LOQ Generation

SOP/1739 DOC Generation

SOP/1728 Waste Management and Disposal SOP

SOP/1953 Organic Extraction Glassware Cleaning and Handling

16. Attachments

Appendix 1: Sonicator Tuning Instructions

Figure 1: Diazomethane Generation Diagram

Appendix 1: Sonicator Tuning Instructions

QSONICA 500 SONICATOR TUNING INSTRUCTIONS

1. Unit is Auto-Tuning.

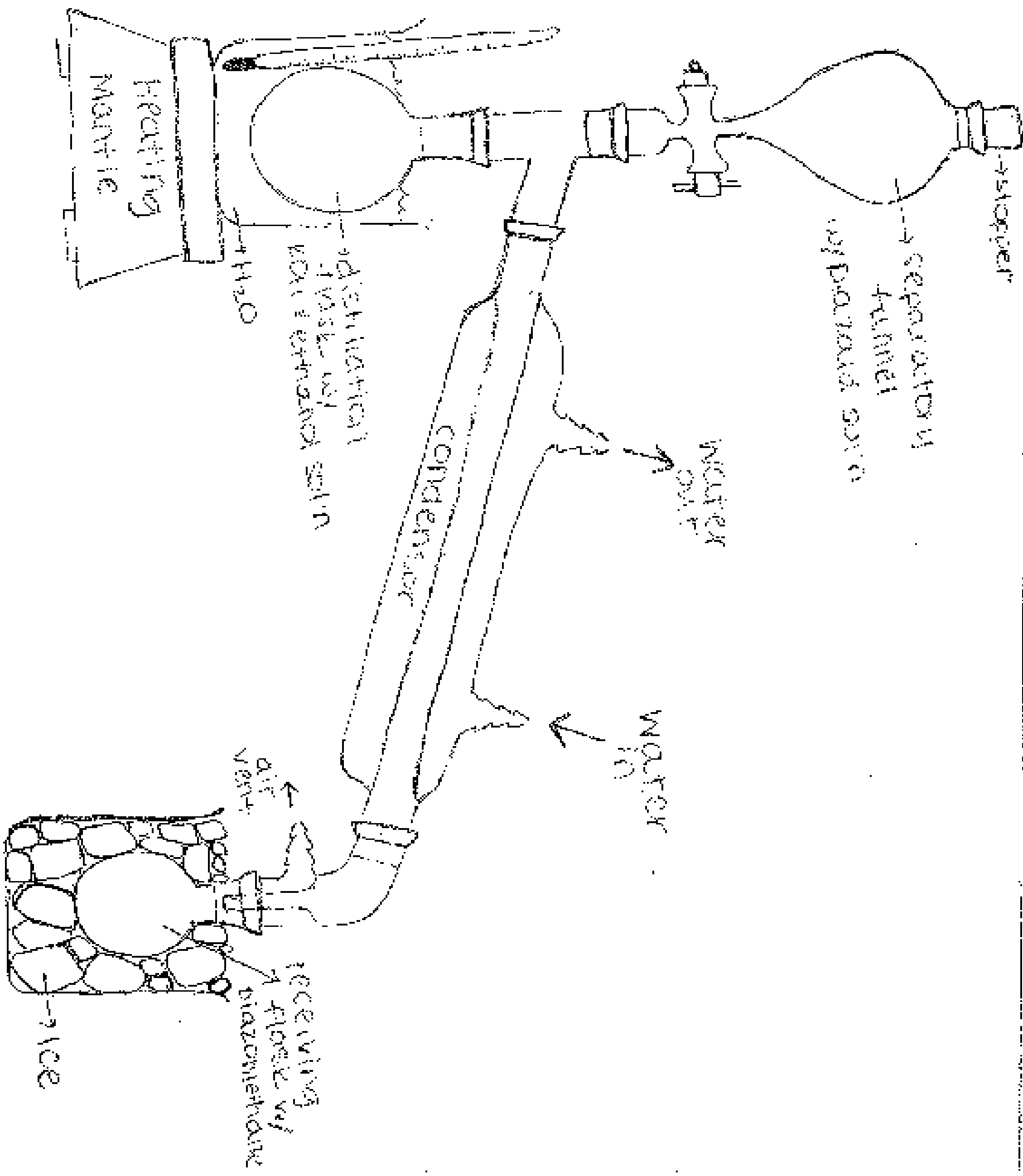
2.Turn unit to “on”.

3.Check settings, Pulse should be “1”, Pause should be “1” and Amplitude should be 50%.

4.Unit should be set to a 3 minute pulse.

5.SONICATOR is ready for use.

Figure 1.


stopper
separatory funnel w/ Diazald soln
water out
Heating Mantle
H2O
distillation flask w/ KOH/ethanol soln
condenser
water in
air vent
receiving flask w/ diazomethane
ice

TPH- Diesel Range Organics

References: **Maine 4.1.25,** Maine Health and Environmental Testing Laboratory, 09/06/1995.

EPA 8015C (Modified), SW-846, Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, EPA SW-846, Update IV, 2007.

EPA 8015D (Modified), SW-846, Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, EPA SW-846, Update IV, June 2003.

1. Scope and Application

Matrices: Diesel Range Organics can be determined in water, soil, sludge and product samples.

Definitions: See Alpha Laboratories Quality Manual Appendix A

TPH-DRO is used to identify and determine the concentration of Diesel Range Organics. This corresponds to the hydrocarbon range of C10 – C28, inclusive (Alpha LIMS products Maine-DRO and TPH-DRO). Alpha also reports the hydrocarbon ranges of C10 – C36 as (Alpha LIMS modified product TPH-DRO-D) and C9 – C44 as (Alpha LIMS modified product TPH-DROD-C44) by this method.

The data report packages present the documentation of any method modification related to the samples tested. Depending upon the nature of the modification and the extent of intended use, the laboratory may be required to demonstrate that the modifications will produce equivalent results for the matrix. Approval of all method modifications is by one of the following laboratory personnel before performing the modification: Area Supervisor, Laboratory Services Manager, Laboratory Director, or Quality Assurance Officer.

This method is restricted to use by or under the supervision of trained analysts experienced in the operation of the Gas Chromatograph and in the interpretation of Gas Chromatograph data. Each analyst must demonstrate the ability to generate acceptable results with this method by performing an initial demonstration of capability.

2. Summary of Method

TPH-DRO provides GC conditions for the detection petroleum fractions. Prior to use of this method, appropriate sample extraction techniques must be used. Both neat and diluted organic liquids may be analyzed by direct injection. A 1µL or 2µL aliquot of the extract is injected into a GC using the solvent flush technique, and compounds are detected by a FID.

2.1 Method Modifications from Reference, EPA 8015C

2.1.1 Alkane Standard Calibration is performed instead of Fuel Oil Calibration.

2.1.2 Quality control samples consist of a Blank, LCS and a Duplicate. MS/MSD is performed upon Client request only.

2.1.3 Alpha LIMS product TPH-DROD product includes C10-C36 and TPH-DROD-C44 product includes C9-C44.

3. Reporting Limits

The reported detection limit for this procedure as outlined is as follows:

- For the Maine DRO Method: 50µg/L for aqueous samples and 3.33mg/kg for soil/solid samples.
- For TPH-DRO, TPH-DRO-D and TPH-DROD-C44 Methods: 500µg/L for aqueous samples and 33.3mg/kg for soil/solid samples.

4. Interferences

Solvents, reagents, glassware, and other sample processing hardware may yield discrete artifacts and/or elevated baselines causing misinterpretation of gas chromatograms. All of these materials must be demonstrated to be free from interferences, under the conditions of the analysis, by analyzing method blanks. Specific selection of reagents and purification of solvents by distillation in all-glass systems may be required.

Interferences co-extracted from samples will vary considerably from source to source, depending upon the waste being sampled.

5. Health and Safety

The toxicity or carcinogenicity of each reagent and standard used in this method is not fully established; however, each chemical compound must be treated as a potential health hazard. From this viewpoint, exposure to these chemicals must be reduced to the lowest possible level by whatever means available. A reference file of material data handling sheets is available to all personnel involved in the chemical analysis. Additional references to laboratory safety are available in the Chemical Hygiene Plan.

All personnel handling environmental samples known to contain or to have been in contact with municipal waste must follow safety practices for handling known disease causative agents.

6. Sample Collection, Preservation, Shipping and Handling

6.1 Sample Collection

Samples must be collected in glass containers with Teflon-lined caps. Plastic containers or lids may not be used for the storage of samples due to the possibility of sample contamination from phthalate esters and other hydrocarbons within the plastic.

Samples must be kept cool until receipt at the Laboratory.

6.2 Sample Preservation

Samples for Maine DRO are preserved with 1:1 HCl to a pH < 2. Samples for TPH-DRO, TPH-DRO-D and TPH-DROD-C44 are not preserved.

6.3 Sample Handling

Samples must be stored under refrigeration to 4 ± 2°C.

Liquid samples must be extracted within 7 days from collection, and soils must be extracted within 14 days from collection.

The extracts must be stored under refrigeration and must be analyzed within 40 days of extraction.

7. Equipment and Supplies

7.1 Gas Chromatograph, Hewlett Packard 6890 (or equivalent): An analytical system suitable for on-column injections. All required accessories, including: detectors, column supplies, recorder, gases and syringes. A data system for measuring peak area and/or peak heights.

7.2 GC Columns
Column 1: RTX-5 – 30m x 0.32mm ID, 0.25µm
Column 2: RTX-5MS – 30m x 0.32mm ID, 0.25µm

7.3 Class A Volumetric Flask: 10, 50, and 100mL with ground glass stopper.

7.4 Microsyringe: 10µL.

7.5 Helium: Compressed Helium, 5.0 ultra high purity.

7.6 Pipets: 9 inch glass pipets.

7.7 Analytical Balance: 0.0001g sensitivity

7.8 Pasteur Pipets: Borosilicate glass

7.9 Autosampler vials: 2mL volume with Teflon-lined septum crimp caps.

8. Reagents and Standards

8.1 Solvents, pesticide quality: Hexane, methylene chloride, acetone and pentane. Store in a flammables cabinet. Expires upon manufacturer’s specified date.

8.2 o-Terphenyl, 2000µg/mL Stock Standard in methylene chloride: Vendor purchased stock solution used to prepare calibration standards. This solution is used only for Calibration Standards preparation. Expires upon manufacturer’s specified date. Store at room temperature.

8.3 99.5% pure Nonane: Vendor purchased. Two sources are purchased. One source is used for the calibration standard and the other source is used for the continuing calibration standard. Store per vendor recommendations. Expires upon manufacturer’s specified date.

8.4 Combination of CT-ETPH Alkane Standard and n-tetratetracontane, 1000ug/mL: Vendor purchased stock solution. This solution is used for LCS/MS spiking solution preparation. Expires upon manufacturer’s specified date if unopened. Once opened, standard expires 6 months from the date of opening or the manufacturer’s specified date, whichever is sooner. Store 20± 2°C.

8.5 Stock Calibration Standards

8.5.1 n-Nonane (c9), 2000µg/mL Stock Working Standard: To a 50mL volumetric flask, add 140µL of vendor purchased 99.5% pure Nonane (Section 8.3). Bring to volume with methylene chloride. Standard expires 6 months from the date of preparation. Store in the refrigerator at 4 ± 2°C.

Use one source for the calibration standards and the other source for the continuing calibration standards.

8.5.2 Calibration/Window defining Hydrocarbon Stock Standard, 1000µg/mL. Vendor purchased stock solution used to prepare calibration standards. Two sources are purchased: One is used for the Calibration Standards, and the other is used for the Continuing Calibration Standards. Contains the following alkanes in methylene chloride:

n-Octane	(c8)	n-Hexacosane	(c26)
n-Decane	(c10)	n-Octacosane	(c28)
n-Dodecane	(c12)	n-Triacontane	(c30)
n-Tetradecane	(c14)	n-Dotriacontane	(c32)
n-Hexadecane	(c16)	n-Tetratriacontane	(c34)
n-Octadecane	(c18)	n-Hexatriacontane	(c36)
n-Eicosane	(c20)	n-Octatriacontane	(c38)
n-Docosane	(c22)	n-Tetracontane	(c40)
n-Tetracosane	(c24)		

Expires upon manufacturer's specified date if unopened. Once opened, standard expires 6 months from the date of opening or the manufacturer's specified date, whichever is sooner. Store in the refrigerator at 20± 2°C .

NOTE: n-Octane (c8), and c38 through c40 are not used in the calculation of the DRO calibration standards, but are present in the solution.

The calibration/window defining hydrocarbon standard also serves: a) to demonstrate sufficient separation between the solvent and C8-alkane peak, b) to ensure that the last component, C36, is eluted within a reasonable amount of time (30minutes), and c) to serve as a retention time marker for oil identification.

8.5.3 n-Tetratetracontane Stock Working Standard: Vendor purchased stock solution used to prepare calibration standards. Two sources are purchased: One is used for the Calibration Standards, and the other is used for the Continuing Calibration Standards. Contains n-Tetratetracontane in carbon disulfide (c44).

Expires upon manufacturer's specified date if unopened. Once opened, standard expires 6 months from the date of opening or the manufacturer's specified date, whichever is sooner. Store in the refrigerator at 20± 2°C .

8.6 Working Calibration Standards: (Also refer to Table 1)

Working calibration standards are stored in the refrigerator at 4 ± 2°C and expire 6 months from the date of preparation.

8.6.1 Level 1 Calibration Standard for TPH-DRO/TPH-DRO-D (3µg/mL): To 994uL of methylene chloride add 6 uL of L6 calibration standard (Section 8.6.6)

8.6.2 **Level 2 Calibration Standard for TPH-DRO/TPH-DRO-D (20µg/mL):** To 960 uL of methylene chloride add 40 uL of L6 calibration standard (Section 8.6.6)

8.6.3 **Level 3 Calibration Standard for TPH-DRO/TPH-DRO-D (50µg/mL):** To 900 uL of methylene chloride add 100 uL of L6 calibration standard (Section 8.6.6)

8.6.4 **Level 4 Calibration Standard for TPH-DRO/TPH-DRO-D (100µg/mL):** To 800 uL of methylene chloride add 200 uL of L6 calibration standard (Section 8.6.6)

8.6.5 **Level 5 Calibration Standard for TPH-DRO/TPH-DRO-D (200µg/mL):** To 600 uL of methylene chloride add 400 uL of L6 calibration standard (Section 8.6.6)

8.6.6 **Level 6 Calibration Standard for TPH-DRO/TPH-DRO-D (500µg/mL):** To a 5mL volumetric flask add 1.25mL of n-Nonane Stock Solution (Section 8.5.1) and 1.25mL o-Terphenyl I Stock Solution (Section 8.2) and 2.5mL of Calibration/Window Defining Hydrocarbon Solution (Section 8.5.2).

8.7 Working Calibration Standards: (Also refer to Table 2)

Working calibration standards are stored in the refrigerator at 4 ± 2°C and expire 6 months from the date of preparation.

8.7.1 **Level 1 Calibration Standard for TPH-DROD-C44 (3µg/mL):** To 988uL of methylene chloride add 12 uL of L5 calibration standard (Section 8.6.6)

8.7.2 **Level 2 Calibration Standard for TPH-DROD-C44 (20µg/mL):** To 920 uL of methylene chloride add 80 uL of L5 calibration standard (Section 8.6.6)

8.7.3 **Level 3 Calibration Standard for TPH-DROD-C44 (50µg/mL):** To 800 uL of methylene chloride add 200 uL of L5 calibration standard (Section 8.6.6)

8.7.4 **Level 4 Calibration Standard for TPH-DROD-C44 (100µg/mL):** To 600 uL of methylene chloride add 400 uL of L5 calibration standard (Section 8.6.6)

8.7.5 **Level 5 Calibration Standard for TPH-DROD-C44 (250µg/mL):** To a 5mL volumetric flask add 1.00mL of n-Nonane Stock Solution (Section 8.5.1) and 1.00mL o-Terphenyl Stock Solution (Section 8.2) and 2.00mL of Calibration/Window Defining Hydrocarbon Solution (Section 8.5.2) and 2.00mL of n-Tetratetracontane (Section 8.5.3).

8.7.6 **Level 6 Calibration Standard for TPH-DROD-C44 (500µg/mL):** To a 10mL volumetric flask add 2.50mL o-Terphenyl Stock Solution (Section 8.2).

8.8 o-Terphenyl:

Vendor purchased. Used to prepare extraction surrogate.Expires upon manufacturer's specified date. Store in the refrigerator at 4 ± 2°C.

8.8.1 **Surrogate Standard Solution, 300ug/L:** To a 500mL volumetric flask, add 15mL of 10000ug/mL o-terphenyl solution. Bring to volume with acetone. The surrogate standard solution expires 6 months from the date of preparation. Store in the refrigerator at 4 ± 2°C.

8.9 LCS / MS spiking solution, 100µg/mL

To a 100mL volumetric flask, add 10mL of the CT-ETPH Alkane Standard (Section 8.4) and 10mL of second source of n-Tetratetracontane (Section 8.5.3) using a 1mL syringe. Bring to volume with pentane. This solution is stored in a refrigerator at 4 ± 2°C and expires 6 months from the date of preparation.

8.10 Continuing Calibration Standards

8.10.1 n-Nonane (c9), 2000µg/mL Stock Working Standard: Refer to Section 8.5.1.

8.10.2 Continuing Calibration Standard, 100µg/mL: To a 50mL volumetric flask, add 5mL of second source, vendor purchased 1000ug/mL o-Terphenyl solution, 2.5mL Nonane solution (Section 8.5.1 alternate source) and 5mL of Calibration/Window defining Hydrocarbon Stock Standard (1000µg/mL, Section 8.5.2) and add 5mL of second source of n-tetratetracontane (1000ug/mL, Section 8.5.3). Bring to volume with methylene chloride. This standard is stored in a refrigerator at 4 ± 2°C and expires 6 months from the date of preparation.

8.11 Fuel Degradation Standard

To a 20mL volumetric flask of methylene chloride, add 500 uL of a 2000 ug/mL of a vendor prepared Fuel Oil Degradation Mix. Adjust to volume with methylene chloride.

9. Procedure

9.1 SET-UP

9.1.1 Extraction

In general, water samples are extracted at a neutral pH with methylene chloride, using Method 3510. Solid samples are extracted using either Method 3540, 3545 or 3546 to achieve maximum sensitivity. The extract must be concentrated to a final volume of 1mL.

9.1.2 Typical Gas Chromatography Conditions

Set helium carrier gas flow at 30mL min^{-1}, column temperature at 45°C for 2 minutes, then 12°C min^{-1} to 320°C, hold for 10.0 minutes. Injection volume can be either 1uL or 2uL depending on the instrument utilized. The same injection volume for all calibration standards and samples extracts must be used.

9.2 Initial Calibration

9.2.1 Calibration Curve Generation:

A curve consisting of the 6 different concentrations (Table 1), each containing C8, C9 and C10 through C40 even numbered alkanes (Section 8.5), is analyzed under the conditions listed in Section 9.1.2.

The %RSD for MEDRO and TPH-DRO (C10-C28) must be < 20% for the initial calibration. The %RSD for Alpha LIMS product TPH-DROD (C10-C36) and TPH-DROD-C44 (C9-C44 must be < 25% for the initial calibration. Once this is achieved, a continuing calibration standard (Section 9.3) is analyzed. If the Maine DRO method is to be analyzed at any point after Initial Calibration, a Fuel Degradation Standard is added after the continuing calibration verification.

9.3 Continuing Calibration

9.3.1 As a minimum requirement, the working calibration curve and retention times must be verified at the beginning of each 12-hour work shift, or every 20 samples, followed by a an acceptable bracketing continuing calibration verification standard. Additional analyses of the verification standard(s) throughout a 12-hour work shift are strongly recommended, especially if the samples being analyzed contain visible concentrations of oily material.

9.3.2 Calculate the % Difference of the standard from the calibration curve.

9.3.2.1 If the response for the MEDRO or TPH-DRO C10-C28 range is within ± 20 of the response obtained during the initial calibration then the initial calibration is still considered valid, and the analyst may continue to use the mean CF or RF values from the initial calibration to quantitate the sample results. Indicvidual alkanes may exceed %D of ± 20, as long as the range is ± 20%.

9.3.2.2 If the response for the Alpha LIMS product TPH-DROD (C10-C36) and TPH-DROD-C44 (C9-C44) range is within ± 25 of the response obtained during the initial calibration then the initial calibration is still considered valid, and the analyst may continue to use the mean CF or RF values from the initial calibration to quantitate the sample results. Individual alkanes may exceed %D of ± 25, as long as the range is ± 25%

9.3.2.3 If the % difference exceeds then preventative maintenance must be performed (Section 9.5).

Once maintenance is complete, another standard is analyzed. If the % difference still exceeds the method requirements, a new initial calibration must be performed (Section 9.2).

9.3.3 Maine DRO, Fuel Degradation Check Standard

For Maine-DRO analysis, each analytical sequence ends with a demonstration that the resolution criteria have been met for all the samples run in that sequence. (i.e. The system must resolve pristane from C17 and phytane from C18 at 50ug/mL total commercial diesel fuel oil, or at the minimum reporting level. This is typically analyzed after an ICAL or analytical sequence containing samples. Peaks are considered to be resolved when 60% resolution has been achieved.

If any of the above criteria are not met, the problem must be corrected before further samples are analyzed. Any samples analyzed between the last acceptable QC samples must be reanalyzed. If reanalysis is not possible (e.g. due to holding time exceedences or limited volume, etc.) the data must be flagged and a narrative included on the final report.

9.4 Sample Analysis and Quantitation

9.4.1 The same GC operating conditions used for the initial calibration must be employed for sample analyses, including sample injection volume (Section 9.1.2).

9.4.2 Tentative identification occurs when a peak from a sample extract falls within the retention time window for the compound.

9.4.3 The sample ranges are quantitated according to the product requested by the Client (TPH-DRO, Maine-DRO, TPH-DRO-D or TPH-DROD-C44). Refer to Table 1 for carbon ranges.

9.4.4 The concentration reported for an extract is calculated using the Target data processing software. Proper quantitation requires the appropriate selection of a baseline from which the peak area or height can be determined. See the Manual Integration SOP for integration guidelines.

9.4.5 If the sample concentration exceeds the highest concentration of the respective calibration curve, the sample extract must be diluted with methylene chloride and reanalyzed.

9.5 Preventative Maintenance

Preventive maintenance is performed at the discretion of the GC analyst.

9.5.1 Cool the oven to 25°C; turn off both the front and back inlet pressure and temperature.

9.5.2 Remove the septum retaining nut and the old septum. Use forceps to insert a new septum, pressing it firmly into the fitting. Replace the septum retaining nut, and tighten finger-tight.

9.5.3 Using a septum nut wrench, loosen the split/splitless insert nut located under the septum retaining nut. Remove and replace the pre-packed glass wool liner from injection ports using forceps.

9.5.4 To replace the inlet seal base, remove the column from the inlet using a ¼-inch wrench. Remove the insulation cup using either a Phillips-head or star-head screwdriver, and a ½ –inch wrench to loosen the reducing nut. The seal is placed in the nut first, followed by the seal, making sure the raised portion is facing downwards. Replace the reducing nut and tighten.

9.5.5 **Capillary Column Replacement**

9.5.5.1 To prepare the capillary column for installation, score the column using a glass or ceramic scribing tool. Break off the column end by supporting it against the column cutter opposite the scribe. Ensure there are no jagged edges. Position the column through the column nut and 0.5 mm graphite Restek ferrule, making sure it extends 4 to 6mm to the end of the ferrule. Insert the column in the inlet and slide the nut and ferrule up the column to the inlet base. Finger-tighten the column nut until it starts to grab the column. Adjust the column position accordingly. Tighten the column nut with a ¼-inch wrench until the column is firmly in place.

9.5.5.2 Reload the method either on the instrument or at the computer terminal. Set the oven temperature to 270 °C for approximately one-half hour.

9.5.5.3 A new calibration curve must be analyzed following capillary column replacement.

9.6 Calculations

Quantitation: The total area under all peaks and any baseline rise is determined for the sample and standard.

For liquids:

$$C = \frac{[(R_S)(V_E)(D)]}{[(V_S)(m)]}$$

Where:

C = Concentration of Standard, µg/L
D = Dilution Factor
Vs = Volume of water sample, L
V_E = Total Volume of sample extract, mL
R_S = GC Response in DRO window
m = Slope of the curve

For solids:

$$C = \frac{[(R_S)(V_E)(D)]}{[(W)(m)]}$$

Where:

C = Concentration of Standard, mg/Kg
D = Dilution Factor
W = Weight of water sample, Kg
V_E = Total Volume of sample extract, mL
R_S = GC Response in DRO window
m = Slope of the curve

10. Quality Control and Data Assessment

The laboratory must maintain records to document the quality of data that is generated. Ongoing data quality checks are compared with established performance criteria to determine if the results of analyses meet the performance characteristics of the method.

10.1 Demonstration of Capability

The analyst must make an initial, one-time, demonstration of the ability to generate acceptable accuracy and precision with this method. Each time a method modification is made, the analyst is required to repeat the procedure.

When one or more of the parameters tested fail at least one of the acceptance criteria, the analyst must locate and correct the source of the problem and repeat the test for failed parameters of the method.

Repeated failure confirms a general problem with the measurement system or analytical technique of the analyst. If the failure repeats, locate and correct the source of the problem and repeat the test for all parameters listed in the method.

10.2 Method Blanks

Method blanks are extracted and analyzed with each analytical batch of 20 or less samples. The result of the method blank must be less than the reporting limit.

If results are detected above the reporting limit and the associated samples are non-detect, a narrative is submitted for inclusion on the final report. If results are detected above the reporting limit and the associated samples also have positive results, all samples in the extraction batch must be reextracted and reanalyzed.

10.3 Laboratory Control Samples (LCS)

A Laboratory Control Sample is extracted with each sample batch. The LCS consists of an aliquot of clean (control) matrix similar to the sample matrix, and of the same weight or volume, and a known amount of analyte spike. The LCS must be recovered between 60 – 140% for Maine-DRO and TPH-DRO products. For the TPH-DRO-D and TPH-DROD-C44 product, the LCS must be recovered between 40 – 140%.

If the LCS recovery is outside of acceptance criteria, all samples in the extraction batch must be reextracted and reanalyzed.

10.4 Duplicates

A duplicate aliquot of a sample is extracted and analyzed to ensure the consistency of the extraction. The relative percent difference (%RPD) must be $\leq$ 20% for the Maine-DRO product. For TPH-DRO and TPH-DRO-D and TPH-DROD-C44 products, the relative percent difference (%RPD) must be $\leq$ 40%.

If the % RPD is outside of acceptance criteria, the Duplicate sample is reextracted and reanalyzed, unless there is obvious sample non-homogeneity. If there is obvious sample non-homogeneity, a narrative is submitted for inclusion on the final report.

10.5 Matrix Spike (MS)

For the Maine-DRO product, a MS is extracted and analyzed with each analytical batch. The MS consists of an aliquot of sample matrix and a known amount of analyte spike. The MS must be recovered between 60 – 140%.
If the MS recovery is outside of acceptance criteria and the LCS is within acceptance criteria, a narrative is submitted for inclusion on the final report. If the MS and the LCS are outside or acceptance criteria, all samples in the extraction batch must be reextracted and reanalyzed.

10.6 Control Limits

The laboratory maintains performance records to document the quality of data that is generated. Method accuracy for samples is assessed and records maintained.

Control limits for the method parameters are generated. The control limits are calculated based on in-house performance data. The limits are compared to the control limits found in the reference method.

10.7 Surrogate Standards

Surrogate recoveries are calculated for all samples and QC samples and must recover within 40 – 140%. If any surrogate recovers outside acceptance criteria, the sample is reextracted and reanalyzed for confirmation.

If any surrogate recovers above acceptance criteria and the sample is non-detect, a narrative is submitted for inclusion on the client report.

If the surrogate in a sample duplicate recovers outside of acceptance criteria and the surrogate in the sample recovers within acceptance criteria, the data may be reported with a narrative submitted for inclusion on the client report.

10.8 Analytical Sequence

A typical 12-hour analytical sequence:

- Continuing Calibration Standard
- Method Blank
- LCS
- Samples (up to 20)
- Bracketing Continuing Calibration Standard

11. Method Performance

The method detection limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the value is above zero. The MDL concentrations were obtained using a diesel fuel mixture that is calculated against the DRO component standard. The MDL actually achieved in a given analysis will vary depending on instrument sensitivity and matrix effects.

Method performance data is on file in the laboratory QC department. Comparison of method performance data for the laboratory to the reference method criteria occurs when laboratory in-house acceptance limits are generated. In-house generated data must be within the specifications of the reference method or the analysis is not continued until corrective action is completed.

12. Corrective Actions

Holding time exceedence, improper preservation and observed sample headspace are noted on the nonconformance report form.

Perform routine preventative maintenance following manufacturer's specification. Record all maintenance in the instrument logbook.

Review of standards, blanks and standard response for acceptable performance occurs for each batch of samples. Record any trends or unusual performance on a nonconformance action form.

If the CCV or LCS recovery of any parameter falls outside the designated acceptance range, the laboratory performance for that parameter is judged to be out of control, and the problem must be immediately identified and corrected. The analytical result for that parameter in the un-spiked samples is suspect and is only reported for regulatory compliance purposes with the appropriate nonconformance action form. Immediate corrective action includes reanalyzing all affected samples by using any retained sample before the expiration of the holding time.

13. Pollution Prevention

See Chemical Hygiene Plan for pollution prevention operations.

14. Waste Management

See Chemical Hygiene Plan for waste handling and disposal.

15. Attachments

Table 1: Calibration Concentrations for TPH-DRO and TPH-DRO-D

Table 2: Calibration Concentrations for TPH-DROD-C44

Table 1: Calibration Concentrations for TPH-DRO and TPH-DRO-D

	Level 1 (ug/mL)	**Level 2 (ug/mL)**	**Level 3 (ug/mL)**	**Level 4 (ug/mL)**	**Level 5 (ug/mL)**	**Level 6 (ug/mL)**
Dodecane	3	20	50	100	200	500
Tetradecane	3	20	50	100	200	500
Hexadecane	3	20	50	100	200	500
Octadecane	3	20	50	100	200	500
Eicosane	3	20	50	100	200	500
Docosane	3	20	50	100	200	500
Tetracosane	3	20	50	100	200	500
Hexacosane	3	20	50	100	200	500
Octacosane	3	20	50	100	200	500
Triacontane	3	20	50	100	200	500
Dotriacontane	3	20	50	100	200	500
Tetratriacontane	3	20	50	100	200	500
Hexatriacontane	3	20	50	100	200	500
C10 - C28 Total (Maine DRO, TPH-DRO)	30	200	500	1000	2000	5000
C10 - C36 Total (TPH-DRO-D)	42	280	700	1400	2800	7000

Table 2: Calibration Concentrations for TPH-DROD-C44

	Level 1 (ug/mL)	**Level 2 (ug/mL)**	**Level 3 (ug/mL)**	**Level 4 (ug/mL)**	**Level 5 (ug/mL)**
Nonane	3	20	50	100	250
Decane	3	20	50	100	250
Dodecane	3	20	50	100	250
Tetradecane	3	20	50	100	250
Hexadecane	3	20	50	100	250
Octadecane	3	20	50	100	250
Eicosane	3	20	50	100	250
Docosane	3	20	50	100	250
Tetracosane	3	20	50	100	250
Hexacosane	3	20	50	100	250
Octacosane	3	20	50	100	250
Triacontane	3	20	50	100	250
Dotriacontane	3	20	50	100	250
Tetratriacontane	3	20	50	100	250
Hexatriacontane	3	20	50	100	250
Octatriacontane	3	20	50	100	250
Tetracontane	3	20	50	100	250
Tetratetracontane	3	20	50	100	250
C9 - C44 Total (TPH-DROD-C44)	54	360	900	1800	4500

APPENDIX D

CHAIN-OF-CUSTODY

ESI

EnviroSystems, Inc.
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Hampton, N.H. 03843

Voice: 603-926-3345
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ESI Job No: 4552

CHAIN OF CUSTODY DOCUMENTATION

Client:	Contact:	Project Name:	Page of
Report to:	Address:	Project Number:	
Invoice to:	Address:	Project Manager:	
Voice:	Fax:	email:	P.O. No: Quote No:

Protocol: RCRA SDWA NPDES USCOE Other

Lab Number (assigned by lab)	Your Field ID: (must agree with container)	Date Sampled	Time Sampled	Sampled By	Grab or composit (G/C)	Container Size (ml.)	Container Type (P/G/T)	Field Preservation	Matrix S=Solid W=Water	Filter N=Not needed F=Done in field L=Lab to do	Analyses Requested\ Special Instructions:

Relinquished By:	Date:	Time:	Received By:	Date:	Time:
Relinquished By:	Date:	Time:	Received at Lab By:	Date:	Time:

Comments:

Sample Delivery Group No:	Page of

COC Doc No:

APPENDIX E

EQAPP TABLES
(Provided to Envirosystems, Inc.)

APPENDIX F

RESPONSES TO CT DEEP AND USEPA COMMENTS ON DRAFT FINAL QAPP

US Army Corps
of Engineers ®

New England District
Engineering Planning Division
696 Virginia Road
Concord, Massachusetts
01742-2751

REVIEW COMMENTS

Project Name: Stratford Army Engine Plant
Location: Stratford, Connecticut
Document Name: (Draft Final) Feasibility Study Work Plan – Quality Assurance Project Plan
Prepared By: Amec Foster Wheeler

Date: September 22, 2017
Reviewer: Connecticut DEEP
Dated: August 9, 2017

No.	COMMENTS	USACE Response
1.	QAPP, Worksheet 15 tables provide the Project Quantitation Limits (PQLs) and the Achievable Laboratory Limits. The tabulated PQLs are higher than typical ecological environmental criteria, and data usability for the project remedial goals may be affected. The QAPP must be revised with PQLs that provide quantification sufficiently sensitive to allow for data evaluation relative to CT Water Quality Criteria and TEC benchmarks (MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000a, Development and Evaluation of Consensus Based Sediment Quality Guidelines for Freshwater Ecosystems, Arch. Environ. Contam. Toxicol. 39:20-31) for all analytes. DEEP is available for consultation if these limits cannot be achieved by the laboratory.	QAPP Worksheet #15 has been revised to reflect PQLs < the CT Water Quality Criteria and TEC benchmarks. The CT Water Quality Criteria and TEC benchmarks have been added as PRGs to Worksheet 15 tables.

US Army Corps
of Engineers ®

New England District
Engineering Planning Division
696 Virginia Road
Concord, Massachusetts
01742-2751

REVIEW COMMENTS

Project Name: Stratford Army Engine Plant
Location: Stratford, Connecticut
Document Name: (Draft Final) Feasibility Study Work Plan – Quality Assurance Project Plan
Prepared By: Amec Foster Wheeler

Date: December 22, 2017
Reviewer: Kim Tisa, USEPA Region 1
Dated: August 21, 2017

No.	COMMENTS	USACE Response
1.	Some of the worksheet(s) will likely need to be amended based on our discussion last week.	The revised Final QAPP worksheets have been amended based on the teleconference held August 18, 2017.
2.	The extraction methods for all PCB samples (liquid and solid) were not provided in any of the tables.	The extraction methods for PCB samples are as follows: Solids - EPA Method 3570 (SW-846), and Aqueous - SW-846 Method 3510C. These extraction methods have been added to Worksheet #s 11 and 12 of the Final QAPP.
3.	The </= 50% RPD for some of the field duplicates may be too high to achieve desired objectives, especially for delineation of >/= 50 ppm PCB areas.	The Department of Defense and Department of Energy Consolidated Quality Systems Manual (QSM) for Environmental Laboratories, DoD Version 5.1, DOE Version 3.1, 2017 QSM and Connecticut Reasonable Confidence Protocols for PCBs do not address field duplicate RPDs. USACE Environmental Quality - Environmental Statistics Manual, EM-200-1-16 references RPD limits of 50% for aqueous and 100% for soils. Based on the former EPA Region I Validation Guidelines for Organics in solid matrices, a validation guideline of 50% for soils was selected.
4.	Worksheet #12 Table 2 (Project QC Limits) appears to be inconsistent with the Table 2 Measurement Performance Criteria for the PCB surrogate recovery	Worksheet #12 for PCBs has been corrected to meet summary criteria presented in Table 2 Project Analytical QC Limits.
5.	Worksheet #15. The units for PCBs in water for LOD and LOQ are given in mg/L (ppm). Shouldn't this be µg/L (ppb)? Otherwise, the LOD and/or LOQ could be too high to meet some of the objectives. Please note that some of the PALs are also shown in mg/L.	Worksheet #15 has been revised to reflect the proper units (ug/L) for PCBs in water for LOD, LOQ, and PAL.
6.	It's not clear why some of the analytes have PALs and others do not.	Worksheet #15 has been revised to include PALs for the analytes.
7.	Generally, Aroclors 1262 and 1268 are included as part of the Aroclor analyses. The list ends at Aroclor 1260. Do you have any past detections of either of these aroclors?	Aroclors 1262 and 1268 have been added to Worksheet #15, as they are Aroclors that are analyzed and reported under Method 8082A.