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:

Wood Environment & Infrastructure, Inc.
511 Congress Street
Portland, Maine 04101

Project No. 3616176064

February 14, 2020

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ACRONYMS

ADR	Automated Data Review
AES	atomic emission spectroscopy
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
ELLE	Eurofins Lancaster Laboratories Environmental, LLC
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
LIMS	Laboratory Information Management System
LK	Lloyd Kahn
LLC	Limited Liability Corporation
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
NTP	Notice To Proceed
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
SC	Sediment Core Sample
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
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
XRF	X-ray Fluorescence

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 Wood.

The QAPP has been prepared in conjunction with the Field Sampling Plan (FSP) (Wood, 2020a) for the Project, and is consistent with the requirements identified in Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP). The FSP (Wood, 2020a), 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) (Wood, 2020b) 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 (Wood, 2020a). 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 (Wood, 2020a).

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, Wood

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

Preparation Date (Day/Month/Year): January 21, 2020

Investigative Organization's Project Manager (PM)/Date: _____
Signature

Printed Name/Organization: Rod Pendleton/Wood

Investigative Organization's Project QA Officer/Date: _____
Signature

Printed Name/Organization: Jeffrey Pickett/Wood

Lead Organization's PM/Date: _____
Signature

Printed Name/Organization: Erika Mark/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
Site Location: 550 South Main Street, Stratford, Fairfield County, Connecticut
Site Number/Code: EPA #CTD001181502
Operable Unit: All Sites
Contractor Name:
Wood, Environment & Infrastructure Solutions, Inc.
Contractor Number: N/A
Contract Title: N/A
Work Assignment Number: W912WJ-15-D-003

Title: Quality Assurance Project Plan
Revision Number: 0 (Draft)
Revision Date:

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:**

   This task is in response to the United States Army Corps of Engineers, North Atlantic Division, New England District (CENAE) Performance Work Statement (PWS) for Corrective Measures Alternatives Analysis in the Tidal Flats of the Stratford Army Engine Plant (SAEP) located in Stratford, Connecticut, under Contract W912WJ-15-D-0003 dated 12 September, 2019, received by electronic mail on October 25, 2019.

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

Title	Approval Date
Final QAPP, Revision 1, Stratford Army Engine Plant, Stratford, CT. Amec Foster Wheeler.	January 10, 2018

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

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

7. List data users:

- Wood Environment & Infrastructure Solutions, Inc.
- 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 Wood 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	Worksheet #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
Erika Mark	Project Manager	CENAE	978-318-8250		erika.l.mark@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	Wood	207-828-3661	Redacted - Privacy Act	jeffrey.pickett@woodplc.com
Rod Pendleton	Project Manager	Wood	207-828-3605	Redacted - Privacy Act	rod.pendleton@woodplc.com
Jason Raimondi	Project Sediment Remediation Specialist	Wood	978-392-5407		jason.raimondi@woodplc.com
Nick Langlais	Project Geotechnical Engineer	Wood	207-828-3629		nick.langlais@woodplc.com
Brad Wolfe	Project Geologist	Wood	207-828-2627	Redacted - Privacy Act	brad.wolfe@woodplc.com
Amberlee Clark	Field Operations Lead	Wood	860-257-5531	Redacted - Privacy Act	amberlee.clark@woodplc.com
Wolfgang Calicchio	Project Chemist	Wood	207-828-3466	Redacted - Privacy Act	wolfgang.calicchio@woodplc.com
Karen Furey	Project Administrator	Wood	207-828-3464		karen.furey@woodplc.com
Natalie Cormier	Project Accountant	Wood	610-877-6003		natalie.cormier@woodplc.com
Dorothy Love	QA Director	Eurofins Lancaster Laboratories, LLC.	717-556-7327		dorothylove@eurofinsus.com
Kay Hower	Project Manager	Eurofins Lancaster Laboratories, LLC.	717-556-7364		kayhower@eurofinsus.com
Nathan Melaro	Director of Operations	GeoTechnics	412-823-7600		nmelaro@geotechnics.net

Worksheet #3 Distribution List

QAPP Recipients	Title	Organization	Telephone Number	Mobile Number	E-mail Address
Tyler Volpe	Safety & Quality Manager	GeoTechnics	412-823-7600		tvolpe@geotechnics.net

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
Erika Mark	Project Manager	978-318-8250		
James Kelly	Technical Lead Engineer	978-318-8227		

Organization: Wood Environment & Infrastructure Solutions, Inc.

Project Personnel	Title	Telephone Number	Signature	Date QAPP Read
Jeffrey Pickett	Program Manager	207-828-3661		
Rod Pendleton	Project Manager	207-828-3605		
Jason Raimondi	Project Sediment Remediation Specialist	978-392-5407		
Nick Langlais	Project Geotechnical Engineer	207-828-3629		
Brad Wolfe	Project Geologist	207-828-2629		
Amberlee Clark	Field Operations Lead	860-257-5531		
Wolfgang Calicchio	Project Chemist	207-828-3466		

Worksheet #4 Project Personnel Sign-Off Sheet

Organization: Eurofins Lancaster Laboratories Environmental, LLC.

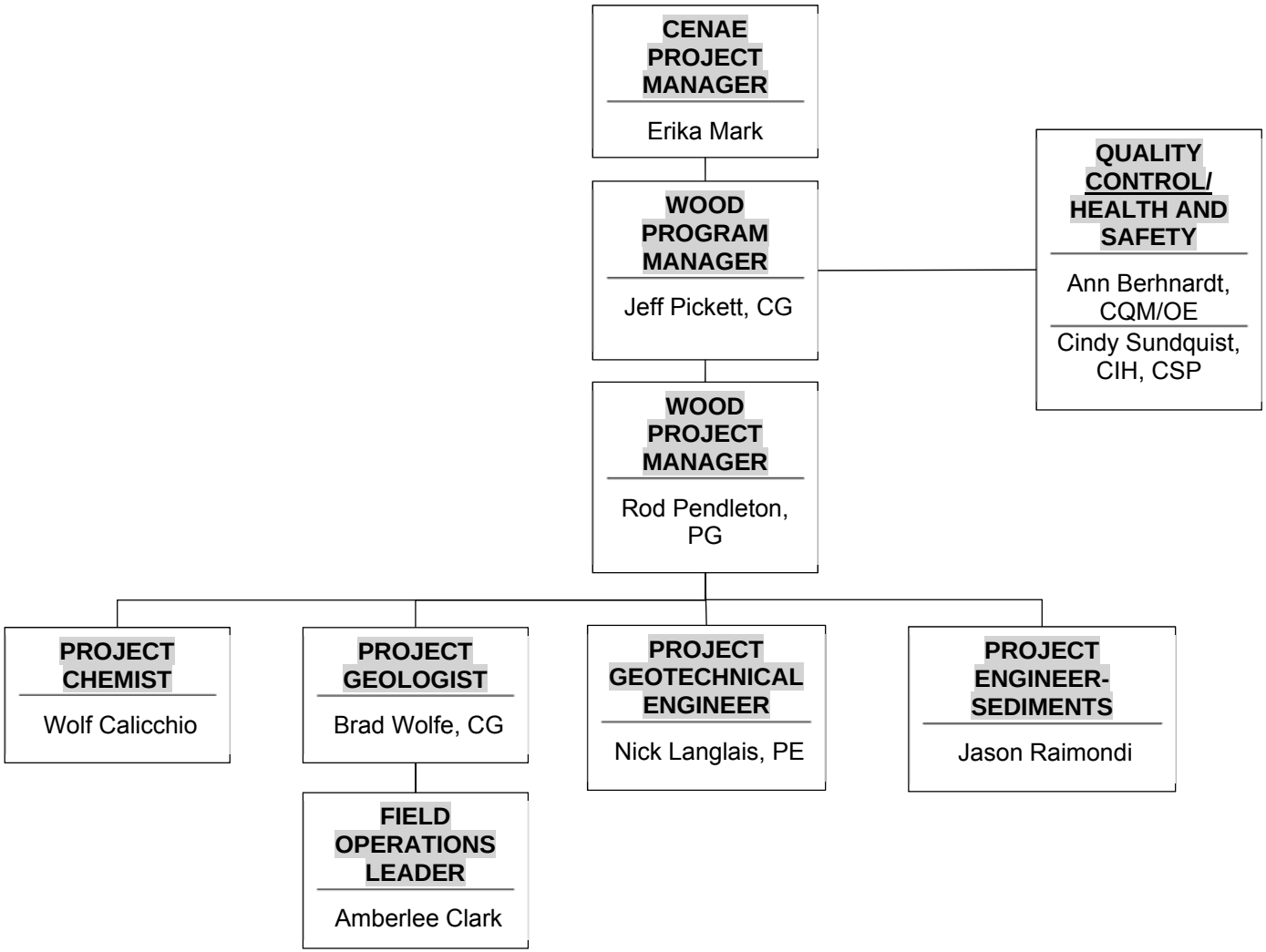
Project Personnel	Title	Telephone Number	Signature	Date QAPP Read
Kay Hower	Laboratory Project Manager	717-556-7364		
Dorothy Love	Laboratory Quality Assurance Director	717-556-7327		

Worksheet #4 Project Personnel Sign-Off Sheet

Organization: GeoTechnics

Project Personnel	Title	Telephone Number	Signature	Date QAPP Read
Nathan Melaro	Director of Operations	412-823-7600		
Tyler Volpe	Safety & Quality Manager	412-823-7600		

Worksheet #5 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	Erika Mark	978-318-8250	As client, will coordinate overall scope of the project, with authority regarding all decisions
Manage all Project Phases	Wood PM	Rod Pendleton	207-828-3605/ Redacted - Privacy Act	Will serve as Wood 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	Amberlee Clark	860-257-5531	Amberlee 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	Amberlee Clark	860-257-5531	Amberlee 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).
Analytical Lab Data QA Issues	Laboratory QA Director	Dorothy Love	717-556-7327	The analytical laboratory QA Director will notify Wolf Calicchio and Rod Pendleton of all QA/QC issues with project field samples as soon as issues are identified.
Geotechnical Lab Data QA Issues	Laboratory QA Manager	Tyler Volpe	412-823-7600	The geotechnical laboratory QA Manager 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	Wood 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 Wood	Laboratory Project Manager	Kay Hower	717-556-7364	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.
Release of Geotechnical Data to Wood	Laboratory Project Manager	Nathan Melaro	412-823-7600	No geotechnical data will be released until corrective actions taken as appropriate.
Data Reviewer/Release of Analytical Data for Project Reports	Wood	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
Erika Mark	Project Manager	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	Wood	• Manage the overall quality of the project; and • Ensure that the necessary resources are made available to the Wood PM for execution of the work.	Designated Wood Program Manager
James Kelly	Technical Lead	CENAE	• Responsible for communication with Wood PM regarding project status, schedule, changes to scope of work; • Responsible for review of work products from Wood'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	Wood	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 Wood requirements under the PWS; and • Maintaining the project file.	Designated Wood PM, Professional Geologist, M.Sc. Environmental Science and Engineering, Sc.B. Geological Sciences
Jason Raimondi	Project Sediment Remediation Specialist	Wood	As Sediment Remediation Specialist, Mr. Raimondi will be consulted regarding aspects of the project related to Feasibility Study and Design.	Senior Engineer
Amberlee Clark	Project FOL	Wood	Wood's Amberlee Clark is the Project Field Operations Leader for the FS tasks. As a field lead, Ms. Clark 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,	Designated Wood Project FOL

Worksheet #7 Personnel Responsibilities and Qualification Table

Name	Title	Organizational Affiliation	Responsibilities	Education and Experience Qualifications
			subcontractors, Wood FS Technical Leads, and Wood PM. As field lead, Ms. Clark 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 Wood 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; • 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	

Worksheet #7 Personnel Responsibilities and Qualification Table

Name	Title	Organizational Affiliation	Responsibilities	Education and Experience Qualifications
			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	Wood	• Corporate Quality Control Officer	Wood, CQM
Cynthia Sundquist	Health & Safety Manager	Wood	• Corporate Health and Safety	Wood, CIH, CSP

Worksheet #7 Personnel Responsibilities and Qualification Table

Name	Title	Organizational Affiliation	Responsibilities	Education and Experience Qualifications
William Colby-George	Project Database Manager	Wood	As the Wood 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 Wood 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 Wood'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

Worksheet #7 Personnel Responsibilities and Qualification Table

Name	Title	Organizational Affiliation	Responsibilities	Education and Experience Qualifications
Wolfgang Calicchio	Project Chemist	Wood	• defining analytical requirements in QAPP; • planning and execution of analytical programs and adherence to specified hold times; • assisting in the selection of appropriate analyses and methods, in cooperation with the QA officer, and analytical subcontractor; • coordinating with the analytical subcontractor on field efforts and associated laboratory services; • providing direct technical input in day-to-day laboratory operations; • review and validation of all analytical data; • review and validation of field XRF analytical data; • maintaining analytical program documentation; • Review and approve eQAPP for ADR.	Designated Wood Project Chemist
Karen Furey	Project Administrator	Wood	• Assists with the development of Project deliverables.	
Richard Karam	Laboratory Director of Operations	Eurofins Lancaster Laboratories Environmental, LLC	The Laboratory Director of Operations 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.	

Worksheet #7 Personnel Responsibilities and Qualification Table

Name	Title	Organizational Affiliation	Responsibilities	Education and Experience Qualifications
Kay Hower	Laboratory PM	Eurofins Lancaster Laboratories Environmental, LLC	As the Laboratory PM, Ms. Hower is the primary point of contact between the laboratory and Wood. Ms. Hower is responsible for: • Establishing a project file and analytical requirements; • Communicating project requirements to ELLE laboratory personnel; • Keeping the laboratory and Wood informed of project status; • Monitoring, reviewing, and evaluating the progress and performance of projects; • Reporting Wood inquiries involving data quality issues or data acceptability to the ELLE Laboratory QA Manager and to the affected laboratory staff; and • Reviewing project data packages for completeness and compliance to Project requirements and Wood needs.	
Dorothy Love	Laboratory QA Manager	Eurofins Lancaster Laboratories Environmental, LLC	The Laboratory QA Manager reports directly to the Laboratory Manager. As the ELLE Laboratory QA Manager, Ms. Love 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.	

Worksheet #7 Personnel Responsibilities and Qualification Table

Name	Title	Organizational Affiliation	Responsibilities	Education and Experience Qualifications
Nathan Melaro	Director of Operations	GeoTechnics	The Laboratory Director of Operations 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.	
Tyler Volpe	Safety & QA Manager	GeoTechnics	The Laboratory QA Manager reports directly to the Laboratory Director of Operations. As the GeoTechnics Safety & QA Manager, Mr. Volpe 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.	

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	Wood personnel	Wood project offices
Data Management	Operations Security Training (OPSEC)	Center for Development of Security Excellence	TBD	Data Managers	Wood personnel	Wood project offices
Administration	OPSEC	Center for Development of Security Excellence	TBD	Administrative Assistant	Wood personnel	Wood 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	Wood personnel	Wood 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	Eurofins Lancaster Laboratories Environmental, LLC.	Appendix F
Analytical Chemistry	National Environmental Laboratory Accreditation Program (NELAP) and CT DEEP Accreditation	NELAP Accrediting State and CTDEEP	NA	Analytical Laboratory	Eurofins Lancaster Laboratories Environmental, LLC.	Appendix F

Worksheet #9 Project Scoping Session Participants Sheet

Worksheet #9 Project Scoping Session Participants Sheet

Project Name: Stratford Army Engine Plant – Feasibility Study 008 Addendum **Projected Date(s) of Sampling:** 2020 **PM:** Rod Pendleton	**Site Name:** Stratford Army Engine Plant Tidal Flats and Outfall **Site Location:** Stratford, Connecticut
Date of Session: October 23, 2019 **Scoping Session Purpose:** Scope discussions.	

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Erika Mark	Project Manager	CENAE	978-318-8250	erika.l.mark@usace.army.mil	Project Manager
James Kelly	Technical Lead	CENAE	978-318-8227	james.a.kelly@usace.army.mil	Technical Lead
Rod Pendleton	Project Manager	Wood	207-775-5401	rod.pendleton@woodplc.com	Project Manager

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

Discussion Topics:
1) Objective of sediment investigation
2) Objectives of geotechnical investigation
3) Sediment Remediation Endpoints Report Addendum
4) Schedule

Action Items:
1) Complete Wood proposal
2) Issue Draft Work Plans to CENAE as soon as possible after award

Worksheet #10 Conceptual Site Model

Worksheet #10 Conceptual Site Model

The problem to be addressed by the project: • Perform sediment sampling and analyses in the Tidal Flats to further delineate: o The vertical extent of ERM-Q values for eight metals exceeding 0.5 part per million (ppm), and o The vertical extent of ERM-Q values for PCB concentrations exceeding 1 ppm, or o The vertical extent of ERM-Q values for mercury above 0.55 ppm. • Collect geotechnical soil samples from the South Parking lot and around OF-008: o to design temporary sheeting and construction of future remediation measures in the Outfall 8 Area; and o to determine the ability of the foundation soils to support stockpiled dredged material.
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-008.*
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.*

Worksheet #10 Conceptual Site Model

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.*
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.*

Worksheet #10 Conceptual Site Model

Data gaps and uncertainties associated with the Conceptual Site Model: *Data gaps to be addressed by the investigations proposed in the FSP (Wood, 2020a) include:*

- *Perform sediment sampling and analyses in the Tidal Flats to further delineate:*
  - *The vertical extent of ERM-Q values for eight metals exceeding 0.5 part per million (ppm), and*
  - *The vertical extent of ERM-Q values for PCB concentrations exceeding 1 ppm, or*
  - *The vertical extent of ERM-Q values for mercury above 0.55 ppm.*
  - *On-site XRF analysis for Copper to evaluate future use of field method during remedial dredging.*
- *Collect geotechnical subsurface soil samples from the South Parking lot and in the vicinity of the Outfall 008 Drainage Ditch:*
  - *to provide data for design temporary sheeting and construction of future remediation measures in the Outfall 008 area; and*
  - *to determine the ability of the foundation soils to support stockpiled dredged material.*

Worksheet #11 Project Quality Objectives /Systematic Planning Process Statements

Worksheet #11 Project Quality Objectives /Systematic Planning Process Statements

Who will use the data? *CENAE, Wood, 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 the Design for sediment remediation in the Tidal Flats and Outfall 008 Drainage Ditch. The proposed sampling will fill data gaps and allow for remedial footprints to be refined vertically. In addition, the geotechnical sampling aims to provide the data required to design temporary sheeting and constriction of future remediation measures in the Outfall 008 Drainage Ditch; and to determine the ability of the foundation soils to support stockpiled dredged material.*
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 and soil will be collected from on-site areas. Samples will be analyzed in off-site analytical laboratories for PCB Homologs, mercury, and total metals to include arsenic, cadmium, chromium, copper, lead, nickel, and zinc, grain size, moisture content, solids, content, Atterberg Limits, and on-site for copper by XRF. Sampling scope for media and planned analyses are described in the FSP (Wood, 2020a).*

Worksheet #11 Project Quality Objectives /Systematic Planning Process Statements

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 activities proposed in the FSP (Wood, 2020a). 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
Delineation	Solid	PCB Homologs	Extraction: EPA Method 3570 Analysis: EPA Method 680 Mod	8
	Solid	Metals	SW-846 Method 6020	161
	Solid	Copper	SW-846 Method 6200	137
	Solid	Mercury	SW-846 Method 7474/7471	160
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
Geotechnical Evaluation	Solid	Sieve Analysis	American Society for Testing and Materials (ASTM) D6913	6
	Solid	Soil Classification	ASTM D2487	6
	Solid	Hydrometer Analysis	ASTM D7928	6
	Solid	Multi-point Atterberg Limits	ASTM D4318	6
	Solid	Moisture Content	ASTM D2216	4

Worksheet #11 Project Quality Objectives /Systematic Planning Process Statements

	Solid	CU Triaxial with Pore Pressure, 3 Points, 3" Diameter (undisturbed)	ASTM D4767	2

Where, when, and how should the data be collected/generated? Sediment and soil samples will be collected as follows:

1. Perform sediment sampling and analyses in the Tidal Flats to further delineate:
   a. The vertical extent of ERM-Q values for eight metals exceeding 0.5 part per million (ppm), and
   b. The vertical extent of ERM-Q values for PCB concentrations exceeding 1 ppm, or
   c. The vertical extent of ERM-Q values for mercury above 0.55 ppm.
2. Collect geotechnical soil samples from the South Parking lot and the Outfall 008 Area:
   a. to design temporary sheeting and construction of future remediation measures in the Outfall 008 Area; and
   b. to determine the ability of the foundation soils to support stockpiled dredged material.

Data will be collected under the following schedule:

TASK	Event	Date
13	Project Management	From notice to proceed (NTP) through Dec 2020
14	Work Plan Addenda	21 days from NTP
15	Field Sampling of Tidal Flats with Mobilization and Lab Support	21 days from Final Work Plan Approval
16	(Optional) – Field Sampling of Tidal Flats without Mobilization	21 days from Final Work Plan Approval
17	(Optional) – Laboratory Support	21 days following Field Sampling
18	Sediment Remediation Endpoint Report Addendum	21 days following receipt of validated data
19	Geotechnical Borings and Report	45 days from receipt of Final Work Plans

Worksheet #11 Project Quality Objectives /Systematic Planning Process Statements

Sample collection to support data *generated* will be done *in accordance with* the FSP (Wood, 2020a) 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.
Who will collect and generate the data? *Wood will collect the environmental samples. Delineation samples will be analyzed by Eurofins Lancaster Laboratories Environmental, LLC. located in Lancaster, PA. Geotechnical samples will be analyzed by GeoTechnics, located in East Pittsburgh, PA. . XRF screening samples will be analyzed on-site by Wood. Field and laboratory data will be managed and reported by Wood.*
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? *Both the analytical laboratory and Wood will obtain the most recent version (ADR.NET) of the LDC ADR software. Wood 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 Wood 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 Wood project chemist. Final results will be provided to CENAE and be entered into EDMS. Final results will also be entered into the Wood TED data management system for use in preparing the FS report and subsequent documents.* *Data from field activities and the analytical laboratory will be entered into the Wood's TED environmental database. The contract laboratory will submit Stage 2a EDDs to Wood 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.*

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	Soil	Sediment
PCB Homologs	Solids Extraction: EPA Method 3570 Sample Analysis: EPA Method 680 Mod		X
Project List Metals (As, Cd, CR, Cu, Pb, Ni, Ag, Zn)	SW-846 6020 Inductively Coupled Plasma Mass Spectroscopy (ICP-MS)		X
Mercury, total	SW-846 7474/7471		X
Copper	SW-846 6200 XRF		X
Sieve Analysis	American Society for Testing and Materials (ASTM) D6913 w/ Hydrometer (ASTM D7928)	X	
Moisture Content	ASTM D2216	X	
CU Triaxial with Pore Pressure, 3 Points 3" Diameter (undisturbed)	ASTM D4767	X	
Atterberg Limits	ASTM D4318	X	

PCB – 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	
		Matrix Spike/ Matrix Spike Duplicate (MS/MSD)			40-140	50
		Surrogates			30-150	
		Field Duplicates				50
Project List Metals	SW-846 6020A	LCS			80-120	
		MS/MSD			75-125	50
		Internal Standard			60-125	
		Lab Duplicates				35
		Field Duplicates				50
XRF Copper	SW-846 6200	Field Duplicates				50
Mercury	SW-846 7474/7471	LCS			75-125	
		MS/MSD			75-125	50
		Lab Duplicates				25
		Field Duplicates				50

LCS - Laboratory Control Sample
MS - Matrix Spike
MSD - Matrix Spike Duplicate
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	SW-846 680 modified/ L-1	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

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-2	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/ Precision	60% to 125% of the Calibration Blank Internal Standard	Internal Standards	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

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)**
		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 SW-846 7474/7471/L-3	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 Metals
Concentration Level	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-8	XRF Analysis SW-846 6200 modified / S-8	Precision - Overall	RPD $\leq$ 50	Field Duplicates	S & A
		Completeness	Field 90%, Laboratory 95%	Data Completeness Check	S & 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 presented in the FSP (Wood, 2002a) are presented below:

Pre-Design Investigation Tidal Flat Sediment Core Sampling

- Sediment sampling will be conducted to determine the vertical extent of ERM-Q values for eight metals exceeding 0.5 part per million (ppm), and PCB concentrations exceeding 1 ppm or mercury above 0.55 ppm. This proposal assumes that up to 5 sediment cores to a depth of 5 feet bgs and 25 sediment cores to a depth of 8 feet bgs will be required to complete vertical delineation of total metals (including mercury) and PCB contamination.
- One sediment core will be collected at a depth of five feet bgs in area B-1 and will be analyzed for Total Metals.
- Six sediment cores will be collected at a depth of five feet bgs in area H-1 and will be analyzed for Total Metals, Mercury, and PCB Homologs.
- Four sediment cores will be collected at a depth of eight feet bgs in area B-7 and will be analyzed for Total Metals and Mercury.
- Seven sediment cores will be collected at a depth of eight feet bgs in area E-7 and will be analyzed for Total Metals and Mercury.
- Nine sediment cores will be collected at a depth of eight feet bgs in area H-5 and will be analyzed for Total Metals and Mercury.
- Five sediment cores will be collected at a depth of eight feet bgs in area L-3 and will be analyzed for Total Metals and Mercury.
- From the seven sediment cores to 5 feet bgs, Wood will collect up to 4 sediment samples for PCB's to vertically delineate the remedial footprint of PCB's greater than 1 ppm from 4-5 ft bgs. Up to seven samples for total metals will be collected from the sediment cores to vertically delineate the remedial footprint for metals results and an average ERM-Q Index greater than 0.5 from 4-5 ft. Wood will collect up to six sediment samples for mercury in order to vertically delineate the remedial footprint of mercury greater than 0.55 ppm from 4-5 ft bgs.
- From the 25 sediment cores to 8 feet bgs, Wood will collect up to 100 samples for total metals to vertically delineate the remedial footprint for metals results and an average ERM-Q greater than 0.5 from 4-8 ft. Wood will collect up to 100 sediment samples for mercury analysis in order to vertically delineate the remedial footprint of mercury greater than 0.55 ppm from 4-8 ft bgs.
- Wood will collect an additional sample aliquot from each sample and field screen for copper utilizing a portable XRF.

Geotechnical Field Exploration

- Wood will subcontract New England Boring Contractors of Glastonbury, Connecticut to advance four borings, FD-19-01 through FD-19-04, using 4-inch steel casing at the approximate locations indicated on Figure 4-2 and in Table 4-4 of the FSP. Final coordinates of these borings will be provided to Wood by CENAE prior to performing utility locating activities. Field work and submittals will reference and report results relative to the NAD 1983 Connecticut State Plane coordinate system Mainland Zone (horizontal), and NAVD 1988 vertical datum. Measurements will be made in feet, and tenths of feet. Inches may be used for measuring amount of spoon penetration if less than 6 inches. Wood will locate borings, using the northings and eastings provided to Wood by CENAE, in the field using Differential GPS (DGPS) survey methods with sub-meter accuracy. Wood will direct the drilling contractor to position and set up the rig in

Worksheet #14 Summary of Project Tasks

such a way that actual field drilling locations are within 5 feet of the location coordinates provided by CENAE. The final coordinates will be recorded on the logs and tabulated separately in the report.

- Borings will be advanced to a depth of 50 feet below ground surface. Split-spoon sampling (2-inch diameter) and in-situ testing (SPT) of soils will be performed at 5-foot intervals. SPT will be conducted in general accordance with ASTM D 1586. Visual classification of soil samples retrieved will be performed by Wood's geotechnical engineer or geologist overseeing the field explorations. Visual classification will be performed in accordance with ASTM D 2488. Boring logs will include the measured depth to water, sampler size and hammer or ram weight. Split-spoon samplers will not be advanced more than 24 inches ahead of the casing without authorization by the CENAE. Borings will be advanced by roller-bit and wash methods as appropriate. Refusal of the sampling spoon for the purposes of this project is defined as 60 blows per inch of penetration or bouncing refusal. If refusal is encountered, the casing and bit will be advanced, and sampling/testing will then be performed at the next 5 ft interval.
- If organic silts are encountered during the field investigation, undisturbed Shelby tube samples will be collected in general accordance with ASTM D 1587. It is anticipated that up to four undisturbed samples will be collected. Prior to sampling, the bottom of the borehole will be cleared of excess drill cuttings and any loose, disturbed soils. The sampler will then be attached to the end of the drill string and lowered to the bottom of the borehole. If sampling below the groundwater table, the water level in the drill casing will be maintained full both during sampler insertion and removal activities. The sampler will then be advanced by hydraulic push until 24 inches of penetration is achieved. A period of a minimum of 10 minutes, measured from the time of insertion to the time of removal, will be accommodated to allow for sample adhesion to the walls of the sampler. Prior to removal, the sampler will be rotated approximately two complete revolutions to shear off the sample.
- Upon removal, recovery (expressed both as inches recovered over inches of penetration, and percent) will be determined and recorded on the boring log. First, the distance from the top of the tube to the top of the sample will be measured. A mark will be made on the outside of the tube at this distance, indicating that the sample starts at that point. The samples recovered via thin-walled tubes will be preserved and transported in general accordance with ASTM D4220. To help preserve the natural moisture content of samples, the tube ends will be sealed with wax or plastic expandable packers. The top of the tube will be sealed with wax, with a minimum thickness of 1 inch. After the wax has set up, approximately 1 to 1.5 inches of natural material will be removed from the bottom of the tube and classified and recorded on the boring log. The bottom of the tube will then be sealed with either wax or a plastic expandable packer. Plastic slip caps will be applied to the ends of the tubes. Slip caps will be sealed with tape and then dipped and sealed in two or more layers of wax.
- Geotechnical borings will be backfilled (i.e., tremie-grouted) with cement-bentonite grout, and the ground surface will be restored to pre-work conditions (i.e., cold patch in pavement areas). Investigation Derived Waste (IDW) (i.e., drill cuttings and fluids) will be containerized in 55-gallon DOT-approved drums, and subsequent sampling, analysis, and characterization will be carried out by Wood.
- Wood will provide a drilling inspector who is trained as a geologist or geotechnical engineer. The inspector will be knowledgeable in the visual soil classification methods of ASTM D2488, in the Unified Soil Classification System of ASTM D2487, and in the general drilling procedures to be used for this project. The inspector will have at least two years of experience in this type of work, including collection of samples for environmental testing. The inspector will perform field inspection, develop field exploration logs, select and classify samples, perform quality control, record the daily operations of the drill crew, and perform other recording and coordination duties as required. The inspector will have no other duties other than the inspection work described. No member of the drilling crew will perform the inspection function in addition to their drilling crew duties. No drilling work or other fieldwork of this project, other than mobilization and demobilization, will be performed in the absence of the inspector. Wood understands that the inspector will be CENAE's primary point-of-contact for this project. Wood will provide the inspector with a cellular telephone or equal means of communication so that contact with CENAE is possible during work hours.

Worksheet #14 Summary of Project Tasks

Analysis Tasks:

- Sediment samples will be analyzed by ELLE, LLC for low level PCB homologs, mercury and metals.
- Sediment samples will be screened for copper by Wood.
- Soil samples will be analyzed by GeoTechnics for grain size, water content, Atterberg Limits, bulk and dry density, and specific gravity of solids.

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 Wood will obtain the most recent version (ADR.NET) of the USACE ADR software. Wood 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 Wood 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 Wood project chemist. Final results will be provided to CENAE and be entered into RADBS. Final results will also be entered into the Wood 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)
SC – Sediment core sample
SW – Surface water sample
EB – Equipment rinsate blank
EL - Elutriate
BL – QC Blank

Sample Program Designator
PCB – PCB Delineation Sampling

Worksheet #14 Summary of Project Tasks

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 "SCPCB0370708".

A duplicate sediment sample collected for PCB delineation from sample location 015, from the depth interval 1-2' bgs would be identified as "SCPCB0150102DUP".

- 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 "SCT030290304MS".

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;
- 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 Wood field team will follow Wood'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)
- 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,

Worksheet #14 Summary of Project Tasks

- unusual observations
- record of photographs
- sketches or diagrams
- signature of person recording the information

Field logbooks will be reviewed daily by the Wood 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 Wood/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 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.

Field QC Sample Record:

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

Worksheet #14 Summary of Project Tasks

record will be provided to the project chemist for use during data validation.

Field Documentation Management System:

The Wood 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 Wood 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 Wood 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 Wood 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.

Upon receipt of the laboratory SEDDs, Wood 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 Wood or its contractors will be proofed for accuracy.

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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 Wood 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 Wood 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	Metals (Low/Medium/High Level), SW-846 6020A, Sediment
15-3	Total Mercury (Low/Medium/High Level), USEPA 7474/7471, Sediment
15-4	XRF Metals (Low/Medium/High Level), SW-846 6200, Sediment

Note: MDLs presented in Table 15 Worksheets are current but should be considered as representative. These limits are updated annually by the laboratories. Wood 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	0.00333	0.001	0.0003
25512-42-9	Dichlorobiphenyl	0.0598	TEC[1]	0.01	0.00333	0.001	0.0003
25323-68-6	Trichlorobiphenyl	0.0598	TEC[1]	0.01	0.00333	0.001	0.0003
26914-33-0	Tetrachlorobiphenyl	0.0598	TEC[1]	0.01	0.00667	0.002	0.0008
25429-29-2	Pentachlorobiphenyl	0.0598	TEC[1]	0.01	0.00667	0.002	0.0008
26601-64-9	Hexachlorobiphenyl	0.0598	TEC[1]	0.01	0.00667	0.002	0.0008
28655-71-2	Heptachlorobiphenyl	0.0598	TEC[1]	0.01	0.01	0.003	0.001
55722-26-4	Octachlorobiphenyl	0.0598	TEC[1]	0.01	0.01	0.003	0.001
53742-07-7	Nonachlorobiphenyl	0.0598	TEC[1]	0.01	0.01667	0.005	0.002
2051-24-3	Decachlorobiphenyl	0.0598	TEC[1]	0.01	0.01667	0.005	0.002

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

mg/kg - milligrams per kilogram

Worksheet #15-2 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-2

		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)
7440-38-2	Arsenic	9.79	TEC[1]	2	0.2	0.16	0.0669
7440-43-9	Cadmium	0.99	TEC[1]	0.5	0.05	0.04	0.0252
7440-47-3	Chromium	43.4	TEC[1]	10	0.4	0.32	0.167
7440-50-8	Copper	31.6	TEC[1]	10	4	3.2	1.79
7439-92-1	Lead	35.8	TEC[1]	1	0.1	0.05	0.0252
7440-02-0	Nickel	22.7	TEC[1]	1	0.4	0.32	0.17
7440-22-4	Silver			0.1	0.05	0.04	0.0203
7440-66-6	Zinc	121	TEC[1]	10	1	0.8	0.2677

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

mg/kg - milligrams per kilogram

Worksheet #15-3 Reference Limits and Evaluation Table

Medium/Matrix: *Sediment*
Matrix Code: *SD*
Analytical Parameter: Total Mercury
Concentration Level: *Low/Medium/High*
Fixed Laboratory Method/SOP: 7474/7471/L-3

		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)
7439-97-6	Mercury	0.18	TEC[1]	0.1	0.8	0.4	0.187

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

mg/kg - milligrams per kilogram

Worksheet #15-4 Reference Limits and Evaluation Table

Medium/Matrix: *Sediment*
Matrix Code: *SD*
Analytical Parameter: XRF Metals
Concentration Level: *Low/Medium/High*
Fixed Laboratory Method/SOP: 6200/S-8

		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)
7440-50-8	Copper	31.6	TEC[1]	33			

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

mg/kg - milligrams per kilogram

Worksheet #16 Project Schedule Timeline Table

TASK	Event	Date
13	Project Management	From notice to proceed (NTP) through Dec 2020
14	Work Plan Addenda	21 days from NTP
15	Field Sampling of Tidal Flats with Mobilization and Lab Support	21 days from Final Work Plan Approval
16	(Optional) – Field Sampling of Tidal Flats without Mobilization	21 days from Final Work Plan Approval
17	(Optional) – Laboratory Support	21 days following Field Sampling
18	Sediment Remediation Endpoint Report Addendum	21 days following receipt of validated data
19	Geotechnical Borings and Report	45 days from receipt of Final Work Plans

Worksheet #17 Sampling Design and Rationale

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

The general objective of the work to be conducted is to supplement the usable, existing Project data collected to date to support development of the FS. In particular, the sampling and analyses specified will fill data gaps and allow for remedial footprints of contaminated sediment in the Tidal Flats Area to be refined vertically. The FSP includes proposed geotechnical soil sample collection, analyses, and testing of soils from the South Parking Lot and OF-008 drainage ditch area.

The objectives of the Tidal Flat delineation and geotechnical components of the work proposed are as follows:

1. *Perform sediment sampling and analyses in the Tidal Flats to further delineate:*
   a. *the vertical extent of ERM-Q values for eight metals exceeding 0.5 part per million (ppm), and*
   b. *the vertical extent of ERM-Q values for PCB concentrations exceeding 1 ppm, or*
   c. *the vertical extent of ERM-Q values for mercury above 0.55 ppm.*
2. *Collect geotechnical soil samples from the South Parking lot and around OF-008:*
   a. *to design temporary sheeting and construction of future remediation measures in the Outfall 8 Area; and*
   b. *to determine the ability of the foundation soils to support stockpiled dredged material.*

The following table provides the rationale for the sediment core sampling schedule:

Select Area	Depth of Core	Number of Cores	Sample Intervals	Sample Parameters	Rationale
B-1	5 feet	1	4-5 ft.	Metals	One ERM-Q exceedance at 3-4 feet. Clean intervals for all contaminants for 5-6 feet and 7-8 feet but the 4-5 foot interval was never sampled
H-1	5 feet	6	4-5 ft.	Metals, Hg, PCBs	Two ERM-Q, 1 PCB and 2 mercury exceedances at 3-4 feet. Clean intervals for all contaminants for 5-6 feet and 7-8 feet but the 4-5 foot interval was never sampled

Worksheet #17 Sampling Design and Rationale

B-7	8 feet	4	0-8 ft.	Metals, Hg	Metals and Hg exceedances 3-4 feet, no PCB exceedances from 0-4 feet
E-7	8 feet	7	0-8 ft.	Metals, Hg	Metals and Hg exceedances 3-4 feet, no PCB above 1ppm from 0-4 feet
H-5	8 feet	9	0-8 ft.	Metals, Hg	Metals and Hg exceedances 3-4 feet, no PCB from 3-4 feet
L-3	8 feet	5	0-8 ft.	Metals, Hg	One ERM-Q and one Hg exceedance at 3-4 feet interval, one PCB detection at 0.54ppm

For the geotechnical sampling, four geotechnical borings will be advanced to characterize the physical and engineering properties of soils beneath the South Parking Lot and OF-008 drainage ditch area at the Site. The information obtained from these borings will be used to design temporary sheeting and construction of future remediation measures in the Outfall 8 Area, in addition to determining the ability of the foundation soils to support stockpiled dredged materials.

Boring Number	Boring Depth (ft)	Drilling Method	Split-Spoon Sampling Interval (ft)	Standard Penetration Test (SPT) Interval (ft)	Shelby Tube Sampling Interval (ft)
FD-20-01	50	Rotary wash with 4" casing	5	5	TBD
FD-20-02	50	Rotary wash with 4" casing	5	5	TBD
FD-20-03	50	Rotary wash with 4" casing	5	5	TBD
FD-20-04	50	Rotary wash with 4" casing	5	5	TBD

See Figures 4-1 through 4-2 of the FSP for proposed sampling locations.

Worksheet #18 Sampling Locations and Methods/SOP Requirements Table

Sediment Core Locations and Coordinates

Area	Location ID	Location Type	Easting	Northing	Depth Intervals				SOPs
					4-5 ft	5-6 ft	6-7 ft	7-8 ft	
B-1	SC-01	5 FT METALS, XRF - Cu	896,668	624,119	x				S-1, L-2, S-8
H-1	SC-02	5 FT METALS, HG, PCBS, XRF - Cu	897,945	623,544	o				S-1, L-1, L-2, L-3, S-8
H-1	SC-03	5 FT METALS, HG, PCBS, XRF - Cu	897,993	623,543	o				S-1, L-1, L-2, L-3, S-8
H-1	SC-04	5 FT METALS, HG, PCBS, XRF - Cu	897,970	623,477	o				S-1, L-1, L-2, L-3, S-8
H-1	SC-05	5 FT METALS, HG, PCBS, XRF - Cu	898,065	623,470	o				S-1, L-1, L-2, L-3, S-8
B-7	SC-06	5 FT METALS, HG, PCBS, XRF - Cu	897,203	625,305	o				S-1, L-1, L-2, L-3, S-8
B-7	SC-07	5 FT METALS, HG, PCBS, XRF - Cu	897,188	625,231	o				S-1, L-1, L-2, L-3, S-8
B-7	SC-08	8 FT METALS, HG, XRF - Cu	897,258	625,179	•	•	•	•	S-1, L-2, L-3, S-8
B-7	SC-09	8 FT METALS, HG, XRF - Cu	897,309	625,220	•	•	•	•	S-1, L-2, L-3, S-8
E-7	SC-10	8 FT METALS, HG, XRF - Cu	897,652	624,918	•	•	•	•	S-1, L-2, L-3, S-8
E-7	SC-11	8 FT METALS, HG, XRF - Cu	897,628	624,817	•	•	•	•	S-1, L-2, L-3, S-8
E-7	SC-12	8 FT METALS, HG, XRF - Cu	897,638	624,728	•	•	•	•	S-1, L-2, L-3, S-8
E-7	SC-13	8 FT METALS, HG, XRF - Cu	897,720	624,883	•	•	•	•	S-1, L-2, L-3, S-8
E-7	SC-14	8 FT METALS, HG, XRF - Cu	897,694	624,728	•	•	•	•	S-1, L-2, L-3, S-8

E-7	SC-15	8 FT METALS, HG, XRF - Cu	897,794	624,791	•	•	•	•	S-1, L-2, L-3, S-8
E-7	SC-16	8 FT METALS, HG, XRF - Cu	897,762	624,695	•	•	•	•	S-1, L-2, L-3, S-8
H-5	SC-17	8 FT METALS, HG, XRF - Cu	898,107	624,413	•	•	•	•	S-1, L-2, L-3, S-8
H-5	SC-18	8 FT METALS, HG, XRF - Cu	898,063	624,321	•	•	•	•	S-1, L-2, L-3, S-8
H-5	SC-19	8 FT METALS, HG, XRF - Cu	898,189	624,372	•	•	•	•	S-1, L-2, L-3, S-8
H-5	SC-20	8 FT METALS, HG, XRF - Cu	898,151	624,280	•	•	•	•	S-1, L-2, L-3, S-8
H-5	SC-21	8 FT METALS, HG, XRF - Cu	898,279	624,330	•	•	•	•	S-1, L-2, L-3, S-8
H-5	SC-22	8 FT METALS, HG, XRF - Cu	898,398	624,247	•	•	•	•	S-1, L-2, L-3, S-8
H-5	SC-23	8 FT METALS, HG, XRF - Cu	898,379	624,193	•	•	•	•	S-1, L-2, L-3, S-8
H-5	SC-24	8 FT METALS, HG, XRF - Cu	898,464	624,186	•	•	•	•	S-1, L-2, L-3, S-8
H-5	SC-25	8 FT METALS, HG, XRF - Cu	898,379	624,109	•	•	•	•	S-1, L-2, L-3, S-8
L-3	SC-26	8 FT METALS, HG, XRF - Cu	898,611	623,597	•	•	•	•	S-1, L-2, L-3, S-8
L-3	SC-27	8 FT METALS, HG, XRF - Cu	898,719	623,637	•	•	•	•	S-1, L-2, L-3, S-8
L-3	SC-28	8 FT METALS, HG, XRF - Cu	898,685	623,568	•	•	•	•	S-1, L-2, L-3, S-8
L-3	SC-29	8 FT METALS, HG, XRF - Cu	898,640	623,482	•	•	•	•	S-1, L-2, L-3, S-8
L-3	SC-30	8 FT METALS, HG, XRF - Cu	898,751	623,537	•	•	•	•	S-1, L-2, L-3, S-8

Notes:

Worksheet #17 Sampling Design and Rationale

-Coordinates are CT State Plane NAD 83, US Survey Feet

- x Metals, XRF - Cu
- o Metals, HG, PCB, XRF - Cu
- ● Metals, HG, XRF-Cu

Geotechnical Sample Locations and Coordinates

Location ID	Easting	Northing	Depth	SOPs
FD-20-01	899,058	621,532	50 ft	S-9, L-7, L-8, L-9, L-10, L-11
FD-20-02	898,657	621, 923	50 ft	S-9, L-7, L-8, L-9, L-10, L-11
FD-20-03	897,863	622,463	50 ft	S-9, L-7, L-8, L-9, L-10, L-11
FD-20-04	896,165	623,922	50 ft	S-9, L-7, L-8, L-9, L-10, L-11

Notes:

- Coordinates are CT State Plane NAD 83, US Survey Feet
- Split-spoon sampling 5-ft intervals
- Standard Penetration Test (SPT) 5-ft intervals
- Shelby tube sampling intervals TBD

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	1 Liter (), 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	Total Project List Metals	Low/Medium/High	SW-846 6020/L-2	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 7474/7471/L-3	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	XRF Copper	Low/Medium/High	SW-846 6200/S-8	4 oz.	One Amber Glass Teflon Lined	Cool, ≤ 6ºC	immediate	Cool, ≤ 6ºC	In a cooler on ice	180 days to analysis
SOIL	Sieve Analysis	N/A	ASTM D422/L-8	16 oz., combined[2]	One Amber Glass Teflon Lined	Cool, ≤ 6ºC	immediate	Cool, ≤ 6ºC	In a cooler on ice	180 days to analysis
SOIL	Moisture Content	N/A	ASTM 2216/L-7	16 oz., combined[3]	One Amber Glass Teflon Lined	Cool, ≤ 6ºC	immediate	Cool, ≤ 6ºC	In a cooler on ice	As soon as possible
SOIL	Hydrometer Analysis	N/A	ASTM D7928/L-11	16 oz., combined[2]	One Amber Glass Teflon Lined	Cool, ≤ 6ºC	immediate	Cool, ≤ 6ºC	In a cooler on ice	180 days to analysis
SOIL	Atterberg Limits	N/A	ASTM D4318/L-9	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
SOIL	CU Triaxial with Pore Pressure	N/A	ASTM D4767/L-10	16 oz., combined[2]	One Amber Glass Teflon Lined	Cool, ≤ 6ºC	immediate	Cool, ≤ 6ºC	In a cooler on ice	180 days to analysis
SOIL	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

Notes:
[1]Total Project List metals, PCB Homologs, 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

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	4	1	1/1	1	None	0	TBD
SED	Total Project List Metals	Low/Medium/High	SW-846 6020/L-2	130	7	7/7	10	None	0	TBD
SED	Total Mercury	Low/Medium/High	EPA 7474/7471/L-3	129	7	7/7	10	None	0	TBD
SED	XRF Copper	Low/Medium/High	SW-846 6200/S-8	130	7	NA	None	None	0	TBD
SOIL	Water Content	N/A	ASTM 2216/L-7	4	NA	NA	None	None	0	TBD
SOIL	Soil Classification (USCS)	N/A	ASTM D2487	6	NA	NA	None	None	0	TBD
SOIL	Sieve Analysis	N/A	ASTM D6913	6	NA	NA	None	None	0	TBD
SOIL	Hydrometer Analysis	N/A	ASTM D7928/L-11	6	NA	NA	None	None	0	TBD
SOIL	Atterberg Limits	N/A	ASTM D4318/L-9	4	NA	NA	None	None	0	TBD
SOIL	CU Triaxial	N/A	ASTM D4767/L-10	2	NA	NA	None	None	0	TBD

Notes:
[1]Specify the appropriate reference letter or number from the Analytical SOP References table (Worksheet_#23)
[2]Parameters for analysis include: PCBs, RCRA Metals, and Mercury

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	Wood	Sediment sampling	N	None
S-2	SOP No. S-2, Calibration of Field Instruments for Water Quality Parameters.	Wood	Water quality parameter meter, turbidity meter	N	None
S-3	SOP No. S-3, Decontamination of Field Equipment	Wood	Liquinox, alconox, deionized water, scrub brushes, wash basins, aluminum foil, polyethylene sheeting	N	None
S-4	SOP No. S-4, Sample Chain of Custody Procedure	Wood	Chains of custody, custody seals, sample labels	N	None
S-5	SOP No. S-5, Field Sample Tracking System	Wood	Computer and field records	N	None
S-6	SOP No. S-6, Sample Packaging and Shipment	Wood	Coolers, plastic bags, packing tape, strapping tape, bubble wrap, ice, chains of custody	N	None
S-7	SOP No. S-7, Use of Field Logbooks	Wood	Field Logbooks	N	None
S-8	SOP No. S-8, XRF Analysis	Wood	XRF	N	None
S-9	SOP No. S-9, Geotechnical Drilling Sampling Logging etc. 2019	Wood	Geotechnical	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-2

Notes:
[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	Definitive	Organics	Gas Chromatograph/Mass Spectrometer (GC/MS)	ELLE, LLC.	N
L-2	ICPMS Metals	Definitive	Inorganics	ICP-MS	ELLE, LLC.	N
L-3	Mercury	Definitive	Inorganics	Cold Vapor Atomic Fluorescence (CVAF)	ELLE, LLC.	N
L-4	Bottle Orders	Definitive	All	LIMS	ELLE, LLC.	N
L-5	Sample Login	Definitive	All	LIMS	ELLE, LLC.	N
L-6	Data Packages	Definitive	All	LIMS	ELLE, LLC.	N
L-7	D2216 Moisture Content	Definitive	Inorganics	Gravimetric	GeoTechnics	N
L-8	USCS Classification	Definitive	Inorganics	NA	GeoTechnics	N
L-9	D4318-17 Atterberg Limits	Definitive	Inorganics	Na	GeoTechnics	N
L-10	D4767 Consolidated Undrained Triaxial Compression Test	Definitive	Inorganics	NA	GeoTechnics	N
L-11	D7298 Hydrometer	Definitive	Inorganics	NA	GeoTechnics	N

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		
	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		
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-2

Worksheet #24 Analytical Instrument Calibration Table

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference[1]
	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-2
	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 7470/7471	6 points plus a calibration blank.	Daily or per batch prior to sample analysis.	≥0.995.	Correct problem and repeat calibration.	Analyst	L-3
	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		

Notes:
[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	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
	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							

[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	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
	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							
CVAF (7470/7471)	Replace tubing, inspect sample introduction system	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-3
XRF (6200)	XRF Tube Energy Check	Daily prior to calibration verification	Acceptance limits specified by the Manufacturer	Daily, prior to analysis	Manufacturer established Pass/Fail	Replace battery, re-test. If continued failure, send to manufacturer for recalibration.	Analyst	S-8

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]
	Instrument Blank	Daily prior to sample analysis, then after every 20 samples analyzed.	Sensitivity and background check	Daily prior to analysis and after every 20 samples analyzed	< RL	Clean instrument probe and re-test.	Analyst	
	Calibration Verification	Daily prior to sample analysis, then after every 20 samples analyzed.	Instrument calibration.	Daily prior to analysis and after every 20 samples analyzed.	20% difference of certified standard value	Recalibrate	Analyst	
	Method Blank	Daily prior to sample analysis, then after every 20 samples analyzed.	Sensitivity and background check	Daily prior to analysis and after every 20 samples prepared	< RL	Re-prep and reanalyze samples.	Analyst	

Notes:
[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): Wood
Sample Packaging (Personnel/Organization): FOL / Wood
Coordination of Shipment (Personnel/Organization): FOL / Wood
Type of Shipment/Carrier: Samples/EnviroSytems Courier or Fed Ex/UPS
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): Various / ELLE, LLC.
Sample Custody and Storage (Personnel/Organization): Various / ELLE, LLC.
Sample Preparation (Personnel/Organization): Various / ELLE, LLC.
Sample Determinative Analysis (Personnel/Organization): Various / ELLE, LLC.
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 / ELLE, LLC.
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 Wood Lead Chemist or Wood 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	Project List Metals (Low/Medium/High Level), SW-846 6020A, Sediment
28-3	Total Mercury (Low/Medium/High Level), EPA 7471/7474, Sediment
28-4	XRF Copper (Low/Medium/High Level), SW-846 6200, Sediment

Worksheet #28-1 QC Samples Table

Matrix:	Sediment	**Sampling SOP:**	S-1	**Field Sampling Organization:**	Wood
Analytical Group:	PCB Homologs	**Analytical Method/ SOP Reference:**	EPA 680 modified / L-1	**Analytical Organization:**	ELLE, LLC.
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:**	Wood
Analytical Group:	PCB Homologs	**Analytical Method/ SOP Reference:**	EPA 680 modified / L-1	**Analytical Organization:**	ELLE, LLC.
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:**		Wood
Analytical Group:	Project List Metals	**Analytical Method/ SOP Reference:**	SW-846 6020A / L-2	**Analytical Organization:**		ELLE, LLC.
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 #28-2 QC Samples Table

Matrix:	Sediment	**Sampling SOP:**	S-1	**Field Sampling Organization:**	Wood
Analytical Group:	Project List Metals	**Analytical Method/ SOP Reference:**	SW-846 6020A / L-2	**Analytical Organization:**	ELLE, LLC.
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 #28-3 QC Samples Table

Matrix:	Sediment	**Sampling SOP:**	S-1	**Field Sampling Organization:**	Wood
Analytical Group:	Total Mercury	**Analytical Method/ SOP Reference:**	SW-846 7470/7471 / L-3	**Analytical Organization:**	ELLE, LLC.
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 #28-3 QC Samples Table

Matrix:	Sediment	**Sampling SOP:**	S-1	**Field Sampling Organization:**	Wood
Analytical Group:	Total Mercury	**Analytical Method/ SOP Reference:**	SW-846 7470/7471 / L-3	**Analytical Organization:**	ELLE, LLC.
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 #28-4 QC Samples Table

Matrix:	Sediment	**Sampling SOP:**	S-1	**Field Sampling Organization:**	Wood
Analytical Group:	XRF Copper	**Analytical Method/ SOP Reference:**	SW-846 6200 / S-8	**Analytical Organization:**	Wood
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
Energy Cal	Daily prior to sample analysis.	Manufacturer Specs. Pass/Fail	Replace battery and repeat calibration.	Analyst	Accuracy/Bias and Precision	Pass/Fail
Instrument Blank	Daily prior to sample analyses and after every 20 samples analyzed.	< RL	Clean instrument and re-analyze.	Analyst	Accuracy/Bias - Contamination	< RL
CCV	Daily prior to sample analyses and after every 20 samples analyzed.	20% difference compared to certified values.	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 20 samples are reanalyzed.	Analyst and Data Validator	Accuracy/Bias and Precision	20% difference from certified values.
Method Blank	One per preparation batch of 20 samples	< 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.
Field Duplicate	One per 20	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 #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	PCB Homologs (EPA 680 Modified)	All	See FS Work Plan/FSP and task work plans	See Worksheet #23	21 Calendar Days	Eurofins Lancaster Laboratories Environmental, LLC.,Lancaster, PA 17601 Tel. 717-656-2300 kayhower@eurofinsus.com	
SD	Project List Metals (SW-846 6020A)	All	See FS Work Plan/FSP and task work plans	See Worksheet #23	21 Calendar Days	Eurofins Lancaster Laboratories Environmental, LLC.,Lancaster, PA 17601 Tel. 717-656-2300 kayhower@eurofinsus.com	
SD	Total Mercury (SW-846 7471/7470)	All	See FS Work Plan/FSP and task work plans	See Worksheet #23	21 Calendar Days	Eurofins Lancaster Laboratories Environmental, LLC.,Lancaster, PA 17601 Tel. 717-656-2300 kayhower@eurofinsus.com	
SL	Soil Classification (USCS), ASTM D2487	All	See FS Work Plan/FSP and task work plans	See Worksheet #23	21 Calendar Days	GeoTechnics East Pittsburgh, PA 15112 Tel. 412-823-7600 nmelaro@geotechnics.net	
SL	Sieve Analysis, ASTM D6913	All	See FS Work Plan/FSP and task work plans	See Worksheet #23	21 Calendar Days	GeoTechnics East Pittsburgh, PA 15112 Tel. 412-823-7600 nmelaro@geotechnics.net	

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
SL	Hydrometer Analysis, ASTM D7928	All	See FS Work Plan/FSP and task work plans	See Worksheet #23	21 Calendar Days	GeoTechnics East Pittsburgh, PA 15112 Tel. 412-823-7600 nmelaro@geotechnics.net	
SL	Multi-point Atterberg Limits, ASTM D4318	All	See FS Work Plan/FSP and task work plans	See Worksheet #23	21 Calendar Days	GeoTechnics East Pittsburgh, PA 15112 Tel. 412-823-7600 nmelaro@geotechnics.net	
SL	Moisture Content, ASTM D2216	All	See FS Work Plan/FSP and task work plans	See Worksheet #23	21 Calendar Days	GeoTechnics East Pittsburgh, PA 15112 Tel. 412-823-7600 nmelaro@geotechnics.net	
SL	CU Triaxial with Pore Pressure, ASTM D4767	All	See FS Work Plan/FSP and task work plans	See Worksheet #23	21 Calendar Days	GeoTechnics East Pittsburgh, PA 15112 Tel. 412-823-7600 nmelaro@geotechnics.net	

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	Wood	Jason Raimondi, Sediment Remediation Specialist Wood	Amberlee Clark, FOL Wood	Jason Raimondi, Sediment Remediation Specialist Wood	Rod Pendleton, PM Wood
Field Sampling Technical Systems Audit	At startup sampling	Internal	Wood	Jason Raimondi, Sediment Remediation Specialist Wood	Amberlee Clark, FOL Wood	Jason Raimondi, Sediment Remediation Specialist Wood	Rod Pendleton, PM Wood
Field Sampling Technical Systems Audit	At startup sampling	External	CENAE	James Kelly, Technical Lead Engineer, CENAE	Amberlee Clark, FOL Wood	Jason Raimondi, Sediment Remediation Specialist Wood	Rod Pendleton, PM Wood
Laboratory Performance	Upon receipt of initial analytical data	Internal	Wood	Wolfgang Calicchio, Project Chemist Wood	ELLE, Laboratory Manager EnviroSytems, Inc.	Dorothy Love, QA Manager, ELLE	Anne Bernhardt, QA Manager Wood
Management Review	Interim Management Review following site mobilization. Final management review upon completion of field work.	Internal	Wood	Rod Pendleton, PM Wood	Jason Raimondi, Sediment Remediation Specialist Wood Brad Wolfe Investigation Technical Lead Wood	Rod Pendleton, PM Wood	Jeffrey Pickett, Program Manager Wood
Field Health and Safety Systems Audit (if required)	Initially at startup	Internal	Wood	Jason Raimondi, Sediment Remediation Specialist Wood	Amberlee Clark, Field Operation Lead Wood	Rod Pendleton, PM Wood	TBD, Health and Safety Wood

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	Brad Wolfe, Investigation Team Lead Wood	72 hours after audit	Memorandum	Rod Pendleton, PM Wood	48 hours after notification
Field Sampling Technical Systems Audit	Memorandum	Amberlee Clark, Wood	Verbal within 24 hrs to CENAE	Memorandum	Rod Pendleton, PM Wood	48 hours after notification
Laboratory Performance	Written Audit Report	Wolf Calicchio, Wood	One week after audit	Corrective Action Report	Catie Sasso, QA Manager Wood	48 hours after notification
Management Review	Memorandum	Jeffrey Pickett, Program Manager Wood	One week after audit	Memorandum	Jeffrey Pickett, Program Manager Wood	48 hours after notification
Field Health and Safety Systems Audit (if required)	Memorandum	Rod Pendleton, PM Wood	Verbal within 24 hrs to CENAE	Memorandum	Jeff Tweeddale, Health and Safety, Wood	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	Amberlee Clark, Field Operation Lead, Wood	Rod Pendleton, PM Wood
Verbal or Written Status Report	As necessary	As necessary	Rod Pendleton, PM Wood	Erika Mark, CENAE PM
Corrective Action Report	As necessary	As necessary	Wolf Calicchio, Project Chemist, Wood	Rod Pendleton, PM Wood
Field Sampling Technical Systems Audit Report	One at startup of sampling	Within 2-3 days of audit	Amberlee Clark, Field Operation Lead Wood	Rod Pendleton, PM Wood
Data Usability Assessment	One after all data generated and validated	TBD	Wolfgang Calicchio, Project Chemist, Wood	Rod Pendleton, PM Wood
Final Project Report	One after Tidal Flats - Feasibility Study completed	TBD	Brad Wolfe, Project Geologist, Wood	Erika Mark, 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	Amberlee Clark, Field Operation Lead Wood
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	Amberlee Clark, Field Operation Lead Wood
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 Wood
Laboratory Data Packages*	All laboratory data packages will be verified internally by the laboratory performing the work for completeness prior to submittal.	Internal	Dorothy Love, QA Director, ELLE, LLC.
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 Wood
Data Validation	All lab data reports will be technically reviewed for accuracy and completeness. Data validation is completed as specified in this QAPP.	Internal	Wolf Calicchio, Project Chemist, Wood
Data Validation Reports	All data validation reports will be reviewed for completeness and technical content.	Internal	Wolf Calicchio, Project Chemist, Wood

*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.	Amberlee Clark, Field Operation Lead Wood; Project Geologist, Brad Wolfe, Wood
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.	Wolf Calicchio, Project Chemist, Wood
IIb	Documentation of QAPP QC Sample Results	Establish that all QAPP required QC samples were collected and analyzed.	Project Geologist, Brad Wolfe, Wood; Wolf Calicchio, Project Chemist, Wood
IIb	Project Quantitation Limits	Determine that the project quantitation limits, outlined in the QAPP, were achieved.	Wolf Calicchio, Project Chemist, Wood
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).	Wolf Calicchio, Project Chemist, Wood
IIb	Validation Report	Summarize data verification and validation components included in the Performance Review. Include final, qualified data and explanation of all qualifiers.	Wolf Calicchio, Project Chemist, Wood

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	Wolf Calicchio, Project Chemist, Wood

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 Addendum 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. 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.

Worksheet #37 Usability Assessment

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:

$$\%R = \frac{(Amount\ in\ Spiked\ Sample - Amount\ in\ Sample)}{Known\ Amount\ Added} x\,100$$

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

$$\%R = \frac{Experiment\ al\ Concentrat\ ion}{Known\ \ Amount\ \ Added} x\,100$$

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 Wood by the laboratories. Wood 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:

$$Completene\ ss = \frac{(number\ of\ valid\ measuremen\ ts)}{(number\ of\ measuremen\ ts\ planned\ )} x\,100$$

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. 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 Wood PM, in conjunction with

Worksheet #37 Usability Assessment

the Wood 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 Wood PM, in conjunction with the Wood 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) and the CENAE representative 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 instrument operation and calibration records, sample collection, preservation, handling, and packaging procedures,

Worksheet #37 Usability Assessment

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 Wood PM, who will be responsible for ensuring that corrective measures are implemented.

Fixed Laboratory TSAs

Prior to the start of the sampling program, the Wood QA Officer will host a kick-off meeting with the Lab Manager from ELLE 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 Wood QA Officer will obtain at least one audit report for ELLE 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 Wood QA Officer or by a designated qualified individual under the direction of the Wood 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

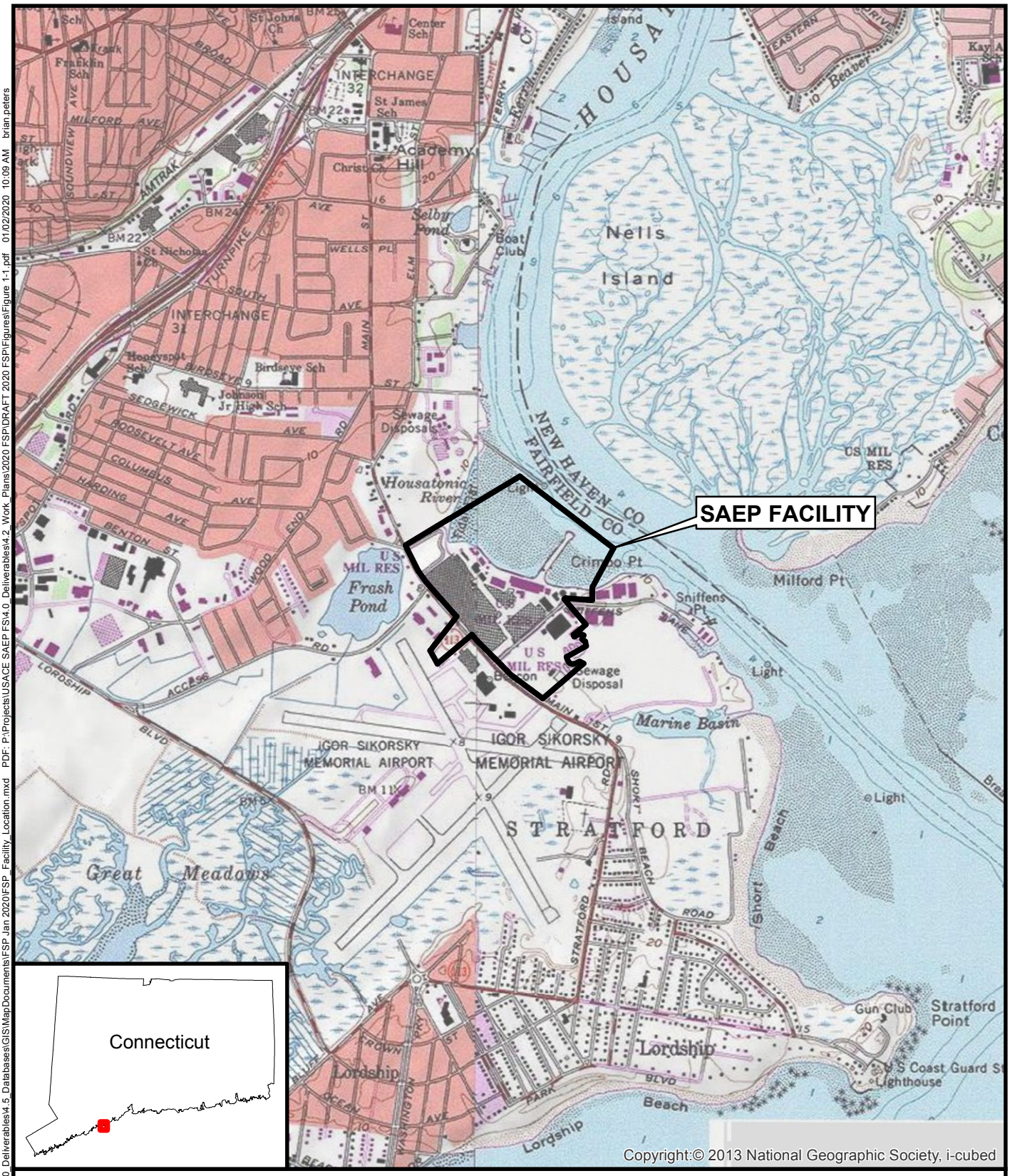
A review of the complete Data Validation Report will be conducted by the Wood QA Officer. This review will include a review of the reported data validation actions and observations, and a review of the Data Validation Report to ensure that all required components are present. This review will also ensure 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

Wood, 2020a. Final Field Sampling Plan, Stratford Army Engine Plant, Stratford, Connecticut. January 2020.

Wood, 2020b. Site-Specific Safety and Health Plan, Stratford Army Engine Plant, Stratford, Connecticut. January 2020.

FIGURES



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0 1,000 2,000 Feet

Prepared/Date: BRP 01/02/20 | Checked/Date: BW 01/02/20

Figure 1-1
Facility Location

Draft Field Sampling Plan
Stratford Army Engine Plant
Stratford, Connecticut

Document: P:\Projects\USACE SAEP FSI\4.0_Deliverables\4.5_Databases\GIS\MapDocuments\FSP Jan 2020\FSP_Facility_Location.mxd PDF: P:\Projects\USACE SAEP FSI\4.0_Deliverables\4.2_Work_Plans\2020 FSP\DRAFT 2020 FSP\Figures\Figure 1-1.pdf 01/02/2020 10:09 AM brian.peters

APPENDICES

APPENDIX A

FIELD SAMPLING SOPS

S-1 Sediment Sampling
S-2 Calibration of Field Instruments for Water Quality Parameters
S-3 Decontamination of Field Equipment
S-4 Sample Chain of Custody Procedure
S-5 Field Sample Tracking System
S-6 Sample Packaging and Shipment
S-7 Use of Field Logbooks
S-8 XRF Analysis
S-9 Geotechnical Drilling, Sampling, and Logging

SOP No. S-1

Wood Environment & Infrastructure Solutions, 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 Wood, 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 a Wood 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, Wood 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-3. 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 85 percent.

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 85%. If recovery is less than 85%, the core will be rejected and another core attempted. A maximum of three cores will be attempted at any one location.

Identifying Sample Intervals. Measurements at time of core collection aboard the vessel do not consider rodding or plugging of uniform material. Multiple cores from similar locations will be opened and laid side by side. Taking percent recovery into consideration, like grain sizes, horizons and rodding or plugging will be identified. In order to improve precision of the estimated interval, depth increment intervals may be adjusted after review of multiple cores side by side. Any adjustments will be noted on the core log.

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)
- Place core aside for multiple core comparison and adjustment of identified intervals.
- For analytical samples, after identifying intervals, 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-3, Decontamination of Field Equipment.

REFERENCES

Wood, 2020. Field Sampling Plan; Stratford Army Engine Plant Feasibility Study For Sediments in Tidal Flats and Outfall 008 Addendum – Stratford, Connecticut. January 2020.

Wood, 2020. Quality Assurance Project Plan; Stratford Army Engine Plant Feasibility Study For Sediments in Tidal Flats and Outfall 008 Addendum – Stratford, Connecticut. January 2020.

- END OF PROCEDURE -

SOP No. S-2

Wood Environment & Infrastructure Solutions, 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.
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

Wood Environment and Infrastructure Solutions, Inc. (Wood) employees will be on site when implementing this SOP. Therefore, Wood personnel shall follow the site-specific Health & Safety Plan (HASP). Wood 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, Wood 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.

pH (electrometric)

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.

Specific Conductance 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.

Oxidation-Reduction Potential 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 (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

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-3

Wood Environment & Infrastructure Solutions, 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 cloth 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-4

Wood Environment & Infrastructures Solutions, 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) SAEP 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. 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.

SOP No. S-5

Wood Environment & Infrastructure Solutions, 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 Wood 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 dependent 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.

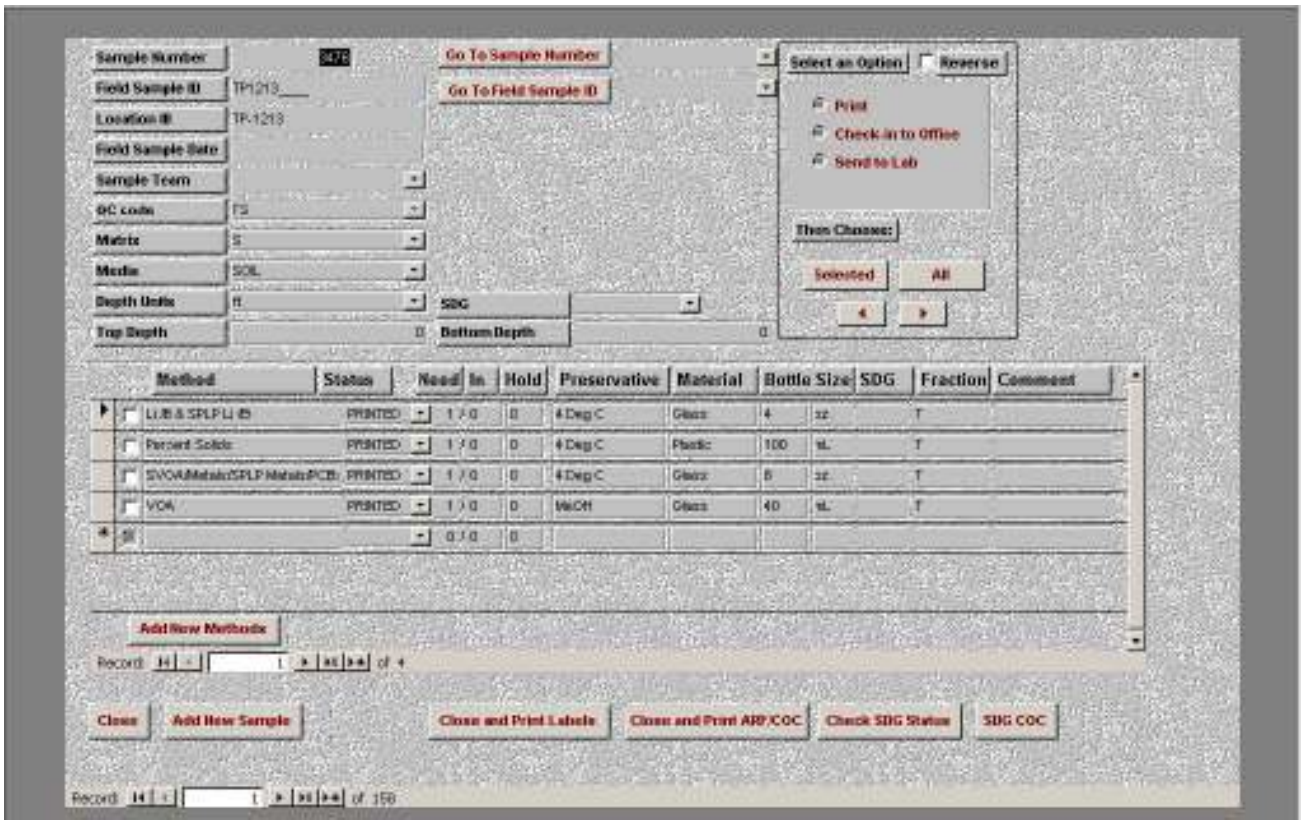
When you have finished identifying all of the methods that need to be shipped to a lab, press the Close and Print ARF/COC Button.

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




Select All
Deselect All
Select Matrix
Analysis_Method
Matrix
of Bottles
Preservative
Bottle Matrix
Bottle Size
Add Methods
Cancel

Figure 2

Figure 3

Figure 3 Computer Generated Chain Of Custody

Eastland Wollen Mill Superfund Site

Site QAPP
Corinna Maine

Lab:

Sample #	*Sample Date*	*Sample Time*	*Field Sample ID*	*Qty Total*	*Qty Each*	*Bottle Size and Material*		*Preservative*	*Media*	*Method*	*Fraction*
2501	8/21/2003	10:00	GW0710	5							
					2	1 L	Amber G	4 Deg C	GW	SVOA/PAH-SIM	T
					3	40 mL	Glass	HCL, 4 Deg C	GW	VOA	T
2511	9/15/2003	9:00	GW0904	6							
					2	1 L	Amber G	4 Deg C	GW	SVOA/PAH-SIM	T
					1	500 mL	Plastic	Sulfuric Acid p	GW	Hydrazine	T
					3	40 mL	Glass	HCL, 4 Deg C	GW	VOA	T

SDG Number: CT003 *Start Date:* __/__/____ *End Date:* __/__/____

*Relinquished:*_____ *Date:* __/__/____ *Time:*____ *Received:*_____ *Date:* __/__/____ *Time:*____

*Relinquished:*_____ *Date:* __/__/____ *Time:*____ *Received:*_____ *Date:* __/__/____ *Time:*____

SOP No. S-6

Wood Environment & Infrastructure Solutions, 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 hours 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-8. 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

Wood Environment & Infrastructure Solutions Inc., Standard Operating Procedure for Chain of Custody S-8 Code of Federal Regulations 40 CFR Part 261.4(d) Samples. Dangerous Goods Regulations, IATA, Most-Current Version.

SOP No. S-7

Wood Environment & Infrastructure Solutions, 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 (Stratford Army Engine Plant) and address (550 South Main Street, Stratford, CT 04497)
- 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. Site Logbook 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.

S-8

Wood Environment & Infrastructure Solutions, Inc.
STANDARD OPERATING PROCEDURE

ELEMENTAL ANALYSIS USING THE INNOV-X SYSTEMS FIELD X-RAY FLUORESCENCE ANALYZER (XRF)

STRATFORD ARMY ENGINE PLANT
TIDAL FLATS FEASIBILITY STUDY

Prepared by: _____ Date: _____
Wolfgang Calicchio, Senior 2 Environmental Scientist

Reviewed by: _____ Date: _____

Approved by: _____ Date: _____
, Project Manager

Table of Contents

Section Number and Title

1.0 Scope and Application

This Standard Operating Procedure (SOP) describes the procedures used to analyze soil samples for metals using the INNOV-X Systems Alpha 4000 portable X-ray Fluorescence (XRF) analyzer. This SOP should be used in conjunction with the INNOV-X Systems XRF Manual.

EPA method 6200 will be used to analyze soil and sediment samples using the XRF. A listing of elements and reporting limits of metals analyzed by the XRF is presented in Table 1 of this SOP. The following documents were used to prepare this SOP for elemental analysis at Sites:

- USEPA Method 6200. Field Portable X-ray Fluorescence Spectrometry for the Determination of Elemental Concentrations in Soil and Sediment. January 1998.
- Region I, EAP-New England. Standard Operating Procedure For Elemental Analysis Using the X-MET 920 Field X-ray Fluorescence Analyzer. USEPA Region I Quality Assurance Unit Staff. October 1996.
- Innov-X Systems, Inc. Metals in Soil Analysis Using Field Portable X-Ray Fluorescence. January 2003.
- Innov-X Systems, Inc. Alpha 4000 Analyzer User Manual. Innov-X Systems, Inc. Version 1.1. October 2002.

Sediment samples collected will be analyzed on-site by XRF for copper content to determine a correlation with mercury content reported by off-site laboratory analysis. The XRF analyzed samples will be run both unprocessed and processed as described in this SOP. The results of the unprocessed and processed copper analyses will be compared to determine a correlation and evaluate potential use in support of removal activities.

2.0 Method Summary

2.1 Principles of Operation

XRF is a nondestructive qualitative and quantitative analytical technique used to determine the chemical composition of metals in a sample. In an XRF analysis, primary X-rays emitted from an X-ray tube or a sealed radioisotope source are utilized to irradiate a sample. The primary X-rays incident on the sample cause the elements present in the sample to emit (that is, fluoresce) their characteristic X-ray line spectra. The elements may be identified by the energies of the wavelengths of their spectral lines. The unit of energy of an X-ray is the kiloelectron volt (keV). The X-

ray energy is proportional to the frequency of the X-ray waves and is inversely proportional to the wavelength. Since it is a fluorescent process, the energy of the fluorescent X-rays will always be of lower energy than the primary X-ray energy. In addition to the fluorescent X-rays, there will be a backscattering of the primary X-rays. Energies of the fluorescent and scattered X-rays are converted (within the detector) into a train of electric pulses, the amplitudes of which are linearly proportional to the energy. An electronic multichannel analyzer measures the pulse amplitudes which is the basis of qualitative X-ray analysis. The number of counts at a given energy per unit of time is representative of the element concentration in a sample and is the basis for quantitative analysis.

2.2 Sample Preparation and Analysis Summary

For quantitative analysis of soil; sticks, stones, and other matter that is non-representative of the sample are removed, and the sample is thoroughly homogenized. There are three accepted methods of sample analysis:

1. In-situ direct: a sample reading is taken directly from the sample location
2. Ex-situ unprepared: a sample is collected into a plastic bag, non-representative material is removed (sticks, stones, non-soil material, etc.) and a reading is taken using the bag as a sample container
3. Ex-situ prepared: a sample is collected into a plastic bag or glass soil jar, non-representative material is removed (sticks, stones, non-soil material, etc.), an aliquot of the collected sample is then prepared as described below, and a reading is done on the prepared sample.

The sample is dried in an oven at 103^{o}C to 105^{o}C for 12 hours, ground up using a mortar and pestle, and sieved through a No. 60 mesh sieve. The fraction of the sample that passes the No. 60 sieve is then re-homogenized and transferred into the XRF sample cup.

The sample cup is capped with a clear Mylar film and the sample identification is clearly labeled prior to analysis. Refer to section 11.0 for a complete discussion of sample preparation.

For analysis, the cup is positioned on top of the XRF analyzer and exposed to primary X-rays from the selected radiation source. The sample fluorescent and backscatter X-rays are detected and the results are recorded by the data system. Qualitative determinations of the elements present in the sample are based on the locations of characteristic peaks produced by individual elements in the energy spectra. Quantitative

determination of an element present is made by comparing the intensity of a characteristic peak in the sample to a calibration curve of the same peak developed from standards of similar matrix and known concentrations.

3.0 Definitions

- ALARA – As low As Reasonably Achievable
- FPXRF - Field Portable XRF instrument
- FSP – Field Sampling Plan
- PTFE – Polytetrafluorethylene
- QA – Quality Assurance
- QC – Quality Control
- RPD – Relative Percent Difference
- RSD – Relative Standard Deviation
- SAEP – Stratford Army Engine Plant
- SD – Standard Deviation
- SOP - Standard Operating Procedure
- SRM - Standard Reference Material
- XRF – X-ray Fluorescence
- %D – Percent Difference

4.0 Health and Safety

The INNOV-X XRF analyzer uses an X-ray tube to generate ionizing radiation for sample analysis. During all measurements the sample cup must be positioned on the analyzer so that the sample cup shields the analyst from exposure to radiation. The probe must not be opened except by an authorized user. Proper training for the safe operation of the instrument and radiation training should be completed by the analyst prior to field operations. Radiation safety information for the INNOV-X XRF can be found in the operator's manual. Protective shielding should never be removed by the analyst or any personnel other than the manufacturer. The analyst should be aware of the local, state and national regulations that pertain to the use of radiation-producing equipment. Radiation safety guidelines for the instrument used the Site are presented in section 3.2 of the INNOV-X Systems Instrument User Manual – Recommended Radiation Safety Training Components. A radiation monitoring program using TLD film badges will be used at the Site. All reasonable measures, including labeling, operator training, and the concepts of time, distance, and shielding, will be implemented to limit radiation exposure to *as low as reasonably achievable* (ALARA).

5.0 Interferences and Potential Problems

5.1 Chemical Matrix Interferences

An interference occurs when the spectral peak from one element overlaps either partially or completely with the spectral peak of another. If the XRF is calibrated for both elements (CASE 1) i.e. the one causing the interference and the one being interfered with, it is generally capable of correctly handling the interference. In this case, the element being interfered with may be measured with a poorer detection limit or poorer precision, but the analytical results should still be acceptable for field-portable XRF. If the XRF is not calibrated for the element causing the interference (CASE 2), then the XRF may report the presence of elements not in the sample, or greatly elevated concentrations of elements in or not in the sample.

- Example CASE 1: Lead and arsenic. Most XRFs are calibrated for lead and arsenic. Lead interferes with arsenic (not vice-versa though). The net effect is a higher detection limit for arsenic, and poorer precision. The XRF handles the correction automatically, but the precision is affected. The loss of precision is also reported by the XRF. (Please refer to Innov-X Applications Sheet: *In-field Analysis of Lead and Arsenic in Soil Using Portable XRF* for more detail).

- Example CASE 2: Bromine in the sample, but XRF is not calibrated for bromine. Bromine, as a fire retardant, is being seen more and more in soil and other sample types. For this reason, Innov-X analyzers include Br in the calibration data. If Br is not calibrated, but is present in the sample, the analyzer will report highly elevated levels of Pb, Hg and As. The levels will depend upon the concentration of Br in the sample.

Interferences between elements can be broadly categorized into a) Z, Z-1, Z+1 interferences, and b) K/L interferences. Interference type “a” occurs when high levels of an element of atomic number Z are present. This can cause elevated levels of elements with atomic number Z-1 or Z+1. Generally, portable XRFs have good correction methods, so this interference only causes problems with very high levels of the element in question. Example: High concentrations of Fe (Z=26) in excess of 10% may cause elevated levels of Mn or Co (Z=25 or Z=27 respectively). The type “b” interference occurs when the L-shell line of one element overlaps with the K-shell spectral line of another element. The most common example is the lead/arsenic interference where the L-alpha line of lead is in nearly the exact same location as the K-alpha line of arsenic.

5.2 Moisture Content

Sample moisture content will affect the accuracy of the sample results. The measurement error may be minor when the moisture content is small (5 to 20 %), or it may be significant when measuring the surface of soils that are saturated with water. For quantitative analysis, moisture content will not be an issue because all samples are dried as part of the sample preparation.

6.0 Personnel Qualifications

Sample analysis will be performed by an authorized user experienced in the operation of the XRF analyzer and knowledgeable in X-ray fluorescence. The analyst must be thoroughly familiar with this SOP and the Innov-X Systems XRF Reference Manual supplied by the instrument manufacturer.

7.0 Equipment and Supplies

7.1 Innov-X Systems Alpha 4000 instrument and accessories

- Alpha 4000 Analyzer with iPAQ attached.
- (2) lithium ion batteries.
- Batter charger and AC adaptor.
- Standardization cap.
- iPAQ cradle and AC adapter.

7.2 Computer

- Excel program for recording data in spreadsheet format.

7.3 Supplies

- Ziploc, quart sized plastic bags for sample collection
- 2 oz glass soil jars for offsite split samples (QC clean quality)
- Oven – for drying sediment and soil samples.
- Sieve – No. 60 (250 µm) stainless steel.
- Polyethylene XRF sample cups – purchased from SPEX Sample Prep, LLC. Cat# 3529 (x-ray cell with snap ring, 31mm).
- Mylar film for sample containment, 2.5 or 6.0µm thick.
- Stainless steel spatulas.
- Mortar and pestle (ceramic or glass).
- Aluminum drying pans.
- Gloves.
- Safety glasses.
- Portable hood.
- Run log book (to record sample analyses).
- NIST SRM – For instrument calibration checks (SRM 2702, SRM 2709a, SRM 2710a, and SRM 2781).
- Polytetrafluorethylene (PTFE) block
- Quartz block
- Instrument Blank standard provided by Innov-X Systems.
- Silicon dioxide (SiO_2) 99.995% clean – for method blank analysis.

8.0 Calibration and Operation

Procedures for calibration and operation of the Alpha 4000 Analyzer are taken from EPA Method 6200 and updated to be specific to the Innov-X analyzer.

The XRF instrument will be calibrated at the factory prior to delivery at the Site. The Alpha 4000 Analyzer will be calibrated by Innov-X Systems Inc. using the Compton Normalization method consisting of the analysis of a single, well characterized standard, such as an SRM or SSCS. The standard data are normalized to the Compton peak. The Compton peak is produced from incoherent backscattering of X-ray radiation from the excitation source and is present in the spectrum of every sample. The matrix affects the way in which source radiation is scattered off the samples. This scatter is directly related to the intensity of the Compton peak. For that reason, normalizing to the Compton peak can reduce problems with matrix effects that vary among samples. Compton normalization is similar to the use of internal standards in analysis for organic analytes.

Operation of the Alpha 4000 Analyzer at the Site will performed as described in the Innov-X Systems User Manual Version 1.1, October 2002.

9.0 Quality Assurance and Quality Control

The following section details proper quality assurance is detailed for analysis of sediment and soil samples using the XRF analyzer. All operators will perform QA/QC procedures as described in this SOP. Procedures are listed below:

9.1 Proper Verification of Instrument Operation

The following procedures were taken from USEPA Method 6200 and updated to be specific to the Innov-X analyzer. Quality assurance here consists of testing known standards to verify calibration, as well as testing blank standards to determine limits of detection and to check for sample cross contamination or instrument contamination.

Components of instrument QC:

1. ENERGY CALIBRATION: An energy calibration check sample will be analyzed at the beginning of each day. The Innov-X analyzer performs this automatically; this is the purpose of the standardization check when the analyzer is started. The software does not allow the analyzer to be used if the standardization is not completed. The energy calibration check is performed by placing the snap on metal clip on the front of the analyzer and selecting standardize on the analysis screen. If the energy calibration fails, the analyst will shut down the instrument, replace the battery with a

fully charged back up, and restart the instrument. An energy calibration will be performed after restarting the XRF.

2. INSTRUMENT BLANK: An instrument blank will be analyzed at the beginning of each day, and for every 20 environmental samples. The operator should use the PTFE block provided with the analyzer. The purpose of this test is to verify there is no contamination on the analyzer window or other component that is “seen” by the x-rays. Method 6200 recommends an instrument blank at least once per day, preferably every 20 samples. For either in-situ or prepared-sample testing, the operator should test the PTFE block to be sure there are no reported contaminant metals. If target analytes are reported in the instrument blank, all contact surfaces of the instrument will be wiped down with a soft cloth to remove any contamination on the detector window (the instrument blank should also be wiped down to ensure it has not been contaminated, or a different instrument blank may be used, such as quartz block). If the instrument continues to detect target analytes in the instrument blank, the Kapton® window covering the detector should be replaced.

3. METHOD BLANK: A method blank will be analyzed daily or for every batch of 20 prepared samples. The purpose of the method blank is to verify that cross-contamination is not introduced into samples during the sample preparation process. A method blank will be prepared with each batch of 20 samples (Method 6200 recommends following the sample preparation procedures with clean SiO2 once every 20 prepared samples). If target analytes are detected in the method blank, all sample prep equipment should be thoroughly cleaned and all samples prepped under that blank should be evaluated. An action limit of five times the reported blank concentration will be established. Any sample results greater than the action limit will be accepted. Sample results below the action limit will require re-prepping and re-analyzing the affected samples after the preparation equipment have been thoroughly cleaned.

4. CALIBRATION VERIFICATION: A calibration verification check (NIST SRM check standard) will be analyzed at the beginning of each day, after 20 samples have been analyzed, or every 4 hours, whichever is more frequent. A calibration verification standard should be selected with target analyte concentrations less than, at/near, and greater than the project action limit. Each calibration verification standard should be monitored, in turn, throughout the field program, this will provide a check on instrument performance overall. The operator will perform a 2-minute test on a NIST standard. The percent difference (%D) between the FPXRF result for an element and the value of the standard should be +/- 20 percent of the certified value. If the calibration check is greater than 20% of the standard value, the operator will adjust the calibration factor of the instrument and

reanalyze the standard (see instrument manual for re-adjustment of calibration factors).

5. LABORATORY DUPLICATE: A laboratory duplicate sample will be analyzed daily. The laboratory duplicate is prepared and analyzed in duplicate with the original sample. The project control limit for the laboratory duplicate relative percent difference (RPD) between the original sample and lab duplicate sample is 50, when positive results for both samples are ≥ 5 times the quantitation limit. If the laboratory duplicate RPD exceeds the 50, sample preparation techniques (specifically homogenization prior to collection of the raw sample aliquot for drying) will be evaluated and improved, if necessary.

6. PRECISION MEASUREMENTS: The precision of the method is monitored by analyzing samples with target analyte concentrations less than, at or near, and greater than the project action limit. During the beginning phase of the program, after sufficient samples have been collected and analyzed for appropriate selections, one sample from each category will be analyzed in replicate seven times. Statistical analysis of the replicate samples, at each concentration category, will be performed. Statistical analysis includes calculation of the percent relative standard deviation (RSD), the standard deviation (SD), and the mean concentration. For the FPXRF data to be considered precise, the RSD for target analytes should be less than or equal to 20.

10.0 Sample Collection, Preservation and Storage

Soil and sediment samples will be collected in press seal plastic bags (Ziploc® or equivalent). Initial homogenization of the sample and removal of non-representative material should take place at the time of sampling. To maintain sample integrity, documentation of all sample locations, dates, times, depth, and associated field sample identification numbers will be recorded in field logbooks at the time of sample collection.

On-site sample documentation procedures are presented in the Stratford Army Engine Plant (SAEP) Tidal Flats Feasibility Study Field Sampling Plan (FSP). Samples may be stored at room temperature and have an indefinite shelf life.

11.0 Sample Preparation and Analysis

11.1 Unprepared Samples

Field samples collected in press seal bags are analyzed by balling up the representative sample and placing the bag with sample upon a hard surface (table top or ground). The probe end of the XRF is then placed in contact with sample bag and held in place during the duration of the analysis interval (60

seconds). It is important that all sticks and rocks have been removed from the sample prior to analysis.

11.2 Prepared Samples

A 10 gram (+/- 2 grams) aliquot of field samples collected in press seal bags are spread out in an aluminum drying pan, clumps are broken up with a stainless steel spatula, and the sample is oven-dried at 105ºC to 103ºC for 12 hours to remove moisture. After drying, any non-representative material (sticks, twigs, leaves, roots, insects, asphalt, rocks, etc.) are removed and the sample is transferred to a mortar and pestle and ground to a uniform consistency. The dried and ground sample is then sieved through a No. 60 (250 µm) mesh stainless steel sieve. At no time should the material be forced through the sieve. The sieved fraction is collected on a white sheet of paper. Pebbles and organic matter remaining on the sieve should be discarded. The under-sieve fraction of the material constitutes the sample. Fill one XRF sample cup approximately 3/4 full with sample. Cut and tension (wrinkle-free) a piece of Mylar film over the top of the cup and seal using the plastic securing ring. Label the sample cups appropriately. The stainless steel sieve and spoons must be wiped clean with a paper towel between sample preparations.

11.3 Sample analysis

Analysis of sample, blanks and check standards (SRMs) will be performed using the Innov-X Systems Alpha 4000 instrument and Innov-X Systems Analyzer software. Refer to section 4.0 of the instrument manual for sample analysis using the analyzer software.

11.4 Analysis Sequence

- Install battery in the XRF unit. Battery should remain charging overnight, when the instrument is not in use.
- Install the iPAQ unit on the top of the XRF. Turn on instrument. Allow instrument to warm-up for 1 hour prior to sample analysis.
- Perform the standardization procedure with the standardization clip attached to the front of the analyzer.
- Analyze the initial calibration check using the SRMs provided with the instrument. There are four SRMs (SRM 2702, SRM 2709a, SRM 2710a, and SRM 2781) that will be analyzed. Refer to Table 2 for SRM certified concentrations. The percent difference (%D) of the calibration check standard must be < ± 20% to continue with analysis. If the %D is greater then 20, the instrument will need to be re-calibrated, per manufactures specifications.
- Analyze the instrument blank (provided with the instrument). There should be no detections greater than the reporting limits.
- Analyze the Method Blank.

- Analyze 20 samples.
- Analyze a continuing calibration standard (SRM)
- Continue analysis of samples, analyzing a continuing calibration sample after every 20 samples, and a method blank with every batch of 20 samples. A laboratory duplicate sample is analyzed daily.

12.0 Documentation and Reporting Results

Sample raw results will be recorded in the field lab log book. The sample raw results will then be evaluated by the field technician for detections above the reporting limit (RL) established for the program (16 mg/kg-dry). Values less than the RL will be reported as "16U". Analysis results will also be recorded on an excel spreadsheet for loading into a database.

13.0 Example Calculations

Percent Difference (%D)

$$\frac{\text{Known result} - \text{Determined result}}{\text{Known result}} \times 100$$

Relative Percent Difference (RPD)

$$\frac{/\ \text{Original result} - \text{Duplicate result}\ /}{(\text{Original result} + \text{Duplicate result})/2} \times 100$$

Standard Deviation (SD)

$$\sqrt{\frac{R1 + R2 + R3 + R4 + R5 + R6 + R7}{7}}$$

Mean

$$\frac{R1 + R2 + R3 + R4 + R5 + R6 + R7}{7}$$

Percent Relative Standard Deviation (RSD)

(SD/Mean) * 100

14.0 References

USEPA Method 6200. Field Portable X-ray Fluorescence Spectrometry For The Determination of Elemental Concentrations in Soil and Sediment. January 1998.

Region I, EAP-New England. Standard Operating Procedure For Elemental Analysis Using the X-MET 920 Field X-ray Fluorescence Analyzer. USEPA Region I Quality Assurance Unit Staff. October 1996.

Innov-X Systems, Inc. Metals in Soil Analysis Using Field Portable X-Ray Fluorescence. January 2003.

Innov-X Systems, Inc. User Instruction Manual Alpha Series X-Ray Fluorescence Spectrometers. Innov-X Systems, Inc. Revision B, March 2003.

15.0 Attachments

TABLE 1

On-site Metals Analysis using Innov-X Systems XRF

Medium/Matrix: *Solid*
Region I Matrix Code (from EPA-NE DQO Summary Form): *SO*
Analytical Parameter: *Metals*
Concentration Level: *Low*
Field Analytical or Fixed Laboratory Method/SOP: Field Method EPA 6200 (XRF)

Contaminants of Concern Table (Reference Limit and Evaluation Table)

Analyte	CAS Number	Project Action Limit (PAL) for soil (mg/kg)	Project Quantitation Limit Derived from Off-site lab methods 6010B (mg/kg)	XRF Instrument Estimated Level of Detection (mg/kg)	Achievable off-site Laboratory Limits (mg/kg)	
					MDLs	QLs
Copper*	7740-50-8	270	10	50 [1]	1.79	4
Copper*	7740-50-8	270	10	33 [2]	1.79	4

* - Contaminant of Concern
1 – Raw sample, no preparation
2 – Dried and sieved sample

TABLE 2

Standard Reference Material Certified Concentrations

SRM	Matrix	Analyte	CAS Number	Certified Concentration (mg/kg)
2702	Marine Sediment	Copper	7740-50-8	117.7
2709a	San Joaquin Soil	Copper	7740-50-8	33.9
2710a	Montana I Soil	Copper	7740-50-8	3,420
2781	Domestic Sludge	Copper	7740-50-8	6,274

General Procedures for
Geotechnical Drilling, Sampling, Testing, Logging, etc.

Contact Information

Please contact the geotechnical engineers listed below at any time with questions during the subsurface exploration program.

1. Nick Langlais — Phone: (207) 828-3629
   E-mail: nicholas.langlais@woodplc.com
2. Rick Egan — Phone: (207) 828-3632
   E-mail: richard.egan@woodplc.com
3. Brian Johnson — Phone: (207) 828-3483
   E-mail: brian.johnson3@woodplc.com

Big Picture/Project-Specific Information

Please document/obtain the following information for each site/project:

- Drill set-up: e.g., truck-mounted, track-mounted, barge, etc.
- Drill rig type/model no.: e.g., CME-45, CME-55, Mobile B-57, etc.
- Rig SPT system: e.g., rope & cathead, auto-hammer, winch/cable, etc.
- SPT hammer type: e.g., safety hammer, self-contained (auto-hammer), donut, etc.
- Verify SPT hammer weight: = 140 lbs

Borehole-Specific Information

Please document/obtain the following information for each borehole:

- Drilling method: e.g., HSAs, rotary-wash w/driven casing (i.e., drive-and-wash), rotary-wash w/spin casing, rotary-wash w/o casing (i.e., open hole).
- For HSA drilling:
  - Note inside diameter (ID) of HSAs;
  - Note whether auger plug used during drilling; and
  - Note whether water added to augers during drilling (specific intervals).
- For rotary-wash drilling:
  - Note ID of casing;
  - Note size of drilling rods (e.g., A-rods = ~ 1.5-inch diameter; N-rods = ~ 2.5-inch diameter);
  - Note roller bit diameter;
  - Note roller bit type (e.g., tri-cone or dual cone, carbide or steel teeth, etc.);
  - Note roller bit fluid jet ports (e.g., side-jetting, bottom jetting, etc.); and

- Note drilling fluid (e.g., water, bentonite "mud", Re-vert™, other additives, etc.).

During Drilling

Please document/obtain the following information (via direct observation or via communication with the drilling foreman) during the advancement of the HSAs and/or casing/roller bit:

- A good driller will use a tape measure (at least some of the time) to confirm HSA/casing depths during drilling and to confirm that the borehole is open to the bottom of HSAs/casing during insertion of sampling equipment (SPTs, Shelby tubes, vanes, etc.). A good geotechnical inspector will do the same (at least periodically). The key is to confirm the length of the HSA head/teeth and/or the casing drive shoe or spin casing shoe (all are usually about 0.5' in length) and then keep track of the tooling in use.
    - As an example … for HSA drilling with the next planned SPT interval at 10-12' bgs, the driller should have 0.5' of auger stick up above the ground surface (= 0.5' auger head and two 5'-long augers = 10.5' of HSAs – 0.5' stickup = 10' of open hole).
    - A typical sampling/tooling configuration may then include a 2' split-spoon; 0.5' of spoon end pieces; 0.5' of spoon to rod adapters; and 10' of drilling rod = 13' of tooling.
    - If the borehole is open to 10' bgs as planned, the rods should be sticking up 3' above ground surface (or 2.5' above HSAs).
    - If this measurement is off by more than a couple inches, you should "raise a red flag" prior to conducting the SPT (or the Shelby tube or vane shear), as these scenarios may indicate one or more of the following conditions:
        - Rods too high … piping/heave of the bottom of the borehole, a common problem when drilling with HSAs in sands or soft silts/clays below the water table. This scenario may warrant the addition of potable water to the top of the augers during drilling/sampling or may necessitate a switch to rotary-wash drilling;
        - Rods too high … plugging of the HSA/inadequate cleanout of the borehole, suggesting too much down pressure relative to rotation;
        - Rods too high … inadequate flush of the casing with water (to get out the suspended sand and gravel);
        - Rods too high … inadequate time grinding on gravel/cobbles with the roller bit (rock fragments are too big at bottom of borehole to be flushed out between the rods and the casing); or
        - Rods too low … potentially too high jetting pressure used for water and/or mud to clean out the casing resulting in scouring of the hole below the casing. This could result in being off on documented sample interval by 0.5' or more, softening of the bottom of the borehole, and/or scour then cave-in.
    - All of the above scenarios will result in skewed SPT blow counts, potentially poor sample quality or recovery, and generally poor overall data quality.
- Note the presence of coarse gravel, cobbles, boulders, etc. or other debris, rubble, wood, organics, etc. (these materials may be present, but may not appear in split-spoon samples); and
- If a strata change is observed between sampling intervals (e.g., sand at 10-12' bgs and then clay at 15-17' bgs), note/estimate the transition depth based on observations of the drilling between the sample intervals and on input from the drilling foreman.

General Procedures for
Geotechnical Drilling, Sampling, Testing, Logging, etc.

Standard Penetration Testing (SPTs)

Please see below for strict procedures and information to document/obtain for each SPT:

- The HSAs and/or casing/roller bit must be advanced to the start/top of the target sampling interval (e.g., if SPTs are planned from 5-7' bgs and from 7-9' bgs, the HSAs and/or casing/roller bit must be advanced from 5' bgs to 7' bgs after the 5-7' SPT is conducted and prior to the 7-9' SPT being conducted). ASTM D 1586 does not allow "back-to-back" SPTs.
- Note size of sampling rods (e.g., A-rods = ~ 1.5-inch diameter; N-rods = ~ 2.5-inch diameter). Typically, A-rods used with HSA drilling. N-rods typically used with rotary-wash drilling. On rare occasions, we have specified that the sampling rods must be A-rods, which would likely necessitate 2 sets of rods in use for rotary-wash drilling.
- Verify outside diameter of split-spoon sampler = 2" (2" OD split-spoon, driven by 140-lb hammer, via a free-fall of 30" is the definition of a SPT). 3" OD split-spoons shall not be utilized without prior authorization from the geotechnical engineer (see Contact Information);
- Periodically check/verify functionality of the split-spoon, especially if poor recovery noted.
    - The ball valve at the top of the spoon should be free move from closed to open, enabling water to pass through during spoon penetration and then retaining water in the drill rods from pushing the recovered sample out of the spoon during extraction.
    - The plastic retaining baskets at the bottom of the spoons should be in tact and stiff.
    - Have the driller/helper correct any issues as noted.
- Record target sampling interval (e.g., 5-7', 8-10', 10-12', etc.).
- Record actual penetration (e.g., 2.0', 1.8', 0.4', etc.). Target = 2.0', assuming typical 2.0' long split-spoon sampler in use.
- Record "blows counts" for each 6-inch increment of split-spoon penetration. Note that practical refusal to further penetration of split-spoon is defined as >60 blows for a 1-inch increment or bouncing refusal for this project.
- Record recovery to the nearest 0.1' (minus any "slop" at top of spoon).
- For fine-grained soils, use hand-held torvane and/or pocket penetrometer on a selected/undisturbed (to the extent practical) section of the recovery. FOS (Portland, ME) has these available for very little cost.
- Have the driller's helper open split-spoons, put them back together when you're done, and decon them as necessary. That's their job. There's too much information for you to collect from each split-spoon and to keep track of during drilling (sample descriptions, jar labeling, tooling in use, presence of gravel/cobbles, confirming depth bgs, etc.).

Soil Descriptions

For each split-spoon sample recovered, please document the following parameters for each soil type/layer/strata within the spoon, in order:

1. Color.
2. Primary soil type (sand, gravel, silt, or clay; OR peat, organic silt, organic clay).
3. Presence/estimated percentage of secondary soil types (based on ASTM D2488 terminology).

- Trace = 1% to 5%
- Few = 5% to 15%
- Little = 15% to 25%
- Some = 25% to 45%

4. Density/consistency, based on SPT N-value (= addition of 2nd and 3rd blow counts) for cohesionless soils and on N-value, torvane/pocket penetrometer readings, and/or other guidelines below for cohesive soils.

   Density of Cohesionless (sands, gravels, and non-plastic silt) Soils

	N-Value
very loose	0 – 4
loose	5 – 10
medium dense	11 – 30
dense	31 – 50
very dense	50+

   Consistency of Cohesive (plastic silt/clay) Soils

	N-Value	Strength (psf)	Other
very soft	0 – 2	0 – 250	Fist easily penetrates
soft	2 – 4	250 – 500	Thumb easily penetrates
medium stiff	4 – 8	500 – 1000	Thumb penetrates w/mod. effort
stiff	8 – 15	1000 – 2000	Indented by thumb w/great effort
very stiff	15 – 30	2000 – 4000	Indented by thumbnail
hard	31+	> 4000	Indented by thumbnail w/difficulty

5. Moisture (dry, moist, or wet).
6. Plasticity (non-plastic, low plasticity, moderate plasticity, high plasticity). See ASTM D 2488.
7. Structure (layering/stratification, varves, fissures, cracks, desiccated, etc.).
   - Layer = > 3";
   - Seam = 1/16" to 3";
   - Parting = < 1/16" thick; and
   - See ASTM D 2488 Table 7 for additional information and terminology.
8. Geologic origin (FILL, glacial till, glacial outwash, marine clay, alluvium, lacustrine, etc.).

9. USCS designation (SP, SW, SP-SM, SW-SM, SM, CL, etc.). See ASTM D 2488.
10. Presence of roots, rootlets, organics, weathered rock fragments, etc.

    - Occasional = Present, but < 10% by volume;
    - Some = 10% to 25% by volume; and
    - Frequent = > 25% by volume.

11. Presence of cobbles, boulders, large debris, wood, etc. (noted during drilling).

    - Occasional = Present, but < 10% by volume;
    - Some = 10% to 25% by volume; and
    - Frequent = > 25% by volume.

If the subsequent sample consists of the same general material, i.e. would be included in the same strata/geologic unit (e.g., Alluvial Sand, Lacustrine Silt/Clay, or Glacial Till), the description may be abbreviated to "SAA" with notes identifying subtle differences, e.g., "SAA, except loose"; "SAA, except becomes medium dense with few gravels"; "SAA, becomes wet with trace gravel", etc.

Sample Jars - Labeling

The driller should provide sample jars. Please confirm with them in advance. Also, confirm their standard jar size provided, as some do not provide adequate jars.

- Preferred jar is wide-mouth, glass, 12 oz to 16 oz in size, with screw-top lids.
- If necessary, driller can obtain these via online/phone order from Israel Andler & Sons in MA.

You should utilize at least 1 sample jar for each primary soil type/layer/strata from each split-spoon recovered.

- Discard any "slop" at the top of the spoon;
- Fill each jar to the extent practical;
- For cohesive to semi-cohesive soils, maintain the structure of the sample in lieu of stuffing the jar full; and
- If multiple soil types/stratified soils are observed within a spoon, provide a sample (and a stand alone jar) of each soil type. Note depth of strata changes on the jars and/or on the field log and label jars accordingly (e.g., "A", "B", or "top", "bottom", etc.).

Label all jar covers with the following information:

- Date, project name, borehole number, sample type (e.g., SS for split-spoon or VS for recovery of a vane shear interval), sample # (e.g. SS-3), sample depth interval (e.g., 5 – 7'), sample penetration and sample recovery in feet (e.g., 2.0/1.4), and blow counts.
- Record the same/corresponding info on field log or in field book.

Keep samples from every split-spoon as described above. All SPT samples should be put in a box (labeled with basic date, project, borehole no. info from above) and retained by Wood.

Field Logs/Notes

The above information provides recommended procedures for describing individual samples and recording the information. The field log needs to go one step further.

- The field log needs to identify the primary soil strata observed from a "big picture" standpoint, e.g., FILL (0' to 5' bgs), SAND (5' to 9' bgs), CLAY(9' to 18' bgs), GLACIAL TILL (18' to 25' bgs), etc.
- In other words, the field engineer/geologist needs to group various sample intervals/descriptions together to provide a big picture/overview of the subsurface conditions, as well as the transition depths from one strata to the next.

Bedrock Cores – Labeling

For each bedrock core "run", please document/obtain the following information on the core box:

- Date, project name, borehole number, sample type (i.e., RC for rock core), sample # (e.g. RC-11, numbers should be consecutive from top of borehole to bottom, regardless of sample type), depth interval (e.g., 25 – 30'), total penetration and sample recovery in feet (e.g., 5.0/4.4), and RQD determination.
- RQD = $\frac{\text{Sum of the lengths of all intact core pieces that are > 4" in length (nearest 0.1')}}{\text{Total penetration length (nearest 0.1')}}$

  (assuming typical NQ/NW-sized core = ~ 1.9" to 2.0" OD rock core)
  (also, include smaller core pieces if length is reduced due to fresh/drilling break)
- Record the same/corresponding info on field log or in field book.

For each rock core recovered, please document the following parameters, in order:

1. Color.
2. Texture (e.g., fine-grained, coarse-grained, etc.).
3. Lithology (e.g., Igneous, sedimentary, metamorphic, etc.).
4. Hardness.
5. Weathering.
   - ° Slight = Weathering is limited to surface of major discontinuities/breaks. Typically iron stained.
   - ° Moderate = Weathering extends throughout the rock mass. The rock is not friable.
   - ° High = Weathering extends throughout the rock mass. The rock is friable.
6. Rock mass description, i.e., bedding, jointing, dip, spacing of discontinuities, etc.
7. Formation (if known).

8. RQD %.
9. Rock mass description (based on RQD).

    - Very poor = < 25%
    - Poor = 25% to 50%
    - Fair = 50% to 75%
    - Good = 75% to 90%
    - Excellent = > 90%

APPENDIX B

FIELD DATA RECORDS

FIELD ACTIVITY DAILY LOG

DAILY LOG	DATE			
	NO.			
	SHEET		OF	

Project Name:	**Project No.**

Installation/Investigation Area:

Description of daily activities and events:

List Samples Collected:

Visitors on Site:	**Deviation from plans:**
Weather conditions:	**Important telephone calls / photos taken:**

Personnel on Site:

Name/Signature:	**Date:**
QA/QC'd by:	**Date:**

Depth (ft)	Casing Blows/ft	Sample No.	Sample Depth (ft)	Blows / 6"	Recovery (ft)	SOIL DESCRIPTION	USCS	Piez. Data	PID

Sample & Test Types: S:split spoon **R**:rock core **C**:2" dia. thin wall tube **U**: 3" thin wall tube **V**: field vane **TV**: torvane **PP**: pocket pen.

SOIL DESCRIPTION: Color, predominant soil type and gradation, secondary soil proportions and gradation, structure (stratified, varved, cemented/bonded, etc.), sand/gravel shape (angular, rounded, subangular, subrounded), consistency or density, plasticity, moisture. Other observations (debris, organics, refusal/drilling difficulty, wash water/mud start depth, color variations [mottling, etc.]).

Water Level Readings					Project Information		Equipment	ID	Hammer/Drop
		Depth of (ft)			Client:		Casing / Augers:		
Date	Time	Casing	Hole	Water	Project:		Split spoon:		
					Project No.:		SPT Info:		
					Location:		Core Barrel ID:		
					Contractor:		Core Barrel Type:		
					Driller:	Drill Rig:	Other:		
Ground Surface Elev. (ft)					wood.		BORING _____		
Date Boring Completed:									
Boring Logged By:							page # 1		

Depth (ft)	Casing Blows/ft	Sample No.	Sample Depth (ft)	Blows / 6"	Recovery (ft)	SOIL DESCRIPTION	USCS	Piez. Data	PID

Sample & Test Types S:split spoon **R**:rock core **C**:2" dia. thin wall tube **U**: 3" thin wall tube **V**: field vane **TV**: torvane **PP**: pocket pen.

SOIL DESCRIPTION: Color, predominant soil type and gradation, secondary soil proportions and gradation, structure (stratified, varved, cemented/bonded, etc.), sand/gravel shape (angular, rounded, subangular, subrounded), consistency or density, plasticity, moisture. Other observations (debris, organics, refusal/drilling difficulty, wash water/mud start depth, color variations [mottling, etc.]).

Ground Surface Elev. (ft)		wood.	**BORING** _____
Date Boring Completed:			page
Boring Logged By:			

EQUIPMENT BLANK SAMPLING RECORD

PROJECT NAME	SAMPLE LOCATION	PROJECT NO
Stratford Army Engine Plant		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:

Stratford Army Engine Plant - Feasibility Study

SEDIMENT CORE and GRAB SAMPLE LOG

Site: Stratford Army Engine Plant	**Project No.:** 3616176064	**Logger:**	
Sub:	**WO:**	**Crew:**	
Date:	**Time :**	**Vessel:**	
Coordinates: Lat	**Long**		
Sampling Station:			
Weather/Conditions:	Traffic:	Water Temp:	

Measured Water Depth:	Total Boring Depth (refusal):
Number of intervals:	*Conditions:*
Off Site Sample: **Y N**	
Dup/MS/MSD:	

Interval	Recovery (ft)	Description (Odor, Color, Type, etc.)	Sample ID
0-1'			
1-2'			
3-4'			
4-5'			
5-6'			
6-7'			
7-8'			
8-10'			

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

Tailgate Safety Meeting Report

Check One:

☐ Initial Kickoff Safety Meeting ☐ Regular/Daily Tailgate Safety Meeting ☐ Unscheduled Tailgate Safety Meeting

Date: _____ Site: _____

Site Manager: _____ Site Health and Safety Officer: _____

Print *Print*

Order of Business

Topics Discussed (Check all that apply – Boxed bold items to be covered daily)

☐ **Scope of Work**	☐ Hazard Analysis of Work Tasks (chemical, physical, biological and energy health hazard effects)
☐ **Anticipated Weather (snow, high winds, rain)**	☐ Chemical Hazards and Controls
☐ **Personnel Roles and Responsibilities**	☐ Signs and symptoms of over exposure to site chemicals
☐ **Data Collection Objectives**	☐ Physical Hazards and Controls (e.g., overhead utility lines)
☐ **Safe work practices**	☐ Biological Hazards and Controls (e.g., poison ivy, spiders)
☐ **Logs, Reports, Recordkeeping**	☐ Temperature Extremes (heat or cold stress symptoms and controls)
☐ Site History/Site Layout	☐ Engineering Controls
☐ Site Control (visitor access, buddy system, work zones, security, communications)	☐ Monitoring Instruments and Personal Monitoring, Action Levels
☐ Training/Permit Requirements	☐ Perimeter Monitoring - Type and Frequency
☐ Applicable SOPs (e.g., Hearing Conservation Program, Safe Driving, etc.)	☐ Near Misses/Hazard ID including worker suggestions to correct and work practices to avoid similar occurrences
☐ PPE Required/PPE Used	☐ Incident Reporting Procedures
☐ Define PPE Levels, Donning, Doffing Procedures	☐ Hazardous Materials Spill Procedures
☐ Decontamination Procedures for Personnel and Equipment	☐ Medical Emergency Procedures (e.g., exposure control precautions, location of first aid kits, etc.)
☐ Sanitation and Illumination	☐ Route to Hospital and Medical Care Provider Visit Guidelines
☐ Medical Surveillance Requirements	☐

Safety Suggestions by Site Workers: ☐ None Provided ☐ Input Given (record in field below)

Action Taken on Previous Suggestions: ☐ None Needed ☐ Actions (record in field below)

Injuries/Incidents/Personnel Changes since last meeting: ☐ None ☐ Occurred (record in field below)

Tailgate Safety Meeting Report

Observations of unsafe work practices/conditions that have developed since previous meeting:

Location of (or changes in the locations of) evacuation routes/safe refuge areas:

☐ Applicable Procedures (AHA, JHA, SWP):

☐ Field Level Risk Assessment Completed (FLRA) (e.g. new hazards identified due to site or equipment conditions):

Attendee signatures below indicate acknowledgment of the information and willingness to abide by the procedures discussed during this safety meeting

Name (Print)	Company	Signature

Meeting Conducted by: _____ Title: _____

Print Name

Signature: _____ Time: _____

PROJECT SITE
OCCUPATIONAL HEALTH & SAFETY INSPECTION CHECK LIST

DATE:	PROJECT LOCATION:	NAME (S) OF PERSON/PEOPLE CONDUCTING INSPECTION:
PROJECT NUMBER:	PROJECT MANAGER:	PROJECT NAME:
SITE ACTIVITIES:	WEATHER:	PERSONNEL PRESENT (AMEC, CLIENT, & CONTRACTORS):

This checklist documents AEI & Subcontractor safety compliance at the project.
Please check (ö) the appropriate box next to the specific item.

"Y" **Indicates compliance.**
"N" **Indicates non-compliance and requires immediate correction.**
"NA" **Indicates that the item is not applicable at the project.**
"CA" **Corrective action – Initials of responsible person to complete.**

	Planning and Documentation	Y	N	N/A	CA
1	Project Specific Job Hazard Assessment completed	☐	☐	☐	
2	Site Specific Safety Plan Available and signed	☐	☐	☐	
3	Project safety program for subcontractors submitted	☐	☐	☐	
4	HAZCOM/WHMIS program provided	☐	☐	☐	
5	MSDS available	☐	☐	☐	
6	Tailgate/Tool Box safety meetings held	☐	☐	☐	
7	Project orientation provided	☐	☐	☐	
8	Project Specific Safety training provided where necessary	☐	☐	☐	
9	First-aid supplies available	☐	☐	☐	
10	Qualified first aid person on project	☐	☐	☐	
11	Safety bulletins, rules, regulations, etc. posted	☐	☐	☐	
12	Emergency telephone numbers posted	☐	☐	☐	
13	Communication system in place	☐	☐	☐	
14	Signs posted where necessary	☐	☐	☐	
	General Safety	**Y**	**N**	**N/A**	**CA**
15	Slip, Trip & Fall hazards identified and cleared	☐	☐	☐	
16	Utility mark out completed	☐	☐	☐	
17	Overhead hazards identified	☐	☐	☐	
18	Safety Zones established (Exclusion, Contamination Reduction, Support)	☐	☐	☐	
19	Decontamination procedure/area established	☐	☐	☐	
20	Confined space procedures followed	☐	☐	☐	
21	Adequate ventilation in work areas	☐	☐	☐	
22	Adequate lighting provided and maintained in work areas	☐	☐	☐	
23	Sharp objects properly disposed of or protected	☐	☐	☐	
24	Proper storage of tools and materials	☐	☐	☐	
25	Accumulation of contaminated debris within acceptable levels	☐	☐	☐	
26	Adequate trash containers provided	☐	☐	☐	
27	Adequate number of toilets and washing facilities	☐	☐	☐	

	Personal Protective Equipment	Y	N	N/A	CA
28	Hardhats worn by workers	☐	☐	☐	
29	Safety glasses or protective eyewear used when required	☐	☐	☐	
30	Appropriate respirators used when required	☐	☐	☐	
31	Proper work shoes worn by all employees	☐	☐	☐	
32	Appropriate hearing protection used when required	☐	☐	☐	
33	Safety vests worn when required	☐	☐	☐	
34	Proper protective clothing used when required	☐	☐	☐	
35	Personal Flotation Devices (PFD) utilized when required	☐	☐	☐	

	Fire Protection and Prevention	Y	N	N/A	CA
36	Fire suppression equipment available and inspected routinely	☐	☐	☐	
37	Flammable and combustible materials stored properly	☐	☐	☐	
38	Flammable liquid stored in approved safety cans	☐	☐	☐	
39	Safety cans have self closing lids and flame arresters	☐	☐	☐	
40	Combustible waste materials routinely disposed of	☐	☐	☐	
41	Flammable containers properly labeled	☐	☐	☐	

	Tools: Hand and Power	Y	N	N/A	CA
42	Proper tool used for job	☐	☐	☐	
43	Hand tools in good condition and free of visible defects	☐	☐	☐	
44	Guards in place	☐	☐	☐	
45	Tool handles not broken	☐	☐	☐	
46	Electric tools double insulated or properly grounded	☐	☐	☐	
47	Power cords on electric tools in safe working condition	☐	☐	☐	
48	Powder actuated tools: operators certified	☐	☐	☐	
49	All belts, chains, sprockets and pulleys properly guarded	☐	☐	☐	
50	Power finishing machines equipped with dead man's switch	☐	☐	☐	

	Electrical	Y	N	N/A	CA
51	GFCI or assured grounding in use	☐	☐	☐	
52	Extension cords are approved three wire construction grade	☐	☐	☐	
53	Extension cords free of visible defects	☐	☐	☐	
54	Extension cords not running through water	☐	☐	☐	
55	Extension cords strung to avoid damage	☐	☐	☐	
56	Temporary lighting properly guarded	☐	☐	☐	
57	Temporary lighting properly suspended	☐	☐	☐	
58	All live circuits and panels clearly posted	☐	☐	☐	
59	Live panels secured to prevent unauthorized access	☐	☐	☐	
60	Only qualified persons working on live circuits and panels	☐	☐	☐	
	Fall Protection	**Y**	**N**	**N/A**	**CA**
61	Excavations properly guarded to prevent fall	☐	☐	☐	
62	Workers by excavation openings utilized fall protection if deeper than 6'	☐	☐	☐	
63	Full body harnesses used as fall protection at unprotected edges greater than 6'	☐	☐	☐	
64	Harnesses are properly worn by worker	☐	☐	☐	
65	Lanyard of proper length to limit fall to less than six feet	☐	☐	☐	
66	Lanyards secured to proper anchorage	☐	☐	☐	
67	Lifelines secured to proper independent anchorage	☐	☐	☐	
68	Controlled access zone warning lines in place	☐	☐	☐	

	Heavy Equipment (Backhoe,Excavator, Drill Rig, Loader)	Y	N	N/A	CA
69	Permits, inspections and licenses in order and valid	☐	☐	☐	
70	Daily inspection of equipment performed	☐	☐	☐	
71	Backup alarm operational	☐	☐	☐	
72	Signal person provided	☐	☐	☐	
73	Clearance to power lines is adequate (20')	☐	☐	☐	
74	Backhoe outriggers fully extended and supported during operation	☐	☐	☐	
75	Boom down prior to drill rig movement	☐	☐	☐	
76	Personnel properly positioned	☐	☐	☐	

	Ladders	Y	N	N/A	CA
77	Ladders are free of visible defects	☐	☐	☐	
78	Ladders proper height for work	☐	☐	☐	
79	Workers do not overextend reach of ladders	☐	☐	☐	
80	Ladders erected on solid level surface	☐	☐	☐	
81	Nonconductive ladder is used when necessary	☐	☐	☐	
82	A-frame ladders used in open position	☐	☐	☐	
83	Workers do not use top two steps of A-frame ladders	☐	☐	☐	
84	Workers do not climb back of A-frame ladders	☐	☐	☐	
85	Straight ladders secured	☐	☐	☐	
86	Straight ladders extend 36 inches above landing	☐	☐	☐	
87	Straight ladders pitched at 1 to 4 ratios	☐	☐	☐	
88	No skid feet provided on straight ladders	☐	☐	☐	
	Public Liability	**Y**	**N**	**N/A**	**CA**
89	Fencing provided where necessary	☐	☐	☐	
90	Warning signs posted where necessary	☐	☐	☐	
91	Flag persons used to direct pedestrian and vehicle traffic if needed	☐	☐	☐	
	Life Safety	**Y**	**N**	**N/A**	**CA**
92	Evacuation plans posted	☐	☐	☐	
93	Paths of emergency egress kept clear	☐	☐	☐	
94	Rescue equipment and team available	☐	☐	☐	

	Excavation	Y	N	N/A	CA
95	Sheeting, shoring and bracing in place (excavation greater than 4')	☐	☐	☐	
96	Sloping and bracing where necessary (excavation greater than 4')	☐	☐	☐	
97	Ingress and egress provided (excavation greater than 4')	☐	☐	☐	
98	Guardrails in place (excavation greater than 4')	☐	☐	☐	
99	Spoils two feet from excavation (excavation greater than 4')	☐	☐	☐	

NOTE: Based on the results of this inspection, all causing, exposing and contractors responsible for correcting deficiencies and non-compliance will be contacted in writing to perform necessary corrective actions.

COMMENTS/ NOTES:

Use back or additional pages for comments and explanations.

APPENDIX C

LABORATORY QUALITY ASSURANCE MANUALS PLANS AND STANDARD OPERATING PROCEDURES

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eurofins	Always check on-line for validity. **Processing Bottle Orders**	Level: **Work Instruction**
Document number: **S-BOT-WI10645**		
Old Reference: **1-P-QM-PRO-9018266; SOP-SB-016**		
Version: **4**		Organisation level: **5-Sub-BU**
Approved by: **UBFR** Effective Date **15-OCT-2009**	Document users: **5_EUUSLA_Sample Bottles_Manager, 6_EUUSLA_ Sample Bottles_Bottle Order Packaging**	Responsible: **5_EUUSLA_Sample Bottles_Manager**

Revision Log

Revision: 04		**Effective Date:** This version
Section	**Justification**	**Changes**
Header	Formatting requirements per LOM-SOP-LAB-201	Added separate line item for revision number
Approvals	Formatting requirements per LOM-SOP-LAB-201	Moved to beginning of document
Revision Log	Formatting requirements per LOM-SOP-LAB-201	Removed revision logs up to the previous version.

Ver. #	Effective Date	Change
03	01/24/06	Major changes are as follows: • Removed Cross Reference section • Updated Definitions, Personnel Training and Qualifications, and Procedure sections

Purpose

This SOP describes the general procedure for processing bottle orders. This covers the time after the order is released into Parallax by Client Services until a printed copy is delivered to the bottles personnel for packing.

Scope

To generate a record of a client bottle order and to provide the packing room with information needed to pack the order.

Definitions

1. SCR – "Sample Container Record" – This form contains the bottle information with regard to description, preservative, analysis and holding time. This form is sent along to the client.

2. Lancaster Laboratories Packing Sheet – This form contains the bottle information with regard to description and preservative. This form is used by the bottles personnel to pack the order.

Personnel Training and Qualfications

1. Know how to follow the Lancaster Laboratories Packing Sheet

2. Know bottle codes

3. Know how to use a computer and printers

4. Know how to collate paperwork and labels

5. Know where to file order once it is generated and collated

Procedure

1. Access the Sample Bottles application in Parallax.

2. Access the Packing Queue under Bottle Order Entry by clicking on the blue "Q" icon.

3. Under Order Status, click on "Initial" and then click on the blue file icon entitled "Retrieve Queue Entries." This will bring up orders that are due to be done that day as well as future dates.

4. Click on the first entry in the queue, which will highlight it. Move over to "Pack Employee" and fill in the employee number. Then click on the yellow pencil icon entitled "Pack Selected Bottle Order." This will automatically print the order paperwork and the labels associated with the order.

5. The paperwork and labels will all have the same order number. They need to be matched and clipped together to be placed in the appropriate bin for packing. If the order is being sent by Fed-Ex, the Sample Container Record should be photocopied so that one copy may be used for shipping.

End of document

eurofins	Always check on-line for validity. **Processing Bottle Orders**	Level: **Work Instruction**
Document number: **S-BOT-WI10645**		
Old Reference: **1-P-QM-PRO-9018266; SOP-SB-016**		
Version: **4**		Organisation level: **5-Sub-BU**
Approved by: **UBFR** Effective Date **15-OCT-2009**	Document users: **5_EUUSLA_Sample Bottles_Manager, 6_EUUSLA_ Sample Bottles_Bottle Order Packaging**	Responsible: **5_EUUSLA_Sample Bottles_Manager**

Version history

Version	Approval	Revision information
4	15.OCT.2009	

eurofins	Always check on-line for validity. **Environmental Sample Entry**	Level: **Work Instruction**
Document number: **S-SA-WI10723**		
Old Reference: **1-P-QM-PRO-9015502; DOD - SOP-SA-101**		
Version: **13**		Organisation level: **5-Sub-BU**
Approved by: **UCSS** Effective Date **06-NOV-2018**	Document users: **6_EUUSLA_ Sample Administration_Sample Entry**	Responsible: **5_EUUSLA_Sample Administration_Manager**

Revision Log

Revision:	13	**Effective Date:**	This version
Section	**Justification**	**Changes**	
Revision Log	Formatting requirement	Removed revision logs up to the previous version	
Personnel Training and Qualification	Reflect current practices	Training no longer includes pricing or completing a written test. Training is based on a review of sample group entries by experienced registration personnel	
Procedure	Reflect current practices	Added references to on the job training	
Procedure	Reflect current practices	Adding information regarding the addition of the new sort code process	

Revision:	12	**Effective Date:**	April 13, 2018
Section	**Justification**	**Changes**	
Revision Log	Formatting requirement	Removed revision logs up to the previous version	
Throughout Document	Reflects re-identification of documents in D4	Replaced all prior Level 1, 2, 3, and 4 document numbers (analyses excluded) with D4 numbers	
Procedure 3	Reflect current procedures	Added section about what to do with samples received for another Eurofins company on Lancaster, PA campus	

Reference

Not applicable

Cross Reference

Document	Document Title
S-SA-WI10725	Environmental Sample Receipt and Unpacking
S-SA-WI10743	Taking the Temperature of Environmental Samples Upon Arrival at the Lab

Purpose

The purpose of this SOP is to briefly describe the procedures used in environmental sample entry. Immediately following receipt at the laboratory, samples are recorded in the Eurofins Lancaster Laboratories Environmental (ELLE) LIMS sample login system. This is one of the most important processes in the operation of the laboratory. The information entered into the computer establishes the foundation of information utilized throughout the laboratory for scheduling, accounting, billing, reporting, marketing, analysis, storage, and quality assurance. Because so many areas are influenced by the information recorded at entry, the importance of this process is evident.

Scope

This SOP describes the general procedures used in computer entry, called sample log-in.

Personnel Training and Qualification

All environmental sample entry personnel performing this procedure must have documentation of reading, understanding, and agreeing to follow the current version of this SOP.

Training of all new environmental sample entry personnel is performed during the first few months of employment. This training includes in-depth instruction of all analyses performed by each environmental technical center, holding times, collection requirements, etc. Entries are reviewed to ensure comprehension until the employee is able to demonstrate a clear understanding of requirements.

Procedure

1. While handling samples in SR, all personnel should wear lab coats and safety glasses. Samples are unpacked and inspected in the receipt area. At this time the samples are examined for breakage, agreement with the associated client paperwork, and the temperature of the samples upon receipt is recorded. See *S-SA-WI10725* for more information on sample receipt and unpacking and *S-SA-WI10743* on taking the temperature of samples.

2. Following receipt, the samples advance to Sample Registration (SR). The individual carts of environmental samples are surveyed by the entry staff for prioritization of entry based on client requested turnaround time and analysis holding time. The sample groups are immediately entered by SR entry staff or placed within storage at the appropriate temperature condition (refrigeration, freezer, or room temperature) until entry. The administrator reads the client's request for analyses and selects the appropriate analysis number for each test requested. The correct account, sample type (matrix), copy routine (reporting), priority, and turnaround time are selected.

3. If it is determined that the submittal group is not for ELLE but is for another Eurofins company on the Lancaster, PA campus, the entry staff will scan all the accompanying paperwork and attach it in an email to group emailbox, !US19_SA_Lancaster. The sample receiving areas of all companies on the Lancaster, PA campus are part of this group email address. Once it is identified who the samples belong to, they will be delivered or picked up by the appropriate staff.

4. If the sample administrator determines that the samples cannot be entered into the sample entry system due to discrepancies, unclear analyses, or the client requests that the samples be held, then the samples are entered into the SA Hold Sample program. The program assigns a unique hold number to each held group. The samples are labeled with the assigned hold number and stored in Sample Registration at the appropriate temperature conditions (refrigeration, freezer, or room temperature). Copies of the hold reports are immediately sent to the assigned client service representative (CSR) and the original client paperwork and hold report are filed within SR. A daily e-mail report is sent to all CSRs listing all outstanding held samples that are waiting resolution. The held sample group is not removed from the daily e-mailed report until the completed hold report is returned to SR with written instructions on how to proceed with entry. This hold report is then filed with all the entry paperwork.

5. The compiled information is then typed into the sample entry program.

6. Immediately following computer entry, a working copy of the acknowledgment describing the account to bill and client purchase order number, reporting information, the number of samples and types (matrixes), analyses ordered for each sample, sample collection information, and number of containers for each sample is printed. The number of containers for each sample is represented by the bottle codes entered. This copy of the acknowledgment represents the information entered into the computer and is attached to the client paperwork for auditing, along with the Receipt Documentation Log. The client's account number, group number and the sample numbers are written on the client's paperwork. Labels are printed for each bottle/package in the sample group. These labels are used to identify each sample and bottle/package while in the computer system. A specific label is attached to each sample bottle/package by comparing the sample ID on the client's label against the sample ID on the ELLE label and confirming the appropriate bottle code for each container. Each label contains a sort code that is used to assist the login personnel to ensure that the container is sent to the correct location (e.g. metal splitting, pH check, soil splitting, etc.) The table used to populate the sort code information is stored in Parallax and maintained by Dept. 6042 management.

7. The sample proceeds to sample preservation and sample storage or to the appropriate technical center. If samples remain in SR prior to delivery to sample storage or the appropriate technical center, the samples are stored within SR at the appropriate temperature conditions for each sample matrix (refrigeration, freezer, or room temperature).

8. If samples must proceed directly to the department without lab labels due to extreme rush or holding time issues, we track them as follows. The containers which need to go directly to the department are checked to make sure they contain all the pertinent information such as the account name, sample ID, collection date and time, and the name and analysis number of the test to be performed. The individual departments record these samples in their lab notebooks by the client name, sample ID, and collection information as necessary. As soon as the lab labels are ready, the labels are delivered to the appropriate department and applied to the appropriate containers. The department then add the laboratory assigned sample number to their notebooks for complete documentation.

9. A Sample Label Audit Notification form is generated for every tenth entry group. The individual sample labels for that group are audited for accuracy by someone other than the entry person. The auditor is performing a comparison check between the information the client supplied on their label versus what the entry person entered onto the lab label. The auditor initials, dates, and times the audit sheet and indicates whether all labels were accurate. If all labels were not accurate, a description of corrections required is written at the bottom of the form. Whenever possible, the original entry person is responsible for making any necessary corrections to the sample labels, as well as to the acknowledgment. If the original entry person is not available, then another entry person may make the changes and document the changes. All audit sheets are filed by date of entry within SR.

10. The complete entry is audited for correctness in SR.During on the job training all groups are double-checked for accuracy until a complete understanding of requirements are demonstrated.

11. The CSR assigned to the account reviews the entry for completeness and correctness.

12. If the computer entry for a sample must be corrected or changed in any way, a change form is electronically generated to document the changes made and to communicate the change to the impacted departments. The change form identifies what changes were made, which samples are affected, why the change was necessary, who made the change and when. The change forms are automatically emailed to the person who made the change, the CSR assigned to that account and to the contacts in each of the technical centers affected by the changes.

13. When all audits and changes are completed, the hard copy paperwork is filed in Client Services.

S-SA-WI10725 Environmental Sample Receipt and Unpacking
S-SA-WI10743 Taking the Temperature of Environmental Samples Upon Arrival at the Lab

End of document

Version history

Version	Approval	Revision information
11	22.JAN.2016	
12	30.MAR.2018	
13	23.OCT.2018	

eurofins	Always check on-line for validity. **Assembly and Review of Environmental Data Packages**	Level: **Work Instruction**
Document number: **S-DD-WI12037**		
Old Reference: **1-P-QM-PRO-9017748; SOP-DP-037**		
Version: **2**		Organisation level: **5-Sub-BU**
Approved by: **UDM6** Effective Date **19-OCT-2016**	Document users: **6_EUUSLA_ Data Deliverables_Data Package Assembly**	Responsible: **5_EUUSLA_Data Deliverables_Manager**

Revision Log

Revision: 2		**Effective Date:** This version
Section	**Justification**	**Changes**
Throughout Document	Reflects re-identification of documents in EtQ	Replaced all prior Level 1, 2, 3, and 4 document numbers (analyses excluded) with EDR numbers
Definitions	"Lablinks" definition is no longer applicable	Forms are not on Lablinks, definition not needed
Procedure 5	Reflect current process	Reworded step
Procedure	No longer applicable	Removed step #s14, 16, and 17

Revision: 01		**Effective Date:** Feb 1, 2012
Section	**Justification**	**Changes**
		New

Cross Reference

Document	Document Title
1-P-QM-FOR-9008526	Dept 4026 Review Checklist
1-P-QM-FOR-9008527	DEPT 25 ASSEMBLY/REVIEW CHECKLIST
1-P-QM-FOR-9008528	Dept 4024 Review Checklist
1-P-QM-FOR-9008529	Dept. 4022 Assembly and Review Checklist
1-P-QM-FOR-9008530	Dept 4021 Review Checklist
1-P-QM-FOR-9008531	Dept 4030 Review Checklist
1-P-QM-FOR-9008532	Dept 4032 Review Checklist
1-P-QM-FOR-9008533	Dept 4029 Review Checklist
1-P-QM-FOR-9008534	Dept 4027 Review Checklist
1-P-QM-FOR-9008535	Dept. 3002, 4028, and 4036 Review Checklist
1-P-QM-FOR-9009110	Standardized Report and Case Narrative Comments

Purpose

The purpose of this SOP is to outline the steps required to simultaneously perform assembly and QA/QC compliance review of environmental data packages.

Scope

This SOP applies to all types of environmental data packages assembled by Department 4038 staff or any other ELLE staff who may be assisting in this procedure.

Definitions

1. Fraction – The data associated with each analysis within a given department is considered a fraction. For example; Pesticide, Herbicide, and Explosives would each be considered a fraction even though they are analyzed in the same technical department.

2. SDG – Sample Delivery Group

3. eLIMS – Eurofins Laboratory Information Management System.

Personnel Training and Qualifications

All personnel performing this procedure must have documentation of reading, understanding, and agreeing to follow the current version of this SOP.

The initial training consists of observing the procedure being carried out by an experienced person. The trainee is to listen to the explanation of the procedural instructions and ask questions to clarify and help ensure understanding of the process. Next, the trainee carries out the procedure under the observation of the experienced person where feedback is given.

The trainee must have a sufficient number of packages re-reviewed by a member of the Quality Assurance department (or their designee). Training is completed when QA (or their designee) determines that the trainee has sufficiently demonstrated the ability to perform the assembly and QA/QC compliance review simultaneously with no non-recoverable errors.

When training is completed, the trainee is responsible to update his/her training records appropriately. After training, the experienced persons are still available for questions and support as needed.

Procedure

NOTE: Forms referenced in this SOP are available through the Document Control interface; therefore they are not provided as attachments to this SOP. These forms are printed (when needed) to ensure that the latest version of the form is being used.

A. For each fraction of the data package, perform the following steps:

1. Generate SDG Reports - The departmental SDG report and the eLIMS SDG report is generated to determine pertinent information for the data package such as: samples to be included, batch number, initial calibration, continuing calibration, blank, LCS/LCSD, MS/MSD

a. The departmental SDG report includes information about re-analysis and/or re-extraction

b. The eLIMS SDG report includes lab notes and/or project notes relevant to the project. Pay attention to any note pertaining to the data package and be sure to follow them.

2. Generate the QC summary forms using the appropriate application or database.

a. For organics data the following forms are generated using the eLIMS Data Package application:

(1) Case narrative

(2) Nonconformance summary

(3) Quality Control Reference List

(4) Method Blank

(5) Surrogate

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

(7) Laboratory Control Sample/ Laboratory Control Sample (LCS/LCSD)

(8) Method Detection Limit/Limit of Quantitation (MDL/LOQ)

b. For volatiles and semivolatiles data forms 4, 5, and 8 are generated using the departmental database (GCMS).

c. For inorganics, instrumental, and wet chemistry data the case narrative, nonconformance summary, QC and calibration forms are generated using respective department applications in Parallax.

3. Non-compliant data issues must be documented in the appropriate section of the case narrative. Please refer to the Standardized Report and Case Narrative Comments (Form #1-P-QM-FOR-9009110) document to determine when comments are required, the proper text to use in the comment, and which section of the case narrative it should be included in.

4. Both level 1 and level 2 comments are added by the technical groups at the time of data verification. The difference between the two comments is that the level 1 comments will show up on both the analysis report and on the data package case narrative but the level 2 comments will only be pulled onto the data package case narrative.

6. Based on the data package type there will be different forms included and in different arrangements. Please refer to the Data Package Format Document for more details.

7. Print out the Quality Control forms and place them in the appropriate section of the data package.

8. If Form 1s for the samples and QC are required to be included in the data package for organics data, the forms are generated using the departmental database.

9. After generating the Form 1s print them out and include them in front of the corresponding sample data.

10. The calibration data is printed from the scanned data files. The scanned files can be found in either: \\lldata\Env or \\uslan-envscan/ENV. There is a folder named as Dept#Scans (i.e. Dept26Scans) for each department.

11. The initial calibration forms are scanned in with the calibration raw data. The forms and the data are separated and placed in the corresponding section of the data package.

12. The extraction data, the sample raw data, the QC raw data, the continuing calibration data and forms can also be accessed from the scanned files as indicated in step 10 above.

NOTE: If the department does not have a scan folder set up, you will need to locate the hard copy of the calibration or batch data and will need to copy the information needed.

13. The data for the samples, QC, and extraction data, continuing calibration forms, and continuing calibration data is separated and placed in the appropriate section of the package.

14. After all the data and forms are printed; proceed to the assembly/review of the data following the individual departmental review checklist. (i.e., Forms 1-P-QM-FOR-9008526, 1-P-QM-FOR-9008527, 1-P-QM-FOR-9008528, 1-P-QM-FOR-9008529, 1-P-QM-FOR-9008530,

1-P-QM-FOR-9008531, 1-P-QM-FOR-9008532, 1-P-QM-FOR-9008533, 1-P-QM-FOR-9008534, 1-P-QM-FOR-9008535)

15. Generate the case narrative and, if necessary, move the comments to the appropriate section in the narrative.

16. If corrections are needed, flag the correction with a removable post-it note on the appropriate section of the package, access the electronic record for the SDG in the eLIMS Data Package tracking system and document any data compliance issues, QC form corrections, missing data, missing signatures, or any other miscellaneous correction. There are also some other fields in the corrections screen that will need to be completed such as dept #, fraction, code, step where correction was found, and responsibility of.

17. Once all fields are filled in, save the changes and email the corrections to the appropriate department DP Contacts distribution list.

End of document

Version history

Version	Approval	Revision information
2	19.OCT.2016	

Standard Operating Procedures - SOP S1

Title:	Test Method for Determination of Water (Moisture) Content of Soils, Rock, and Soil-Aggregate Mixtures **Appendix:** Percent Solids Determination
Material Applicability:	Soils and Aggregate
Reference Standard:	ASTM D 2216-19 / AASHTO T265-15
Target Property:	Moisture Content
Units:	Percent
Test Equipment:	Drying Oven (110 +/- 5º C), Balance(0.01 gm), Specimen Containers & lids, gloves, tongs, misc. handling equipment
Data Sheet:	DS-S1, Water Content. DS-S1A, Percent Solids

Summary of Procedure:

1. Geotechnics typically uses Method B of the Standard method. This is because the results of water content tests are often used in other test methods whose calculations require 4 significant digits. Select a representative sample of the material to be tested. Test specimen selection shall have representative moisture content of the material as a whole and shall be obtained by quartering or splitting. The manner in which it is selected must be based on the purpose and application of the test, type of material, the water condition, and the type of sample. Section 9 of the reference standard provides additional information.

    a. For disturbed samples such as trimmings or bag samples, obtain the test specimen by one of the following methods:

        - If the material can be manipulated and handled without significant moisture loss, mix and reduce to the required size by quartering or splitting;

- If the material cannot be thoroughly mixed or split, form a stockpile of material, mixing as much as possible. Take at least 5 portions of material at random locations using a shovel, scoop, trowel or other similar device. Combine all portions for the test specimen.

b. For undisturbed samples such as blocks, Shelby tubes, etc. obtain the test specimen by one of the following methods:

- Carefully trim at least 3 mm of material from the outer surface of the sample to see if the material is layered and to remove material that appears to either wetter or dryer than the main portion of the sample. Carefully trim at least 5 mm from the entire exposed surface.

- Slice the material in half. Carefully remove at least 5 mm from the exposed surface of one half. Avoid any material on the edges that may be wetter or drier than the main portion of the sample.

- If the material appears layered (or more than one type of material is encountered) select an average specimen, or individual specimens, or both. Appropriate remarks shall be entered on the data sheet.

2. The table below provides the minimum size of sample to be tested.

Maximum particle size (100% passing)	Standard Sieve Size	Recommended Minimum Mass of Test Specimen for Water Content Reported to ±0.1%	Recommended Minimum Mass of Test Specimen for Water Content Reported to ±1%
2 mm	No. 10	20 gm.	20 gm
4.75 mm	No. 4	100 gm.	20 gm
9.5 mm	3/8 in.	500 gm.	50 gm
19.0 mm	3/4 in.	2.5 Kg.	250 gm
37.5 mm	1 1/2 in.	10 Kg.	1000 gm
75.0 mm	3 in.	50 Kg.	5000 gm

Note: Samples less than 200 g shall be covered with a tightly fitting lid during measurement and cooling periods (not during the oven drying process).

Using a test specimen smaller than the minimum indicated in the table above requires discretion, though it may be adequate for the purposes of the test. Any specimen not meeting these requirements must be noted on the data sheet.

Select a pre-numbered tare and weigh it, and record the tare number and tare weight at the appropriate location on the data sheet.

3. Place the representative specimen in the tare and record the wet weight + tare.

4. Place the specimen in a drying oven that is calibrated to 110° C ± 5° C for at least 16 hours. or when it has reached a constant mass. If there is any doubt, constant mass may be determined by two consecutive readings which are at least an hour apart and which are less than 0.1% apart. In most cases this will occur overnight. If by inspection it appears that a specimen in a drying oven is not dry the entire contents of the oven are not to be weighed until the next day.

   Important - Ovens are continually filled up during the normal work day with additional specimens. The following day all the samples are removed and weighed successively before new moist specimens are placed in the oven. All specimens are dried at a minimum of 16 hours.

5. Remove the specimen from the drying oven and allow it to cool (if the specimen is less than 200 g, the container should be covered with a close-fitting lid during cooling) so that it can be handled without gloves but is still warm to the touch. If the samples are weighed immediately after they are removed from the oven and while they are still hot it is not necessary to cover them.

6. Record the data in Moisture Content data sheet DCN: DS -S1 (Data Drive on Geoserver: /Excel QA/Datasheets/WATDAT.xls).

7. Transfer the data into the spreadsheet DCN:CT- S1 (Data Drive on Geoserver:/Excel QA/WATCONT.xls.) Refer to SOP 52 on how to transfer data to the spreadsheet.

Appendix: Percent Solids Determination

1. Repeat steps one through five of SOP S1.

2. Record the data on Moisture Content and Percent Solids data sheet DCN: DS-S1A (Data Drive on Geoserver: /Excel QA/Datasheets/Solidsdat.xls).

3. Transfer the data to the spreadsheet DCN: CT-S1A (Data Drive on Geoserver: /Excel QA/Spreadsheets/Solids.xls). Refer to SOP 52 on how to transfer data to the spreadsheet.

Standard Operating Procedures - SOP S2B

Title: Classification of Soils for Engineering Purposes (USCS)

Reference Standard: ASTM D 2487-17 / M145-91(2017)

Material Applicability: Soils

Target Property: Classification

Units: USCS Symbols.

Test Equipment: Drying Oven (110 +/-5 ^{o}C); Balance(0.01 gm); Set of Sieves, Hydrometer, Hydrometer Cylinder, Mixer, Beakers, Tares.

Data Sheet: All particle size distribution computer templates.

Summary of Procedure:
Note: All USCS classification is performed by Geotechnics computer software analysis. The steps listed below describe manual classification

1. This SOP is used in conjunction with general procedure SOP-S3A - Particle Size Analysis.

2. Perform particle size test as described in SOP-S3A.

3. Complete the table for grain size distribution including the data from the sieve shaker and from the hydrometer test.

4. Calculate the percent retained:
   on #4 ----------gravel.
   on #200 ----------sand
   and % passing #200---clay.

5. Further classify the material based on the fractional division of each group using:
   Table 1.- Soil classification Chart, ASTM D2487
   -Figure 1a.- Flow chart for classifying Fine Grained Soil (50% or more passing #200 sieve. ASTM D 2487
   -Figure 2. Flow chart for classifying Coarse-grained Soils (more than 50% Retained on #200 sieve. ASTM D 2487
   -Plasticity chart or plasticity index classification for grained soils and fine grained fractions of coarse-grained soils. ASTM D2487.

Standard Operating Procedures - SOP S4

Title:	Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils
Reference Standard:	ASTM D 4318-17, AASHTO T88-13 (2017) and T89-16
Material Applicability:	Fine-grained soils passing #40 sieve
Target Property:	Liquid Limit, Plastic Limit and Plasticity Index.
Units:	Nearest whole number
Test Equipment:	Liquid limit device which complies with ASTM and AASHTO specifications, grooving tool, block gauge, mixing apparatus, mixing spatula, 12 inch diameter glass plate, drying containers with close fitting lids, Class C balance (to 0.01g), oven per ASTM D2216, #10 and #40 sieves, zip-lock bags for sample storage
Data Sheet:	DS-S4, 5 Point Atterberg Limit; DS-S4A, One Point Atterberg Limit; DS–S4B, 3 Point Atterberg Limit; DS-S4C, Non-Plastic Limit

Specimen Selection

Samples in which specimens will be prepared using the wet prep procedure must be kept at their as sampled water content prior to preparation.

Where sampling operations have preservd the natural stratification of a sample, (ex. Shelby Tube) the various strata must be kept separated from the stratum of interest. When other tests are to be performed, use the same material where possible. When a mixture of materials is to be used, mix them sufficiently to form a representative sample. Obtain a representative specimen from the total sample sufficient to provide 150-200 grams of (- #40) material. For free flowing materials, this may be accomplished by splitting or quartering. Non-free flowing or cohesive matereials may be mixed as above and a specimen may be taken from the total mass by making one or more sweeps with a scoop through the mixed mass.

Liquid Limit -Wet Preparation Method

1. If the specimen appears to have little or no material retained on a #40 sieve, prepare 150 to 200 grams by mixing with de-mineralized or distilled water on the glass plate. Adjust the water content to a consistency that would require 25-35 blows to close the groove. If, during mixing, +#40 particles are encountered, remove them by hand if possible. If not practical, remove by working the specimen through a #40 sieve. If this is not practical, remove +#40 material by washing. See step 2.

2. If the specimen contains particles retained on the #40 sieve, place the specimen in a pan or dish and add sufficient water to cover the material. Soak until all lumps have softened and the fines no longer adhere to the coarse particles. Wash the material over a #40 sieve. Discard the +#40 material.

3. Reduce the water content of the material passing the #40 sieve until it approaches the liquid limit. Several methods may be used to reduce the water content, including a fan, hair dryer , and decanting the clear water. In addition to these methods, Geotechnics uses a Plaster of Paris plate lined with high strength filter paper to drain the specimen. While draining, the specimen should be stirred often to avoid over-drying of the edges and peaks.

4. Remove the specimen from the filter paper. Mix on the glass plate, adjusting the water content by drying or adding de-mineralized water to achieve a water content that would require 25-35 blows of the limit device to close the groove.

5. Place the prepared material in sandwich baggie, mark with the appropriate ID or pan number, and allow to cure for at least16 hours (overnight).

Liquid Limit - Dry Prep Method

1. Air-Dry the specimen at room temperature or in an oven not exceding 60º C until it will pulverize readily.

2. Pulverize the soil in a mortar with a rubber tipped pestle or in some other way that does not cause the breakdown of individual particles. An out of service standard proctor rammer that has been removed from it's sleeve and capped with a rubber cap (a 2" Fernco cap works well). Do not crush stone, shells or other fragile particles, but remove them by hand.

3. Separate the material on a #40 sieve by hand shaking. Repeat the pulverizing and sieving procedure.

4. Place material retained on the #40 sieve in a dish and soak in a small amount of distilled or deionized water. Stir and transfer without loss of material, to a #40 sieve. Rinse the material retained with a wash bottle, catching the wash water and suspended fines. Pour this suspension into a dish containing the previously sieved -#40 material. Discard the + #40 material.

5. Mix on the glass plate, adjusting the water content by drying or adding de-ionized water to achieve a water content that would require 25-35 blows of the limit device to close the groove.

6. Place the prepared material in a sandwich baggie, mark with the appropriate ID or pan number, and allow to cure for at least16 hours (overnight).

Test Procedure

1. Remove soil from the baggie and place on ground glass plate and mix thoroughly with a spatula or other mixing tool. A 3/4 inch wide spatula is recommended. The material on the glass plate should be kept covered with a moist paper towel when not being manipulated.

2. Set 20 grams of material aside. This will be used for the plastic limit portion of the test.

3. A liquid limit device will be needed for the first part of the test. Check the drop distance of the brass cup of the device as described in the Calibrations Procedures . Note: The height of the drop should be adjusted so that the point on the cup that contacts the base rises to 10 mm (+/- 0.2 mm). The 10 mm high gage block can be used for this purpose. The cup should slightly tap on the gauge block. Adjust if necessary by using the 2 thumb screws.

4. Place a portion of the material into the cleaned cup of the liquid limit device. Make sure the cup is resting on the base. Place a moist paper towel over the unused sample.

5. Press and spread the mixture with the spatula into the lower 2/3 of the cup. The sample should have no air bubbles in it and should be 10 mm at its deepest point. The upper portion should be tapered to form a horizontal level surface.

6. Form a groove in the soil from top to bottom by drawing the grooving tool through the soil pat. Make sure the tool is held perpendicular to the cup throughout its movement. Care should be taken to prevent “tearing” of the soil and sliding of the soil on the bottom of the cup. In soils where a groove

cannot be made in one stroke without tearing the soil, cut the groove with several strokes of the grooving tool.

7. Make sure no crumbs of soil are clinging to the bottom of the cup. Turn the crank at a rate of 2 drops/second until the 2 halves of the soil pat come together along a distance of 1/2 inch (13mm). Note: Make sure that an air bubble didn't close the groove prematurely. If it did, repeat steps 13-17. A calibrated length scale should be used to verify that the groove has closed 1/2 inch. Record the number of drops on the data sheet. Note: If after several trials at successively higher water contents, the soil continues to slide in the cup or if the number of blows required to close the groove is always less than 25, record that the liquid limit could not be determined, and report as non-plastic. In this case the test is over. Do not proceed any further.

8. With the spatula, remove approximately 20 gm of material (approximately the width of the spatula) from the pat at the point of closure. Place this material into a tare, cover the tare , and weigh. Perform water content of removed slice in accordance with SOP S1 (ASTM D2216). Remove remaining soil from limit device using a rubber or plastic spatula. Wipe brass cup clean and dry with paper towels. Return soil specimen to sample and recover with moist towel.

9. Repeat steps 12-20 for at least two additional trials. One of the trials shall be for a closure requiring 25 to 35 blows, one for a closure between 20 and 30 blows, and one trial for a closure requiring 15 to 25 blows. The range of blows between the wettest and driest specimen shall be at least ten.

10. Record the data on the datasheet "Atterberg Limits", DCN: DS-S4B, (Geoserver: /Excel QA/Datasheeets/3ptlimdat.xls). Transfer the data from the datasheet to the spreadsheet CT-S4B (Geoserver: /Excel QA/Spreadsheets/3ptimit.xls). Refer to SOP-S52 on how to transfer data from the datasheet to the spreadsheet. The client may request a five point test. If so, follow all steps above with the exception of Step 9. Substitute a range of 5 points that are evenly spaced between 10 and 45 drops. Example: 8-14, 15-21, 22-28, 29-34, 34-42 drops. Record this data on the datasheet "5 Point Atterberg Limits", DCN: DS-S4 (Geoserver:/Excel QA/Datasheets/Limidat.xls).Transfer the data to the spreadsheet CT-S4 (Geoserver: /Excel QA/Spreadsheets/Liqlim.xls). Refer to SOP-S52 on how to transfer data from the data sheet to the spreadsheet.

Plastic Limit

1. Using the portion of material set aside previously in step #2 of "Test Procedure", knead the specimen into a ball to mix it thoroughly on the glass mixing plate with the 3/4 inch spatula.

2. Pinch a small amount of material (1.5 to 2.0 g) off and roll on a ground glass plate using the heel of your palm.

3. Roll soil into a thread approximately 1/8" in diameter, taking no more than two minutes. Break the thread into several pieces, squeeze the pieces together and roll back into an ellipsoidal mass. Repeat the rolling out process. Do this until the thread crumbles and can no longer be rolled into a 1/8" diameter. **The only criteria for continuing the test is that these threads can be reformed into an ellipsoidal mass and rolled out again.** Note: The normal rate of rolling for most soils should be approximately 80-90 strokes per minute with a stroke defined as one complete motion of the hand. The rate may have to be decreased for fragile soils. A 1/8 inch drill bit is available to aid in the determination of the proper diameter. Note: A Rolling Device may be used as an alternate method. See ASTM D4318-10 Section 16.2.2 for instructions.

4. Place each thread into a tare and cover with a lid to prevent moisture loss.

5. Repeat steps 1-4 approximately three times or until at least 6 grams of material is collected in the tare.

6. Record the weight of the tare and the tare plus wet soil on the datasheet.

7. Repeat steps 2-6 two more times. This will provide 2 tares containing 6 grams or more of material, and one additional 6 gram specimen to be used as a backup in case of error or loss of either of the first two specimens. Only two moisture contents shall be reported and used in the plastic limit calculation.

8. If soil is unable to be rolled, then it is considered to be non-plastic (see Note 1).

9. Place the 5 tares from the liquid portion along with the 3 tares from the plastic portion of the test into an oven set at 110^{o}C for at least 16 hours. Determine the water content of the material in accordance with ASTM D2216.

10. Record the data on the datasheet appropriate to the number of liquid limit points being performed (see #10 above or One Point Limit, # 8 below). Transfer the data from the datasheet to the corresponding spreadsheet. Refer to SOP-S52 on how to transfer data from the datasheet to the spreadsheet.

Note 1: If soil is unable to be rolled, then it is considered to be non-plastic. Record the sample ID in the spreadsheet Non Plastic Limit, DCN: CT-S4C

(N: /Excel QA/Spreadsheets/Nplimit.xls). Refer to SOP-S52 on how to transfer data from the datasheet to the spreadsheet.

One Point Liquid Limit

1. Prepare the sample in the same manner as steps 1-17 as in the multi-point except adjust the moisture content accordingly so that it requires 20-30 drops of the limit device cup to close the groove 1/2 inch (13mm).

2. With the spatula, remove at least 20 grams of material from the cup at the point of closure. Place the material into a tare and weigh. Record this weight on the data sheet and the number of drops to obtain it.

3. Immediately after removing the moisture content sample in step 2, remix the remaining material and repeat step 1.

4. If the number of drops remains constant (+/- 2 drops), obtain a second moisture content and record the weight and the number of drops. If it is greater than ± 2 drops, remix all material adjust the water content accordingly and repeat.

5. If the soil pat slides in the cup or the number of drops is always < 25, then the sample is considered non-plastic. (See page 3, Step 18)

6. The plastic limit portion of the test is the same as steps 1-10 (plastic limit multi-point).

7. Place the 2 tares from the liquid limit portion along with the 3 tares from the plastic limit portion into an oven set at 110^{o}C for at least 16 hours to determine the moisture content. **Note: If soil is unable to be rolled, then it is considered to be non-plastic. Record the sample ID in the spreadsheet Non Plastic Limit, CT-S4C (N: /Excel QA/Spreadsheets/Nplimit.xls). Refer to SOP-S52 on how to transfer data from the datasheet to the spreadsheet**.

8. Record the data in the datasheet DCN: DS-S4A. (Geoserver: /Excel QA/ Datasheeets/1plimdat.xls). Transfer the data from the datasheet to the spreadsheet CT-S4A (Geoserver: /Excel QA/1plimit.xls). Refer to SOP-S52 on how to transfer data from the datasheet to the spreadsheet.

Standard Operating Procedures - SOP S28

Title: Standard Test Method for Consolidated, Undrained Triaxial Compression Test on Cohesive Soils

Reference Standard: ASTM D4767-11

Material Applicability: Undisturbed, Remolded or Compacted Cohesive Soils

Target Property: stress, strain, friction angle, cohesion (c)

Units: pounds/square foot, percent, degrees, pounds/square foot

Test Equipment: Triaxial compression device with pore pressure measurement; LVDT deformation indicator; vertical displacement gauge (+/- 0.001 inch); 2.8 inch diameter mold, 6 inches long; 2 inch diameter. tamping hammer, 5.5 pounds; porous disks and filter paper; rubber membranes; sample extruder; calipers; balance (0.01 g); water content containers; oven (110 degrees +/- 5 degrees); miscellaneous carving, trimming tools, rubber membrane for failed Shelby tube samples; -3/8 inch material

Data Sheet: DS-S28, 28A, 28B

Summary of Procedure:

Compacted Specimens

1. Collect representative air-dried samples (approximately 6000 grams) which had been prepared in accordance with SOP SA1. Use (- 3/8 inch) material for test.

2. Determine water content per SOP S1 (ASTM D2216) using at least 300 grams of material.

3. Calculate the water needed to be removed or added to achieve the specified level. Adjust the water content of each specimen to produce the desired water content.

4. Allow specimen to sit for 16 hours at the or very near the desired water content.

5. Weigh an empty 6 inch x 2.8 inch cylindrical mold complying with the specification for a height to diameter ratio of between 2 and 2.5 and a minimum diamenter of 1.3 inches.

Compact the specimen in the mold in six layers. Use the 5.5 pound, 2" diameter manual proctor hammer.

6. When the mold is full, strike of the excess material. Weigh the mold and soil. Calculate the density of the compacted soil. If not within 0.5 pcf of the desired or specified density, adjust the number of layers, the number of blows, or the force per tamp as necessary to achieve the desired results. (Note: If not specified the default density shall be 95% of the standard proctor density.)

7. From the trimmings or remaining material, determine the actual water content in accordance with SOP S1 (ASTM D2216).

8. Extrude the sample out of the mold using the hydraulic sample extruder provided.

Undisturbed Sample

1. Ensure that shelby tube is 2.8 inch diameter. If not, have the Project Coordinator contact Client to discuss alternative testing. Handle specimen with care to prevent disturbance, changes, in cross-section, or moisture loss.

2. Using a tubing cutter, cut the bottom of the shelby tube, 0.2 ft. from bottom. Use a wire saw to cut through soil. Make a second cut on the tube to achieve a section approximately 5.8 inches long.

3. Obtain weight of specimen and tube. Remove tube from specimen and weigh empty tube. (Note: Ensure tube has been thoroughly clean of soil.) Record information on the data sheet.

4. From the trimmings or adjacent material, determine the moisture content in accordance with SOP S1 (ASTM D2216).

5. Remove any rocks that might cause point stress conditions during loading and fill in any voids with remolded soil obtained from trimmings.

6. Measure height of the Shelby tube specimen with a minimum of three separate measurements at 120 degrees apart. Take a minium of 3 diameter measurments at the quarter points of the height. Enter the measurements on the data sheet. The computer template will then calculate thein-situ density of the Shelby tube specimen using the mass of the specimen and volume of the cut specimen.

General Testing Procedure

1. Check to see that the lines are not obstructed by passing deaired water through the system. This also aids in saturation by placing deaired water into the sytem. Place the

boiled porous disk (minimum 10 minutes) on the bottom pedestal, followed by a soaked filter paper disc, the specimen, a soaked filter paper, porous disk, and the top pedestal.

2. Place the saturated filter paper side drains on the side of the specimen. Do not cover more than 50% of the sample.

3. Place membrane around specimen set-up and seal with rubber "O" rings at each end. Attach drainage lines. Check alignment of cap.

4. Assemble the triaxial cell, Bring the load piston into contact with the specimen cap to ensure proper seating.

5. Place a vertical displacement gauge on top of the specimen. Record initial height of specimen.

6. Fill cell with tap water. Apply 7.5 psi pressure to cell being careful to avoid trapping air or leaving air space in the chamber. (Water shall be discharged out the drain to ensure that all the air has been removed.

7. Flush lines and porous stones with deaired water @5psi pressure to remove entrapped air.

8. Saturate the specimen as follows:
   - Set back pressure to 5 psi.
   - Discharge specimen pressure to 0 psi.
   - Allow water to permeate specimen with de-aired water.

   Note: If effective pressure is specified is less than 5 psi, adjust the saturation pressure to not exceed the effective pressure.

9. Increase pressure in 5 psi increments until the cell pressure is 35 psi, the inlet pressure is 30 psi and the discharge pressure is 25 psi. Pressures may be adjusted to reflect clients specifications.

10. Shut off the discharge pressure valve.

11. Allow sample pore pressure to stabilize for approximately 12 hours, depending on the soil. Pore pressure measurements can be periodically checked to verify when equilibrium has been reached (i.e. pore pressure is uniform throughout the specimen).

12. Verify saturation by checking the B value. If B value is equal to or greater than 0.95, take a specimen height reading and begin consolidation procedure.

13. Shut off inlet pore pressure, set cell pressures to the required pressure in order to achieve the specified effective pressure (which is defined as the difference between the cell pressure and pore pressure). Install jumper to IN and OUT.

14. Record the burette volume that supplies pore pressure. Open the inlet valve to allow the burette to be filled. Run 3-dimensional consolidation.

15. Record the height and burette volume change. Wait until the burette volume change is complete.

16. Place the specimen on the load device. Apply pore pressure transducer on jumper. Check for leaks. (Note: after turning off the transducer valve, the pressure should remain constant).

17. Open transducer valve and shut inlet pore pressure valve. Check for constant pressure to verify consolidation has been completed.

18. Take a final change in height reading.

19. Install LVDT to measure deformation. Seat piston onto top platen without applying a load > 0.5% of the estimated axial load at failure.

20. Turn on computer. When piston starts loading, shut off cell valves except to the transducer.

21. Run test at 0.002 inches/minute or slower as per evaluation of 3 dimensional consolidation.

22. Shear sample until 1.2 inches of deformation (20% of specimen height) is achieved unless otherwise specified.

23. Remove cell from machine. Bleed pressure. Break the specimen down. Take a water content of the entire specimen. Sketch the specimen failure.

Standard Operating Procedures - SOP S73

Title: Standard Test Method for Particle-Size Distribution of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis

Reference Standard: ASTM D1633-17

Material Applicability: Fine-grained portion of soils

Target Property: Gradation

Units: Particle diameter (mm), % finer by mass

Test Equipment: 152H Hydrometer Bulb, Hydrometer sedimentation cylinders, No. 10 sieve, No. 200 sieve, 76 mm immersion Thermometer, Timing device, Balance, Drying oven, 250 ml mixing beaker, Drying pan for oven, Dispersion (Stirring) apparatus and cup.

Data Sheet: DS-S73H

Summary of Procedure:

1. The sample must be kept at as received moisture content if possible. An oven dried sample shall not be used. D6913, Sect 9 gives additional information regarding sampling.

2. Reduce the sample, if necessary, to a maximum particle size of 3/8 in. The mass of the reduced sample must meet or exceed D1633 Table 1.

3. Preparation of the sedimentation specimen shall be by the moist method unless the specimen was received in an air-dried state. Process the entire sample through a No. 10 sieve. Use test water, if needed, to aid in working the material through the sieve.

4. Estimate the amount of moist mass needed for the test using the equation using the equation found in D1633 Section 9.5:
   Est. Moist mass = 55 x (100 /estimate % - #200 Sieve) x (1+(estimate WC/100))

5. If the sample contains enough material, split or quarter into 2 portions: one for a water content and one for the sedimentation test. If not, obtain the dry mass of the specimen at the end of the test.

6. Record the mass of the moist specimen used for the test to the nearest 0.1%.

7. Place the specimen in the mixing beaker and record the identification of the container.

8. Add 5.0 ± 0.1 g of sodium hexametaphosphate to the specimen OR dissolve this amount in 100 mL of test water and then add it to the specimen. Record the actual amount of dispersant added to the nearest 0.01 g.

9. Mix the contents with a spatula or similar device until all the soil aggregations are broken up and a slurry is created.

10. Transfer the slurry to the dispersion cup of the mixing device. Use a wash bottle filled with test water to make sure all the slurry has been transferred. Add additional test water until the cup is half full and mix the slurry for about 1 minute.

11. Transfer all the slurry to the sedimentation cylinder (Hydrometer jar). Use the wash bottle as before. Add test water to bring the bottom of the meniscus to the 1000 ml mark.

12. Mix the slurry in the cylinder using the agitator device or the tipping method following the instructions given in section 11.3.2 of the standard method (Geotechnics prefers the tipping method).

13. Cover the cylinders to prevent evaporation and allow them to sit overnight. Repeat the mixing procedure described in section 11.3.2 of the method.

14. After the last cylinder inversion, set the cylinder on a stable flat surface and start the timer. Hydrometer readings shall be taken at approximately 1, 2, 4, 15, 30, 60, 240, and 1440 minutes.

15. About 15-20 seconds before the reading is due, gently place the hydrometer into the cylinder to a depth approximately equal to the level at which it will float. When it is stable record the reading to ¼ division and record the elapsed time.

16. Remove the hydrometer within 5-10 seconds with a steady motion. Any drop on the tip should be allowed to flow back into the cylinder by touching the hydrometer tip on the inside lip of the cylinder.

17. With a spinning motion, place the hydrometer into a wash cylinder filled with water to clean off the hydrometer. Dry it off prior to the next reading.

18. Immediately after taking the reading, gently insert the thermometer and record the temperature of the suspension. The first temperature may be used for the initial readings up to 30 minutes.

19. After the last hydrometer reading is obtained, transfer all the soil suspension to the oven drying pan. Facilitate the removal of the soil from the cylinder by agitation and wash

bottle use. Be sure to record the dry, empty weight of the pan and the weight of the pan plus the soil suspension so that the dry mass of the soil may be calculated.

20. Dry the suspension to a constant mass or 24 hours. If there is any doubt, the constant mass test must be performed after an addition 6 hours of oven drying.

21. Remove the container from the oven and allow it to cool in a desiccator or a tightly covered/sealed container. After the container has cooled, determine and record the dry mass of the container plus soil and dispersant to the nearest 0.01 g.

22. After recording the dry mass, cover the specimen with tap water and allow to soak. During soaking gently stir to disperse soil particles. Pour the soaked material over the #200 sieve, taking care not to lose any material. Remove any remining material from the span with a water spray.

23. Wash the material over the #200 until the wash water is clear. Transfer the material back to the oven drying pan, taking care not to lose any material. Dry the material overnight (12 to 16 h) to a constant mass using a forced air oven.

24. Remove the container from the oven and allow to cool in a desiccator or cover with a tight-fitting lid. After cooling, determine and record the dry mass of the +#200 material to the nearest 0.01g. Note: The dispersant will have been washed away.

25. All calculations will be performed by the excel computer template noted below. At the time this procedure was written, Geotechnics performs the Hydrometer Analysis only when done with an accompanying Sieve analysis (ASTM D6913 or D422 as requested). The appropriate SieveHyd computer template is chosen based on the material and client specifications.

26. Record all data on DCN: DS-S73H (Geoserver\GT-DB\ds\Hyddat D7928.xls. Transfer data to the appropriate SieveHyd computer template DCN: CT-S30B \Geoserver)\Excel\ExcelQA\Spreadsheets\(appropriate template).xls) .

APPENDIX D

CHAIN-OF-CUSTODY FORMS

APPENDIX E

EQAPP TABLES
(Provided to ELLE, LLC.)