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FINAL SAMPLING AND ANALYSIS PLAN FOR FORMER CARR POINT SHOOTING RANGE  
MUNITIONS RESPONSE PROGRAM SITE 1 OPERABLE UNIT 9 (OU 9) NS NEWPORT RI  
10/11/2013  
RESOLUTION CONSULTANTS

**SAMPLING AND ANALYSIS PLAN  
Former Carr Point Shooting Range  
(MRP Site 1, OU9), Naval Station (NAVSTA)  
Newport, Rhode Island**

**FINAL**

**Prepared for:**



**Department of the Navy  
Naval Facilities Engineering Command, Mid-Atlantic  
9742 Maryland Ave.  
Norfolk, VA 23511-3095**

**Contract Number N62470-11-D-8013**

**CTO WE06**

**Prepared by:**



**Resolution Consultants  
*A Joint Venture of AECOM & EnSafe*  
1500 Wells Fargo Building  
440 Monticello Avenue  
Norfolk, VA 23510**

**October 11, 2013**

**SAP Worksheet #1: Title and Approval Page**

**Final**

**SAMPLING AND ANALYSIS PLAN**

**October 11, 2013**

**Former Carr Point Shooting Range (MRP Site 1, OU9)  
NAVSTA, Newport, RI**

**Prepared for:  
Department of the Navy  
Naval Facilities Engineering Command, Mid-Atlantic  
9742 Maryland Ave.  
Norfolk, VA 23511-3095**

**Prepared by:  
Resolution Consultants  
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Melissa Cannon, CTO Manager  
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Janice Nielsen/Chemist, QA Manager  
US Navy

Date

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Maritza Montegross, Navy RPM  
US Navy

Date

SAP Worksheet #1: Title and Approval Page

Draft

**SAMPLING AND ANALYSIS PLAN**

November 5, 2012

Former Carr Point Shooting Range (MRP Site 1, OU9) and Former Carr Point Storage Area (IR Site 22, OU10)  
NAVSTA, Newport, RI

Prepared for:  
Department of the Navy  
Naval Facilities Engineering Command, Mid-Atlantic  
9742 Maryland Ave.  
Norfolk, VA 23511-3095

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Maritza Montegross, Navy RPM  
US Navy

Date

## EXECUTIVE SUMMARY

This Remedial Investigation (RI) Work Plan has been prepared in the form of a Sampling and Analysis Plan (SAP) by Resolution Consultants (Resolution), under contract with the U.S. Department of the Navy (Navy) and the Naval Facilities Engineering Command (NAVFAC). This SAP was prepared under the Navy's Environmental Restoration Program (ERP), which generally parallels the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process. This SAP specifically pertains to a planned field investigation and data evaluation at the Former Carr Point Shooting Range, Munitions Response Program (MRP) Site 1, Operable Unit (OU) 9 located at the Naval Station (NAVSTA) Newport, Rhode Island.

The primary objective of the planned investigation is to refine the conceptual site model (CSM) and position the site for an appropriate response action per the Navy's ERP and the United States Environmental Protection Agency's (USEPA's) CERCLA process. The specific goals of the investigation are listed below and further defined throughout this SAP:

- Goal 1 – Refine the extent of historical releases from prior operations
- Goal 2 – Evaluate the potential risk/hazard to human and ecological receptors exposed to site media

Matrices to be sampled include surface soil, subsurface soil, groundwater, sediment, and shellfish tissue. Analytical parameters to achieve the specific goals listed above are summarized in Table ES-1.

**Table ES-1**  
**Analytical Parameters Designed to Achieve Investigation Goals**  
**Carr Point Shooting Range (MRP Site 1, OU9), NAVSTA Newport, RI**

Analytical Parameter	Matrix
<b>Parameters of Interest</b>	
PAHs	SS, SB, SD, GW, TS, BS
Propellants (Nitroaromatics & Nitramines)	SS
Metals	SS, SB, SD, GW, TS, BS
Hexavalent Chromium	SS, SB, SD, GW, BS
Pellet count	SD
<b>Physical and Geochemical Data</b>	
TOC	SS, SB, SD, GW, BS
AVS/SEM	SD, BS
Grain size	SS, SB, SD, BS
pH	SS, SB, GW
Bulk density, porosity	SS, SB
Conductivity	SS, SB
ORP, DO	GW
TSS, TDS	GW
Alkalinity	GW
Chloride, nitrite/nitrate, sulfate	GW
Ortho-phosphate-P	GW
Ferrous Iron	GW
Methane, ethane, ethene	GW
Salinity	GW
Toxicity testing	SD, BS
Macroinvertebrate analysis	SD, BS
Percent Lipids	TS
VOCs, SVOCs	BS
PCBs	BS
Pesticides	BS

Notes:

SS – Surface soil, SB – Subsurface soil, GW – Groundwater, SD – Sediment,  
TS – Tissue, BS – Background Sediment

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## CONTENTS

SAP Worksheet #1: Title and Approval Page .....	WS 1-1
SAP Worksheet #2: Sampling and Analysis Plan Identifying Information .....	WS 2-1
SAP Worksheet #3: Distribution List .....	WS 3-1
SAP Worksheet #4: Project Personnel Sign-Off Sheet.....	WS 4-1
SAP Worksheet #5: Project Organizational Chart .....	WS 5-1
SAP Worksheet #6: Communication Pathways.....	WS 6-1
SAP Worksheet #7: Personnel Responsibilities Table.....	WS 7-1
SAP Worksheet #8: Special Personnel Training Requirements Table.....	WS 8-1
SAP Worksheet #9-1: Project Scoping Session Participants Sheet.....	WS 9-1
SAP Worksheet #10: Conceptual Site Model.....	WS 10-1
SAP Worksheet #11: Project Quality Objectives/Systematic Planning Process Statements ...	WS 11-1
SAP Worksheet #12-1 Measurement Performance Criteria – Field QC Samples .....	WS 12-1
SAP Worksheet #13: Secondary Data Criteria and Limitations Table.....	WS 13-1
SAP Worksheet #14: Summary of Project Tasks .....	WS 14-1
SAP Worksheet #15: Establishing Laboratory Reference Limits .....	WS 15-1
SAP Worksheet #16: Project Schedule/Timeline Table.....	WS 16-1
SAP Worksheet #17: Sampling Design and Rationale .....	WS 17-1
SAP Worksheet #18-1: Location-Specific Sampling Methods/SOP Requirements Table, Former Carr Point Shooting Range (MRP Site 1, OU9) .....	WS 18-1
SAP Worksheet #19: Field Sampling Requirements Table <sup>1</sup> .....	WS 19-1
SAP Worksheet #20: Field Quality Control Sample Summary Table .....	WS 20-1
SAP Worksheet #21: Project Sampling SOP References Table.....	WS 21-1
SAP Worksheet #22: Field Equipment Calibration, Maintenance, Testing, and Inspection Table .....	WS 22-1
SAP Worksheet #23-1: Analytical SOP References Table <sup>1</sup> .....	WS 23-1
SAP Worksheet #24: Analytical Instrument Calibration Table.....	WS 24-11
SAP Worksheet #25: Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table .....	WS 25-1
SAP Worksheet #26: Sample Handling System .....	WS 26-1
SAP Worksheet #27: Sample Custody Requirements.....	WS 27-1
SAP Worksheet #28-1: Laboratory QC Samples Table .....	WS 28-1
SAP Worksheet #29: Project Documents and Records Table.....	WS 29-1
SAP Worksheet #30: Analytical Services Table .....	WS 30-1
SAP Worksheet #31: Planned Project Assessments Table .....	WS 31-1
SAP Worksheet #32: Assessment Findings and Corrective Action Responses Table .....	WS 32-1
SAP Worksheet #33: Quality Assurance Management Reports Table .....	WS 33-1
SAP Worksheets #34-36: Data Verification and Validation (Steps I and IIa/IIb) Process Table .....	WS 34 - 36-1
SAP Worksheet #37: Usability Assessment.....	WS 37-1
References .....	R-1

## Figures

- Figure 1 Regional Location, Former Carr Point Shooting Range and Storage Area Sites
- Figure 2 Potential Exposure Pathways, Former Carr Point Shooting Range
- Figure 3 Proposed Soil Sample Locations, Former Carr Point Shooting Range
- Figure 4 Proposed Groundwater Sample Locations, Former Carr Point Shooting Range
- Figure 5 Proposed Near-Shore Sediment Sample Locations, Former Carr Point Shooting Range
- Figure 6 Conceptual Reference Sediment Sample Locations, Former Carr Point Shooting Range and Storage Area Sites
- Figure 7 Bedrock Elevation Contours, Groundwater Elevations, and Proposed Groundwater Monitoring Wells
- Figure 8 Sediment Sampling Process for MRP Site 1 Surficial and Sub-Surficial Samples
- Figure 9 Sampling Locations, Former Carr Point Storage Area and Shooting Range

## Appendices

(Refer to CD Provided with Document)

- Appendix A Resolution Consultants SOPs
- Appendix B Laboratory Certifications
- Appendix C Laboratory Chains-of Custody
- Appendix D Risk Assessment Work Plan Technical Memorandum, NAVSTA Newport

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## ACRONYMS AND ABBREVIATIONS

°C	Degrees Celsius
ARARs	Applicable or Relevant and Appropriate Requirements
AVS/SEM	Acid Volatile Sulfides/Simultaneously Extracted Metals
BERA	Ecological Risk Assessment
bgs	Below Ground Surface
BHHRA	Baseline Human Health Risk Assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLEAN	Comprehensive Long-Term Environmental Action, Navy
CoC	Chain-of-Custody
COC	Chemicals of Concern
COPC	Chemical of Potential Concern
CSM	Conceptual Site Model
CTO	Contract Task Order
DH	Dirty Hands
DL	Detection Limit
DO	Dissolved Oxygen
DoD	Department of Defense
DQI	Data Quality Indicator
DRO	Diesel Range Organic
EE/CA	Engineering Evaluation and Cost Analysis
ELAP	Environmental Laboratory Accreditation Program
ERA	Ecological Risk Assessment
FS	Feasibility Study
FTL	Field Team Leader
FTMR	Field Task Modification Request
GRO	Gasoline Range Organic
GPS	Global Positioning System
HHRA	Human Health Risk Assessment
IDW	Investigation-Derived Waste
IR	Installation Restoration
LOD	Limit of Detection
LOQ	Limit of Quantitation
MassDEP	Massachusetts Department of Environmental Protection
MCL	Maximum Contaminant Level
MRP	Munitions Response Program
MS/MSD	Matrix Spike/Matrix Spike Duplicate
MWR	Morale, Welfare and Recreation
NA	Not Applicable
NAVD	North American Vertical Datum
NAVFAC MIDLANT	Naval Facilities Engineering Command, Mid-Atlantic
NAVSTA	Naval Station
Navy	U.S. Department of the Navy
NEDD	Navy Electronic Data Deliverable
NIRIS	Naval Installation Restoration Information Solution
NTR	Navy Technical Representative
NTU	Nephelometric Turbidity Unit
ORP	Oxidation-Reduction Potential

OU	Operable Unit
OUPV	Operator of Uninspected Passenger Vehicle
PAHs	Polynuclear Aromatic Hydrocarbons
PAL	Project Action Limit
PCBs	Polychlorinated Biphenyls
PDF	Portable Document Format
PM	Project Manager
POC	Point of Contact
PQOs	Project Quality Objectives
PVC	Polyvinyl Chloride
QA/QC	Quality Assurance/Quality Control
QSM	Quality Systems Manual
RAOs	Remedial Action Objectives
Resolution	Resolution Consultants
RI	Remedial Investigation
RIDEM	Rhode Island Department of Environmental Management
RPD	Relative Percent Difference
RPM	Remedial Program Manager
RTC	Response to Comments
RV	Recreational Vehicle
RSL	Regional Screening Levels
SAP	Sampling and Analysis Plan
SDG	Sample Delivery Group
SI	Site Investigation
SOP	Standard Operating Procedure
SSO	Site Safety Officer
SVOCs	Semi-Volatile Organic Compounds
TAL	Target Analyte List
TAT	Turnaround Time
TBD	To Be Determined
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbons
TSS/TDS	Total Suspended Solids/Total Dissolved Solids
UFP-QAPP	Uniform Federal Policy for Quality Assurance Project Plans
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VOCs	Volatile Organic Compounds
WAMS	Water Area Munitions Study

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## SAP Worksheet #2: Sampling and Analysis Plan Identifying Information

[\(UFP-QAPP Manual Section 2.2.4\)](#)

Site Name/Number: Former Carr Point Shooting Range  
Munitions Response Program (MRP) Site 1

Operable Unit: Operable Unit (OU) 9 – MRP Site 1

Contractor Name: Resolution Consultants (Resolution)

Contract Number: N62470-11-D-8013

Contract Title: Atlantic Comprehensive Long-Term Environmental Action, Navy (CLEAN), Naval Facilities Engineering Command, Mid-Atlantic (NAVFAC MIDLANT)

Work Assignment Number: Contract Task Order (CTO) WE-06

1. This Sampling and Analysis Plan (SAP) was prepared in accordance with the requirements of the *Uniform Federal Policy for Quality Assurance Plans (UFP-QAPP)* (USEPA, 2005) and United States Environmental Protection Agency (USEPA) *Guidance for Quality Assurance Project Plans, USEPA QA/G-5* (USEPA, 2002c).
2. Regulatory program: IR Program, which follows the general framework of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), with consideration of Rhode Island Department of Environmental Management (RIDEM) review and input.
3. This SAP is a Tier I project-specific SAP for MRP Site 1.
4. List organizational partners (stakeholders) and identify the connection with lead organization:

Organization Partners/Stakeholders	Connection
Navy, NAVFAC MIDLANT	Responsible Federal Agency
USEPA, Region 1	Federal Regulatory Agency
RIDEM	State Regulatory Agency

5. Lead organization: NAVFAC MIDLANT
6. If any required SAP elements and required information are not applicable to the project or are provided elsewhere, then note the omitted SAP elements and provide an explanation for their exclusion below: N/A

### SAP Worksheet #3: Distribution List

[\(UFP-QAPP Manual Section 2.3.1\)](#)

SAP Recipients	Title	Organization	Telephone Number (optional)	E-mail Address or Mailing Address
Winoma Johnson	Navy Northeast IPT Leader	NAVFAC MIDLANT	757.341.2008	<a href="mailto:Winoma.Johnson@navy.mil">Winoma.Johnson@navy.mil</a>
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Melissa Cannon	CTO Manager	Resolution	978.400.1213	<a href="mailto:Melissa.Cannon@aecom.com">Melissa.Cannon@aecom.com</a>
Constance Lapite	Project Chemist/Data Validation Manager	Resolution	781.224.6628	<a href="mailto:Constance.Lapite@aecom.com">Constance.Lapite@aecom.com</a>
Ryan McCarthy	Sediment Scientist	Resolution	978.905.2312	<a href="mailto:Ryan.McCarthy@aecom.com">Ryan.McCarthy@aecom.com</a>
Julie Kabel	Human Health Risk Assessor	Resolution	603.263.2145	<a href="mailto:Julie.Kabel@aecom.com">Julie.Kabel@aecom.com</a>

<b>SAP Recipients</b>	<b>Title</b>	<b>Organization</b>	<b>Telephone Number (optional)</b>	<b>E-mail Address or Mailing Address</b>
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Josh Millard	Field Team Leader/Site Safety Officer	Resolution	978.905.2324	<a href="mailto:Joshua.Millard@aecom.com">Joshua.Millard@aecom.com</a>
Jennifer Obrin	Analytical Laboratory Manager	Katahdin Analytical, Inc.	207.874.2400 x17	<a href="mailto:jobrin@katahdinlab.com">jobrin@katahdinlab.com</a>
Kathryn Kelly*	Analytical Laboratory Manager	Test America Burlington	802.660.1990	<a href="mailto:Kathryn.Kelly@testamericainc.com">Kathryn.Kelly@testamericainc.com</a>
Ken Simon	Analytical Laboratory Manager	EnviroSystems, Inc.	603.926.3345	<a href="mailto:ksimon@envirosystems.com">ksimon@envirosystems.com</a>
Jim Blake	Analytical Laboratory Manager	Resolution	508.457.7900	<a href="mailto:James.Blake@aecom.com">James.Blake@aecom.com</a>
Michael Perry*	Analytical Laboratory Manager	ALS Rochester	585.288.5380	<a href="mailto:Michael.Perry@alsglobal.com">Michael.Perry@alsglobal.com</a>
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Kenneth Munney	Technical Representative and Trustee	USFWS	603.223.2541	Kenneth.Munney@fws.gov
Kenneth Finkelstein	Technical Representative and Trustee	NOAA	617.918.1499	ken.finkelstein@noaa.gov

Notes:  
Distribution of the SAP can include a copy on the submittal cover letter, a hardcopy, an electronic copy via CD or email and/or an upload via NIRIS. Distribution may vary depending on the deliverable version (e.g., draft, draft final, final) and/or individual preferences of SAP recipients.

\*The laboratory is subcontracted by Katahdin Analytical, Inc. therefore, communications with this laboratory must include the Katahdin Analytical Laboratory Manager.

**SAP Worksheet #4: Project Personnel Sign-Off Sheet**

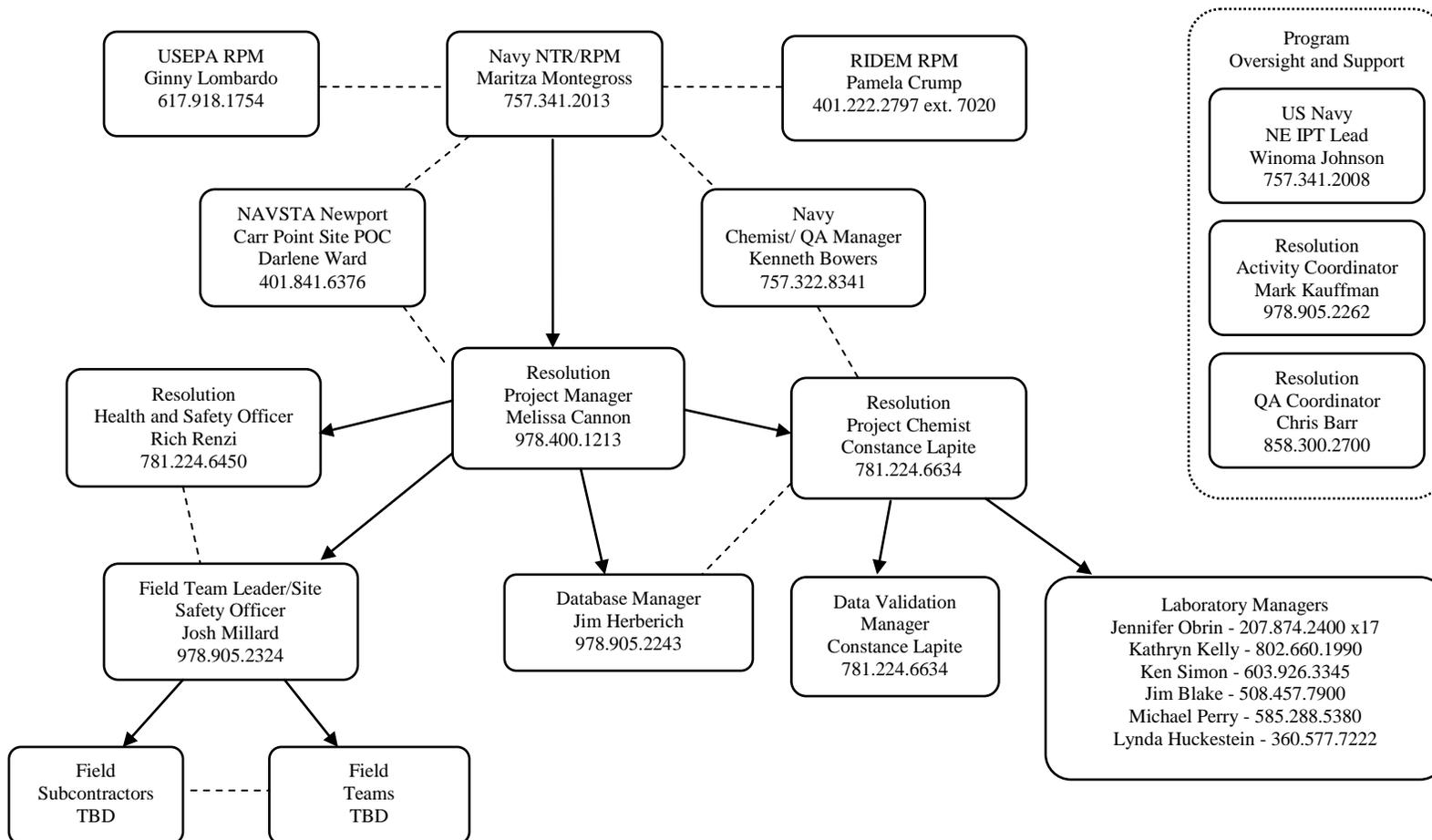
[\(UFP-QAPP Manual Section 2.3.2\)](#)

All key personnel to receive a copy of this project-specific SAP will be required to read and understand the SAP prior to performing project tasks. The following table will be modified as applicable and used to document this. This table as well as worksheet #1 will be completed and maintained within Resolution's files.

Project Personnel	Title/Organization	Telephone Number	Signature	Date
Maritza Montegross	Navy Technical Representative (NTR)/ Remedial Project Manager (RPM), NAVFAC MIDLANT	757.341.2013		
Mark Kauffman	Activity Coordinator, Resolution	978.905.2262		
Melissa Cannon	CTO Manager, Resolution	978.400.1213		
Constance Lapite	Project Chemist/ Data Validation Manager, Resolution	781.224.6628		
Ryan McCarthy	Sediment Scientist, Resolution	978.905.2312		
Julie Kabel	Human Health Risk Assessor, Resolution	603.263.2145		
Christine Archer	Ecological Risk Assessor, Resolution	603.622.1556		
Josh Millard	Field Team Leader/ Site Safety Officer, Resolution	978.905.2324		
Jennifer Obrin	Analytical Laboratory Manager, Katahdin Analytical, Inc.	207.874.2400 x17		
Kathryn Kelly	Analytical Laboratory Manager, Test America Burlington	802.660.1990		
Ken Simon	Analytical Laboratory Manager, EnviroSystems, Inc.	603.926.3345		
Jim Blake	Analytical Laboratory Manager, Resolution	508.457.7900		
Michael Perry	Analytical Laboratory Manager, ALS Rochester	585.288.5380		
Lynda Huckestein	Analytical Laboratory Manager, ALS Kelso	360.577.7222		

### SAP Worksheet #5: Project Organizational Chart

Lines of Authority ————— Lines of Communication - - - - -



## SAP Worksheet #6: Communication Pathways

[\(UFP-QAPP Manual Section 2.4.2\)](#)

The communication pathways for the SAP are shown below.

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathway To/From, etc.)
Regulatory Agency Interface	NAVFAC MIDLANT	Maritza Montegross	757.341.2013	Navy RPM will interface with Regulatory Agency directly via phone or email as needed.
Field Progress Reports	Resolution	Melissa Cannon	978.400.1213	The Resolution Field Team Leader will email daily field progress reports to the Resolution PM. In addition, there will be phone conversation between the Resolution Field Team Leader and the Resolution PM as needed.
Stop Work due to Safety Issues	Resolution	SSO – Josh Millard	978.905.2324	The Resolution SSO will verbally inform onsite personnel, including subcontractors as soon as possible. The Resolution SSO will verbally inform the Resolution PM of the Stop Work condition as well as when it is resolved. As need be, the Resolution SSO and/or PM will work with the Resolution Health & Safety Officer to resolve issues.
SAP/WP Changes prior to Field/Laboratory Work	Resolution	Melissa Cannon	978.400.1213	The Resolution PM will notify the Navy RPM either verbally or via email of any planned amendments to the SAP. The Resolution PM will document the changes via a Field Task Modification Request (FTMR) form and a concurrence letter.
SAP/WP Changes in the Field	Resolution	FTL – Josh Millard	978.905.2324	The Resolution Field Team Leader will verbally notify the Resolution PM as soon as practical of realizing a need for an amendment. The Resolution PM will notify the Navy RPM either verbally or via email the same day of the realized change and the changes will be documented in a scheduled impact letter to the Navy RPM.
Field Corrective Actions	Resolution	FTL – Josh Millard	978.905.2324	The need for corrective action for field issues will be determined by the Resolution Field Team Leader. The Resolution Field Team Leader will notify the Resolution PM.
Sample Receipt Variances	Resolution	Constance Lapite	781.224.6634	The laboratory will notify the Resolution Project Chemist of any issues with respect to sample receipt. The Resolution Project Chemist will notify the Resolution PM and/or Field Team Leader.
Reporting Lab Quality Variances	Resolution	Constance Lapite	781.224.6634	The laboratory will notify the Resolution Project Chemist of any issues in the analytical report case narrative.
Analytical Corrective Actions	Resolution	Constance Lapite	781.224.6634	The need for corrective action for analytical issues will be determined by the Resolution Project Chemist.

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathway To/From, etc.)
Laboratory Quality Issues	Resolution	Constance Lapite	781.224.6634	The Resolution Project Chemist will make the Resolution PM aware of any laboratory quality issues. The Resolution PM will notify the Navy RPM if any laboratory quality issues will significantly impact the project (i.e., significant meaning data is not useable or project schedule or costs have been majorly impacted). As appropriate, the Navy RPM will notify the Navy Chemist to ensure other Navy projects are not impacted.
Reporting Data Validation Issues	Resolution	Constance Lapite	781.224.6634	The Resolution Project Chemist will provide the Resolution PM with a report of any issues affecting data quality as identified during the validation process. As necessary, the Resolution Project Chemist will notify the laboratory as soon as possible if issues are found with the data and work with the laboratory to resolve any issues.
Data Validation Corrective Actions	Resolution	Constance Lapite	781.224.6634	The Resolution Project Chemist will notify the Resolution PM of any actions that may be required as a result of the data validation.

**SAP Worksheet #7: Personnel Responsibilities Table**

[\(UFP-QAPP Manual Section 2.4.3\)](#)

Title/Role	Organizational Affiliation	Responsibilities
Maritza Montegross, RPM	NAVFAC MIDLANT	Responsible for coordination/oversight of IR activities at Carr Point.
Mark Kauffman, Activity Coordinator	Resolution	Provides senior oversight and review. Coordination among NAVSTA Newport sites.
Melissa Cannon, CTO Manager	Resolution	Responsible for coordination/oversight of investigation activities associated with this SAP.
Constance Lapite, Project Chemist	Resolution	Responsible for oversight of/coordination with laboratory and data validators and management of sample tracking.
Rich Renzi, H&S Officer	Resolution	Responsible for oversight of health and safety for field activities.
Josh Millard, FTL/SSO	Resolution	Responsible for coordination of field activities; supervises field events; ensures the implementation of the health and safety plan.
Jennifer Obrin, Laboratory PM	Katahdin Analytical, Inc.	Responsible for coordination/oversight of analytical services for Katahdin. Responsible for subcontracting Test America Burlington and ALS Rochester.
Kathryn Kelly, Laboratory PM	Test America Burlington	Responsible for coordination/oversight of analytical services.
Ken Simon, Laboratory PM	EnviroSystems, Inc.	Responsible for coordination/oversight of analytical services.
Michael Perry, Laboratory PM	ALS Rochester	Responsible for coordination/oversight of analytical services.
Lynda Huckestein, Laboratory PM	ALS Kelso	Responsible for coordination/oversight of analytical services.
Jim Blake, Laboratory PM	Resolution	Responsible for coordination/oversight of analytical services.
Julie Kabel, Project HHRA	Resolution	Responsible for oversight/coordination of human health risk assessment.
Christine Archer, Project ERA	Resolution	Responsible for oversight/coordination of ecological risk assessment.
Ryan McCarthy, Sediment Scientist	Resolution	Responsible for oversight/coordination of field activities associated with diving and sediment sampling.

**SAP Worksheet #8: Special Personnel Training Requirements Table**

[\(UFP-QAPP Manual Section 2.4.4\)](#)

<b>Project Function</b>	<b>Specialized Training By Title or Description of Course</b>	<b>Training Provider</b>	<b>Training Date</b>	<b>Personnel/Groups Receiving Training</b>	<b>Personnel Titles/ Organizational Affiliation</b>	<b>Location of Training Records/Certificates</b>
Scientific Diving Surveys	Open Water SCUBA Diving, DAN First AID for Professional Divers	NAUI/PADI, DAN	2001 to 2004, 2008	All members of the scientific dive team, Dive Safety Officer	Dive Safety Officer, Lead Scientific Diver, Scientific Diver, Scientific Dive Tender-Resolution	Copies present on site/electronic archives
Sediment Survey	Operator of Uninspected Passenger Vehicle License (OUPV)	USGS	2008	Vessel captains responsible for Sediment Surveys	Vessel Captains – OSI	Copies present on site/electronic archives

## SAP Worksheet #9-1: Project Scoping Session Participants Sheet

[\(UFP-QAPP Manual Section 2.5.1\)](#)

<b>Project Name:</b>	MRP Site 1 SAP	<b>Site Name:</b>	Former Carr Point Shooting Range (MRP Site 1, OU9)		
<b>Projected Date(s) of Sampling:</b>	Spring 2013	<b>Site Location:</b>	Carr Point, NAVSTA, Newport, RI		
<b>Project Manager:</b>	Melissa Cannon				
<b>Date of Session:</b>	5/22/2012				
<b>Scoping Session Purpose:</b>	Partnering Team Meeting				
Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Maritza Montegross	NTR/RPM	NAVFAC MIDLANT	757.341.2013	<a href="mailto:Maritza.Montegross@navy.mil">Maritza.Montegross@navy.mil</a>	Coordinates IR Activities
Tom Campbell	Former Project Manager	Tetra Tech	978.474.8400	<a href="mailto:Thomas.Campbell@tetrattech.com">Thomas.Campbell@tetrattech.com</a>	Former Contract Project Manager
Mark Kauffman	Activity Coordination	Resolution	978.905.2262	<a href="mailto:Mark.Kauffman@aecom.com">Mark.Kauffman@aecom.com</a>	Senior Oversight/Review
Melissa Cannon	CTO Manager	Resolution	978.400.1213	<a href="mailto:Melissa.Cannon@aecom.com">Melissa.Cannon@aecom.com</a>	Oversight of SAP Production

### Comments/Decisions:

- Discussed the scope of the investigation.
- Discussed the history of MRP Site 1, specifically previous work conducted as part of the SI.
- Navy provided insight on planned Engineering Evaluation/Cost Analysis (EE/CA).
- Resolution was informed that there was a subsurface drainage pipe underlying the MRP Site 1 with a discharge point (outfall) along the shoreline of Narragansett Bay.
- Navy indicated that MRP Site 1 is serviced by municipal water (i.e., no drinking water wells present on-site).

### Action Items:

- Set up a separate call as needed with the risk assessors.

Consensus Decisions:

- SAP needs to be a Tier I SAP.
- Need to include future residential exposure pathway.
- Need to evaluate drinking water for potability.
- Need to add soil sampling at outfall discharge point.
- Include macroinvertebrate sampling, toxicity testing, and additional physical and geochemical parameters in the SAP to avoid second mobilization, particularly for sediment where the mobilization has a larger impact.

## SAP Worksheet #9-2: Project Scoping Session Participants Sheet

[\(UFP-QAPP Manual Section 2.5.1\)](#)

<b>Project Name:</b>	MRP Site 1 SAP	<b>Site Name:</b>	Former Carr Point Shooting Range (MRP Site 1, OU9)		
<b>Projected Date(s) of Sampling:</b>	Spring 2013	<b>Site Location:</b>	Carr Point, NAVSTA, Newport, RI		
<b>Project Manager:</b>	Melissa Cannon				
<b>Date of Session:</b>	7/23/2012				
<b>Scoping Session Purpose:</b>	Partnering Team Meeting				
Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Tim Reisch	Navy Northeast IPT	NAVFAC MIDLANT	757.341.2015	<a href="mailto:Timothy.Reisch@navy.mil">Timothy.Reisch@navy.mil</a>	Coordinates NE Activities
Winoma Johnson	Navy Northeast IPT Leader	NAVFAC MIDLANT	757.341.2008	<a href="mailto:Winoma.Johnson@navy.mil">Winoma.Johnson@navy.mil</a>	Senior Oversight/Review
Maritza Montegross	NTR/RPM	NAVFAC MIDLANT	757.341.2013	<a href="mailto:Maritza.Montegross@navy.mil">Maritza.Montegross@navy.mil</a>	Coordinates IR Activities
Mark Kauffman	Activity Coordination	Resolution	978.905.2262	<a href="mailto:Mark.Kauffman@aecom.com">Mark.Kauffman@aecom.com</a>	Senior Oversight/Review
Melissa Cannon	CTO Manager	Resolution	978.400.1213	<a href="mailto:Melissa.Cannon@aecom.com">Melissa.Cannon@aecom.com</a>	Oversight of SAP Production

### Comments/Decisions:

- Discussed SAP schedule.
- Discussed need for the two OUs to be separate sites; however, will proceed with one SAP for both sites.
- Discussed need for full analytical parameters; needed for RI/risk assessment purposes.
- Discussed need for petroleum hydrocarbons sampling.
- Discussed groundwater classification/need for sampling of salinity.
- Discussed Project Action Limits (PALs); Navy provided input on typical discussion/coordination with the laboratories to meet the PALs.

### Action Items:

- Navy to provide initial comments on Worksheets #10, #11 and #17 by 7/27/2012.

Consensus Decisions:

- Need to create a revised project schedule.
- Need to include petroleum hydrocarbons analysis; however, make clear that it not required for CERCLA.
- Need to include assessment of salinity to evaluate potability of the groundwater.

### SAP Worksheet #9-3: Project Scoping Session Participants Sheet

[\(UFP-QAPP Manual Section 2.5.1\)](#)

<b>Project Name:</b>	MRP Site 1 SAP	<b>Site Name:</b>	Former Carr Point Shooting Range (MRP Site 1, OU9)		
<b>Projected Date(s) of Sampling:</b>	Spring 2013	<b>Site Location:</b>	Carr Point, NAVSTA, Newport, RI		
<b>Project Manager:</b>	Melissa Cannon				
<b>Date of Session:</b>	9/14/2012 & 9/18/12				
<b>Scoping Session Purpose:</b>	Partnering Team Meeting				
Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Tim Reisch	Navy Northeast IPT	NAVFAC MIDLANT	757.341.2015	<a href="mailto:Timothy.Reisch@navy.mil">Timothy.Reisch@navy.mil</a>	Coordinates NE Activities
Winoma Johnson	Navy Northeast IPT Leader	NAVFAC MIDLANT	757.341.2008	<a href="mailto:Winoma.Johnson@navy.mil">Winoma.Johnson@navy.mil</a>	Senior Oversight/Review
Maritza Montegross	NTR/RPM	NAVFAC MIDLANT	757.341.2013	<a href="mailto:Maritza.Montegross@navy.mil">Maritza.Montegross@navy.mil</a>	Coordinates IR Activities
Dave Barclift	Navy Risk Assessor	NAVFAC MIDLANT	215.897.4913	<a href="mailto:David.Barclift@navy.mil">David.Barclift@navy.mil</a>	Risk Assessor
Jen Corack	Navy Risk Assessor	NAVFAC MIDLANT	757.953.0950	<a href="mailto:Jennifer.Corak@med.navy.mil">Jennifer.Corak@med.navy.mil</a>	Risk Assessor
Kenneth Bowers	Navy Chemist/QA Manager	NAVFAC MIDLANT	757.322.8341	<a href="mailto:Kenneth.Bowers@navy.mil">Kenneth.Bowers@navy.mil</a>	Chemist/QA Manager
Mark Kauffman	Activity Coordination	Resolution	978.905.2262	<a href="mailto:Mark.Kauffman@aecom.com">Mark.Kauffman@aecom.com</a>	Senior Oversight/Review
Melissa Cannon	CTO Manager	Resolution	978.400.1213	<a href="mailto:Melissa.Cannon@aecom.com">Melissa.Cannon@aecom.com</a>	Oversight of SAP Production
Jenny Phillips	Senior Risk Assessor	Resolution	970.493.8878	<a href="mailto:Jenny.Phillips@aecom.com">Jenny.Phillips@aecom.com</a>	Senior Risk Assessor
Julie Kabel	Human Health Risk Assessor	Resolution	603.263.2145	<a href="mailto:Julie.Kabel@aecom.com">Julie.Kabel@aecom.com</a>	Human Health Risk Assessor
Christine Archer	Ecological Risk Assessor	Resolution	603.622.1556	<a href="mailto:Christine.Archer@aecom.com">Christine.Archer@aecom.com</a>	Ecological Risk Assessor

#### Comments/Decisions:

- Discussed whether the Risk Assessment Work Plan Technical Memorandum would be site-specific document or generic document for NAVSTA Newport, RI and whether it would be a standalone document or included with every SAP.

- Discussed dispute resolutions [comparison of results to chemical-based Applicable or Relevant and Appropriate Requirements (ARARs)]
- Discussed separating sites into two distinct OUs with separate SAP worksheet sections as-warranted.
- Discussed the need to use the SI data to limit SAP needs for RI.
- Discussed the need to better align the objective of the SAP with the planned sampling program and prior SI results.
- Discussed the need for phased approach versus collecting additional parameters to minimize second mobilization.
- Discussed media to be sampled and which analytical parameters are applicable based on the SI.
- Resolution became aware that there was supplemental SI data collected in January 2010 and presented in a separate Technical Memorandum. Discussed incorporating that data to refine the planned sampling locations and parameters.
- SAP needs to be clear how results will be compared to background conditions, used for risk assessment, and compared to chemical-specific ARARs.
- Discussed the approach for pellet counting and material that will be submitted for laboratory analysis.
- Discussed need for the bathymetry survey. Not yet necessary.
- Discussed background data, available data and data needs.
- Discussed the need for additional physical and geochemical parameters to characterize chemical behavior, and FS alternative evaluations if necessary.
- Discussed the need for a contaminated watershed document for this site. No need identified.
- Discussed the need for surface water sampling. No water bodies on-site. No need identified.

Action Items:

- Revise Internal Draft SAP and resubmit to the Navy by 10/15/2012.

Consensus Decisions:

- The Risk Assessment Work Plan Technical Memorandum will be a NAVSTA Newport document to outline the framework for the risk assessments, and will be attached to the SAP. Site-specific details specific to Carr Point will be incorporated into the SAP worksheets, as necessary.
- The historic SI data will be incorporated into the SAP and used to limit the SAP needs for the RI.

- The media to be sampled include: soil, groundwater, and sediment. No surface water sampling is warranted.
- The parameters of interest at the Former Shooting Range are Target Analyte List (TAL) metals and polycyclic aromatic hydrocarbons (PAHs).
- Surface water sampling was eliminated from the scope of work.
- The approach for pellet counting and preparing samples for analytical is sufficient.
- The bathymetric survey will be eliminated as it does not provide a baseline for this site and if needed for future purposes, it will need to be redone at that time; therefore, it does not provide value now.
- Agreed that background sediment data will be collected as part of this SAP.
- The SAP will need to include the collection of upgradient groundwater data for comparison purposes.
- Remove toxicity characteristic leaching procedure (TCLP) analysis.
- Agreed that a contaminated watershed document would not be necessary for this site; however, we will need to document the other potential sources.
- Sediment toxicity testing will be conducted at MRP Site 1.

## SAP Worksheet #9-4: Project Scoping Session Participants Sheet

[\(UFP-QAPP Manual Section 2.5.1\)](#)

<b>Project Name:</b>	MRP Site 1 SAP	<b>Site Name:</b>	Former Carr Point Shooting Range (MRP Site 1, OU9)		
<b>Projected Date(s) of Sampling:</b>	Spring 2013	<b>Site Location:</b>	Carr Point, NAVSTA, Newport, RI		
<b>Project Manager:</b>	Melissa Cannon				
<b>Date of Session:</b>	10/11/2012				
<b>Scoping Session Purpose:</b>	Telephone conversation to obtain information on current on-site workers				
Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Maritza Montegross	NTR/RPM	NAVFAC MIDLANT	757.341.2013	<a href="mailto:Maritza.Montegross@navy.mil">Maritza.Montegross@navy.mil</a>	Coordinates IR Activities
Mark Kauffman	Activity Coordinator	Resolution	978.905.2262	<a href="mailto:Mark.Kauffman@aecom.com">Mark.Kauffman@aecom.com</a>	Senior Oversight/Review

### Comments/Decisions:

- Discussed the current on-site workers present at MRP Site 1.

### Consensus Decisions:

- There is minimal periodic maintenance worker activity at MRP Site 1. Per the RPM, there is an occasional visit by site workers to unlock the chain link fence for RV campers or landscapers. The landscapers mow the lawn for an estimated duration of 2 hours, at a frequency of 2 times per month. Other infrequent site activities may include routine road or landscape maintenance from storm or winter damage. Those events would be an estimated duration of 4 hours, at a frequency of 2 times per year. Nearby picnic tables located in the RV area are not typically used by site workers.

## SAP Worksheet #9-5: Project Scoping Session Participants Sheet

[\(UFP-QAPP Manual Section 2.5.1\)](#)

<b>Project Name:</b>	MRP Site 1 SAP	<b>Site Name:</b>	Former Carr Point Shooting Range (MRP Site 1, OU9)		
<b>Projected Date(s) of Sampling:</b>	Spring 2013	<b>Site Location:</b>	Carr Point, NAVSTA, Newport, RI		
<b>Project Manager:</b>	Melissa Cannon				
<b>Date of Session:</b>	10/25-26/2012				
<b>Scoping Session Purpose:</b>	Partnering Team Meeting				
Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Winoma Johnson	Navy Northeast IPT Leader	NAVFAC MIDLANT	757.341.2008	<a href="mailto:Winoma.Johnson@navy.mil">Winoma.Johnson@navy.mil</a>	Senior Oversight/Review
Maritza Montegross	NTR/RPM	NAVFAC MIDLANT	757.341.2013	<a href="mailto:Maritza.Montegross@navy.mil">Maritza.Montegross@navy.mil</a>	Coordinates IR Activities
Dave Barclift	Navy Risk Assessor	NAVFAC MIDLANT	215.897.4913	<a href="mailto:David.Barclift@navy.mil">David.Barclift@navy.mil</a>	Risk Assessor
Jen Corack	Navy Risk Assessor	NAVFAC MIDLANT	757.953.0950	<a href="mailto:Jennifer.Corak@med.navy.mil">Jennifer.Corak@med.navy.mil</a>	Risk Assessor
Mark Kauffman	Activity Coordinator	Resolution	978.905.2262	<a href="mailto:Mark.Kauffman@aecom.com">Mark.Kauffman@aecom.com</a>	Senior Oversight/Review
Melissa Cannon	CTO Manager	Resolution	978.400.1213	<a href="mailto:Melissa.Cannon@aecom.com">Melissa.Cannon@aecom.com</a>	Oversight of SAP Production
Julie Kabel	Human Health Risk Assessor	Resolution	603.263.2145	<a href="mailto:Julie.Kabel@aecom.com">Julie.Kabel@aecom.com</a>	Human Health Risk Assessor
Christine Archer	Ecological Risk Assessor	Resolution	603.622.1556	<a href="mailto:Christine.Archer@aecom.com">Christine.Archer@aecom.com</a>	Ecological Risk Assessor

### Comments/Decisions:

- Discussed/refined the Study Goals associated with the SAP.
- Discussed/refine language associated with the PALs.
- Discussed approach to toxicity testing.
- Discussed specific topics associated with the HHRA and ERA.
- Discussed background/reference sediment sampling approach.

Action Items:

- Draft SAP to be submitted to the regulatory agencies for review by 11/5/12.

Consensus Decisions:

- It was decided that additional volume of sediment would be collected at the surficial sediment sample locations at MRP Site 1 and the background/reference locations; that a rush 7-day turnaround time (TAT) would be requested for analytical parameters at these locations; upon receipt of analytical parameters, sample would then be released for additional analysis, including toxicity analysis.
- It was decided that all background/reference sediment samples would be submitted for metals, PAHS, and pesticides analyses. Other parameters may be analyzed in the samples selected for toxicity testing at MRP Site 1 to rule out additional stressors.
- It was determined that groundwater data would be evaluated directly to evaluate groundwater quality instead of the evaluation of soil in comparison to soil to groundwater screening levels.

## **SAP Worksheet #10: Conceptual Site Model**

[\(UFP-QAPP Manual Section 2.5.2\)](#)

### **Overview**

The Former Carr Point Shooting Range (MRP Site 1) is situated within a coastal portion of the Naval Station (NAVSTA), Newport, Rhode Island. MRP Site 1 is adjacent to the Former Carr Point Storage Area (IR Site 22), which is undergoing a separate investigation and is the subject of a separate RI Work Plan (SAP). MRP Site 1 encompasses approximately 4 acres of land along an estimated 500-foot bank of Narragansett Bay. Additionally, the planned investigation area for MRP Site 1 will also encompass an estimated 17 acres of the adjacent East Passage of Narragansett Bay to assess potential offshore site impacts from prior operations. Refer to Figure 1 for the regional location.

Three reference documents are available that best describe the operational history, physical characteristics, and other key elements of the CSM: the Water Area Munitions Study (WAMS) Report (Malcolm Pirnie, 2005), the Site Investigation (SI) Report (Tetra Tech, 2010a) and the Recreational Risk Assessment Technical Memorandum (Tetra Tech, 2010b). These three reference documents provide the majority of information discussed in this worksheet.

The following CSM figures have been developed to support this worksheet and the overall approach to the planned site investigation.

- Figure 1 – Regional Location, Former Carr Point Shooting Range and Storage Area Sites
- Figure 2 – Potential Exposure Pathways, Former Carr Point Shooting Range
- Figure 3 – Proposed Soil Sample Locations, Former Carr Point Shooting Range
- Figure 4 – Proposed Groundwater Sample Locations, Former Carr Point Shooting Range
- Figure 5 – Proposed Near-Shore Sediment Sample Locations, Former Carr Point Shooting Range
- Figure 6 – Conceptual Reference Sediment Sample Locations, Former Carr Point Shooting Range and Storage Area Sites
- Figure 7 – Bedrock Elevation Contours, Groundwater Elevations, and Proposed Groundwater Monitoring Wells
- Figure 8 – Sediment Sampling Process for MRP Site 1 Surficial and Sub-Surficial Samples
- Figure 9 - Sampling Locations, Former Carr Point Storage Area and Shooting Range

### **Operational History**

The Former Carr Point Shooting Range (MRP Site 1) was a recreational skeet-shooting range where small arms (i.e., shotguns) were discharged at moving targets over the water. The range was used by Navy personnel from 1967 to 1973, and subsequently by the Aquidneck Island Military Rod and

Gun Club from 1975 to 1989 (Malcolm Pirnie, 2005). During its use, clay pigeons were launched toward Narragansett Bay, and shot guns were fired at the targets as they flew over the water. As such, targets and ammunition dropped into the water or adjacent shoreline, with shells and casings released at the firing points (Malcolm Pirnie, 2005).

Initially one firing arc and one firing fan were identified. As shown on the attached figures, the "arc" refers to onshore areas where participants fired at the targets, and the "fan" refers to offshore landing areas that were impacted by the lead shot and targets. The estimated firing fan sizes were adjusted in January 2009 (Tetra Tech, 2010a), when additional records not provided in the WAMS report were discovered. The additional records showed the presence of a second firing arc, with anecdotal evidence suggesting the presence of a third firing arc (not previously depicted on drawings or maps).

The firing fan extends over the water 20 degrees to the left of the southernmost range and 20 degrees to the right of the northernmost range. In addition, the area of potential target fragment accumulation ("target area") was estimated to be 300 feet and a conservative estimate for potential lead shot accumulation ("overshoot area") was estimated to be 900 feet (Malcolm Pirnie, 2005). The estimated firing fan, including the target and overshoot areas, are depicted on Figure 5.

The report also confirmed the presence of clay pigeon fragments and casings along the shoreline at the western edge of the former shooting range, which were also reported along the low cliffs and beach rocks (Malcolm Pirnie, 2005).

Buildings associated with the Former Carr Point Shooting Range (MRP Site 1) include Building 233 (Club House). This building was demolished on March 15, 2011.

In addition, there is also reportedly an underground pipe which discharges to Narragansett Bay beneath this portion of Carr Point; however, no other information, such as construction details or origination, is available.

### **Current Site Use**

The Former Carr Point Shooting Range (MRP Site 1) is currently used as a Recreational Vehicle (RV) campground for Navy and Department of Defense (DoD) personnel and has been since 1995. The RV Park is open from Memorial Day weekend through October for rental by DoD personnel and active/retired military and their families. It is not available for use by the general public. The RV Park visitors are allowed to stay for up to 2 weeks per year. Current workers within MRP Site 1 include RV Park management and maintenance workers within the RV Park. Trespassers may also access MRP Site 1. There are no existing buildings on MRP Site 1.

Terrestrial portions of MRP Site 1, including areas of maintained lawn, may provide habitat for ecological receptors such as plants, soil invertebrates, and small birds and mammals. However, pavement and gravel areas are unlikely to provide suitable habitat or foraging areas for many ecological receptors.

Groundwater at the site is not currently being used for potable use, there are no drinking water wells present on site, and the site is served by the municipal water supply.

MRP Site 1 is located adjacent to the Narragansett Bay. However, human access to the bay and the shoreline from the site is limited by overgrown vegetation with only one walking path/access point at the north side of MRP Site 1. There is also a sign posted on the site restricting swimming and shellfishing in the bay. Shellfishing is currently prohibited in the majority of Narragansett Bay (RIDEM, 2012). Along the majority of the shoreline, sediment is covered by stones and cobbles and may provide habitat for benthic invertebrates.

The former clay pigeon launching area, portions of the former firing arcs and the area immediately downgradient of the former firing arcs are separated from the remaining portions of the MRP Site 1 by a secure chain-link fence, demarking an approximate 27,000 square foot area with the highest estimated impacts from prior shooting range activities. A portion of this area was addressed by a recent surface soil removal action. Refer to the Engineering Evaluation and Cost Analysis (EE/CA) prepared by the Navy (Tetra Tech, 2012) for further background detail pertaining to the former clay pigeon launching area/firing arcs. The Navy is currently completing a removal action completion report. Please refer to Figure 3 for the location of the fenced area and surface soil removal area.

### **Topography and Geology**

The topographic profile of Carr Point and most of NAVSTA Newport is generally flat with a mean elevation of approximately 25 feet above sea level. The Former Carr Point Shooting Range (MRP Site 1) is flat and slopes downward toward the beach. Portions of Carr Point may have historically been filled (Tetra Tech, 2010a).

Located within the Narragansett Basin are primarily Pennsylvanian aged sedimentary rocks. The bedrock at Carr Point is predominately a Phyllite with varying amounts of weathering in the upper two to five feet. Soil types reportedly consist of silt and sandy loam on the east side, with sand, gravel, cobbles, stones, boulders, and rocks on the west side (Malcolm Pirnie, 2005). A basal till from 5 to 8 ft is encountered on the bedrock surface.

Bedrock elevations and contours for the Former Carr Point shooting range (MRP Site 1) and storage areas (IR Site 22) are provided on Figure 7. For a more comprehensive understanding of the

bedrock surface underlying the shooting range, information from both MRP Site 1 and IR Site 22 were combined. The bedrock surface is encountered at depths ranging from 17 to 39 feet below ground surface (ft bgs). Bedrock highs are present to the south beneath the former material storage area and the former drum storage area, with a bedrock low between the two areas, as well as lows to the east, west, and north of the drum storage area. The lowest bedrock elevation is present along the northern boundary of the shooting range (SB-09) where it is encountered at a depth of 39 ft bgs. No information was available to evaluate the bedrock surface elevation along the eastern boundary of the shooting range site.

Vegetation near the site consists of forests of mature or climax successional stage. Vegetative species of special concern have been identified, which include Smooth Orach, Seabeach Sandwort, Scotch Lovage, Northern Blazing Star, Indian Grass, Saltmarsh Bulrush, Golden Heather, Woodland Sunflower, and Bristly Foxtail (Malcolm Pirnie, 2005).

An intertidal gravel and sand beach extends along the western edge the site. Sub-tidal depositional sand is present offshore. The shoreline associated with Carr Point, extending north to Melville-North, is mapped as an inter-tidal sand beach with limited area of back beach.

### **Hydrology and Hydrogeology**

MRP Site 1 is located adjacent to Narragansett Bay. There are no inland surface water bodies within MRP Site 1. The nearest inland surface water body is Norman's Brook located 0.3 miles southeast of Carr Point. Groundwater underlying Carr Point is typical of NAVSTA Newport. Groundwater is generally located within aquifers located in the glacial till and bedrock. At Carr Point, the groundwater surface is encountered in the glacial out wash and till deposits, and the average depth to groundwater at the site is approximately 7 to 12 feet. Based on the groundwater elevations posted on Figure 7, groundwater flows from east to west towards Narragansett Bay. The groundwater underlying MRP Site 1 is classified as Class GA, which is a RIDEM designation for groundwater that is "suitable for drinking water use without treatment." In addition, USEPA requires the consideration of groundwater for use as drinking water. The area planned for investigation is considered one shallow overburden aquifer zone with a saturated thickness ranging from 6 to 25 feet over the bedrock surface encountered from 17 to 39 feet bgs.

### **Previous Site Investigation Activities**

Between May 2009 and January 2010, SI activities were completed at MRP Site 1. Results of the investigations were documented in the Site Investigation (Tetra Tech, 2010a) and the Recreational Risk Assessment Technical Memorandum (Tetra Tech, 2010b).

As part of SI activities, surface soil, subsurface soil, groundwater and sediment samples were collected from MRP Site 1. The following is a brief summary of the results, and the exceedances in soil, groundwater and sediment are depicted on Figures 3, 4 and 5, respectively.

### Surface Soil

In May 2009, two soil borings (SB01 and SB09) were advanced and surface soil samples (0 to 1 foot below ground surface [bgs]). were collected for analysis of volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), including polycyclic aromatic hydrocarbons (PAHs), pesticides, polychlorinated biphenyls (PCBs), metals and total petroleum hydrocarbons (TPH) – diesel range organics (DRO) and gasoline range organics (GRO). At both boring locations, various PAHs and metals were detected above the project action limits (PALs) and/or residential Regional Screening Levels (Res RSL), as identified in the SI (Tetra Tech, 2010a). In addition, pesticides and DRO were detected above PALs and/or Res RSL at SB09.

In May 2009, multi-incremental sampling techniques were utilized to collect surface soil samples (0 to 2 inches bgs) from the former firing arcs. The soil samples were submitted for analysis of propellants (2,4-dinitrotoluene, 2,6-dinitrotoluene, and nitroglycerin) and SVOCs, including PAHs. Nitroglycerin and various PAHs were detected above PALs and/or Res RSL, as identified in the SI (Tetra Tech, 2010a), in all the soil samples submitted for analysis from the firing arcs.

In January 2010, additional surface soil samples (ranging from 0 to 1 foot bgs) were collected from 24 locations across MRP Site 1. The soil samples were submitted for laboratory analysis of PAHs and lead. The data was utilized in a focused human health risk assessment (HHRA) and results were utilized to identify areas that will be targeted for an interim action. As mentioned above, a surface soil removal action has recently been completed by the Navy. Refer to the EE/CA (Tetra Tech, 2012) for further details on the background and basis of the removal action.

### Subsurface Soil

In May 2009, two soil borings (SB01 and SB09) were advanced and multiple subsurface soils were collected for analysis of VOCs, SVOCs, pesticides, PCBs, metals and TPH – DRO and GRO. Various metals were detected above PALs and/or Res RSL, as identified in the SI (Tetra Tech, 2010a), in subsurface soil samples from both boring locations. In addition, one PAH, benzo(a)pyrene, was detected above PALs and/or Res RSL from 6 to 8 feet bgs at SB09.

### Groundwater

One soil boring (SB01) was completed as a permanent groundwater monitoring well (MW01) at MRP Site 1. In June 2009, a groundwater sample was collected from this monitoring well for

analysis of VOCs, SVOCs, pesticides, PCBs, total and dissolved metals and TPH – DRO and GRO. Based on the results, no constituents exceeded the PALs [as identified in the SI (Tetra Tech, 2010a)], which were based on the federal Maximum Contaminant Levels (MCLs) and RIDEM GA groundwater objectives; however, concentrations of metals were noted above risk screening levels (Tetra Tech, 2010a).

### Sediment

In June 2009, twenty (20) sediment samples were collected from Narragansett Bay in the area identified as the potential impact zone from the former firing arcs. The samples were collected from intervals ranging from 0 and 1 feet. Upon collection of the sediment samples, the samples were sieved to allow for the counting of lead pellets. Eighteen (18) of the 20 samples exceeded the established threshold of 10 pellets/square foot. Nine (9) sediment samples were submitted for analysis of PAHs, while all 20 samples were submitted for analysis of metals. PAHs were not identified as exceeding the PALs, as identified in the SI; however, concentrations of PAHs exceeded ecological screening levels defined in the SI at two locations, SD01 and SD02 (Tetra Tech, 2010a). Concentrations of metals exceeded PALs, as identified in the SI, in 17 of 20 locations. Lead was the only metal to exceed in 15 of these 17 locations.

### Summary

Based on the results of the SI, elevated concentrations of PAHs, metals, and propellants were detected in surface soil and elevated concentrations of PAHs were detected in subsurface soil at MRP Site 1. Note that elevated concentrations of VOCs and PAHs were not encountered in soil samples collected from the interval directly above the bedrock surface at the shooting range. In addition, elevated concentrations of PAHs and metals, as well as lead pellets in excess of the established threshold of 10 pellets per square foot, were detected in sediment in the firing fan associated with MRP Site 1 in Narragansett Bay.

### **Nature and Extent of Contamination**

The primary sources of contamination at the Former Carr Point Shooting Range (MRP Site 1) consist of painted clay pigeons, associated clay pigeon fragments, and lead shot. Clay pigeons can potentially contain “petroleum pitch,” which is blended with the clay and can consist of PAHs. In addition, the clay pigeons were often painted and the paint potentially contained lead. The previous SI identified elevated concentrations of PAHs, lead and propellants in the surface soil, PAHs in the subsurface soil, and PAHs, metals, primarily lead, and lead shot in sediment.

Although propellant residues (i.e., nitroglycerin) were reported during prior investigations (Tetra Tech, 2010a), they are considered to be limited to the clay pigeon launching/firing arc area and are

not considered a potential compound of interest for other areas of the MRP Site 1. A portion of this area was included in a recent removal action (Tetra Tech, 2012). In that area, no surface soil samples are warranted. However, data from the removal action will be evaluated and additional borings/samples may be collected at the bottom of excavation and/or along the periphery of the excavation (if necessary) to confirm the absence/presence of propellants.

It should be noted that post-excavation soil samples, as appropriate, will be incorporated into the risk assessment and RI for this site.

The planned investigation described in this SAP is primarily intended to refine the extent of historical release(s) from prior operations at MRP Site 1. This investigation has been designed to expand upon the information that currently exists; therefore, PAHs and TAL metals will be assessed as part of the planned investigation at MRP Site 1. Chromium at this site is expected to be in the more common trivalent state. However, a subset of samples per media will be analyzed for hexavalent chromium, in addition to total chromium, to provide information on whether the hexavalent state is present. Surface soil samples within the clay pigeon launching/firing arc area will be analyzed for propellants (nitroaromatics and nitramines) where removal actions were not conducted. Depending on results from the recent removal action within the clay pigeon launching/firing arc area, [additional borings/samples may be collected to confirm the absence/presence of propellants at the bottom of excavation and along the periphery of the excavation area.](#)

### Target Matrices

The primary sources of contamination have generally been limited to shallow soil, which is expected from the operational history of the site. Because of the relatively shallow depth to groundwater at the site and the proximity to Narragansett Bay, surface soil, subsurface soil, groundwater, and sediment will be assessed during the planned investigation.

MRP Site 1 is located adjacent to the Narragansett Bay. However, contact with surface water in Narragansett Bay is not considered to be a significant pathway of exposure to site-related chemicals due to the tidal influence. In addition, there are no inland surface water bodies within MRP Site 1. The nearest inland surface water body is Norman's Brook located 0.3 miles southeast of Carr Point. Therefore, surface water is not considered to be a media of concern and will not be evaluated in the planned investigation.

### **CSM Summary**

In addition to refining the extent of historical release(s) from prior operations, data to be collected during the planned investigation will also be used to better quantify potential risks to receptors and

position the site for final environmental response actions. Figure 2 presents graphical potential exposure pathways. These pathways present the potential sources, pathways and receptors that are being evaluated through this investigation. An overall CSM summary of MRP Site 1 is briefly presented below.

### Sources and Release Mechanisms

Primary sources of contamination at the Former Carr Point Shooting Range (MRP Site 1) consist of painted clay pigeons, associated clay pigeon fragments, and lead shot. Based on this and previous investigations, surface and subsurface soil, groundwater and sediment will be analyzed for potential PAHs and metals. A subset of samples per media (with the exception of groundwater- hexavalent chromium samples will be collected at each monitoring well) will be analyzed for hexavalent chromium, in addition to total chromium, to provide information on whether the hexavalent state is present in Site media. Surface soil may be collected and analyzed for propellants within portions the clay pigeon launching/firing arc area that were not addressed as part of a recent removal action. Primary release mechanisms consist of direct discharge of materials to the surface soil in the former shooting range areas, as well as direct impacts into Narragansett Bay from airborne clay pigeons and lead shot. Secondary release mechanisms could include volatilization of certain PAHs, generation of fugitive dust from soil, chemical leaching into groundwater, groundwater discharge into Narragansett Bay, and food-chain uptake.

### Receptors and Exposure Pathways

#### *Human Health*

The receptors and exposure pathways that will be evaluated in the HHRA based on current and potential future land use are summarized below. For future land-use scenarios, it is assumed that there would be some level of construction to convert the area to the desired use. Therefore, it is assumed that current subsurface soils may be brought to the surface and become available for exposure by future receptors. Site-specific exposure pathways and numerical exposure assumptions are discussed in detail in this worksheet. General receptors that will be evaluated are discussed below and in the NAVSTA Newport Risk Assessment Work Plan Technical Memorandum, provided as Appendix C. The numerical exposure assumptions for the general receptors are also provided in Appendix C.

#### Construction/Utility Worker

A construction/utility worker exposure scenario will be evaluated in the HHRA assuming that construction or utility maintenance activities may occur in the future. The exposure pathways that will be evaluated for a construction/utility worker are as follows:

- Exposure to combined surface soil and subsurface soil up to maximum likely depth of excavation (0-12 ft, or to depth at which groundwater is encountered) through incidental ingestion, dermal contact and inhalation of airborne particles (i.e., fugitive dust) in outdoor air;
- Exposure to groundwater in an excavation trench through incidental ingestion, dermal contact, and inhalation of air within the trench. Inhalation of excavation trench air will only be evaluated where volatiles in groundwater are identified as chemicals of potential concern (COPCs).

The sediment exposure pathway for a construction/utility worker is considered incomplete. Outfall(s) associated with the site, an area in which a construction/utility worker may potentially be present, terminate in the upland bank where soil (not sediment) is present. Therefore, a construction/utility worker's exposure to sediment will not be evaluated in the HHRA.

Representative exposure assumptions selected for evaluation of a construction/utility worker that will be used in the HHRA are included in Table 10-1. Note that Table 10-1 presents the same numeric exposure assumptions that are presented in Table 1 of the Risk Assessment Work Plan Technical Memorandum, provided as Appendix C.

#### Current On-Site Worker

Information on current on-site workers present on MRP Site 1 was obtained as documented in SAP Worksheet #9-7. There is minimal periodic maintenance worker activity at MRP Site 1. There is an occasional visit by site workers to unlock the chain link fence for RV campers or landscapers. The landscapers mow the lawn for an estimated duration of 2 hours per event, at a frequency of 2 events per month. Other infrequent site activities may include routine road or landscape maintenance from storm or winter damage. Those events would be an estimated duration of 4 hours per event, at a frequency of 2 events per year. Nearby picnic tables in the RV area are not typically used by site workers. Therefore, the HHRA will evaluate a current on-site worker scenario for exposure to surface soil (0-1 ft) through incidental ingestion, dermal contact and inhalation of airborne particles (i.e., fugitive dust) in outdoor air. The sediment exposure pathway for an on-site worker is considered incomplete.

Representative exposure assumptions selected for evaluation of a current on-site worker that will be used in the HHRA are included in Table 10-2.

#### Future On-Site Worker

Future development of the site could also include commercial/industrial development, including workers at the site on a more frequent basis. The sediment exposure pathway for an on-site worker is considered incomplete. Outfall(s) associated with the site, an area in which an on-site worker may potentially be present, terminate in the upland bank where soil (not sediment) is

present. Therefore, an on-site worker's exposure to sediment will not be evaluated in the HHRA. Groundwater at the site is categorized by RIDEM as GA, suitable for potable use without treatment. However, groundwater at the site is not currently being used for potable use, there are no drinking water wells present on site, and the site is served by the municipal water supply. The SAP will include an assessment of potability based on salinity, etc. to help determine whether groundwater would be suitable for potable use if a drinking water well were to be installed. The drinking water exposure pathway will be assessed in the HHRA only if the salinity results indicate that the groundwater could theoretically be suitable for potable use. Therefore, the following exposure scenarios will be evaluated in the HHRA for a future on-site worker exposure scenario:

- Exposure to combined surface and subsurface soil (0-12 ft, or depth at which groundwater is encountered) through incidental ingestion, dermal contact and inhalation of airborne particles (i.e., fugitive dust) in outdoor air;
- Exposure to indoor air via volatilization from the subsurface (i.e., vapor intrusion); and
- Exposure to groundwater through ingestion of drinking water.

Representative exposure assumptions selected for evaluation of a future on-site worker that will be used in the HHRA are included in Table 10-3. Note that Table 10-3 presents the same numeric exposure assumptions that are presented in Table 2 of the NAVSTA Newport Risk Assessment Work Plan Technical Memorandum, provided as Appendix C.

#### Current/Future Trespassing Teenager

It is anticipated that trespassers may access MRP Site 1 in addition to the shoreline of Narragansett Bay. For future land-use scenarios, it is assumed that there would be some level of construction to convert the area to the desired use. Therefore, it is assumed that current subsurface soils may be brought to the surface and become available for exposure by future receptors. Therefore, the HHRA will evaluate current and future trespassing teenager scenarios for the following pathways:

- Exposure to soil through incidental ingestion, dermal contact and inhalation of airborne particles (i.e., fugitive dust) in outdoor air. The current scenario will evaluate exposure to surface soil (0-1 ft) and the future scenario will evaluate exposure to combined surface and subsurface soil (0-12 ft, or depth at which groundwater is encountered).
- Exposure to sediment through incidental ingestion and dermal contact.

Representative exposure assumptions selected for evaluation of a current and future trespassing teenager that will be used in the HHRA are included in Table 10-4. Note, that Table 10-4 includes the numerical exposure assumptions included in Table 3 of the NAVSTA Newport Risk Assessment Work Plan Technical Memorandum, provided as Appendix C. However, the site-specific numerical exposure assumptions associated with the sediment exposure pathway have been added to Table 10-4, since this pathway is applicable for MRP Site 1.

### Hypothetical Future On-Site Resident

There are currently no residential receptors on the site, it is not zoned for residential use, nor will it likely be in the future according to NAVSTA personnel. However, since future residential development is possible, it will be evaluated in the HHRA as a conservative measure of hypothetical future site use. MRP Site 1 is approximately 4 acres in size. Therefore, if developed for residential use in the future, the site may be divided into multiple residential lots. The HHRA will include an assessment of whether hot spots exist within the site. If a hot spot is determined to exist, the hot spot area will be evaluated separately from the rest of the site. However, if no hot spots are identified, the site will be evaluated as one exposure area.

Groundwater at the site is categorized by RIDEM as GA, suitable for potable use without treatment. However, groundwater at the site is not currently being used for potable use, there are no drinking water wells present on site, and the site is served by the municipal water supply. The SAP will include an assessment of potability based on salinity, etc. to help determine whether groundwater would be suitable for potable use if a drinking water well were to be installed. The drinking water exposure pathway will be assessed in the HHRA only if the salinity results indicate that the groundwater could theoretically be suitable for potable use.

MRP Site 1 is located adjacent to the Narragansett Bay. However, human access to the bay and the shoreline from the site is limited by overgrown vegetation with only one walking path/access point at the north side of MRP Site 1. There is also a sign posted on the site restricting swimming and shellfishing in the bay. In addition, contact with surface water in Narragansett Bay is not considered to be a significant pathway of exposure to site-related chemicals due to the tidal influence. Therefore, surface water is not considered a media of concern and exposure to surface water will not be evaluated in the risk assessment.

Although shellfishing is currently prohibited in a large portion of Narragansett Bay, ingestion of shellfish may be a potentially complete pathway under a hypothetical future-use scenario if shellfish are present in surface water within MRP Site 1. Therefore, the shellfish ingestion pathway will be evaluated for hypothetical future residential receptors in the HHRA, assuming that future residents may collect shellfish on a recreational basis. The evaluation of the shellfish ingestion pathway is considered to be highly conservative, as further discussed in Worksheet 14-1. Shellfish tissue samples are proposed for collection at MRP Site 1. Therefore, tissue samples will be evaluated in the HHRA. However, if shellfish are not present during the sampling event, it will be concluded that there is not a sustainable source of shellfish on-site and the CSM will be modified to indicate that the shellfish ingestion pathway is incomplete for all receptors.

Along the majority of the shoreline, sediment is covered by stones and cobbles and is therefore not exposed for contact by human receptors except for a small portion. Although human exposure to

sediment is expected to be limited, it is proposed for evaluation in the HHRA as a conservative measure.

Therefore, the HHRA will evaluate a hypothetical future on-site residential scenario for the following pathways:

- Exposure to combined surface and subsurface soil (0-12 ft, or depth at which groundwater is encountered) through incidental ingestion, dermal contact and inhalation of airborne particles (i.e., fugitive dust) in outdoor air;
- Exposure to groundwater through ingestion of drinking water and dermal contact and inhalation during bathing;
- Exposure to indoor air via volatilization from the subsurface (i.e., vapor intrusion);
- Exposure to sediment through incidental ingestion and dermal contact; and
- Ingestion of shellfish.

Representative exposure assumptions selected for evaluation of a hypothetical future on-site resident that will be used in the HHRA are included in Table 10-5. Note, that Table 10-5 includes the numerical exposure assumptions included in Table 4 of the NAVSTA Newport Risk Assessment Work Plan Technical Memorandum, provided as Appendix C. However, the numerical exposure assumptions associated with the sediment and shellfish exposure pathways have been added to Table 10-5, since they are applicable for MRP Site 1.

#### Current Recreational Adult and Child (RV Park Visitors)

MRP Site 1 is currently used as an RV camping park. The RV Park is open from Memorial Day weekend through October for rental by DoD personnel and active/retired military and their families. It is not available for use by the general public. The RV Park visitors are allowed to stay for up to 2 weeks per year. MRP Site 1 is located adjacent to the Narragansett Bay. However, human access to the bay and the shoreline from the site is limited by overgrown vegetation with only one walking path/access point at the north side of MRP Site 1. There is also a sign posted on the site restricting swimming in the bay. In addition, contact with surface water in Narragansett Bay is not considered to be a significant pathway of exposure to site-related chemicals due to the tidal influence. Therefore, surface water is not considered a media of concern and exposure to surface water will not be evaluated in the risk assessment.

Along the majority of the shoreline, sediment is covered by stones and cobbles and is therefore not exposed for contact by human receptors except for a small portion. Although human exposure to sediment is expected to be limited, it is proposed for evaluation in the HHRA as a conservative measure.

Therefore, the HHRA will evaluate a recreational adult and child (RV Park visitors) scenario for the following pathways:

- Exposure to surface soil (0-1 ft) through incidental ingestion, dermal contact and inhalation of airborne particles (i.e., fugitive dust) in outdoor air; and
- Exposure to sediment through incidental ingestion and dermal contact.

Representative exposure assumptions selected for evaluation of a recreational adult and child (RV Park visitors) scenario that will be used in the HHRA are included in Table 10-6.

### *Ecological*

It is anticipated that ecological receptors may come in contact with surface soil (0 to 1 ft bgs) and surface sediment (0 to 0.5 ft bgs) within MRP Site 1. In addition, as a result of historic skeet-shooting activities, birds may be exposed to lead pellet fragments ingested intentionally as a source of grit or incidentally during ingestion of prey items. Ecological receptors are not exposed to groundwater so the pathway to this medium is not complete and will not be evaluated in the ecological evaluation. Exposure to site-related constituents in Narragansett Bay surface water is assumed to be negligible due to the tidal influence and will not be evaluated in the ecological evaluation.

Tables 5 through 11 in the NAVSTA Newport Risk Assessment Work Plan Technical Memorandum, provided as Appendix C, provide the toxicity values and exposure assumptions that will be used to evaluate the receptors listed below.

The following exposure pathways will be evaluated for MRP Site 1:

- Soil invertebrates and plants directly exposed to site-related compounds in surface soil.
- Birds and mammals exposed to site-related compounds through incidental ingestion of surface soil and by ingestion of contaminated prey items impacted by surface soil.
- Benthic invertebrates directly exposed to site-related compounds in surface sediment in Narragansett Bay adjacent to MRP Site 1.
- Birds and mammals exposed to site-related compounds through incidental ingestion of sediment and by ingestion of contaminated prey items impacted by sediment in Narragansett Bay adjacent to MRP Site 1.
- Birds (e.g., diving ducks) exposed to lead through ingestion of lead shot pellets found in sediment in Narragansett Bay adjacent to MRP Site 1.

The following representative birds and mammals will be evaluated in the food chain model:

- Herbivorous upland mammal - meadow vole
- Herbivorous upland bird - bobwhite quail

- Insectivorous upland mammal - short-tailed shrew
- Insectivorous upland bird - American robin
- Omnivorous semi-aquatic mammal - raccoon
- Piscivorous/insectivorous semi-aquatic bird - herring gull

TABLE 10-1  
SUMMARY OF POTENTIAL EXPOSURE ASSUMPTIONS - CURRENT/FUTURE CONSTRUCTION/UTILITY WORKER  
HUMAN HEALTH RISK ASSESSMENT  
NEWPORT, RHODE ISLAND

Parameter	Current/Future Construction/Utility Worker			
	RME		CTE	
Parameters Used in the Outdoor Air (Fugitive Dust and Excavation Air) Inhalation Pathway				
Exposure Time (hr/day)	8	(a)	8	(a)
Exposure Frequency (days/year)	250	(b)	130	(g)
Exposure Duration (yr)	1	(c)	0.5	(c)
Parameters Used in the Soil Pathway				
Exposure Frequency (days/year)	250	(b)	130	(g)
Exposure Duration (yr)	1	(c)	0.5	(c)
Soil Ingestion Rate (mg/day)	330	(f)	330	(f)
Exposed Skin Surface Area (cm <sup>2</sup> )	3300	(e)(f)	3300	(e)(f)
Adherence Factor (mg/cm <sup>2</sup> )	0.3	(h)	0.1	(h)
Body Weight (kg)	70	(f)	70	(f)
Parameters Used in the Groundwater Contact Pathway				
Exposure Time (hr/day)	1	(i)	1	(i)
Exposure Frequency (days/year)	250	(b)	130	(g)
Exposure Duration (yr)	1	(c)	0.5	(c)
Water Ingestion Rate (l/day)	0.005	(d)	0	(j)
Exposed Skin Surface Area (cm <sup>2</sup> )	3300	(e)	3300	(e)
Body Weight (kg)	70	(f)	70	(f)

Notes:

RME - Reasonable Maximum Exposure.

CTE - Central Tendency Exposure.

USEPA, 2004. Risk Assessment Guidance for Superfund, Supplemental Guidance for Dermal Risk Assessment.

(a) Based on a typical 8 hour workday.

(b) Exposure frequency is equivalent to 5 days per week for the exposure duration.

(c) Construction activities are assumed to occur within a 1 year period (for RME scenario) and for a 6 month period (for CTE scenario) based on professional judgment.

(d) Based on professional judgment and USEPA, 1989, Risk Assessment Guidance for Superfund, Volume I. Value is one-tenth of that assumed to occur during a swimming event via incidental ingestion. Assumes drinking water is obtained offsite.

(e) USEPA, 2004. Exhibit 3-5, recommended value.

(f) USEPA, 2002. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. Exhibit 1-2.

(g) Exposure frequency is equivalent to 5 days per week for exposure duration (26 weeks).

(h) USEPA, 2004. Exhibit 3-3, recommended values for construction workers.

(i) Assumes that contact with water occurs only for a fraction of the total exposure duration and time.

(j) Assumes construction workers obtain their drinking water offsite and that incidental ingestion to groundwater is trivial.

TABLE 10-2  
SUMMARY OF POTENTIAL EXPOSURE ASSUMPTIONS - CURRENT ON-SITE WORKER  
HUMAN HEALTH RISK ASSESSMENT  
NEWPORT, RHODE ISLAND

Parameter	Current On-Site Worker			
	RME		CTE	
Parameters Used in the Outdoor Air (Fugitive Dust) Inhalation Pathway				
Exposure Time (hr/day)	2	(d)	4	(d)
Exposure Frequency (days/year)	24	(d)	2	(d)
Exposure Duration (yr)	25	(b)	7	(e)
Parameters Used in the Soil Pathway				
Exposure Frequency (days/year)	24	(d)	2	(d)
Exposure Duration (yr)	25	(a)(b)	7	(e)
Ingestion Rate (mg/day)	100	(a)	50	(f)
Fraction ingested from contaminated source (unitless)	0.25	(g)	0.5	(g)
Exposed Skin Surface Area (cm <sup>2</sup> )	3300	(c)	3300	(c)
Adherence Factor (mg/cm <sup>2</sup> )	0.2	(c)	0.02	(c)
Body Weight (kg)	70	(a)	70	(a)
Notes:				
RME - Reasonable Maximum Exposure.				
CTE - Central Tendency Exposure.				
USEPA, 1997. USEPA Exposure Factors Handbook. Volume I. August 1997.				
USEPA, 2004. Risk Assessment Guidance for Superfund, Supplemental Guidance for Dermal Risk Assessment. July 2004.				
(a) USEPA, 1991. Standard Default Exposure Factors.				
(b) USEPA, 2002. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, December, 2002.				
(c) USEPA, 2004. Exhibit 3-5, recommended value.				
(d) Based on information of current on-site worker maintenance activities provided by the Navy Remedial Program Manager. The RME scenario represents a typical landscaper who is present on site for 2 hours per event for 2 events per month; The CTE scenario represents other less frequent maintenance activities that occur for 4 hours per event for 2 events per year. Additional details on this receptor are provided in the report text.				
(e) USEPA, 1997. Recommended value for median occupational tenure, average of values for men and women. (Table 15-158).				
(f) USEPA, 1997. Mean value for the adult population (Table 4-23).				
(g) Assumes exposure occurs for 2 hours (RME scenario) and 4 hours (CTE scenario) out of a typical 8 hour workday.				

TABLE 10-3  
SUMMARY OF POTENTIAL EXPOSURE ASSUMPTIONS - FUTURE ON-SITE WORKER  
HUMAN HEALTH RISK ASSESSMENT  
NEWPORT, RHODE ISLAND

Parameter	Future On-Site Worker			
	RME		CTE	
Parameters Used in the Outdoor Air (Fugitive Dust) Inhalation Pathway				
Exposure Time (hr/day)	4	(d)	4	(d)
Exposure Frequency (days/year)	250	(a)	219	(c)
Exposure Duration (yr)	25	(b)	7	(e)
Parameters Used in the Indoor Air Inhalation Pathway				
Exposure Time (hr/day)	4	(d)	4	(d)
Exposure Frequency (days/year)	250	(a)	219	(c)
Exposure Duration (yr)	25	(a)(b)	7	(e)
Parameters Used in the Soil Pathway				
Exposure Frequency (days/year)	250	(a)	219	(c)
Exposure Duration (yr)	25	(a)(b)	7	(e)
Ingestion Rate (mg/day)	100	(a)	50	(f)
Exposed Skin Surface Area (cm <sup>2</sup> )	3300	(c)	3300	(c)
Adherence Factor (mg/cm <sup>2</sup> )	0.2	(c)	0.02	(c)
Body Weight (kg)	70	(a)	70	(a)
Parameters Used in the Groundwater Ingestion Pathway				
Exposure Frequency (days/year)	250	(a)	219	(c)
Exposure Duration (yr)	25	(a)(b)	7	(e)
Water Ingestion Rate (l/day)	1	(a)	0.7	(g)
Body Weight (kg)	70	(a)	70	(a)
Notes:				
RME - Reasonable Maximum Exposure.				
CTE - Central Tendency Exposure.				
USEPA, 1997. USEPA Exposure Factors Handbook. Volume I. August 1997.				
USEPA, 2004. Risk Assessment Guidance for Superfund, Supplemental Guidance for Dermal Risk Assessment. July 2004.				
(a) USEPA, 1991. Standard Default Exposure Factors.				
(b) USEPA, 2002. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, December, 2002.				
(c) USEPA, 2004. Exhibit 3-5, recommended value.				
(d) Based on professional judgment assuming an onsite worker performs both indoor and outdoor maintenance activities for a typical 8 hour workday.				
(e) USEPA, 1997. Recommended value for median occupational tenure, average of values for men and women. (Table 15-158).				
(f) USEPA, 1997. Mean value for the adult population (Table 4-23).				
(g) One-half of the recommended mean value for the ingestion of drinking water for the associated age range (USEPA, 1997. Table 3-30), assuming workers get one-half of their daily drinking water at work.				

TABLE 10-4  
SUMMARY OF POTENTIAL EXPOSURE ASSUMPTIONS - CURRENT/FUTURE TRESPASSING TEENAGER  
HUMAN HEALTH RISK ASSESSMENT  
NEWPORT, RHODE ISLAND

Parameter	Trespassing Teenager (7 to <16 years)			
	RME		CTE	
Parameters Used in the Outdoor Air Inhalation Pathway				
Exposure Time (hr/day)	4	(e)	2	(a)
Exposure Frequency (days/year)	52	(h)	26	(b)
Exposure Duration (yr)	9	(c)	9	(c)
Parameters Used in the Soil Pathway				
Exposure Frequency (days/year)	52	(h)	26	(b)
Exposure Duration (yr)	9	(c)	9	(c)
Ingestion Rate (mg/day)	100	(i)	50	(f)
Exposed Skin Surface Area (cm <sup>2</sup> )	4286	(d)	4286	(d)
Adherence Factor (mg/cm <sup>2</sup> )	0.2	(m)	0.04	(m)
Body Weight (kg)	43	(g)	43	(g)
Parameters Used in the Sediment Pathway				
Exposure Frequency (days/year)	52	(h)	26	(b)
Exposure Duration (yr)	9	(c)	9	(c)
Ingestion Rate (mg/day)	100	(i)	50	(f)
Exposed Skin Surface Area (cm <sup>2</sup> )	3159	(n)	3159	(n)
Adherence Factor (mg/cm <sup>2</sup> )	0.2	(m)	0.04	(m)
Body Weight (kg)	43	(g)	43	(g)
Notes:				
RME - Reasonable Maximum Exposure.				
CTE - Central Tendency Exposure.				
USEPA, 2004. Risk Assessment Guidance for Superfund, Supplemental Guidance for Dermal Risk Assessment.				
USEPA, 1997. USEPA Exposure Factors Handbook. Volume I. August 1997.				
(a) Assumes a trespasser is on-site for 2 hours per day. Based on professional judgment.				
(b) 1 day per week for 26 weeks (6 warmer months) of the year.				
(c) Duration reflects age-range.				
(d) USEPA, 1997. Tables 6-6, 6-7, and 6-8. Represents 50th percentile surface area for males and females. Contact is assumed to occur with the hands, forearms, lower legs, and head, consistent with USEPA's (2004) assumptions for the adult.				
(e) Assumes a trespasser is on-site for 4 hours per day. Based on professional judgment.				
(f) USEPA, 1997. Mean value for the adult population (Table 4-23).				
(g) USEPA, 2002. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, December, 2002.				
(h) 2 days per week for 26 weeks (6 warmer months) of the year.				
(i) USEPA, 1991. Standard Default Exposure Factors.				
(m) USEPA, 2004. Exhibit 3-5, recommended value.				
(n) USEPA, 1997. Tables 6-6, 6-7, and 6-8. Represents 50th percentile surface area for males and females, including hands, lower legs and feet, for the associated age range. These body parts were selected based on best professional judgment assuming contact with sediment may occur as part of a wading scenario.				

TABLE 10-5  
SUMMARY OF POTENTIAL EXPOSURE ASSUMPTIONS - HYPOTHETICAL FUTURE RESIDENT  
HUMAN HEALTH RISK ASSESSMENT  
NEWPORT, RHODE ISLAND

Parameter	RME					CTE				
	Assumptions for Noncarcinogenic Evaluation		Assumptions for Carcinogenic Evaluation			Assumptions for Noncarcinogenic Evaluation		Assumptions for Carcinogenic Evaluation		
	Young Child (0 to 6 yrs)	Young Child (0 to <2 yrs)	Older Child (2 to <6 yrs)	Adolescent (6 to <16)	Adult	Young Child (0 to 6 yrs)	Young Child (0 to <2 yrs)	Older Child (2 to <6 yrs)	Adolescent (6 to <16)	Adult
Parameters Used in the Outdoor Air Inhalation Pathway										
Exposure Time (hr/day)	5 (d)	5 (d)	5 (d)	5 (d)	5 (d)	5 (d)	5 (d)	5 (d)	5 (d)	5 (d)
Exposure Frequency (days/year)	350 (a)	350 (a)	350 (a)	350 (a)	350 (a)	234 (f)	234 (f)	234 (f)	234 (f)	234 (f)
Exposure Duration (yr)	6 (a)	2 (h)	4 (h)	10 (h)	14 (h)	6 (a)	2 (h)	4 (h)	10 (h)	9 (h)
Parameters Used in the Indoor Air Inhalation Pathway										
Exposure Time (hr/day)	19 (k)	19 (k)	19 (k)	19 (k)	19 (k)	17 (b)	17 (b)	17 (b)	17 (b)	17 (b)
Exposure Frequency (days/year)	350 (a)	350 (a)	350 (a)	350 (a)	350 (a)	234 (f)	234 (f)	234 (f)	234 (f)	234 (f)
Exposure Duration (yr)	6 (a)	2 (h)	4 (h)	10 (h)	14 (h)	6 (a)	2 (h)	4 (h)	10 (h)	9 (h)
Parameters Used in the Soil Pathway										
Exposure Frequency (days/year)	350 (a)	350 (a)	350 (a)	350 (a)	350 (a)	234 (f)	234 (f)	234 (f)	234 (f)	234 (f)
Exposure Duration (yr)	6 (a)	2 (h)	4 (h)	10 (h)	14 (h)	6 (a)	2 (h)	4 (h)	10 (h)	9 (h)
Ingestion Rate (mg/day)	200 (a)(c)	200 (a)(c)	200 (a)(c)	100 (a)(c)	100 (a)(c)	100 (a)(c)	100 (a)(c)	100 (a)(c)	50 (a)(c)	50 (a)(c)
Exposed Skin Surface Area (cm <sup>2</sup> )	2800 (i)(n)	2600 (i)	2939 (i)	4156 (i)	5700 (i)(n)	2800 (i)(n)	2600 (i)	2939 (i)	4156 (i)	5700 (i)(n)
Adherence Factor (mg/cm <sup>2</sup> )	0.2 (n)	0.2 (n)	0.2 (n)	0.07 (n)	0.07 (n)	0.04 (n)	0.04 (n)	0.04 (n)	0.01 (n)	0.01 (n)
Body Weight (kg)	15 (l)	8 (l)	18 (l)	41 (l)	70 (a)	15 (l)	8 (l)	18 (l)	41 (l)	70 (a)
Parameters Used in the Groundwater Contact Pathway										
Exposure Frequency (days/year)	350 (a)	350 (a)	350 (a)	350 (a)	350 (a)	234 (f)	234 (f)	234 (f)	234 (f)	234 (f)
Exposure Duration (yr)	6 (a)	2 (h)	4 (h)	10 (h)	14 (h)	6 (a)	2 (h)	4 (h)	10 (h)	9 (h)
Water Ingestion Rate (l/day)	1 (a)	1 (a)	2 (a)	2 (a)	2 (a)	0.6 (j)	0.6 (j)	1.4 (j)	1.4 (j)	1.4 (j)
Body Weight (kg)	15 (l)	8 (l)	18 (l)	41 (l)	70 (a)	15 (l)	8 (l)	18 (l)	41 (l)	70 (a)
Parameters Used in the Showering/Bathing Pathway										
Exposure Time (hr/day)	1 (e)	1 (e)	1 (e)	0.58 (e)	0.58 (e)	0.33 (e)	0.33 (e)	0.33 (e)	0.25 (e)	0.25 (e)
Exposure Frequency (days/year)	350 (a)	350 (a)	350 (a)	350 (a)	350 (a)	234 (f)	234 (f)	234 (f)	234 (f)	234 (f)
Exposure Duration (yr)	6 (a)	2 (h)	4 (h)	10 (h)	14 (h)	6 (a)	2 (h)	4 (h)	10 (h)	9 (h)
Exposed Skin Surface Area (cm <sup>2</sup> )	6600 (e)(m)	5910 (m)	6880 (m)	12346 (m)	18000 (e)(m)	6600 (e)(m)	5910 (m)	6880 (m)	12346 (m)	18000 (e)(m)
Body Weight (kg)	15 (l)	8 (l)	18 (l)	41 (l)	70 (a)	15 (l)	8 (l)	18 (l)	41 (l)	70 (a)
Parameters Used in the Sediment Pathway										
Exposure Frequency (days/year)	52 (p)	52 (p)	52 (p)	52 (p)	52 (p)	26 (q)	26 (q)	26 (q)	26 (q)	26 (q)
Exposure Duration (yr)	6 (a)	2 (h)	4 (h)	10 (h)	14 (h)	6 (a)	2 (h)	4 (h)	10 (h)	9 (h)
Ingestion Rate (mg/day)	200 (a)(c)	200 (a)(c)	200 (a)(c)	100 (a)(c)	100 (a)(c)	100 (a)(c)	100 (a)(c)	100 (a)(c)	50 (a)(c)	50 (a)(c)
Exposed Skin Surface Area (cm <sup>2</sup> )	1459 (o)	1220 (o)	1586 (o)	3026 (o)	4500 (o)	1459 (o)	1220 (o)	1586 (o)	3026 (o)	4500 (o)
Adherence Factor (mg/cm <sup>2</sup> )	0.2 (n)	0.2 (n)	0.2 (n)	0.07 (n)	0.07 (n)	0.04 (n)	0.04 (n)	0.04 (n)	0.01 (n)	0.01 (n)
Body Weight (kg)	15 (l)	8 (l)	18 (l)	41 (l)	70 (a)	15 (l)	8 (l)	18 (l)	41 (l)	70 (a)
Parameters Used in the Shellfish Ingestion Pathway										
Exposure Frequency (days/year)	365 (w)(v)	NA (u)	365 (w)(v)	365 (w)(t)	365 (w)(t)	365 (w)(v)	NA (u)	365 (w)(v)	365 (w)(t)	365 (w)(t)
Fraction Ingested (unitless)	1 (x)	NA (u)	1 (x)	1 (x)	1 (x)	0.5 (x)	NA (u)	0.5 (x)	0.5 (x)	0.5 (x)
Exposure Duration (yr)	6 (a)	NA (u)	4 (h)	10 (h)	14 (h)	6 (a)	NA (u)	4 (h)	10 (h)	9 (h)
Shellfish Ingestion Rate (g/kg-day)	0.06 (r)	NA (u)	0.06 (r)	0.06 (r)	0.06 (r)	0.06 (r)	NA (u)	0.06 (r)	0.06 (r)	0.06 (r)
Shellfish Ingestion Rate (kg/day)	0.0009 (s)(v)	NA (u)	0.0011 (s)(v)	0.0025 (s)(t)	0.0042 (s)(t)	0.0009 (s)(v)	NA (u)	0.0011 (s)(v)	0.0025 (s)(t)	0.0042 (s)(t)
Body Weight (kg)	15 (l)	NA (u)	18 (l)	41 (l)	70 (a)	15 (l)	NA (u)	18 (l)	41 (l)	70 (a)

TABLE 10-5  
SUMMARY OF POTENTIAL EXPOSURE ASSUMPTIONS - HYPOTHETICAL FUTURE RESIDENT  
HUMAN HEALTH RISK ASSESSMENT  
NEWPORT, RHODE ISLAND

Parameter	RME					CTE																
	Assumptions for Noncarcinogenic Evaluation	Assumptions for Carcinogenic Evaluation				Assumptions for Noncarcinogenic Evaluation	Assumptions for Carcinogenic Evaluation															
	Young Child (0 to 6 yrs)	Young Child (0 to <2 yrs)	Older Child (2 to <6 yrs)	Adolescent (6 to <16)	Adult	Young Child (0 to 6 yrs)	Young Child (0 to <2 yrs)	Older Child (2 to <6 yrs)	Adolescent (6 to <16)	Adult												
<p>Notes:</p> <p>NA - Not applicable.  RME - Reasonable Maximum Exposure.  CTE - Central Tendency Exposure.  USEPA, 1991. Standard Default Exposure Factors.  USEPA, 1993. USEPA Superfund's Standard Default Exposure Factors For the Central Tendency and Reasonable Maximum Exposure. Preliminary Review Draft. May 5, 1993.  USEPA, 1997. Exposure Factors Handbook. Volume I. August 1997.  USEPA, 2004. Risk Assessment Guidance for Superfund, Supplemental Guidance for Dermal Risk Assessment. July 2004.</p> <p>(a) USEPA, 1991.  (b) USEPA, 1997. Value for time spent indoors (at residence) (Table 15-176).  (c) USEPA, 1993.  (d) Adult and child residents are assumed to spend 5 out of 16 waking hours (or 30% of their time) outdoors (USEPA, 1991).  (e) USEPA, 2004. Exhibit 3-2, recommended value.  (f) Value recommended by USEPA (1993) for CTE scenario.  (g) USEPA, 1997. Value for time spent outdoors by a residential receptor (Table 15-176).  (h) Duration reflects the age range being evaluated for the RME scenario for a combined lifetime exposure duration of 30 years. The breakdown for age ranges is as follows:</p> <table border="0"> <tr> <td>Age range</td> <td>Total Years</td> </tr> <tr> <td>0 to &lt;2 yrs</td> <td>= 2 yrs</td> </tr> <tr> <td>2 to &lt;6 yrs</td> <td>= 4 yrs</td> </tr> <tr> <td>6 to &lt;16 yrs</td> <td>= 10 yrs</td> </tr> <tr> <td>&gt; 16 yrs</td> <td>= 14 yrs</td> </tr> <tr> <td></td> <td><u>30 yrs</u></td> </tr> </table> <p>For the CTE the children exposure remains the same but the adult is reduced to 9 years based on a total residence time of 25 years (USEPA, 1997, Table 15-174).</p> <p>(i) USEPA, 1997. Tables 6-6, 6-7, and 6-8. Represents 50th percentile surface area for males and females. For the child age groups, contact is assumed to occur with the hands, forearms, lower legs, feet, and head, consistent with USEPA (2004). For the adolescent and adult, contact is assumed to occur with the hands, forearms, lower legs, and head, consistent with USEPA's (2004) assumptions for the adult.  (j) USEPA, 1997. Recommended mean value for the ingestion of drinking water for the associated age range (Table 3-30).  (k) Based on professional judgment; Conservatively assumes that a resident spends 24 hours per day at the residence. Equals 24 hours minus 5 hours spent outdoors as recommended by USEPA (1991) (d).  (l) USEPA, 1997. Recommended mean body weights. Weighted average of associated age ranges (Tables 7-1, 7-3).  (m) USEPA, 1997. Represents the 50th percentile total body surface area for males and females.  (n) USEPA, 2004. Exhibit 3-5, recommended value.  (o) USEPA, 1997. Tables 6-6, 6-7, and 6-8. Represents 50th percentile surface area for males and females, including hands, lower legs and feet, for the associated age range. These body parts were selected based on best professional judgment assuming contact with sediment may occur as part of a wading scenario.  (p) 2 days per week for 26 weeks (6 warmer months) of the year.  (q) 1 day per week for 26 weeks (6 warmer months) of the year.  (r) Equal to the mean per capita shellfish intake rate of 0.06 g/kg-day for the whole population (uncooked weight) recommended in Table 10-9 (USEPA, 1997). The recommended shellfish intake rate is based on the total consumption of shellfish that is then annualized over a 1 year period.  (s) Equal to the shellfish intake rate (g/kg-day) multiplied by the age-specific body weight and divided by 1000 to convert from grams to kilograms.  (t) The ingestion rate of 0.06 g/kg-day is equivalent to the consumption of approximately 13 shellfish meals per year for a 70 kg adult and approximately 8 shellfish meals per year for a 41 kg adolescent, assuming a meal consists of approximately 1 pound of unshelled clams (or other similar mollusk), which is equivalent to approximately 4 ounces (115 grams) of meat. <a href="http://www.cooksinfo.com/clams#ixzz2O2LJW2Rf">http://www.cooksinfo.com/clams#ixzz2O2LJW2Rf</a>.  (u) A child less than 2 years old is not assumed to consume shellfish.  (v) The ingestion rate is equivalent to the consumption of approximately 5-7 shellfish meals per year for children between the ages of 2 and 6 years old, assuming a meal consists of approximately one-half pound of unshelled clams (or other similar mollusk), which is equivalent to approximately 2 ounces (57 grams) of meat (i.e., one-half the size of an adult serving).  (w) An exposure frequency of 365 days is used because the shellfish intake rate has been annualized over a 1 year period (USEPA, 1997) as [described in (r)]. It is not assumed that people would be eating shellfish 365 days per year. The frequency of shellfish intake is described in footnotes (t) and (v).  (x) Represents the fraction of shellfish obtained from the site (versus other locations off-site). The RME scenario assumes 100% of shellfish consumed is obtained from the site. The CTE scenario assumes one-half (50%) of shellfish consumed is obtained from the site.</p>											Age range	Total Years	0 to <2 yrs	= 2 yrs	2 to <6 yrs	= 4 yrs	6 to <16 yrs	= 10 yrs	> 16 yrs	= 14 yrs		<u>30 yrs</u>
Age range	Total Years																					
0 to <2 yrs	= 2 yrs																					
2 to <6 yrs	= 4 yrs																					
6 to <16 yrs	= 10 yrs																					
> 16 yrs	= 14 yrs																					
	<u>30 yrs</u>																					

TABLE 10-6  
SUMMARY OF POTENTIAL EXPOSURE ASSUMPTIONS - CURRENT RECREATIONAL ADULT AND CHILD (RV PARK VISITORS)  
HUMAN HEALTH RISK ASSESSMENT  
NEWPORT, RHODE ISLAND

Parameter	RME					CTE				
	Assumptions for Noncarcinogenic Evaluation	Assumptions for Carcinogenic Evaluation				Assumptions for Noncarcinogenic Evaluation	Assumptions for Carcinogenic Evaluation			
	Young Child (0 to 6 yrs)	Young Child (0 to <2 yrs)	Older Child (2 to <6 yrs)	Adolescent (6 to <16)	Adult	Young Child (0 to 6 yrs)	Young Child (0 to <2 yrs)	Older Child (2 to <6 yrs)	Adolescent (6 to <16)	Adult
Parameters Used in the Outdoor Air Inhalation Pathway										
Exposure Time (hr/day)	24 (d)	24 (d)	24 (d)	24 (d)	24 (d)	24 (d)	24 (d)	24 (d)	24 (d)	24 (d)
Exposure Frequency (days/year)	14 (g)	14 (g)	14 (g)	14 (g)	14 (g)	7 (g)	7 (g)	7 (g)	7 (g)	7 (g)
Exposure Duration (yr)	6 (a)	2 (h)	4 (h)	10 (h)	14 (h)	6 (a)	2 (h)	4 (h)	10 (h)	9 (h)
Parameters Used in the Soil Pathway										
Exposure Frequency (days/year)	14 (g)	14 (g)	14 (g)	14 (g)	14 (g)	7 (g)	7 (g)	7 (g)	7 (g)	7 (g)
Exposure Duration (yr)	6 (a)	2 (h)	4 (h)	10 (h)	14 (h)	6 (a)	2 (h)	4 (h)	10 (h)	9 (h)
Ingestion Rate (mg/day)	200 (a)(b)	200 (a)(b)	200 (a)(b)	100 (a)(b)	100 (a)(b)	100 (a)(b)	100 (a)(b)	100 (a)(b)	50 (a)(b)	50 (a)(b)
Exposed Skin Surface Area (cm <sup>2</sup> )	2800 (i)(f)	2600 (i)	2939 (i)	4156 (i)	5700 (i)(f)	2800 (i)(f)	2600 (i)	2939 (i)	4156 (i)	5700 (i)(f)
Adherence Factor (mg/cm <sup>2</sup> )	0.2 (f)	0.2 (f)	0.2 (f)	0.07 (f)	0.07 (f)	0.04 (f)	0.04 (f)	0.04 (f)	0.01 (f)	0.01 (f)
Body Weight (kg)	15 (c)	8 (c)	18 (c)	41 (c)	70 (a)	15 (c)	8 (c)	18 (c)	41 (c)	70 (a)
Parameters Used in the Sediment Pathway										
Exposure Frequency (days/year)	14 (g)	14 (g)	14 (g)	14 (g)	14 (g)	7 (g)	7 (g)	7 (g)	7 (g)	7 (g)
Exposure Duration (yr)	6 (a)	2 (h)	4 (h)	10 (h)	14 (h)	6 (a)	2 (h)	4 (h)	10 (h)	9 (h)
Ingestion Rate (mg/day)	200 (a)(b)	200 (a)(b)	200 (a)(b)	100 (a)(b)	100 (a)(b)	100 (a)(b)	100 (a)(b)	100 (a)(b)	50 (a)(b)	50 (a)(b)
Exposed Skin Surface Area (cm <sup>2</sup> )	1459 (e)	1220 (e)	1586 (e)	3026 (e)	4500 (e)	1459 (e)	1220 (e)	1586 (e)	3026 (e)	4500 (e)
Adherence Factor (mg/cm <sup>2</sup> )	0.2 (f)	0.2 (f)	0.2 (f)	0.07 (f)	0.07 (f)	0.04 (f)	0.04 (f)	0.04 (f)	0.01 (f)	0.01 (f)
Body Weight (kg)	15 (c)	8 (c)	18 (c)	41 (c)	70 (a)	15 (c)	8 (c)	18 (c)	41 (c)	70 (a)

TABLE 10-6  
SUMMARY OF POTENTIAL EXPOSURE ASSUMPTIONS - CURRENT RECREATIONAL ADULT AND CHILD (RV PARK VISITORS)  
HUMAN HEALTH RISK ASSESSMENT  
NEWPORT, RHODE ISLAND

Parameter	RME					CTE				
	Assumptions for Noncarcinogenic Evaluation	Assumptions for Carcinogenic Evaluation				Assumptions for Noncarcinogenic Evaluation	Assumptions for Carcinogenic Evaluation			
	Young Child (0 to 6 yrs)	Young Child (0 to <2 yrs)	Older Child (2 to <6 yrs)	Adolescent (6 to <16)	Adult	Young Child (0 to 6 yrs)	Young Child (0 to <2 yrs)	Older Child (2 to <6 yrs)	Adolescent (6 to <16)	Adult
Notes: RME - Reasonable Maximum Exposure. CTE - Central Tendency Exposure. USEPA, 1993. USEPA Superfund's Standard Default Exposure Factors For the Central Tendency and Reasonable Maximum Exposure. Preliminary Review Draft. May 5, 1993. USEPA, 1997. Exposure Factors Handbook. August 1997. USEPA, 2004. Risk Assessment Guidance for Superfund, Supplemental Guidance for Dermal Risk Assessment. July 2004. (a) USEPA, 1991. Standard Default Exposure Factors. (b) USEPA, 1993. (c) USEPA, 1997. Recommended mean body weights. Weighted average of associated age ranges (Tables 7-1, 7-3). (d) Based on professional judgment that visitors to the RV park are present on site for 24 hours per day. (e) USEPA, 1997. Tables 6-6, 6-7, and 6-8. Represents 50th percentile surface area for males and females, including hands, lower legs and feet, for the associated age range. These body parts were selected based on best professional judgment assuming contact with sediment may occur as part of a wading scenario. (f) USEPA, 2004. Exhibit 3-5, recommended value. (g) RV park visitors are allowed to stay at the park for up to 2 weeks per year. Therefore, the RME scenario assumes a 14 day exposure frequency and the CTE assumes a 7 day exposure frequency (assuming visitors stay at the park for 1 week per year). (h) Duration reflects the age range being evaluated for the RME scenario for a combined lifetime exposure duration of 30 years. The breakdown for age ranges is as follows: Age range Total Years 0 to <2 yrs = 2 yrs 2 to <6 yrs = 4 yrs 6 to <16 yrs = 10 yrs <u>&gt; 16 yrs = 14 yrs</u> 30 yrs For the CTE the children exposure remains the same but the adult is reduced to 9 years based on a total residence time of 25 years (USEPA, 1997, Table 15-174). (i) USEPA, 1997. Tables 6-6, 6-7, and 6-8. Represents 50th percentile surface area for males and females. For the child age groups, contact is assumed to occur with the hands, forearms, lower legs, feet, and head, consistent with USEPA (2004). For the adolescent and adult, contact is assumed to occur with the hands, forearms, lower legs, and head, consistent with USEPA's (2004) assumptions for the adult.										

## **SAP Worksheet #11: Project Quality Objectives/Systematic Planning Process Statements**

### [\(UFP-QAPP Manual Section 2.6.1\)](#)

The planned investigation at MRP Site 1 is intended to complete the regulatory requirements for the RI phase of the CERCLA process. Although the primary project quality objectives (PQOs) entail refining the extent of historical release(s) from prior operations, there are multiple PQOs to be achieved through the planned investigation, as described in this worksheet. The PQOs were developed for this investigation based on the *Guidance on Systematic Planning Using the Data Quality Objectives Process* (USEPA QA/G-4) (USEPA, 2006) and are presented below.

### **Step 1 – Problem Statement**

A site investigation (SI) conducted at MRP Site 1 (Tetra Tech, 2010a) concluded that contaminants were found at MRP Site 1 that may pose potential risk/hazard above target levels to human health and the environment. These contaminants include metals and PAHs in soil and sediment, metals in groundwater, and lead pellets in sediment.

Based on current data, the extent of historical release(s) from prior operations, potential contaminant migration pathways, and/or potential risks to human and ecological receptors have not been fully defined. Horizontal and/or vertical delineation of soil, sediment, and groundwater impacts is necessary to refine the extent of historical release(s) from prior operations, delineate the extent of the compounds, and quantify the potential for associated risks, if present.

### **Step 2 – Study Goals**

The objective of the MRP Site 1 RI is to evaluate the extent of the potential threat presented by the release of hazardous substances that have occurred at the site. The specific study goals of the planned investigation are listed below, and intended to refine the CSM and position the site for identifying and selecting an appropriate response action per the CERCLA process.

- Goal 1 – Refine the extent of historical release(s) from prior operations
- Goal 2 – Evaluate the potential risk/hazard to human and ecological receptors exposed to site media

### **Step 3 – Information Inputs**

Information inputs will consist of environmental screening data and field samples from MRP Site 1, as presented in this SAP. Figures 3, 4 and 5 present prior exceedances in site media, as well as the planned sampling locations. Sample numbers and rationale by media are presented on Tables 17-1

and 17-2 in Worksheet 17. The following information inputs will be compiled to characterize the location, extent, and characteristics of historic release(s) from prior operations:

- Field parameters – pH, specific conductivity, turbidity, temperature, dissolved oxygen (DO), salinity, ferrous iron, and oxidation-reduction potential (ORP) in groundwater
- Surface soil sampling – PAHs, metals, hexavalent chromium, propellants (nitroaromatics and nitramines), total organic carbon (TOC), pH, bulk density, porosity, conductivity, and grain size
- Subsurface soil sampling – PAHs, metals, hexavalent chromium, TOC, pH, bulk density, porosity, conductivity, and grain size
- Groundwater sampling – PAHs, metals, alkalinity, chloride, nitrate/nitrite, sulfate, TOC, ortho-phosphate-P, methane/ethane/ethene, total suspended solids/total dissolved solids (TSS/TDS), and salinity
- Sediment sampling – PAHs, metals, acid volatile sulfide/simultaneously extracted metals (AVS/SEM), TOC, grain size, pellet count and pellet size, macroinvertebrate analysis, and toxicity testing
- Tissue samples (if shellfish are identified) – PAHs, metals and percent lipids
- Background sediment sampling – PAHs, metals, pesticides, hexavalent chromium, TOC, AVS/SEM, grain size, VOCs, SVOCs, PCBs, macroinvertebrate analysis and toxicity testing
- Background data – Representative background concentrations for relevant environmental media for comparison to site-specific data
- Risk assessment inputs – Exposure assumption inputs, toxicity/dose-response values, risk-based screening levels

The specific physical and geochemical measurements and parameters listed above will be used for multiple purposes, including (1) to quantify the potential transport and mobility of the parameters of interest (e.g., pH, TOC); (2) as part of the risk assessment process to quantify potential exposures from site impacts (e.g., TOC, AVS/SEM, and grain size); (3) to refine the CSM relative to chemical behavior (e.g., solubility of metals); (4) to assess the potential for biodegradation in the event that site-related compounds are detected in groundwater (e.g., chloride, nitrite/nitrate, etc.); (5) to assess the potential potability of the aquifer in the event that site-related compounds are detected in groundwater (e.g., TDS, TSS, salinity); and (6) to evaluate groundwater provenance and profiling as it relates to hydrogeologic flow and chemical behavior (e.g., select metals and alkalinity).

The data compiled in the Basewide Background Study Report (Tetra Tech, 2007) will be used in the upland (soil) evaluation of MRP Site 1. The Basewide Background Study Report evaluated soil from six different soil types at the base and determined that these soil types represent very different concentrations of background inorganic constituents. The Basewide Background Study Report

recommends that the data may be used one of two ways to evaluate consistency of site data with base-wide background data: (a) comparison using statistical tests to evaluate consistency between means or (b) an upper prediction limit (UPL) using geochemical statistics where all soil types are included in the calculations. The choice to use comparative or geochemical statistics will depend on the data collected from the sites. It is preferable to use comparative statistics, but geochemical statistics may be used to augment the evaluation, or if the site data are not conducive to comparative statistics.

Data collected from MRP Site 1 will be evaluated to determine (1) which constituents in soil require comparison to background (i.e., exceedence of risk-based values); (2) whether the constituents that require comparison to background are naturally occurring or have anthropogenic constituent sources; (3) if the samples collected from each Site are from the same soil type, and if so, if that soil type matches one from the Background Report; and (4) distribution of the data (i.e., are the data normally distributed).

Analyses conducted will be consistent with USEPA (2002a), NAVFAC (2002) and USEPA (2010).

#### **Step 4 – Study Boundaries**

MRP Site 1 site consists of approximately 4 acres of land along an estimated 500-foot bank of Narragansett Bay. Part of the planned investigation area will also encompass an estimated 17 acres of the adjacent East Passage of Narragansett Bay. Refer to Figure 1 for the regional location. Spatial and temporal boundaries are described below.

#### **Spatial Boundaries**

A key element for this investigation is to refine the lateral extent of historical release(s) that may warrant site remediation and or site restrictions. Prior investigations at MRP Site 1 have identified PAHs and metals in soil; metals in groundwater; and PAHs, metals and lead pellets in sediment within the adjacent Narragansett Bay. However, the specific boundaries of impacts have not been fully delineated. The approximate extent of impacts is shown on Figures 3, 4 and 5. The planned investigation is designed to collect site-specific and background data to better define the extent of site-related impacts. Proposed sampling locations, target sampling depths, and target screen intervals have been identified based on prior site investigations (refer to Figure 3, 4 and 5 and Tables 17-1 and 17-2); however, it is anticipated that modifications may be made in the field based on actual field conditions (i.e., depth to groundwater, field parameters, visual observations, etc.) to best refine the extent of potential impacts. In addition, it is possible that additional step-out sample locations will be necessary based on field conditions (i.e., field parameters, visual observation, etc.) to refine the extent of potential impacts.

The depth of impacts is considered to be relatively shallow (generally limited to surface soil), based on prior investigations. This planned investigation will include assessment of soil to an estimated depth of 12 feet, or depth to groundwater if shallower, and sediment to estimated depths of 3 feet to confirm that the vertical extent of historical release(s) is defined.

Groundwater is relatively shallow as well, with the planned investigation area limited to the overburden aquifer zone. The shallow overburden aquifer zone ranges from approximately 7 to 12 feet to the top of bedrock, which ranges from approximate depths of 17 to 39 feet bgs.

### **Temporal Boundaries**

The temporal boundaries for this study will be the period of the actual field investigation, anticipated to occur in the Fall 2013 or Spring 2014. If the anticipated investigation season is different, there will be no anticipated impacts to the data quality or usability. There are no seasonal variations anticipated to affect this investigation.

### **Step 5 – Analytical Approach**

The analytic approach for the planned investigation is comprised of a series of “if... then...” statements.

#### Goal 1 – Refine the Extent of Historical Release(s) from Prior Operations

- If compounds are present in site-specific environmental media, then they will be compared to available background data to help determine whether they are site-related.
- If site-related compounds are present in site-specific environmental media, then their distribution will be used to refine the general site study area boundary.
- If visual observations made during soil sampling identify potential impacts (e.g., staining), then additional step-out samples may be collected and either analyzed or held for potential future analysis to refine the general study area boundary.
- If the diving survey identifies skeet fragments at the proposed sediment sampling locations, then additional step-out samples will be collected in order to assess the extent of skeet fragments.
- If visual observations made during the sediment coring effort identify potential impacts (e.g., presence of skeet fragments or lead shot), then additional step-out samples and/or deeper samples (in 1-foot intervals) may be collected and either analyzed along with the proposed samples, or frozen (archived) for potential future analysis (pending review of the proposed samples).

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Goal 2 – Evaluate potential risk/hazard to human and ecological receptors exposed to site media

- If the Tier IA human health risk based screening evaluation (discussed in the attached Risk Assessment Work Plan Technical Memorandum) identifies compounds that are detected above risk-based screening levels and inconsistent with the background dataset, these compounds will be further evaluated in a Tier II Baseline Human Health Risk Assessment (BHHRA).
- If the Tier II BHHRA identifies unacceptable risks due to exposure to site-related compounds, then they will be identified as chemicals of concern (COC) for the site. If a Feasibility Study (FS) is warranted, then further evaluation will be conducted via a Tier III risk evaluation.
- If the Tier 1 ecological screening risk assessment identifies compounds with hazard quotients greater than 1 (discussed in the attached Risk Assessment Work Plan Technical Memorandum), then those compounds and receptors for which they were identified will be further evaluated in a Tier 2 BBERA.
- If the Tier 2 BERA identifies unacceptable risks due to site-related compounds, then they will be identified as COCs for the site.
- If warranted based on the result of the risk assessments, a FS could be considered to identify and evaluate potential site response actions. More specific detail on the data comparison and risk assessment approach is provided in the attached Risk Assessment Work Plan Technical Memorandum developed by the Navy for NAVSTA Newport.

**Step 6 – Performance Criteria**

The objective of this section is to complete the following:

- Identify potential sources of study error (e.g., field error, analytical error, etc.);
- Establish and identify the methods used to reduce potential sources of error; and
- Determine how decision errors will be managed during the project.

**Sampling Strategy**

The soil, sediment, and groundwater sampling design was developed to further characterize contaminant concentrations historically detected in soil, sediment, and groundwater at the site. A biased sampling design based on previously identified site impacts, with regulatory agency input during the planned pre-investigation site visit, will be used to place the soil sampling locations, new water table groundwater monitoring wells, deep aquifer short screen monitoring wells on the bedrock surface, and sediment sampling locations. It is possible that additional step-out sample

locations from the proposed locations will be necessary based on field conditions (i.e., field parameters, visual observation, etc.) in order to identify the extent of potential impacts.

### **Potential Sources of Error**

Potential sources of error in the RI may be divided into two main categories: sampling errors and measurement errors. A sampling error can occur when the sampling design, planning, and implementation do not provide for a representative range of heterogeneity at the site. A measurement error can occur when performance variance from laboratory instrumentation, analytical methods, and/or operator error occurs. USEPA identifies the combination of these errors as a "total study error" (USEPA, 2006). One objective of the planned investigation is to reduce the total study error so that decision-makers can be confident that the data collected accurately represent the chemical characteristics of the sites.

### **Managing Decision Error**

The investigation will utilize decision-error minimization techniques in sampling design, sampling methodologies, and laboratory measurement of compounds of interest. Possible decision errors will be minimized during the field investigation by using the following methods:

- Evaluate available historical data and perform site reconnaissance visits as needed to identify site-related compounds, sampling locations, and site characteristics.
- Use standard field sampling methodologies (as discussed in Worksheets #18 and #21). Perform sampling activities in accordance with the standard operating procedures (SOPs) referenced in this SAP.
- Use applicable analytical methods (discussed in Worksheets #23, #24, and #25) for sample analysis by a competent analytical laboratory certified by the DoD Environmental Laboratory Accreditation Program (ELAP) to reduce measurement errors.
- Confirm analytical data to identify and control potential laboratory error and sampling error by using spikes, blanks, and replicated samples.
- For analytical results that do not achieve desired PALs, include a discussion of alternate information inputs as part of the HHRA and ERA conclusions and uncertainty analysis.

Decision errors associated with judgmental sampling are based on sample design and measurement errors. Assuming that the best possible professional judgment was used to develop the sampling plan (e.g., position sampling locations), the most important decision errors will be associated with field and laboratory techniques involved in the collection and analysis of the data.

### Sampling Methods and Procedures

- Possible decision errors generated by sampling errors will be minimized during the field investigation by applying standardized field sampling methodologies (to be discussed in Worksheets #18, #20, #21, and #22).

### Laboratory Measurement of Compounds of Interest

- Possible decision errors generated by laboratory measurement errors will be minimized by using applicable analytical methods (to be discussed Worksheets #23, #24, and #25) for sample analysis by a competent analytical laboratory evaluated and certified by the DoD ELAP.

### **Managing Laboratory Sampling Error**

Control of potential laboratory error and sampling error will be minimized by using spikes, blanks, and duplicates. Sampling error may be introduced when the laboratory chemist selects a single portion of the field sample for laboratory analysis. Homogenizing the sample prior to selecting an aliquot for laboratory analysis will help to minimize the sampling error.

### **Step 7 – Obtaining the Data**

The sampling design for MRP Site 1 was developed to optimize resources and generate data to satisfy the PQOs. The critical objective is to obtain a quality dataset for evaluation in the RI and risk assessments. The sampling design and rationale for the site is presented in Worksheet #17 and analyses and associated methods per media are presented in Worksheet #20.

### **Field Parameters**

Field measurements will be recorded in a field logbook and/or onto field data collection sheets. Groundwater will be measured in the field for water level, pH, specific conductivity, turbidity, temperature, DO, ferrous iron, salinity and ORP. In addition, hydraulic conductivity testing will be completed. Field data will be compiled and stored in project folders, for subsequent use in evaluating analytical data and completing the RI report.

### **Analytical Laboratory Sample Management**

The sample matrix, number of samples, and number and type of laboratory quality assurance and quality control (QA/QC) samples are summarized in the "Sample Details Table" of this SAP. Details on the analytical group, sample volumes, sample container specifications, preservation requirements, and maximum holding times are identified in Worksheet #19 and #20 of this SAP.

The laboratory will provide EQUIS electronic data deliverable files, portable document format (PDF) files of the data deliverables for all project data, and a hard copy of data deliverables for all results including results from secondary subcontract laboratories. Designated samples will be used to obtain necessary subsamples for laboratory QC measurements, which includes analytical sample duplicate and sample matrix spike/matrix spike duplicate (MS/MSD). Tasks will be completed using the laboratory SOPs.

Resolution will provide data validation services and verify and evaluate the usability of the data as identified in Worksheets #31 through #37.

PDF copies of all analytical data packages will be stored on CD-ROM, archived in the NAVFAC LANT Administrative Record, and uploaded onto the Naval Installation Restoration Information Solution (NIRIS) system using the Navy Electronic Data Deliverable (NEDD) database format.

Other data generated in the field and reports generated for the project will be stored as computer readable data files by Resolution.

**SAP Worksheet #12-1: Measurement Performance Criteria – Field QC Samples**

[\(UFP-QAPP Manual Section 2.6.2\)](#)

Matrix: Soil

Analytical Group: Polynuclear Aromatic Hydrocarbons (Full Scan and Selected Ion Monitoring)

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Equipment Rinsate Blank	Polynuclear Aromatic Hydrocarbons (Full Scan and Selected Ion Monitoring)	One per day of sampling per type of equipment used	Accuracy/Bias	No target compounds > 1/2 LOQ (> LOQ for common laboratory contaminants) and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).
Cooler Temperature Indicator		One per cooler	Accuracy/Representativeness	Temperature ≤ 6 degrees Celsius.
Field Duplicate		One per ten samples per matrix	Precision	RPD ≤ 50% if both results are ≥ 2 x LOQ
Matrix Spike/Matrix Spike Duplicate		Submitted: One per twenty samples per matrix. Analyzed: More frequent of one per twenty samples or SDG per matrix.	Accuracy/Bias/Precision	Refer to Worksheet #28-1

**SAP Worksheet #12-2: Measurement Performance Criteria – Field QC Samples**

[\(UFP-QAPP Manual Section 2.6.2\)](#)

Matrix: Soil

Analytical Group: Nitroaromatics and Nitramines

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Equipment Rinsate Blank	Nitroaromatics and Nitramines	One per day of sampling per type of equipment used	Accuracy/Bias	No analytes detected > LOQ and > 1/10 the amount measured in any sample or 1/10 the PAL (whichever is greater). Blank result must not otherwise affect sample results (see DoD QSM Box D-1).
Cooler Temperature Indicator		One per cooler	Accuracy/Representativeness	Temperature ≤ 6 degrees Celsius.
Field Duplicate		One per ten samples per matrix	Precision	RPD ≤ 50% if both results are ≥ 2 x LOQ
Matrix Spike/Matrix Spike Duplicate		Submitted: One per twenty samples per matrix. Analyzed: More frequent of one per twenty samples or SDG per matrix.	Accuracy/Bias/Precision	Refer to Worksheet 28-2

**SAP Worksheet #12-3: Measurement Performance Criteria – Field QC Samples**

[\(UFP-QAPP Manual Section 2.6.2\)](#)

Matrix: Soil

Analytical Group: ICP-MS Metals

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Equipment Rinsate Blank	ICP-MS Metals	One per day of sampling per type of equipment used	Accuracy/Bias	No target metals > 1/2 LOQ (> LOQ for common laboratory contaminants) and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. For negative blanks, absolute value < LOD. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).
Field Duplicate		One per ten samples per matrix	Precision	RPD ≤ 50% if both results are ≥ 5 x LOQ.  Diff  ≤ LOQ if values are < 5x LOQ
Matrix Spike		Submitted: One per twenty samples per matrix. Analyzed: Most frequent of one per twenty samples or SDG per matrix, or one per prep batch per matrix.	Accuracy/Bias	Refer to Worksheet #28-3

**SAP Worksheet #12-4: Measurement Performance Criteria – Field QC Samples**

[\(UFP-QAPP Manual Section 2.6.2\)](#)

Matrix: Soil

Analytical Group: ICP-AES Metals

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Equipment Rinsate Blank	ICP-AES Metals	One per day of sampling per type of equipment used	Accuracy/Bias	No target metals > 1/2 LOQ (> LOQ for common laboratory contaminants) and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. For negative blanks, absolute value must be < LOD. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).
Field Duplicate		One per ten samples per matrix	Precision	RPD ≤ 50% if both results are ≥ 5 x LOQ.  Diff  ≤ LOQ if values are < 5x LOQ
Matrix Spike		Submitted: One per twenty samples per matrix. Analyzed: Most frequent of one per twenty samples or SDG per matrix, or one per prep batch per matrix.	Accuracy/Bias	Refer to Worksheet #28-4

**SAP Worksheet #12-5: Measurement Performance Criteria – Field QC Samples**

[\(UFP-QAPP Manual Section 2.6.2\)](#)

Matrix: Soil

Analytical Group: Mercury (CVAA)

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Equipment Rinsate Blank	Mercury (CVAA)	One per day of sampling per type of equipment used	Accuracy/Bias	No mercury > 1/2 LOQ and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. For negative blanks, absolute value < LOD. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).
Cooler Temperature Indicator		One per cooler	Accuracy/Representativeness	Temperature ≤ 6 degrees Celsius.
Field Duplicate		One per ten samples per matrix	Precision	RPD ≤ 50% if both results are ≥ 5 x LOQ.  Diff  ≤ LOQ if values are < 5x LOQ
Matrix Spike		Submitted: One per twenty samples per matrix. Analyzed: Most frequent of one per twenty samples or SDG per matrix, or one per prep batch per matrix.	Accuracy/Bias	Refer to Worksheet #28-5

**SAP Worksheet #12-6: Measurement Performance Criteria – Field QC Samples**

[\(UFP-QAPP Manual Section 2.6.2\)](#)

Matrix: Soil

Analytical Group: Hexavalent Chromium (SW-846 Method 7196A)

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Equipment Rinsate Blank	Hexavalent Chromium	One per day of sampling per type of equipment used	Accuracy/Bias	No analyte detected > 1/2 the reporting limit and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results (see DoD QSM Box D-1).
Cooler Temperature Indicator		One per cooler	Accuracy/Representativeness	Temperature ≤ 6 degrees Celsius.
Field Duplicate		One per ten samples per matrix	Precision	RPD ≤ 50% if both results are ≥ 5 x LOQ.  Diff  ≤ LOQ if values are < 5x LOQ
Matrix Spike		Submitted: One per twenty samples per matrix. Analyzed: Most frequent of one per twenty samples or SDG per matrix, or one per prep batch per matrix.	Accuracy/Bias	Refer to Worksheet #28-6

**SAP Worksheet #12-7: Measurement Performance Criteria – Field QC Samples**

[\(UFP-QAPP Manual Section 2.6.2\)](#)

Matrix: Soil

Analytical Group: Hexavalent Chromium (SW-846 Method 7199)

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Equipment Rinsate Blank	Hexavalent Chromium	One per day of sampling per type of equipment used	Accuracy/Bias	No analyte detected > 1/2 the reporting limit and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results (see DoD QSM Box D-1).
Cooler Temperature Indicator		One per cooler	Accuracy/Representativeness	Temperature ≤ 6 degrees Celsius.
Field Duplicate		One per ten samples per matrix	Precision	RPD ≤ 50% if both results are ≥ 5 x LOQ.  Diff  ≤ LOQ if values are < 5x LOQ
Matrix Spike		Submitted: One per twenty samples per matrix. Analyzed: Most frequent of one per twenty samples or SDG per matrix, or one per prep batch per matrix.	Accuracy/Bias	Refer to Worksheet #28-7

**SAP Worksheet #12-8: Measurement Performance Criteria – Field QC Samples**

[\(UFP-QAPP Manual Section 2.6.2\)](#)

Matrix: Soil

Analytical Group: Total Organic Carbon (Method 9060M)

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Cooler Temperature Indicator	Total Organic Carbon (Method 9060M)	One per cooler	Accuracy/Representativeness	Temperature ≤ 6 degrees Celsius.
Field Duplicate		One per ten samples per matrix	Precision	RPD ≤ 50% if both results are >3 x LOQ; RPD ≤ 100% for samples ≤ 3 x LOQ
Matrix Spike		Submitted: One per twenty samples per matrix. Analyzed: One per ten samples per matrix.	Accuracy/Bias	Refer to Worksheet #28-8

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**SAP Worksheet #12-9: Measurement Performance Criteria – Field QC Samples**

[\(UFP-QAPP Manual Section 2.6.2\)](#)

Matrix: Soil

Analytical Group: Grain Size (Sieve Only)

Concentration Level: NA

<b>QC Sample</b>	<b>Analytical Group</b>	<b>Frequency</b>	<b>Data Quality Indicators (DQIs)</b>	<b>Measurement Performance Criteria</b>
Field Duplicate	Grain Size (Sieve Only)	One per ten samples per matrix	Precision	RPD ≤ 30%

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**SAP Worksheet #12-10: Measurement Performance Criteria – Field QC Samples**

[\(UFP-QAPP Manual Section 2.6.2\)](#)

Matrix: Soil

Analytical Group: Bulk Density

Concentration Level: NA

<b>QC Sample</b>	<b>Analytical Group</b>	<b>Frequency</b>	<b>Data Quality Indicators (DQIs)</b>	<b>Measurement Performance Criteria</b>
Field Duplicate	Bulk Density	One per ten samples per matrix	Precision	RPD $\leq$ 30%

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**SAP Worksheet #12-11: Measurement Performance Criteria – Field QC Samples**

[\(UFP-QAPP Manual Section 2.6.2\)](#)

Matrix: Soil

Analytical Group: Porosity (Total Air/Water)

Concentration Level: NA

<b>QC Sample</b>	<b>Analytical Group</b>	<b>Frequency</b>	<b>Data Quality Indicators (DQIs)</b>	<b>Measurement Performance Criteria</b>
Field Duplicate	Porosity (Total Air/Water)	One per ten samples per matrix	Precision	RPD $\leq$ 30%

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**SAP Worksheet #12-12: Measurement Performance Criteria – Field QC Samples**

[\(UFP-QAPP Manual Section 2.6.2\)](#)

Matrix: Soil

Analytical Group: pH

Concentration Level: NA

<b>QC Sample</b>	<b>Analytical Group</b>	<b>Frequency</b>	<b>Data Quality Indicators (DQIs)</b>	<b>Measurement Performance Criteria</b>
Field Duplicate	pH	One per ten samples per matrix	Precision	$ \text{Diff}  \leq 0.5$ Standard Units

**SAP Worksheet #12-13: Measurement Performance Criteria – Field QC Samples**

[\(UFP-QAPP Manual Section 2.6.2\)](#)

Matrix: Soil

Analytical Group: Conductivity

Concentration Level: NA

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Cooler Temperature Indicator	Conductivity	One per cooler	Accuracy/Representativeness	Temperature $\leq$ 6 degrees Celsius.
Field Duplicate		One per ten samples per matrix	Precision	RPD $\leq$ 20% if both results are $>3 \times$ LOQ; RPD $\leq$ 100% for samples $\leq 3 \times$ LOQ

**SAP Worksheet #12-14: Measurement Performance Criteria – Field QC Samples**

[\(UFP-QAPP Manual Section 2.6.2\)](#)

Matrix: Groundwater

Analytical Group: Polynuclear Aromatic Hydrocarbons (Full Scan and Selected Ion Monitoring)

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Equipment Rinsate Blank	Polynuclear Aromatic Hydrocarbons (Full Scan and Selected Ion Monitoring)	One per day of sampling per type of equipment used	Accuracy/Bias	No target compounds > 1/2 LOQ (> LOQ for common laboratory contaminants) and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).
Cooler Temperature Indicator		One per cooler	Accuracy/Representativeness	Temperature ≤ 6 degrees Celsius.
Field Duplicate		One per ten samples per matrix	Precision	RPD ≤ 30% if both results are ≥ 2 x LOQ
Matrix Spike/Matrix Spike Duplicate		Submitted: One per twenty samples per matrix. Analyzed: More frequent of one per twenty samples or SDG per matrix.	Accuracy/Bias/Precision	Refer to Worksheet #28-14

**SAP Worksheet #12-15: Measurement Performance Criteria – Field QC Samples**

[\(UFP-QAPP Manual Section 2.6.2\)](#)

Matrix: Groundwater

Analytical Group: ICP-MS Metals

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Equipment Rinsate Blank	ICP-MS Metals	One per day of sampling per type of equipment used	Accuracy/Bias	No target metals > 1/2 LOQ (> LOQ for common laboratory contaminants) and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. For negative blanks, absolute value < LOD. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).
Field Duplicate		One per ten samples per matrix	Precision	RPD ≤ 30% if both results are ≥ 5 x LOQ.  Diff  ≤ LOQ if values are < 5x LOQ
Matrix Spike		Submitted: One per twenty samples per matrix. Analyzed: Most frequent of one per twenty samples or SDG per matrix, or one per prep batch per matrix.	Accuracy/Bias	Refer to Worksheet #28-15

**SAP Worksheet #12-16: Measurement Performance Criteria – Field QC Samples**

[\(UFP-QAPP Manual Section 2.6.2\)](#)

Matrix: Groundwater

Analytical Group: ICP-AES Metals

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Equipment Rinsate Blank	ICP-AES Metals	One per day of sampling per type of equipment used	Accuracy/Bias	No target metals > 1/2 LOQ (> LOQ for common laboratory contaminants) and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. For negative blanks, absolute value must be < LOD. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).
Field Duplicate		One per ten samples per matrix	Precision	RPD ≤ 30% if both results are ≥ 5 x LOQ.  Diff  ≤ LOQ if values are < 5x LOQ
Matrix Spike		Submitted: One per twenty samples per matrix. Analyzed: Most frequent of one per twenty samples or SDG per matrix, or one per prep batch per matrix.	Accuracy/Bias	Refer to Worksheet #28-16

**SAP Worksheet #12-17: Measurement Performance Criteria – Field QC Samples**

[\(UFP-QAPP Manual Section 2.6.2\)](#)

Matrix: Groundwater

Analytical Group: Mercury (CVAA)

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Equipment Rinsate Blank	Mercury (CVAA)	One per day of sampling per type of equipment used	Accuracy/Bias	No mercury > 1/2 LOQ and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. For negative blanks, absolute value < LOD. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).
Cooler Temperature Indicator		One per cooler	Accuracy/Representativeness	Temperature ≤ 6 degrees Celsius.
Field Duplicate		One per ten samples per matrix	Precision	RPD ≤ 30% if both results are ≥ 5 x LOQ; If < 5 x LOQ,  Diff  ≤ LOQ
Matrix Spike		Submitted: One per twenty samples per matrix. Analyzed: Most frequent of one per twenty samples or SDG per matrix, or one per prep batch per matrix.	Accuracy/Bias	Refer to Worksheet #28-17

**SAP Worksheet #12-18: Measurement Performance Criteria – Field QC Samples**

[\(UFP-QAPP Manual Section 2.6.2\)](#)

Matrix: Groundwater

Analytical Group: Hexavalent Chromium (SW-846 Method 7196A)

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Equipment Rinsate Blank	Hexavalent Chromium	One per day of sampling per type of equipment used	Accuracy/Bias	No analyte detected > 1/2 the reporting limit and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results (see DoD QSM Box D-1).
Cooler Temperature Indicator		One per cooler	Accuracy/Representativeness	Temperature ≤ 6 degrees Celsius.
Field Duplicate		One per ten samples per matrix	Precision	RPD ≤ 50% if both results are ≥ 5 x LOQ.  Diff  ≤ LOQ if values are < 5x LOQ
Matrix Spike		Submitted: One per twenty samples per matrix. Analyzed: Most frequent of one per twenty samples or SDG per matrix, or one per prep batch per matrix.	Accuracy/Bias	Refer to Worksheet #28-18

**SAP Worksheet #12-19: Measurement Performance Criteria – Field QC Samples**

[\(UFP-QAPP Manual Section 2.6.2\)](#)

Matrix: Groundwater

Analytical Group: Salinity (Laboratory)

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Equipment Rinsate Blank	Salinity (Laboratory)	One per day of sampling per type of equipment used	Accuracy/Bias	No target analytes > LOQ (0.1 ppt) and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).
Cooler Temperature Indicator		One per cooler	Accuracy/Representativeness	Temperature ≤ 6 degrees Celsius.
Field Duplicate		One per ten samples per matrix	Precision	RPD ≤ 30 if both results are >3 x LOQ (0.1 ppt); RPD ≤100% for samples ≤ 3 x LOQ (0.1 ppt)

**SAP Worksheet #12-20: Measurement Performance Criteria – Field QC Samples**

[\(UFP-QAPP Manual Section 2.6.2\)](#)

Matrix: Groundwater

Analytical Group: Alkalinity

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Cooler Temperature Indicator	Alkalinity	One per cooler	Accuracy/Representativeness	Temperature ≤ 6 degrees Celsius.
Field Duplicate		One per ten samples per matrix	Precision	RPD ≤ 30 if both results are >3 x LOQ; RPD ≤ 100% for samples ≤ 3 x LOQ
Matrix Spike		Submitted: One per twenty samples per matrix. Analyzed: One per ten samples.	Accuracy/Bias	Refer to Worksheet #28-20

**SAP Worksheet #12-21: Measurement Performance Criteria – Field QC Samples**

[\(UFP-QAPP Manual Section 2.6.2\)](#)

Matrix: Groundwater

Analytical Group: Anions (Chloride, Nitrate, Nitrite, Ortho-phosphate-P, Sulfate)

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Cooler Temperature Indicator	Anions (Chloride, Nitrate, Nitrite, Ortho-phosphate-P, Sulfate)	One per cooler	Accuracy/Representativeness	Temperature ≤ 6 degrees Celsius.
Field Duplicate		One per ten samples per matrix	Precision	RPD ≤ 30 if both results are >3 x LOQ; RPD ≤ 100% for samples ≤ 3 x LOQ
Matrix Spike/Matrix Spike Duplicate		Submitted and Analyzed: One per twenty samples per matrix.	Accuracy/Bias/Precision	Refer to Worksheet #28-21

**SAP Worksheet #12-22: Measurement Performance Criteria – Field QC Samples**

[\(UFP-QAPP Manual Section 2.6.2\)](#)

Matrix: Groundwater

Analytical Group: Total Organic Carbon (Method 9060)

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Cooler Temperature Indicator	Total Organic Carbon (Method 9060)	One per cooler	Accuracy/Representativeness	Temperature ≤ 6 degrees Celsius.
Field Duplicate		One per ten samples per matrix	Precision	RPD ≤ 30 if both results are >3 x LOQ; RPD ≤ 100% for samples ≤ 3 x LOQ
Matrix Spike		Submitted: One per twenty samples per matrix. Analyzed: One per ten samples per matrix.	Accuracy/Bias	Refer to Worksheet #28-22

**SAP Worksheet #12-23: Measurement Performance Criteria – Field QC Samples**

[\(UFP-QAPP Manual Section 2.6.2\)](#)

Matrix: Groundwater

Analytical Group: Methane/Ethane/Ethene

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Cooler Temperature Indicator	Methane/Ethane/Ethene	One per cooler	Accuracy/Representativeness	Temperature ≤ 6 degrees Celsius.
Field Duplicate		One per ten samples per matrix	Precision	RPD ≤ 30% if both results are ≥ 2 x LOQ
Matrix Spike/Matrix Spike Duplicate		Submitted and Analyzed: One per twenty samples per matrix.	Accuracy/Bias/Precision	Refer to Worksheet #28-23

**SAP Worksheet #12-24: Measurement Performance Criteria – Field QC Samples**

[\(UFP-QAPP Manual Section 2.6.2\)](#)

Matrix: Groundwater

Analytical Group: Total Suspended Solids

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Cooler Temperature Indicator	Total Suspended Solids	One per cooler	Accuracy/Representativeness	Temperature ≤ 6 degrees Celsius.
Field Duplicate		One per ten samples per matrix	Precision	RPD ≤ 30 if both results are >3 x LOQ; RPD ≤ 100% for samples ≤ 3 x LOQ

**SAP Worksheet #12-25: Measurement Performance Criteria – Field QC Samples**

[\(UFP-QAPP Manual Section 2.6.2\)](#)

Matrix: Groundwater

Analytical Group: Total Dissolved Solids

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Cooler Temperature Indicator	Total Dissolved Solids	One per cooler	Accuracy/Representativeness	Temperature ≤ 6 degrees Celsius.
Field Duplicate		One per ten samples per matrix	Precision	RPD ≤ 30 if both results are >3 x LOQ; RPD ≤ 100% for samples ≤ 3 x LOQ

**SAP Worksheet #12-26: Measurement Performance Criteria – Field QC Samples**

[\(UFP-QAPP Manual Section 2.6.2\)](#)

Matrix: Sediment

Analytical Group: Polynuclear Aromatic Hydrocarbons (Full Scan and Selected Ion Monitoring)

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Equipment Rinsate Blank	Polynuclear Aromatic Hydrocarbons (Full Scan and Selected Ion Monitoring)	One per day of sampling per type of equipment used	Accuracy/Bias	No target compounds > 1/2 LOQ (> LOQ for common laboratory contaminants) and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).
Cooler Temperature Indicator		One per cooler	Accuracy/Representativeness	Temperature ≤ 6 degrees Celsius.
Field Duplicate		One per ten samples per matrix	Precision	RPD ≤ 50% if both results are ≥ 2 x LOQ
Matrix Spike/Matrix Spike Duplicate		Submitted: One per twenty samples per matrix. Analyzed: More frequent of one per twenty samples or SDG per matrix.	Accuracy/Bias/Precision	Refer to Worksheet #28-26

**SAP Worksheet #12-27: Measurement Performance Criteria – Field QC Samples**

[\(UFP-QAPP Manual Section 2.6.2\)](#)

Matrix: Sediment

Analytical Group: ICP-MS Metals

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Equipment Rinsate Blank	ICP-MS Metals	One per day of sampling per type of equipment used	Accuracy/Bias	No target metals > 1/2 LOQ (> LOQ for common laboratory contaminants) and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. For negative blanks, absolute value < LOD. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).
Field Duplicate		One per ten samples per matrix	Precision	RPD ≤ 50% if both results are ≥ 5 x LOQ.  Diff  ≤ LOQ if values are < 5x LOQ
Matrix Spike		Submitted: One per twenty samples per matrix. Analyzed: Most frequent of one per twenty samples or SDG per matrix, one per prep batch per matrix.	Accuracy/Bias	Refer to Worksheet #28-27

**SAP Worksheet #12-28: Measurement Performance Criteria – Field QC Samples**

[\(UFP-QAPP Manual Section 2.6.2\)](#)

Matrix: Sediment

Analytical Group: ICP-AES Metals

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Equipment Rinsate Blank	ICP-AES Metals	One per day of sampling per type of equipment used	Accuracy/Bias	No target metals > 1/2 LOQ (> LOQ for common laboratory contaminants) and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. For negative blanks, absolute value must be < LOD. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).
Field Duplicate		One per ten samples per matrix	Precision	RPD ≤ 50% if both results are ≥ 5 x LOQ.  Diff  ≤ LOQ if values are < 5x LOQ
Matrix Spike		Submitted: One per twenty samples per matrix. Analyzed: Most frequent of one per twenty samples or SDG per matrix, one per prep batch per matrix.	Accuracy/Bias	Refer to Worksheet #28-28

**SAP Worksheet #12-29: Measurement Performance Criteria – Field QC Samples**

[\(UFP-QAPP Manual Section 2.6.2\)](#)

Matrix: Sediment

Analytical Group: Mercury (CVAA)

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Equipment Rinsate Blank	Mercury (CVAA)	One per day of sampling per type of equipment used	Accuracy/Bias	No mercury > 1/2 LOQ and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. For negative blanks, absolute value < LOD. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).
Cooler Temperature Indicator		One per cooler	Accuracy/Representativeness	Temperature ≤ 6 degrees Celsius.
Field Duplicate		One per ten samples per matrix	Precision	RPD ≤ 50% if both results are ≥ 5 x LOQ.  Diff  ≤ LOQ if values are < 5x LOQ
Matrix Spike		Submitted: One per twenty samples per matrix. Analyzed: Most frequent of one per twenty samples or SDG per matrix, one per prep batch per matrix.	Accuracy/Bias	Refer to Worksheet #28-29

**SAP Worksheet #12-30: Measurement Performance Criteria – Field QC Samples**

[\(UFP-QAPP Manual Section 2.6.2\)](#)

Matrix: Sediment

Analytical Group: Hexavalent Chromium (SW-846 Method 7196A)

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Equipment Rinsate Blank	Hexavalent Chromium	One per day of sampling per type of equipment used	Accuracy/Bias	No analyte detected > 1/2 the reporting limit and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results (see DoD QSM Box D-1).
Cooler Temperature Indicator		One per cooler	Accuracy/Representativeness	Temperature ≤ 6 degrees Celsius.
Field Duplicate		One per ten samples per matrix	Precision	RPD ≤ 50% if both results are ≥ 5 x LOQ.  Diff  ≤ LOQ if values are < 5x LOQ
Matrix Spike		Submitted: One per twenty samples per matrix. Analyzed: Most frequent of one per twenty samples or SDG per matrix, or one per prep batch per matrix.	Accuracy/Bias	Refer to Worksheet #28-30

**SAP Worksheet #12-31: Measurement Performance Criteria – Field QC Samples**

[\(UFP-QAPP Manual Section 2.6.2\)](#)

Matrix: Sediment

Analytical Group: Hexavalent Chromium (SW-846 Method 7199)

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Equipment Rinsate Blank	Hexavalent Chromium	One per day of sampling per type of equipment used	Accuracy/Bias	No analyte detected > 1/2 the reporting limit and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results (see DoD QSM Box D-1).
Cooler Temperature Indicator		One per cooler	Accuracy/Representativeness	Temperature ≤ 6 degrees Celsius.
Field Duplicate		One per ten samples per matrix	Precision	RPD ≤ 50% if both results are ≥ 5 x LOQ.  Diff  ≤ LOQ if values are < 5x LOQ
Matrix Spike		Submitted: One per twenty samples per matrix. Analyzed: Most frequent of one per twenty samples or SDG per matrix, or one per prep batch per matrix.	Accuracy/Bias	Refer to Worksheet #28-31

**SAP Worksheet #12-32: Measurement Performance Criteria – Field QC Samples**

[\(UFP-QAPP Manual Section 2.6.2\)](#)

Matrix: Sediment

Analytical Group: Total Organic Carbon (Lloyd Kahn)

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Cooler Temperature Indicator	Total Organic Carbon (Lloyd Kahn)	One per cooler	Accuracy/Representativeness	Temperature ≤ 6 degrees Celsius.
Field Duplicate		One per ten samples per matrix	Precision	RPD ≤ 50 if both results are >3 x LOQ; RPD ≤ 100% for samples ≤ 3 x LOQ
Matrix Spike		Submitted: One per twenty samples per matrix. Analyzed: One per ten samples per matrix	Accuracy/Bias	Refer to Worksheet #28-32

**SAP Worksheet #12-33: Measurement Performance Criteria – Field QC Samples**

[\(UFP-QAPP Manual Section 2.6.2\)](#)

Matrix: Sediment

Analytical Group: Acid Volatile Sulfide/Simultaneously Extracted Metals

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Cooler Temperature Indicator	Acid Volatile Sulfide/Simultaneously Extracted Metals	One per cooler	Accuracy/Representativeness	Temperature ≤ 6 degrees Celsius.
Field Duplicate		One per ten samples per matrix	Precision	RPD ≤ 50% if both results are ≥ 5 x LOQ.  Diff  ≤ LOQ if values are < 5x LOQ
Matrix Spike		Submitted: One per twenty samples per matrix. Analyzed: One per ten samples per matrix.	Accuracy/Bias	Refer to Worksheet #28-33

**SAP Worksheet #12-34: Measurement Performance Criteria – Field QC Samples**

[\(UFP-QAPP Manual Section 2.6.2\)](#)

Matrix: Sediment

Analytical Group: Volatile Organic Compounds (Full Scan)

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Trip Blank	Volatile Organic Compounds (Full Scan)	One per cooler containing VOC Samples	Accuracy/Bias	No target compounds > 1/2 LOQ (> LOQ for common laboratory contaminants) and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).
Equipment Rinsate Blank		One per day of sampling per type of equipment used	Accuracy/Bias	No target compounds > 1/2 LOQ (> LOQ for common laboratory contaminants) and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).
Cooler Temperature Indicator		One per cooler	Accuracy/Representativeness	Temperature ≤ 6 degrees Celsius.
Field Duplicate		One per ten samples per matrix	Precision	RPD ≤ 50% if both results are ≥ 2 x LOQ
Matrix Spike/Matrix Spike Duplicate		Submitted: One per twenty samples per matrix. Analyzed: More frequent of one per twenty samples or SDG per matrix.	Accuracy/Bias/Precision	Refer to Worksheet #28-35

**SAP Worksheet #12-35: Measurement Performance Criteria – Field QC Samples**

[\(UFP-QAPP Manual Section 2.6.2\)](#)

Matrix: Sediment

Analytical Group: Volatile Organic Compounds (Selected Ion Monitoring)

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Trip Blank	Volatile Organic Compounds (Selected Ion Monitoring)	One per cooler containing VOC samples	Accuracy/Bias	No target compounds > 1/2 LOQ (> LOQ for common laboratory contaminants) and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).
Equipment Rinsate Blank		One per day of sampling per type of equipment used	Accuracy/Bias	No target compounds > 1/2 LOQ (> LOQ for common laboratory contaminants) and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).
Cooler Temperature Indicator		One per cooler	Accuracy/Representativeness	Temperature ≤ 6 degrees Celsius.
Field Duplicate		One per ten samples per matrix	Precision	RPD ≤ 50% if both results are ≥ 2 x LOQ
Matrix Spike/Matrix Spike Duplicate		Submitted: One per twenty samples per matrix. Analyzed: More frequent of one per twenty samples or SDG per matrix.	Accuracy/Bias/Precision	Refer to Worksheet #28-36

**SAP Worksheet #12-36: Measurement Performance Criteria – Field QC Samples**

[\(UFP-QAPP Manual Section 2.6.2\)](#)

Matrix: Sediment

Analytical Group: Semivolatile Organic Compounds (Full Scan)

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Equipment Rinsate Blank	Semivolatile Organic Compounds (Full Scan)	One per day of sampling per type of equipment used	Accuracy/Bias	No target compounds > 1/2 LOQ (> LOQ for common laboratory contaminants) and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).
Cooler Temperature Indicator		One per cooler	Accuracy/Representativeness	Temperature ≤ 6 degrees Celsius.
Field Duplicate		One per ten samples per matrix	Precision	RPD ≤ 50% if both results are ≥ 2 x LOQ
Matrix Spike/Matrix Spike Duplicate		Submitted: One per twenty samples per matrix. Analyzed: More frequent of one per twenty samples or SDG per matrix.	Accuracy/Bias/Precision	Refer to Worksheet #28-38

**SAP Worksheet #12-37: Measurement Performance Criteria – Field QC Samples**

[\(UFP-QAPP Manual Section 2.6.2\)](#)

Matrix: Sediment

Analytical Group: Organochlorine Pesticides

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Equipment Rinsate Blank	Organochlorine Pesticides	One per day of sampling per type of equipment used	Accuracy/Bias	No target compounds > ½ LOQ and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).
Cooler Temperature Indicator		One per cooler	Accuracy/Representativeness	Temperature ≤ 6 degrees Celsius.
Field Duplicate		One per ten samples per matrix	Precision	RPD ≤ 50% if both results are ≥ 2 x LOQ
Matrix Spike/Matrix Spike Duplicate		Submitted: One per twenty samples per matrix. Analyzed: More frequent of one per twenty samples or SDG per matrix.	Accuracy/Bias/Precision	Refer to Worksheet #28-41

**SAP Worksheet #12-38: Measurement Performance Criteria – Field QC Samples**

[\(UFP-QAPP Manual Section 2.6.2\)](#)

Matrix: Sediment

Analytical Group: Polychlorinated Biphenyls (Aroclors)

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Equipment Rinsate Blank	Polychlorinated Biphenyls (Aroclors)	One per day of sampling per type of equipment used	Accuracy/Bias	No target compounds > ½ LOQ and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).
Cooler Temperature Indicator		One per cooler	Accuracy/Representativeness	Temperature ≤ 6 degrees Celsius.
Field Duplicate		One per ten samples per matrix	Precision	RPD ≤ 50% if both results are ≥ 2 x LOQ
Matrix Spike/Matrix Spike Duplicate		Submitted: One per twenty samples per matrix. Analyzed: More frequent of one per twenty samples or SDG per matrix.	Accuracy/Bias/Precision	Refer to Worksheet #28-42

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**SAP Worksheet #12-39: Measurement Performance Criteria – Field QC Samples**

[\(UFP-QAPP Manual Section 2.6.2\)](#)

Matrix: Sediment

Analytical Group: Grain Size (Sieve Only)

Concentration Level: NA

<b>QC Sample</b>	<b>Analytical Group</b>	<b>Frequency</b>	<b>Data Quality Indicators (DQIs)</b>	<b>Measurement Performance Criteria</b>
Field Duplicate	Grain Size (Sieve Only)	One per ten samples per matrix	Precision	RPD $\leq$ 30%

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**SAP Worksheet #12-40: Measurement Performance Criteria – Field QC Samples**

[\(UFP-QAPP Manual Section 2.6.2\)](#)

Matrix: Sediment

Analytical Group: Pellet Count

Concentration Level: NA

<b>QC Sample</b>	<b>Analytical Group</b>	<b>Frequency</b>	<b>Data Quality Indicators (DQIs)</b>	<b>Measurement Performance Criteria</b>
Field Duplicate	Pellet Count	One per ten samples per matrix	Precision	If both results > 20 pellets per square foot, RPD ≤ 10% ; otherwise  Diff  = 0

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**SAP Worksheet #12-41: Measurement Performance Criteria – Field QC Samples**

[\(UFP-QAPP Manual Section 2.6.2\)](#)

Matrix: Sediment

Analytical Group: Toxicity Testing

Concentration Level: NA

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
None				

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**SAP Worksheet #12-42: Measurement Performance Criteria – Field QC Samples**

[\(UFP-QAPP Manual Section 2.6.2\)](#)

Matrix: Sediment

Analytical Group: Macro Invertebrate

Concentration Level: NA

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
None				

**SAP Worksheet #12-43: Measurement Performance Criteria – Field QC Samples**

[\(UFP-QAPP Manual Section 2.6.2\)](#)

Matrix: Tissue

Analytical Group: Polynuclear Aromatic Hydrocarbons (Selected Ion Monitoring)

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Field Duplicate	Polynuclear Aromatic Hydrocarbons (Selected Ion Monitoring)	One per ten samples per matrix	Precision	RPD ≤ 50% if both results are ≥ 2 x LOQ
Matrix Spike/Matrix Spike Duplicate		Submitted: One per twenty samples per matrix. Analyzed: More frequent of one per twenty samples or SDG per matrix.	Accuracy/Bias/Precision	Refer to Worksheet #28-38

**SAP Worksheet #12-44: Measurement Performance Criteria – Field QC Samples**

[\(UFP-QAPP Manual Section 2.6.2\)](#)

Matrix: Tissue

Analytical Group: ICP-AES Metals

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Field Duplicate	ICP-AES Metals	One per ten samples per matrix	Precision	RPD $\leq$ 50% if both results are $\geq 5 \times$ LOQ.  Diff  $\leq$ LOQ if values are $< 5 \times$ LOQ
Matrix Spike		Submitted: One per twenty samples per matrix. Analyzed: Most frequent of one per twenty samples or SDG per matrix, or one per prep batch per matrix.	Accuracy/Bias	Refer to Worksheet #28-39

**SAP Worksheet #12-45: Measurement Performance Criteria – Field QC Samples**

[\(UFP-QAPP Manual Section 2.6.2\)](#)

Matrix: Tissue

Analytical Group: ICP-MS Metals

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Field Duplicate	ICP-MS Metals	One per ten samples per matrix	Precision	RPD $\leq$ 50% if both results are $\geq 5 \times$ LOQ.  Diff  $\leq$ LOQ if values are $< 5 \times$ LOQ
Matrix Spike		Submitted: One per twenty samples per matrix. Analyzed: Most frequent of one per twenty samples or SDG per matrix, or one per prep batch per matrix.	Accuracy/Bias	Refer to Worksheet #28-40

**SAP Worksheet #12-46: Measurement Performance Criteria – Field QC Samples**

[\(UFP-QAPP Manual Section 2.6.2\)](#)

Matrix: Tissue

Analytical Group: Mercury (CVAFS)

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Field Duplicate	Mercury (CVAFS)	One per ten samples per matrix	Precision	RPD $\leq$ 50% if both results are $\geq$ 5 x LOQ.  Diff  $\leq$ LOQ if values are $<$ 5x LOQ
Matrix Spike		Submitted: One per twenty samples per matrix. Analyzed: Most frequent of one per twenty samples or SDG per matrix, or one per prep batch per matrix.	Accuracy/Bias	Refer to Worksheet #28-41

## **SAP Worksheet #12: Notes**

[\(UFP-QAPP Manual Section 2.6.2\)](#)

|Diff| – Absolute Difference

DoD QSM – Department of Defense Quality Systems Manual

DQI – Data Quality Indicator

LOD – Limit of Detection

LOQ – Limit of Quantitation

NA – Not Applicable

PAL – Project Action Limit

RPD – Relative Percent Difference

SDG – Sample Delivery Group

VOC – Volatile Organic Compound

**SAP Worksheet #13: Secondary Data Criteria and Limitations Table**

[\(UFP-QAPP Manual Section 2.7\)](#)

<b>Secondary Data</b>	<b>Data Source (originating organization, report title and date)</b>	<b>Data Generator(s) (originating organization, data types, data generation / collection dates)</b>	<b>How Data Will Be Used</b>	<b>Limitations on Data Use</b>
Soil Data	Tetra Tech NUS, Inc., Basewide Background Study Report, October 2007.	Tetra Tech NUS, Inc., Soil Data, September 2006/March 2007.	Data will be incorporated, as appropriate, to the RI and risk assessments for MRP Site 1.	None.
Soil, Groundwater and Sediment Data	Tetra Tech NUS, Inc., Site Investigation Report for Munitions Response Program (MRP) Site 1 - Carr Point, NAVSTA, Newport RI, May 2010.	Tetra Tech NUS, Inc., Soil, Groundwater and Sediment Data, May-June 2009.	Data will be incorporated, as appropriate, to the RI and risk assessments for MRP Site 1.	Historical reporting limits may not be sufficiently low to meet project action limits for this investigation.
Soil Data	Tetra Tech NUS, Inc., Final Technical Memorandum, Recreational Risk Evaluation, MRP Site 1, Carr Point, NAVSTA, Newport RI, May 14, 2010.	Tetra Tech NUS, Inc., Soil Data, January 2010.	Data will be incorporated, as appropriate, to the RI and risk assessments for MRP Site 1.	Historical reporting limits may not be sufficiently low to meet project action limits for this investigation.

## **SAP Worksheet #14: Summary of Project Tasks**

[\(UFP-QAPP Manual Section 2.8.1\)](#)

### **Clearing**

Prior to the initiation of intrusive field work, Resolution, the Navy and the regulatory agencies will conduct a site visit to mark out the locations of the proposed soil boring and monitoring wells. The mark out of the locations will be utilized for utility clearance (described below). In addition, Resolution will identify any locations which will require clearing of vegetation in order to advance the soil borings. If clearing of vegetation is necessary, Resolution will arrange for the vegetation to be cleared prior to the initiation of field activities.

### **Utility Clearance**

Prior to the initiation of intrusive field work, utility clearance will be conducted in accordance with SOP 3-01.

### **Drilling, Soil Sample Collection and Monitoring Well Installation**

Reference Worksheet #21 for the appropriate drilling, soil sampling, monitoring well installation, and groundwater sampling SOPs. Complete all applicable forms (soil boring logs, well construction logs, and well development logs) on a daily basis). Review health and safety plan with the field crew.

Soil borings will be advanced in the upland portion of the site, along the shoreline, and at the outfall (if identified). Locations of proposed borings are shown on Figure 3, and proposed boring rationale are included on Table 17-1. An estimated 32 soil borings are proposed to help delineate the extent of site impacts at MRP Site 1; 26 along the upland portion of the site, five along the Narragansett Bay shoreline, and one at the outfall associated with a drainage pipe which underlies the site and discharges at the upland bank along Narragansett Bay (assuming the outfall can be identified in the field). Soil borings will be advanced utilizing direct push technology. If direct push technology is ineffective, a hollow stem auger will be utilized to complete the drilling. At the outfall and along the shoreline, it is expected that a hand auger will be utilized to collect the soil samples. Additional soil borings may be advanced as step out locations based on field conditions and the results of the soil removal action in the form firing arcs area.

If the outfall is identified in the field, a metal detector will be employed and a series of test trenches will be hand-excavated to determine if the discharge pipe previously extended further into the bay and the approximate terminus of that pipe. Test trenches will be advanced along a transect 10 feet from the outfall and perpendicular to the potential pipe axis. If remnants of an historic pipe are found, additional transects will be advanced at 10 foot spacing to the low tide line

(approximately 60 ft away) until no pipe remnants are observed. An additional soil boring shall be advanced by hand auger at the pipe terminus, if identified.

Soil samples will be collected continuously via acetate liners, split spoons or hand auger for visual description of soil composition. Soil samples along the shoreline will also be observed for a qualitative assessment of lead pellets. The borings will be advanced to a maximum depth of approximately 12 feet at the upland boring locations and approximately 5 feet at the outfall. Proposed soil boring depths are provided in Table 17-1. Final depths will be determined, based on field conditions, at the time of drilling.

Surface soils and subsurface soils will be collected for laboratory analyses. Surface soils will be collected from 0-1 ft bgs from a subset of soil borings, and one to two subsurface soil samples will be collected from greater than 1 ft bgs from each soil borings. Table 17-1 identifies what soil samples will be collected for each boring, target depth, and rationale. Target depth may be modified in the field based on actual field conditions. Additionally, if the historic pipe terminus is identified, one surface soil sample and one subsurface soil sample will be collected at an adjacent location.

The soil samples will be analyzed for PAHs, propellants (nitroaromatics and nitramines) and TAL metals. A subset of these samples will also be analyzed for hexavalent chromium TOC, grain size, pH, bulk density, porosity and conductivity. Worksheets #18, 19, 20, and 30 specify the required bottle types, preservation, target analytes, analytical methods, and holding times for this investigation.

Five monitoring wells will be installed in borings advanced by either hollow stem auger or drive and wash methodologies. Soil samples will be collected continuously via split-spoons, macrocore, or hand auger for visual description of soil composition and PID head space screening. Three wells will be constructed of 10 foot screens installed across the water table to be consistent with the existing monitoring well network. Two deep overburden wells, MW-01D and MW-12D, will be constructed of five foot screens installed on the bedrock surface, and paired with wells MW-01 and MW-12, respectively. The deep wells are constructed of short screens to maximize the distance between the shallow and deep well pairs, to evaluate the vertical extent of key constituents, and evaluate vertical groundwater elevation gradients. The monitoring wells will be constructed in accordance with SOP 3-12 and RIDEM regulations (RIDEM, 2010, and 2011). Monitoring well filter packs will be designed based on the formation encountered and the well screen slot size selected. Based on the SI boring log soil descriptions, a #0 Morie Sand or equivalent filter pack and 0.010 inch slot screens will be installed. Based on the CSM (refer to Worksheet #10), there is no history or expectation for non-aqueous phase liquid (NAPL) at MRP Site 1. If NAPL is observed in soils

collected from within the proposed screen interval or coarser grain size formations are encountered, a #1 Morie Sand or equivalent filter pack and 0.020 inch slot screen will be installed.

The proposed boring and monitoring well locations are shown on Figures 3, 4, and 7. Please refer to Table 17-2 for the groundwater sampling rationale and proposed screen intervals.

### **Monitoring Well Development**

Following installation, the monitoring wells will be developed in accordance with SOP 3-13. Per RIDEM regulations, well development will not commence until at least 24 hours after well installation. In compliance with RIDEM regulations, the monitoring well will be developed until turbidity is equal to or less than 5 nephelometric turbidity units (NTU), if possible. Development fluids will be containerized and temporarily stored at the decontamination area for proper off-site disposal.

### **Groundwater Quality Monitoring and Sample Collection**

Following development, per RIDEM regulations, the newly installed monitoring well will be allowed to stabilize for at least 1 week prior to groundwater gauging and sampling. The newly installed monitoring wells, as well as existing monitoring wells, will be gauged and sampled in accordance with SOP 3-14 and USEPA Region 1 Low-Flow Sampling Guidance.

The wells will be gauged for depth to water, depth to NAPL if present (not expected), and depth to bottom. Gauging results will be used to calculate groundwater elevations to determine flow direction and horizontal and vertical hydraulic gradients at shallow/deep well pairs.

Groundwater samples will be analyzed for PAHs, TAL metals, hexavalent chromium, salinity, TOC, TSS/TDS, alkalinity, chloride, nitrate/nitrite, sulfate, ortho-phosphate-P, and methane/ethane /ethene. All development and purge water will be managed as Investigation-Derived Waste (IDW).

Worksheets #18, 19, 20, and 30 specify the required bottle types, preservation, target analytes, analytical methods, and holding times for this investigation. If warranted, subsequent rounds of groundwater sampling may be implemented using the same procedures outlined in this SAP.

### **Hydraulic Conductivity Testing**

Following installation, development and sampling of the newly installed wells, hydraulic conductivity will be calculated using slug testing. The slug testing will commence at least a week after installation and a significant enough time after developing and sampling to allow the well to return to equilibrium. Hydraulic conductivity will be conducted in accordance with SOP 3-35. Any decontamination water will be managed as IDW.

### **Scientific SCUBA Diving, Habitat Observations, and Tissue Collection**

The objective of scientific dive surveys will be to assess the extent of skeet fragments in the benthos in order to define the magnitude and location of subsequent analytical sampling and to characterize habitat complexity and ecological functions within the areas potentially impacted from historical activity at the site. This ecological investigation will include quantifying the extent of submerged aquatic vegetation (SAV) and viable macroinvertebrate communities. While it is anticipated that dive surveys can confidently identify and delineate the presence of skeet fragments in the aquatic habitats of MRP Site 1, it is likely that dive surveys will not be able to discriminate between lead pellets and naturally occurring marine substrates. The divers will also document the presence of potential eelgrass beds, shellfish beds, or other relevant biological habitats or communities within the sediment sampling area. If shellfish are present, tissue samples will be collected by the divers for metals, PAH, and lipids analysis in accordance with SOP 3-38. Shellfish tissue sampling is further detailed in Worksheet #20 and summarized in Table ES-1 and Worksheet #18-1.

The dive transect locations will be selected to assess the presence of skeet fragments along the proposed perimeter sediment sampling locations identified in Figure 5. These perimeter locations are just outside of the surveyed area identified in the SI (Tetra Tech, 2010a). Per Goal 1 described in Worksheet #11, if the diving survey identifies skeet fragments at the proposed perimeter sediment sampling locations, then additional step-out samples will be collected in order to assess the extent of skeet fragments (e.g., the divers will move out away from the firing range). In addition, if visual observations made during the sediment coring effort identify potential impacts (e.g., presence of skeet fragments or lead shot), then additional step-out samples and/or deeper samples (in 1-foot intervals) may be collected and either analyzed along with the proposed samples, or frozen (archived) for potential future analysis (pending review of the analytical data).

Outer extent transects will be established along the boundary of the study area in an attempt to delineate the boundary of the study area. Divers equipped with a one square meter (m<sup>2</sup>) PVC framed quadrat will descend to each anchor (tethered to the end of each transect) and survey the area within the quadrat every 25 ft along each transect. Divers will assess the presence/absence of skeet fragments as well as count the approximate the number and size of skeet fragments observed. Although a transect will not be surveyed if no skeet fragments are observed in three successive quadrats, the divers will mark the outermost observation of skeet fragments along each transect with an anchored buoy. Divers will relay observations to surface staff using underwater communication systems and collect representative underwater video as visibility permits.

Habitat evaluation transects will be established over the study area (parallel to the shoreline), starting at the outermost extent extending across its entire length. These transects will be spaced such that approximately 10% of the overall study area is covered. Divers will record all pertinent habitat observations (SAV, substrate, presence of marine life, etc.) Information regarding the presence of skeet fragments or other anthropogenic impacts will also be recorded. Divers will relay observations to surface staff using underwater communication systems and collect representative underwater video as visibility permits.

While transiting between quadrat sampling locations along each transect, divers will conduct a qualitative surficial habitat survey to identify eelgrass beds, shellfish beds or other relevant biological habitats or communities. Divers will note the habitat composition, percent exposed sediment, bottom relief, submerged aquatic vegetation, and macroinvertebrate and fish communities observed along each transect

If shellfish are identified, samples (e.g., clams, mussels, etc.) will be collected by the divers for metals, PAHs, and lipids analysis of the tissue residues. A Scientific Collector's Permit will be obtained through the RIDEM Division of Fish and Wildlife prior to any tissue sample collection activities taking place. It is anticipated that up to 15 samples may be collected. The number of samples collected will be dependent upon the number and species of shellfish present. Each sample will be composed of a single species. Multiple individuals of a single species and similar size may be composited to provide sufficient sample volume for analysis. Several individual shellfish will be weighed whole (shell-on) and then opened so the soft tissue can be removed and weighed to determine an approximate ratio of soft tissue weight to whole animal weight. The field team will use this ratio and the whole animal weights, to determine the number of individual shellfish needed for each composite sample. The whole shellfish (shell-on) will be rinsed with deionized water to remove sediment, wrapped in extra heavy duty aluminum foil, euthanized using ice, and sent to the laboratory for opening, processing, and tissue residue analysis. Shellfish will not be depurated prior to processing.

Sediment samples will be collected from areas where shellfish are collected in order to provide site-specific bioaccumulation information. Therefore, the GPS locations where shellfish are collected will be recorded and these locations will be sampled as part of the sediment collection effort. It is anticipated that these locations will overlap with locations already proposed for sampling on Figure 5, but additional sediment samples may be collected to adequately capture the shellfish sampling locations.

## Sediment Sampling

- Sediment samples will be collected in accordance with SOP 3-22 from locations within Narragansett Bay in the vicinity of MRP Site 1, to further evaluate the horizontal and vertical extent of potentially impacted sediments in this area. The proposed sediment sample locations are depicted on Figure 5. Please refer to Table 17-1 for the sampling rationale.

The following distinct sediment horizons will be targeted for sampling in this program (the vertical extent of sampling may be limited based on field conditions [i.e., sampler refusal]):

- 0.0 to 0.5 ft
- 0.5 to 1.0 ft
- 1.0 to 2.0 ft
- 2.0 to 3.0 ft

The sediment samples will be analyzed for PAHs, pellet counting, and TAL metals. A subset of these samples will also be analyzed for hexavalent chromium, TOC, grain size, AVS/SEM, toxicity testing, and macroinvertebrate survey.

The surficial sediment horizon is of interest as it contains the most recently deposited sediments and the most epifaunal and infaunal organisms are found within this horizon (USEPA, 2001a) (i.e., the surficial sediment sample is assumed to represent the bioactive zone). Based on the earlier studies, it is anticipated that the substrate is primarily comprised of sandy material and that sampling with a Ted Young grab, Ekman Dredge, or petite Ponar is not likely to be successful.

Therefore, to ensure successful collection of surficial sediments (0 to 0.5 ft) from MRP Site 1 locations, surficial sediments will be collected using a power grab sampler or equivalent sampling device. A power grab sampler is a stainless steel device equipped with a remote operated pneumatic ram to assist with jaw closure in coarse sediments. Available power grab samplers are approximately 1.25 ft by 1.25 ft with a square penetration to 0.75 ft and a maximum penetration to 1.0 ft at the center. This approach will capture the surficial sediment horizon and provide the sample volume required for co-located analytical chemistry, toxicity testing, and macroinvertebrate community sampling in the potentially sandy substrate of the study area. Dependant on overall sample volume requirements (e.g., QA/QC samples), multiple grab samples may be necessary to collect sufficient sediment for analysis.

Once the sample is collected, the top of the grab sampler will be opened to determine whether the sample collected is acceptable for analysis. In accordance with USEPA (2000) guidance, an acceptable grab is one having relatively level, intact sediment over the entire area of the grab, and a sediment depth at the center of at least 7 centimeters. Samples deemed unacceptable may

result from inadequate penetration, angle of closure, completeness of closure of the jaws, and potential loss of sample material during retrieval.

Whenever boat access is feasible (i.e., when tidal water levels permit), the sub-surficial sediment sampling will be conducted via a vibracore sampling device (hydraulic/ pneumatic) mounted aboard a suitable sampling vessel. In the case that a vibracore device cannot be utilized, a decontaminated hand-held coring device will be used to attempt to sample sub-surficial materials. The deployment and retrieval of the sampling device will be conducted in a controlled manner to avoid deficient samples. All samples will be visually inspected immediately upon retrieval, and a qualitative assessment of grain size will be conducted/ recorded. Sample acceptability will be based on the guidelines outlined in Section 3.3 of the USEPA Method for Collection, Storage, and Manipulation of Sediments for Chemical and Toxicological Analysis: Technical Manual (USEPA, 2001a) whereas samples may be rejected based on lack of penetration, over penetration, loss of fine-grained particulates on sediment surface, etc. Water depth will be recorded for each sampling location along with sample station positioning information using a portable differential GPS unit with sub-meter accuracy and real-time radial beacon correction.

Each core will be logged, photographed, and sub-sampled as the previously specified analytes require. It is anticipated that collecting sub-surficial sediment samples from certain portions of the sampling area may be challenging due to geological constraints, and that therefore deeper sediment samples may not be obtainable from all target stations. If the field observations (e.g., presence of skeet fragments or lead shot) indicate that there may be a need to sample horizons deeper than three feet in depth, samples will be collected in subsequent one-foot intervals (e.g., 3 to 4 ft, 4 to 5 ft, etc.) and either analyzed along with the shallower samples, or frozen (archived) for potential future analysis (pending review of the shallower horizons).

Figure 8 provides a flow chart showing the steps to be performed to collect the appropriate sediment and pellet samples for analysis. Surficial sediment samples for AVS/SEM and the benthic invertebrate community survey will be collected from the first grab sample prior to any sediment sieving/ homogenization to avoid disturbing the sulfides or damaging the invertebrates. The invertebrate samples will be sieved and preserved as described below. The remaining surficial or sub-surficial sample will be homogenized in a decontaminated stainless steel bowl.

The appropriate sediment horizon will be removed from the sampling device using a stainless steel spoon/scoop and placed in a decontaminated 1-gallon stainless steel or Pyrex glass mixing bowl. Each sample will then be visually examined for physical characteristics such as composition, layering, odor, and discoloration. Each discrete sampling horizon will be weighed to the nearest gram and recorded on the on the sample log sheet.

For the surficial samples, both wet and dry sieved sediment analytical chemistry samples will be collected. Dry sieved samples will be pushed through a #10 sieve (2 mm) with a spatula. The sediment which passes through the sieve will be sampled for PAHs and metals and will serve as the basis of the analytical program. These samples will be analyzed on a rapid turnaround basis in order to allow decision-making for the selection samples for toxicity testing and the macroinvertebrate survey.

In order to evaluate the potential impact of the wet sieving process on the analytical results and to allow comparisons with the samples collected to support the SI (Tetra Tech, 2010), a sub-set of wet sieved sediment analytical samples will also be collected. To prepare these samples, an aliquot of homogenized sediment will be wet sieved using a #10 sieve (2 mm) and minimal amounts of seawater. The surface area and depth of the aliquot will be recorded to allow for a determination of the number of pellets per square foot. Each discrete sampling aliquot will be weighed to the nearest gram and recorded on the sample log sheet prior to sieving. The material that does not pass through the sieve (i.e., lead pellets and other larger material) will be weighed, placed in a sample container, and sent to a subcontracted laboratory in order to be sorted and counted. Sediment in the seawater will be allowed to settle, the seawater will be siphoned out, and the remaining sediment will be sampled as the wet sieved chemistry sample. These samples will be put on hold at the analytical laboratory and a sub-set will be analyzed following a review of the dry sieved chemistry results.

For the sub-surficial samples, only dry sieved sediment analytical chemistry samples will be collected. Pellets for pellet count purposes may be removed by wet or dry sieving.

Samples of whole (un-sieved) sediment will be collected for toxicity testing, grain size, and TOC. As described above, samples for the benthic invertebrate community survey will be collected prior to any sediment sieving/ homogenization and will also be representative of whole sediment.

### Toxicity Testing

The objective of the sediment toxicity testing program will be to obtain laboratory data to further evaluate potential ecological risks to invertebrate receptors. Therefore, sediment toxicity testing will be conducted with an estuarine crustacean, the amphipod *Leptocheirus plumulosus*, according to the method described in EPA's Method for Assessing the Chronic Toxicity of Marine and Estuarine Sediment-associated Contaminants with the Amphipod *Leptocheirus plumulosus* (USEPA, 2001b). These tests provide a direct measure of the potential for benthic invertebrate toxicity due to exposure to sediment. For each test, five replicates containing 20 organisms each will be exposed to sediment for 28 days under laboratory conditions. A laboratory control (i.e., negative control) and reference location samples will be included with each test to assess the health of the test

organisms and to determine test acceptability. At test termination, survival, growth, and reproduction (based on number of offspring present) will be measured. As indicated in the testing guidance (USEPA, 2001b) test acceptability for the *L. plumulosus* test include an average of at least 80% survival in the laboratory control and measureable growth and reproduction of test organisms in the control sediment.

To ensure successful collection of surficial sediments (0 to 0.5 ft) from MRP Site 1 locations, as described above, toxicity samples from the 0 to 0.5 ft horizon will be collected using a power grab sampler or equivalent sampling device. Additional samples collected from reference locations will also be submitted for toxicity testing. The surficial sediments represent the biologically active zone to which benthic receptors are the most exposed. Samples will be removed from the sampling device using a stainless steel spoon/scoop and placed in a decontaminated 1-gallon stainless steel or Pyrex glass mixing bowl. Each sample will be visually examined for physical characteristics such as composition, layering, odor, and discoloration. The whole (un-sieved) sample will be homogenized in the mixing bowl (as described above) and placed in appropriate sample containers for toxicity testing. Samples collected for sediment toxicity testing will be co-located with sediment samples to be analyzed for chemistry (i.e., samples for sediment chemistry, toxicity testing, and the macroinvertebrate community survey will be collected from the same homogenized surficial sediment sample).

Surficial sediment samples will be collected from all of the MRP Site 1 and reference sampling locations and held at the toxicity testing lab pending a review of the preliminary analytical results. Samples submitted for toxicity testing will be selected based on the analytical results from the proposed surficial sediment sampling. The analytical chemistry results will be reviewed in order to select ten (10) MRP Site 1 sampling locations that represent a range of metals, PAH, and lead pellet concentrations. Samples from three (3) reference locations will also be submitted for toxicity testing. The Navy will propose locations for toxicity testing to the stakeholders for concurrence prior to the initiation of the tests. The analytical laboratory will dry sieve the samples selected for toxicity testing with a #10 sieve (2 mm) to remove pellets and predatory organisms prior to the initiation of the toxicity test.

Sampling environmental media concurrently for both toxicity testing and analytical chemistry allows for the co-evaluation of chemical, physical, and toxicological stressors. Attempts will be made to relate the results of the toxicity-testing program with measured concentrations of target chemicals to develop potential associations between observed toxicity and chemical concentrations.

### Macroinvertebrate Sampling

To provide a direct assessment of the integrity of the benthic community, a reconnaissance level macroinvertebrate community survey is proposed. The results of the macroinvertebrate survey will also provide a direct measure of the available biomass (typical prey for diving ducks) over a defined surface area in support of the ERA.

Macroinvertebrate community survey stations will be co-located with a sub-set of the analytical sediment chemistry stations in an attempt to relate the results of the benthic community survey with measured concentrations of target chemicals. Similar to the selection of samples for toxicity testing described above, the selection of sampling locations for the macroinvertebrate survey will be conducted following a review of the analytical results from the proposed surficial sediment sampling. Selected sampling locations may also be refined based on substrate type and an effort will be made to select homogenous sampling stations with regard to habitat conditions. It is anticipated that the same ten (10) MRP Site 1 samples and three (3) reference samples will be submitted for both toxicity testing and the macroinvertebrate community survey.

Sampling techniques to collect the benthic macroinvertebrates will be consistent with the technique used to collect surficial sediment (see SOP 3-22) and in accordance with SOP 3-36. The macroinvertebrate sampling technique will incorporate sampling method aspects from the USEPA Estuarine and Coastal Marine Waters: Bioassessment and Biocriteria Technical Guidance (USEPA, 2000). The depth of the Study Area limits the selection of gear type to conduct a macroinvertebrate survey to grab samplers. Therefore, a power grab sampler or equivalent sampling device will be used to collect the benthic invertebrate samples from each location. This method will permit sampling of deep habitats that preclude the use of shallow water sampling techniques such as Kick nets or Dip nets. For each macroinvertebrate sample, four 10 cm x 10 cm x 10 cm subcores will be removed from the power grab sampler prior to any sediment sieving/homogenization to avoid damaging the invertebrates and to provide an appropriate sediment volume for evaluation. Prior to sampling, a physical/chemical field data sheet will be completed to document supplementary information including water quality, depth, etc. A field sketch of the sampling area will be drawn to document major habitats, shoreline conditions, and other local attributes and weather conditions will be documented.

Duplicate samples will be collected at each sampling location. The subcores for each sample will be emptied into a collection bucket. Samples will be rinsed with seawater and large debris (e.g., rocks) will be removed from the sample; however, no attempt will be made to remove small debris. All samples will be preserved in 98 percent formalin to cover the sample (please see SOP 3-36 for full description of benthic sample processing). Sample bottles will be labeled with the site name, the station number, a unique sample identification number, date and time of collection, depth of

collection, preservative use, and name of collectors. Samples will be sent to a subcontracted laboratory for analysis. The laboratory will identify any benthic invertebrates present within the sample to at least class and family and record abundance. The laboratory analysis will also determine the benthic invertebrate biomass present as potential prey for diving ducks (e.g., presence/absence of a food base). The biomass data may also be used along with the surface sediment chemistry data to assess potential trends between biomass and analyte concentrations. Detailed field notes will be kept to document the macroinvertebrate survey.

#### Background/ Reference Locations

It is assumed that up to 12 surficial sediment samples will be collected to represent reference/background conditions for use in the HHRA and ERA. These locations will be analyzed for the metals, PAHs, pesticides, AVS/SEM, TOC, and grain size to physically characterize the sediments and provide data on naturally occurring and anthropogenic sources. In addition, a sub-set of three (3) locations will be selected for hexavalent chromium, toxicity testing and macroinvertebrate sampling in addition to VOCs, SVOCs, and PCBs to identify additional stressors that might be present in these samples. Reference locations will be selected to have comparable substratum, water depths, and hydrologic/tidal regimes as the Study Area.

Reference/ background samples will be collected from the same discrete horizons as the site samples (e.g., 0 to 0.5 ft, etc). If observed, shellfish samples will also be collected from these background/ reference locations in accordance with the procedures described previously. Shellfish of the same species observed at MRP Site 1 will be targeted for collection.

Several reference samples are proposed to be located in the vicinity of the Carr Point site; however, outside the extent of lead shot and other site impacts. Several potential sample locations are depicted on Figure 6 and include samples collected along transects perpendicular to the shoreline to provide a variety of water depths and sediment types matching those collected from the site; however, the final selection of the reference locations will be established with the stakeholders' concurrence and may be dependent on conditions encountered in the field.

Sediment sampling equipment such as bowls, spoons, augers, and dredges will be decontaminated prior to and following sample collection as described below.

## Quality Assurance/Quality Control

The QA/QC sample collection frequency is as follows (also shown in Worksheet #20):

- **Equipment blanks** - 1 per day per type of sampling equipment used for those methods and matrices for which they are included. Equipment blanks will not be submitted for the analyses presented for physical and geochemical characterization of soil, groundwater, and sediment.
- **Trip blanks** - 1 per cooler containing VOC samples
- **Field duplicates** – (single blind samples) 1 per 10 samples per method and matrix
- **MS/MSD or MS/Matrix Duplicate** - 1 per 20 samples per method and matrix

## Equipment Decontamination

To the maximum extent possible, Resolution will utilize dedicated and disposable sampling equipment to avoid the potential for cross contamination of samples due to inadequate decontamination processes. The sampling equipment will include dedicated plastic scoops, disposable Teflon or polyethylene tubing, disposable gloves, and laboratory supplied sample bottles.

Non-disposable or non-dedicated sampling equipment (e.g., dredge or core barrel, stainless spoons, stainless bowls, surge blocks, submersible pumps, water level indicators, water quality meters and data logger transducers, etc.) will be decontaminated prior to sampling and between samples. Cleaning of equipment is performed to prevent cross-contamination between samples and to maintain a clean working environment for all personnel. Decontamination will generally consist of a water rinse station to remove gross contamination (if needed), followed by a non-phosphate detergent (e.g., Alconox) water rinse, and a rinse with de-ionized water. If equipment is to be stored or transported, it will be wrapped in aluminum foil after air-drying. If a hollow stem auger drill rig is required during the project, the auger flights will be decontaminated between each bore hole and split spoon samplers will be decontaminated after each sample collection. All decontamination water generated during decontamination of sampling equipment will be containerized as IDW and properly disposed of.

## Investigation-Derived Waste Management

The IDW, consisting of soil cuttings, sediment left over from core processing, purge/well development water, water generated during decontamination processes and PPE, generated during the advancement of soil borings/monitoring wells, sediment sample collection, well development/sampling and decontamination activities will be collected in properly labeled 55-gallon drums and temporarily stored on the site for subsequent off-site disposal. Subsequently, the

containers will be characterized with laboratory analyses and properly disposed at a Navy approved disposal facility.

### **Land Surveying**

A survey of the soil boring and monitoring well locations will be conducted at the end of the fieldwork by a Rhode Island-licensed surveyor under the direct supervision of Resolution. The locations will be tied into the existing base map developed for the site. After the monitoring wells are installed, a notch or mark will be made at the top of the inner casing. The vertical location of these points will be surveyed to a reference point determined in the field and reported to 0.01 of a foot. All elevations will be referenced to the North American Vertical Datum (NAVD) 1988. The horizontal locations of each point will be established from directly measuring from site features with an accuracy of 0.1 foot.

### **Laboratory Coordination, Data Management and Validation**

Resolution's Project Chemist will track the samples from collections through analysis and obtain data packets from the laboratories within the appropriate TAT of sample receipt. A signed certificate of analysis will be provided in the narrative section of each laboratory data package. The laboratory will submit the data in hard copy and an electronic format.

Analytical results will be validated according to the procedures in Worksheet #36. Resolution will be provided with the hard copy and electronic version of the laboratory. The hardcopy and electronic versions will be examined for completeness and accuracy. The electronic copy will be compared to the hardcopy results by Resolution's Project Chemist and then loaded into the Resolution Sharepoint site and database.

### **Risk Assessment**

Following data collection, analysis and validation, a HHRA and ERA will be completed for MRP Site 1 per the Risk Assessment Work Plan Technical Memorandum attached to this SAP as Appendix C. The HHRA and ERA will include the evaluation of historical data collected at the site in addition to data collected per this SAP. The memorandum was designed to provide the risk assessment approach that would apply to the majority of the NAVSTA Newport sites. The information presented below is additional site-specific information related to the risk assessment for MRP Site 1.

## Human Health Risk Assessment

### *Evaluation of Potential Risks to Hypothetical Future Residents Due to Shellfish Ingestion*

If present, shellfish tissue samples will be collected and the data will be used to develop exposure point concentrations (EPCs) for evaluation of the ingestion pathway for hypothetical future residential receptors. If shellfish are not present during the sampling event, it will be concluded that there is not a sustainable source of shellfish on-site and the CSM will be modified to indicate that the shellfish ingestion pathway is incomplete for all receptors.

The evaluation of the shellfish ingestion pathway is considered to be highly conservative and overestimate potential risk to humans for several reasons. Concentrations of constituents measured in shellfish tissue samples will overestimate constituent concentrations that humans may actually ingest. Shellfish tissue samples being collected at the site will not be depurated (a process which introduces clean water to remove/flush out gut contents) prior to analysis. Depuration will not be conducted so that tissue samples will also be appropriate for evaluation in the ecological risk assessment. However, prior to human consumption, the depuration process is typically done, which would reduce constituent concentrations in the shellfish tissue. In addition, further reduction of constituent concentrations in shellfish tissue is expected as a result of the preparation and cooking process. Therefore, if the HHRA results indicate that the shellfish ingestion pathway is a risk driver for the hypothetical future on-site resident, consideration will be given as to whether further evaluation of this pathway is appropriate (i.e., collection and analysis of depurated shellfish tissue, determining whether there is a sustainable population of shellfish, etc.) before making remedial decisions based upon the results of this highly conservative evaluation.

### *Tier IA - Human Health Risk-Based Screening Evaluation*

#### Sediment

Published human health screening levels for sediment are not available. Therefore, sediment screening levels for use in the Tier IA Human Health Risk-Based Screening Evaluation, described in the Risk Assessment Work Plan Technical Memorandum, will be derived on a site-specific basis using the most current version of the USEPA Regional Screening Level (RSL) Calculator [[http://epa-prgs.ornl.gov/cgi-bin/chemicals/csl\\_search](http://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search)] available at the time the HHRA is started by altering the residential soil RSLs based on the exposure factors below, which will be conservative inputs of site-specific sediment exposure for receptors at MRP Site 1:

- Exposure frequency (days/year) – 52
- Exposure duration (years) – Adult – 24; Child – 6
- Exposure time (hours/day) – 4
- Skin surface area (cm<sup>2</sup>/day) – Adult – 4500; Child – 1459

- Adherence factor (mg/cm<sup>2</sup>) – Adult – 0.07; Child – 0.2
- Ingestion/intake rate (mg/day) – Adult – 100; Child – 200
- Body Weight (kg) – Adult – 70; Child – 15

Sediment screening levels for non-carcinogenic chemicals will be divided by ten to account for potential cumulative effects on the same target organ.

### Shellfish Tissue

Shellfish tissue screening levels for use in the Tier IA Human Health Risk-Based Screening Evaluation, described in the Risk Assessment Work Plan Technical Memorandum, will be equal to the USEPA RSL for fish tissue (USEPA, 2012). The RSLs are based on a target excess lifetime cancer risk (ELCR) of  $1 \times 10^{-6}$  and hazard quotient (HQ) of 1. RSLs for non-carcinogenic chemicals will be divided by ten to account for potential cumulative effects on the same target organ. Chemicals detected above these screening levels will be identified as COPCs for further evaluation in the Tier II HHRA.

### *Tier II – Baseline Human Health Risk Assessment*

Exposure point concentrations (EPCs) for sediment and shellfish tissue will be equal to the 95% upper confidence limit (95% UCL) on the arithmetic mean concentration or the maximum concentration, whichever is lower (USEPA, 2002b). USEPA's ProUCL Version 4.1.01 software (USEPA, 2011) will be used to calculate the 95% UCL. Based on information presented in the ProUCL guidance (USEPA, 2010) regarding minimum sample size and frequency of detection, UCLs will be calculated where at least 10 samples and at least 6 detects are available. ProUCL version 4.1.01 recommends 10 to 15 or more distinct results for the most accurate and reliable UCL calculation. When the minimum sample size and number of detects are not met for a dataset the maximum detected concentration will be used as the EPC. EPCs for evaluation of lead will be equal to the arithmetic mean concentration in accordance with USEPA guidance.

Sediment EPCs will be calculated for use in the HHRA based on sediment samples collected from locations in which humans may have access, such as along the shoreline or under shallow water in Narragansett Bay. Humans are not expected to have significant exposure to sediment consistently covered by surface water.

Prior to calculating EPCs for shellfish tissue, consideration will be given to whether there is a difference in shellfish tissue concentrations in shallow versus deeper water. Recreational shellfishing is more likely to occur in shallower water (i.e., depths in which people could walk during collection). Therefore, if a difference in concentration is noted, shellfish tissue concentrations from shellfish collected in shallow water may be selected over those collected from deeper water.

## Ecological Risk Assessment

### *Evaluation of Potential Risks to Shellfish and Risks to Wildlife Due to Shellfish Ingestion*

If present, shellfish will be collected and the residue data incorporated into the ecological food web modeling as a measurement of site-specific bioaccumulation. In addition, the tissue data will be used as an additional endpoint to assess the potential for risks to the benthic invertebrate community. Rather than selecting one individual effects-based critical body residue (CBR) for evaluating potential effects of residues, the tissue data will be evaluated in the context of a number of different studies. Lowest Observable Effects Level (LOEL) and No Observable Effects Level (NOEL) values for shellfish (or similar species) will be identified from a review of the U.S. Army Corps of Engineers' (USACE) Environmental Residue Effects Database (ERED) (<http://www.wes.army.mil/el/ered/>) and Jarvinen and Ankley (1999). The MRP Site 1 shellfish tissue residue data will be discussed in relation to the range of body burden toxicity data available.

### *Evaluation of Ecological Risks Due to Lead Pellets*

To assess potential risks to birds due to ingestion of lead shot (e.g., diving ducks like the greater scaup or common goldeneye), the number of pellets per square foot within the sediment of Narragansett Bay potentially impacted by shooting range activities will be compared against a screening-level benchmark of 7 pellets/square foot. A benchmark of 10 pellets/square foot was previously used in the SI (Tetra Tech, 2010a). The 7 pellets/square foot benchmark was selected in response to stakeholder concerns about selecting an appropriately conservative level.

In an ERA for the Prime Hook National Wildlife Refuge (USFWS, 2004), based on a model it was determined that a mallard and a dove had a 10% probability of ingesting shot at levels of approximately 7 and 9 shot pellets/square foot, respectively. Also, in an ERA for the Nahant Marsh (USFWS, 1998), a value of 10 pellets/square foot was used to screen for waterfowl. This value was based on previous work conducted by Irwin and Karstad (1972). An ERA for an upland trap and skeet range located on the Patuxent Research Refuge identified a remedial goal for the mourning dove of 3 pellets/square foot, not to exceed 13 pellets/square foot, based on a 10% probability of ingesting lead shot (USFWS and USEPA, 2004).

Therefore, the following assessment endpoint and measure of effect will be used in the Tier 1 – Ecological Screening Risk Assessment (see Appendix C for additional details of the risk assessment approach).

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Assessment Endpoint	Measure of Effect
Protection and maintenance of diving birds that may ingest lead pellets as grit at levels similar to those of nearby populations not exposed to site-related chemicals.	Comparison of lead pellet counts against benchmarks identified to be protective of avian receptors.

To further assess the potential for impacts to diving ducks due to ingestion of lead pellets, the available literature and site-specific data may be reviewed to refine the screening-level measure of effect (i.e., comparison of pellets to benchmark of 7 pellets/square foot). Detailed evaluations of grain size may be needed to evaluate the potential for ingestion of lead pellets (e.g., identification of fraction of pellets within particular size ranges) by local birds. The presence of particular bird species and any grit size preferences may need to be investigated. Birds typically only retain grit within certain size ranges so the availability of lead pellets within the relevant size range may be important to quantify. The availability of prey items for diving ducks (e.g., benthic invertebrates, mussels) within the area containing lead pellets may also be considered through the evaluation of macroinvertebrate biomass data and the findings from the dive survey (to assess the likelihood that the area is used for foraging).

Pellets have not been observed in the upland portions of MRP Site 1 and are not expected to be present. However, if pellets are observed during the soil sampling effort, then the potential for upland exposures to lead pellets will be considered in the ecological risk evaluation.

### Report Preparation

Following data collection, analysis and validation, a RI report will be prepared for the Carr Point sites. The RI report elements will include a summary of field efforts, deviations from the work plan (if any), data tables and figures, comprehensive discussion of the extent of site impacts, and all other standard USEPA and Navy requirements for RI Reports. In addition, the RI Report will include the results of the HHRA and ERA, to be conducted per the Risk Assessment Work Plan Technical Memorandum attached to this SAP as Appendix C.

## SAP Worksheet #15: Establishing Laboratory Reference Limits

[\(UFP-QAPP Manual Section 2.8.1\)](#)

The following table identifies the PALs and comparison of the PALs to analytical laboratory reference limits (i.e., LODs, LOQs and DLs). The PALs represent the limits of detection that analytical data must meet in order to be of sufficient quality for use in the RI, risk assessment, and FS. These levels are designed to represent the lowest of the relevant human health and ecological screening levels and other applicable criteria that will be used in the RI and/or FS. However, the PALs are not intended to be used as cleanup levels or to identify the presence of risk/hazard. Further detail on the risk assessment approach is provided in the attached Risk Assessment Work Plan Technical Memorandum developed by the Navy for NAVSTA Newport. The sources considered for development of PALs are referenced at the bottom of the following tables. For ease of reference, the parameters included for the upcoming field program are as follows:

Analytical Parameter	Matrix
<b>Parameters of Interest</b>	
PAHs	SS, SB, SD, GW, TS, BS
Propellants (Nitroaromatics & Nitramines)	SS
Metals	SS, SB, SD, GW, TS, BS
Hexavalent Chromium	SS, SB, SD, GW, BS
Pellet count	SD
<b>Physical and Geochemical Data</b>	
TOC	SS, SB, SD, GW, BS
AVS/SEM	SD, BS
Grain size	SS, SB, SD, BS
pH	SS, SB, GW
Bulk density, porosity	SS, SB
Conductivity	SS, SB
ORP, DO	GW
TSS, TDS	GW
Alkalinity	GW
Chloride, nitrite/nitrate, sulfate	GW
Ortho-phosphate-P	GW
Ferrous Iron	GW
Methane, ethane, ethene	GW
Salinity	GW

<b>Analytical Parameter</b>	<b>Matrix</b>
Toxicity testing	SD, BS
Macroinvertebrate analysis	SD, BS
Percent Lipids	TS
VOCs, SVOCs	BS
PCBs	BS
Pesticides	BS

Notes:

SS – Surface soil, SB – Subsurface soil, GW – Groundwater, SD – Sediment,  
TS – Tissue, BS – Background Sediment

Table 15-1  
 Project Action Limits (PALs) - Soil  
 Former Carr Point Shooting Range, MRP Site 1  
 Newport, Rhode Island

Analytical Method	Compound	CAS	Project Action Limits for Soil (mg/kg) (a)						Laboratory Reference Limits (mg/kg)					
			HH		Eco		Selected (b)		LOQs	Is LOQ >PAL (Y/N)?	LODs	Is LOD >PAL (Y/N)?	DLs	Is DL >PAL (Y/N)?
			Value (c)	Source	Value (d)	Source	Value	Source						
PAHs via SW8270D (e)	Acenaphthene	83-32-9	4.30E+01	RIDEM M1 Res Soil	2.00E+01	ORNL (plants)	2.00E+01	ORNL (plants)	0.33	N	0.25	N	0.065	N
PAHs via SW8270D (e)	Acenaphthylene	208-96-8	2.30E+01	RIDEM M1 Res Soil	2.00E+01	ORNL (plants)	2.00E+01	ORNL (plants)	0.33	N	0.25	N	0.07	N
PAHs via SW8270D (e)	Anthracene	120-12-7	3.50E+01	RIDEM M1 Res Soil	2.00E+01	ORNL (plants)	2.00E+01	ORNL (plants)	0.33	N	0.25	N	0.084	N
PAHs via SW8270D (e)	Benz(a)anthracene	56-55-3	1.50E-01	USEPA Res Soil RSL	1.80E+01	Eco-SSL (inverts)	1.50E-01	USEPA Res Soil RSL	0.33	Y	0.25	Y	0.086	N
PAHs via SW8270D (e)	Benzo(a)pyrene	50-32-8	1.50E-02	USEPA Res Soil RSL	1.10E+00	Eco-SSL (mammals)	1.50E-02	USEPA Res Soil RSL	0.33	Y	0.25	Y	0.093	Y
PAHs via SW8270D (e)	Benzo(b)fluoranthene	205-99-2	1.50E-01	USEPA Res Soil RSL	1.10E+00	Eco-SSL (mammals)	1.50E-01	USEPA Res Soil RSL	0.33	Y	0.25	Y	0.134	N
PAHs via SW8270D (e)	Benzo(g,h,i)perylene	191-24-2	8.00E-01	RIDEM M1 Res Soil	1.10E+00	Eco-SSL (mammals)	8.00E-01	RIDEM M1 Res Soil	0.33	N	0.25	N	0.104	N
PAHs via SW8270D (e)	Benzo(k)fluoranthene	207-08-9	9.00E-01	RIDEM M1 Res Soil	1.10E+00	Eco-SSL (mammals)	9.00E-01	RIDEM M1 Res Soil	0.33	N	0.25	N	0.083	N
PAHs via SW8270D (e)	Chrysene	218-01-9	4.00E-01	RIDEM M1 Res Soil	1.10E+00	Eco-SSL (mammals)	4.00E-01	RIDEM M1 Res Soil	0.33	N	0.25	N	0.095	N
PAHs via SW8270D (e)	Dibenz(a,h)anthracene	53-70-3	1.50E-02	USEPA Res Soil RSL	1.80E+01	Eco-SSL (inverts)	1.50E-02	USEPA Res Soil RSL	0.33	Y	0.25	Y	0.128	Y
PAHs via SW8270D (e)	Fluoranthene	206-44-0	2.00E+01	RIDEM M1 Res Soil	2.00E+01	ORNL (plants)	2.00E+01	RIDEM M1 Res Soil	0.33	N	0.25	N	0.081	N
PAHs via SW8270D (e)	Fluorene	86-73-7	2.80E+01	RIDEM M1 Res Soil	2.00E+01	ORNL (plants)	2.00E+01	ORNL (plants)	0.33	N	0.25	N	0.081	N
PAHs via SW8270D (e)	Indeno(1,2,3-cd)pyrene	193-39-5	1.50E-01	USEPA Res Soil RSL	1.10E+00	Eco-SSL (mammals)	1.50E-01	USEPA Res Soil RSL	0.33	Y	0.25	Y	0.122	N
PAHs via SW8270D (e)	Naphthalene	91-20-3	3.60E+00	USEPA Res Soil RSL	2.00E+01	ORNL (plants)	3.60E+00	USEPA Res Soil RSL	0.33	N	0.25	N	0.087	N
PAHs via SW8270D (e)	Phenanthrene	85-01-8	4.00E+01	RIDEM M1 Res Soil	2.00E+01	ORNL (plants)	2.00E+01	ORNL (plants)	0.33	N	0.25	N	0.083	N
PAHs via SW8270D (e)	Pyrene	129-00-0	1.30E+01	RIDEM M1 Res Soil	1.10E+00	Eco-SSL (mammals)	1.10E+00	Eco-SSL (mammals)	0.33	N	0.25	N	0.101	N
PAHs via SW8270D SIM (e)	Acenaphthene	83-32-9	4.30E+01	RIDEM M1 Res Soil	2.00E+01	ORNL (plants)	2.00E+01	ORNL (plants)	0.02	N	0.01	N	0.0015	N
PAHs via SW8270D SIM (e)	Acenaphthylene	208-96-8	2.30E+01	RIDEM M1 Res Soil	2.00E+01	ORNL (plants)	2.00E+01	ORNL (plants)	0.02	N	0.01	N	0.0012	N
PAHs via SW8270D SIM (e)	Anthracene	120-12-7	3.50E+01	RIDEM M1 Res Soil	2.00E+01	ORNL (plants)	2.00E+01	ORNL (plants)	0.02	N	0.01	N	0.0012	N
PAHs via SW8270D SIM (e)	Benzo(a)anthracene	56-55-3	1.50E-01	USEPA Res Soil RSL	1.80E+01	Eco-SSL (inverts)	1.50E-01	USEPA Res Soil RSL	0.02	N	0.01	N	0.0019	N
PAHs via SW8270D SIM (e)	Benzo(a)pyrene	50-32-8	1.50E-02	USEPA Res Soil RSL	1.10E+00	Eco-SSL (mammals)	1.50E-02	USEPA Res Soil RSL	0.02	Y	0.01	N	0.0033	N
PAHs via SW8270D SIM (e)	Benzo(b)fluoranthene	205-99-2	1.50E-01	USEPA Res Soil RSL	1.10E+00	Eco-SSL (mammals)	1.50E-01	USEPA Res Soil RSL	0.02	N	0.01	N	0.0024	N
PAHs via SW8270D SIM (e)	Benzo(g,h,i)perylene	191-24-2	8.00E-01	RIDEM M1 Res Soil	1.10E+00	Eco-SSL (mammals)	8.00E-01	RIDEM M1 Res Soil	0.02	N	0.01	N	0.002	N
PAHs via SW8270D SIM (e)	Benzo(k)fluoranthene	207-08-9	9.00E-01	RIDEM M1 Res Soil	1.10E+00	Eco-SSL (mammals)	9.00E-01	RIDEM M1 Res Soil	0.02	N	0.01	N	0.0031	N
PAHs via SW8270D SIM (e)	Chrysene	218-01-9	4.00E-01	RIDEM M1 Res Soil	1.10E+00	Eco-SSL (mammals)	4.00E-01	RIDEM M1 Res Soil	0.02	N	0.01	N	0.0017	N
PAHs via SW8270D SIM (e)	Dibenz(a,h)anthracene	53-70-3	1.50E-02	USEPA Res Soil RSL	1.80E+01	Eco-SSL (inverts)	1.50E-02	USEPA Res Soil RSL	0.02	Y	0.01	N	0.0018	N
PAHs via SW8270D SIM (e)	Fluoranthene	206-44-0	2.00E+01	RIDEM M1 Res Soil	2.00E+01	ORNL (plants)	2.00E+01	RIDEM M1 Res Soil	0.02	N	0.01	N	0.0018	N
PAHs via SW8270D SIM (e)	Fluorene	86-73-7	2.80E+01	RIDEM M1 Res Soil	2.00E+01	ORNL (plants)	2.00E+01	ORNL (plants)	0.02	N	0.01	N	0.0032	N
PAHs via SW8270D SIM (e)	Indeno(1,2,3-cd)pyrene	193-39-5	1.50E-01	USEPA Res Soil RSL	1.10E+00	Eco-SSL (mammals)	1.50E-01	USEPA Res Soil RSL	0.02	N	0.01	N	0.0019	N
PAHs via SW8270D SIM (e)	Naphthalene	91-20-3	3.60E+00	USEPA Res Soil RSL	2.00E+01	ORNL (plants)	3.60E+00	USEPA Res Soil RSL	0.02	N	0.01	N	0.0026	N
PAHs via SW8270D SIM (e)	Phenanthrene	85-01-8	4.00E+01	RIDEM M1 Res Soil	2.00E+01	ORNL (plants)	2.00E+01	ORNL (plants)	0.02	N	0.01	N	0.0018	N
PAHs via SW8270D SIM (e)	Pyrene	129-00-0	1.30E+01	RIDEM M1 Res Soil	1.10E+00	Eco-SSL (mammals)	1.10E+00	Eco-SSL (mammals)	0.02	N	0.01	N	0.0021	N
TAL Metals via SW6010	Aluminum	7429-90-5	7.70E+03	USEPA Res Soil RSL	5.00E+01	ORNL (plants)	5.00E+01	ORNL (plants)	30	N	10	N	0.71	N
TAL Metals via SW6010	Calcium	7440-70-2	NA	NA	NA	NA	NA	NA	10	N	8	N	1.78	N
TAL Metals via SW6010	Iron	7439-89-6	5.50E+03	USEPA Res Soil RSL	2.00E+02	USEPA R4 (unspecified)	2.00E+02	USEPA R4 (unspecified)	10	N	8	N	1.419	N
TAL Metals via SW6010	Magnesium	7439-95-4	NA	NA	NA	NA	NA	NA	10	N	8	N	0.6777	N
TAL Metals via SW6010	Potassium	7440-09-7	NA	NA	NA	NA	NA	NA	100	N	50	N	2.9	N
TAL Metals via SW6010	Sodium	7440-23-5	NA	NA	NA	NA	NA	NA	100	N	50	N	1.4759	N
TAL Metals via SW6020	Antimony	7440-36-0	3.10E+00	USEPA Res Soil RSL	2.70E-01	Eco-SSL (mammals)	2.70E-01	Eco-SSL (mammals)	0.1	N	0.05	N	0.02	N
TAL Metals via SW6020	Arsenic	7440-38-2	6.10E-01	USEPA Res Soil RSL	1.80E+01	Eco-SSL (plants)	6.10E-01	USEPA Res Soil RSL	0.5	N	0.4	N	0.15	N
TAL Metals via SW6020	Barium	7440-39-3	1.50E+03	USEPA Res Soil RSL	3.30E+02	Eco-SSL (inverts)	3.30E+02	Eco-SSL (inverts)	0.2	N	0.1	N	0.037	N
TAL Metals via SW6020	Beryllium	7440-41-7	1.50E+00	RIDEM M1 Res Soil	1.00E+01	ORNL (plants)	1.50E+00	RIDEM M1 Res Soil	0.1	N	0.02	N	0.0041	N
TAL Metals via SW6020	Cadmium	7440-43-9	7.00E+00	USEPA Res Soil RSL	3.60E-01	Eco-SSL (mammals)	3.60E-01	Eco-SSL (mammals)	0.1	N	0.02	N	0.0076	N
TAL Metals via SW6020	Chromium	7440-47-3	2.90E-01	USEPA Res Soil RSL	4.00E-01	ORNL (inverts)	2.90E-01	USEPA Res Soil RSL	0.5	Y	0.4	Y	0.05	N
TAL Metals via SW6020	Cobalt	7440-48-4	2.30E+00	USEPA Res Soil RSL	1.30E+01	Eco-SSL (plants)	2.30E+00	USEPA Res Soil RSL	0.1	N	0.03	N	0.0054	N
TAL Metals via SW6020	Copper	7440-50-8	3.10E+02	USEPA Res Soil RSL	2.80E+01	Eco-SSL (birds)	2.80E+01	Eco-SSL (birds)	0.3	N	0.2	N	0.071	N
TAL Metals via SW6020	Lead	7439-92-1	1.50E+02	RIDEM M1 Res Soil	1.10E+01	Eco-SSL (birds)	1.10E+01	Eco-SSL (birds)	0.1	N	0.05	N	0.007	N
TAL Metals via SW6020	Manganese	7439-96-5	1.80E+02	USEPA Res Soil RSL	2.20E+02	Eco-SSL (plants)	1.80E+02	USEPA Res Soil RSL	0.2	N	0.1	N	0.042	N
TAL Metals via SW6020	Nickel	7440-02-0	1.50E+02	USEPA Res Soil RSL	3.80E+01	Eco-SSL (plants)	3.80E+01	Eco-SSL (plants)	0.2	N	0.12	N	0.026	N
TAL Metals via SW6020	Selenium	7782-49-2	3.90E-01	USEPA Res Soil RSL	5.20E-01	Eco-SSL (plants)	5.20E-01	Eco-SSL (plants)	0.5	N	0.3	N	0.039	N
TAL Metals via SW6020	Silver	7440-22-4	3.90E+01	USEPA Res Soil RSL	2.00E+00	USEPA R4 (unspecified)	2.00E+00	USEPA R4 (unspecified)	0.1	N	0.04	N	0.0066	N
TAL Metals via SW6020	Thallium	7440-28-0	7.80E-02	USEPA Res Soil RSL	5.69E-02	USEPA R5 (shrew/vole)	5.69E-02	USEPA R5 (shrew/vole)	0.1	Y	0.04	N	0.0094	N
TAL Metals via SW6020	Vanadium	7440-62-2	3.90E+01	USEPA Res Soil RSL	2.00E+00	ORNL (plants)	2.00E+00	ORNL (plants)	0.5	N	0.4	N	0.11	N
TAL Metals via SW6020	Zinc	7440-66-6	2.30E+03	USEPA Res Soil RSL	4.60E+01	Eco-SSL (birds)	4.60E+01	Eco-SSL (birds)	1	N	0.8	N	0.13	N
TAL Metals via SW7470A	Mercury	7439-97-6	2.30E+00	USEPA Res Soil RSL	1.58E-03	USEPA R5 (shrew/vole)	1.58E-03	USEPA R5 (shrew/vole)	0.033	Y	0.017	Y	0.00523	Y
Propellants via 8330A	2,4-Dinitrotoluene	121-14-2	9.00E-01	RIDEM M1 Res Soil	5.00E-02	USEPA R4 (unspecified)	5.00E-02	USEPA R4 (unspecified)	0.1	Y	0.05	Y	0.015	Y
Propellants via 8330A	Nitroglycerin	55-63-0	6.10E-01	USEPA Res Soil RSL	NA	NA	6.10E-01	USEPA Res Soil RSL	0.8	Y	0.4	Y	0.124	Y
SW3060A/7196A	Hexavalent Chromium	18540-29-9	2.90E-01	USEPA Res Soil RSL	4.00E-01	ORNL (inverts)	2.90E-01	USEPA Res Soil RSL	0.5	Y	0.3	Y	0.152	Y
ASTM D 422-63	Grain Size (Sieve Only)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ASTM D 2937-04	Bulk Density	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ASTM D 854-06 - Method B	Total Porosity (Calc. From Bulk Density and Specific Gravity)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SW846 9045D	pH	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SW846 9060 Modified	Total Organic Carbon	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SM2510B / CA-744	Conductivity	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes are presented on the next page.

Table 15-1  
 Project Action Limits (PALs) - Soil  
 Former Carr Point Shooting Range, MRP Site 1  
 Newport, Rhode Island

Analytical Method	Compound	CAS	Project Action Limits for Soil (mg/kg) (a)						Laboratory Reference Limits (mg/kg)					
			HH		Eco		Selected (b)		LOQs	Is LOQ > PAL (Y/N)?	LODs	Is LOD > PAL (Y/N)?	DLs	Is DL > PAL (Y/N)?
			Value (c)	Source	Value (d)	Source	Value	Source						
Notes:														

CAS - Chemical Abstracts Service.

DL - Detection Limit.

Eco - Indicates the selected PAL that is protective of ecological receptors.

HH - Indicates the selected PAL that is protective of human health receptors.

LOD - Limit of Detection.

LOQ - Limit of Quantitation.

NA - Not available/applicable.

PAL - Project Action Limit.

PAH - Polycyclic Aromatic Hydrocarbon.

SIM - Selective Ion Monitoring.

Highlighting indicates the compound's laboratory reference value(s) is/are above the selected PAL.

(a) The PAL represents the limits of detection that analytical data must meet in order to be of sufficient quality for use in the Remedial Investigation, Risk Assessment, and Feasibility Study.

PALs are presented for compounds proposed for laboratory analysis and therefore do not include groups of compounds (such as Total PAHs) that will be calculated based on individual PAHs and individual arclor data for evaluation.

(b) Indicates the lower of the PALs based on levels protective of human health and ecological receptors.

(c) HH PALs were selected based on the lower of the following sources:

RIDEM M1 Res Soil = RIDEM, 2011. Method 1 Soil Objectives. Direct Exposure Criteria. Value for Residential Exposure.

RIDEM M1 Comm Soil = RIDEM, 2011. Method 1 Soil Objectives. Direct Exposure Criteria. Value for Commercial/Industrial Exposure.

USEPA Res Soil RSL = USEPA Regional Screening Level for Residential Soil. May 2013. Values adjusted for a target hazard quotient of 0.1 to account for cumulative effects on the same target organ.

USEPA Comm Soil RSL = USEPA Regional Screening Level for Industrial Soil. May 2013. Values adjusted for a target hazard quotient of 0.1 to account for cumulative effects on the same target organ.

(d) Eco PALs were selected based on the following sources (parentheses indicate receptor to which PAL applies):

Eco-SSL = Eco-SSLs derived by USEPA according to USEPA guidance (2007). Values listed are current as of May 25, 2012. Individual Eco-SSL documents are available here - <http://www.epa.gov/ecotox/ecossl/>

ORNL (plants) = Efroymson, R.A., M.E. Will, G.W. Suter II and A.C. Wooten. 1997. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Terrestrial Plants: 1997 Revision,

Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN, ES/ER/TM-85/R3.

ORNL (inverts) = Efroymson, R.A., M.E. Will and G.W. Suter II. 1997. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Soil and Litter Invertebrates and Heterotrophic

Process: 1997 Revision, Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN, ES/ER/TM-126/R2.

ORNL (birds/mammals) = Efroymson, R.A., G.W. Suter II, B.E. Sample, and D.S. Jones. 1997. Preliminary Remediation Goals for Ecological Endpoints, Oak Ridge National Laboratory Oak Ridge, TN, ES/ER/TM-162/R2.

USEPA R5 = USEPA. 2003. USEPA Region 5 Ecological Screening Levels. Revision August 2003. Available on-line at <http://www.epa.gov/reg5rcra/ca/edql.htm>. Values based on shrew or vole unless otherwise noted.

USEPA R4 = USEPA. 2001. Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment. Originally published November 1995. Website version last updated November 30, 2001:

<http://www.epa.gov/region4/superfund/programs/riskassess/ecolbul.html>

CCME = Canadian Council of Ministers of the Environment (2002). Canadian soil quality guidelines.

TV = Target Value. Dutch standards presented in Buchman (2008).

(e) SIM analysis will be conducted for the compound presented only if the concentration of the target compound is below the full scan LOQ as determined by the corresponding full scan analysis, and the concentration of non-target analyte is not prohibitively great, as determined by the laboratory performing the analyses.

Table 15-2  
Project Action Limits (PALs) - Sediment  
Former Carr Point Shooting Range, MRP Site 1  
Newport, Rhode Island

Analytical Method	Compound	CAS	Project Action Limits for Sediment (mg/kg) (a)						Laboratory Reference Limits (mg/kg)					
			HH		Eco		Selected (b)		LOQs	Is LOQ > PAL (Y/N)?	Is LOD > PAL (Y/N)?	DLs	Is DL > PAL (Y/N)?	
			Value (c)	Source	Value (d)	Source	Value	Source						
VOCs via SW8260B	1,1,1,2-Tetrachloroethane	630-20-6	NA	(f)	NA		NA	NA	0.005	N	0.0025	N	0.0007	N
VOCs via SW8260B	1,1,1-Trichloroethane	71-55-6	NA		8.56E-01	USEPA R3 (Marine; EqP method)	8.56E-01	USEPA R3 (Marine; EqP method)	0.005	N	0.0025	N	0.00042	N
VOCs via SW8260B	1,1,2,2-Tetrachloroethane	79-34-5	NA		2.02E-01	USEPA R3 (Marine; EqP method)	2.02E-01	USEPA R3 (Marine; EqP method)	0.005	N	0.0025	N	0.00084	N
VOCs via SW8260B	1,1,2-Trichloroethane	79-00-5	NA		5.70E-01	USEPA R3 (Marine; EqP method)	5.70E-01	USEPA R3 (Marine; EqP method)	0.005	N	0.0025	N	0.00097	N
VOCs via SW8260B	1,1-Dichloroethane	75-34-3	NA		NA		NA	NA	0.005	N	0.0025	N	0.0017	N
VOCs via SW8260B	1,1-Dichloroethene	75-35-4	NA		2.78E+00	USEPA R3 (Marine; EqP method)	2.78E+00	USEPA R3 (Marine; EqP method)	0.005	N	0.0025	N	0.00093	N
VOCs via SW8260B	1,1-Dichloropropene	563-58-6	NA		NA		NA	NA	0.005	N	0.0025	N	0.00091	N
VOCs via SW8260B	1,2,3-Trichlorobenzene	87-61-6	NA		4.80E-03	NOAA SQuiRT (Marine; AET)	4.80E-03	NOAA SQuiRT (Marine; AET)	0.005	Y	0.0025	N	0.00076	N
VOCs via SW8260B	1,2,3-Trichloropropane	96-18-4	NA		NA		NA	NA	0.005	N	0.0025	N	0.0012	N
VOCs via SW8260B	1,2,4-Trichlorobenzene	120-82-1	NA		4.80E-03	NOAA SQuiRT (Marine; AET)	4.80E-03	NOAA SQuiRT (Marine; AET)	0.005	Y	0.0025	N	0.00079	N
VOCs via SW8260B	1,2,4-Trimethylbenzene	95-63-6	NA		1.37E-01	USEPA R3 (Marine; EqP method)	1.37E-01	USEPA R3 (Marine; EqP method)	0.005	N	0.0025	N	0.00087	N
VOCs via SW8260B	1,2-Dibromo-3-chloropropane	96-12-8	NA		NA		NA	NA	0.005	N	0.0025	N	0.0015	N
VOCs via SW8260B	1,2-Dibromoethane	106-93-4	NA		NA		NA	NA	0.005	N	0.0025	N	0.0012	N
VOCs via SW8260B	1,2-Dichlorobenzene	95-50-1	NA		1.30E-02	NOAA SQuiRT (Marine; AET)	1.30E-02	NOAA SQuiRT (Marine; AET)	0.005	N	0.0025	N	0.00078	N
VOCs via SW8260B	1,2-Dichloroethane	107-06-2	NA		NA		NA	NA	0.005	N	0.0025	N	0.001	N
VOCs via SW8260B	1,2-Dichloropropane	78-87-5	NA		NA		NA	NA	0.005	N	0.0025	N	0.0014	N
VOCs via SW8260B	1,3,5-Trimethylbenzene	108-67-8	NA		1.37E-01	USEPA R3 (Marine; EqP method)	1.37E-01	USEPA R3 (Marine; EqP method)	0.005	N	0.0025	N	0.00067	N
VOCs via SW8260B	1,3-Dichlorobenzene	541-73-1	NA		1.30E-02	NOAA SQuiRT (Marine; AET)	1.30E-02	NOAA SQuiRT (Marine; AET)	0.005	N	0.0025	N	0.00062	N
VOCs via SW8260B	1,3-Dichloropropane	142-28-9	NA		NA		NA	NA	0.005	N	0.0025	N	0.00094	N
VOCs via SW8260B	1,4-Dichlorobenzene	106-46-7	NA		1.10E-01	NOAA SQuiRT (Marine; AET)	1.10E-01	NOAA SQuiRT (Marine; AET)	0.005	N	0.0025	N	0.00044	N
VOCs via SW8260B	2,2-Dichloropropane	594-20-7	NA		NA		NA	NA	0.005	N	0.0025	N	0.0005	N
VOCs via SW8260B	2-Butanone	78-93-3	NA		NA		NA	NA	0.025	N	0.0125	N	0.0059	N
VOCs via SW8260B	2-Chlorotoluene	95-49-8	NA		1.09E+00	USEPA R3 (Marine; EqP method)	1.09E+00	USEPA R3 (Marine; EqP method)	0.005	N	0.0025	N	0.0011	N
VOCs via SW8260B	2-Hexanone	591-78-6	NA		NA		NA	NA	0.025	N	0.0125	N	0.0048	N
VOCs via SW8260B	4-Chlorotoluene	106-43-4	NA		1.09E+00	USEPA R3 (Marine; EqP method)	1.09E+00	USEPA R3 (Marine; EqP method)	0.005	N	0.0025	N	0.00049	N
VOCs via SW8260B	4-Methyl-2-pentanone	108-10-1	NA		NA		NA	NA	0.025	N	0.0125	N	0.0059	N
VOCs via SW8260B	Acetone	67-64-1	NA		NA		NA	NA	0.025	N	0.0125	N	0.0051	N
VOCs via SW8260B	Benzene	71-43-2	NA		1.37E-01	USEPA R3 (Marine; EqP method)	1.37E-01	USEPA R3 (Marine; EqP method)	0.005	N	0.0025	N	0.00092	N
VOCs via SW8260B	Bromobenzene	108-86-1	NA		1.37E-01	USEPA R3 (Marine; EqP method)	1.37E-01	USEPA R3 (Marine; EqP method)	0.005	N	0.0025	N	0.00074	N
VOCs via SW8260B	Bromochloromethane	74-97-5	NA		NA		NA	NA	0.005	N	0.0025	N	0.00091	N
VOCs via SW8260B	Bromodichloromethane	75-27-4	NA		NA		NA	NA	0.005	N	0.0025	N	0.0006	N
VOCs via SW8260B	Bromoform	75-25-2	NA		1.31E+00	USEPA R3 (Marine; EqP method)	1.31E+00	USEPA R3 (Marine; EqP method)	0.005	N	0.0025	N	0.0007	N
VOCs via SW8260B	Bromomethane	74-83-9	NA		NA		NA	NA	0.01	N	0.005	N	0.0011	N
VOCs via SW8260B (e)	Carbon Disulfide	75-15-0	NA		8.51E-04	USEPA R3 (FW used for Marine)	8.51E-04	USEPA R3 (FW used for Marine)	0.005	Y	0.0025	Y	0.00078	N
VOCs via SW8260B	Carbon tetrachloride	56-23-5	NA		7.24E+00	USEPA R3 (Marine; EqP method)	7.24E+00	USEPA R3 (Marine; EqP method)	0.005	N	0.0025	N	0.0013	N
VOCs via SW8260B	Chlorobenzene	108-90-7	NA		1.62E-01	USEPA R3 (Marine; EqP method)	1.62E-01	USEPA R3 (Marine; EqP method)	0.005	N	0.0025	N	0.00051	N
VOCs via SW8260B	Chlorodibromomethane	124-48-1	NA		NA		NA	NA	0.005	N	0.0025	N	0.001	N
VOCs via SW8260B	Chloroethane	75-00-3	NA		NA		NA	NA	0.01	N	0.005	N	0.0013	N
VOCs via SW8260B	Chloroform	67-66-3	NA		NA		NA	NA	0.005	N	0.0025	N	0.00035	N
VOCs via SW8260B	Chloromethane	74-87-3	NA		NA		NA	NA	0.01	N	0.005	N	0.0014	N
VOCs via SW8260B	cis-1,2-Dichloroethene	156-59-2	NA		NA		NA	NA	0.005	N	0.0025	N	0.00091	N
VOCs via SW8260B	cis-1,3-Dichloropropene	10061-01-5	NA		NA		NA	NA	0.005	N	0.0025	N	0.00072	N
VOCs via SW8260B	Dibromomethane	74-95-3	NA		NA		NA	NA	0.005	N	0.0025	N	0.00051	N
VOCs via SW8260B	Dichlorodifluoromethane	75-71-8	NA		NA		NA	NA	0.01	N	0.005	N	0.00092	N
VOCs via SW8260B (e)	Ethylbenzene	100-41-4	NA		4.00E-03	NOAA SQuiRT (Marine; AET)	4.00E-03	NOAA SQuiRT (Marine; AET)	0.005	Y	0.0025	N	0.00065	N
VOCs via SW8260B	Hexachlorobutadiene	87-68-3	NA		1.30E-03	NOAA SQuiRT (Marine; AET)	1.30E-03	NOAA SQuiRT (Marine; AET)	0.005	Y	0.0025	Y	0.00074	N
VOCs via SW8260B	Isopropylbenzene	98-82-8	NA		8.60E-02	USEPA R3 (FW used for Marine)	8.60E-02	USEPA R3 (FW used for Marine)	0.005	N	0.0025	N	0.00092	N
VOCs via SW8260B	Methylcyclohexane	108-87-2	NA		NA		NA	NA	0.005	N	0.0025	N	0.00096	N
VOCs via SW8260B	Methyl tert-butyl ether	1634-04-4	NA		NA		NA	NA	0.005	N	0.0025	N	0.0011	N
VOCs via SW8260B	Methylene chloride	75-09-2	NA		NA		NA	NA	0.025	N	0.0125	N	0.0079	N
VOCs via SW8260B	Naphthalene	91-20-3	NA		1.60E-01	NOAA ERL (Marine)	1.60E-01	NOAA ERL (Marine)	0.005	N	0.0025	N	0.00088	N
VOCs via SW8260B	n-Butylbenzene	104-51-8	NA		1.37E-01	USEPA R3 (Marine; EqP method)	1.37E-01	USEPA R3 (Marine; EqP method)	0.005	N	0.0025	N	0.00092	N
VOCs via SW8260B	n-Propylbenzene	103-65-1	NA		1.37E-01	USEPA R3 (Marine; EqP method)	1.37E-01	USEPA R3 (Marine; EqP method)	0.005	N	0.0025	N	0.00083	N
VOCs via SW8260B	p-Isopropyltoluene	99-87-6	NA		1.09E+00	USEPA R3 (Marine; EqP method)	1.09E+00	USEPA R3 (Marine; EqP method)	0.005	N	0.0025	N	0.00076	N
VOCs via SW8260B	sec-Butylbenzene	135-98-8	NA		1.37E-01	USEPA R3 (Marine; EqP method)	1.37E-01	USEPA R3 (Marine; EqP method)	0.005	N	0.0025	N	0.00091	N
VOCs via SW8260B	Styrene	100-42-5	NA		7.07E+00	USEPA R3 (Marine; EqP method)	7.07E+00	USEPA R3 (Marine; EqP method)	0.005	N	0.0025	N	0.00051	N
VOCs via SW8260B	tert-Butyl-Alcohol	75-65-0	NA		NA		NA	NA	0.025	N	0.0125	N	0.011	N
VOCs via SW8260B	tert-Butylbenzene	98-06-6	NA		1.37E-01	USEPA R3 (Marine; EqP method)	1.37E-01	USEPA R3 (Marine; EqP method)	0.005	N	0.0025	N	0.0009	N
VOCs via SW8260B	Tetrachloroethene	127-18-4	NA		5.70E-02	NOAA SQuiRT (Marine; AET)	5.70E-02	NOAA SQuiRT (Marine; AET)	0.005	N	0.0025	N	0.0012	N
VOCs via SW8260B	Toluene	108-88-3	NA		1.09E+00	USEPA R3 (Marine; EqP method)	1.09E+00	USEPA R3 (Marine; EqP method)	0.005	N	0.0025	N	0.0014	N
VOCs via SW8260B	Total-1,2-Dichloroethene	540-59-0	NA		1.05E+00	USEPA R3 (Marine)	1.05E+00	USEPA R3 (Marine)	0.005	N	0.0025	N	0.00071	N
VOCs via SW8260B	trans-1,2-Dichloroethene	156-60-5	NA		1.05E+00	USEPA R3 (FW used for Marine)	1.05E+00	USEPA R3 (FW used for Marine)	0.005	N	0.0025	N	0.00071	N
VOCs via SW8260B	trans-1,3-Dichloropropene	10061-02-6	NA		NA		NA	NA	0.005	N	0.0025	N	0.00086	N
VOCs via SW8260B	Trichloroethene	79-01-6	NA		4.10E-02	NOAA SQuiRT (Marine; AET)	4.10E-02	NOAA SQuiRT (Marine; AET)	0.005	N	0.0025	N	0.00059	N
VOCs via SW8260B	Trichlorofluoromethane	75-69-4	NA		NA		NA	NA	0.01	N	0.005	N	0.00091	N

Table 15-2  
Project Action Limits (PALs) - Sediment  
Former Carr Point Shooting Range, MRP Site 1  
Newport, Rhode Island

Analytical Method	Compound	CAS	Project Action Limits for Sediment (mg/kg) (a)						Laboratory Reference Limits (mg/kg)					
			HH		Eco		Selected (b)		LOQs	Is LOQ > PAL (Y/N)?	Is LOD > PAL (Y/N)?	DLs	Is DL > PAL (Y/N)?	
			Value (c)	Source	Value (d)	Source	Value	Source						
VOCs via SW8260B	Vinyl chloride	75-01-4	NA		NA		NA	NA	0.01	N	0.005	N	0.00087	N
VOCs via SW8260B (e)	Xylenes (total)	1330-20-7	NA		4.00E-03	NOAA SQuiRT (Marine; AET)	4.00E-03	NOAA SQuiRT (Marine; AET)	0.015	Y	0.0075	Y	0.0013	N
VOCs via SW8260B SIM (e)	Carbon Disulfide	75-15-0	NA		8.51E-04	USEPA R3 (FW used for Marine)	8.51E-04	USEPA R3 (FW used for Marine)	0.0005	N	0.00025	N	0.0001	N
VOCs via SW8260B SIM (e)	Ethylbenzene	100-41-4	NA		4.00E-03	NOAA SQuiRT (Marine; AET)	4.00E-03	NOAA SQuiRT (Marine; AET)	0.0005	N	0.00025	N	0.00014	N
VOCs via SW8260B SIM (e)	Xylenes (total)	1330-20-7	NA		4.00E-03	NOAA SQuiRT (Marine; AET)	4.00E-03	NOAA SQuiRT (Marine; AET)	0.0015	N	0.00075	N	0.00014	N
PAHs via SW8270D (e)	Acenaphthene	83-32-9	2.66E+03	RSL Calculator	1.60E-02	NOAA ERL (Marine)	1.60E-02	NOAA ERL (Marine)	0.33	Y	0.25	Y	0.065	Y
PAHs via SW8270D (e)	Acenaphthylene	208-96-8	2.66E+03	RSL Calculator	4.40E-02	NOAA ERL (Marine)	4.40E-02	NOAA ERL (Marine)	0.33	Y	0.25	Y	0.07	Y
PAHs via SW8270D (e)	Anthracene	120-12-7	1.33E+04	RSL Calculator	8.53E-02	NOAA ERL (Marine)	8.53E-02	NOAA ERL (Marine)	0.33	Y	0.25	Y	0.084	N
PAHs via SW8270D (e)	Benz(a)anthracene	56-55-3	1.13E+00	RSL Calculator	2.61E-01	NOAA ERL (Marine)	2.61E-01	NOAA ERL (Marine)	0.33	Y	0.25	N	0.086	N
PAHs via SW8270D (e)	Benzo(a)pyrene	50-32-8	1.13E-01	RSL Calculator	4.30E-01	NOAA ERL (Marine)	1.13E-01	RSL Calculator	0.33	Y	0.25	Y	0.093	N
PAHs via SW8270D (e)	Benzo(b)fluoranthene	205-99-2	1.13E+00	RSL Calculator	6.00E-01	NOAA ERL (Marine)	6.00E-01	NOAA ERL (Marine)	0.33	N	0.25	N	0.134	N
PAHs via SW8270D (e)	Benzo(g,h,i)perylene	191-24-2	1.33E+03	RSL Calculator	6.34E-02	NOAA ERL (Marine)	6.34E-02	NOAA ERL (Marine)	0.33	Y	0.25	Y	0.104	Y
PAHs via SW8270D (e)	Benzo(k)fluoranthene	207-08-9	1.13E+01	RSL Calculator	6.00E-01	NOAA ERL (Marine)	6.00E-01	NOAA ERL (Marine)	0.33	N	0.25	N	0.083	N
PAHs via SW8270D (e)	Chrysene	218-01-9	1.13E+02	RSL Calculator	3.84E-01	NOAA ERL (Marine)	3.84E-01	NOAA ERL (Marine)	0.33	N	0.25	N	0.095	N
PAHs via SW8270D (e)	Dibenz(a,h)anthracene	53-70-3	1.13E-01	RSL Calculator	6.34E-02	NOAA ERL (Marine)	6.34E-02	NOAA ERL (Marine)	0.33	Y	0.25	Y	0.128	Y
PAHs via SW8270D (e)	Fluoranthene	206-44-0	1.77E+03	RSL Calculator	6.00E-01	NOAA ERL (Marine)	6.00E-01	NOAA ERL (Marine)	0.33	N	0.25	N	0.106	N
PAHs via SW8270D (e)	Fluorene	86-73-7	1.77E+03	RSL Calculator	1.90E-02	NOAA ERL (Marine)	1.90E-02	NOAA ERL (Marine)	0.33	Y	0.25	Y	0.081	Y
PAHs via SW8270D (e)	Indeno(1,2,3-cd)pyrene	193-39-5	1.13E+00	RSL Calculator	6.34E-02	NOAA ERL (Marine)	6.34E-02	NOAA ERL (Marine)	0.33	Y	0.25	Y	0.122	Y
PAHs via SW8270D (e)	Naphthalene	91-20-3	1.44E+02	RSL Calculator	1.60E-01	NOAA ERL (Marine)	1.60E-01	NOAA ERL (Marine)	0.33	Y	0.25	Y	0.087	N
PAHs via SW8270D (e)	Phenanthrene	85-01-8	1.33E+03	RSL Calculator	2.40E-01	NOAA ERL (Marine)	2.40E-01	NOAA ERL (Marine)	0.33	Y	0.25	Y	0.083	N
PAHs via SW8270D (e)	Pyrene	129-00-0	1.33E+03	RSL Calculator	6.55E-01	NOAA ERL (Marine)	6.55E-01	NOAA ERL (Marine)	0.33	N	0.25	N	0.101	N
PAHs via SW8270D SIM (e)	Acenaphthene	83-32-9	2.66E+03	RSL Calculator	1.60E-02	NOAA ERL (Marine)	1.60E-02	NOAA ERL (Marine)	0.02	Y	0.01	N	0.0015	N
PAHs via SW8270D SIM (e)	Acenaphthylene	208-96-8	2.66E+03	RSL Calculator	4.40E-02	NOAA ERL (Marine)	4.40E-02	NOAA ERL (Marine)	0.02	N	0.01	N	0.0012	N
PAHs via SW8270D SIM (e)	Anthracene	120-12-7	1.33E+04	RSL Calculator	8.53E-02	NOAA ERL (Marine)	8.53E-02	NOAA ERL (Marine)	0.02	N	0.01	N	0.0012	N
PAHs via SW8270D SIM (e)	Benzo(a)anthracene	56-55-3	1.13E+00	RSL Calculator	2.61E-01	NOAA ERL (Marine)	2.61E-01	NOAA ERL (Marine)	0.02	N	0.01	N	0.0019	N
PAHs via SW8270D SIM (e)	Benzo(a)pyrene	50-32-8	1.13E-01	RSL Calculator	4.30E-01	NOAA ERL (Marine)	1.13E-01	RSL Calculator	0.02	N	0.01	N	0.0033	N
PAHs via SW8270D SIM (e)	Benzo(b)fluoranthene	205-99-2	1.13E+00	RSL Calculator	6.00E-01	NOAA ERL (Marine)	6.00E-01	NOAA ERL (Marine)	0.02	N	0.01	N	0.0024	N
PAHs via SW8270D SIM (e)	Benzo(g,h,i)perylene	191-24-2	1.33E+03	RSL Calculator	6.34E-02	NOAA ERL (Marine)	6.34E-02	NOAA ERL (Marine)	0.02	N	0.01	N	0.002	N
PAHs via SW8270D SIM (e)	Benzo(k)fluoranthene	207-08-9	1.13E+01	RSL Calculator	6.00E-01	NOAA ERL (Marine)	6.00E-01	NOAA ERL (Marine)	0.02	N	0.01	N	0.0031	N
PAHs via SW8270D SIM (e)	Chrysene	218-01-9	1.13E+02	RSL Calculator	3.84E-01	NOAA ERL (Marine)	3.84E-01	NOAA ERL (Marine)	0.02	N	0.01	N	0.0017	N
PAHs via SW8270D SIM (e)	Dibenz(a,h)anthracene	53-70-3	1.13E-01	RSL Calculator	6.34E-02	NOAA ERL (Marine)	6.34E-02	NOAA ERL (Marine)	0.02	N	0.01	N	0.0018	N
PAHs via SW8270D SIM (e)	Fluoranthene	206-44-0	1.77E+03	RSL Calculator	6.00E-01	NOAA ERL (Marine)	6.00E-01	NOAA ERL (Marine)	0.02	N	0.01	N	0.0018	N
PAHs via SW8270D SIM (e)	Fluorene	86-73-7	1.77E+03	RSL Calculator	1.90E-02	NOAA ERL (Marine)	1.90E-02	NOAA ERL (Marine)	0.02	Y	0.01	N	0.0032	N
PAHs via SW8270D SIM (e)	Indeno(1,2,3-cd)pyrene	193-39-5	1.13E+00	RSL Calculator	6.34E-02	NOAA ERL (Marine)	6.34E-02	NOAA ERL (Marine)	0.02	N	0.01	N	0.0019	N
PAHs via SW8270D SIM (e)	Naphthalene	91-20-3	1.44E+02	RSL Calculator	1.60E-01	NOAA ERL (Marine)	1.60E-01	NOAA ERL (Marine)	0.02	N	0.01	N	0.0026	N
PAHs via SW8270D SIM (e)	Phenanthrene	85-01-8	1.33E+03	RSL Calculator	2.40E-01	NOAA ERL (Marine)	2.40E-01	NOAA ERL (Marine)	0.02	N	0.01	N	0.0018	N
PAHs via SW8270D SIM (e)	Pyrene	129-00-0	1.33E+03	RSL Calculator	6.55E-01	NOAA ERL (Marine)	6.55E-01	NOAA ERL (Marine)	0.02	N	0.01	N	0.0021	N
Pesticides via SW8081B	4,4'-DDD	72-54-8	NA		1.22E-03	USEPA R3 (Marine; FL TEL)	1.22E-03	USEPA R3 (Marine; FL TEL)	0.00066	N	0.00033	N	0.00004	N
Pesticides via SW8081B	4,4'-DDE	72-55-9	NA		2.20E-03	NOAA ERL (Marine)	2.20E-03	NOAA ERL (Marine)	0.00066	N	0.00033	N	0.000038	N
Pesticides via SW8081B	4,4'-DDT	50-29-3	NA		1.58E-03	NOAA ERL (Marine)	1.58E-03	NOAA ERL (Marine)	0.00066	N	0.00033	N	0.000062	N
Pesticides via SW8081B	Aldrin	309-00-2	NA		9.50E-03	NOAA SQuiRT (Marine; AET)	9.50E-03	NOAA SQuiRT (Marine; AET)	0.00034	N	0.00017	N	0.000056	N
Pesticides via SW8081B	alpha-BHC	319-84-6	NA		3.20E-04	NOAA SQuiRT (Marine; TEL)	3.20E-04	NOAA SQuiRT (Marine; TEL)	0.00034	Y	0.00017	N	0.000068	N
Pesticides via SW8081B	alpha-Chlordane	5103-71-9	NA		5.00E-04	NOAA SQuiRT (Marine; ERL)	5.00E-04	NOAA SQuiRT (Marine; ERL)	0.00034	N	0.00017	N	0.000042	N
Pesticides via SW8081B	beta-BHC	319-85-7	NA		3.20E-04	NOAA SQuiRT (Marine; TEL)	3.20E-04	NOAA SQuiRT (Marine; TEL)	0.00034	Y	0.00017	N	0.000066	N
Pesticides via SW8081B	delta-BHC	319-86-8	NA		3.20E-04	NOAA SQuiRT (Marine; TEL)	3.20E-04	NOAA SQuiRT (Marine; TEL)	0.00034	Y	0.00017	N	0.000064	N
Pesticides via SW8081B	Dieldrin	60-57-1	NA		2.00E-05	NOAA SQuiRT (Marine; ERL)	2.00E-05	NOAA SQuiRT (Marine; ERL)	0.00066	Y	0.00033	Y	0.000044	Y
Pesticides via SW8081B	Endosulfan I	959-98-8	NA		2.90E-03	USEPA R3 (FW used for Marine)	2.90E-03	USEPA R3 (FW used for Marine)	0.00034	N	0.00017	N	0.000048	N
Pesticides via SW8081B	Endosulfan II	33213-65-9	NA		1.40E-02	USEPA R3 (FW used for Marine)	1.40E-02	USEPA R3 (FW used for Marine)	0.00066	N	0.00033	N	0.000068	N
Pesticides via SW8081B	Endosulfan sulfate	1031-07-8	NA		3.57E-04	USEPA R3 (Marine; EqP method)	3.57E-04	USEPA R3 (Marine; EqP method)	0.00066	Y	0.00033	N	0.000116	N
Pesticides via SW8081B	Endrin	72-20-8	NA		2.67E-03	USEPA R3 (Marine; CCME ISQG)	2.67E-03	USEPA R3 (Marine; CCME ISQG)	0.00066	N	0.00033	N	0.00017	N
Pesticides via SW8081B	Endrin aldehyde	7421-93-4	NA		2.67E-03	USEPA R3 (Marine)	2.67E-03	USEPA R3 (Marine)	0.00066	N	0.00033	N	0.000098	N
Pesticides via SW8081B	Endrin ketone	53494-70-5	NA		2.67E-03	USEPA R3 (Marine)	2.67E-03	USEPA R3 (Marine)	0.00066	N	0.00033	N	0.00008	N
Pesticides via SW8081B	gamma-BHC	58-89-9	NA		3.20E-04	USEPA R3 (Marine; FL TEL)	3.20E-04	USEPA R3 (Marine; FL TEL)	0.00034	Y	0.00017	N	0.000054	N
Pesticides via SW8081B	gamma-Chlordane	5103-74-2	NA		5.00E-04	NOAA SQuiRT (Marine; ERL)	5.00E-04	NOAA SQuiRT (Marine; ERL)	0.00034	N	0.00017	N	0.000046	N
Pesticides via SW8081B	Heptachlor	76-44-8	NA		3.00E-04	NOAA SQuiRT (Marine; AET)	3.00E-04	NOAA SQuiRT (Marine; AET)	0.00034	Y	0.00017	N	0.000058	N
Pesticides via SW8081B	Heptachlor epoxide	1024-57-3	NA		6.00E-04	NOAA SQuiRT (Marine; T20)	6.00E-04	NOAA SQuiRT (Marine; T20)	0.00034	N	0.00017	N	0.000044	N
Pesticides via SW8081B	Methoxychlor	72-43-5	NA		2.96E-02	USEPA R3 (Marine; EqP method)	2.96E-02	USEPA R3 (Marine; EqP method)	0.0034	N	0.0017	N	0.0001	N

Table 15-2  
 Project Action Limits (PALs) - Sediment  
 Former Carr Point Shooting Range, MRP Site 1  
 Newport, Rhode Island

Analytical Method	Compound	CAS	Project Action Limits for Sediment (mg/kg) (a)						Laboratory Reference Limits (mg/kg)					
			HH		Eco		Selected (b)		LOQs	Is LOQ > PAL (Y/N)?	LODs	Is LOD > PAL (Y/N)?	DLs	Is DL > PAL (Y/N)?
			Value (c)	Source	Value (d)	Source	Value	Source						
Pesticides via SW8081B	Toxaphene	8001-35-2	NA		1.00E-04	NOAA SQuiRT (Marine; TEL)	1.00E-04	NOAA SQuiRT (Marine; TEL)	0.0066	Y	0.0033	Y	0.0014	Y
PCBs via SW8082A	Aroclor-1016	12674-11-2	NA		2.27E-02	NOAA ERL (Marine)	2.27E-02	NOAA ERL (Marine)	0.0034	N	0.0017	N	0.0012	N
PCBs via SW8082A	Aroclor-1221	11104-28-2	NA		2.27E-02	NOAA ERL (Marine)	2.27E-02	NOAA ERL (Marine)	0.0034	N	0.0017	N	0.00158	N
PCBs via SW8082A	Aroclor-1232	11141-16-5	NA		2.27E-02	NOAA ERL (Marine)	2.27E-02	NOAA ERL (Marine)	0.0034	N	0.002	N	0.00186	N
PCBs via SW8082A	Aroclor-1242	53469-21-9	NA		2.27E-02	NOAA ERL (Marine)	2.27E-02	NOAA ERL (Marine)	0.0034	N	0.0017	N	0.00116	N
PCBs via SW8082A	Aroclor-1248	12672-29-6	NA		2.27E-02	NOAA ERL (Marine)	2.27E-02	NOAA ERL (Marine)	0.0034	N	0.0017	N	0.00122	N
PCBs via SW8082A	Aroclor-1254	11097-69-1	NA		2.27E-02	NOAA ERL (Marine)	2.27E-02	NOAA ERL (Marine)	0.0034	N	0.0017	N	0.00094	N
PCBs via SW8082A	Aroclor-1260	11096-82-5	NA		2.27E-02	NOAA ERL (Marine)	2.27E-02	NOAA ERL (Marine)	0.0034	N	0.0017	N	0.0012	N
PCBs via SW8082A	Aroclor-1262	37324-23-5	NA		2.27E-02	NOAA ERL (Marine)	2.27E-02	NOAA ERL (Marine)	0.0034	N	0.0017	N	0.0005	N
PCBs via SW8082A	Aroclor-1268	11100-14-4	NA		2.27E-02	NOAA ERL (Marine)	2.27E-02	NOAA ERL (Marine)	0.0034	N	0.0017	N	0.0005	N
TAL Metals via SW6010	Aluminum	7429-90-5	5.25E+04	RSL Calculator	1.80E+04	NOAA SQuiRT (Marine; AET)	1.80E+04	NOAA SQuiRT (Marine; AET)	30	N	4	N	0.51	N
TAL Metals via SW6010	Calcium	7440-70-2	NA		NA		NA	NA	10	N	8	N	3.83	N
TAL Metals via SW6010	Iron	7439-89-6	3.69E+04	RSL Calculator	2.20E+05	NOAA SQuiRT (Marine; AET)	3.69E+04	RSL Calculator	10	N	6	N	2.4	N
TAL Metals via SW6010	Magnesium	7439-95-4	NA		NA		NA	NA	10	N	8	N	1.37	N
TAL Metals via SW6010	Potassium	7440-09-7	NA		NA		NA	NA	100	N	40	N	4.6	N
TAL Metals via SW6010	Sodium	7440-23-5	NA		NA		NA	NA	100	N	40	N	2.6	N
TAL Metals via SW6020	Antimony	7440-36-0	2.11E+01	RSL Calculator	2.00E+00	NOAA ERL (Freshwater)	2.00E+00	NOAA ERL (Freshwater)	0.1	N	0.05	N	0.02	N
TAL Metals via SW6020	Arsenic	7440-38-2	4.36E+00	RSL Calculator	8.20E+00	NOAA ERL (Marine)	4.36E+00	RSL Calculator	0.5	N	0.4	N	0.15	N
TAL Metals via SW6020	Barium	7440-39-3	1.05E+04	RSL Calculator	4.80E+01	NOAA SQuiRT (Marine; AET)	4.80E+01	NOAA SQuiRT (Marine; AET)	0.2	N	0.1	N	0.037	N
TAL Metals via SW6020	Beryllium	7440-41-7	1.05E+02	RSL Calculator	NA		1.05E+02	RSL Calculator	0.1	N	0.02	N	0.0041	N
TAL Metals via SW6020	Cadmium	7440-43-9	4.97E+01	RSL Calculator	1.20E+00	NOAA ERL (Marine)	1.20E+00	NOAA ERL (Marine)	0.1	N	0.02	N	0.0076	N
TAL Metals via SW6020	Chromium	7440-47-3	2.00E+00	RSL Calculator	8.10E+01	NOAA ERL (Marine)	2.00E+00	RSL Calculator	0.5	N	0.4	N	0.05	N
TAL Metals via SW6020	Cobalt	7440-48-4	1.58E+01	RSL Calculator	1.00E+01	NOAA SQuiRT (Marine; AET)	1.00E+01	NOAA SQuiRT (Marine; AET)	0.1	N	0.03	N	0.0054	N
TAL Metals via SW6020	Copper	7440-50-8	2.11E+03	RSL Calculator	3.40E+01	NOAA ERL (Marine)	3.40E+01	NOAA ERL (Marine)	0.3	N	0.2	N	0.071	N
TAL Metals via SW6020	Lead	7439-92-1	4.00E+02	RSL Calculator	4.67E+01	NOAA ERL (Marine)	4.67E+01	NOAA ERL (Marine)	0.1	N	0.05	N	0.007	N
TAL Metals via SW6020	Manganese	7439-96-5	1.26E+03	RSL Calculator	2.60E+02	NOAA SQuiRT (Marine; AET)	2.60E+02	NOAA SQuiRT (Marine; AET)	0.2	N	0.1	N	0.042	N
TAL Metals via SW6020	Nickel	7440-02-0	1.05E+03	RSL Calculator	2.09E+01	NOAA ERL (Marine)	2.09E+01	NOAA ERL (Marine)	0.2	N	0.12	N	0.026	N
TAL Metals via SW6020	Selenium	7782-49-2	2.63E+02	RSL Calculator	1.00E+00	NOAA SQuiRT (Marine; AET)	1.00E+00	NOAA SQuiRT (Marine; AET)	0.5	N	0.3	N	0.039	N
TAL Metals via SW6020	Silver	7440-22-4	2.63E+02	RSL Calculator	1.00E+00	NOAA ERL (Marine)	1.00E+00	NOAA ERL (Marine)	0.1	N	0.04	N	0.0066	N
TAL Metals via SW6020	Thallium	7440-28-0	5.26E-01	RSL Calculator	NA		5.26E-01	RSL Calculator	0.1	N	0.04	N	0.0094	N
TAL Metals via SW6020	Vanadium	7440-62-2	2.65E+02	RSL Calculator	5.70E+01	NOAA SQuiRT (Marine; AET)	5.70E+01	NOAA SQuiRT (Marine; AET)	0.5	N	0.4	N	0.11	N
TAL Metals via SW6020	Zinc	7440-66-6	1.58E+04	RSL Calculator	1.50E+02	NOAA ERL (Marine)	1.50E+02	NOAA ERL (Marine)	1	N	0.8	N	0.13	N
TAL Metals via SW7470A	Mercury	7439-97-6	1.58E+01	RSL Calculator	1.50E-01	NOAA ERL (Marine)	1.50E-01	NOAA ERL (Marine)	0.033	N	0.017	N	0.0052	N
SW3060A/7196A	Hexavalent Chromium	18540-29-9	2.00E+00	RSL Calculator	8.10E+01	NOAA ERL (Marine)	2.00E+00	RSL Calculator	0.5	N	0.3	N	0.152	N
Lloyd Kahn	Total Organic Carbon	NA	NA		NA		NA	NA	NA	NA	NA	NA	NA	NA
EPA 821/R-91-100	Acid Volatile Sulfide/Simultaneously Extracted Metals	NA	NA		NA		NA	NA	NA	NA	NA	NA	NA	NA
ASTM D 422-63	Grain Size (Sieve Only)	NA	NA		NA		NA	NA	NA	NA	NA	NA	NA	NA
RC Procedure TBD/ CA-774-00	Pellet Counting	NA	NA		NA		NA	NA	NA	NA	NA	NA	NA	NA
TBD	Lead Particle Size Distribution	NA	NA		NA		NA	NA	NA	NA	NA	NA	NA	NA
28-day Leptocheirus plumulosus	Sediment Toxicity Testing	NA	NA		NA		NA	NA	NA	NA	NA	NA	NA	NA
USEPA RPB Modified	Macroinvertebrate Community Survey	NA	NA		NA		NA	NA	NA	NA	NA	NA	NA	NA

Notes are presented on the next page.

Table 15-2  
 Project Action Limits (PALs) - Sediment  
 Former Carr Point Shooting Range, MRP Site 1  
 Newport, Rhode Island

Analytical Method	Compound	CAS	Project Action Limits for Sediment (mg/kg) (a)						Laboratory Reference Limits (mg/kg)					
			HH		Eco		Selected (b)		LOQs	Is LOQ >PAL (Y/N)?	LODs	Is LOD >PAL (Y/N)?	DLs	Is DL >PAL (Y/N)?
			Value (c)	Source	Value (d)	Source	Value	Source						

**Notes:**

- AET - Apparent Effect Threshold.
- CAS - Chemical Abstracts Service.
- CCME ISQG - Canadian Council of Ministers of the Environment Interim Sediment Quality Guideline.
- DL - Detection Limit.
- EqP - Equilibrium Partitioning.
- Eco - Indicates the selected PAL that is protective of ecological receptors.
- ERL - Effects Range Low.
- FL - Florida.
- FW - Freshwater.
- HH - Indicates the selected PAL that is protective of human health receptors.
- LOD - Limit of Detection
- LOQ - Limit of Quantitation.
- NA - Not available/applicable.
- NOAA - National Oceanic and Atmospheric Administration.
- PAH - Polycyclic Aromatic Hydrocarbon.
- PAL - Project Action Limit.
- PCB - Polychlorinated Biphenyls.
- RIDEM - Rhode Island Department of Environmental Management.
- SIM - Selective Ion Monitoring.
- SQuiRT - Screening Quick Reference Tables.
- SVOC - Semi-Volatile Organic Compound.
- T20 - 20% Effect Level.
- TBD - To be determined.
- TEL - Threshold Effect Limit.
- TPH - Total Petroleum Hydrocarbons.
- VOC - Volatile Organic Compound.

Highlighting indicates the compound's laboratory reference value(s) is/are above the selected PAL.

- (a) The PAL represents the limits of detection that analytical data must meet in order to be of sufficient quality for use in the Remedial Investigation, Risk Assessment, and Feasibility Study.  
 PALs are presented for compounds proposed for laboratory analysis and therefore do not include groups of compounds (such as Total PAHs and Total PCBs) that will be calculated based on individual PAHs and individual aroclor data for evaluation
- (b) Indicates the lower of the PALs based on levels protective of human health and ecological receptors.
- (c) HH PALs were derived using the USEPA Regional Screening Level (RSL) Calculator (2013) by altering the residential soil RSLs based on the following site-specific exposure factors, which will be conservative inputs of sediment exposure  
 Values were adjusted for a target hazard quotient of 0.1 to account for cumulative effects on the same target organ.  
 Exposure frequency (days/year) - 52  
 Exposure duration (years) - Adult - 24; Child - 6  
 Exposure time (hours/day) - 4  
 Adherence factor (mg/m<sup>2</sup>) - Adult - 0.07; Child - 0.2  
 Body Weight (kg) - Adult - 70; Child - 15  
 Skin surface area (cm<sup>2</sup>/day) - Adult - 4500; Child - 1459  
 Ingestion/intake rate (mg/day) - Adult - 100; Child - 200
- (d) Eco PALs were selected based on the following sources (parentheses indicate specific type of screening value):  
 NOAA ERL = Effects Range Low (Marine - Long, et al., 1995; Freshwater - Long and Morgan, 1991).  
 NOAA SQuiRT = Buchman, M.F., 2008. NOAA Screening Quick Reference Tables. NOAA OR&R Report 08-1. Seattle WA. Office of Response and Restoration Division National Oceanic and Atmospheric Administration, 34 pages.  
 USEPA R3 = USEPA Region 3 marine sediment screening values (USEPA, 2006a,b). Freshwater values only used if no marine value is available.  
 Batelle = Battelle. 2007. Sediment Toxicity of Petroleum Hydrocarbon Fractions. Prepared for Massachusetts Department of Environmental Protection. Values adjusted to reflect 1% total organic carbon.
- (e) SIM analysis will be conducted for the compound presented only if the concentration of the target compound is below the full scan LOQ as determined by the corresponding full scan analysis, and the concentration of non-target analyte is not prohibitively great, as determined by the laboratory performing the analyses.

Table 15-3  
 Project Action Limits (PALs) - Groundwater  
 Former Carr Point Shooting Range, MRP Site 1  
 Newport, Rhode Island

Analytical Method	Compound	CAS	Project Action Limits for Groundwater (ug/L) (a)		Laboratory Reference Limits (ug/L)					
			Value	Source (b)	LOQs	Is LOQ >PAL (Y/N)?	LODs	Is LOD >PAL (Y/N)?	DLs	Is DL >PAL (Y/N)?
PAHs via SW8270D (c)	Acenaphthene	83-32-9	4.00E+01	USEPA Tapwater RSL	10	N	7.5	N	1.5	N
PAHs via SW8270D (c)	Acenaphthylene	208-96-8	4.00E+01	USEPA Tapwater RSL	10	N	7.5	N	1.5	N
PAHs via SW8270D (c)	Anthracene	120-12-7	1.30E+02	USEPA Tapwater RSL	10	N	7.5	N	1.7	N
PAHs via SW8270D (c)	Benz(a)anthracene	56-55-3	2.90E-02	USEPA Tapwater RSL	10	Y	7.5	Y	1.6	Y
PAHs via SW8270D (c)	Benzo(a)pyrene	50-32-8	2.90E-03	USEPA Tapwater RSL	10	Y	7.5	Y	1.2	Y
PAHs via SW8270D (c)	Benzo(b)fluoranthene	205-99-2	2.90E-02	USEPA Tapwater RSL	10	Y	7.5	Y	1.2	Y
PAHs via SW8270D (c)	Benzo(g,h,i)perylene	191-24-2	8.70E+00	USEPA Tapwater RSL	10	Y	7.5	N	1.5	N
PAHs via SW8270D (c)	Benzo(k)fluoranthene	207-08-9	2.90E-01	USEPA Tapwater RSL	10	Y	7.5	Y	1.6	Y
PAHs via SW8270D (c)	Chrysene	218-01-9	2.90E+00	USEPA Tapwater RSL	10	Y	7.5	Y	1.7	N
PAHs via SW8270D (c)	Dibenzo(a,h)anthracene	53-70-3	2.90E-03	USEPA Tapwater RSL	10	Y	7.5	Y	1.7	Y
PAHs via SW8270D (c)	Fluoranthene	206-44-0	6.30E+01	USEPA Tapwater RSL	10	N	7.5	N	2.4	N
PAHs via SW8270D (c)	Fluorene	86-73-7	2.20E+01	USEPA Tapwater RSL	10	N	7.5	N	2.1	N
PAHs via SW8270D (c)	Indeno(1,2,3-cd)pyrene	193-39-5	2.90E-02	USEPA Tapwater RSL	10	Y	7.5	Y	1.9	Y
PAHs via SW8270D (c)	Naphthalene	91-20-3	1.40E-01	USEPA Tapwater RSL	10	Y	7.5	Y	2.2	Y
PAHs via SW8270D (c)	Phenanthrene	85-01-8	8.70E+00	USEPA Tapwater RSL	10	Y	7.5	N	2.4	N
PAHs via SW8270D (c)	Pyrene	129-00-0	8.70E+00	USEPA Tapwater RSL	10	Y	7.5	N	1.9	N
PAHs via SW8270D SIM (c)	Acenaphthene	83-32-9	4.00E+01	USEPA Tapwater RSL	0.2	N	0.1	N	0.064	N
PAHs via SW8270D SIM (c)	Acenaphthylene	208-96-8	4.00E+01	USEPA Tapwater RSL	0.2	N	0.1	N	0.054	N
PAHs via SW8270D SIM (c)	Anthracene	120-12-7	1.30E+02	USEPA Tapwater RSL	0.2	N	0.1	N	0.044	N
PAHs via SW8270D SIM (c)	Benzo(a)anthracene	56-55-3	2.90E-02	USEPA Tapwater RSL	0.2	Y	0.1	Y	0.046	Y
PAHs via SW8270D SIM (c)	Benzo(a)pyrene	50-32-8	2.90E-03	USEPA Tapwater RSL	0.2	Y	0.1	Y	0.066	Y
PAHs via SW8270D SIM (c)	Benzo(b)fluoranthene	205-99-2	2.90E-02	USEPA Tapwater RSL	0.2	Y	0.1	Y	0.089	Y
PAHs via SW8270D SIM (c)	Benzo(g,h,i)perylene	191-24-2	8.70E+00	USEPA Tapwater RSL	0.2	N	0.1	N	0.065	N
PAHs via SW8270D SIM (c)	Benzo(k)fluoranthene	207-08-9	2.90E-01	USEPA Tapwater RSL	0.2	N	0.1	N	0.049	N
PAHs via SW8270D SIM (c)	Chrysene	218-01-9	2.90E+00	USEPA Tapwater RSL	0.2	N	0.1	N	0.036	N
PAHs via SW8270D SIM (c)	Dibenzo(a,h)anthracene	53-70-3	2.90E-03	USEPA Tapwater RSL	0.2	Y	0.1	Y	0.07	Y
PAHs via SW8270D SIM (c)	Fluoranthene	206-44-0	6.30E+01	USEPA Tapwater RSL	0.2	N	0.1	N	0.073	N
PAHs via SW8270D SIM (c)	Fluorene	86-73-7	2.20E+01	USEPA Tapwater RSL	0.2	N	0.1	N	0.061	N
PAHs via SW8270D SIM (c)	Indeno(1,2,3-cd)pyrene	193-39-5	2.90E-02	USEPA Tapwater RSL	0.2	Y	0.1	Y	0.052	Y
PAHs via SW8270D SIM (c)	Naphthalene	91-20-3	1.40E-01	USEPA Tapwater RSL	0.2	Y	0.1	N	0.064	N
PAHs via SW8270D SIM (c)	Phenanthrene	85-01-8	8.70E+00	USEPA Tapwater RSL	0.2	N	0.1	N	0.051	N
PAHs via SW8270D SIM (c)	Pyrene	129-00-0	8.70E+00	USEPA Tapwater RSL	0.2	N	0.1	N	0.059	N
TAL Metals via SW6010	Aluminum	7429-90-5	1.60E+03	USEPA Tapwater RSL	300	N	100	N	14.8	N
TAL Metals via SW6010	Calcium	7440-70-2	NA		100	N	80	N	11.2	N
TAL Metals via SW6010	Iron	7439-89-6	1.10E+03	USEPA Tapwater RSL	100	N	80	N	5.42	N
TAL Metals via SW6010	Magnesium	7439-95-4	NA		100	N	80	N	7.8	N
TAL Metals via SW6010	Potassium	7440-09-7	NA		1000	N	500	N	41	N
TAL Metals via SW6010	Sodium	7440-23-5	NA		1000	N	500	N	23.72	N
TAL Metals via SW6020	Antimony	7440-36-0	6.00E-01	USEPA Tapwater RSL	1	Y	0.5	N	0.054165	N
TAL Metals via SW6020	Arsenic	7440-38-2	4.50E-02	USEPA Tapwater RSL	5	Y	4	Y	2.249535	Y
TAL Metals via SW6020	Barium	7440-39-3	2.90E+02	USEPA Tapwater RSL	5	N	3	N	0.234	N
TAL Metals via SW6020	Beryllium	7440-41-7	1.60E+00	USEPA Tapwater RSL	1	N	0.2	N	0.033694	N
TAL Metals via SW6020	Cadmium	7440-43-9	6.90E-01	USEPA Tapwater RSL	1	Y	0.2	N	0.029753	N
TAL Metals via SW6020	Chromium	7440-47-3	3.10E-02	USEPA Tapwater RSL	5	Y	4	Y	0.22247	Y
TAL Metals via SW6020	Cobalt	7440-48-4	4.70E-01	USEPA Tapwater RSL	1	Y	0.3	N	0.060474	N
TAL Metals via SW6020	Copper	7440-50-8	6.20E+01	USEPA Tapwater RSL	3	N	2	N	0.184405	N
TAL Metals via SW6020	Lead	7439-92-1	1.50E+01	RIDEM M1 GA	5	N	4	N	1.07	N
TAL Metals via SW6020	Manganese	7439-96-5	3.20E+01	USEPA Tapwater RSL	5	N	4	N	1.06	N
TAL Metals via SW6020	Nickel	7440-02-0	3.00E+01	USEPA Tapwater RSL	10	N	4	N	0.281	N
TAL Metals via SW6020	Selenium	7782-49-2	7.80E+00	USEPA Tapwater RSL	5	N	3	N	0.185439	N

Table 15-3  
 Project Action Limits (PALs) - Groundwater  
 Former Carr Point Shooting Range, MRP Site 1  
 Newport, Rhode Island

Analytical Method	Compound	CAS	Project Action Limits for Groundwater (ug/L) (a)		Laboratory Reference Limits (ug/L)					
			Value	Source (b)	LOQs	Is LOQ >PAL (Y/N)?	LODs	Is LOD >PAL (Y/N)?	DLs	Is DL >PAL (Y/N)?
TAL Metals via SW6020	Silver	7440-22-4	7.10E+00	USEPA Tapwater RSL	1	N	0.4	N	0.050396	N
TAL Metals via SW6020	Thallium	7440-28-0	1.60E-02	USEPA Tapwater RSL	1	Y	0.4	Y	0.06035	Y
TAL Metals via SW6020	Vanadium	7440-62-2	6.30E+00	USEPA Tapwater RSL	5	N	4	N	0.514225	N
TAL Metals via SW6020	Zinc	7440-66-6	4.70E+02	USEPA Tapwater RSL	20	N	10	N	0.725	N
TAL Metals via SW7470A	Mercury	7439-97-6	4.30E-01	USEPA Tapwater RSL	0.2	N	0.1	N	0.01338	N
SW3060A/7196A	Hexavalent Chromium	18540-29-9	3.10E-02	USEPA Tapwater RSL	0.025	N	0.013	N	0.0027	N
SM2520B	Salinity (Laboratory)	NA	NA		NA	NA	NA	NA	NA	NA
RC Procedure TBD	Salinity (Field)	NA	NA		NA	NA	NA	NA	NA	NA
RC Procedure 3-24	pH, ORP, DO, Spec. Cond. (Field)	NA	NA		NA	NA	NA	NA	NA	NA
RC Procedure 3-24	Turbidity (Field)	NA	NA		NA	NA	NA	NA	NA	NA
SM2320B	Alkalinity	NA	NA		NA	NA	NA	NA	NA	NA
SW846 9056A	Anions (Chloride, Nitrate, Nitrite, Orthophosphate-P, Sulfate)	NA	NA		NA	NA	NA	NA	NA	NA
SW846 9060	Total Organic Carbon	NA	NA		NA	NA	NA	NA	NA	NA
RSK-175	Methane/Ethane/Ethene	NA	NA		NA	NA	NA	NA	NA	NA
SM 2540 D	Total Suspended Solids	NA	NA		NA	NA	NA	NA	NA	NA
SM 2540C	Total Dissolved Solids	NA	NA		NA	NA	NA	NA	NA	NA
RC Procedure 3-18	Ferrous Iron (Field)	NA	NA		NA	NA	NA	NA	NA	NA

**Notes:**

CAS - Chemical Abstracts Service.  
 DL - Detection Limit.  
 LOD - Limit of Detection.  
 LOQ - Limit of Quantitation.  
 NA - Not available/applicable.  
 PAH - Polycyclic Aromatic Hydrocarbon.  
 PAL - Project Action Limit.  
 SIM - Selective Ion Monitoring.

Highlighting indicates the compound's laboratory reference value(s) is/are above the selected PAL.

(a) The PAL represents the limits of detection that analytical data must meet in order to be of sufficient quality for use in the Remedial Investigation, Risk Assessment, and Feasibility Study.

(b) Groundwater PALs were selected based on the lower of the following sources of screening levels:

RIDEM M1 GA = RIDEM, 2011. Method 1 GA Groundwater Objectives. Presumable to be suitable for drinking water use without treatment.

RIDEM M1 GB = RIDEM, 2011. Method 1 GB Groundwater Objectives. Presumed not suitable for use as a current or potential source of drinking water.

USEPA Tapwater RSL = USEPA Regional Screening Levels for Tapwater. May 2013. Values adjusted for a target hazard quotient of 0.1 to account for cumulative effects on the same target organ.

USEPA VI = USEPA Target Groundwater Concentrations for the Vapor Intrusion Pathway. Calculated using the USEPA Vapor Intrusion Screening Level Calculator. Version 3.1, June 2013 RSLs.

USEPA MCL = USEPA Maximum Contaminant Levels (MCLs). USEPA Drinking Water Standards and Health Advisories. EPA 822-R-06-013. April 2012.

(c) SIM analysis will be conducted for the compound presented only if the concentration of the target compound is below the full scan LOQ as determined by the corresponding full scan analysis, and the concentration of non-target analyte is not prohibitively great, as determined by the laboratory performing the analyses.

Table 15-4  
Project Action Limits (PALs) - Shellfish Tissue  
Former Carr Point Shooting Range, MRP Site 1  
Newport, Rhode Island

Analytical Method	Compound	CAS	Project Action Limits for Shellfish Tissue (mg/kg) (a)						Laboratory Reference Limits (mg/kg)					
			HH		Eco		Selected (b)		LOQs	Is LOQ > PAL (Y/N)?	LODs	Is LOD > PAL (Y/N)?	DLs	Is DL > PAL (Y/N)?
			Value (c)	Source	Value (d)	Source	Value	Source						
PAHs via SW8270D SIM	Acenaphthene	83-32-9	8.10E+00	USEPA Fish Tissue RSL	NA		8.10E+00	USEPA Fish Tissue RSL	0.0005	N	0.0001	N	0.000047	N
PAHs via SW8270D SIM	Acenaphthylene	208-96-8	8.10E+00	USEPA Fish Tissue RSL	NA		8.10E+00	USEPA Fish Tissue RSL	0.0005	N	0.0001	N	0.000046	N
PAHs via SW8270D SIM	Anthracene	120-12-7	4.10E+01	USEPA Fish Tissue RSL	NA		4.10E+01	USEPA Fish Tissue RSL	0.0005	N	0.0001	N	0.000038	N
PAHs via SW8270D SIM	Benzo(a)anthracene	56-55-3	4.30E-03	USEPA Fish Tissue RSL	NA		4.30E-03	USEPA Fish Tissue RSL	0.0005	N	0.0001	N	0.000038	N
PAHs via SW8270D SIM	Benzo(a)pyrene	50-32-8	4.30E-04	USEPA Fish Tissue RSL	NA		4.30E-04	USEPA Fish Tissue RSL	0.0005	Y	0.0001	N	0.000073	N
PAHs via SW8270D SIM	Benzo(b)fluoranthene	205-99-2	4.30E-03	USEPA Fish Tissue RSL	NA		4.30E-03	USEPA Fish Tissue RSL	0.0005	N	0.0001	N	0.000066	N
PAHs via SW8270D SIM	Benzo(g,h,i)perylene	191-24-2	4.10E+00	USEPA Fish Tissue RSL	NA		4.10E+00	USEPA Fish Tissue RSL	0.0005	N	0.0001	N	0.000095	N
PAHs via SW8270D SIM	Benzo(k)fluoranthene	207-08-9	4.30E-02	USEPA Fish Tissue RSL	NA		4.30E-02	USEPA Fish Tissue RSL	0.0005	N	0.0001	N	0.000057	N
PAHs via SW8270D SIM	Chrysene	218-01-9	4.30E-01	USEPA Fish Tissue RSL	NA		4.30E-01	USEPA Fish Tissue RSL	0.0005	N	0.0001	N	0.000055	N
PAHs via SW8270D SIM	Dibenzo(a,h)anthracene	53-70-3	4.30E-04	USEPA Fish Tissue RSL	NA		4.30E-04	USEPA Fish Tissue RSL	0.0005	Y	0.0001	N	0.000086	N
PAHs via SW8270D SIM	Fluoranthene	206-44-0	5.40E+00	USEPA Fish Tissue RSL	NA		5.40E+00	USEPA Fish Tissue RSL	0.0005	N	0.0001	N	0.000049	N
PAHs via SW8270D SIM	Fluorene	86-73-7	5.40E+00	USEPA Fish Tissue RSL	NA		5.40E+00	USEPA Fish Tissue RSL	0.0005	N	0.0001	N	0.000052	N
PAHs via SW8270D SIM	Indeno(1,2,3-cd)pyrene	193-39-5	4.30E-03	USEPA Fish Tissue RSL	NA		4.30E-03	USEPA Fish Tissue RSL	0.0005	N	0.0001	N	0.000096	N
PAHs via SW8270D SIM	Naphthalene	91-20-3	2.70E+00	USEPA Fish Tissue RSL	NA		2.70E+00	USEPA Fish Tissue RSL	0.001	N	0.00015	N	0.00015	N
PAHs via SW8270D SIM	Phenanthrene	85-01-8	4.10E+00	USEPA Fish Tissue RSL	NA		4.10E+00	USEPA Fish Tissue RSL	0.0005	N	0.0001	N	0.000066	N
PAHs via SW8270D SIM	Pyrene	129-00-0	4.10E+00	USEPA Fish Tissue RSL	NA		4.10E+00	USEPA Fish Tissue RSL	0.0005	N	0.00015	N	0.00012	N
TAL Metals via SW6010	Aluminum	7429-90-5	1.40E+02	USEPA Fish Tissue RSL	NA		1.40E+02	USEPA Fish Tissue RSL	1	N	1	N	0.3	N
TAL Metals via SW6010	Calcium	7440-70-2	EN		NA		NA	NA	8	N	5	N	3	N
TAL Metals via SW6010	Iron	7439-89-6	9.50E+01	USEPA Fish Tissue RSL	NA		9.50E+01	USEPA Fish Tissue RSL	2	N	1.6	N	0.4	N
TAL Metals via SW6010	Magnesium	7439-95-4	EN		NA		NA	NA	2	N	1.6	N	0.4	N
TAL Metals via SW6010	Potassium	7440-09-7	EN		NA		NA	NA	40	N	24	N	6	N
TAL Metals via SW6010	Sodium	7440-23-5	EN		NA		NA	NA	20	N	12	N	3	N
TAL Metals via SW6020	Antimony	7440-36-0	5.40E-02	USEPA Fish Tissue RSL	NA		5.40E-02	USEPA Fish Tissue RSL	0.05	N	0.025	N	0.02	N
TAL Metals via SW6020	Arsenic	7440-38-2	2.10E-03	USEPA Fish Tissue RSL	4.00E+00	ERED/ToxRes	2.10E-03	USEPA Fish Tissue RSL	0.5	Y	0.25	Y	0.04	Y
TAL Metals via SW6020	Barium	7440-39-3	2.70E+01	USEPA Fish Tissue RSL	NA		2.70E+01	USEPA Fish Tissue RSL	0.05	N	0.025	N	0.009	N
TAL Metals via SW6020	Beryllium	7440-41-7	2.70E-01	USEPA Fish Tissue RSL	NA		2.70E-01	USEPA Fish Tissue RSL	0.02	N	0.01	N	0.009	N
TAL Metals via SW6020	Cadmium	7440-43-9	1.40E-01	USEPA Fish Tissue RSL	3.60E-01	ERED/ToxRes	1.40E-01	USEPA Fish Tissue RSL	0.02	N	0.01	N	0.005	N
TAL Metals via SW6010	Chromium	7440-47-3	6.30E-03	USEPA Fish Tissue RSL	1.00E+00	ERED/ToxRes	6.30E-03	USEPA Fish Tissue RSL	0.2	Y	0.2	Y	0.08	Y
TAL Metals via SW6020	Cobalt	7440-48-4	4.10E-02	USEPA Fish Tissue RSL	NA	ERED/ToxRes	4.10E-02	USEPA Fish Tissue RSL	0.02	N	0.01	N	0.002	N
TAL Metals via SW6020	Copper	7440-50-8	5.40E+00	USEPA Fish Tissue RSL	1.32E+00	ERED/ToxRes	1.32E+00	ERED/ToxRes	0.4	N	0.05	N	0.03	N
TAL Metals via SW6020	Lead	7439-92-1	NA		5.80E-01	ERED/ToxRes	5.80E-01	ERED/ToxRes	0.02	N	0.01	N	0.005	N
TAL Metals via SW6020	Manganese	7439-96-5	1.90E+01	USEPA Fish Tissue RSL	NA	ERED/ToxRes	1.90E+01	USEPA Fish Tissue RSL	0.05	N	0.025	N	0.007	N
TAL Metals via SW6020	Nickel	7440-02-0	2.70E+00	USEPA Fish Tissue RSL	7.90E+01	ERED/ToxRes	2.70E+00	USEPA Fish Tissue RSL	0.2	N	0.1	N	0.02	N
TAL Metals via SW6020	Selenium	7782-49-2	6.80E-01	USEPA Fish Tissue RSL	NA	ERED/ToxRes	6.80E-01	USEPA Fish Tissue RSL	1	Y	0.25	N	0.2	N
TAL Metals via SW6020	Silver	7440-22-4	6.80E-01	USEPA Fish Tissue RSL	4.47E+00	ERED/ToxRes	6.80E-01	USEPA Fish Tissue RSL	0.04	N	0.02	N	0.02	N
TAL Metals via SW6020	Thallium	7440-28-0	1.40E-03	USEPA Fish Tissue RSL	NA	ERED/ToxRes	1.40E-03	USEPA Fish Tissue RSL	0.02	Y	0.01	Y	0.002	Y
TAL Metals via SW6020	Vanadium	7440-62-2	6.80E-01	USEPA Fish Tissue RSL	NA	ERED/ToxRes	6.80E-01	USEPA Fish Tissue RSL	0.2	N	0.1	N	0.08	N
TAL Metals via SW6020	Zinc	7440-66-6	4.10E+01	USEPA Fish Tissue RSL	5.00E+00	ERED/ToxRes	5.00E+00	ERED/ToxRes	0.5	N	0.25	N	0.08	N
TAL Metals via SW1631E	Mercury	7439-97-6	1.40E-02	USEPA Fish Tissue RSL	2.80E+01	ERED/ToxRes	1.40E-02	USEPA Fish Tissue RSL	0.001	N	0.00075	N	0.0003	N
USEPA 2000 / Blich & Dyer 1959	Percent Lipids	NA	NA		NA		NA	NA	NA		NA		NA	

## Notes:

CAS - Chemical Abstracts Service.  
Eco - Indicates the selected PAL that is protective of ecological receptors.  
EN - Essential Nutrient.  
ERED - Environmental Residue Effects Database. <http://www.wes.army.mil/el/ered/index.html>  
HH - Indicates the selected PAL that is protective of human health receptors.  
LOD - Limit of Detection  
LOQ - Limit of Quantitation.  
NA - Not available/applicable.  
PAL - Project Action Limit.  
RSL - Regional Screening Level.  
ToxRes - Toxicity/Residue Database. [http://www.epa.gov/med/Prods\\_Pubs/tox\\_residue.htm](http://www.epa.gov/med/Prods_Pubs/tox_residue.htm)  
USEPA - United States Environmental Protection Agency.

Highlighting indicates the compound's laboratory reference value(s) is/are above the selected PAL.

(a) The PAL represents the limits of detection that analytical data must meet in order to be of sufficient quality for use in the Remedial Investigation, Risk Assessment, and Feasibility Study

(b) Indicates the lower of the PALs based on levels protective of human health and ecological receptors.

(c) HH PALs are equal to the USEPA Regional Screening Level for Fish Tissue. May 2013.

Values adjusted for a target hazard quotient of 0.1 to account for cumulative effects on the same target organ.

(d) Eco PALs represent the lowest critical body residue for shellfish identified in reviews of the ERED and ToxRes databases.

**SAP Worksheet #16: Project Schedule/Timeline Table**

[\(UFP-QAPP Manual Section 2.8.2\)](#)

Deliverable	Timeframe	Planned Date <sup>(2)</sup>
<b>RI Field Program, Data Evaluation</b>		
Complete Field Program	60 days after Final RI SAP	12/26/2013
Complete Laboratory Analysis	30 day standard TAT <sup>(1)</sup>	1/25/2014
Complete Data Validation and Import	45 days for data validation	3/11/2014
Complete Internal Draft RI Report	45 days for report preparation	4/25/2014
<b>RI Report (and risk assessments)</b>		
Internal Draft to Navy	Upon completion of Field Program and Data Evaluation	4/25/2014
Receive Navy Comments	30 days after Internal Draft	5/25/2014
Draft to Agencies	30 days after receipt of comments	6/24/2014
Receive Agency Comments	45 days after Draft	8/8/2014
Navy RTC to Agencies	45 days after receipt of comments	9/22/2014
Draft Final to Agencies	45 days after Navy RTC	11/6/2014
Agency Concurrence on Draft Final	30 days after Draft Final	12/6/2014
Final to Agencies	60 days after Draft Final	1/5/2015

**Notes:**

(1) – Quicker TATs may be implemented per this SAP to assist with potential step-out sampling and sequential laboratory analysis.

(2) – Actual dates will vary based on regulatory concurrence, field conditions, and/or other relevant factors.

## **SAP Worksheet #17: Sampling Design and Rationale**

[\(UFP-QAPP Manual Section 3.1.1\)](#)

### **Overview**

This section describes the sampling rationale and sampling design for the collection of surface and subsurface soil, sediment, and groundwater samples at MRP Site 1. The general approach for the planned investigation is to collect a wide variety of site characterization data, designed to refine the CSM and to support the completion of the RI and risk assessment. A key element of this investigation is to refine the lateral and vertical extent of site-related impacts that may warrant site remediation and/or site restrictions. Prior investigations for MRP Site 1 have identified PAHs and metals in soil; metals in groundwater; and PAHs, metals, and lead pellets in sediment within the adjacent Narragansett Bay. However, the specific boundaries of impacts have not been fully delineated. The planned investigation is designed to collect site-specific and background environmental media (i.e., soil, groundwater, and sediment) data to better define the extent of site-related impacts. Further details regarding the specific DQOs for the planned investigation are presented in Worksheet #11, and PALs are quantified in Worksheet #15. The PALs represent the limits of detection that analytical data must meet in order to be of sufficient quality for use in the RI and risk assessment. These levels are designed to be equal to or lower than relevant human health and ecological screening levels. However, the PALs are not intended to be used as cleanup levels or to identify the presence of risk/hazard. The following paragraphs describe the general methodology and rationale for the specific sampling approach.

### **Soil Sampling**

An estimated 89 soil samples from 32 locations are approximate locations of soil borings and soil samples planned for collection during the investigation program at MRP Site 1, are shown on Figure 3 and target depths are depicted on Table 17-1. These locations will be field-adjusted as necessary to accomplish the DQOs for this program.

The planned investigation has been planned to refine the understanding of the extent of site impacts, based on an evaluation of previously collected data. The specific methodology and procedures to be implemented for soil sampling are included within the SOPs provided with this SAP. Based on the field parameter measurements and discussion among the project team, sample locations and depths will be selected to refine the extent of site impacts.

Surface soil samples (0 to 1 foot bgs) will be collected from each location, except where indicated on Table 17-1. A soil removal action was recently completed in the former clay pigeon firing arc area, which addressed impacted surface soils; therefore, no surface soil samples are warranted

within the removal action area as part of this investigation. However, data from the removal action will be evaluated and additional borings/samples may be collected at the bottom of excavation and/or along the periphery of the excavation (if necessary) to confirm the absence/presence of propellants. In addition, a subset of soil samples will be collected from 1 to 2 feet bgs.

Subsurface soil samples will be collected from borings at each boring location with target depths/rationale are shown on Table 17-1; however, the precise depths may be modified based on actual field conditions (i.e., visual/olfactory evidence of impacts, depth to groundwater, etc.). Additionally, one surface soil sample and one subsurface soil sample will be collected at the discharge point associated with a drainage pipe and at the discharge point of the historic pipe terminus (if identified).

Soil samples will be collected and handled in accordance with SOP 3-21 and analyzed for PAHs and metals. In addition, a subset of the samples will be analyzed for, hexavalent chromium, propellants (nitroaromatics and nitramines, TOC, pH, bulk density, porosity, conductivity, and grain size. This subset of parameters has not been identified, with the exception of propellants, on the rationale table (Table 17-1) and will be determined in the field based on actual field conditions (i.e., sample depth, strata type, field parameters, etc.). In addition to the primary samples, QA/QC samples will be collected in accordance with this SAP.

Samples will be shipped on the day of sampling or as soon as logistically possible. The samples will be preserved, chilled, etc. in accordance with this SAP. All sample shipments to a designated laboratory will contain appropriate chain of custody (CoC) forms.

### **Field Parameters**

Field parameters will consist of measurements associated with groundwater well development and sampling. Measurements of pH, specific conductivity, turbidity, temperature, DO, ferrous iron, salinity and ORP will be recorded in relevant field logs. The specific methodology and procedures to be implemented for field parameters are included within the SOPs provided with this SAP.

### **Groundwater Sampling**

Five new groundwater monitoring wells will be constructed during the planned investigation at MRP Site 1. These wells will augment the existing monitoring well network at MRP Site 1, as shown on Figures 4 and 7 and detailed on Table 17-2. In total, groundwater samples will be collected from six monitoring wells.

Based on the CSM (refer to Worksheet #10), there is no history or expectation for NAPL at MRP Site 1. If any of the monitoring wells (new or existing) exhibit the presence of NAPL, the thickness will be quantified and the Navy will coordinate with EPA and RIDEM to establish an approach to further assessment and/or laboratory analysis.

If the existing monitoring well exhibits visual evidence of stagnation (i.e., turbidity readings greater than 5 NTUs), it will be re-developed to reduce the turbidity to the lowest condition possible for the formation. Similarly, all new monitoring wells will be developed. After development, wells will be allowed to stabilize for a minimum of 1 week, before returning to the monitoring well for groundwater sampling. The specific methodology and procedures to be implemented for monitoring well development and sampling are included within the SOPs provided with this SAP.

The intent of the groundwater sampling program is to compile a current depiction of groundwater quality from the monitoring well network, evaluate groundwater quality on the bedrock surface, and evaluate vertical groundwater flow characteristics. The groundwater data will be used to assess potential impacts at the site due to historical activities, quantifying potential risks to receptors, and evaluating alternatives in a forthcoming FS as necessary.

To support Goals 1 and 2 (refined CSM and evaluation of potential risks), groundwater data will also be assessed for salinity and other parameters to evaluate the potability of the aquifer, better quantify whether a future drinking water exposure pathway is realistic, and refine remedial action objectives (RAOs) during the FS process. Both field and laboratory analysis for salinity will be conducted on the groundwater samples collected during the first round of groundwater monitoring. Final salinity measurements, taken before collection of samples for fixed-laboratory analysis, will be compared to the fixed laboratory results for all samples.

All site wells, including the five new wells, will be sampled. Groundwater samples will be collected and handled in accordance with SOP 3-24 and USEPA Region 1 Low-Flow Sampling Guidance (USEPA, 2010a) and analyzed for PAHs and metals. In addition, a subset of samples will be analyzed for salinity, hexavalent chromium, alkalinity, chloride, nitrate/nitrite, sulfate, TOC, ortho-phosphate-P, methane/ethane/ethene, and TSS/TDS. In addition to the primary samples, QA/QC samples will be collected in accordance with this SAP.

Samples will be shipped on the day of sampling or as soon as logistically possible. The samples will be preserved, chilled, etc. in accordance with this SAP. All sample shipments to a designated laboratory will contain appropriate CoC forms.

If warranted, subsequent rounds of groundwater sampling could be implemented using the same procedures outlined in this SAP.

## **Sediment Sampling**

Sediment samples will be collected locations within Narragansett Bay in the vicinity of MRP Site 1. Similar to the design and rationale for soil sampling, the primary intent is to better define the extent of historical release(s). The proposed sediment sample locations are shown on Figure 5 and the sampling rationale is explained in Table 17-1.

The planned investigation will include data collection outside of the approximate impacted area, as defined in the Tetra Tech SI (2010a), to refine the extent of historical release(s) related to firing range activities. In addition, two locations will also assess potential impacts from the outfall associated with MRP Site 1.

It should be noted that historically, Tetra Tech only assessed sediment samples from the target area for PAHs and based on PALs identified in the SI, identified two locations with PAH exceedances (refer to Figure 5). As described in this SAP, sediment samples will be collected for PAHs analysis at the proposed locations; however, it is possible that samples from the overshoot area will be held for analysis pending the results of the proposed samples in the target area.

The proposed sampling locations may be refined after completion of the dive survey. The dive survey will be conducted to assess skeet fragment presence and absence. In addition, proposed sampling locations may be refined based on actual field conditions (i.e., visual evidence of impact, strata type, depositional areas, etc.) and it may be necessary to add step-out locations in order to define the extent of impact. For example, a threshold of 7 lead pellets per square foot has been established as screening-level criteria for this site; the presence of lead pellets above this level may warrant additional step-out locations.

In addition, surficial sediment samples will be collected from up to 12 locations to establish/supplement a background/reference data set.

Sediment samples will be collected from 4 distinct horizons (0 to 0.5 ft, 0.5 to 1 ft, 1 to 2 ft, 2 to 3 ft) in order to vertically delineate potential site-related impacts in the bay. However, it is anticipated that the risk assessments will only evaluate potential risks associated with the surficial sediment (0 to 0.5 ft). The human health risk assessment will evaluate a sub-set of the surficial sediment data representing locations most likely to be encountered by potential receptors (e.g., samples collected from areas of shallow water depth). Therefore, the approximate water depth and tidal phase will be recorded at each station to assist with selecting data for use in the human health risk assessment. The ERA will evaluate the full surficial sediment data set.

Sediment samples will be collected and handled in accordance with SOP 3-22 and analyzed for PAHs and metals. In addition, a subset of the samples will be analyzed for AVS/SEM, TOC, and grain size. In addition, the sediment samples will be evaluated for the presence of lead pellets in accordance with SOP 3-30. It is anticipated that pellet counts and a determination of pellet size (i.e., grain size evaluation) will be conducted on all of the surficial sediment samples. For vertical delineation, pellet counts will be conducted at sequential depths if the shallower depths exceed the 7 pellets per square foot threshold. In deeper samples, pellet size will be evaluated on approximately 25% of the samples submitted for pellet counting. These deeper sediments are not currently available for birds to contact; however, it may be useful to know whether the pellet size distribution varies vertically. All pellet samples will be archived in the event that additional characterization is warranted.

A subset of surficial sediment samples will be analyzed for macroinvertebrate analysis and toxicity testing to support the ERA. Surficial sediment samples will be collected from all of the MRP Site 1 and reference sampling locations and held pending a review of the preliminary analytical results. Samples submitted for macroinvertebrate analysis and toxicity testing will be selected to represent a range of metals, PAH, and lead pellet concentrations in order to assess the relationship between these potential stressors and biological indicators (i.e., sediment toxicity, macroinvertebrate community and biomass).

In addition to the primary samples, QA/QC samples will be collected in accordance with this SAP. Samples will be shipped on the day of sampling or as soon as logistically possible. The samples will be preserved, chilled, etc. in accordance with this SAP. All sample shipments to a designated laboratory will contain appropriate CoC forms.

### **Tissue Sampling**

Samples from within MRP Site 1 may be collected for shellfish tissue residue analysis in order to provide a site-specific assessment of bioaccumulation. The number of samples collected will be dependent upon the number and species of shellfish observed during the dive survey. Additional samples will also be collected from the reference locations. Shellfish of the same species observed at MRP Site 1 will be targeted for collection in the reference areas to allow comparisons between the data sets. Tissue residues will be analyzed for metals, PAHs, and percent lipids and these data will be incorporated into the risk assessments to evaluate the potential for risks to shellfish and consumers of shellfish.

Table 17-1  
 Soil and Sediment Sampling Rationale Table  
 Former Carr Point Shooting Range  
 Carr Point, NAVSTA, Newport, RI

Proposed Sample Location	Media	Target Depth <sup>(1)</sup>	PAHs	Propellants	Metals	Hex Chromium <sup>(2)</sup>	Phys and Geochem Data <sup>(2),(3)</sup>	Pellet Count <sup>(4)</sup>	Qual Lead Pellet Assess <sup>(5)</sup>	Rationale
SB201	Surface Soil	0-1'	X		X					SI exceedances of PAHs; additional delineation of SS116
SB201	Subsurface Soil	3-5'	X		X					To assess potential impacts to subsurface soils
SB201	Subsurface Soil	10-12'	X		X					To assess potential impacts to subsurface soils
SB202	Surface Soil	0-1'	X		X					SI exceedances of PAHs; additional delineation of SS117 and SS118
SB202	Subsurface Soil	3-5'	X		X					To assess potential impacts to subsurface soils
SB202	Subsurface Soil	6-8'	X		X					To assess potential impacts to subsurface soils
SB203	Surface Soil	0-1'	X		X					SI exceedances of PAHs; additional delineation of SS119 and SS120
SB203	Subsurface Soil	3-5'	X		X					To assess potential impacts to subsurface soils
SB203	Subsurface Soil	6-8'	X		X					To assess potential impacts to subsurface soils
SB204	Surface Soil	0-1'	X		X					SI exceedances of PAHs and metals; additional delineation of SS120, SS121 and SS122
SB204	Subsurface Soil	3-5'	X		X					To assess potential impacts to subsurface soils
SB204	Subsurface Soil	10-12'	X		X					To assess potential impacts to subsurface soils
SB205	Surface Soil	0-1'	X		X					SI exceedances of PAHs and metals; additional delineation of SS122, SS123 and SS115
SB205	Subsurface Soil	3-5'	X		X					To assess potential impacts to subsurface soils
SB205	Subsurface Soil	6-8'	X		X					To assess potential impacts to subsurface soils
SB206	Surface Soil	0-1'	X		X					SI exceedances of PAHs; additional delineation of SS107, SS115 and SS123
SB206	Subsurface Soil	3-5'	X		X					To assess potential impacts to subsurface soils
SB206	Subsurface Soil	6-8'	X		X					To assess potential impacts to subsurface soils
SB207	Surface Soil	0-1'	X		X					Upgradient surface soil reference point
SB207	Subsurface Soil	3-5'	X		X					Upgradient subsurface soil reference point
SB207	Subsurface Soil	6-8'	X		X					Upgradient subsurface soil reference point
SB208	Surface Soil	0-1'	X		X					SI exceedances of PAHs and metals; additional delineation of SB01 and SS106
SB208	Subsurface Soil	3-5'	X		X					To assess potential impacts to subsurface soils
SB208	Subsurface Soil	6-8'	X		X					To assess potential impacts to subsurface soils
SB209	Surface Soil	0-1'	X		X					SI exceedances of PAHs and metals; additional delineation of SS104 and SS105
SB209	Surface Soil	1-2'	X		X					SI exceedances of PAHs and metals; additional delineation of SS104 and SS105
SB209	Subsurface Soil	3-5'	X		X					To assess potential impacts to subsurface soils
SB209	Subsurface Soil	10-12'	X		X					To assess potential impacts to subsurface soils
SB210	Surface Soil	0-1'	X		X				X	SI exceedances of PAHs and metals; additional delineation of SS103 and SS104
SB210	Subsurface Soil	3-5'	X		X				X	To assess potential impacts to subsurface soils
SB210	Subsurface Soil	6-8'	X		X					To assess potential impacts to subsurface soils
SB211	Surface Soil	0-1'	X		X					SI exceedances of PAHs and metals; additional delineation of SS102 and SS103
SB211	Surface Soil	1-2'	X		X					SI exceedances of PAHs and metals; additional delineation of SS102 and SS103
SB211	Subsurface Soil	3-5'	X		X					To assess potential impacts to subsurface soils
SB211	Subsurface Soil	10-12'	X		X					SI exceedances of PAHs; additional delineation of SB09
SB212	Surface Soil	0-1'	X		X					SI exceedances of PAHs and metals; additional delineation of SB09 and SS101
SB212	Surface Soil	1-2'	X		X					SI exceedances of PAHs and metals; additional delineation of SB09 and SS101
SB212	Subsurface Soil	3-5'	X		X					To assess potential impacts to subsurface soils
SB212	Subsurface Soil	6-8'	X		X					SI exceedances of PAHs; additional delineation of SB09
SB213	Surface Soil	0-1'	X		X					SI exceedances of PAHs and metals; additional delineation of SS100, SS108, SS116 and SB09
SB213	Surface Soil	1-2'	X		X					SI exceedances of PAHs and metals; additional delineation of SS100, SS108, SS116 and SB09

Table 17-1  
Soil and Sediment Sampling Rationale Table  
Former Carr Point Shooting Range  
Carr Point, NAVSTA, Newport, RI

Proposed Sample Location	Media	Target Depth <sup>(1)</sup>	PAHs	Propellants	Metals	Hex Chromium <sup>(2)</sup>	Phys and Geochem Data <sup>(2),(3)</sup>	Pellet Count <sup>(4)</sup>	Qual Lead Pellet Assess <sup>(5)</sup>	Rationale
SB213	Subsurface Soil	3-5'	X		X					To assess potential impacts to subsurface soils
SB213	Subsurface Soil	6-8'	X		X					SI exceedances of PAHs; additional delineation of SB09
SB214	Subsurface Soil	3-5'	X	X	X					To assess potential impacts to subsurface soils
SB214	Subsurface Soil	6-8'	X		X					To assess potential impacts to subsurface soils
SB215	Subsurface Soil	3-5'	X	X	X					To assess potential impacts to subsurface soils
SB215	Subsurface Soil	10-12'	X		X					To assess potential impacts to subsurface soils
SB216	Subsurface Soil	3-5'	X	X	X					To assess potential impacts to subsurface soils
SB216	Subsurface Soil	6-8'	X		X					To assess potential impacts to subsurface soils
SB217	Surface Soil	0-1'	X	X	X					SI exceedances of PAHs and metals; additional delineation of SS107, SS106, SS115, and SS114, delineate limits of the form firing arcs
SB-217	Surface Soil	1-2'	X	X	X					SI exceedances of PAHs and metals; additional delineation of SS107, SS106, SS115, and SS114, delineate limits of the form firing arcs
SB217	Subsurface Soil	3-5'	X	X	X					Upgradient subsurface soil reference point
SB217	Subsurface Soil	6-8'	X		X					Upgradient subsurface soil reference point
SB218	Surface Soil	0-1'	X	X	X					SI exceedances of PAHs and metals; additional delineation of SS121, SS122, SS123, SS115, and SS114, delineate limits of the form firing arcs
SB218	Surface Soil	1-2'	X	X	X					SI exceedances of PAHs and metals; additional delineation of SS121, SS122, SS123, SS115, and SS114, delineate limits of the form firing arcs
SB218	Subsurface Soil	3-5'	X	X	X					To assess potential impacts to subsurface soils
SB219	Surface Soil	0-1'	X	X	X					SI exceedances of PAHs and metals; additional delineation of SS113, SS112, SS120, and SS121, delineate limits of the form firing arcs
SB219	Subsurface Soil	3-5'	X	X	X					To assess potential impacts to subsurface soils
SB220	Surface Soil	0-1'	X	X	X					SI exceedances of PAHs and metals; additional delineation of SS111 and SS119, delineate limits of the form firing arcs
SB220	Surface Soil	1-2'	X	X	X					SI exceedances of PAHs and metals; additional delineation of SS111 and SS119, delineate limits of the form firing arcs
SB220	Subsurface Soil	3-5'	X	X	X					To assess potential impacts to subsurface soils
SB-221	Surface Soil	0-1'	X		X					SI exceedance of SVOCs, pesticides, PCBs and metals; additional delineation of SB02, SB10, TP05 and OFS001
SB-221	Subsurface Soil	3-5'	X		X					To assess potential impacts to subsurface soil
SB-221	Subsurface Soil	6-8'	X		X					To assess potential impacts to subsurface soil
SB222	Surface Soil	0-1'	X		X				X	SI exceedance of SVOCs, pesticides, PCBs and metals; additional delineation of SB02, SB10 and OFS001
SB222	Subsurface Soil	3-5'	X		X				X	To assess potential impacts to subsurface soil
SB223	Subsurface Soil	6-8'	X		X				X	To assess potential impacts to subsurface soil
SB224	Surface Soil	0-1'	X		X				X	SI exceedance of SVOCs, pesticides, PCBs and metals; additional delineation of firing arcs
SB224	Subsurface Soil	3-5'	X		X				X	To assess potential impacts to subsurface soil
SB225	Surface Soil	0-1'	X		X				X	SI exceedance of SVOCs, pesticides, PCBs and metals; additional delineation of firing arcs
SB225	Subsurface Soil	3-5'	X		X				X	To assess potential impacts to subsurface soil
SB226	Surface Soil	0-1'	X		X				X	SI exceedance of SVOCs, pesticides, PCBs and metals; additional delineation of firing arcs
SB226	Subsurface Soil	3-5'	X		X				X	To assess potential impacts to subsurface soil
SB227	Surface Soil	0-1'	X		X				X	SI exceedance of SVOCs, pesticides, PCBs and metals; additional delineation of firing arcs
SB227	Subsurface Soil	3-5'	X		X				X	To assess potential impacts to subsurface soil
SB228	Surface Soil	0-1'	X		X					SI exceedance of SVOCs, pesticides, PCBs and metals; additional delineation of SB02, SB10, TP05 and OFS001
SB228	Subsurface Soil	3-5'	X		X					To assess potential impacts to subsurface soil
SB228	Subsurface Soil	6-8'	X		X					To assess potential impacts to subsurface soil
SB301	Surface Soil	0-1'	X		X					SI exceedance of SVOCs, pesticides, PCBs and metals; additional delineation of SB02, SB10 and TP05

Table 17-1  
Soil and Sediment Sampling Rationale Table  
Former Carr Point Shooting Range  
Carr Point, NAVSTA, Newport, RI

Proposed Sample Location	Media	Target Depth <sup>(1)</sup>	PAHs	Propellants	Metals	Hex Chromium <sup>(2)</sup>	Phys and Geochem Data <sup>(2),(3)</sup>	Pellet Count <sup>(4)</sup>	Qual Lead Pellet Assess <sup>(5)</sup>	Rationale
SB301	Subsurface Soil	3-5'	X		X					To assess potential impacts to subsurface soil
SB301	Subsurface Soil	6-8'	X		X					To assess potential impacts to subsurface soil
SB302	Surface Soil	0-1'	X		X					SI exceedance of PCBs; additional delineation of SB02
SB302	Subsurface Soil	3-5'	X		X					To assess potential impacts to subsurface soil
SB302	Subsurface Soil	6-8'	X		X					To assess potential impacts to subsurface soil
SB303	Surface Soil	0-1'	X		X					SI exceedance of SVOCs, pesticides, PCBs and metals; additional delineation of SB02, SB10, TP05 and SB03
SB303	Subsurface Soil	3-5'	X		X					To assess potential impacts to subsurface soils
SB303	Subsurface Soil	6-8'	X		X					To assess potential impacts to subsurface soils
OFS001	Surface Soil	0-1'	X		X					To assess potential impact to surface soil at the outfall
OFS001	Subsurface Soil	4-5'	X		X					To assess potential impact to subsurface soil at the outfall
SD101	Surface Sediment	0-0.5'	X		X			X		To assess potential impact from the outfall; SI exceedances of PAHs, metals and pellets; additional delineation of SD02
SD101	Subsurface Sediment	0.5-1'	X		X			X		To assess potential impact from the outfall; SI exceedances of PAHs, metals and pellets; additional delineation of SD02
SD101	Subsurface Sediment	1-2'	X		X			X		To assess potential impact from the outfall
SD101	Subsurface Sediment	2-3'	X		X			X		To assess potential impact from the outfall
SD102	Surface Sediment	0-0.5'	X		X			X		To assess potential impact from the outfall; exceedances of lead and pellets; additional delineation of SD05 and SD09
SD102	Subsurface Sediment	0.5-1'	X		X			X		To assess potential impact from the outfall; SI exceedances of lead and pellets; additional delineation of SD05 and SD09
SD102	Subsurface Sediment	1-2'	X		X			X		To assess potential impact from the outfall
SD102	Subsurface Sediment	2-3'	X		X			X		To assess potential impact from the outfall
SD103	Surface Sediment	0-0.5'	X		X			X		SI exceedances of lead and pellets; additional delineation of SD05
SD103	Subsurface Sediment	0.5-1'	X		X			X		SI exceedances of lead and pellets; additional delineation of SD05
SD103	Subsurface Sediment	1-2'	X		X			X		To assess potential impacts to deeper sediment
SD103	Subsurface Sediment	2-3'	X		X			X		To assess potential impacts to deeper sediment
SD104	Surface Sediment	0-0.5'	X		X			X		SI exceedances of lead and pellets; additional delineation of SD12
SD104	Subsurface Sediment	0.5-1'	X		X			X		SI exceedances of lead and pellets; additional delineation of SD12
SD104	Subsurface Sediment	1-2'	X		X			X		To assess potential impacts to deeper sediment
SD104	Subsurface Sediment	2-3'	X		X			X		To assess potential impacts to deeper sediment
SD105	Surface Sediment	0-0.5'	X		X			X		SI exceedances of lead and pellets; additional delineation of SD17
SD105	Subsurface Sediment	0.5-1'	X		X			X		SI exceedances of lead and pellets; additional delineation of SD17
SD105	Subsurface Sediment	1-2'	X		X			X		To assess potential impacts to deeper sediment
SD105	Subsurface Sediment	2-3'	X		X			X		To assess potential impacts to deeper sediment
SD106	Surface Sediment	0-0.5'	X		X			X		SI exceedances of lead and pellets; additional delineation of SD17
SD106	Subsurface Sediment	0.5-1'	X		X			X		SI exceedances of lead and pellets; additional delineation of SD17
SD106	Subsurface Sediment	1-2'	X		X			X		To assess potential impacts to deeper sediment
SD106	Subsurface Sediment	2-3'	X		X			X		To assess potential impacts to deeper sediment
SD107	Surface Sediment	0-0.5'	X		X			X		SI exceedances of lead and pellets; additional delineation of SD16 and SD17
SD107	Subsurface Sediment	0.5-1'	X		X			X		SI exceedances of lead and pellets; additional delineation of SD16 and SD17
SD107	Subsurface Sediment	1-2'	X		X			X		To assess potential impacts to deeper sediment
SD107	Subsurface Sediment	2-3'	X		X			X		To assess potential impacts to deeper sediment
SD108	Surface Sediment	0-0.5'	X		X			X		SI exceedances of lead and pellets; additional delineation of SD19
SD108	Subsurface Sediment	0.5-1'	X		X			X		SI exceedances of lead and pellets; additional delineation of SD19
SD108	Subsurface Sediment	1-2'	X		X			X		To assess potential impacts to deeper sediment
SD108	Subsurface Sediment	2-3'	X		X			X		To assess potential impacts to deeper sediment
SD109	Surface Sediment	0-0.5'	X		X			X		SI exceedances of lead and pellets; additional delineation of SD19
SD109	Subsurface Sediment	0.5-1'	X		X			X		SI exceedances of lead and pellets; additional delineation of SD19
SD109	Subsurface Sediment	1-2'	X		X			X		To assess potential impacts to deeper sediment
SD109	Subsurface Sediment	2-3'	X		X			X		To assess potential impacts to deeper sediment
SD110	Surface Sediment	0-0.5'	X		X			X		SI exceedances of lead and pellets; additional delineation of SD19
SD110	Subsurface Sediment	0.5-1'	X		X			X		SI exceedances of lead and pellets; additional delineation of SD19

Table 17-1  
Soil and Sediment Sampling Rationale Table  
Former Carr Point Shooting Range  
Carr Point, NAVSTA, Newport, RI

Proposed Sample Location	Media	Target Depth <sup>(1)</sup>	PAHs	Propellants	Metals	Hex Chromium <sup>(2)</sup>	Phys and Geochem Data <sup>(2),(3)</sup>	Pellet Count <sup>(4)</sup>	Qual Lead Pellet Assess <sup>(5)</sup>	Rationale
SD110	Subsurface Sediment	1-2'	X		X			X		To assess potential impacts to deeper sediment
SD110	Subsurface Sediment	2-3'	X		X			X		To assess potential impacts to deeper sediment
SD111	Surface Sediment	0-0.5'	X		X			X		SI exceedances of lead and pellets; additional delineation of SD13 and SD14
SD111	Subsurface Sediment	0.5-1'	X		X			X		SI exceedances of lead and pellets; additional delineation of SD13 and SD14
SD111	Subsurface Sediment	1-2'	X		X			X		To assess potential impacts to deeper sediment
SD111	Subsurface Sediment	2-3'	X		X			X		To assess potential impacts to deeper sediment
SD112	Surface Sediment	0-0.5'	X		X			X		SI exceedances of lead and pellets; additional delineation of SD13
SD112	Subsurface Sediment	0.5-1'	X		X			X		SI exceedances of lead and pellets; additional delineation of SD13
SD112	Subsurface Sediment	1-2'	X		X			X		To assess potential impacts to deeper sediment
SD112	Subsurface Sediment	2-3'	X		X			X		To assess potential impacts to deeper sediment
SD113	Surface Sediment	0-0.5'	X		X			X		SI exceedances of lead and pellets; additional delineation of SD13
SD113	Subsurface Sediment	0.5-1'	X		X			X		SI exceedances of lead and pellets; additional delineation of SD13
SD113	Subsurface Sediment	1-2'	X		X			X		To assess potential impacts to deeper sediment
SD113	Subsurface Sediment	2-3'	X		X			X		To assess potential impacts to deeper sediment
SD114	Surface Sediment	0-0.5'	X		X			X		SI exceedances of lead and pellets; additional delineation of SD1C
SD114	Subsurface Sediment	0.5-1'	X		X			X		SI exceedances of lead and pellets; additional delineation of SD1C
SD114	Subsurface Sediment	1-2'	X		X			X		To assess potential impacts to deeper sediment
SD114	Subsurface Sediment	2-3'	X		X			X		To assess potential impacts to deeper sediment
SD115	Surface Sediment	0-0.5'	X		X			X		SI exceedances of lead and pellets; additional delineation of SD06
SD115	Subsurface Sediment	0.5-1'	X		X			X		SI exceedances of lead and pellets; additional delineation of SD06
SD115	Subsurface Sediment	1-2'	X		X			X		To assess potential impacts to deeper sediment
SD115	Subsurface Sediment	2-3'	X		X			X		To assess potential impacts to deeper sediment
SD116	Surface Sediment	0-0.5'	X		X			X		SI exceedances of PAHs, metals and pellets; additional delineation of SD01
SD116	Subsurface Sediment	0.5-1'	X		X			X		SI exceedances of PAHs, metals and pellets; additional delineation of SD01
SD116	Subsurface Sediment	1-2'	X		X			X		To assess potential impacts to deeper sediment
SD116	Subsurface Sediment	2-3'	X		X			X		To assess potential impacts to deeper sediment
SD117	Surface Sediment	0-0.5'	X		X			X		SI exceedances of PAHs, metals and pellets; additional delineation of SD01 and SD02
SD117	Subsurface Sediment	0.5-1'	X		X			X		SI exceedances of PAHs, metals and pellets; additional delineation of SD01 and SD02
SD117	Subsurface Sediment	1-2'	X		X			X		To assess potential impacts to deeper sediment
SD117	Subsurface Sediment	2-3'	X		X			X		To assess potential impacts to deeper sediment
SD118	Surface Sediment	0-0.5'	X		X			X		SI exceedances of lead and pellets; confirmation of levels within the firing area
SD118	Subsurface Sediment	0.5-1'	X		X			X		SI exceedances of lead and pellets; additional sampling within target area
SD118	Subsurface Sediment	1-2'	X		X			X		To assess potential impacts to deeper sediment
SD118	Subsurface Sediment	2-3'	X		X			X		To assess potential impacts to deeper sediment
SD119	Surface Sediment	0-0.5'	X		X			X		SI exceedances of lead and pellets; confirmation of levels within the firing area
SD119	Subsurface Sediment	0.5-1'	X		X			X		SI exceedances of lead and pellets; additional sampling within overshoot area
SD119	Subsurface Sediment	1-2'	X		X			X		To assess potential impacts to deeper sediment
SD119	Subsurface Sediment	2-3'	X		X			X		To assess potential impacts to deeper sediment
SD120	Surface Sediment	0-0.5'	X		X			X		SI exceedances of lead and pellets; confirmation of levels within the firing area
SD120	Subsurface Sediment	0.5-1'	X		X			X		SI exceedances of lead and pellets; additional sampling within overshoot area
SD120	Subsurface Sediment	1-2'	X		X			X		To assess potential impacts to deeper sediment
SD120	Subsurface Sediment	2-3'	X		X			X		To assess potential impacts to deeper sediment
SD121	Surface Sediment	0-0.5'	X		X			X		SI exceedances of lead and pellets; confirmation of levels within the firing area
SD121	Subsurface Sediment	0.5-1'	X		X			X		SI exceedances of lead and pellets; additional sampling within overshoot area
SD121	Subsurface Sediment	1-2'	X		X			X		To assess potential impacts to deeper sediment
SD121	Subsurface Sediment	2-3'	X		X			X		To assess potential impacts to deeper sediment
SD122	Surface Sediment	0-0.5'	X		X			X		SI exceedances of PAHs, metals and pellets; additional delineation between shoreline and SD01 and SD02
SD122	Subsurface Sediment	0.5-1'	X		X			X		SI exceedances of PAHs, metals and pellets; additional delineation between shoreline and SD01 and SD02

Table 17-1  
Soil and Sediment Sampling Rationale Table  
Former Carr Point Shooting Range  
Carr Point, NAVSTA, Newport, RI

Proposed Sample Location	Media	Target Depth <sup>(1)</sup>	PAHs	Propellants	Metals	Hex Chromium <sup>(2)</sup>	Phys and Geochem Data <sup>(2),(3)</sup>	Pellet Count <sup>(4)</sup>	Qual Lead Pellet Assess <sup>(5)</sup>	Rationale
SD122	Subsurface Sediment	1-2'	X		X			X		SI exceedances of PAHs, metals and pellets; additional delineation between shoreline and SD01 and SD02
SD122	Subsurface Sediment	2-3'	X		X			X		SI exceedances of PAHs, metals and pellets; additional delineation between shoreline and SD01 and SD02
SD123	Surface Sediment	0-0.5'	X		X			X		SI exceedances of PAHs, metals and pellets; additional delineation between shoreline and SD01 and SD02
SD123	Subsurface Sediment	0.5-1'	X		X			X		SI exceedances of PAHs, metals and pellets; additional delineation between shoreline and SD01 and SD02
SD123	Subsurface Sediment	1-2'	X		X			X		SI exceedances of PAHs, metals and pellets; additional delineation between shoreline and SD01 and SD02
SD123	Subsurface Sediment	2-3'	X		X			X		SI exceedances of PAHs, metals and pellets; additional delineation between shoreline and SD01 and SD02
SD124	Surface Sediment	0-0.5'	X		X			X		SI exceedances of PAHs, metals and pellets; additional delineation between shoreline and SD01 and SD02
SD124	Subsurface Sediment	0.5-1'	X		X			X		SI exceedances of PAHs, metals and pellets; additional delineation between shoreline and SD01 and SD02
SD124	Subsurface Sediment	1-2'	X		X			X		SI exceedances of PAHs, metals and pellets; additional delineation between shoreline and SD01 and SD02
SD124	Subsurface Sediment	2-3'	X		X			X		SI exceedances of PAHs, metals and pellets; additional delineation between shoreline and SD01 and SD02

Notes:

(1) - Subsurface soil sample depths may be modified in the field based on actual field conditions (i.e., field screening, soil types, depth to water). In addition, sediment samples will be collected at depth as possible. Previous investigations met refusal in several locations at approximately 5 to 6 inches below grade.

(2) - The specific samples for analysis of hexavalent chromium and physical and geochemical parameters have not yet been determined. It is expected to be a well-distributed subset of soil and sediment samples.

(3) - Physical/geochemical analysis consists of TOC, grain size, pH, bulk density, porosity and conductivity for soil and TOC, AVS/SEM and grain size for sediment. Physical/geochemical analysis will be conducted on a subset of samples based on matrix and field conditions (i.e, sample depth, strata type, field screening, etc.).

(4) - Evaluation of lead pellets may not be necessary in all samples at depth, depending on results of shallower samples.

(5) - The qualitative lead pellet assessment will be performed in the field during soil sample observation and description.

Site Investigation (SI) exceedances are based Tetra Tech's 2010 SI Report and were identified as concentrations elevated above the SI project action limits (PALs) and/or risk-based screening criteria, as identified in the SI.

Surface sediment samples to be submitted for toxicity testing and macroinvertebrate sampling will be selected based on a review of the analytical chemistry results for those samples. The analytical chemistry results will be used to select ten locations that represent a range of metals, PAH, and lead pellet concentrations.

It should be noted that historically, Tetra Tech only assessed sediment samples from the target area for PAHs and based on PALs identified in the SI, identified two locations with PAH exceedances (refer to Figure 5). As described in this SAP, sediment samples will be collected for PAHs analysis at the proposed locations; however, it is possible that samples from the overshoot area will be held for analysis pending the results of the proposed samples in the target area.

Hand auger, macrocore or split-spoon samples will be collected during overburden drilling at all proposed soil boring and monitoring well locations for soil descriptions and PID headspace screening.

Surface soils (1-2') will be collected from a subset of of boring locations within the firing arcs. Although samples are included at locations SB209, SB211, SB212, SB213, SB217, SB218, and SB220, final selection of samples will be performed in the field.

Table 17-2  
 Well Construction and Groundwater Sampling Rationale Table  
 Former Carr Point Shooting Range  
 Carr Point, NAVSTA, Newport, RI

Groundwater Monitoring Well	Status	Screened Interval (ft bgs)	Bedrock Surface (ft bgs) <sup>(1)</sup>	Ground Surface Elevation (ft) <sup>(2)</sup>	Bedrock Surface Elevation (ft) <sup>(2)</sup>	PAHs	Metals	Hex Chromium <sup>(3)</sup>	Phys and Geochem Data <sup>(3),(4)</sup>	Rationale
MW-1	Existing	5 - 15	28.5	16.9	-11.6	X	X			SI exceedance of metals; additional groundwater data collection
MW-1D	Proposed	24 - 29	28.5	16.9	-11.6	X	X			Determine groundwater conditions on bedrock surface, and measure vertical gradients.
MW-11	Proposed	5 - 15	NA	NA	NA	X	X			SI exceedance of metals; additional groundwater data collection
MW-12	Proposed	5 - 15	39.5	16	-23.5 (7)	X	X			SI exceedance of metals; additional groundwater data collection
MW-12D	Proposed	35 - 40	39.5	16	-23.5 (7)	X	X			Determine groundwater conditions on deepest bedrock surface, and measure vertical gradients.
MW-13	Proposed	8 - 18	NA	NA	NA	X	X			Delineation of existing well network; potential upgradient reference point

Notes:

(1) - Bedrock surface estimated based on split-spoon refusal depths noted on SI boring logs.

(2) - Site Reference - Reference elevation is unclear. SI: "relative elevation of each monitoring well was determined by a State of Rhode Island registered land surveyor."

(3) - The specific samples for analysis of hexavalent chromium and physical and geochemical parameters have not yet been determined. It is expected to be a well-distributed subset of groundwater samples.

(4) - Physical/geochemical analysis consists of salinity, alkalinity, anions (chloride, nitrate/nitrite, ortho-phosphate-p, sulfate), TOC, methane/ethane/ethene and TSS/TDS.

Proposed well screen intervals to be adjusted during installation based on field observations.

Split-spoon samples will be collected during overburden drilling at all proposed soil boring and monitoring well locations for soil descriptions and PID headspace screening.

Ground surface elevation estimated for MW-12 and MW-12D.

**SAP Worksheet #18-1: Location-Specific Sampling Methods/SOP Requirements Table, Former Carr Point Shooting Range (MRP Site 1, OU9)**

[\(UFP-QAPP Manual Section 3.1.1\)](#)

Sampling Location / ID Number	Matrix	Depth (units)	Analytical Group	Number of Samples	Sampling SOP Reference
Refer to attached figures for proposed sampling locations; refer to Worksheet #27 for nomenclature protocols	Soil	0 – 12 feet	PAHs, metals	89	3-17 Direct Push Sampling Technique, 3-21 Surface and Subsurface Soil Sampling, 3-33 Subsurface Soil Sampling by Split Spoon
			TOC, grain size, pH, bulk density, porosity, conductivity, hexavalent chromium	14	
			Propellants (Nitroaromatics & Nitroamines)	14	
Refer to attached figures for proposed sampling locations; refer to Worksheet #27 for nomenclature protocols	Groundwater	Mid-screen	PAHs, metals	6	3-14 Monitoring Well Sampling
			TOC, TSS/TDS, alkalinity, chloride, nitrate/nitrite, sulfate, ortho-phosphate-P, methane/ethane/ethene, hexavalent chromium, salinity (lab)	2	
			Salinity, ORP, DO, pH, conductivity, turbidity, ferrous iron (all field)	6	
Refer to attached figures for proposed sampling locations; refer to Worksheet #27 for nomenclature protocols	Sediment	0 – 3 feet	PAHs, metals, pellet count	96	3-22 Sediment Sampling, 3-30 Sediment Field Sieving and Pellet Removal, 3-32 Sediment Coring Using a Vibracore Sampler, 3-36 Benthic Grab Sampling, 3-38 Shellfish Tissue Sampling
			Hexavalent chromium, TOC, AVS/SEM, grain size	15	
			Toxicity Testing and Macroinvertebrate Analysis	10	
Refer to attached figures for proposed sampling locations; refer to Worksheet #27 for nomenclature protocols	Tissue (Shellfish)	N/A	PAHs, metals, percent lipids	15	-22 Sediment Sampling, 3-30 Sediment Field Sieving and Pellet Removal, 3-32 Sediment Coring Using a Vibracore Sampler, 3-36 Benthic Grab Sampling, 3-38 Shellfish Tissue Sampling

**SAP Worksheet #18-2: Location-Specific Sampling Methods/SOP Requirements Table, Background/Reference Sediment Sample Locations**

[\(UFP-QAPP Manual Section 3.1.1\)](#)

Sampling Location / ID Number	Matrix	Depth (units)	Analytical Group	Number of Samples	Sampling SOP Reference
Refer to attached Figure 6 for proposed sampling locations; refer to Worksheet #27 for nomenclature protocols	Sediment	0 – 3 feet	PAHs, pesticides, metals	48	3-22 Sediment Sampling, 3-32 Sediment Coring Using a Vibracore Sampler, 3-36 Benthic Grab Sampling, 3-38 Shellfish Tissue Sampling
			Hexavalent chromium, TOC, AVS/SEM, grain size	8	
			Toxicity Testing and Macroinvertebrate Analysis, VOCs, SVOCs, PCBs	3	

**SAP Worksheet #19: Field Sampling Requirements Table<sup>1</sup>**

[\(UFP-QAPP Manual Section 3.1.1\)](#)

Matrix	Analytical Group <sup>2</sup>	Analytical and Preparation Method / SOP Reference <sup>3</sup>	Containers (number, size, and type) <sup>7</sup>	Sample Volume (units) <sup>4</sup>	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time <sup>5</sup> (preparation / analysis)
Soil	Polynuclear Aromatic Hydrocarbons (Full Scan and Selected Ion Monitoring)	SW846 3540C or 3550C, 8270D SIM / CA-213, CA-226, CA-512, CA-526	One 4-oz amber glass wide-mouth jar	30 g	Cool to ≤ 6 °C; store in the dark	14 days to extraction, 40 days to analysis
	Nitroaromatics and Nitramines	SW846 3535, 8330A / CA-402, CA-548	One 2-oz amber glass wide-mouth jar	10 g	Cool to ≤ 6 °C;	Nitroaromatics and Nitramines
	ICP-AES Metals	SW846 3050B, 6010C / CA-605, CA-608	One 2-oz wide-mouth glass jar	2 g	None	6 months to analysis
	ICP-MS Metals	SW846 3050B, 6020A / CA-605, CA-627	One 2-oz wide-mouth glass jar	2 g	None	6 months to analysis
	Mercury (CVAA)	SW846 7471B / CA-611	One 2-oz wide-mouth glass jar	0.6 g	Cool to ≤ 6 °C	28 days to analysis
	Hexavalent Chromium	SW846 3060A/7196A/CA-625 W/contingency for SW846 3060A/7199/ GEN-3060/GEN-7199	Two 4 oz and one 2-oz wide-mouth glass jar	2.5 g (Cr only)	Cool to ≤ 6 °C	7196A: 30 days to extraction; 24 hrs to analysis 7199: 30 days until digestion; 7 days until pH adjustment and analysis
	Total Organic Carbon (Method 9060M)	SW846 9060 / CA-763	One 2-oz wide-mouth amber glass jar	0.5 g	Cool to ≤ 6 °C; store in the dark	28 days to analysis
	Grain Size (Sieve Only)	ASTM D 422-63 / BR-GT-006, Rev. 6 and BR-GT-008	One 16 oz wide-mouth glass or HDPE jar	500 g	None	None

Matrix	Analytical Group <sup>2</sup>	Analytical and Preparation Method / SOP Reference <sup>3</sup>	Containers (number, size, and type) <sup>7</sup>	Sample Volume (units) <sup>4</sup>	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time <sup>5</sup> (preparation / analysis)
Soil (continued)	Bulk Density	ASTM D 2937-04 / BR-GT-018, Rev. 5	Tube - Undisturbed Material (Per Method) or Glass or Plastic - Bulk Material (Lab to Remold)	500 g	None	None
	Total Porosity (Calc. From Bulk Density and Specific Gravity)	ASTM D 854-06 – Method B / BR-GT-004, Rev. 6	One 16 oz wide-mouth glass Jar w/ Teflon Lid	500 g	None	None
	pH	SW846 9045D / CA-709	One 2-oz wide-mouth amber jar	20g	Cool to ≤ 6 ° C; store in the dark	As soon as possible
	Conductivity	SM2510B / CA-744		10 g	Cool to ≤ 6 ° C; store in the dark	28 Days to analysis
Sediment	Polynuclear Aromatic Hydrocarbons (Full Scan and Selected Ion Monitoring)	SW8463540C or 3550C,e 8270D SIM / CA-213, CA-226, CA-512, CA-526	One 4-oz amber glass wide-mouth jar	30 g	Cool to ≤ 6 ° C; store in the dark	14 days to extraction, 40 days to analysis <sup>8</sup>
	ICP-AES Metals	SW846 3050B, 6010C/CA-605, CA-608	One 2-oz wide-mouth glass jar	2 g	None	6 months to analysis <sup>8</sup>
	ICP-MS Metals	SW846 3050B, 6020A/CA-605, CA-627	One 2-oz wide-mouth glass jar	2 g	None	6 months to analysis <sup>8</sup>
	Mercury	SW846 7471A/CA-611	One 2-oz wide-mouth glass jar	0.6 g	Cool to ≤ 6 ° C	28 days to analysis <sup>8</sup>

Matrix	Analytical Group <sup>2</sup>	Analytical and Preparation Method / SOP Reference <sup>3</sup>	Containers (number, size, and type) <sup>7</sup>	Sample Volume (units) <sup>4</sup>	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time <sup>5</sup> (preparation / analysis)
Sediment (continued)	Hexavalent Chromium	SW846 3060A/7196A/CA-625 W/contingency for SW846 3060A/7199/ GEN-3060/GEN-7199	Two 4 oz and one 2-oz wide-mouth glass jar	2.5 g (Cr only)	Cool to ≤ 6 °C	7196A: 30 days to extraction; 24 hrs to analysis 7199: 30 days until digestion; 7 days until pH adjustment and analysis
	TOC	Lloyd Kahn/CA-741	One 2-oz wide-mouth glass jar	0.5 g	Cool to ≤ 6 °C	28 days to analysis
	AVS-SEM	USEPA 376.3/CA-738	One 2-oz wide-mouth glass jar	10g	Fill jar completely with sediment; protected from oxygen; Cool to ≤ 6 °C	14 days to analysis
	Grain Size (Sieve Only)	ASTM D 422-63 / BR-GT-006, Rev. 6 and BR-GT-008	One 16 oz wide-mouth glass or HDPE jar	500 g	None	None
	Pellet Counting	RC SOP 3-30/CA-774	Double zip-seal bags (freezer-style)	Not Applicable	Cool to ≤ 6 °C	None
	Sediment Toxicity Testing	USEPA 600/R-01/020, <i>Methods for Assessing the Chronic Toxicity of Marine and Estuarine Sediment-associated Contaminants with the Amphipod, Leptocheirus plumulosus</i> / ESI SOP QA-1448	1-2 Gallon Plastic (See sample volume note)	1 Gallon (See Note 4)	2 - 6°C	8 Weeks
	Macroinvertebrate Community Survey	Benthic Infaunal Sample Processing SOP/ Wet-Weight Biomass Analysis SOP	1-liter, polypropylene jar	0.04m <sup>2</sup> grab	10% buffered formalin	None
Groundwater	Polynuclear Aromatic Hydrocarbons (Selected Ion Monitoring)	SW846 3510C or 3520C, 8270D SIM / CA-213, CA-502	Two 1-L wide-mouth amber glass bottles	1000 ml	Cool to ≤ 6 °C; store in the dark	7 days to extraction 40 days to analysis
	ICP-AES Metals	SW846 3010A, 6010C / CA-604, CA-608	One 250-ml wide-mouth HDPE bottle	50 ml	HNO <sub>3</sub> to pH<2	6 months to analysis

Matrix	Analytical Group <sup>2</sup>	Analytical and Preparation Method / SOP Reference <sup>3</sup>	Containers (number, size, and type) <sup>7</sup>	Sample Volume (units) <sup>4</sup>	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time <sup>5</sup> (preparation / analysis)
Groundwater (continued)	ICP-MS Metals	SW846 3010A, 6020A / CA-604, CA-627	One 250-ml wide-mouth HDPE bottle	50 ml	HNO <sub>3</sub> to pH<2	6 months to analysis
	Mercury (CVAA)	SW7470A / CA-615	One 250-ml wide-mouth HDPE bottle	25 ml	HNO <sub>3</sub> to pH<2	28 days to analysis
	Hexavalent Chromium	SW846 7196A/ CA-772	One 250-ml wide-mouth HDPE bottle	2 ml	Cool to ≤ 6 °C	24 hrs to analysis
	Salinity (Laboratory)	SM-2520B / CA-748	One 100-ml wide-mouth HDPE bottle	10 ml	Cool to ≤ 6 °C	14 days to analysis
	Alkalinity	SM 2320 B / CA-739	One 100-ml wide-mouth HDPE bottle	50 ml	Settled; Cool to ≤ 6 °C	14 days to analysis
	Anions (Chloride, Nitrate, Nitrite, Ortho-phosphate-P, Sulfate)	USEPA 300.0 / CA-742	One 100-ml wide-mouth HDPE bottle	1 ml	Cool to ≤ 6 °C	48 hours (nitrate, nitrite and orthophosphate) / 28 days (sulfate and chloride) to analysis
	Total Organic Carbon (Method 9060)	SM 9060 / CA-763	Two 40-ml VOA vials	40 ml	Cool to ≤ 6 °C	28 days to analysis
	Methane, Ethane, Ethene	RSK-175 / CA-336	Two 40-ml VOA vial	40 ml	HCl, pH <2; Cool to ≤ 6 °C; no headspace	14 days to analysis
	Total Dissolved Solids	SM 2540C / CA-719	One 250-ml wide-mouth HDPE bottle	100 ml	Cool to ≤ 6 °C	7 days to analysis
Total Suspended Solids	SM 2540 D / CA-720	One 500-ml wide-mouth HDPE bottle	250 ml	Cool to ≤ 6 °C	7 days to analysis	
Tissue	Polynuclear Aromatic Hydrocarbons (Selected Ion Monitoring)	EPA SW-846 8270D / SVM-8270P	One 4-oz amber glass wide-mouth jar	50 grams	Freeze to ≤10°C	1 year

Matrix	Analytical Group <sup>2</sup>	Analytical and Preparation Method / SOP Reference <sup>3</sup>	Containers (number, size, and type) <sup>7</sup>	Sample Volume (units) <sup>4</sup>	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time <sup>5</sup> (preparation / analysis)
Tissue (continued)	ICP-AES Metals	EPA SW-846 6010C / SOP MET-ICP	One 4-oz amber glass wide-mouth jar	50 grams	Freeze to ≤10°C	1 year
	ICP-MS Metals	EPA SW-846 6020A / SOP MET-ICPMS	One 4-oz amber glass wide-mouth jar	50 grams	Freeze to ≤10°C	1 year
	Mercury (CVAF)	EPA 1631E / MET-1631	One 4-oz amber glass wide-mouth jar	50 grams	Freeze to ≤10°C	1 year
	Percent Lipid	EXT-Lipid	One 4-oz amber glass wide-mouth jar	50 grams	Freeze to ≤10°C	1 year
Background Sediment	Polynuclear Aromatic Hydrocarbons (Full Scan and Selected Ion Monitoring)	SW8463540C or 3550C,e 8270D SIM / CA-213, CA-226, CA-512, CA-526	One 4-oz amber glass wide-mouth jar	30 g	Cool to ≤ 6 °C; store in the dark	14 days to extraction, 40 days to analysis <sup>8</sup>
	ICP-AES Metals	SW846 3050B, 6010C/CA-605, CA-608	One 2-oz wide-mouth glass jar	2 g	None	6 months to analysis <sup>8</sup>
	ICP-MS Metals	SW846 3050B, 6020A/CA-605, CA-627	One 2-oz wide-mouth glass jar	2 g	None	6 months to analysis <sup>8</sup>
	Mercury	SW846 7471A/CA-611	One 2-oz wide-mouth glass jar	0.6 g	Cool to ≤ 6 °C	28 days to analysis <sup>8</sup>
	Hexavalent Chromium	SW846 3060A/7196A/CA-625 W/contingency for SW846 3060A/7199/ GEN-3060/GEN-7199	Two 4 oz and one 2-oz wide-mouth glass jar	2.5 g (Cr only)	Cool to ≤ 6 °C	7196A: 30 days to extraction; 24 hrs to analysis 7199: 30 days until digestion; 7 days until pH adjustment and analysis

Matrix	Analytical Group <sup>2</sup>	Analytical and Preparation Method / SOP Reference <sup>3</sup>	Containers (number, size, and type) <sup>7</sup>	Sample Volume (units) <sup>4</sup>	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time <sup>5</sup> (preparation / analysis)
Background Sediment (continued)	TOC	Lloyd Kahn/CA-741	One 2-oz wide-mouth glass jar	0.5 g	Cool to ≤ 6 ° C	28 days to analysis
	AVS-SEM	USEPA 376.3/CA-738	One 2-oz wide-mouth glass jar	10g	Fill jar completely with sediment; protected from oxygen; Cool to ≤ 6 ° C	14 days to analysis
	Grain Size (Sieve Only)	ASTM D 422-63 / BR-GT-006, Rev. 6 and BR-GT-008	One 16 oz wide-mouth glass or HDPE jar	500 g	None	None
	Sediment Toxicity Testing	USEPA 600/R-01/020, <i>Methods for Assessing the Chronic Toxicity of Marine and Estuarine Sediment-associated Contaminants with the Amphipod, Leptocheirus plumulosus</i> / ESI SOP QA-1448	1-2 Gallon Plastic (See sample volume note)	1 Gallon (See Note 4)	2 - 6°C	8 Weeks
	Macroinvertebrate Community Survey	Benthic Infaunal Sample Processing SOP/ Wet-Weight Biomass Analysis SOP	1-liter, polypropylene jar	0.04m <sup>2</sup> grab	10% buffered formalin	None
	Volatile Organic Compounds (Full Scan)	SW-846 5035, 8260B / CA-202, CA-214	Three 40-ml VOA vials	5 g	5 ml reagent water; Cool to ≤ 6 ° C; store in the dark	48 hours to freezing at --7°C, 14 days to analysis
			One 40-ml VOA vial	5 g	5 ml methanol; Cool to ≤ 6 ° C; store in the dark	14 days to analysis
			One 2-oz wide-mouth glass jar for percent moisture	5 g	Cool to ≤ 6 ° C	NA
Volatile Organic Compounds (Selected Ion Monitoring)	SW846 8260 (SIM) / CA-220	Three 40-ml VOA vials	5 g	5 ml reagent water; Cool to ≤ 6 ° C	48 hours to freezing at --7°C, 14 days to analysis	

Matrix	Analytical Group <sup>2</sup>	Analytical and Preparation Method / SOP Reference <sup>3</sup>	Containers (number, size, and type) <sup>7</sup>	Sample Volume (units) <sup>4</sup>	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time <sup>5</sup> (preparation / analysis)
Background Sediment (continued)	Semivolatile Organic Compounds and Polynuclear Aromatic Hydrocarbons (Full Scan)	SW-846 3540C, 3546 or 3550C, 8270D / CA-204, CA-512, CA-526, CA-549	One 4-oz amber glass wide-mouth jar	30 g	Cool to ≤ 6 °C; store in the dark	14 days to extraction, 40 days to analysis <sup>8</sup>
	Organochlorine Pesticides	SW846 3540C, 3546, 3550C, 8081B / CA-329, CA-500, CA-524, CA-549	One 4-oz wide-mouth amber glass jar	30 g	Cool to ≤ 6 °C; store in the dark	14 days to extraction, 40 days to analysis <sup>8</sup>
	Polychlorinated Biphenyls (Aroclors)	SW846 3540C, 3546, 3550C, 8082A / CA-329, CA-500, CA-524, CA-549	One 4-oz wide-mouth amber glass jar	30 g	Cool to ≤ 6 °C; store in the dark	30 days to extraction; 40 days to analysis <sup>6,8</sup>

Notes:

- Only analyses that will be submitted to a fixed laboratory are included. Field analyses for water quality parameters (DO, ORP, temperature, specific conductance), salinity, and ferrous iron will be analyzed immediately.
- Refer to Worksheet #15 for specific target analytes.
- Refer to the Analytical SOP References table (Worksheet #23).
- Minimum sample volume requirement.
- Maximum holding time is calculated from the time the sample is collected to the time the sample is extracted, digested or analyzed.
- All bottles and jars will have Teflon™ lined lids.
- Freezing will be used to extend holding time up to one year. If sediment samples are frozen, holding time will be considered suspended until removal from the freezer. Once sample preparation begins the stated method holding times apply.

Abbreviations:

°C – Degrees Celcius  
 CVAA – Cold Vapor Atomic Absorption  
 g – grams  
 HCl – hydrochloric acid  
 VOA – volatile organic analysis  
 ICP-AES - Inductively Coupled Plasma Atomic Emission Spectroscopy

ICP-MS- Inductively Coupled Plasma Mass Spectrometry  
 ml – milliliter  
 oz - ounce  
 HDPE – high-density polyethylene  
 HNO<sub>3</sub> - nitric acid

**SAP Worksheet #20: Field Quality Control Sample Summary Table, Former Carr Point Shooting Range, MRP Site 1 (OU9)**

(UFP-QAPP Manual Section 3.1.1)

Soil Characterization														
Matrix/Analytical Group	Analytical Method	FIELD SAMPLES				LABORATORY SAMPLES			PER ROUND (No. of)			No. of Rounds	TOTALS	
		Field Samples	Equipment Blank <sup>1</sup>	Trip Blanks <sup>2</sup>	Field Duplicates <sup>3</sup>	MS <sup>4</sup>	MSD <sup>4</sup>	MD <sup>5</sup>	Field Samples <sup>6</sup>	Field Days <sup>8</sup>	SDGs <sup>7,8</sup>		No. of SDGs <sup>7</sup>	No. of Field Samples <sup>6,8</sup>
<i>Soil</i>														
Polycyclic Aromatic Hydrocarbons	SW846 8270D	89	4	--	9	5	5	--	102	4	6	1	6	102
Polynuclear Aromatic Hydrocarbons (Selected Ion Monitoring)	SW846 8270D (SIM)	89	4	--	9	5	5	--	102	4	6	1	6	102
ICP-MS Metals	SW846 6020A	89	4	--	9	5	--	5	102	4	6	1	6	102
ICP-AES Metals	SW846 6010C	89	4	--	9	5	--	5	102	4	6	1	6	102
Mercury (CVAA)	SW846 7471B	89	4	--	9	5	--	5	102	4	6	1	6	102
Hexavalent Chromium	SW-846 Method 7196	14	4	--	2	1	--	1	20	4	4	1	4	20
Nitroaromatics and Nitramines (Propellants)	SW-846 Method 8330A	14	4	--	2	1	--	1	20	4	4	1	4	20

Supplemental Soil Characterization														
Matrix/Parameter	Analytical Method	FIELD SAMPLES				LABORATORY SAMPLES			PER ROUND			No. of Rounds	TOTALS	
		Field Samples	Equipment Blank <sup>1</sup>	Trip Blanks <sup>2</sup>	Field Duplicates <sup>3</sup>	MS <sup>4</sup>	MSD <sup>4</sup>	MD <sup>5</sup>	Field Samples <sup>6</sup>	Field Days <sup>8</sup>	SDGs <sup>7,8</sup>		No. of SDGs <sup>7</sup>	No. of Field Samples <sup>6,8</sup>
<i>Soil</i>														
Grain Size (Sieve Only)	ASTM D 422-63	14	--	--	2	--	--	--	16	4	4	1	2	16
Bulk Density	ASTM D 2937-04	14	--	--	2	--	--	--	16	4	4	1	2	16
Total Porosity (Calc. From Bulk Density and Specific Gravity)	ASTM D 854-06 – Method B	14	--	--	2	--	--	--	16	4	4	1	2	16
pH	SW846 9045D	14	--	--	2	--	--	1	16	4	4	1	2	16
Total Organic Carbon (Method 9060M)	SW846 9060 Modified	14	--	--	2	1	--	1	16	4	4	1	2	16
Conductivity	SM2510B / CA-744	14	--	--	2	--	--	1	16	4	4	1	2	16

Groundwater Investigation														
Matrix/Parameter	Analytical Method	FIELD SAMPLES				LABORATORY SAMPLES			PER ROUND			No. of Rounds	TOTALS	
		Field Samples	Equipment Blank <sup>1</sup>	Trip Blanks <sup>2</sup>	Field Duplicates <sup>3</sup>	MS <sup>4</sup>	MSD <sup>4</sup>	MD <sup>5</sup>	Field Samples <sup>6</sup>	Field Days <sup>8</sup>	SDGs <sup>7,8</sup>		No. of SDGs <sup>7</sup>	No. of Field Samples <sup>6,8</sup>
<i>Groundwater</i>														
Polycyclic Aromatic Hydrocarbons	SW846 8270D	6	2	--	1	1	1	--	9	1	1	2	2	18
Polynuclear Aromatic Hydrocarbons (Selected Ion Monitoring)	SW846 8270D (SIM)	6	2	--	1	1	1	--	9	1	1	2	2	18
ICP-MS Metals	SW846 6020A	6	2	--	1	1	--	1	9	1	1	2	2	18
ICP-AES Metals	SW846 6010C	6	2	--	1	1	--	1	9	1	1	2	2	18
Mercury (CVAA)	SW846 7470A	6	2	--	1	1	--	1	9	1	1	2	2	18
Hexavalent Chromium	SW-846 Method 7196	2	2	--	1	1	--	1	5	1	1	2	2	10
Salinity (Laboratory)	SM2520B	2	2	--	1	--	--	1	5	1	1	1	1	5
Salinity (Field)	RC Procedure 3-14	6	--	--	--	--	--	--	6	1	1	2	2	12
pH, ORP, DO, Spec. Cond. (Field)	RC Procedure 3-24	6	--	--	--	--	--	--	6	1	1	2	2	12
Turbidity (Field)	RC Procedure 3-24	6	--	--	1	--	--	--	7	1	1	2	2	14

Supplemental Groundwater Characterization														
Matrix/Parameter	Analytical Method	FIELD SAMPLES				LABORATORY SAMPLES			PER ROUND			No. of Rounds	TOTALS	
		Field Samples	Equipment Blank <sup>1</sup>	Trip Blanks <sup>2</sup>	Field Duplicates <sup>3</sup>	MS <sup>4</sup>	MSD <sup>4</sup>	MD <sup>5</sup>	Field Samples <sup>6</sup>	Field Days <sup>8</sup>	SDGs <sup>7,8</sup>		No. of SDGs <sup>7</sup>	No. of Field Samples <sup>6,8</sup>
<i>Groundwater</i>														
Alkalinity	SM2320B	2	--	--	1	1	--	1	3	1	1	1	1	3
Anions (Chloride, Nitrate, Nitrite, Ortho-phosphate-P, Sulfate)	SW846 9056A	2	--	--	1	1	1	1	3	1	1	1	1	3
Total Organic Carbon (Method 9060)	SW846 9060	2	--	--	1	1	--	1	3	1	1	1	1	3
Methane/Ethane/Ethene	RSK-175	2	--	--	1	1	1	--	3	1	1	1	1	3
Total Suspended Solids	SM 2540 D	2	--	--	1	--	--	1	3	1	1	1	1	3
Total Dissolved Solids	SM 2540C	2	--	--	1	--	--	1	3	1	1	1	1	3
Ferrous Iron (Field)	RC Procedure 3-18	6	--	--	1	--	--	1	7	1	1	1	1	7

Sediment Investigation														
Matrix/Parameter	Analytical Method	FIELD SAMPLES				LABORATORY SAMPLES			PER ROUND			No. of Rounds	TOTALS	
		Field Samples	Equipment Blank <sup>1</sup>	Trip Blanks <sup>2</sup>	Field Duplicates <sup>3</sup>	MS <sup>4</sup>	MSD <sup>4</sup>	MD <sup>5</sup>	Field Samples <sup>6</sup>	Field Days <sup>8</sup>	SDGs <sup>7,8</sup>		No. of SDGs <sup>7</sup>	No. of Field Samples <sup>6,8</sup>
<i>Sediment</i>														
Polycyclic Aromatic Hydrocarbons	SW846 8270D	96	15	--	10	5	5	--	121	4.5	7	1	7	121
Polynuclear Aromatic Hydrocarbons (Selected Ion Monitoring)	SW846 8270D (SIM)	96	15	--	10	5	5	--	121	4.5	7	1	7	121
ICP-MS Metals;	SW846 6020A	96	15	--	10	5	--	5	121	4.5	7	1	7	121
ICP-AES Metals	SW846 6010C	96	15	--	10	5	--	5	121	4.5	7	1	7	121
Mercury	SW846 7471B	96	15	--	10	5	--	5	121	4.5	7	1	7	121
Hexavalent Chromium	SW-846 Method 7196	15	15	--	10	5	--	5	40	4.5	5	1	5	40

Supplemental Sediment Characterization														
Matrix/Parameter	Analytical Method	FIELD SAMPLES				LABORATORY SAMPLES			PER ROUND			No. of Rounds	TOTALS	
		Field Samples	Equipment Blank <sup>1</sup>	Trip Blanks <sup>2</sup>	Field Duplicates <sup>3</sup>	MS <sup>4</sup>	MSD <sup>4</sup>	MD <sup>5</sup>	Field Samples <sup>6</sup>	Field Days <sup>8</sup>	SDGs <sup>7,8</sup>		No. of SDGs <sup>7</sup>	No. of Field Samples <sup>6,8</sup>
<i>Sediment</i>														
Total Organic Carbon (Lloyd Kahn)	Lloyd Kahn	15	--	--	2	1	--	1	17	2	2	1	2	17
Acid Volatile Sulfide/Simultaneously Extracted Metals	EPA 821/R-91-100	15	--	--	2	1	--	1	17	2	2	1	2	17
Grain Size (Sieve Only)	ASTM D 422-63	15	--	--	2	--	--	--	17	2	2	1	2	17

Sediment Lead Pellet Assessment														
Matrix/Parameter	Analytical Method	FIELD SAMPLES				LABORATORY SAMPLES			PER ROUND			No. of Rounds	TOTALS	
		Field Samples	Equipment Blank <sup>1</sup>	Trip Blanks <sup>2</sup>	Field Duplicates <sup>3</sup>	MS <sup>4</sup>	MSD <sup>4</sup>	MD <sup>5</sup>	Field Samples <sup>6</sup>	Field Days <sup>8</sup>	SDGs <sup>7,8</sup>		No. of SDGs <sup>7</sup>	No. of Field Samples <sup>6,8</sup>
<i>Sediment</i>														
Pellet Counting	RC Procedure TBD/ CA-774-00	96	--	--	10	--	--	--	106	4.5	6	1	6	106
Lead Particle Size Distribution	TBD	TBD	--	--		--	--	TBD	TBD	TBD	TBD	1	TBD	TBD

Sediment Ecological Risk Investigation														
Matrix/Parameter	Analytical Method	FIELD SAMPLES				LABORATORY SAMPLES			PER ROUND			No. of Rounds	TOTALS	
		Field Samples	Equipment Blank <sup>1</sup>	Trip Blanks <sup>2</sup>	Field Duplicates <sup>3</sup>	MS <sup>4</sup>	MSD <sup>4</sup>	MD <sup>5</sup>	Field Samples <sup>6</sup>	Field Days <sup>8</sup>	SDGs <sup>7,8</sup>		No. of SDGs <sup>7</sup>	No. of Field Samples <sup>6,8</sup>
<i>Sediment</i>														
Sediment Toxicity Testing	28-day <i>Leptocheirus plumulosus</i>	10	--	--	--	--	--	--	10	2	2	1	2	10
Macroinvertebrate Community Survey	USEPA RPB Modified	10	--	--	10	--	--	--	20	2	2	1	2	20

Tissue Investigation														
Matrix/Parameter	Analytical Method	FIELD SAMPLES				LABORATORY SAMPLES			PER ROUND			No. of Rounds	TOTALS	
		Field Samples	Equipment Blank <sup>1</sup>	Trip Blanks <sup>2</sup>	Field Duplicates <sup>3</sup>	MS <sup>4</sup>	MSD <sup>4</sup>	MD <sup>5</sup>	Field Samples <sup>6</sup>	Field Days <sup>8</sup>	SDGs <sup>7,8</sup>		No. of SDGs <sup>7</sup>	No. of Field Samples <sup>6,8</sup>
<i>Tissue</i>														
Polynuclear Aromatic Hydrocarbons (Selected Ion Monitoring)	SW846 8270D (SIM)	15	--	--	2	1	1	--	17	2	2	1	2	17
ICP-MS Metals;	SW846 6020A	15	--	--	2	1	--	1	17	2	2	1	2	17
ICP-AES Metals	SW846 6010C	15	--	--	2	1	--	1	17	2	2	1	2	17
Mercury	EPA Method 1631E	15	--	--	2	1	--	1	17	2	2	1	2	17
Percent Lipids	USEPA 2000 / Bligh & Dyer 1959	15	--	--	2	--	--	1	17	2	2	1	2	17

Background Sediment Investigation

Matrix/Parameter	Analytical Method	FIELD SAMPLES				LABORATORY SAMPLES			PER ROUND			No. of Rounds	TOTALS	
		Field Samples	Equipment Blank <sup>1</sup>	Trip Blanks <sup>2</sup>	Field Duplicates <sup>3</sup>	MS <sup>4</sup>	MSD <sup>4</sup>	MD <sup>5</sup>	Field Samples <sup>6</sup>	Field Days <sup>8</sup>	SDGs <sup>7,8</sup>		No. of SDGs <sup>7</sup>	No. of Field Samples <sup>6,8</sup>
<b>Sediment</b>														
Polycyclic Aromatic Hydrocarbons	SW846 8270D	48	36	--	5	3	3	--	89	12	12	1	12	89
Polynuclear Aromatic Hydrocarbons (Selected Ion Monitoring)	SW846 8270D (SIM)	48	12	--	5	3	3	--	65	4	4	1	4	65
ICP-MS Metals;	SW846 6020A	48	12	--	5	3	--	3	65	4	4	1	4	65
ICP-AES Metals	SW846 6010C	48	12	--	5	3	--	3	65	4	4	1	4	65
Mercury	SW846 7471B	48	12	--	5	3	--	3	65	4	4	1	4	65
Organochlorine Pesticides	SW846 8081B	8	0	--										
Hexavalent Chromium	SW-846 Method 7196	8	8	--	1	1	--	1	17	8	8	1	8	17

**Supplemental Background Sediment Characterization**

Matrix/Parameter	Analytical Method	FIELD SAMPLES				LABORATORY SAMPLES			PER ROUND			No. of Rounds	TOTALS	
		Field Samples	Equipment Blank <sup>1</sup>	Trip Blanks <sup>2</sup>	Field Duplicates <sup>3</sup>	MS <sup>4</sup>	MSD <sup>4</sup>	MD <sup>5</sup>	Field Samples <sup>6</sup>	Field Days <sup>9</sup>	SDGs <sup>7,8</sup>		No. of SDGs <sup>7</sup>	No. of Field Samples <sup>6,8</sup>
<b>Sediment</b>														
Total Organic Carbon (Lloyd Kahn)	Lloyd Kahn	48	--	--	5	3	--	3	53	4	4	1	4	53
Acid Volatile Sulfide/Simultaneously Extracted Metals	EPA 821/R-91-100	48	--	--	5	3	--	3	53	4	4	1	4	53
Grain Size (Sieve Only)	ASTM D 422-63	48	--	--	5	--	--	--	53	4	4	1	4	53

**SAP Worksheet #21: Project Sampling SOP References Table**

[\(UFP-QAPP Manual Section 3.1.2\)](#)

Reference Number	Title, Revision Date and / or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Y/N)	Comments
3-01	Utility Clearance	Resolution	Ground Penetrating Radar, Air Knife	N	
3-02	Log Books	Resolution		N	
3-03	Record Keeping, Sample Labeling, and Chain-of-Custody	Resolution		N	
3-04	Sampling Handling, Storage and Shipping	Resolution		N	
3-05	IDW Management	Resolution		N	
3-06	Equipment Decontamination	Resolution		N	
3-07	Land Surveying	Resolution	GPS	N	
3-12	Monitoring Well Installation	Resolution	Direct-push or HSA Drill Rig	N	
3-13	Monitoring Well Development	Resolution	Surge Block, Bailer, Submersible Pump, Oil Water Interface Probe	N	
3-14	Monitoring Well Sampling	Resolution	YSI, Turbidity Meter, Peristaltic Pump, Oil Water Interface Probe	N	
3-16	Soil and Rock Classification	Resolution		N	
3-17	Direct Push Sampling Techniques	Resolution	Direct-push Drill Rig	N	
3-18	Field Analysis of Ferrous Iron HACH	Resolution	HACH Ferrous Iron Field Kit	N	
3-19	Headspace Screening for Total VOCs	Resolution	PID	N	
3-20	Operation and Calibration of a PID	Resolution	PID	N	
3-21	Surface and Subsurface Soil Sampling	Resolution	Direct-push or HSA Drill Rig	N	
3-22	Sediment Sampling	Resolution	Grab/Hand Sampler, GPS	N	

<b>Reference Number</b>	<b>Title, Revision Date and / or Number</b>	<b>Originating Organization of Sampling SOP</b>	<b>Equipment Type</b>	<b>Modified for Project Work? (Y/N)</b>	<b>Comments</b>
3-24	Water Quality Parameter Testing	Resolution	YSI, Turbidity Meter, Peristaltic Pump	N	
3-30	Sediment Field Sieving and Pellet Removal	Resolution		N	
3-32	Sediment Coring Using a Vibracore Sampler	Resolution	Vibracore Sampler	N	
3-33	Subsurface Soil Sampling by Split Spoon	Resolution	Hollow Stem Auger Drill Rig	N	
3-35	Hydraulic Conductivity Testing	Resolution		N	
3-36	Benthic Grab Sampling	Resolution	Grab Sampler	N	
3-38	Shellfish Tissue Sampling	Resolution	Grab Sampler	N	

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

[\(UFP-QAPP Manual Section 3.1.2.4\)](#)

<b>Field Equipment</b>	<b>Activity</b>	<b>Frequency</b>	<b>Acceptance Criteria</b>	<b>Corrective Action</b>	<b>Resp. Person</b>	<b>SOP Reference</b>	<b>Comments</b>
YSI Water Quality Meter	Calibration	Daily before use.	pH reads 4 DO and temperatures, consistent with current atmospheric pressure and ambient temperature.	Clean sensors with deionized water and calibrate again. Do not use instrument if not able to calibrate properly	Field Team Lead	3-24 Water Quality Parameter Testing	
Turbidity Meter	Calibration	Daily before use. and before each sample	0.00 NTU, or blank standard	Wipe tubes and chamber. Test blank three times to ensure consistent readings of 0.00. Do not use instrument if not able to calibrate properly.	Field Team Lead	3-24 Water Quality Parameter Testing	
Ferrous Iron Field Kit	Calibration	Daily before use.	0.0 mg/L ferrous iron in blank	Clean sample cell and recalibrate.	Field Team Lead	3-18 Field Analysis of Ferrous Iron HACH	
Photoionization Detector	Calibration	Daily before use, every 20 readings, or anytime unstable readings occur.	Isobutylene reads 100 ppm	Inspect connections to ensure proper seal. Calibrate again. Do not use instrument if not able to calibrate properly	Field Team Lead	3-20 Operation and Calibration of a PID	

**SAP Worksheet #23-1: Analytical SOP References Table<sup>1</sup>**

[\(UFP-QAPP Manual Section 3.2.1\)](#)

Laboratory Name and Address: Katahdin Analytical Services (Please refer to Worksheet #30 for Contact Information)

Lab SOP Number	Title, Revision Date, and Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Variance to QSM	Modified for Project Work? (Y/N)
CA-213	Analysis of Semivolatile Organic Compounds By: SW 846 Method 8270 – Modified For Selected Ion Monitoring (SIM), 05/12, Revision 10.	Definitive	Soil, Sediment, Groundwater / PAHs	GC/MS	No Variance	N
CA-226	Analysis of SVOAs by Capillary Column GC/MS: SW-846 Method 8270D, 01/12 Revision 3.	Definitive	Soil, Sediment, Groundwater / PAHs	GC/MS	No Variance	N
CA-302	Analysis of Pesticides by Gas Chromatography/Electron Capture Detector (GC/ECD): SW-846 Method 8081. 06/11, Revision 12.	Definitive	Soil, Sediment, Groundwater / Pesticides	Gas Chromatography (GC)/ Electron Capture Detector (ECD)	No Variance	N
CA-329	Analysis Of PCBs As Total Aroclors By Gas Chromatography/Electron Capture Detector (GC/ECD): SW-846 Method 8082, 07/11, Revision 12.	Definitive	Soil, Sediment, Groundwater / PCBs	GC/ECD	No Variance	N
CA-336	Dissolved Gas Analysis In Water Samples Using GC Headspace Equilibration Technique USEPA SOP RSK-175, 07/11, Rev. 5.	Definitive	Groundwater / MEE	GC/FID	No Variance	N

Lab SOP Number	Title, Revision Date, and Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Variance to QSM	Modified for Project Work? (Y/N)
CA-402	Determination Of Nitroaromatics And Nitramines By HPLC Method 8330, 01/12, Revision 6	Definitive	Soil, Sediment / Explosives	HPLC	No Variance	N
CA-502	Preparation Of Aqueous Samples For Extractable Semivolatile Analysis, 04/12, Revision 7.	Definitive	Groundwater / PAHs	Not applicable (extraction)	No Variance	N
CA-512	Preparation Of Sediment/Soil Samples By Sonication Using Method 3550 For Subsequent Extractable Semi-Volatiles Analysis, 04/12, Revision 9.	Definitive	Soil, Sediment / PAHs	Not applicable (extraction)	No Variance	N
CA-526	Preparation Of Sediment/Soil Samples By Soxhlet Extraction Using Method 3540 For Subsequent Extractable Semivolatile Analysis, 04/12, Revision 8.	Definitive	Soil, Sediment / PAHs	Not applicable (extraction)	No Variance	N
CA-548	Preparation of Aqueous and Solid Samples for Explosive Analysis by Method 8330, 02/12, Revision 0.	Definitive	Soil, Sediment / Explosives	Not applicable (extraction)	No Variance	N
CA-604	Acid Digestion of Aqueous Samples by USEPA Method 3010 for ICP Analysis of Total or Dissolved Metals, 04/10, Revision 5.	Definitive	Groundwater / TAL Metals	Not applicable (digestion)	No Variance	N
CA-605	Acid Digestion of Solid Samples by USEPA Method 3050 for Metals by ICP-AES and GFAA, 09/10, Revision 5.	Definitive	Soil, Sediment / TAL Metals	Not applicable (digestion)	No Variance	N

Lab SOP Number	Title, Revision Date, and Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Variance to QSM	Modified for Project Work? (Y/N)
CA-608	Trace Metals Analysis By ICP-AES Using USEPA Method 6010, 04/12, Revision 13.	Definitive	Soil, Sediment, Groundwater / TAL Metals	Inductively Coupled Plasma (ICP) – Atomic Emission Spectroscopy (AES)	No Variance	N
CA-611	Digestion and Analysis of Solid Samples for Mercury by USEPA Method 7471, 04/12, Revision 9.	Definitive	Soil, Sediment / Mercury	Mercury Analyzer	No Variance	N
CA-615	Digestion and Analysis of Aqueous Samples for Mercury by USEPA Method 7470, 04/12, Revision 7.	Definitive	Groundwater / Mercury	Mercury Analyzer	No Variance	N
CA-625	Alkaline Digestion and Subsequent Determination of Hexavalent Chromium In Solid Samples Using EPA SW846 Methods 3060 and 7196, 04/12, Revision 5.	Definitive	Soil, Sediment / Hexavalent Chromium	Manual Spectrophotometer	No Variance	N
CA-627	Trace Metals Analysis By ICP-MS Using USEPA Method 6020, 04/12, Revision 8.	Definitive	Soil, Sediment, Groundwater / TAL Metals	ICP-MS	No Variance	N
CA-709	pH Concentration Measurements In Soil Matrices – SW 846 Method 9045, 05/12, Revision 9.	Definitive	Soil / pH	pH Meter	No Variance	N
CA-719	Total Dissolved Solids (Filterable Residue) by USEPA Method 160.1 and Standard Methods 2540 C, 05/12, Revision 7.	Definitive	Groundwater / Total Dissolved Solids	Balance	No Variance	N

Lab SOP Number	Title, Revision Date, and Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Variance to QSM	Modified for Project Work? (Y/N)
CA-720	Total Suspended Solids (Non-Filterable Residue) by USEPA Method 160.2 and Standard Methods 2540 D, 05/12, Revision 7.	Definitive	Groundwater / Total Suspended Solids	Balance	No Variance	N
CA-738	Determination of Acid Volatile Sulfide and Simultaneously Extractable Metals in Sediments, 05/12, Revision 3.	Definitive	Sediment / Acid Volatile Sulfide and Simultaneously Extractable Metals	Buret – Acid Volatile sulfides ICP – Simultaneously Extractable Metals	No Variance	N
CA-739	Titrimetric Determination of Total Alkalinity by USEPA Method 310.1 and SM 2320 B using the Mettler DI25 Autotitrator, and Calculation of the Component Forms of Alkalinity by SM 4500–CO <sub>2</sub> D, 05/12, Revision 9.	Definitive	Groundwater / Alkalinity	Autotitrator	No Variance	N
CA-741	Determination of Total Organic Carbon in Solids Using the USEPA Region II Lloyd Kahn Method, 06/10, Revision 4.	Definitive	Sediment / Total Organic Carbon	Total Organic Carbon Analyzer	No Variance	N
CA-742	Anions by Ion Chromatography (IC) – Method 300.0, 06/12, Revision 9.	Definitive	Groundwater / Anions	Ion Chromatograph	No Variance	N
CA-744	Conductivity at 25 °C by USEPA Method 120.1 and Standard Methods 2510B, 06/10, Revision 3.	Definitive	Soil / Conductivity	Conductivity Meter	No Variance	N
CA-748	Practical Salinity – Electrical Conductivity Method, 08/09, Revision 2.	Definitive	Groundwater / Salinity	Conductivity Meter	No Variance	N

Lab SOP Number	Title, Revision Date, and Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Variance to QSM	Modified for Project Work? (Y/N)
CA-763	Analysis of TOC, DOC, and TIC in Aqueous Samples using the Shimadzu Carbon Analyzer: USEPA Method 415.1, SW846 9060 and SM5310B, 05/12, Revision 7.	Definitive	Soil, Groundwater / Total Organic Carbon	Total Organic Carbon Analyzer	No Variance	N
CA-772	Colorimetric Analysis Of Hexavalent Chromium Using The Automated Konelab Multiwavelength Photometric Analyzer, 02/13, Revision 3.	Definitive	Groundwater / Hexavalent Chromium	Automated Spectrophotometer	No Variance	N
CA-774	Shot Count	Definitive	Sediment	None	Not Applicable	N

Notes:

1. Lab Accreditation and Certification requirements and verification for the work of this project are presented on Worksheet #30.

**SAP Worksheet #23-2: Analytical SOP References Table<sup>1</sup>**

[\(UFP-QAPP Manual Section 3.2.1\)](#)

Laboratory Name and Address: TestAmerica Burlington (Please refer to Worksheet #30 for Contact Information)

Lab SOP Number	Title, Revision Date, and Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Variance to QSM	Modified for Project Work? (Y/N)
BR-GT-004	Specific Gravity of Soil Solids by Water Pycnometer (ASTM D 854-06 – Method B) SOP No. BR-GT-004, Rev 6, 03/22/10	Screening	Solid / Sediments Geotechnical"	NA	Not determined	N
BR-GT-006	Particle Size Analysis (ASTM D 2217 and D422-63) SOP No. BR-GT-006, Rev 6, 03/17/10"	Screening	Solid / Sediments Geotechnical"	NA	Not determined	N
BR-GT-008	Calibration/Verification Procedures for GEO Equipment SOP No. BR-GT-008, Rev 5, 06/24/11"	Screening	Solid / Sediments Geotechnical"	NA	Not determined	N
BR-GT-018	Density in Soils by Drive Cylinder Method (ASTM D2937-04) SOP No. BR-GT-018, Rev 5, 06/21/10	Screening	Solid / Sediments Geotechnical"	NA	Not determined	N

Notes:

1. Lab Accreditation and Certification requirements and verification for the work of this project are discussed on Worksheet #30.

**SAP Worksheet #23-3: Analytical SOP References Table<sup>1</sup>**

[\(UFP-QAPP Manual Section 3.2.1\)](#)

Laboratory Name and Address: Resolution (Please refer to Worksheet #30 for Contact Information)<sup>2</sup>

Lab SOP Number	Title, Revision Date, and Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Variance to QSM	Modified for Project Work? (Y/N)
AECOM-SOP-1	Benthic Infaunal Sample Processing, Rev 0, October 2012	Screening	Benthic invertebrates	Taxonomic identification of benthic invertebrates	Not determined	N
AECOM-SOP-2	Wet-Weight Biomass Analysis	Screening	Benthic invertebrates	Scale	Not determined	N

Notes:

1. Lab Accreditation and Certification requirements and verification for the work of this project are presented on Worksheet #30.
2. Analytical SOPs are presented on this table for the Macroinvertebrate Community Survey.

**SAP Worksheet #23-4: Analytical SOP References Table<sup>1</sup>**

[\(UFP-QAPP Manual Section 3.2.1\)](#)

Laboratory Name and Address: EnviroSystems, Incorporated (Please refer to Worksheet #30 for Contact Information)

Lab SOP Number	Title, Revision Date, and Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Variance to QSM	Modified for Project Work? (Y/N)
QA-1448	Chronic Toxicity of Sediments to the Amphipod, <i>Leptocheirus plumulosus</i> February 2012 Revision Number 11	Definitive	Sediment	NA	No variance	N

Notes:

1. Lab Accreditation and Certification requirements and verification for the work of this project are presented on Worksheet #30.

**SAP Worksheet #23-5: Analytical SOP References Table<sup>1</sup>**

[\(UFP-QAPP Manual Section 3.2.1\)](#)

Laboratory Name and Address: ALS Environmental, Kelso, WA (Please refer to Worksheet #30 for Contact Information)

Lab SOP Number	Title, Revision Date, and Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Variance to QSM	Modified for Project Work? (Y/N)
SVM-8270P	PAHs by GC/MS-SIM Rev 8	Definitive	Tissue	GC/MS	No variance	N
EXT-3541	Soxhlet Ext Rev 7	Definitive	Tissue	Soxhlet	No variance	N
MET-6020	Metals by EPA 6020 Rev 14	Definitive	Tissue	ICP-MS	No variance	N
MET-ICP	Metals by EPA 6010 Rev 24	Definitive	Tissue	ICP-OES	No variance	N
MT-DIG	Metals prep Rev 3	Definitive	Tissue	various	No variance	N
MET-1631	Hg by EPA 1631 Rev 12	Definitive	Tissue	CVAFS	No variance	N
EXT-Lipids	Percent Lipids in Tissue Rev 3	Definitive	Tissue	Balance	No variance	N

Notes:

1. Lab Accreditation and Certification requirements and verification for the work of this project are presented on Worksheet #30.

**SAP Worksheet #23-6: Analytical SOP References Table<sup>1</sup>**

[\(UFP-QAPP Manual Section 3.2.1\)](#)

Laboratory Name and Address: ALS Environmental, Rochester NY (Please refer to Worksheet #30 for Contact Information)

Lab SOP Number	Title, Revision Date, and Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Variance to QSM	Modified for Project Work? (Y/N)
GEN-7199	Hexavalent Chromium by Ion Chromatography, Rev. 5, 6/7/12	Definitive	Groundwater, Soil	IC	None	No
GEN-3060	Alkaline Digestion for Hexavalent Chromium in Soil, Rev. 3, 3/1/13	Prep	Soil	Prep	None	No

Notes:

1. Lab Accreditation and Certification requirements and verification for the work of this project are presented on Worksheet #30.

## SAP Worksheet #24: Analytical Instrument Calibration Table

[\(UFP-QAPP Manual Section 3.2.2\)](#)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference
GC/MS (Full Scan and SIM) PAHs	ICAL - A minimum 5-point calibration is required for all SVOCs.	Instrument receipt, instrument change (new column, source cleaning, etc.), when CCV is out of criteria. Six-point initial calibration for all analytes.	The average RF for SPCCs must be $\geq 0.050$ ;  The %RSD for RFs for CCCs must be $\leq 30\%$ , and one option below must be met: Option 1) %RSD $< 15\%$ for all compounds. If not met: Option 2) Linear least squares regression: $r \geq 0.995$ Option 3) Non-linear regression: $r^2 \geq 0.99$ (6 points for second order).	Recalibrate and/or perform the necessary equipment maintenance. Check the calibration standards. Reanalyze the affected data.	Analyst, Department Manager	CA-213, CA-226, SVM-8270P
	Breakdown Check	At the beginning of each 12-hour period, prior to analysis of samples.	Degradation $\leq 20\%$ for DDT. Benzidine and pentachlorophenol should be present at their normal responses, and should not exceed a tailing factor of 2.	Correct problem then repeat breakdown check.		
	ICV	Once after each ICAL.	The %R must be within 80-120% for all project compounds.	Correct problem and verify second source standard. Rerun second source verification. If that fails, correct problem and repeat ICAL.	Analyst, Department Manager	
	CCV	Analyze a standard at the beginning of each 12-hour shift after a decafluorotriphenylphosphine (DFTPP) tune.	The average RF for SPCCs must be $\geq 0.050$ ;  The %D for all target compounds and surrogates must be $\leq 20\%D$ (D = Difference or Drift)	DoD project level approval must be obtained for each of the failed analytes or corrective action must be taken. Correct problem, then rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since last acceptable CCV.	Analyst, Department Manager	
	DFTPP Tune	Every 12 hours	Criteria listed in Section 7.4, current revision of SOPs CA-213 and CA-226	Retune and/or clean source.	Analyst, Department Manager	

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference
GC/FID-Methane, Ethane, Ethene	ICAL	Instrument receipt, major instrument change, when CCV does not meet criteria	Average %RSD must be $\leq 30$	Recalibrate and/or perform necessary equipment maintenance. Check calibration standards. Reanalyze affected data.	Analyst, Supervisor	CA-336
	ICV	Immediately following calibration.	The %D of the expected value must be $\leq 25\%$ for all analytes.	Correct problem, rerun ICV. If that fails, repeat ICAL.	Analyst, Department Manager	
	CCV	If initial calibration analyzed, daily and after 20 samples, and at end of sequence.	%D for all analytes within 30%	Evaluate the samples: If the %RPD $> 30\%$ and sample results are $< \text{PQL}$ , narrate. If %RPD $> 30\%$ and is likely a result of matrix interference, narrate. Otherwise, reanalyze all samples after last acceptable CV.		CA-336
HPLC Explosives	ICAL - 7-point calibration of all explosives	Instrument receipt, major instrument change, when CV does not meet criteria.	7 point calibration – correlation coefficient $(r) \geq 0.995$ or $(r)^2 \geq 0.990$	Repeat Initial calibration and/or perform necessary equipment maintenance. Check calibration standards. Reanalyze affected data.	Analyst, Department Manager	CA-402
	ICV	Once after initial calibration.	%R must within 85%-115% for all project compounds.	Correct problem, rerun ICV. If that fails, repeat ICAL.	Analyst, Department Manager	
	CCV	After every 10 samples; If calibration curve previously analyzed, analyze daily before samples.	%D must be $\leq 15\%$ for all project compounds.	Correct problem, then rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since the last successful calibration verification.	Analyst, Department Manager	
ICP-AES – Metals	ICAL	At the beginning of each day or if QC is out of criteria.	One point calibration plus a blank per manufacturer's guidelines.	Recalibrate and/or perform necessary equipment maintenance. Check calibration standards.	Analyst, Department Manager	CA-608 / MET-ICP

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference
	ICV	Once after each ICAL, prior to beginning a sample run.	%R must be within 90-110% for all project compounds.	Correct problem and verify second source standard. Rerun ICV. If that fails, correct problem and repeat ICAL.	Analyst, Department Manager	
	Calibration Blank (CB)	Before beginning a sample sequence, after every 10 samples and at end of the analysis sequence.	No analytes detected > LOD. For negative blanks, absolute value < LOD.	Correct problem. Re-prepare and reanalyze calibration blank. All samples following the last acceptable calibration blank must be reanalyzed.	Analyst, Department Manager	
	CCV	After every 10 samples and at the end of each run sequence.	%R must be within 90-110% for all project compounds.	Correct problem, rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since the last successful calibration verification.	Analyst, Department Manager	
	Low-level Calibration Check Standard (if using one-point ICAL)	Daily after one-point ICAL.	%R must within 80%-120% for all project compounds.	Correct problem, then reanalyze.	Analyst, Department Manager	
	ICS - ICSA & ICSB	Daily, before sample injections	ICSA recoveries must be less than the absolute value of the LOD and ICSB %Rs must be within 80-120%.	Correct the problem, then re-prepare checks and reanalyze all affected samples.	Analyst, Department Manager	
ICP-MS Metals	Tune	Daily prior to calibration.	Mass calibration must be within 0.1 atomic mass unit (amu) from the true value. Resolution must be <0.9 amu full width at 10% peak height. Four injections %RSD must be <5%.	Perform necessary equipment maintenance.	Analyst, Department Manager	CA-627
	ICAL - 4 point calibration plus blank	Daily prior to sample analysis.	Correlation coefficient (r) must be $\geq 0.995$ .	Recalibrate and/or perform necessary equipment maintenance. Check calibration standards.	Analyst, Department Manager	

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference
ICP-MS Metals (continued)	ICV	Once after each ICAL, and before beginning a sample run.	%R must be within 90-110% for all project compounds.	Correct problem and verify second source standard. Rerun ICV. If that fails, correct problem and repeat ICAL.	Analyst, Department Manager	CA-627
	CCB	Before beginning a sample sequence, after every 10 samples and at end of the analysis sequence. For negative blanks, absolute value < LOD.	No analytes detected > LOD.	Correct the problem, then re-prepare and reanalyze.	Analyst, Department Manager	
	CCV	After every 10 samples and at the end of each run sequence.	%R must be within 90-110% for all project compounds.	Correct problem, rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since the last successful calibration verification.	Analyst, Department Manager	
	Low-level calibration check standard	Daily after ICAL	Within $\pm 20\%$ of true value.	Correct problem, then reanalyze.	Analyst, Department Manager	
	ICS - ICSA & ICSB	Daily, before sample injections	ICSA recoveries must be less than the absolute value of the LOD <sup>(2)</sup> and ICSB %Rs must be within 80-120%.	Correct the problem, then re-prepare checks and reanalyze all affected samples.	Analyst, Department Manager	
Mercury analyzer	ICAL - 5 points plus a calibration blank	Upon instrument receipt, major instrument change, at the start of each day.	Correlation coefficient (r) must be $\geq 0.995$ .	Recalibrate and/or perform necessary equipment maintenance. Check calibration standards.	Analyst, Department Manager	CA-611, CA-615
	ICV	Once after each ICAL, prior to beginning a sample run.	%R must be within 90-110%	Correct problem and verify second source standard. Rerun ICV. If that fails, correct problem and repeat ICAL.	Analyst, Department Manager	
	CCB	Before beginning a sample sequence, after every 10 samples and at end of the analysis sequence. For negative blanks, absolute value < LOD.	No analytes detected > LOD.	Correct problem. Re-prepare and reanalyze calibration blank. All samples following the last acceptable calibration blank must be reanalyzed.	Analyst, Department Manager	

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference
Mercury analyzer (continued)	CCV	Beginning and end of each run sequence and every 10 samples.	%R must be within 80-120%	Correct problem, rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since the last successful calibration verification.	Analyst, Department Manager	CA-611, CA-615
Autotitrator / Alkalinity	CCV	One after every 10 samples	%R must within 80%-120%	(1) If the CCV fails high, report samples that are <PQL. (2) Recalibrate and/or reanalyze other samples.	Analyst, Department Manager	CA-739
Balance / Total Dissolved Solids, Total Suspended Solids,	Balance Verification	Every day before use.	0.0020 ± 0.0002 0.1000 ± 0.0005 1.0000 ± 0.0005 10.0000 ± 0.0005 50.0000 ± 0.0005 100.0000 ± 0.0005	Investigate problem. Do not use balance until verification has passed.	Analyst, Department Manager	CA-719, CA-720
Total Organic Carbon Analyzer / Total Organic Carbon	ICAL – Minimum of a 5-point calibration curve plus a blank is prepared.	Initially, when the daily CCV does not pass, but, no longer than every 3 months.	Correlation coefficient ≤ 0.995	Recalibrate and/or perform necessary equipment maintenance. Check calibration standards	Analyst, Department Manager	CA-763, CA-741
Total Organic Carbon Analyzer / Total Organic Carbon (continued)	ICV	Once after each ICAL, prior to beginning a sample run.	%R must within 80%-120%	If the ICV fails high, report samples that are <PQL. Redigest, recalibrate and/or reanalyze other samples.	Analyst, Department Manager	CA-763, CA-741
	CCV	Every 10 samples and at the end of the run	%R must within 80%-120%	If the CCV fails high, report samples that are <PQL. Recalibrate and/or reanalyze samples back to last acceptable CCV recovery.	Analyst, Department Manager	
Ion Chromatography / Chloride, Sulfate, ortho-Phosphorous, Nitrite, Nitrate	ICAL – A minimum of a 5-point calibration is prepared.	Prior to sample analysis.	R must be ≥0.995.	Correct problem and rerun calibration.	Analyst, Department Manager	CA-742

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference
Ion Chromatography / Chloride, Sulfate, ortho-Phosphorous, Nitrite, Nitrate (continued)	ICV	Once after each ICAL prior to sample analysis.	The %R must be within 90-110% of true value and retention times (RTs) must be within appropriate windows.	Correct problem and verify second source standard. Rerun second source verification. If that fails, correct problem and repeat ICAL.	Analyst, Department Manager	CA-742
	CCV	After every 10 samples and at the end of the sequence.	The %R must be within 90-110% of true value and all project analytes must be within established RT windows.	Correct problem, then rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since the last successful calibration verification.	Analyst, Department Manager	
Konelab – Hexavalent Chromium	ICAL – Minimum of a 5-point calibration curve plus a blank is prepared.	Daily ICAL prior to sample analysis.	Correlation coefficient (r) must be $\geq 0.995$ .	Correct problem, then repeat ICAL.	Analyst, Department Manager	CA-625, CA-772
	ICV	Once after each ICAL, prior to beginning a sample run.	The %R must be within 90-110% of true value	Correct problem and verify second source standard. Rerun second source verification. If that fails, correct problem and repeat ICAL.	Analyst, Department Manager	
	CCV	One after every 15 samples analyzed and at close of run	The %R must be within 90-110% of true value	Correct problem, then rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since the last successful calibration verification.	Analyst, Department Manager	
IC/UVVIS – Hexavalent Chromium (Contingency)	ICAL	Prior to sample analysis	Correlation Coefficient > 0.999	Correct problem then repeat ICAL	Analyst/Supervisor	GEN-7199
	ICV	After each ICAL	90-110% Recovery	Correct problem and verify second source standard. Rerun ICV. If that fails, correct problem and repeat ICAL.	Analyst/Supervisor	

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference
IC/UVVIS – Hexavalent Chromium (Contingency) (continued)	CCV	At the beginning of the analytical sequence; after each 10 field samples; at the end of the analytical sequence	90-110% Recovery	Correct problem, rerun CCV. If that fails, then repeat ICAL. Reanalyze all samples since the last acceptable CCV.	Analyst/Supervisor	GEN-7199
Spectrophotometer / AVS	ICAL – Minimum of a 5-point calibration curve plus a blank is prepared.	Prior to sample analysis	Linear Regression Correlation Coefficient $r \geq 0.995$	Investigate source of problem, Recalibrate	Analyst, Department Manager	CA-738
	ICV	One of each per prep batch	70-130 %R	Recalibrate and reanalyze sample batch	Analyst, Department Manager	
	CCV	At beginning of run, after every 10 samples and at the end of the run	80-120 %R	Reanalyze all samples back to last acceptable CCV recovery	Analyst, Department Manager	
Hydrometer ASTM D 422	Hydrometer Calibration	Once every two years	Critical dimension check of the hydrometer by measuring with digital calipers each critical dimension as provided.	If the hydrometer fails any check remove from service and notify supervisor.	Analyst	SOP BR-GT-008
Sieves ASTM D 422	Sieve Calibration	Once every six months	The openings must conform to requirements listed in Table 1 of BR-GT-008.	Label out of service and set aside.	Analyst	SOP BR-GT-008
Ro-Tap sieve shaker ASTM D 422	Ro-Tap sieve shaker Calibration	Once every twelve months	Per manufacturers' instructions	Per manufacturers' instructions	Analyst	SOP BR-GT-008
Conductivity, pH, Dissolved Oxygen Combination Meter	As per user manual and SOP	Start and end of day	For pH, Check Solution Second Standard $\pm 0.05$ SU	Correct problem and recalibrate	Staff Toxicologist / Department Manager	ESI SOP QA-1219
CVAFS EPA Methods 1631	Establish IDLs	Every 3 months	In accordance with manufacturer's recommendation or lab SOP.	Notify the manufacturer if problem occurs.	Certified instrument technician	MET-1631
	Calibrate using the multi-point standard calibration	Daily prior to analysis of sample	Correlation coefficient $\geq 0.995$ .	Correct problem then repeat initial calibration.	Lab Manager/Analyst or certified instrument technician	
	Establish linear dynamic range	Once every 6 months or when the system is repaired	The calculated value should be within $\pm 10\%$ of the true value.	Correct problem then repeat the calibration process.	Lab Manager/Analyst or certified instrument technician	
	Run second source calibration verification (ICV)	Once after standard calibration	$\pm 15\%$ of its true value.	Correct problem then repeat the calibration process.	Lab Manager/Analyst or certified instrument technician	MET-1631

<b>Instrument</b>	<b>Calibration Procedure</b>	<b>Frequency of Calibration</b>	<b>Acceptance Criteria</b>	<b>Corrective Action</b>	<b>Person Responsible for Corrective Action</b>	<b>SOP Reference</b>
CVAFS EPA Methods 1631 (continued)	Run CCV	Once every 10 samples	±15% of its true value.	Terminate analysis; recalibrate and reanalyze the samples.	Lab Manager/Analyst or certified instrument technician	
	Run CCB	Once every 10 samples	Less than the established lower limit of quantitation for any desired target analyte.	Terminate analysis; recalibrate and reanalyze the samples.	Lab Manager/Analyst or certified instrument technician	
	Instrument blank	Daily at beginning and end of day and every 20 field measurements	Less than instrument detection limit	Correct problem, repeat measurement. If acceptance criteria still cannot be met, re-zero instrument.	Field analyst	
	Duplicate (two consecutive readings)	10% of field measurements	RPD < 50%	Correct problem, repeat measurement.	Field analyst	

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

[\(UFP-QAPP Manual Section 3.2.3\)](#)

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
GC/MS PAHs (full scan and SIM)	Check pressure and gas supply daily. Manual tune if DFTPP not in criteria, change septa as needed, change liner as needed, cut column as needed. Other maintenance specified in lab Equipment Maintenance SOP.	SVOCs and PAHs	Ion source, injector liner, column, column flow.	Prior to ICAL and/or as necessary.	Acceptable calibration or CCV	Correct the problem and repeat calibration or CCV	Analyst, Department Manager	CA-213, CA-226, SVM-8270P
ICP-AES	Clean torch assembly and spray chamber when discolored or when degradation in data quality is observed. Clean nebulizer, check argon, replace peristaltic pump tubing as needed. Other maintenance specified in lab Equipment Maintenance SOP.	TAL Metals, Simultaneously Extracted Metals	Torch, nebulizer chamber, pump, pump tubing.	Prior to ICAL and as necessary.	Acceptable calibration or CCV	Correct the problem and repeat calibration or CCV	Analyst, Department Manager	CA-608, MET-ICP
ICP-MS	Clean torch assembly and spray chamber when discolored or when degradation in data quality is observed. Clean nebulizer, check argon, and replace peristaltic pump tubing as needed. Other maintenance specified in lab Equipment Maintenance SOP.	TAL Metals	Torch, nebulizer, spray chamber, pump tubing.	Prior to ICAL and as necessary	Acceptable calibration or CCV	Correct the problem and repeat calibration or CCV	Analyst, Department Manager	CA-627, MET-6020

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
Mercury Analyzer	Replace peristaltic pump tubing, replace mercury lamp, replace drying tube, clean optical cell and/or clean liquid/gas separator as needed. Other maintenance specified in lab Equipment Maintenance SOP.	Mercury	Tubing, sample probe, optical cell.	Prior to ICAL and as necessary	Acceptable calibration or CCV	Correct the problem and repeat calibration or CCV	Analyst, Department Manager	CA-611, CA-615, MET-1631
Autotitrator	Fill pH electrode as needed, clean stirring paddle weekly, fill rinse as needed.	Alkalinity	pH electrode, stirring paddle, reagent bottles.	As necessary	Acceptable CCV	Correct the problem reanalyze CCV.	Analyst, Department Manager	CA-739
Balance	Weights	Total Dissolved Solids, Total Suspended Solids	Cleanliness	Prior to sample weighing	Acceptable CCV	Correct the problem, reanalyze CCV.	Analyst, Department Manager	CA-719, CA-720
TOC Combustion Analyzer	Check level of dilution water, drain vessel water, humidifier water, auto sampler rinse water and phosphoric acid vessel and fill as needed. Replace oxygen cylinder.	Total Organic Carbon	Tubing, sample boat, syringe, humidifier, rinse reservoir, phosphoric acid vessel, oxygen pressure	Prior to initial calibration and as necessary	Acceptable calibration or CCV	Correct the problem and repeat calibration or CCV	Analyst, Department Manager	CA-763, CA-741
Ion Chromatograph	Check regenerate pump tubing and replace as needed. Clean or regenerate column as needed. Replace analytical column or guard column as needed. Change suppressor as needed.	Chloride, Sulfate, Ortho-Phosphorus, Nitrite, Nitrate	Tubing, column, suppressor.	Prior to initial calibration and/or as necessary.	Passing ICAL or CCV.	Correct problem and repeat calibration or CCV.	Analyst, Department Manager	CA-742
Probe - pH, Conductivity	Clean, drain, and refill reference electrode as needed.	pH, Conductivity	Reference electrode for white crystals, Inspect electrode for damage.	Before use	pH 7 ± 0.05 pH units (pH)	Correct problem and repeat calibration.	Analyst, Department Manager	CA-709, CA-744

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
HPLC	Check and sonicate pump valves as needed. Backflush column as needed. Replace analytical column or guard column as needed. Sonicate and replace solvent with every use. Replace the UV lamp as needed. Check and replace seal-pak as needed	Explosives	Column flow, pressure	<b>Prior to initial calibration and/or as necessary.</b>	Acceptable calibration or CCV	Correct the problem and repeat calibration or CCV	Analyst, Department Manager	CA-402
Konelab	Check and clean segments weekly, clean reagent tubes monthly. Change lamp, change diluent and wash tubes, change mixing paddles and syringes, change dispensing needle, all as needed.	Cyanide, Ammonia, ortho-Phosphorus, Hexavalent Chromium (Aq)	Reagent tubes, lamp, wash tubes, paddles, syringes, dispensing needles.	<b>Prior to initial calibration and/or as necessary.</b>	Acceptable calibration or CCV	Correct the problem and repeat calibration or CCV	Analyst, Department Manager	CA-625, CA-772
IC/UWVIS	Change column bed supports	Hexavalent Chromium	Change column bed supports	<b>monthly or as needed</b>	must meet initial and/or continuing calibration criteria	Repeat maintenance activity or remove from service	Analyst/Supervisor	GEN-7199
	Clean column	Hexavalent Chromium	Clean column	<b>monthly or as needed</b>	must meet initial and/or continuing calibration criteria	Repeat maintenance activity or remove from service	Analyst/Supervisor	
	Clean column	Hexavalent Chromium	Change column	<b>Every 6 months or as needed</b>	must meet initial and/or continuing calibration criteria	Repeat maintenance activity or remove from service	Analyst/Supervisor	
	Change tubing	Hexavalent Chromium	Change tubing	<b>Annually or as needed</b>	must meet initial and/or continuing calibration criteria	Repeat maintenance activity or remove from service	Analyst/Supervisor	
Hydrometer	Hydrometer Calibration	Per SOP	Per SOP	As needed	Per SOP	Per SOP	Laboratory Analyst	SOP BR-GT-008
Sieves	Sieve Calibration	Per SOP	Per SOP	As needed	Per SOP	Per SOP	Laboratory Analyst	SOP BR-GT-008
Ro-Tap sieve shaker ASTM D 422	Ro-Tap sieve shaker Calibration	Per SOP	Per SOP	As needed	Per SOP	Per SOP	Laboratory Analyst	SOP BR-GT-008

<b>Instrument/ Equipment</b>	<b>Maintenance Activity</b>	<b>Testing Activity</b>	<b>Inspection Activity</b>	<b>Frequency</b>	<b>Acceptance Criteria</b>	<b>Corrective Action</b>	<b>Responsible Person</b>	<b>SOP Reference</b>
Probe - pH, Conductivity, Dissolved Oxygen	Clean, drain, and refill reference electrode as needed, replace DO membrane as needed.	pH, Conductivity, Dissolved Oxygen	Inspect electrodes for damage.	Before use	pH $7 \pm 0.05$ pH units (pH)	Correct problem and repeat calibration.	Staff Toxicologist, Department Manager	ESI SOP QA-1219
Balance	Weights	Organism Dry Weights	Cleanliness	Prior to sample weighing	Acceptable CCV	Correct the problem, reanalyze CCV.	Staff Toxicologist, Department Manager	ESI SOP QA-1124

## SAP Worksheet #26: Sample Handling System

[\(UFP-QAPP Manual Appendix A\)](#)

<b>SAMPLE COLLECTION, PACKAGING, AND SHIPMENT</b>	
Sample Collection (Personnel/Organization):	Resolution Field Team Staff
Sample Packaging (Personnel/Organization):	Resolution Field Team Staff
Coordination of Shipment (Personnel/Organization):	Resolution Field Team Staff (Refer to Worksheet #30 for the contact information for each laboratory providing analytical services)
Type of Shipment/Carrier:	Air Courier (FedEx Overnight) or Laboratory Courier (for Katahdin Analytical Services only)
<b>SAMPLE RECEIPT AND ANALYSIS</b>	
Sample Receipt (Personnel/Organization):	Assigned laboratory personnel (Refer to Worksheet #30 for laboratories providing analytical services)
Sample Custody and Storage (Personnel/Organization):	Assigned laboratory personnel (Refer to Worksheet #30 for laboratories providing analytical services)
Sample Preparation (Personnel/Organization):	Assigned laboratory personnel (Refer to Worksheet #30 for laboratories providing analytical services)
Sample Determinative Analysis (Personnel/Organization):	Assigned laboratory personnel (Refer to Worksheet #30 for laboratories providing analytical services)
<b>SAMPLE ARCHIVING</b>	
Field Sample Storage (No. of days from sample collection):	Field Sample Storage (number of days from sample collection): With the exception of the fraction of the sediment samples that is removed for pellet counting, samples will not be stored in the field but will be shipped to the designated laboratory the same day as collection or no later than the day after collection if holding times allow ( $\geq 14$ days). If circumstances require that the samples be stored in the field, they will be maintained as required by method-specified preservation (Refer to Worksheet #19 for sample container, preservation, and holding time requirements.). Samples which are archived for possible future analyses will be stored under the conditions recommended for the potential analyses.
Sample Extract/Digestate Storage (No. of days from extraction/digestion):	Sample extracts and digests will be archived by the laboratory for 180 days from sample receipt.
Biological Sample Storage (No. of days from sample collection):	Samples for macro-invertebrate and toxicity analysis will be archived by the laboratory for 180 days from sample receipt.
<b>SAMPLE DISPOSAL</b>	
Personnel/Organization:	Assigned laboratory personnel (Refer to Worksheet #30 for laboratories providing analytical services)
Number of Days from Analysis:	Unused sample will be archived by the laboratories for 180 days from sample receipt. Samples archived for potential future lead particle size distribution will be archived for a period of 1 year. The fraction of the sediment samples removed by field-sieving exclusive of lead pellets will be returned to the sampling locations.

## **SAP Worksheet #27: Sample Custody Requirements**

[\(UFP-QAPP Manual Section 3.3.3\)](#)

### Sample Labeling

Samples will be labeled in accordance with Resolution *Procedure 3-03, Recordkeeping, Sample Labeling, and Chain-of-Custody*, presented in Appendix A. Effort will be made to label the sample containers prior to collection with a subset of information that is predetermined (e.g., method, preservative), and complete the sample labels immediately after collection (e.g., sample collection date, sampler's initials).

### Sample Nomenclature

Samples will be identified using a unique sample identification system. Sample nomenclature will be based on the sample locations presented in Worksheet #18, and will adhere to the following scheme:

#### **Field Samples**

Field samples will be named using the following conventions. The backslashes in the descriptions are included to separate each section of the description but will not be included in the sample identification.

Soil: Site Identifier/Sample Type/Sample Location Number/Sample Depth/Sieved Sample

Sediment: Site Identifier/Sample Type/Sample Location Number /Sample Depth/Quadrat (if applicable)

Groundwater: Site Identifier/Sample Type/Sample Location Number /Round/Filtered Sample  
Tissue (Shellfish): Site Identifier/Sample Type/Sample Location Number /Sample Depth/Quadrat (if applicable)

#### Site Identifier

Site Identifier will consist of four characters. Background sediment samples will use Base Background. Monitoring wells installed as part of this investigation will be assigned to OU09:  
BSBG – Base Background  
OU09 – MRP Site 1 OU09

#### Sample Type

Sample type will consist of two characters:

MW – Monitoring Well

OF – Outfall Sample (discharge terminus)

SD – Sediment

SS – Surface Soil

SB – Subsurface Soil

TS - Tissue

### Sample Location Number

Sample location numbers that will be used are those presented on Worksheet #18 exclusive of the two-letter description for sample type. For example, sample location MW009 is sample location number 009. Sample location SD201 is sample location number 201.

### Depths

Depth will consist of 4 digits, 2 for starting depth and 2 for ending depth:

Sediment: use inches

Soil Borings: use feet

### Sediment Quadrat

Sediment quadrat consists of one character based on the cardinal direction in which the quadrat is placed:

N – north

S – south

E – east

W – west

### Round

Round refers to sampling round and will consist of two numbers numbered sequentially beginning with 01.

### Filtered

If a sample is field filtered, "F" will be added to the sample identification.

### Sieved Sample

If a sample is wet sieved, "W" will be added to the sample identification

## **Field QC Samples**

Field QC samples will be named using the following convention. The backslashes in the descriptions are included to separate each section of the description but will not be included in the sample identification.

### **QC Type/Date/Number/Filtered**

#### QC Type

QC type will consist of two characters:

TB- Trip Blank

RB – Rinsate (equipment) Blank

FD – Field Duplicate

Matrix spike/matrix spike duplicates and matrix duplicates will be noted on the chains of custody, but since they consist of only additional volume for a field sample, no distinct nomenclature is required.

#### Date

Date will consist of six numbers for MMDDYY.

#### Number

Number will consist of two digits. Each sample type will be numbered sequentially on a daily basis.

#### Filtered

If a sample is field filtered, "F" will be added to the sample identification.

### **Conventions for Naming Sampling Locations**

Monitoring wells will be numbered MW11, MW-12, MW-13, MW-1D and MW-12D.

Soil borings will be numbered consecutively beginning with SB201 for OU09 locations.

Samples collected from the discharge points will be numbered sequentially from north to south starting with OFS001 (for soil).

For OU09, sediment sampling locations in Narragansett Bay will be numbered consecutively beginning with SD101.

Sediments collected for background data will be numbered consecutively beginning with SD301.

### Sample Custody Procedures

Sample custody will be maintained in accordance with Resolution *Procedures 3-03, Recordkeeping, Sample Labeling, and Chain-of-Custody* and *3-04, Sample Handling, Storage, and Shipping*, both presented in Appendix A.

Samples will be collected by and remain in the custody of Resolution until they are either released to the air courier that will be used for shipment to the laboratory or transferred to the custody of the laboratory as represented by the laboratory courier. A sample is considered to be in someone's custody if it:

- Is in his/her possession
- Is in his/her view, after being in his/her possession
- Is in his/her possession and has been placed in a secured location
- Is in a designated secure area

Sample custody procedures followed by each subcontract laboratory are presented in the laboratory quality manuals and standard operating procedures.

### Chains-of-Custody and Sample Login Forms

Resolution will use hardcopy chains of custody available from the fixed-laboratories performing the analyses. Examples of the chains of custody that will be used are presented in Figures 27-1 through 27-5 for Katahdin Analytical Services, TestAmerica Burlington, ALS Environmental, and Resolution Consultants (macro invertebrate survey), respectively. Sample Login Forms are presented as Figures 27-5 through 27-8 for Katahdin Analytical Services, TestAmerica Burlington, ALS Environmental, and Envirosystems, Inc., respectively. Internal chains of custody are presented as Figures 27-11 for TestAmerica Burlington. All Figures are included in Appendix C as well.









**Figure 27-5  
Katahdin Analytical Services Login Form**

**Katahdin Analytical Services, Inc. Sample Receipt Condition Report**

Client:		KAS PM:	Sampled By:
Project:		KIMS Entry By:	Delivered By:
KAS Work Order#:		KIMS Review By:	Received By:
SDG #:	Cooler: _____ of _____	Date/Time Rec.:	

Receipt Criteria	Y	N	EX*	NA	Comments and/or Resolution
1. Custody seals present / intact?					
2. Chain of Custody present in cooler?					
3. Chain of Custody signed by client?					
4. Chain of Custody matches samples?					
5. Temperature Blanks present? If not, take temperature of any sample w/ IR gun.					Temp (°C):
Samples received at <6 °C w/o freezing?					Note: Not required for metals analysis.
Ice packs or ice present?					The lack of ice or ice packs (i.e. no attempt to begin cooling process) may not meet certain regulatory requirements and may invalidate certain data.
If temp. out, has the cooling process begun (i.e. ice or packs present) and sample collection times <6hrs., but samples are not yet cool?					Note: No cooling process required for metals analysis.
6. Volatiles free of headspace: <b>Aqueous:</b> No bubble larger than a pea <b>Soil/Sediment:</b> Received in airtight container?					
Received in methanol?					
Methanol covering soil?					
7. Trip Blank present in cooler?					
8. Proper sample containers and volume?					
9. Samples within hold time upon receipt?					
10. Aqueous samples properly preserved? Metals, COD, NH3, TKN, O/G, phenol, TPO4, N+N, TOC, DRO, TPH – pH <2 Sulfide - >9 Cyanide – pH >12					

\* Log-In Notes to Exceptions: document any problems with samples or discrepancies or pH adjustments



**Figure 27-7**  
**ALS Environmental Login Form**



PC \_\_\_\_\_

**Cooler Receipt and Preservation Form**

Client / Project: \_\_\_\_\_ Service Request **KI3**

Received: \_\_\_\_\_ Opened: \_\_\_\_\_ By: \_\_\_\_\_ Unloaded: \_\_\_\_\_ By: \_\_\_\_\_

- Samples were received via? *Mail Fed Ex UPS DHL PDX Courier Hand Delivered*
- Samples were received in: (circle) *Cooler Box Envelope Other* NA
- Were custody seals on coolers? NA Y N If yes, how many and where? \_\_\_\_\_  
If present, were custody seals intact? Y N If present, were they signed and dated? Y N

Raw Cooler Temp	Corrected Cooler Temp	Raw Temp Blank	Corrected Temp Blank	Corr. Factor	Thermometer ID	Cooler/COC ID	Tracking Number	NA	Filed

- Packing material: *Inserts Baggies Bubble Wrap Gel Packs Wet Ice Dry Ice Sleeves* \_\_\_\_\_
- Were custody papers properly filled out (ink, signed, etc.)? NA Y N
- Did all bottles arrive in good condition (unbroken)? *Indicate in the table below.* NA Y N
- Were all sample labels complete (i.e analysis, preservation, etc.)? NA Y N
- Did all sample labels and tags agree with custody papers? *Indicate major discrepancies in the table on page 2.* NA Y N
- Were appropriate bottles/containers and volumes received for the tests indicated? NA Y N
- Were the pH-preserved bottles (*see SMO GEN SOP*) received at the appropriate pH? *Indicate in the table below* NA Y N
- Were VOA vials received without headspace? *Indicate in the table below.* NA Y N
- Was C12/Res negative? NA Y N

Sample ID on Bottle	Sample ID on COC	Identified by:

Sample ID	Bottle Count	Out of	Head-space	Broke	pH	Reagent	Volume added	Reagent Lot Number	Initials	Time

**Notes, Discrepancies, & Resolutions:** \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

**Figure 27-8  
EnviroSystems, Inc. Login Form**

**ESI**

**SAMPLE RECEIPT AND CONDITION DOCUMENTATION**

Page 1 of 1

STUDY NO: 00000

SDG No:

Project:

Delivered via:

Date and Time Received:

Date and Time Logged into Lab:

Received By:

Logged into Lab by:

Air bill / Vway bill:

Air bill included in folder if received?

Cooler on ice/packs:

Custody Seals present?

Cooler Blank Temp (C) at arrival:

Custody Seals intact?

Number of COC Pages:

COC Serial Number(s):

COC Complete:

Does the info on the COC match the samples?

    Sampled Date:

Were samples received within holding time?

    Field ID complete:

Were all samples properly labeled?

    Sampled Time:

Were proper sample containers used?

    Analysis request:

Were samples received intact? (none broken or leaking)

COC Signed and dated:

Were sample volumes sufficient for requested analysis?

Were all samples received?

Were VOC vials free of headspace?

Client notification/authorization:

Field ID	Lab ID	Mx	Analysis Requested	Bottle	Req'd Pres'n	Verified Pres'n
Field ID	LabID	M	Analyses Requested	CTR	PRES	

Notes and qualifications:



**SAP Worksheet #28-1: Laboratory QC Samples Table**

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Soil

Analytical Group: Polynuclear Aromatic Hydrocarbons (Full Scan and Selected Ion Monitoring)

Analytical Method/ SOP Reference: SW846 8270D (Full Scan and SIM) / CA-226 and CA-213

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per preparation batch of twenty or fewer samples of similar matrix.	No target compounds > 1/2 LOQ (> LOQ for common laboratory contaminants) and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).	Correct the problem. Report sample results that are <LOD or >10x the blank concentration. Reprepare and reanalyze the method blank and all associated samples with results > LOD and < 10x the contaminated blank result.	Analyst, Laboratory Department Manager and Data Validator	Bias/contamination	Same as Method/SOP QC Acceptance Limits.

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Surrogate	3 per sample: 2- Methylnaphthalene-d10 Fluorene-d10 Pyrene-d10	%R must be within DoD QSM limits, if available; otherwise, within laboratory's statistically-derived QC limits.	For QC and field samples, correct problem then reprepare and reanalyze all failed samples for failed surrogates in the associated preparatory batch, if sufficient sample material is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary.  Contact Client if samples cannot be reprepared within hold time.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
LCS	One per preparation batch of twenty or fewer samples of similar matrix.	%R must be within DoD QSM limits, if available; otherwise, within laboratory's statistically-derived QC limits. Allow for the number of marginal exceedances presented in DoD QSM Table G-1.	Correct problem, then reprepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available (see full explanation in Appendix E-1 of DoD QSM v4.2).  Contact Client if samples cannot be reprepared within hold time.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy / Bias	Same as Method/SOP QC Acceptance Limits.
MS/MSD	One per SDG or every 20 samples. Full Scan MS/MSD may be applied.	%R should be within the same limits as for the LCS. RPD should be $\leq 30\%$ .	Corrective actions will not be taken for samples when recoveries are outside limits if likely due to matrix, otherwise contact client.	Analyst, Laboratory Department Manager, and Data Validator	Precision/Accuracy/ Bias	Same as Method/SOP QC Acceptance Limits.
IS	Six per sample: 1,4- Dichlorobenzene-d4 Naphthalene-d8 Acenaphthene-d10 Phenanthrene-d10 Chrysene-d12 Perylene-d12	Retention times for internal standards must be $\pm 30$ seconds and the responses within -50% to +100% of the ICAL midpoint.	Inspect mass spectrometer or gas chromatograph for malfunctions. Mandatory reanalysis of samples analyzed while system was malfunctioning.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/ Bias	Same as Method/SOP QC Acceptance Limits.
Results between DL and LOQ	NA	Apply "J" qualifier to results between DL and LOQ.	NA	Analyst, Laboratory Department Manager, and Data Validator	Accuracy	Same as QC Acceptance Limits.

**SAP Worksheet #28-2: Laboratory QC Samples Table**

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Soil

Analytical Group: Nitroaromatics and Nitramines

Analytical Method/ SOP Reference: SW846 8330A / CA-402

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per preparation batch of twenty or fewer samples of similar matrix.	No analytes detected > LOQ and > 1/10 the amount measured in any sample or 1/10 the PAL (whichever is greater). Blank result must not otherwise affect sample results (see DoD QSM Box D-1).	Correct the problem. Report sample results that are <LOD or >10 x the blank concentration. Reprepare and reanalyze the method blank and all associated samples with results > LOD and < 10 x the contaminated blank result.	Analyst, Laboratory Department Manager and Data Validator	Bias/contamination	Same as Method/SOP QC Acceptance Limits. If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply B-flag to all results for the specific analyte(s) in all samples in the associated preparatory batch.
Surrogate	All field and QC samples.	%R must be within DoD QSM limits, if available; otherwise, within laboratory's statistically-derived QC limits.	For QC and field samples, correct problem then reprepare and reanalyze all failed samples for failed surrogates in the associated preparatory batch if sufficient sample material is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary. Contact Client if samples cannot be reprepared within hold time.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
Confirmation of positive results	Second column or second detector	Calibration and QC criteria same as for initial or primary column analysis. Results between primary and second column RPD ≤ 40%.	Not applicable	Analyst, Laboratory Department Manager, and Data Validator	Precision	Same as Method/SOP QC Acceptance Limits.

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
LCS	One per preparation batch of twenty or fewer samples of similar matrix.	%R must be within DoD QSM limits, if available; otherwise, within laboratory's statistically-derived QC limits.	Correct problem, then reprepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes if sufficient sample material is available (see full explanation in Appendix E-1 of DoD QSM v4.2). Contact Client if samples cannot be reprepared within hold time.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy /Bias	Same as Method/SOP QC Acceptance Limits.
MS/MSD	One per SDG or every 20 samples. Full Scan MS/MSD may be applied.	%R should be within the same limits as for the LCS. RPD should be $\leq 30\%$ .	Corrective actions will not be taken for samples when recoveries are outside limits if likely due to matrix, otherwise contact Client.	Analyst, Laboratory Department Manager, and Data Validator	Precision/Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
Results between DL and LOQ	NA	Apply "J" qualifier to results between DL and LOQ.	NA	Analyst, Laboratory Department Manager, and Data Validator	Accuracy	Same as QC Acceptance Limits.

**SAP Worksheet #28-2a: Laboratory QC Samples Table**

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Soil

Analytical Group: Nitroaromatics and Nitramines

Analytical Method/ SOP Reference: SW846 8330A / CA-402

Analyte	CAS Number	Recovery Limits	
		Lower	Upper
2,4-Dinitrotoluene	121-14-2	80	125
Nitroglycerin	55-63-0	67	138
1,2-Dinitrobenzene (surr.)	528-29-0	51	115

**SAP Worksheet #28-3: Laboratory QC Samples Table**

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Soil

Analytical Group: ICP-MS Metals

Analytical Method/ SOP Reference: SW846 6020A / CA-627

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per digestion batch of 20 or fewer samples of similar matrix.	No target metals > ½ LOQ (> LOQ for common laboratory contaminants) and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. For negative blanks, absolute value < LOD. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).	Correct the problem. Report sample results that are <LOD or >10x the blank concentration. Reprep and reanalyze the method blank and all associated samples with results > LOD and < 10x the contaminated blank result.	Analyst, Laboratory Department Manager and Data Validator	Bias/contamination	Same as Method/SOP QC Acceptance Limits
LCS	One per digestion batch of 20 or fewer samples of similar matrix.	%R must be within 80-120%, allowing for the marginal exceedances presented in DoD QSM Table G-1.	Redigest and reanalyze all associated samples for affected analyte.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias/ Contamination	Same as Method/SOP QC Acceptance Limits.
MS	One per digestion batch SDG or every 20 samples.	Same as Method/SOP QC Acceptance Limits for LCS.	Flag results for affected analytes for all associated samples with an "N."	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
Post-digestion Spike	When dilution test fails or analyte concentration in all samples < 50x LOD	%R should be within 75-125%.	Run associated samples by method of standard addition or flag results.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Laboratory Duplicate	One per digestion batch or SDG or every 20 samples.	Project-specific criteria: If values are $\geq 5x$ LOQ, RPD should be $\leq 20\%$ . If values are $< 5x$ LOQ, Absolute Difference should be $\leq$ LOQ.	Flag results for affected analytes for all associated samples.	Analyst, Laboratory Department Manager, and Data Validator	Precision	RPD $< 20\%$
ICP Serial Dilution	One per preparation batch of twenty or fewer samples of similar matrix.	If original sample result is at least $50x$ LOQ, 5-fold dilution must agree within $\pm 10\%$ of the original result.	Flag results for affected analytes for all associated samples with "E."	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
IS	Appropriate IS required for all analytes in all samples. Mass of IS must be $< 50$ amu different from that of analyte	For each sample, IS intensity must be within 30-120% of that of initial calibration standard.	Reanalyze affected samples.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.

**SAP Worksheet #28-4: Laboratory QC Samples Table**

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Soil

Analytical Group: ICP-AES Metals

Analytical Method/ SOP Reference: SW846 6010C / CA 608

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per digestion batch of 20 or fewer samples of similar matrix.	No target metals > 1/2 LOQ (> LOQ for common laboratory contaminants) and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. For negative blanks, absolute value must be < LOD. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).	Correct the problem. Report sample results that are <LOD or >10x the blank concentration. Re-prepare and reanalyze the method blank and all associated samples with results > LOD and < 10x the contaminated blank result.	Analyst, Laboratory Department Manager and Data Validator	Bias/contamination	Same as Method/SOP QC Acceptance Limits.
LCS	One per digestion batch of 20 or fewer samples of similar matrix (varies by lot).	%R must be within DoD QSM limits, allowing for the marginal exceedances presented in DoD QSM Table G-1.	Re-digest and reanalyze all associated samples for affected analyte.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias/Contamination	Same as Method/SOP QC Acceptance Limits.
MS	One per digestion batch or SDG or every 20 samples.	%R should be within the DoD QSM limits for LCS, if sample < 4x spike added.	Flag results for affected analytes for all associated samples with "N."	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits for LCS.
Post-digestion Spike	When dilution test fails or analyte concentration in all samples < 50x LOD	%R within 75-125%.	Run associated samples by method of standard addition or flag results.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Laboratory Duplicate	One per digestion batch or SDG or every 20 samples.	Project-specific criteria: If values are $\geq 5x$ LOQ, RPD should be $\leq 20\%$ . If values are $< 5x$ LOQ, Absolute Difference should be $\leq$ LOQ.	Flag results for affected analytes for all associated samples.	Analyst, Laboratory Department Manager, and Data Validator	Precision	RPD $< 20\%$
ICP Serial Dilution	One per preparation batch of 20 or fewer samples of similar matrix.	If original sample result is at least $50x$ LOQ, 5-fold dilution must agree within $\pm 10\%$ of the original result.	Flag results for affected analytes for all associated samples with "E."	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
Results between DL and LOQ	NA	Apply "J" qualifier to results between DL and LOQ.	NA	Analyst, Laboratory Department Manager, and Data Validator	Accuracy	Same as QC Acceptance Limits.

**SAP Worksheet #28-5: Laboratory QC Samples Table**

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Soil

Analytical Group: Mercury (CVAA)

Analytical Method/ SOP Reference: SW846 7471B / CA-611

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per digestion batch of 20 or fewer samples of similar matrix.	No mercury > 1/2 LOQ and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. For negative blanks, absolute value < LOD. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).	Correct the problem. Report sample results that are <LOD or >10x the blank concentration. Reprepare and reanalyze the method blank and all associated samples with results > LOD and < 10x the contaminated blank result.	Analyst, Laboratory Department Manager and Data Validator	Bias/contamination	Same as Method/SOP QC Acceptance Limits.
LCS	One per digestion batch of 20 or fewer samples of similar matrix.	Water and Sediment: %R must be within 80-120%.	Redigest and reanalyze all associated samples for affected analyte.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias/Contamination	Same as Method/SOP QC Acceptance Limits.
MS	One per digestion batch or SDG or every 20 samples.	%R should be within 80-120% if sample < 4x spike added.	Flag results for affected analytes for all associated samples with "N."	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits for LCS.
Laboratory Duplicate	One per digestion batch or SDG or every 20 samples.	Project-specific criteria: If values are ≥ 5x LOQ, RPD should be ≤ 20%. If values are < 5x LOQ, Absolute Difference should be ≤ LOQ.	Flag results for affected analytes for all associated samples.	Analyst, Laboratory Department Manager, and Data Validator	Precision	RPD < 20%
Results between DL and LOQ	NA	Apply "J" qualifier to results between DL and LOQ	NA	Analyst, Supervisor	Accuracy	Same as QC Acceptance Limits.

## SAP Worksheet #28-6: Laboratory QC Samples Table

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Soil

Analytical Group: Hexavalent Chromium (SW-846 7196A)

Analytical Method/ SOP Reference: SW846 7196A / CA-625

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per digestion batch of 20 or fewer samples of similar matrix.	No analyte > 1/2 LOQ and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. For negative blanks, absolute value must be < LOD. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).	Correct the problem. Report sample results that are <LOD or >10x the blank concentration. Re-prepare and reanalyze the method blank and all associated samples with results > LOD and < 10x the contaminated blank result.	Analyst, Laboratory Department Manager and Data Validator	Bias/contamination	Same as Method/SOP QC Acceptance Limits.
LCS	One per digestion batch of 20 or fewer samples of similar matrix (varies by lot).	%R must be within 80-120%	Re-digest and reanalyze all associated samples.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias/Contamination	Same as Method/SOP QC Acceptance Limits.
Sample matrix verification (also known as matrix spike)	Once for every sample matrix analyzed.	Spike recovery within 85–115%.	If check indicates interference, dilute and reanalyze sample; persistent interference indicates the need to use alternative method or analytical conditions, or to use method of standard additions.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias/Contamination	Same as Method/SOP QC Acceptance Limits.
MS (Soluble)	Once for every sample matrix analyzed.	Spike recovery within 75–125%.	First failure: Re-digest and reanalyze all associated samples for affected analyte and MSs and MSi analysis. Conduct ferrous iron, sulfide, and TOC analysis on matrix spike sample. Second failure: If reducing conditions are not indicated by the auxiliary analyses conducted, contact AECOM. Samples may be submitted for analysis by Method 7199.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
MS (Insoluble)	Once for every sample matrix analyzed.	Spike recovery within 75–125%.	First failure: Re-digest and reanalyze all associated samples for affected analyte and MSs and MSi analysis. Conduct ferrous iron, sulfide, and TOC analysis on matrix spike sample. Second failure: If reducing conditions are not indicated by the auxiliary analyses conducted, contact AECOM. Samples may be submitted for analysis by Method 7199.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
Post-digestion Spike	One per preparatory batch	%R within 85-115%.	Correct problem and rehomogenize, redigest, and reanalyze samples. Persistent interference indicates the need to use an alternative method or analytical conditions, or to use method of standard additions.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
Laboratory Duplicate	One per preparatory batch	Project-specific criteria: If values are $\geq 5x$ LOQ, RPD should be $\leq 30\%$ . If values are $< 5x$ LOQ, Absolute Difference should be $\leq$ LOQ.	Flag results for affected analytes for all associated samples.	Analyst, Laboratory Department Manager, and Data Validator	Precision	RPD $< 30\%$
Results between DL and LOQ	NA	Apply "J" qualifier to results between DL and LOQ.	NA	Analyst, Laboratory Department Manager, and Data Validator	Accuracy	Same as QC Acceptance Limits.

**SAP Worksheet #28-7: Laboratory QC Samples Table**

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Soil

Analytical Group: Hexavalent Chromium (SW-846 7199)

Analytical Method/ SOP Reference: SW846 7199/ GEN-7199

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per digestion batch of 20 or fewer samples of similar matrix.	No analyte > 1/2 LOQ and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. For negative blanks, absolute value must be < LOD. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).	Correct the problem. Report sample results that are <LOD or >10x the blank concentration. Re-prepare and reanalyze the method blank and all associated samples with results > LOD and < 10x the contaminated blank result.	Analyst, Laboratory Department Manager and Data Validator	Bias/contamination	Same as Method/SOP QC Acceptance Limits.
LCS	One per digestion batch of 20 or fewer samples of similar matrix.	%R must be within 80-120%	Re-digest and reanalyze all associated samples.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias/ Contamination	Same as Method/SOP QC Acceptance Limits.
MS (Soluble)	One per digestion batch of 20 or fewer samples of similar matrix.	If native concentration <4x spike concentration, spike recovery within 75-125%.	First failure: Re-digest and reanalyze all associated samples. Conduct ferrous iron, sulfide, and TOC analysis on matrix spike sample. Second failure: If reducing conditions are not indicated by the auxiliary analyses conducted, contact AECOM.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
MS (Insoluble)	One per digestion batch of 20 or fewer samples of similar matrix.	If native concentration <4x spike concentration, spike recovery within 75-125%.	First failure: Re-digest and reanalyze all associated samples. Conduct ferrous iron, sulfide, and TOC analysis on matrix spike sample. Second failure: If reducing conditions are not indicated by the auxiliary analyses conducted, contact AECOM.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Post-digestion Spike	One per preparatory batch	%R within 85-115%.	If MSs pass, respire and reanalyze. If MSs fail, matrix interference is confirmed. Persistent interference indicates the need to use an alternative method or analytical conditions, or to use method of standard additions.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
Laboratory Duplicate	One per preparatory batch	Project-specific criteria: If values are $\geq 5x$ LOQ, RPD should be $\leq 30\%$ . If values are $< 5x$ LOQ, Absolute Difference should be $\leq$ LOQ.	Flag results for affected analytes for all associated samples.	Analyst, Laboratory Department Manager, and Data Validator	Precision	RPD $< 30\%$
Results between DL and LOQ	NA	Apply "J" qualifier to results between DL and LOQ.	NA	Analyst, Laboratory Department Manager, and Data Validator	Accuracy	Same as QC Acceptance Limits.

## SAP Worksheet #28-8: Laboratory QC Samples Table

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Soil

Analytical Group: Total Organic Carbon (Method 9060M)

Analytical Method/ SOP Reference: SW846 9060 / CA-763

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per analytical batch of 20 or fewer samples.	No target analytes > ½ LOQ and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).	Correct the problem. Report sample results that are <LOD or >10x the blank concentration. Re-prepare and reanalyze the method blank and all associated samples with results > LOD and < 10x the contaminated blank result.	Analyst, Laboratory Department Manager and Data Validator	Bias/contamination	Same as Method/SOP QC Acceptance Limits.
LCS	One per analytical batch of 20 or fewer samples.	%R must be within 80-120	(1) Investigate source of problem. (2) If the LCS recovery is high but the sample results are <LOQ, narrate. Otherwise, reprep a blank and the remaining samples.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias/ Contamination	Same as Method/SOP QC Acceptance Limits.
MS	One for every set 10 samples	%R must be within: 75-125	(1) Evaluate the samples and associated QC: i.e. If the LCS results are acceptable, narrate. (2) If both the LCS and MS are unacceptable reprep and reanalyze the samples and QC. (3) Notate sample result in raw data if matrix interference suspected.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
Laboratory Duplicate	One sample duplicate per 20 samples.	RPD ≤20 if both results are >3 x LOQ; RPD ≤100% for samples ≤ 3 x LOQ	(1) Investigate problem and reanalyze sample in duplicate (2) If RPD still >20, report original result with notation or narration.	Analyst, Laboratory Department Manager, and Data Validator	Precision	RPD < 20%

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**SAP Worksheet #28-9: Laboratory QC Samples Table**

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Soil

Analytical Group: Grain Size (Sieve Only)

Analytical Method/ SOP Reference: ASTM D 422-63 / BR-GT-006, Rev. 6 and BR-GT-008

<b>QC Sample:</b>	<b>Frequency &amp; Number</b>	<b>Method/SOP QC Acceptance Limits</b>	<b>Corrective Action</b>	<b>Person(s) Responsible for Corrective Action</b>	<b>DQI</b>	<b>Measurement Performance Criteria</b>
None						

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**SAP Worksheet #28-10: Laboratory QC Samples Table**

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Soil

Analytical Group: Bulk Density

Analytical Method/ SOP Reference: ASTM D 2937-04 / BR-GT-018, Rev. 5

<b>QC Sample:</b>	<b>Frequency &amp; Number</b>	<b>Method/SOP QC Acceptance Limits</b>	<b>Corrective Action</b>	<b>Person(s) Responsible for Corrective Action</b>	<b>DQI</b>	<b>Measurement Performance Criteria</b>
None						

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**SAP Worksheet #28-11: Laboratory QC Samples Table**

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Soil

Analytical Group: Total Porosity (Calc. From Bulk Density and Specific Gravity)

Analytical Method/ SOP Reference: ASTM D 854-06 – Method B / BR-GT-004, Rev. 6

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
None						

**SAP Worksheet #28-12: Laboratory QC Samples Table**

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Soil

Analytical Group: pH

Analytical Method/ SOP Reference: SW846 9045D / CA-709

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
LCS	One per analytical batch of 20 or fewer samples.	%R must be within 90-110	(1) Investigate source of problem. (2) If the LCS recovery is high but the sample results are <LOQ, narrate. Otherwise, reprep a blank and the remaining samples.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias/Contamination	Same as Method/SOP QC Acceptance Limits.
Laboratory Duplicate	One sample duplicate per 20 samples.	RPD $\leq$ 20 if both results are $>3 \times$ LOQ; RPD $\leq$ 100% for samples $\leq 3 \times$ LOQ	(1) Investigate problem and reanalyze sample in duplicate (2) If RPD still $>20$ , report original result with notation or narration.	Analyst, Laboratory Department Manager, and Data Validator	Precision	RPD $< 20\%$

**SAP Worksheet #28-13: Laboratory QC Samples Table**

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Soil

Analytical Group: Conductivity

Analytical Method/ SOP Reference: SM2510B / CA-744

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per analytical batch of 20 or fewer samples.	Conductivity must not be > LOQ and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).	Correct the problem. Report sample results that are <LOD or >10x the blank concentration. Re-prepare and reanalyze the method blank and all associated samples with results > LOD and < 10x the contaminated blank result.	Analyst, Laboratory Department Manager and Data Validator	Bias/contamination	Same as Method/SOP QC Acceptance Limits.
LCS	One per analytical batch of 20 or fewer samples.	%R must be within 80-120	(1) Investigate source of problem. (2) If the LCS recovery is high but the sample results are <LOQ, narrate. Otherwise, reprep a blank and the remaining samples.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias/Contamination	Same as Method/SOP QC Acceptance Limits.
Laboratory Duplicate	One sample duplicate per 20 samples.	RPD $\leq$ 20 if both results are >3 x LOQ; RPD $\leq$ 100% for samples $\leq$ 3 x LOQ	(1) Investigate problem and reanalyze sample in duplicate (2) If RPD still >20, report original result with notation or narration.	Analyst, Laboratory Department Manager, and Data Validator	Precision	RPD < 20%

**SAP Worksheet #28-14: Laboratory QC Samples Table**

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Groundwater

Analytical Group: Polynuclear Aromatic Hydrocarbons (Full Scan and Selected Ion Monitoring)

Analytical Method/ SOP Reference: SW846 8270D (Full Scan and SIM) / CA-213 and CA-226

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per preparation batch of twenty or fewer samples of similar matrix. Full Scan MS/MSD may be applied.	No target compounds > 1/2 LOQ (> LOQ for common laboratory contaminants) and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).	Correct the problem. Report sample results that are <LOD or >10x the blank concentration. Reprepare and reanalyze the method blank and all associated samples with results > LOD and < 10x the contaminated blank result.	Analyst, Laboratory Department Manager and Data Validator	Bias/contamination	Same as Method/SOP QC Acceptance Limits.

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Surrogate	3 per sample: 2- Methylnaphthalene-d10 Fluorene-d10 Pyrene-d10	%R must be within DoD QSM limits, if available; otherwise, within laboratory's statistically-derived QC limits.	For QC and field samples, correct problem then reprepare and reanalyze all failed samples for failed surrogates in the associated preparatory batch, if sufficient sample material is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary.  Contact Client if samples cannot be reprepared within hold time.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
LCS	One per preparation batch of twenty or fewer samples of similar matrix.	%R must be within DoD QSM limits, if available; otherwise, within laboratory's statistically-derived QC limits. Allow for the number of marginal exceedances presented in DoD QSM Table G-1.	Correct problem, then reprepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available (see full explanation in Appendix E-1 of DoD QSM v4.2).  Contact Client if samples cannot be reprepared within hold time.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy / Bias	Same as Method/SOP QC Acceptance Limits.
MS/MSD	One per SDG or every 20 samples.	%R should be within the same limits as for the LCS. RPD should be ≤ 30%.	Corrective actions will not be taken for samples when recoveries are outside limits if likely due to matrix, otherwise contact client.	Analyst, Laboratory Department Manager, and Data Validator	Precision/Accuracy/ Bias	Same as Method/SOP QC Acceptance Limits.
IS	Six per sample: 1,4- Dichlorobenzene-d4 Naphthalene-d8 Acenaphthene-d10 Phenanthrene-d10 Chrysene-d12 Perylene-d12	Retention times for internal standards must be ± 30 seconds and the responses within - 50% to +100% of the ICAL midpoint.	Inspect mass spectrometer or gas chromatograph for malfunctions. Mandatory reanalysis of samples analyzed while system was malfunctioning.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/ Bias	Same as Method/SOP QC Acceptance Limits.
Results between DL and LOQ	NA	Apply "J" qualifier to results between DL and LOQ.	NA	Analyst, Laboratory Department Manager, and Data Validator	Accuracy	Same as QC Acceptance Limits.

**SAP Worksheet #28-15: Laboratory QC Samples Table**

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Groundwater

Analytical Group: ICP-MS Metals

Analytical Method/ SOP Reference: SW846 6020A / CA-627

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per digestion batch of 20 or fewer samples of similar matrix.	No target metals > ½ LOQ (> LOQ for common laboratory contaminants) and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. For negative blanks, absolute value < LOD. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).	Correct the problem. Report sample results that are <LOD or >10x the blank concentration. Reprepare and reanalyze the method blank and all associated samples with results > LOD and < 10x the contaminated blank result.	Analyst, Laboratory Department Manager and Data Validator	Bias/contamination	Same as Method/SOP QC Acceptance Limits.
LCS	One per digestion batch of 20 or fewer samples of similar matrix.	%R must be within 80-120%, allowing for the marginal exceedances presented in DoD QSM Table G-1.	Redigest and reanalyze all associated samples for affected analyte.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias/ Contamination	Same as Method/SOP QC Acceptance Limits.
MS	One per digestion batch or SDG or every 20 samples.	%R should be within 80-120% if sample < 4x spike added.	Flag results for affected analytes for all associated samples with an "N."	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits for LCS.
Post-digestion Spike	When dilution test fails or analyte concentration in all samples < 50x LOD	%R should be within 75-125%.	Run associated samples by method of standard addition or flag results.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Laboratory Duplicate	One per digestion batch or SDG or every 20 samples.	Project-specific criteria: If values are $\geq 5x$ LOQ, RPD should be $\leq 20\%$ . If values are $< 5x$ LOQ, Absolute Difference should be $\leq$ LOQ.	Flag results for affected analytes for all associated samples.	Analyst, Laboratory Department Manager, and Data Validator	Precision	Same as Method/SOP QC Acceptance Limits.
ICP Serial Dilution	One per preparation batch of twenty or fewer samples of similar matrix.	If original sample result is at least $50x$ LOQ, 5-fold dilution must agree within $\pm 10\%$ of the original result.	Flag results for affected analytes for all associated samples with "E."	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
IS	Appropriate IS required for all analytes in all samples. Mass of IS must be $<50$ amu different from that of analyte	For each sample, IS intensity must be within 30-120% of that of initial calibration standard.	Reanalyze affected samples.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Per the method, for each sample, IS intensity must be $\geq 70\%$ of that of initial calibration standard.

**SAP Worksheet #28-16: Laboratory QC Samples Table**

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Groundwater

Analytical Group: ICP-AES Metals

Analytical Method/ SOP Reference: SW846 6010C / CA-608

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per digestion batch of 20 or fewer samples of similar matrix.	No target metals > 1/2 LOQ (> LOQ for common laboratory contaminants) and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. For negative blanks, absolute value must be < LOD. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).	Correct the problem. Report sample results that are <LOD or >10x the blank concentration. Re-prepare and reanalyze the method blank and all associated samples with results > LOD and < 10x the contaminated blank result.	Analyst, Laboratory Department Manager and Data Validator	Bias/contamination	Same as Method/SOP QC Acceptance Limits.
LCS	One per digestion batch of 20 or fewer samples of similar matrix (varies by lot).	%R must be within DoD QSM limits, allowing for the marginal exceedances presented in DoD QSM Table G-1.	Re-digest and reanalyze all associated samples for affected analyte.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias/Contamination	Same as Method/SOP QC Acceptance Limits.
Matrix Spike	One per digestion batch or SDG or every 20 samples.	%R should be within the DoD QSM limits for LCS, if sample < 4x spike added.	Flag results for affected analytes for all associated samples with "N."	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits for LCS.
Post-digestion Spike	When dilution test fails or analyte concentration in all samples < 50x LOD	%R should be within 75-125%.	Run associated samples by method of standard addition or flag results.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Laboratory Duplicate	One per digestion batch or SDG or every 20 samples.	Project-specific criteria: If values are $\geq 5x$ LOQ, RPD should be $\leq 20\%$ . If values are $< 5x$ LOQ, Absolute Difference should be $\leq$ LOQ.	Flag results for affected analytes for all associated samples.	Analyst, Laboratory Department Manager, and Data Validator	Precision	Same as Method/SOP QC Acceptance Limits.
ICP Serial Dilution	One per preparation batch of 20 or fewer samples of similar matrix.	If original sample result is at least $50x$ LOQ, 5-fold dilution must agree within $\pm 10\%$ of the original result.	Flag results for affected analytes for all associated samples with "E."	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
Results between DL and LOQ	NA	Apply "J" qualifier to results between DL and LOQ.	NA	Analyst, Laboratory Department Manager, and Data Validator	Accuracy	Same as QC Acceptance Limits.

**SAP Worksheet #28-17: Laboratory QC Samples Table**

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Groundwater

Analytical Group: Mercury (CVAA)

Analytical Method/ SOP Reference: SW846 7470A / CA-615

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per digestion batch of 20 or fewer samples of similar matrix.	No mercury > 1/2 LOQ and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. For negative blanks, absolute value < LOD. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).	Correct the problem. Report sample results that are <LOD or >10x the blank concentration. Reprepare and reanalyze the method blank and all associated samples with results > LOD and < 10x the contaminated blank result.	Analyst, Laboratory Department Manager and Data Validator	Bias/contamination	Same as Method/SOP QC Acceptance Limits.
LCS	One per digestion batch of 20 or fewer samples of similar matrix.	Water and Sediment: %R must be within 80-120%.	Redigest and reanalyze all associated samples for affected analyte.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias/ Contamination	Same as Method/SOP QC Acceptance Limits.
MS	One per digestion batch or SDG or every 20 samples.	%R should be within 80-120% if sample < 4x spike added.	Flag results for affected analytes for all associated samples with "N."	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits for LCS.
Laboratory Duplicate	One per digestion batch or SDG or every 20 samples.	Project-specific criteria: If values are ≥ 5x LOQ, RPD should be ≤ 20%. If values are < 5x LOQ, Absolute Difference should be ≤ LOQ.	Flag results for affected analytes for all associated samples.	Analyst, Laboratory Department Manager, and Data Validator	Precision	Same as Method/SOP QC Acceptance Limits.
Results between DL and LOQ	NA	Apply "J" qualifier to results between DL and LOQ	NA	Analyst, Supervisor	Accuracy	Same as QC Acceptance Limits.

### SAP Worksheet #28-18: Laboratory QC Samples Table

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Groundwater

Analytical Group: Hexavalent Chromium (SW-846 7196A)

Analytical Method/ SOP Reference: SW846 7196A / CA-772

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per digestion batch of 20 or fewer samples of similar matrix.	No analyte > 1/2 LOQ and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. For negative blanks, absolute value must be < LOD. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).	Correct the problem. Report sample results that are <LOD or >10x the blank concentration. Re-prepare and reanalyze the method blank and all associated samples with results > LOD and < 10x the contaminated blank result.	Analyst, Laboratory Department Manager and Data Validator	Bias/contamination	Same as Method/SOP QC Acceptance Limits.
LCS	One per digestion batch of 15 or fewer samples of similar matrix (varies by lot).	%R must be within 90-110%	Re-digest and reanalyze all associated samples.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias/Contamination	Same as Method/SOP QC Acceptance Limits.
Sample matrix verification (also known as matrix spike)	Once for every sample matrix analyzed.	Spike recovery within 85-115%.	If check indicates interference, dilute and reanalyze sample; persistent interference indicates the need to use alternative method or analytical conditions, or to use method of standard additions.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias/Contamination	Same as Method/SOP QC Acceptance Limits.
Laboratory Duplicate	One per every 10 project samples per matrix	Project-specific criteria: If values are $\geq 5x$ LOQ, RPD should be $\leq 20\%$ . If values are $< 5x$ LOQ, Absolute Difference should be $\leq$ LOQ.	Flag results for affected analytes for all associated samples.	Analyst, Laboratory Department Manager, and Data Validator	Precision	RPD < 20%
Results between DL and LOQ	NA	Apply "J" qualifier to results between DL and LOQ.	NA	Analyst, Laboratory Department Manager, and Data Validator	Accuracy	Same as QC Acceptance Limits.

**SAP Worksheet #28-19: Laboratory QC Samples Table**

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Groundwater

Analytical Group: Salinity (Laboratory)

Analytical Method/ SOP Reference: SM2520B / CA-748

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per analytical batch of 20 or fewer samples.	No target analytes > LOQ and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).	Correct the problem. Report sample results that are <LOD or >10x the blank concentration. Re-prepare and reanalyze the method blank and all associated samples with results > LOD and < 10x the contaminated blank result.	Analyst, Laboratory Department Manager and Data Validator	Bias/contamination	Same as Method/SOP QC Acceptance Limits.
LCS	One per analytical batch of 20 or fewer samples.	%R must be within 80-120	(1) Investigate source of problem. (2) If the LCS recovery is high but the sample results are <LOQ, narrate. Otherwise, reprep a blank and the remaining samples.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias/Contamination	Same as Method/SOP QC Acceptance Limits.
Laboratory Duplicate	One sample duplicate per 20 samples.	RPD $\leq$ 20 if both results are >3 x LOQ; RPD $\leq$ 100% for samples $\leq$ 3 x LOQ	(1) Investigate problem and reanalyze sample in duplicate (2) If RPD still >20, report original result with notation or narration.	Analyst, Laboratory Department Manager, and Data Validator	Precision	RPD < 20%

**SAP Worksheet #28-20: Laboratory QC Samples Table**

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Groundwater

Analytical Group: Alkalinity

Analytical Method/ SOP Reference: SM2320B / CA-739

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per analytical batch of 20 or fewer samples.	No target analytes > ½ LOQ and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).	Correct the problem. Report sample results that are <LOD or >10x the blank concentration. Re-prepare and reanalyze the method blank and all associated samples with results > LOD and < 10x the contaminated blank result.	Analyst, Laboratory Department Manager and Data Validator	Bias/contamination	Same as Method/SOP QC Acceptance Limits.
LCS	One per analytical batch of 20 or fewer samples.	%R must be within 80-120	(1) Investigate source of problem. (2) If the LCS recovery is high but the sample results are <LOQ, narrate. Otherwise, reprep a blank and the remaining samples.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias/ Contamination	Same as Method/SOP QC Acceptance Limits.
MS	One for every set 10 samples	%R must be within: 75-125	(1) Evaluate the samples and associated QC: i.e. If the LCS results are acceptable, narrate. (2) If both the LCS and MS are unacceptable reprep and reanalyze the samples and QC. (3) Notate sample result in raw data if matrix interference suspected.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
Laboratory Duplicate	One sample duplicate per 20 samples.	RPD ≤20 if both results are >3 x LOQ; RPD ≤100% for samples ≤ 3 x LOQ	(1) Investigate problem and reanalyze sample in duplicate (2) If RPD still >20, report original result with notation or narration.	Analyst, Laboratory Department Manager, and Data Validator	Precision	Same as Method/SOP QC Acceptance Limits.

**SAP Worksheet #28-21: Laboratory QC Samples Table**

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Groundwater

Analytical Group: Anions (Chloride, Nitrate, Nitrite, Ortho-phosphate-P, Sulfate)

Analytical Method/ SOP Reference: SW846 9056A / CA-742

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per analytical batch of 20 or fewer samples.	No target analytes > ½ LOQ and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).	Correct the problem. Report sample results that are <LOD or >10x the blank concentration. Re-prepare and reanalyze the method blank and all associated samples with results > LOD and < 10x the contaminated blank result.	Analyst, Laboratory Department Manager and Data Validator	Bias/contamination	Same as Method/SOP QC Acceptance Limits.
LCS	One per analytical batch of 20 or fewer samples.	%R must be within 80-120	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available (see full explanation in Appendix G of DoD QSM v4.2).	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias/ Contamination	Same as Method/SOP QC Acceptance Limits.
MS/MSD	One set for every set 20 samples	%R must be within: 80-120  RPD ≤ 15% (between MS and MSD).	Examine the project-specific DQOs. Contact the client as to additional measures to be taken.	Analyst, Laboratory Department Manager, and Data Validator	Precision/Accuracy/Bias	RPD ≤ 15%; Recovery same as Method/SOP QC Acceptance Limits for LCS.
Laboratory Duplicate	One sample duplicate per 20 samples.	RPD ≤ 20 for samples >3X the LOQ, <100% RPD for samples <3X the LOQ. Apply J-flag if sample cannot be rerun or reanalysis does not correct problem.	Correct problem and reanalyze sample and duplicate.	Analyst, Laboratory Department Manager, and Data Validator	Precision	RPD < 20%

**SAP Worksheet #28-22: Laboratory QC Samples Table**

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Groundwater

Analytical Group: Total Organic Carbon (Method 9060)

Analytical Method/ SOP Reference: SW846 9060 / CA-763

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per analytical batch of 20 or fewer samples.	No target analytes > ½ LOQ and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).	Correct the problem. Report sample results that are <LOD or >10x the blank concentration. Re-prepare and reanalyze the method blank and all associated samples with results > LOD and < 10x the contaminated blank result.	Analyst, Laboratory Department Manager and Data Validator	Bias/contamination	Same as Method/SOP QC Acceptance Limits.
LCS	One per analytical batch of 20 or fewer samples.	%R must be within 80-120	(1) Investigate source of problem. (2) If the LCS recovery is high but the sample results are <LOQ, narrate. Otherwise, reprep a blank and the remaining samples.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias/ Contamination	Same as Method/SOP QC Acceptance Limits.
MS	One for every set 10 samples	%R must be within: 75-125	(1) Evaluate the samples and associated QC: i.e. If the LCS results are acceptable, narrate. (2) If both the LCS and MS are unacceptable reprep and reanalyze the samples and QC. (3) Notate sample result in raw data if matrix interference suspected.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
Laboratory Duplicate	One sample duplicate per 20 samples.	RPD ≤20 if both results are >3 x LOQ; RPD ≤100% for samples ≤ 3 x LOQ	(1) Investigate problem and reanalyze sample in duplicate (2) If RPD still >20, report original result with notation or narration.	Analyst, Laboratory Department Manager, and Data Validator	Precision	Same as Method/SOP QC Acceptance Limits.

**SAP Worksheet #28-23: Laboratory QC Samples Table**

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Groundwater

Analytical Group: Methane/Ethane/Ethene

Analytical Method/ SOP Reference: RSK-175 / CA-336

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per preparation batch of 20 or fewer samples.	No analytes detected > 1/2 LOQ and > 1/10 the amount measured in any sample (whichever is greater).	Investigate source of contamination. Evaluate the samples and associated QC: i.e. If the blank results are above the LOQ, report samples results which are < LOQ or >10X the blank concentration. Otherwise, reprep a blank and the remaining samples.	Analyst, Department Manager	Bias/ contamination	Same as Method/SOP QC Acceptance Limits.
LCS	One per batch of up to 20 samples.	%R must be within 70-130%.	Evaluate the samples and associated QC. If an MS/MSD was performed and acceptable, narrate. If the LCS recovery is high but the sample results are < LOQ, narrate. Otherwise, reprep.	Analyst, Department Manager	Accuracy/bias	Same as Method/SOP QC Acceptance Limits.
MS/MSD	One set per 20 field samples	%R must be within 70-130% RPD ≤30.	Evaluate the samples and associated QC. If an LCS was performed and acceptable, narrate. If the LCS recovery is high but the sample results are < LOQ, narrate. Otherwise, reprep	Analyst, Department Manager	Precision/Accuracy/bias	Same as Method/SOP QC Acceptance Limits.

**SAP Worksheet #28-24: Laboratory QC Samples Table**

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Groundwater

Analytical Group: Total Suspended Solids

Analytical Method/ SOP Reference: SM 2540 D / CA-720

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per analytical batch of 20 or fewer samples.	No target analytes > LOQ and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).	Correct the problem. Report sample results that are <LOD or >10x the blank concentration. Re-prepare and reanalyze the method blank and all associated samples with results > LOD and < 10x the contaminated blank result.	Analyst, Laboratory Department Manager and Data Validator	Bias/contamination	Same as Method/SOP QC Acceptance Limits.
LCS	One per analytical batch of 20 or fewer samples.	%R must be within 80-120	(1) Investigate source of problem. (2) If the LCS recovery is high but the sample results are <LOQ, narrate. Otherwise, reprep a blank and the remaining samples.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias/Contamination	Same as Method/SOP QC Acceptance Limits.
Laboratory Duplicate	One sample duplicate per 20 samples.	RPD $\leq$ 20 if both results are >3 x LOQ; RPD $\leq$ 100% for samples $\leq$ 3 x LOQ	(1) Investigate problem and reanalyze sample in duplicate (2) If RPD still >20, report original result with notation or narration.	Analyst, Laboratory Department Manager, and Data Validator	Precision	RPD < 20%

**SAP Worksheet #28-25: Laboratory QC Samples Table**

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Groundwater

Analytical Group: Total Dissolved Solids

Analytical Method/ SOP Reference: SM 2540C / CA-719

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per analytical batch of 20 or fewer samples.	No target analytes > LOQ and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).	Correct the problem. Report sample results that are <LOD or >10x the blank concentration. Re-prepare and reanalyze the method blank and all associated samples with results > LOD and < 10x the contaminated blank result.	Analyst, Laboratory Department Manager and Data Validator	Bias/contamination	Same as Method/SOP QC Acceptance Limits.
LCS	One per analytical batch of 20 or fewer samples.	%R must be within 80-120	(1) Investigate source of problem. (2) If the LCS recovery is high but the sample results are <LOQ, narrate. Otherwise, reprep a blank and the remaining samples.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias/Contamination	Same as Method/SOP QC Acceptance Limits.
Laboratory Duplicate	One sample duplicate per 20 samples.	RPD $\leq$ 20 if both results are >3 x LOQ; RPD $\leq$ 100% for samples $\leq$ 3 x LOQ	(1) Investigate problem and reanalyze sample in duplicate (2) If RPD still >20, report original result with notation or narration.	Analyst, Laboratory Department Manager, and Data Validator	Precision	RPD < 20%

**SAP Worksheet #28-26: Laboratory QC Samples Table**

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Sediment

Analytical Group: Polynuclear Aromatic Hydrocarbons (Full Scan and Selected Ion Monitoring)

Analytical Method/ SOP Reference: SW846 8270D (Full Scan and SIM) / CA-226 and CA-213

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per preparation batch of twenty or fewer samples of similar matrix.	No target compounds > 1/2 LOQ (> LOQ for common laboratory contaminants) and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).	Correct the problem. Report sample results that are <LOD or >10x the blank concentration. Reprepare and reanalyze the method blank and all associated samples with results > LOD and < 10x the contaminated blank result.	Analyst, Laboratory Department Manager and Data Validator	Bias/contamination	Same as Method/SOP QC Acceptance Limits.

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Surrogate	3 per sample: 2- Methylnaphthalene-d10 Fluorene-d10 Pyrene-d10	%R must be within DoD QSM limits, if available; otherwise, within laboratory's statistically-derived QC limits.	For QC and field samples, correct problem then reprepare and reanalyze all failed samples for failed surrogates in the associated preparatory batch, if sufficient sample material is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary.  Contact Client if samples cannot be reprepared within hold time.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
LCS	One per preparation batch of twenty or fewer samples of similar matrix.	%R must be within DoD QSM limits, if available; otherwise, within laboratory's statistically-derived QC limits. Allow for the number of marginal exceedances presented in DoD QSM Table G-1.	Correct problem, then reprepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available (see full explanation in Appendix E-1 of DoD QSM v4.2).  Contact Client if samples cannot be reprepared within hold time.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy / Bias	Same as Method/SOP QC Acceptance Limits.
MS/MSD	One per SDG or every 20 samples.	%R should be within the same limits as for the LCS. RPD should be $\leq 30\%$ .	Corrective actions will not be taken for samples when recoveries are outside limits if likely due to matrix, otherwise contact client.	Analyst, Laboratory Department Manager, and Data Validator	Precision/Accuracy/ Bias	Same as Method/SOP QC Acceptance Limits.
IS	Six per sample: 1,4- Dichlorobenzene-d4 Naphthalene-d8 Acenaphthene-d10 Phenanthrene-d10 Chrysene-d12 Perylene-d12	Retention times for internal standards must be $\pm 30$ seconds and the responses within -50% to +100% of the ICAL midpoint.	Inspect mass spectrometer or gas chromatograph for malfunctions. Mandatory reanalysis of samples analyzed while system was malfunctioning.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/ Bias	Same as Method/SOP QC Acceptance Limits.
Results between DL and LOQ	NA	Apply "J" qualifier to results between DL and LOQ.	NA	Analyst, Laboratory Department Manager, and Data Validator	Accuracy	Same as QC Acceptance Limits.

**SAP Worksheet #28-27: Laboratory QC Samples Table**

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Sediment

Analytical Group: ICP-MS Metals

Analytical Method/ SOP Reference: SW846 6020A / CA-627

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per digestion batch of 20 or fewer samples of similar matrix.	No target metals > ½ LOQ (> LOQ for common laboratory contaminants) and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. For negative blanks, absolute value < LOD. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).	Correct the problem. Report sample results that are <LOD or >10x the blank concentration. Reprepare and reanalyze the method blank and all associated samples with results > LOD and < 10x the contaminated blank result.	Analyst, Laboratory Department Manager and Data Validator	Bias/contamination	Same as Method/SOP QC Acceptance Limits.
LCS	One per digestion batch of 20 or fewer samples of similar matrix.	%R must be within 80-120%, allowing for the marginal exceedances presented in DoD QSM Table G-1.	Redigest and reanalyze all associated samples for affected analyte.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias/ Contamination	Same as Method/SOP QC Acceptance Limits.
MS	One per digestion batch or SDG or every 20 samples.	%R should be within 80-120% if sample < 4x spike added.	Flag results for affected analytes for all associated samples with an "N."	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits for LCS.
Post-digestion Spike	When dilution test fails or analyte concentration in all samples < 50x LOD	%R should be within 75-125%.	Run associated samples by method of standard addition or flag results.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Laboratory Duplicate	One per digestion batch or SDG or every 20 samples.	Project-specific criteria: If values are $\geq 5x$ LOQ, RPD should be $\leq 20\%$ . If values are $< 5x$ LOQ, Absolute Difference should be $\leq$ LOQ.	Flag results for affected analytes for all associated samples.	Analyst, Laboratory Department Manager, and Data Validator	Precision	RPD $< 20\%$
ICP Serial Dilution	One per preparation batch of twenty or fewer samples of similar matrix.	If original sample result is at least $50x$ LOQ, 5-fold dilution must agree within $\pm 10\%$ of the original result.	Flag results for affected analytes for all associated samples with "E."	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
IS	Appropriate IS required for all analytes in all samples. Mass of IS must be $< 50$ amu different from that of analyte	For each sample, IS intensity must be within 30-120% of that of initial calibration standard.	Reanalyze affected samples.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.

**SAP Worksheet #28-28: Laboratory QC Samples Table**

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Sediment

Analytical Group: ICP-AES Metals

Analytical Method/ SOP Reference: SW846 6010C / CA 608

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per digestion batch of 20 or fewer samples of similar matrix.	No target metals > 1/2 LOQ (> LOQ for common laboratory contaminants) and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. For negative blanks, absolute value must be < LOD. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).	Correct the problem. Report sample results that are <LOD or >10x the blank concentration. Re-prepare and reanalyze the method blank and all associated samples with results > LOD and < 10x the contaminated blank result.	Analyst, Laboratory Department Manager and Data Validator	Bias/contamination	Same as Method/SOP QC Acceptance Limits.
LCS	One per digestion batch of 20 or fewer samples of similar matrix (varies by lot).	%R must be within DoD QSM limits, allowing for the marginal exceedances presented in DoD QSM Table G-1.	Re-digest and reanalyze all associated samples for affected analyte.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias/Contamination	Same as Method/SOP QC Acceptance Limits.
Matrix Spike	One per digestion batch or SDG or every 20 samples.	%R should be within the DoD QSM limits for LCS, if sample < 4x spike added.	Flag results for affected analytes for all associated samples with "N."	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
Post-digestion Spike	When dilution test fails or analyte concentration in all samples < 50x LOD	%R should be within 75-125%.	Run associated samples by method of standard addition or flag results.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
Laboratory Duplicate	One per digestion batch or SDG or every 20 samples.	Project-specific criteria: If values are ≥ 5x LOQ, RPD should be ≤ 20%. If values are < 5x LOQ, Absolute Difference should be ≤ LOQ.	Flag results for affected analytes for all associated samples.	Analyst, Laboratory Department Manager, and Data Validator	Precision	RPD < 20%

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
ICP Serial Dilution	One per preparation batch of 20 or fewer samples of similar matrix.	If original sample result is at least 50x LOQ, 5-fold dilution must agree within $\pm 10\%$ of the original result.	Flag results for affected analytes for all associated samples with "E."	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
Results between DL and LOQ	NA	Apply "J" qualifier to results between DL and LOQ.	NA	Analyst, Laboratory Department Manager, and Data Validator	Accuracy	Same as QC Acceptance Limits.

**SAP Worksheet #28-29: Laboratory QC Samples Table**

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Sediment

Analytical Group: Mercury (CVAA)

Analytical Method/ SOP Reference: SW846 7471B / CA-611

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per digestion batch of 20 or fewer samples of similar matrix.	No mercury > 1/2 LOQ and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. For negative blanks, absolute value < LOD. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).	Correct the problem. Report sample results that are <LOD or >10x the blank concentration. Reprepare and reanalyze the method blank and all associated samples with results > LOD and < 10x the contaminated blank result.	Analyst, Laboratory Department Manager and Data Validator	Bias/contamination	Same as Method/SOP QC Acceptance Limits.
LCS	One per digestion batch of 20 or fewer samples of similar matrix.	Water and Sediment: %R must be within 80-120%.	Redigest and reanalyze all associated samples for affected analyte.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias/Contamination	Same as Method/SOP QC Acceptance Limits.
MS	One per digestion batch or SDG or every 20 samples.	%R should be within 80-120% if sample < 4x spike added.	Flag results for affected analytes for all associated samples with "N."	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits for LCS.
Laboratory Duplicate	One per digestion batch or SDG or every 20 samples.	Project-specific criteria: If values are ≥ 5x LOQ, RPD should be ≤ 20%. If values are < 5x LOQ, Absolute Difference should be ≤ LOQ.	Flag results for affected analytes for all associated samples.	Analyst, Laboratory Department Manager, and Data Validator	Precision	RPD < 20%
Results between DL and LOQ	NA	Apply "J" qualifier to results between DL and LOQ	NA	Analyst, Supervisor	Accuracy	Same as QC Acceptance Limits.

**SAP Worksheet #28-30: Laboratory QC Samples Table**

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Sediment

Analytical Group: Hexavalent Chromium (SW-846 7196A)

Analytical Method/ SOP Reference: SW846 7196A / CA-625

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per digestion batch of 20 or fewer samples of similar matrix.	No analyte > 1/2 LOQ and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. For negative blanks, absolute value must be < LOD. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).	Correct the problem. Report sample results that are <LOD or >10x the blank concentration. Re-prepare and reanalyze the method blank and all associated samples with results > LOD and < 10x the contaminated blank result.	Analyst, Laboratory Department Manager and Data Validator	Bias/contamination	Same as Method/SOP QC Acceptance Limits.
LCS	One per digestion batch of 20 or fewer samples of similar matrix (varies by lot).	%R must be within 80-120%	Re-digest and reanalyze all associated samples.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias/Contamination	Same as Method/SOP QC Acceptance Limits.
Sample matrix verification (also known as matrix spike)	Once for every sample matrix analyzed.	Spike recovery within 85–115%.	If check indicates interference, dilute and reanalyze sample; persistent interference indicates the need to use alternative method or analytical conditions, or to use method of standard additions.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias/Contamination	Same as Method/SOP QC Acceptance Limits.

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
MS (Soluble)	Once for every sample matrix analyzed.	Spike recovery within 75–125%.	First failure: Re-digest and reanalyze all associated samples for affected analyte and MSs and MSi analysis. Conduct ferrous iron, sulfide, and TOC analysis on matrix spike sample. Second failure: If reducing conditions are not indicated by the auxiliary analyses conducted, contact AECOM. Samples may be submitted for analysis by Method 7199.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
MS (Insoluble)	Once for every sample matrix analyzed.	Spike recovery within 75–125%.	First failure: Re-digest and reanalyze all associated samples for affected analyte and MSs and MSi analysis. Conduct ferrous iron, sulfide, and TOC analysis on matrix spike sample. Second failure: If reducing conditions are not indicated by the auxiliary analyses conducted, contact AECOM. Samples may be submitted for analysis by Method 7199.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
Post-digestion Spike	One per preparatory batch	%R within 85-115%.	Correct problem and rehomogenize, redigest, and reanalyze samples. Persistent interference indicates the need to use an alternative method or analytical conditions, or to use method of standard additions.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
Laboratory Duplicate	One per preparatory batch	Project-specific criteria: If values are $\geq 5x$ LOQ, RPD should be $\leq 30\%$ . If values are $< 5x$ LOQ, Absolute Difference should be $\leq$ LOQ.	Flag results for affected analytes for all associated samples.	Analyst, Laboratory Department Manager, and Data Validator	Precision	RPD $< 30\%$
Results between DL and LOQ	NA	Apply "J" qualifier to results between DL and LOQ.	NA	Analyst, Laboratory Department Manager, and Data Validator	Accuracy	Same as QC Acceptance Limits.

**SAP Worksheet #28-31: Laboratory QC Samples Table**

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Sediment

Analytical Group: Hexavalent Chromium (SW-846 7199)

Analytical Method/ SOP Reference: SW846 7199/ GEN-7199

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per digestion batch of 20 or fewer samples of similar matrix.	No analyte > 1/2 LOQ and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. For negative blanks, absolute value must be < LOD. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).	Correct the problem. Report sample results that are <LOD or >10x the blank concentration. Re-prepare and reanalyze the method blank and all associated samples with results > LOD and < 10x the contaminated blank result.	Analyst, Laboratory Department Manager and Data Validator	Bias/contamination	Same as Method/SOP QC Acceptance Limits.
LCS	One per digestion batch of 20 or fewer samples of similar matrix.	%R must be within 80-120%	Re-digest and reanalyze all associated samples.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias/Contamination	Same as Method/SOP QC Acceptance Limits.
MS (Soluble)	One per digestion batch of 20 or fewer samples of similar matrix.	If native concentration <4x spike concentration, spike recovery within 75–125%.	First failure: Re-digest and reanalyze all associated samples. Conduct ferrous iron, sulfide, and TOC analysis on matrix spike sample. Second failure: If reducing conditions are not indicated by the auxiliary analyses conducted, contact AECOM.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
MS (Insoluble)	One per digestion batch of 20 or fewer samples of similar matrix.	If native concentration <4x spike concentration, spike recovery within 75–125%.	First failure: Re-digest and reanalyze all associated samples. Conduct ferrous iron, sulfide, and TOC analysis on matrix spike sample. Second failure: If reducing conditions are not indicated by the auxiliary analyses conducted, contact AECOM.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Post-digestion Spike	One per preparatory batch	%R within 85-115%.	If MSs pass, respire and reanalyze. If MSs fail, matrix interference is confirmed. Persistent interference indicates the need to use an alternative method or analytical conditions, or to use method of standard additions.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
Laboratory Duplicate	One per preparatory batch	Project-specific criteria: If values are $\geq 5x$ LOQ, RPD should be $\leq 30\%$ . If values are $< 5x$ LOQ, Absolute Difference should be $\leq$ LOQ.	Flag results for affected analytes for all associated samples.	Analyst, Laboratory Department Manager, and Data Validator	Precision	RPD $< 30\%$
Results between DL and LOQ	NA	Apply "J" qualifier to results between DL and LOQ.	NA	Analyst, Laboratory Department Manager, and Data Validator	Accuracy	Same as QC Acceptance Limits.

## SAP Worksheet #28-32: Laboratory QC Samples Table

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Sediment

Analytical Group: Volatile Organic Compounds (Full Scan)

Analytical Method/ SOP Reference: SW846 8260B / CA-202

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per preparation batch of twenty or fewer samples of similar matrix.	No target compounds > ½ LOQ (> LOQ for common laboratory contaminants) and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).	Correct the problem. Report sample results that are <LOD or >10x the blank concentration. Reprepare and reanalyze the method blank and all associated samples with results > LOD and < 10x the contaminated blank result.	Analyst, Laboratory Department Manager, and Data Validator	Bias/Contamination	Same as Method/SOP QC Acceptance Limits.
Surrogate	Four per sample: Dibromofluoromethane 1,2-Dichloroethane-d4 Toluene-d8 4-Bromofluorobenzene (BFB)	%R must be within DoD QSM limits, if available; otherwise, within laboratory's statistically-derived QC limits.	For QC and field samples, correct problem then reprepare and reanalyze all failed samples for failed surrogates in the associated preparatory batch, if sufficient sample material is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary. Contact Client if samples cannot be reanalyzed within hold time.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
LCS	One per preparation batch of twenty or fewer samples of similar matrix.	%R must be within DoD QSM limits, if available; otherwise, within laboratory's statistically-derived QC limits (Refer to Worksheet #28-35a). Allow for the number of marginal exceedances presented in DoD QSM Table G-1.	Correct problem, then reprepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. Contact Client if samples cannot be reanalyzed within hold time.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/ Bias	Same as Method/SOP QC Acceptance Limits.

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
MS/MSD	One per SDG or every 20 samples.	%R should be within the same limits as for the LCS. RPD should be $\leq 30\%$ .	Corrective actions will not be taken for samples when recoveries are outside limits if likely due to matrix; otherwise contact client.	Analyst, Laboratory Department Manager, and Data Validator	Precision/Accuracy/ Bias	Same as Method/SOP QC Acceptance Limits.
IS	Four per sample: Pentafluorobenzene Chlorobenzene-d5 1,4-dichlorobenzene-d4 1,4-difluorobenzene	Retention times for internal standards must be + 30 seconds and the responses within - 50% to +100% of the ICAL midpoint standard.	Inspect mass spectrometer or gas chromatograph for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/ Bias	Same as Method/SOP QC Acceptance Limits.
Results between DL and LOQ	Not applicable (NA)	Apply "J" qualifier to results between DL and LOQ.	NA	Analyst, Laboratory Department Manager, and Data Validator	Accuracy	Same as QC Acceptance Limits.

**SAP Worksheet #28-32a: Laboratory QC Samples Table**

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Sediment

Analytical Group: Volatile Organic Compounds (Full Scan)

Analytical Method/ SOP Reference: SW846 8260B / CA-202

Analyte	CAS Number	Recovery Limits	
		Lower	Upper
Methyl tert-butyl ether	1634-04-4	81	125
Methyl Cyclohexane	108-87-2	71	127
Tert-Butyl alcohol	75-65-0	62	148
Xylenes (total)	1330-20-7	81	114

**SAP Worksheet #28-33: Laboratory QC Samples Table**

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Sediment

Analytical Group: Volatile Organic Compounds (Selected Ion Monitoring)

Analytical Method/ SOP Reference: SW846 8260B (SIM) / CA-220

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per preparation batch of twenty or fewer samples of similar matrix.	No target compounds > ½ LOQ (> LOQ for common laboratory contaminants) and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).	Correct the problem. Report sample results that are <LOD or >10x the blank concentration. Reprepare and reanalyze the method blank and all associated samples with results > LOD and < 10x the contaminated blank result.	Analyst, Laboratory Department Manager, and Data Validator	Bias/Contamination	Same as Method/SOP QC Acceptance Limits.

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Surrogate	Four per sample: Dibromofluoromethane 1,2-Dichloroethane-d4 Toluene-d8 4-Bromofluorobenzene (BFB)	%R must be within DoD QSM limits, if available; otherwise, within laboratory's nominal QC limits.	For QC and field samples, correct problem then reprepare and reanalyze all failed samples for failed surrogates in the associated preparatory batch, if sufficient sample material is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary. Contact Client if samples cannot be reanalyzed within hold time.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
LCS	One per preparation batch of twenty or fewer samples of similar matrix.	%R must be within DoD QSM limits, if available; otherwise, within laboratory's nominal QC limits(Refer to Worksheet #28-36a). Allow for the number of marginal exceedances presented in DoD QSM Table G-1.	Correct problem, then reprepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.  Contact Client if samples cannot be reanalyzed within hold time.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/ Bias	Same as Method/SOP QC Acceptance Limits.
MS/MSD	One per SDG or every 20 samples.	%R should be within the same limits as for the LCS. RPD should be ≤ 30%.	Corrective actions will not be taken for samples when recoveries are outside limits if likely due to matrix; otherwise contact client.	Analyst, Laboratory Department Manager, and Data Validator	Precision/Accuracy/ Bias	Same as Method/SOP QC Acceptance Limits.
IS	Four per sample: Pentafluorobenzene Chlorobenzene-d5 1,4-dichlorobenzene-d4 1,4-difluorobenzene	Retention times for internal standards must be ± 30 seconds and the responses within -50% to +100% of the ICAL midpoint standard.	Inspect mass spectrometer or gas chromatograph for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/ Bias	Same as Method/SOP QC Acceptance Limits.
Results between DL and LOQ	Not applicable (NA)	Apply "J" qualifier to results between DL and LOQ.	NA	Analyst, Laboratory Department Manager, and Data Validator	Accuracy	Same as QC Acceptance Limits.

**SAP Worksheet #28-33a: Laboratory QC Samples Table**

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Sediment

Analytical Group: Volatile Organic Compounds (Selected Ion Monitoring)

Analytical Method/ SOP Reference: SW846 8260B (SIM) / CA-220

Analyte	CAS Number	Recovery Limits	
		Lower	Upper
Methyl cyclohexane	108-87-2	50	150
Xylenes (total)	1330-20-7	50	150

**SAP Worksheet #28-34: Laboratory QC Samples Table**

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Sediment

Analytical Group: Semivolatile Organic Compounds (Full Scan)

Analytical Method/ SOP Reference: SW846 8270D / CA-226

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per preparation batch of twenty or fewer samples of similar matrix.	No target compounds > 1/2 LOQ (> LOQ for common laboratory contaminants) and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).	Correct the problem. Report sample results that are <LOD or >10x the blank concentration. Reprepare and reanalyze the method blank and all associated samples with results > LOD and < 10x the contaminated blank result.	Analyst, Laboratory Department Manager and Data Validator	Bias/contamination	Same as Method/SOP QC Acceptance Limits.

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Surrogate	6 per sample: 2-Fluorophenol Phenol-d6 Nitrobenzene-d5 2-Fluorobiphenyl 2,4,6-Tribromophenol Terphenyl-d14	%R must be within DoD QSM limits, if available; otherwise, within laboratory's statistically-derived QC limits.	For QC and field samples, correct problem then reprepare and reanalyze all failed samples for failed surrogates in the associated preparatory batch, if sufficient sample material is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary.  Contact Client if samples cannot be reprepared within hold time.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
LCS	One per preparation batch of twenty or fewer samples of similar matrix.	%R must be within DoD QSM limits, if available; otherwise, within laboratory's statistically-derived QC limits(Refer to Worksheet #28-38a). Allow for the number of marginal exceedances presented in DoD QSM Table G-1.	Correct problem, then reprepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available (see full explanation in Appendix E-1 of DoD QSM v4.2).  Contact Client if samples cannot be reprepared within hold time.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy / Bias	Same as Method/SOP QC Acceptance Limits.
MS/MSD	One per SDG or every 20 samples.	%R should be within the same limits as for the LCS. RPD should be $\leq 30\%$ .	Corrective actions will not be taken for samples when recoveries are outside limits if likely due to matrix, otherwise contact client.	Analyst, Laboratory Department Manager, and Data Validator	Precision/Accuracy/ Bias	Same as Method/SOP QC Acceptance Limits.
IS	Six per sample: 1,4-Dichlorobenzene-d4 Naphthalene-d8 Acenaphthene-d10 Phenanthrene-d10 Chrysene-d12 Perylene-d12	Retention times for internal standards must be $\pm 30$ seconds and the responses within -50% to +100% of the ICAL midpoint.	Inspect mass spectrometer or gas chromatograph for malfunctions. Mandatory reanalysis of samples analyzed while system was malfunctioning.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/ Bias	Same as Method/SOP QC Acceptance Limits.
Results between DL and LOQ	NA	Apply "J" qualifier to results between DL and LOQ.	NA	Analyst, Laboratory Department Manager, and Data Validator	Accuracy	Same as QC Acceptance Limits.

**SAP Worksheet #28-34a: Laboratory QC Samples Table**

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Sediment

Analytical Group: Semivolatile Organic Compounds (Full Scan)

Analytical Method/ SOP Reference: SW846 8270D / CA-226

Analyte	CAS Number	Recovery Limits	
		Lower	Upper
1,1-Biphenyl	92-52-4	31	99
1,2-Diphenylhydrazine	122-66-7	50	110
2,6-Dichlorophenol	87-65-0	38	98
Benzidine	92-87-5	10	150
Caprolactam	105-60-2	10	81
n-Nitrosopyrrolidine	930-55-2	30	150

**SAP Worksheet #28-35: Laboratory QC Samples Table**

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Sediment

Analytical Group: Organochlorine Pesticides

Analytical Method/ SOP Reference: SW846 8081B / CA-302

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per preparation batch of 20 or fewer samples of similar matrix.	No target compounds > 1/2 LOQ and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).	Correct the problem. Report sample results that are <LOD or >10x the blank concentration. Re-prepare and reanalyze the method blank and all associated samples with results > LOD and < 10x the contaminated blank result. Contact Client if samples cannot be re-prepared within hold time.	Analyst, Laboratory Department Manager and Data Validator	Bias/ contamination	Same as Method/SOP QC Acceptance Limits.
Surrogates	Two per sample: Decachloro-biphenyl Tetrachloro-m-xylene	%R must be within DoD QSM limits, if available; otherwise, within laboratory's statistically-derived or nominal QC limits.	For QC and field samples, correct problem then re-prepare and reanalyze all failed samples for failed surrogates in the associated preparatory batch, if sufficient sample material is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary.  Contact Client if samples cannot be re-prepared within hold time.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
LCS	One per preparation batch of 20 or fewer samples of similar matrix.	%R must be within DoD QSM limits, if available; otherwise, within laboratory's statistically-derived QC limits(Refer to Worksheet #28-41a). Allow for the number of marginal exceedances presented in DoD QSM Table G-1.	Correct problem, then re-prepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.  Contact Client if samples cannot be re-prepared within hold time.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/ Bias	Same as Method/SOP QC Acceptance Limits.
MS/MSD	One per SDG or every 20 samples.	%R should be within the same limits as for the LCS. RPD should be $\leq 30\%$ .	Corrective actions will not be taken for samples when recoveries are outside limits if likely due to matrix, otherwise contact client.	Analyst, Laboratory Department Manager, and Data Validator	Precision/ Accuracy/ Bias	Same as Method/SOP QC Acceptance Limits.
Second Column Confirmation	All positive results must be confirmed.	Results between primary and second column must be RPD $\leq 40\%$ .	None. Apply qualifier if RPD $>40\%$ and discuss in the case narrative. The higher of the two results will be reported unless matrix interference is apparent.	Analyst, Laboratory Department Manager, and Data Validator	Precision	Same as Method/SOP QC Acceptance Limits.
Results between DL and LOQ	NA	Apply "J" qualifier to results between DL and LOQ.	NA	Analyst, Laboratory Department Manager, and Data Validator	Accuracy	Same as QC Acceptance Limits.

**SAP Worksheet #28-35a: Laboratory QC Samples Table**

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Sediment

Analytical Group: Organochlorine Pesticides

Analytical Method/ SOP Reference: SW846 8081B / CA-302

Analyte	CAS Number	Recovery Limits	
		Lower	Upper
Toxaphene	8001-35-2	30	122

**SAP Worksheet #28-36: Laboratory QC Samples Table**

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Sediment

Analytical Group: Polychlorinated Biphenyls (Aroclors)

Analytical Method/ SOP Reference: SW846 8082A / CA-329

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per preparation batch of 20 or fewer samples of similar matrix.	No target compounds > 1/2 LOQ and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).	Correct the problem. Report sample results that are <LOD or >10x the blank concentration. Re-prepare and reanalyze the method blank and all associated samples with results > LOD and < 10x the contaminated blank result. Contact Client if samples cannot be re-prepared within hold time.	Analyst, Laboratory Department Manager and Data Validator	Bias/ contamination	Same as Method/SOP QC Acceptance Limits.
Surrogates	Two per sample: Decachloro-biphenyl Tetrachloro-m-xylene.	%R must be within DoD QSM limits, if available; otherwise, within laboratory's statistically-derived or nominal QC limits.	For QC and field samples, correct problem then re-prepare and reanalyze all failed samples for failed surrogates in the associated preparatory batch, if sufficient sample material is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary.  Contact Client if samples cannot be re-prepared within hold time.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
LCS	One per preparation batch of 20 or fewer samples of similar matrix.	%R must be within DoD QSM limits, if available; otherwise, within laboratory's statistically-derived QC limits(Refer to Worksheet #28-42a). Allow for the number of marginal exceedances presented in DoD QSM Table G-1.	Correct problem, then re-prepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.  Contact Client if samples cannot be re-prepared within hold time.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/ Bias	Same as Method/SOP QC Acceptance Limits.
MS/MSD	One per SDG or every 20 samples.	%R should be within the same limits as for the LCS. RPD should be $\leq 30\%$ .	Corrective actions will not be taken for samples when recoveries are outside limits if likely due to matrix, otherwise contact client.	Analyst, Laboratory Department Manager, and Data Validator	Precision/ Accuracy/ Bias	Same as Method/SOP QC Acceptance Limits.
Second Column Confirmation	All positive results must be confirmed.	Results between primary and second column must be RPD $\leq 40\%$ .	None. Apply qualifier if RPD $>40\%$ and discuss in the case narrative. The higher of the two results will be reported unless matrix interference is apparent.	Analyst, Laboratory Department Manager, and Data Validator	Precision	Same as Method/SOP QC Acceptance Limits.
Results between DL and LOQ	NA	Apply "J" qualifier to results between DL and LOQ.	NA	Analyst, Laboratory Department Manager, and Data Validator	Accuracy	Same as QC Acceptance Limits.

**SAP Worksheet #28-36a: Laboratory QC Samples Table**

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Sediment

Analytical Group: Polychlorinated Biphenyls (Aroclors)

Analytical Method/ SOP Reference: SW846 8082A / CA-329

Analyte	CAS Number	Recovery Limits	
		Lower	Upper
Tetrachloro-m-xylene	877-09-8	56	115

## SAP Worksheet #28-37: Laboratory QC Samples Table

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Sediment

Analytical Group: Total Organic Carbon (Lloyd Kahn)

Analytical Method/ SOP Reference: Lloyd Kahn / CA-741

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per analytical batch of 20 or fewer samples.	No target analytes > 1/2 LOQ and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).	Correct the problem. Report sample results that are <LOD or >10x the blank concentration. Re-prepare and reanalyze the method blank and all associated samples with results > LOD and < 10x the contaminated blank result.	Analyst, Laboratory Department Manager and Data Validator	Bias/contamination	Same as Method/SOP QC Acceptance Limits.
LCS	One per analytical batch of 20 or fewer samples.	%R must be within 80-120	(1) Investigate source of problem. (2) If the LCS recovery is high but the sample results are <LOQ, narrate. Otherwise, reprep a blank and the remaining samples.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias/ Contamination	Same as Method/SOP QC Acceptance Limits.
MS	One for every set 10 samples	%R must be within: 75-125	(1) Evaluate the samples and associated QC: i.e. If the LCS results are acceptable, narrate. (2) If both the LCS and MS are unacceptable reprep and reanalyze the samples and QC. (3) Notate sample result in raw data if matrix interference suspected.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
Laboratory Duplicate	One sample duplicate per 20 samples.	RPD $\leq$ 20 if both results are >3 x LOQ; RPD $\leq$ 100% for samples $\leq$ 3 x LOQ	(1) Investigate problem and reanalyze sample in duplicate (2) If RPD still >20, report original result with notation or narration.	Analyst, Laboratory Department Manager, and Data Validator	Precision	Same as Method/SOP QC Acceptance Limits.

**SAP Worksheet #28-38: Laboratory QC Samples Table**

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Sediment

Analytical Group: Acid Volatile Sulfide/Simultaneously Extracted Metals

Analytical Method/ SOP Reference: EPA 821/R-91-100 / CA-738

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per prep batch of 20 or fewer samples	No analytes detected > LOQ and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results (see DoD QSM Box D-1).	Investigate source of contamination. Reprep and analyze method blank and all samples processed with the contaminated blank	Analyst, Laboratory Department Manager, and Data Validator	Bias/ contamination	Same as Method/SOP QC Acceptance Limits.
LCS	One of each per prep batch	80-120 %R	Recalibrate and reanalyze sample batch	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/bias	Same as Method/SOP QC Acceptance Limits.
MS	One for every set of 10 samples	75-125 %R	Notate sample result in raw data with Notation I-1	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/bias	Same as Method/SOP QC Acceptance Limits.
Laboratory Duplicate	One sample duplicate per twenty samples or per batch	RPD $\leq$ 20	If lab QC in criteria and matrix interference suspected, flag data. Else, reanalyze	Analyst, Laboratory Department Manager, and Data Validator	Precision	Same as Method/SOP QC Acceptance Limits.

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**SAP Worksheet #28-39: Laboratory QC Samples Table**

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Sediment

Analytical Group: Grain Size (Sieve Only)

Analytical Method/ SOP Reference: ASTM D 422-63 / BR-GT-006, Rev. 6 and BR-GT-008

<b>QC Sample:</b>	<b>Frequency &amp; Number</b>	<b>Method/SOP QC Acceptance Limits</b>	<b>Corrective Action</b>	<b>Person(s) Responsible for Corrective Action</b>	<b>DQI</b>	<b>Measurement Performance Criteria</b>
None						

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**SAP Worksheet #28-40: Laboratory QC Samples Table**

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Sediment

Analytical Group: Pellet Count

Analytical Method/ SOP Reference: RC SOP 3-30/CA-774

<b>QC Sample:</b>	<b>Frequency &amp; Number</b>	<b>Method/SOP QC Acceptance Limits</b>	<b>Corrective Action</b>	<b>Person(s) Responsible for Corrective Action</b>	<b>DQI</b>	<b>Measurement Performance Criteria</b>
None						

**SAP Worksheet #28-41: Laboratory QC Samples Table**

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Sediment

Analytical Group: Toxicity Testing

Analytical Method/ SOP Reference: 28-day *Leptocheirus plumulosus* / QA-1448

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Laboratory Control	One per batch per assay	1. Survival $\geq$ 80% 2. Mean end dry weight > mean start dry weight 3. Evidence of reproduction	Repeat Assay	R. McIsaak, EcoRisk Project Manager	Laboratory Control Treatment	1. Survival $\geq$ 80% 2. Mean end dry weight > mean start dry weight 3. Evidence of reproduction

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**SAP Worksheet #28-42: Laboratory QC Samples Table**

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Sediment

Analytical Group: Macroinvertebrate Community Survey

Analytical Method/ SOP Reference: Benthic Infaunal Sample Processing SOP/Wet-Weight Biomass Analysis SOP

<b>QC Sample:</b>	<b>Frequency &amp; Number</b>	<b>Method/SOP QC Acceptance Limits</b>	<b>Corrective Action</b>	<b>Person(s) Responsible for Corrective Action</b>	<b>DQI</b>	<b>Measurement Performance Criteria</b>
None						

**SAP Worksheet #28-43: Laboratory QC Samples Table**

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Tissue

Analytical Group: Polynuclear Aromatic Hydrocarbons (Selected Ion Monitoring)

Analytical Method/ SOP Reference: SW846 8270D (SIM) / SVM-8270P

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per preparation batch of twenty or fewer samples of similar matrix.	No target compounds > ½ LOQ (> LOQ for common laboratory contaminants) and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).	Correct the problem. Report sample results that are <LOD or >10x the blank concentration. Reprepare and reanalyze the method blank and all associated samples with results > LOD and < 10x the contaminated blank result.	Analyst, Laboratory Department Manager and Data Validator	Bias/contamination	Same as Method/SOP QC Acceptance Limits.

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Surrogate	3 per sample: 2- Methylnaphthalene-d10 Fluorene-d10 Pyrene-d10	%R must be within DoD QSM limits, if available; otherwise, within laboratory's statistically-derived QC limits.	For QC and field samples, correct problem then reprepare and reanalyze all failed samples for failed surrogates in the associated preparatory batch, if sufficient sample material is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary.  Contact Client if samples cannot be reprepared within hold time.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
LCS	One per preparation batch of twenty or fewer samples of similar matrix.	%R must be within DoD QSM limits, if available; otherwise, within laboratory's statistically-derived QC limits. Allow for the number of marginal exceedances presented in DoD QSM Table G-1.	Correct problem, then reprepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available (see full explanation in Appendix E-1 of DoD QSM v4.2).  Contact Client if samples cannot be reprepared within hold time.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy / Bias	Same as Method/SOP QC Acceptance Limits.
MS/MSD	One per SDG or every 20 samples. Full Scan MS/MSD may be applied.	%R should be within the same limits as for the LCS. RPD should be $\leq 30\%$ .	Corrective actions will not be taken for samples when recoveries are outside limits if likely due to matrix, otherwise contact client.	Analyst, Laboratory Department Manager, and Data Validator	Precision/Accuracy/ Bias	Same as Method/SOP QC Acceptance Limits.
IS	Six per sample: 1,4- Dichlorobenzene-d4 Naphthalene-d8 Acenaphthene-d10 Phenanthrene-d10 Chrysene-d12 Perylene-d12	Retention times for internal standards must be $\pm 30$ seconds and the responses within -50% to +100% of the ICAL midpoint.	Inspect mass spectrometer or gas chromatograph for malfunctions. Mandatory reanalysis of samples analyzed while system was malfunctioning.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/ Bias	Same as Method/SOP QC Acceptance Limits.
Results between DL and LOQ	NA	Apply "J" qualifier to results between DL and LOQ.	NA	Analyst, Laboratory Department Manager, and Data Validator	Accuracy	Same as QC Acceptance Limits.

**SAP Worksheet #28-44: Laboratory QC Samples Table**

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Tissue

Analytical Group: ICP-AES Metals

Analytical Method/ SOP Reference: SW846 6010C / MET-6010

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per digestion batch of 20 or fewer samples of similar matrix.	No target metals > 1/2 LOQ (> LOQ for common laboratory contaminants) and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. For negative blanks, absolute value must be < LOD. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).	Correct the problem. Report sample results that are <LOD or >10x the blank concentration. Re-prepare and reanalyze the method blank and all associated samples with results > LOD and < 10x the contaminated blank result.	Analyst, Laboratory Department Manager and Data Validator	Bias/contamination	Same as Method/SOP QC Acceptance Limits.
LCS	One per digestion batch of 20 or fewer samples of similar matrix (varies by lot).	%R must be within DoD QSM limits, allowing for the marginal exceedances presented in DoD QSM Table G-1.	Re-digest and reanalyze all associated samples for affected analyte.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias/Contamination	Same as Method/SOP QC Acceptance Limits.
MS	One per digestion batch or SDG or every 20 samples.	%R should be within the DoD QSM limits for LCS, if sample < 4x spike added.	Flag results for affected analytes for all associated samples with "N."	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits for LCS.
Post-digestion Spike	When dilution test fails or analyte concentration in all samples < 50x LOD	%R within 75-125%.	Run associated samples by method of standard addition or flag results.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Laboratory Duplicate	One per digestion batch or SDG or every 20 samples.	Project-specific criteria: If values are $\geq 5x$ LOQ, RPD should be $\leq 20\%$ . If values are $< 5x$ LOQ, Absolute Difference should be $\leq$ LOQ.	Flag results for affected analytes for all associated samples.	Analyst, Laboratory Department Manager, and Data Validator	Precision	RPD $< 20\%$
ICP Serial Dilution	One per preparation batch of 20 or fewer samples of similar matrix.	If original sample result is at least $50x$ LOQ, 5-fold dilution must agree within $\pm 10\%$ of the original result.	Flag results for affected analytes for all associated samples with "E."	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
Results between DL and LOQ	NA	Apply "J" qualifier to results between DL and LOQ.	NA	Analyst, Laboratory Department Manager, and Data Validator	Accuracy	Same as QC Acceptance Limits.

**SAP Worksheet #28-45: Laboratory QC Samples Table**

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Tissue

Analytical Group: ICP-MS Metals

Analytical Method/ SOP Reference: SW846 6020A / MET-6020

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per digestion batch of 20 or fewer samples of similar matrix.	No target metals > ½ LOQ (> LOQ for common laboratory contaminants) and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. For negative blanks, absolute value < LOD. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).	Correct the problem. Report sample results that are <LOD or >10x the blank concentration. Reprepare and reanalyze the method blank and all associated samples with results > LOD and < 10x the contaminated blank result.	Analyst, Laboratory Department Manager and Data Validator	Bias/contamination	Same as Method/SOP QC Acceptance Limits
LCS	One per digestion batch of 20 or fewer samples of similar matrix.	%R must be within 80-120%, allowing for the marginal exceedances presented in DoD QSM Table G-1.	Redigest and reanalyze all associated samples for affected analyte.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias/Contamination	Same as Method/SOP QC Acceptance Limits.
MS	One per digestion batch SDG or every 20 samples.	Same as Method/SOP QC Acceptance Limits for LCS.	Flag results for affected analytes for all associated samples with an "N."	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
Post-digestion Spike	When dilution test fails or analyte concentration in all samples < 50x LOD	%R should be within 75-125%.	Run associated samples by method of standard addition or flag results.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Laboratory Duplicate	One per digestion batch or SDG or every 20 samples.	Project-specific criteria: If values are $\geq 5x$ LOQ, RPD should be $\leq 20\%$ . If values are $< 5x$ LOQ, Absolute Difference should be $\leq$ LOQ.	Flag results for affected analytes for all associated samples.	Analyst, Laboratory Department Manager, and Data Validator	Precision	RPD $< 20\%$
ICP Serial Dilution	One per preparation batch of twenty or fewer samples of similar matrix.	If original sample result is at least $50x$ LOQ, 5-fold dilution must agree within $\pm 10\%$ of the original result.	Flag results for affected analytes for all associated samples with "E."	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
IS	Appropriate IS required for all analytes in all samples. Mass of IS must be $< 50$ amu different from that of analyte	For each sample, IS intensity must be within 30-120% of that of initial calibration standard.	Reanalyze affected samples.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.

**SAP Worksheet #28-46: Laboratory QC Samples Table**

[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Tissue

Analytical Group: Mercury (CVAFS)

Analytical Method/ SOP Reference: SW846 1631 / MET-1631

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One per digestion batch of 20 or fewer samples of similar matrix.	No mercury > 1/2 LOQ and > 1/10 the amount measured in any sample or 1/10 the PAL, whichever is greater. For negative blanks, absolute value < LOD. Blank result must not otherwise affect sample results (see DoD QSM Box D-1).	Correct the problem. Report sample results that are <LOD or >10x the blank concentration. Reprepare and reanalyze the method blank and all associated samples with results > LOD and < 10x the contaminated blank result.	Analyst, Laboratory Department Manager and Data Validator	Bias/contamination	Same as Method/SOP QC Acceptance Limits.
LCS	One per digestion batch of 20 or fewer samples of similar matrix.	Water and Sediment: %R must be within 80-120%.	Redigest and reanalyze all associated samples for affected analyte.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias/Contamination	Same as Method/SOP QC Acceptance Limits.
MS	One per digestion batch or SDG or every 20 samples.	%R should be within 80-120% if sample < 4x spike added.	Flag results for affected analytes for all associated samples with "N."	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits for LCS.
Laboratory Duplicate	One per digestion batch or SDG or every 20 samples.	Project-specific criteria: If values are ≥ 5x LOQ, RPD should be ≤ 20%. If values are < 5x LOQ, Absolute Difference should be ≤ LOQ.	Flag results for affected analytes for all associated samples.	Analyst, Laboratory Department Manager, and Data Validator	Precision	RPD < 20%
Results between DL and LOQ	NA	Apply "J" qualifier to results between DL and LOQ	NA	Analyst, Supervisor	Accuracy	Same as QC Acceptance Limits.

## **SAP Worksheet #28 and 28a: Notes**

[\(UFP-QAPP Manual Section 3.4\)](#)

amu – atomic mass unit  
Calc. – calculated  
CAS – Chemical Abstracts Service  
DL – Detection Limit  
DoD QSM – Department of Defense Quality Systems Manual  
DQI – Data Quality Indicator  
ICAL – Initial Calibration  
ICP – Inductively Coupled Plasma  
IDL – Instrument Detection Limit  
IS – Internal Standard  
LCS – Laboratory Control Spike  
LCSD – Laboratory Control Spike Duplicate  
LOD – Limit of Detection  
LOQ – Limit of Quantitation  
MS – Matrix Spike  
MSD – Matrix Spike Duplicate  
NA – Not Applicable  
PAL – Project Action Limit  
PT – Proficiency Test  
QA – Quality Assurance  
QC – Quality Control  
R – Recovery  
RPD – Relative Percent Difference  
Rev. – Revision  
SDG – Sample Delivery Group  
SOP – Standard Operating Procedure

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## SAP Worksheet #29: Project Documents and Records Table

[\(UFP-QAPP Manual Section 3.5.1\)](#)

Document <sup>(1)</sup>	Where Maintained
Field Logbooks	Resolution Office/SharePoint
Chain-of-Custodies	Resolution Office/SharePoint
Equipment Calibration Records	Resolution Office/SharePoint
Boring Logs	Resolution Office/SharePoint
Monitoring Well Construction Logs	Resolution Office/SharePoint
Field Parameter Collection Records	Resolution Office/SharePoint
Electronic Data Deliverables	Resolution SharePoint; data will be loaded in project database; data will be loaded into the Navy NIRIS system.
Data Validation Reports	Resolution Office/SharePoint; revised data will be updated in project database.

Notes:

(1) – A Remedial Investigation (RI) Report will be prepared for formal documentation of the information inputs, analytical data, nature and extent of contamination, and risk assessment results for this investigation program. The final RI document will be maintained in the Resolution Office/Share Point files, will be uploaded to the Navy NIRIS system and will be placed in the Administrative Record.

**SAP Worksheet #30: Analytical Services Table**

[\(UFP-QAPP Manual Section 3.5.2.3\)](#)

Matrix/ Investigation	Analytical Group	Sample Locations/ID Numbers	Analytical SOP	Deliverable Level <sup>1</sup>	Data Package Turnaround Time	Laboratory/Organization (name and address, contact person and telephone number) <sup>2</sup>	Backup Laboratory/Organization (name and address, contact person and telephone number)
Soil Characterization							
	Polynuclear Aromatic Hydrocarbons (Full Scan and Selected Ion Monitoring)	See attached figures and Worksheet #27	CA-213, CA-226, CA-512, CA-526	Full	21 calendar days	Katahdin Analytical Services <sup>4</sup>	NA
	Nitroaromatics and Nitramines	See attached figures and Worksheet #27	CA-402	Full	21 calendar days	Katahdin Analytical Services <sup>4</sup>	NA
	ICP-MS Metals	See attached figures and Worksheet #27	CA-627	Full	21 calendar days	Katahdin Analytical Services <sup>3</sup>	NA
	ICP-AES Metals	See attached figures and Worksheet #27	CA-605, CA-608	Full	21 calendar days	Katahdin Analytical Services <sup>3</sup>	NA
	Mercury	See attached figures and Worksheet #27	CA-611	Full	21 calendar days	Katahdin Analytical Services <sup>3</sup>	NA
	Hexavalent Chromium	See attached figures and Work sheet #27	CA-625 (Contingency GEN-7199 <sup>6</sup> )	Full	21 calendar days	Katahdin Analytical Services <sup>3</sup>	NA
	Total Organic Carbon (Method 9060M)	See attached figures and Worksheet #27	CA-763	Full	21 calendar days	Katahdin Analytical Services <sup>3</sup>	NA
Physical/Geochemical Soil Characterization <sup>8</sup>							
	Grain Size (Sieve Only)	See attached figures and Worksheet #27	BR-GT-006, Rev. 6 and BR-GT-008	Full	21 calendar days	TestAmerica Burlington <sup>3</sup>	NA
	Bulk Density	See attached figures and Worksheet #27	BR-GT-018, Rev. 5	Full	21 calendar days	TestAmerica Burlington <sup>5</sup>	NA

Matrix/ Investigation	Analytical Group	Sample Locations/ID Numbers	Analytical SOP	Deliverable Level <sup>1</sup>	Data Package Turnaround Time	Laboratory/Organization (name and address, contact person and telephone number) <sup>2</sup>	Backup Laboratory/Organization (name and address, contact person and telephone number)
	Total Porosity (Calc. From Bulk Density and Specific Gravity)	See attached figures and Worksheet #27	BR-GT-004, Rev. 6	Full	21 calendar days	TestAmerica Burlington <sup>5</sup>	NA
	pH	See attached figures and Worksheet #27	CA-709	Full	21 calendar days	Katahdin Analytical Services <sup>3</sup>	NA
	Conductivity	See attached figures and Worksheet #27	CA-744	Full	21 calendar days	Katahdin Analytical Services <sup>3</sup>	NA
Groundwater Investigation							
	Polynuclear Aromatic Hydrocarbons (Full Scan and Selected Ion Monitoring)	See attached figures and Worksheet #27	CA-213, CA-226, CA-502	Full	21 calendar days	Katahdin Analytical Services <sup>4</sup>	NA
	ICP-MS Metals	See attached figures and Worksheet #27	CA-627	Full	21 calendar days	Katahdin Analytical Services <sup>3</sup>	NA
	ICP-AES Metals	See attached figures and Worksheet #27	CA-604, CA-608	Full	21 calendar days	Katahdin Analytical Services <sup>3</sup>	NA
	Mercury	See attached figures and Worksheet #27	CA-615	Full	21 calendar days	Katahdin Analytical Services <sup>3</sup>	NA
	Hexavalent Chromium	See attached figures and Worksheet #27	CA-772	Full	21 calendar days	Katahdin Analytical Services <sup>3</sup>	NA
	Salinity (Laboratory)	See attached figures and Worksheet #27	CA-748	Full	21 calendar days	Katahdin Analytical Services <sup>3</sup>	NA
Physical/Geochemical Groundwater Characterization <sup>8</sup>							
	Alkalinity	See attached figures and Worksheet #27	CA-739	Full	21 calendar days	Katahdin Analytical Services <sup>3</sup>	NA
	Anions (Chloride, Nitrate, Nitrite, Ortho-phosphate-P, Sulfate)	See attached figures and Worksheet #27	CA-742	Full	21 calendar days	Katahdin Analytical Services <sup>3</sup>	NA

Matrix/ Investigation	Analytical Group	Sample Locations/ID Numbers	Analytical SOP	Deliverable Level <sup>1</sup>	Data Package Turnaround Time	Laboratory/Organization (name and address, contact person and telephone number) <sup>2</sup>	Backup Laboratory/Organization (name and address, contact person and telephone number)
	Total Organic Carbon (Method 9060M)	See attached figures and Worksheet #27	CA-763	Full	21 calendar days	Katahdin Analytical Services <sup>3</sup>	NA
	Methane/Ethane/Ethene	See attached figures and Worksheet #27	CA-336	Full	21 calendar days	Katahdin Analytical Services <sup>3</sup>	NA
	Total Suspended Solids	See attached figures and Worksheet #27	CA-720	Full	21 calendar days	Katahdin Analytical Services <sup>4</sup>	NA
	Total Dissolved Solids	See attached figures and Worksheet #27	CA-719	Full	21 calendar days	Katahdin Analytical Services <sup>4</sup>	NA
Sediment Investigation							
	Polynuclear Aromatic Hydrocarbons (Full Scan and Selected Ion Monitoring)	See attached figures and Worksheet #27	CA-213, CA-226, CA-512, CA-526	Full	21 calendar days/7 calendar days <sup>7</sup>	Katahdin Analytical Services <sup>4</sup>	NA
	ICP-MS Metals	See attached figures and Worksheet #27	CA-627	Full	21 calendar days/7 calendar days <sup>9</sup>	Katahdin Analytical Services <sup>3</sup>	NA
	ICP-AES Metals	See attached figures and Worksheet #27	CA-605, CA-608	Full	21 calendar days/7 calendar days <sup>9</sup>	Katahdin Analytical Services <sup>3</sup>	NA
	Mercury	See attached figures and Worksheet #27	CA-615	Full	21 calendar days/7 calendar days <sup>9</sup>	Katahdin Analytical Services <sup>3</sup>	NA
	Hexavalent Chromium	See attached figures and Worksheet #27	CA-625 (Contingency GEN-7199 <sup>7</sup> )	Full	21 calendar days	Katahdin Analytical Services <sup>3</sup> (Contingency ALS Rochester, NY <sup>6</sup> )	NA
	Pesticides	See attached figures and Worksheet #27	CA-302, CA-500, CA-524, CA-549	Full	21 calendar days/7 calendar days <sup>7</sup>	Katahdin Analytical Services <sup>3</sup>	NA

Matrix/ Investigation	Analytical Group	Sample Locations/ID Numbers	Analytical SOP	Deliverable Level <sup>1</sup>	Data Package Turnaround Time	Laboratory/Organization (name and address, contact person and telephone number) <sup>2</sup>	Backup Laboratory/Organization (name and address, contact person and telephone number)
	Polychlorinated Biphenyls	See attached figures and Worksheet #27	CA-329, CA-500, CA-524, CA-549	Full	21 calendar days	Katahdin Analytical Services <sup>3</sup>	NA
	Volatile Organic Compounds (Full Scan)	See attached figures and Worksheet #27	CA-202, CA-214	Full	21 calendar days	Katahdin Analytical Services <sup>3</sup>	NA
	Volatile Organic Compounds (Selected Ion Monitoring)	See attached figures and Worksheet #27	CA-220, CA-214	Full	21 calendar days	Katahdin Analytical Services <sup>4</sup>	NA
	Semivolatile Organic Compounds and Polynuclear Aromatic Hydrocarbons (Full Scan)	See attached figures and Worksheet #27	CA-226, CA-512, CA-526	Full	21 calendar days/7 calendar days <sup>7</sup>	Katahdin Analytical Services <sup>3</sup>	NA
Physical/Geochemical Sediment Characterization <sup>8</sup>							
	Total Organic Carbon (Lloyd Kahn)	See attached figures and Worksheet #27	CA-741	Full	21 calendar days	Katahdin Analytical Services <sup>3</sup>	NA
	Acid Volatile Sulfide/Simultaneously Extracted Metals	See attached figures and Worksheet #27	CA-738	Full	21 calendar days	Katahdin Analytical Services <sup>3</sup>	NA
	Grain Size (Sieve Only)	See attached figures and Worksheet #27	BR-GT-006, Rev. 6 and BR- GT-008	Full	21 calendar days	TestAmerica Burlington <sup>3</sup>	NA
Sediment-Lead Pellet Assessment							
	Pellet Counting	See attached figures and Worksheet #27	CA-774	Full	21 calendar days	Katahdin Analytical Services	NA
	Sample Archival	See attached figures and Worksheet #27	NA	NA	NA	Katahdin Analytical Services	NA

Matrix/ Investigation	Analytical Group	Sample Locations/ID Numbers	Analytical SOP	Deliverable Level <sup>1</sup>	Data Package Turnaround Time	Laboratory/Organization (name and address, contact person and telephone number) <sup>2</sup>	Backup Laboratory/Organization (name and address, contact person and telephone number)
Sediment Ecological Risk Investigation <sup>8</sup>							
	Sediment Toxicity Testing	See attached figures and Worksheet #27	QA-1448	Toxicity Testing	Draft: 30 calendar days from test termination; Final: 7 days from receipt of RC comments	EnviroSystems, Incorporated <sup>4</sup>	NA
	Macroinvertebrate Community Survey	See attached figures and Worksheet #27	Benthic Infaunal Sample Processing SOP/Wet- Weight Biomass Analysis SOP	Macro- invertebrate Survey	28 calendar days	Resolution <sup>5</sup> Jim Blake Woods Hole, MA	NA
Shellfish Tissue Investigation	Polynuclear Aromatic Hydrocarbons (Selected Ion Monitoring)	See attached figures and Worksheet #27	SVM-8270P	Full	35 calendar days	ALS Kelso, WA <sup>7</sup>	NA
	ICP-MS Metals	See attached figures and Worksheet #27	MET-6020	Full	35 calendar days	ALS Kelso, WA <sup>7</sup>	NA
	ICP-AES Metals	See attached figures and Worksheet #27	MET-ICP	Full	35 calendar days	ALS Kelso, WA <sup>7</sup>	NA
	Mercury	See attached figures and Worksheet #27	MET-1631	Full	35 calendar days	ALS Kelso, WA <sup>7</sup>	NA
	Percent Lipids	See attached figures and Worksheet #27	EXT-Lipid	Full	35 calendar days	ALS Kelso, WA <sup>7</sup>	NA

#### Note 1: DATA DELIVERABLES

##### Full

A full data deliverable is the most complete deliverable available from commercial laboratories. The full data deliverable consists of a hardcopy data deliverable (HDD) and Electronic Data Deliverable (EDD).

The detailed requirements for a full data deliverable HDD are presented in the Resolution's *Statement Of Work To Master Services Agreement For Laboratory Analytical Services, Appendix C* (February 2012). The requirements are consistent with the requirements set forth in Section 5.10 of the DoD QSM, V4.2. The HDD will be delivered in paper and/or pdf. The pdf must be bookmarked and searchable, and will be submitted on CD ROM to the Project Data Validation Coordinator or Project Chemist (to be determined prior to data receipt). The HDD will consist of the following:

- I. Cover Sheet
- II. Table of Contents
- III. Case Narrative
- IV. Laboratory Communications
- V. Sample Management Records (CoC forms, shipping documents, sample condition receipt, etc.)
- VI. Method Sections
  - A. Summary Forms
  - B. Supporting Raw Data (including copies of pertinent logbooks and bench sheets)

The EDD will be delivered on CD ROM or via email to the Project Data Validation Coordinator or Project Chemist (to be determined prior to data receipt). Detailed EDD requirements are presented in the *Resolution Data Deliverables Specification for EQUIS Deliverables* (March 16, 2010), presented in the work order issued to the laboratory. The EDD is an Resolution Custom EQUIS 4-file format which can be obtained directly from the EQUIS Data Processor. Each EDD will comprise 4 files, to describe samples, tests, results, and batches. The format file has two different sections for samples, Field and Lab, only one of which can be included in the EDD. The list of valid values applicable to the project and the section (Field or Lab) to use will be communicated by the Resolution Data Manager at project setup, prior to submission of samples.

##### Field Worksheets

Documents associated with these analyses will consist of the worksheets used for low-flow groundwater sampling and instrument calibration. Water quality parameters measured during low-flow sampling of groundwater wells (DO, ORP, specific conductance, temperature, and turbidity) and ferrous iron test kit results will be recorded on the Groundwater Sample Collection Record Form presented in Resolution Consultant's *Procedure 3-14, Monitoring Well Sampling*. The associated instrument calibration and calibration checks for water quality parameters will be documented on the Field Instrument Calibration Form presented in Resolution's *Procedure 3-24, Water Quality Parameter Testing for Groundwater Sampling*. The calibration and calibration checks for the ferrous iron test kits will be recorded in the field logbook. Resolution's Procedures are provided in Appendix A. Completed worksheets will be provided along with copies of the field logbook pages by the Resolution's Field Team Leader to the Resolution CTO Manager within one week of the conclusion of each field sampling event.

##### Toxicity Testing

Draft and final reports are to be provided electronically on a CD as PDFs including all associated text, tables, and supporting materials (e.g., lab data sheets, statistical program outputs). In addition, the report tables and replicate-by-replicate test termination results (e.g., survival, growth, reproduction) are to be provided in spreadsheet format.

Macroinvertebrate Survey

Documentation will include a description of the methods used and will provide the following information for each sample – number of organisms counted, identification of individuals to family/major taxa, and measurement of wet weight biomass.

<b>Note 2: LABORATORY CONTACT INFORMATION</b>					
<p>Katahdin Analytical Services 600 Technology Way Scarborough, Maine 04074</p> <p>Project Manager: Jennifer Obrin Federal Programs Project Manager Direct: 207.874.2400 x17 Fax: 207.775.4029 Email: <a href="mailto:jobrin@katahdinlab.com">jobrin@katahdinlab.com</a></p> <p>(Note that a laboratory courier may be available)</p>	<p>TestAmerica Burlington 30 Community Drive Suite 11 South Burlington, VT 05403</p> <p>Kathryn Kelly Telephone:802.660.1990 (subcontracted by Katahdin Analytical Services)</p>	<p>Sediment Toxicity Laboratory EnviroSystems, Incorporated One Lafayette Road PO Box 778 Hampton, NH 03843-0778</p> <p>Ken Simon Telephone: 603.926.3345</p>	<p>Macroinvertebrate Community Survey Laboratory Resolution Consultants 89 Water Street Woods Hole, Massachusetts 02543</p> <p>Jim Blake Telephone: 508.457.7900</p>	<p>ALS Kelso 1317 South 13<sup>th</sup> Ave Kelso, WA 98626</p> <p>Lynda Huckestein 360.577.7222 Lynda.Huckestein@alsglobal.com</p>	<p>ALS Rochester 1565 Jefferson Road, Building 300, Suite 360 Rochester, NY 14623</p> <p>Michael Perry 585.288.5380 (Subcontracted by Katahdin Analytical Services)</p>

<b>Notes 3 -7: DoD ELAP ACCREDITATION</b>
<p>3. The laboratory holds current DoD ELAP Accreditation for this analysis. Certificates of accreditation are presented in Appendix B: Katahdin Analytical Services Certificate Number L2223 is granted through November 4, 2012. Current accreditation will be verified prior to submission of samples for analysis. Katahdin Analytical Services also holds current certification from the State of Rhode Island and Providence Plantations Department of Health for Potable and Non-potable Water Organic and Inorganic Chemistry (Certificate Number LAO00303, current through 12/30/2012).</p> <p>4. Certification of accreditation is not presented for this analysis. In the case of VOC and SVOC SIM analyses, this is believed to be an oversight of the accrediting company as it is a consistent finding among the laboratories solicited. Documentation of accreditation will be required prior to submittal of samples for these analyses. In the case of Sediment Toxicity, the laboratory is currently in the process of obtaining DoD ELAP accreditation for all of its toxicological testing services. It is anticipated that the accreditation process will be completed before the end of 2012, prior to sampling activities.</p> <p>5. DoD ELAP accreditation for this analysis was not sought because the data quality objectives allow for screening level data. In the case of field measurements for salinity, comparability with laboratory results will be evaluated and subsequent salinity field measurements will only be considered as definitive data if comparability is sufficient to meet DQOs for the data.</p> <p>6. If analysis of sediment or soil samples by Method 7196 fail matrix spike recovery criteria such that data rejection is recommended and reducing conditions are not indicated, analysis by Method 7199 may be conducted. Analysis will be subcontracted by Katahdin to ALS Rochester, NY, which holds current DoD ELAP certification for Method 7199.</p> <p>7. ALS Kelso holds current DoD ELAP Accreditation for all analyses proposed for tissue analysis in the solid matrix except Method 1631E. The laboratory will demonstrate the required certification for all proposed analyses in the tissue matrix prior to commencement of sampling activities.</p>

<b>Note 8: SAMPLE LOCATIONS</b>
<p>8. A subset of soil, groundwater and sediment samples will be collected for physical and geochemical characterization. It has not yet been determine which sample locations the additional samples will be collected from. Similarly, sediment samples for ecological risk assessment (i.e., toxicity testing and macroinvertebrate sampling) samples will be determined in the field.</p>

**Note 9: TURNAROUND TIME**

9. A 7-calendar-day turnaround time will be obtained for the surficial sediment samples from MRP Site 1 and the background sediment samples in order to allow sufficient time to select samples for toxicity testing and obtain analytical data for the additional analyses that will be conducted on these samples while still meeting analytical holding times for those additional analyses.

**ABBREVIATIONS:**

NA- Not Available

RC – Resolution Consultants

**SAP Worksheet #31: Planned Project Assessments Table**

[\(UFP-QAPP Manual Section 4.1.1\)](#)

<b>Assessment Type</b>	<b>Frequency</b>	<b>Internal or External</b>	<b>Organization Performing Assessment</b>	<b>Person(s) Responsible for Performing Assessment (title and organizational affiliation)</b>	<b>Person(s) Responsible for Responding to Assessment Findings (title and organizational affiliation)</b>	<b>Person(s) Responsible for Identifying and Implementing CA (title and organizational affiliation)</b>	<b>Person(s) Responsible for Monitoring Effectiveness of CA (title and organizational affiliation)</b>
Safety Audit	Once during first week of field work	Internal	Resolution	Resolution Health and Safety Officer	Resolution Field Team Leader and Resolution CTO Manager	Resolution Field Team Leader and Resolution CTO Manager	Resolution Health and Safety Officer
On-Site Technical Audit of Field Activities	Once at start of field operations; follow-up audits as needed	Internal	Resolution	Resolution QA Coordinator	Resolution Field Team Leader and Resolution CTO Manager	Resolution Field Team Leader and Resolution CTO Manager	Resolution QA Coordinator

Notes:

- CA - corrective action
- CTO - Contract Task Order
- QA - Quality Assurance

**SAP Worksheet #32: Assessment Findings and Corrective Action Responses Table**

[\(UFP-QAPP Manual Section 4.1.2\)](#)

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, organization)	Timeframe for Response
Safety Audit	Written audit report	Melissa Cannon, Resolution CTO Manager; Phil Platcow, Resolution Environment Safety, Health & Environment Manager, U.S. Northeast Region	Verbal summary of major findings within 24 hours; written report within one month	Stop work may be issued for major finding that poses severe and immediate risk; Memo with possible follow-up audit	Melissa Cannon, Resolution CTO Manager; Phil Platcow, Resolution Environment Safety, Health & Environment Manager, U.S. Northeast Region; Sean Liddy, Resolution Health and Safety Officer	Major findings within 24 hours; response to written report within one week
On-Site Technical Audit of Field Activities	Written audit report	Melissa Cannon, Resolution CTO Manager	Verbal summary of major findings within 24 hours; written report within one month	Memo with possible follow-up audit	Melissa Cannon, Resolution CTO Manager; Resolution QA Coordinator	Major findings within 24 hours; response to written report within one week

Notes:

- CA - corrective action
- CTO - Contract Task Order
- QA - Quality Assurance

**SAP Worksheet #33: Quality Assurance Management Reports Table**

[\(UFP QAPP Manual Section 4.2\)](#)

<b>Type of Report</b>	<b>Frequency (daily, weekly monthly, quarterly, annually, etc.)</b>	<b>Projected Delivery Date(s)</b>	<b>Person(s) Responsible for Report Preparation (title and organizational affiliation)</b>	<b>Report Recipient(s) (title and organizational affiliation)</b>
Technical Audit of Field Activities: Audit Report	Once at start of field program; follow-up audits as needed	Dependent on field schedule; Please refer to Worksheet #16	Resolution QA Coordinator	Resolution CTO Manager; Resolution QA Coordinator
Safety Audit	Once during first week of field work	Dependent on field schedule; Please refer to Worksheet #16	Resolution Health and Safety Officer	Resolution CTO Manager; Resolution Environment Safety, Health & Environment Manager, U.S. Northeast Region
Daily Field Progress Reports	Daily	Daily	Resolution Field Team Leader	Resolution CTO Manager
Data Validation Reports	One per SDG; after laboratory data is received and validated	Estimated 90 days after receipt of complete SDG	Resolution Data Validation Coordinator	Resolution CTO Manager, Resolution Project Chemist
Data Usability Report	Once per field program; after all data are validated	Estimated 30 days after completion of data validation	Resolution Project Chemist	Resolution CTO Manager
RI Report	Once per report iterate	Estimated 45 days after completion of data validation	Resolution CTO Manager	Navy, USEPA, RIDEM

Notes:

CTO - Contract Task Order  
RI – Remedial Investigation  
QA - Quality Assurance  
SDG – Sample Delivery Group  
RI Report includes Human Health and Ecological Risk Assessments

**SAP Worksheets #34-36: Data Verification and Validation (Steps I and IIa/IIb) Process Table**

[\(UFP-QAPP Manual Section 5.2.1\)](#), [\(UFP-QAPP Manual Section 5.2.2\)](#), [\(Figure 37 UFP-QAPP Manual\)](#), [\(Table 9 UFP-QAPP Manual\)](#)

<b>Data Review Input</b>	<b>Description</b>	<b>Responsible for Verification (name, organization)</b>	<b>Step I / IIa / IIb<sup>1</sup></b>	<b>Internal/ External</b>
Chain-of-Custody Forms	The Resolution Field Team Leader or designee will review and sign each chain-of-custody form to verify that all samples listed are included in the shipment to the laboratory and the sample information is accurate. The chain-of-custody forms will be signed by the sampler and a copy will be retained for the project file, the Resolution CTO Manager, and the Resolution Data Validator. See SOP.	Field Team Leader and Field Crew, Resolution	I	Internal
Chain-of-Custody Forms	The Laboratory Sample Custodian will review the sample shipment for completeness and integrity and will sign accepting the shipment.	Laboratory Sample Custodian	I	External
Chain-of-Custody Forms	The data validator will check that the chain-of-custody form was signed and dated by the Resolution SS or designee relinquishing the samples and also by the Laboratory Sample Custodian receiving the samples for analyses. The data validator will Confirm that the custody and integrity of the samples were maintained from collection to analysis and that custody records are complete and any deviations are recorded.	Data Validator, Resolution	I	Internal
Field SOPs/Field Logs/Sample Collection	Confirm that all sampling SOPs were followed. Verify that deviations have been documented and performance criteria have been achieved, that samples were correctly identified, that sampling location coordinates are accurate, and that documentation establishes an unbroken chain of custody from sample collection to report generation. Verify that the correct sampling and analytical procedures were applied. Verify that the SAP was followed as written and that any deviations are documented.	CTO Manager, Field Team Leader, or designee, Resolution	IIa	Internal
Sample Tables	Proposed samples verified to have been collected.	Field Team Leader and Field Crew, Resolution	IIa	Internal

<b>Data Review Input</b>	<b>Description</b>	<b>Responsible for Verification (name, organization)</b>	<b>Step I / IIa / IIb<sup>1</sup></b>	<b>Internal/ External</b>
Sample Log Sheets	Log sheets completed as samples are collected in the field are verified for completeness and are maintained at the project office.	CTO Manager, Field Team Leader, or designee, Resolution	IIa	Internal
Field QC Samples	Verify that field QC samples listed in Worksheet #12 were collected as required.	Field Team Leader or designee, Resolution	IIa	Internal
Sample Coordinates	Sample locations will be validated to be correct and in accordance with the SAP (compare map of proposed locations to map of actual locations).	CTO Manager, Field Team Leader, or designee, Resolution	IIa	Internal
Analytical SOPs	Confirm that all laboratory SOPs were followed. Verify that the correct analytical methods/SOPs were applied.	Laboratory Quality Assurance Manager	IIa	Internal
Documentation of Method QC Results	Establish that all method QC samples were analyzed and in control as listed in the analytical SOPs. If method QA is not in control, the Laboratory Quality Assurance Manager will contact Resolution for guidance prior to report preparation.	Laboratory Quality Assurance Manager	IIa	Internal
Analytical Data Packages	All analytical data packages will be verified internally for completeness by the laboratory performing the work. The Laboratory Quality Assurance Manager will sign the case narrative for each data package.	Laboratory Quality Assurance Manager	IIa	Internal
Analytical Data Packages	Verify that the data package contains all the elements required by the laboratory Master Services Agreement and laboratory work order. Missing information will be requested from the laboratory, and data validation (if applicable) will be suspended until missing data are received.	Data Validator, Resolution	IIa	External
Documentation of Analytical Reports for Completeness	Confirm that the required analytical samples have been collected, appropriate sample identifications have been used, and correct analytical methods have been applied. Data Validator will verify that elements of the data package required for validation are present, and if not, the laboratory will be contacted and the missing information will be requested. Validation will be performed as described below per Worksheet #36. Verify all data have been transferred correctly and completely to the final SQL database.	Data Validator, Resolution	IIa	External

Data Review Input	Description	Responsible for Verification (name, organization)	Step I / IIa / IIb <sup>1</sup>	Internal/ External
Electronic Data Deliverables	The electronic data will be compared to the chain-of-custody form and hard copy data package to verify accuracy and completeness.	Data Validator, Resolution	IIa	External
Analytical Data Packages	For the matrices and analyses presented in the table below*, Limited Data Validation will be performed using criteria for the methods listed in Worksheet #'s 12, 15, 24, and 28, the DoD QSM, laboratory work order, and laboratory SOPs. If not addressed in the worksheets or DoD QSM, the logic outlined in the <i>Region I, USEPA-New England Data Validation Functional Guidelines For Evaluating Environmental Analyses</i> (December 1996), <i>USEPA National Functional Guidelines for Superfund Organic Methods Data Review</i> (June 2008), and <i>USEPA National Functional Guidelines for Inorganic Methods Data Review</i> (January 2010) will be used to apply qualifiers to data.	Data Validator, Resolution	IIb	External

Data Review Input	Description	Responsible for Verification (name, organization)	Step I / IIa / IIb <sup>1</sup>	Internal/ External
Analytical Data Packages (in addition to Limited Validation)	<p><u>Data Results:</u> Spot-check the summary form results to confirm they match the raw data.</p> <p><u>Holding Times:</u> Verify that the samples were shipped and stored at the required temperature and that the sample pH values for chemically preserved samples meet the requirements listed in Worksheet # 19. Verify that the analyses were performed within the holding times listed in Worksheet # 19.</p> <p><u>Laboratory Data Results for Accuracy:</u> Confirm that the laboratory QC samples listed in Worksheet # 28 were analyzed and that the MPCs listed in Worksheet # 12 were met for all field samples and QC analyses. Verify that specified field QC samples were collected and analyzed and that the analytical QC criteria set up for this project were met.</p> <p><u>Field and Laboratory Duplicate Analyses for Precision:</u> Verify the field sampling precision by checking the RPD for field duplicate samples. Verify laboratory precision by checking RPDs or %D values from laboratory duplicate, MS/MSD, MS/Sample Duplicate, and LCS/LCSD analyses. Confirm compliance with the methods and project MPC accuracy goals listed in Worksheet # 12 and 28.</p> <p><u>Project Quantitation Limits for Sensitivity:</u> Verify that the QLs listed in Worksheet # 15 were achieved.</p> <p><u>Sample Results for Representativeness:</u> Verify that the laboratory recorded the temperature of each sample at sample receipt and the pH of chemically preserved samples to confirm sample integrity from sample collection to analysis.</p>	Data Validator, Resolution	IIa/IIb	External
Data Validation Report	Summarize deviations from methods, procedures, or contracts. Qualify data results based on method or QC deviation and explain all data qualifications. Print a copy of the project database, qualified data depicting data qualifiers, and data qualifiers codes that summarize the reason for data qualifications. Determine if the data met the MPCs and determine the impact of any deviations on the technical usability of the data.	Data Validator, Resolution	IIa/IIb	External

Data Review Input	Description	Responsible for Verification (name, organization)	Step I / IIa / IIb <sup>1</sup>	Internal/ External
Project Action Limits	Discuss the impact of matrix interferences or sample dilutions performed, because of the high concentration of one or more contaminants, on the other target compounds reported as not detected. Document this usability issue and inform the Resolution CTO Manager.	Data Validator, Resolution	IIa/IIb	External
SAP QC Sample Documentation	Verify that all QC samples specified in the SAP were collected and analyzed and that the associated results were within prescribed SAP acceptance limits. Verify that QC samples and standards prescribed in analytical SOPs were analyzed and within the prescribed control limits. If any significant QC deviations occur, the Laboratory Quality Assurance Manager shall have contacted the Resolution Project Chemist or CTO Manager.	Data Validator, Resolution	IIa/IIb	External
Analytical Data Deviations	Determine the impact of any deviation from sampling or analytical methods, SOP requirements, and matrix interferences on the analytical results.	Data Validator, Resolution	IIa/IIb	External

Notes: 1 IIa=compliance with methods, procedures, and contracts [see Table 10, page 117, UFP-QAPP manual, V.1, March 2005.]  
IIb=comparison with measurement performance criteria in the SAP [see Table 11, page 118, UFP-QAPP manual, V.1, March 2005]

<b>*Data Undergoing Limited Data Validation</b>	
<b>Matrix</b>	<b>Analytical Group</b>
Soil	Polynuclear Aromatic Hydrocarbons (Full Scan and Selected Ion Monitoring)
	Nitroaromatics and Nitramines
	ICP-MS Metals;
	ICP-AES Metals
	Mercury (CVAA)
Groundwater	Hexavalent Chromium
	Polynuclear Aromatic Hydrocarbons (Full Scan and Selected Ion Monitoring)
	ICP-MS Metals;
	ICP-AES Metals
	Mercury (CVAA)
	Hexavalent Chromium
	Salinity (Laboratory)
	Alkalinity
Anions (Chloride, Nitrate, Nitrite, Ortho-phosphate-P, Sulfate)	
Sediment	Methane/Ethane/Ethene
	Polynuclear Aromatic Hydrocarbons (Full Scan and Selected Ion Monitoring)
	ICP-MS Metals;
	ICP-AES Metals
	Mercury (CVAA)
	Hexavalent Chromium
Shellfish Tissue	Acid Volatile Sulfide/Simultaneously Extracted Metals
	Polynuclear Aromatic Hydrocarbons (Selected Ion Monitoring)
	ICP-MS Metals;
	ICP-AES Metals
	Mercury (CVAFS)

## **SAP Worksheet #37: Usability Assessment**

[\(UFP-QAPP Manual Section 5.2.3\)](#)

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

Resolution Consultant's data validation staff will validate all laboratory data in accordance with the protocols described in Worksheets #34-36. These procedures are consistent with USEPA National and Regional Data Validation Functional Guidelines. The Project Chemist, in conjunction with the project team, will determine whether the analytical data meet the requirements to support the RI. The results of laboratory measurements will be compared to the data quality objectives described in Worksheet #11.

**Describe the evaluative procedures used to assess overall measurement error associated with the project**

During the data validation process the validator will use information confirming sample identification, sample preparation, analysis within holding time, instrument calibration data, and results of QC samples designed to assess blank contamination, analytical precision, and accuracy to identify any limitations in data use and, if known, data bias. The validator will apply qualifiers as needed to reflect any limitations on the use of specific data points and prepare a report detailing the information reviewed, data limitations, and overall usability. Patterns of data use limitations or anomalies which become apparent during the validation process or during use will be reviewed with the Project Chemist and the appropriate laboratory. Data that do not meet the quality acceptance limits of Worksheet #28, or quality levels of Worksheet #15, or analytical performance criteria specified in Worksheet #12 will be clearly identified in the database so data users are aware of any limitations associated with data usability. Details of the problems identified during data validation and the bias in the data will be provided in the associated validation memorandum.

**Identify the personnel responsible for performing the usability assessment**

Data validation will be performed by Resolution's data validation staff under the supervision of the Data Validation Coordinator and Project Chemist.

**Describe the documentation that will be generated during usability assessment and how usability assessment results will be presented so that they identify trends, relationships (correlations), and anomalies**

The documentation generated during data validation will include a comprehensive memorandum that describes the information reviewed, the results of this review, and provides a recommendation

on overall data usability and limitations on specific data points. The memorandum and associated validation worksheets provide information on the samples included in the review and the date they were collected, the condition of samples when received at the laboratory and any discrepancies noted during the receiving process, verification of sample preparation and analysis within the method specified holding time, instrument calibration information, review of associated QC analyses including blanks, LCSs, MSs, and field and/or laboratory duplicates, and verification of selected reported values from raw data. As a result of this review standard qualifiers are entered into the database so that data users can readily identify any limitations associated with a specific data point.

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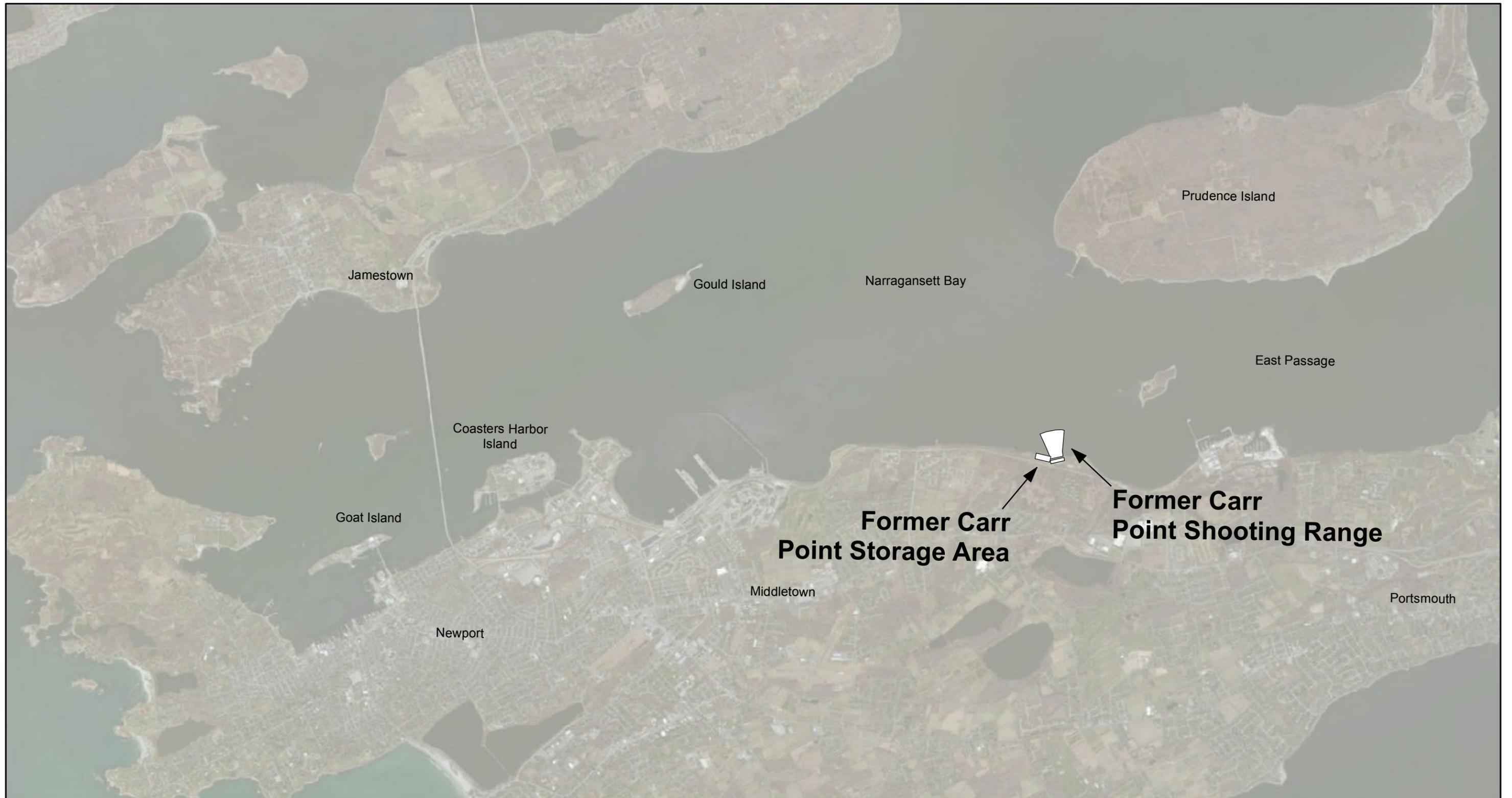
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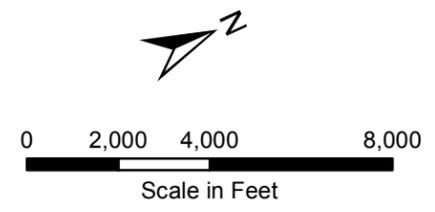
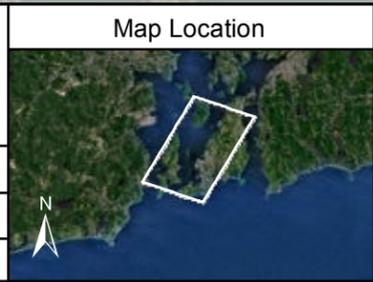
## Figures



**Former Carr Point Storage Area**

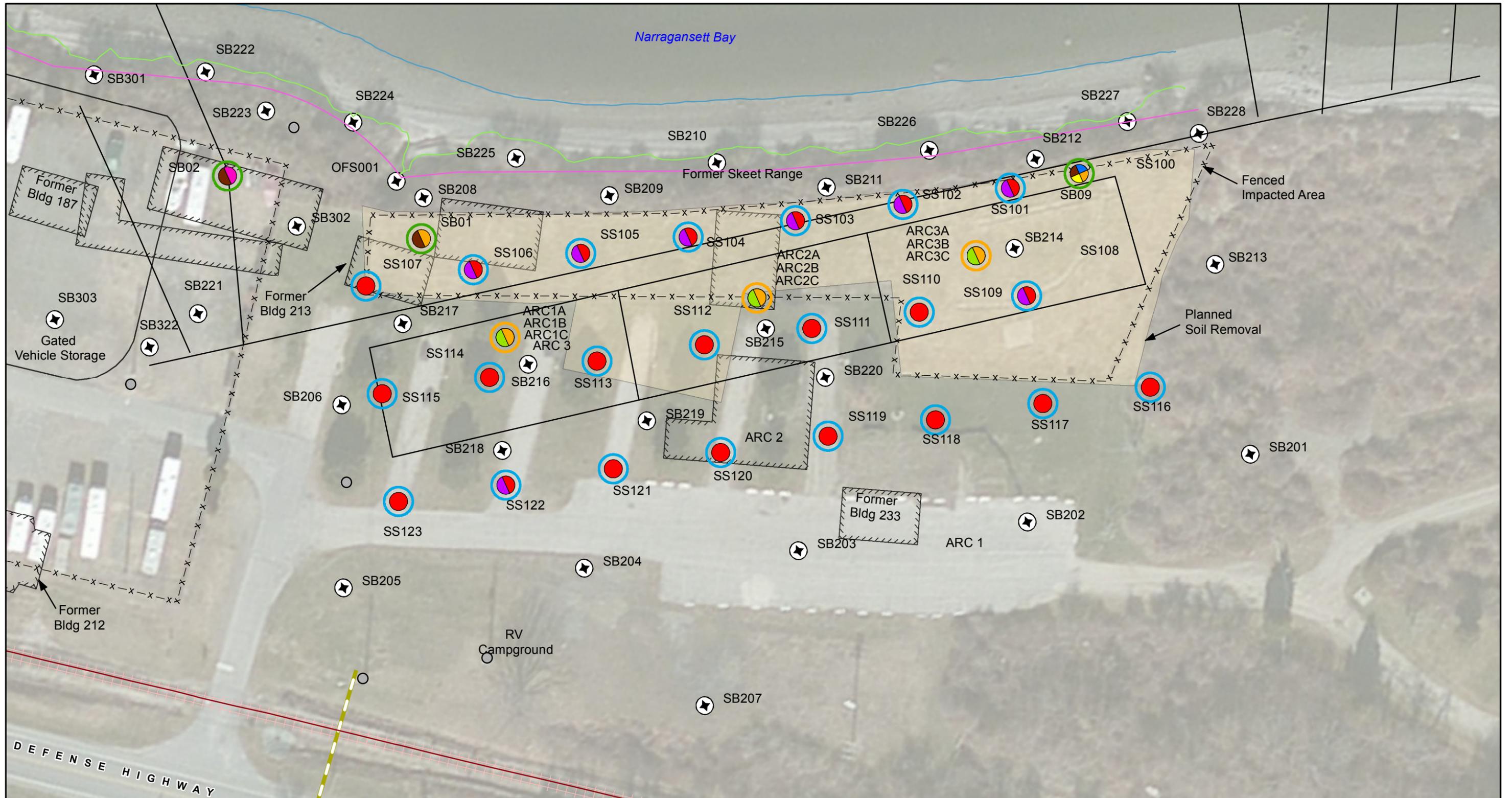
**Former Carr Point Shooting Range**

  
**RESOLUTION CONSULTANTS**  
 Drawn: BC 10/12/2012  
 Approved: MC 10/12/2012  
 Project #: 60250336



**FIGURE 1**  
**REGIONAL LOCATION**  
**FORMER CARR POINT SHOOTING RANGE**  
**AND STORAGE AREA SITES**  
**NAVSTA NEWPORT, RHODE ISLAND**



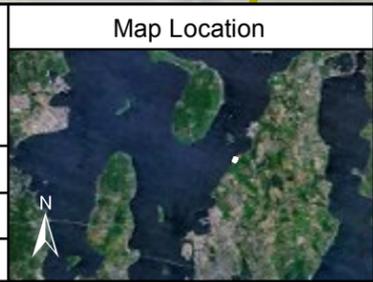


**RESOLUTION CONSULTANTS**

Drawn: BC 06/10/2013

Approved: MC 10/08/2013

Project #: 60250336



**Legend**

SI Exceedences	PCBs	PAHs
VOCs	Metals	Lead
SVOCs	TPH	Propellants
Pesticides		

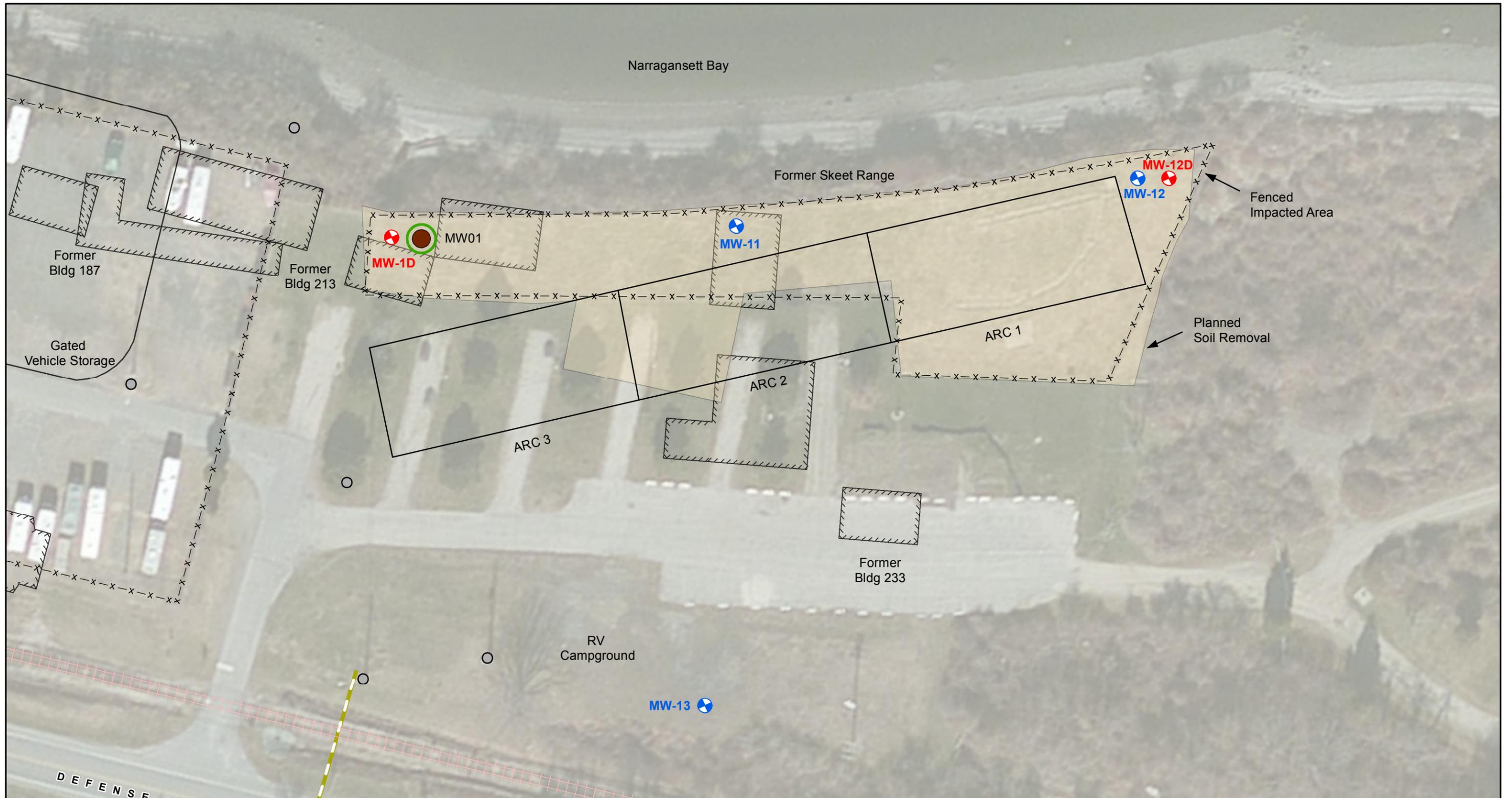
Approximate High Water Line Estimated by Surveyor  
 Approximate High Water Line Marked Via GPS June 2009  
 Approximate Low Water Line

Analysis of VOCs, SVOCs, pesticides, PCBs, metals and TPH  
 Analysis of PAHs and lead  
 Analysis of SVOCs and Propellants  
 Proposed Soil Borings  
 Submarine Cable  
 Pole-Mounted Transformers  
 Potential Location of Former Buildings Based on Historical Drawings

0 25 50 100  
 Scale in Feet

**FIGURE 3**  
**PROPOSED SOIL SAMPLE**  
**LOCATIONS**

**FORMER CARR POINT SHOOTING RANGE**  
**NAVSTA NEWPORT, RHODE ISLAND**

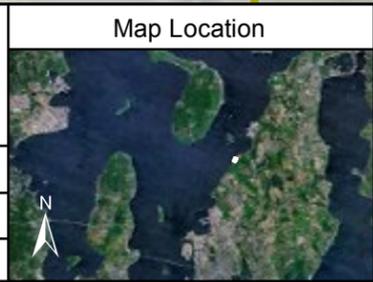


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Drawn: BC 2/19/2013

Approved: MC 2/19/2013

Project #: 60250336



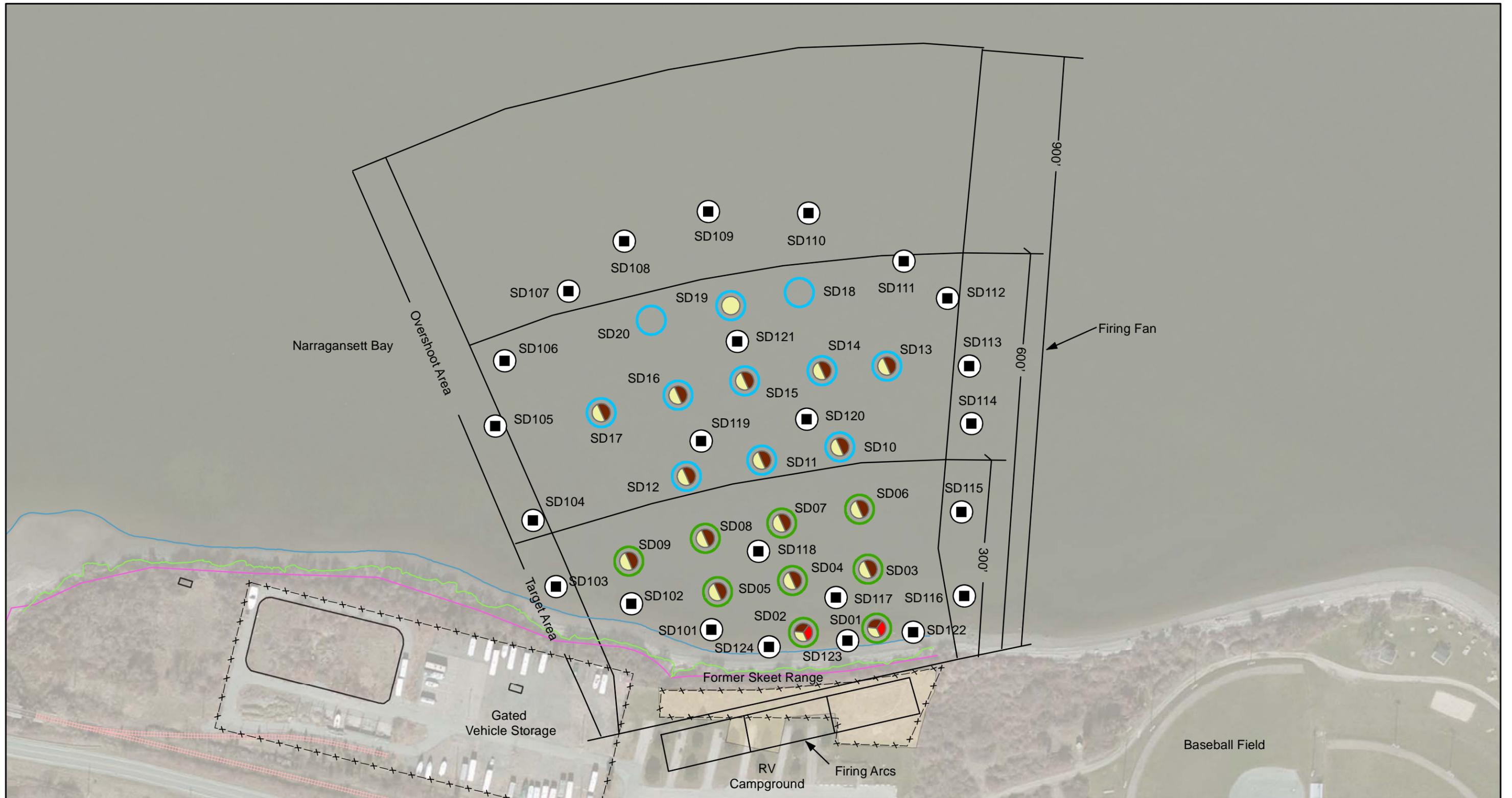
**Legend**

SI Exceedences	Analysis of VOCs, SVOCs, pesticides, PCBs, metals and TPH
VOCs	Proposed Shallow Monitoring Well
SVOCs	Proposed Deep Monitoring Well
Pesticides	Potential Location of Former Buildings Based on Historical Drawings
PCBs	Pole-Mounted Transformers
Metals	Submarine Cable
TPH	

Scale in Feet

**FIGURE 4**  
**PROPOSED GROUNDWATER**  
**SAMPLE LOCATIONS**

**FORMER CARR POINT SHOOTING RANGE**  
**NAVSTA NEWPORT, RHODE ISLAND**



**RESOLUTION CONSULTANTS**

Drawn: BC 1/23/2013

Approved: MC 1/23/2013

Project #: 60250336



**Legend**

- Proposed Sediment Samples
- SI Exceedences
- PAHs
- Metals
- Pellets
- Approximate High Water Line Estimated by Surveyor
- Approximate High Water Line Marked Via GPS June 2009
- Approximate Low Water Line

0 75 150 300  
Scale in Feet

**FIGURE 5**  
**PROPOSED NEAR-SHORE SEDIMENT**  
**SAMPLE LOCATIONS**  
**FORMER CARR POINT SHOOTING RANGE**  
**NAVSTA NEWPORT, RHODE ISLAND**

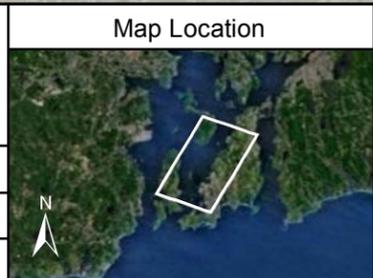



**RESOLUTION  
CONSULTANTS**

Drawn: BC 2/18/2013

Approved: MC 2/18/2013

Project #: 60250336



**Legend**

 Conceptual Reference Sediment Sample Locations

Notes:

1. For locations in vicinity of Carr Point, sample locations will be placed approximately 500 ft from the edge of determined extent of lead pellet.
2. For Locations in vicinity of Carr Point, sample locations to bracket water depth (shallow, mid, deep)
3. For off-site locations, one or more area to be sampled, up to 6 locations, based on field match of Carr Point sediment characteristics.
4. All locations are approximate





Scale in Feet

**FIGURE 6**  
**CONCEPTUAL REFERENCE SEDIMENT**  
**SAMPLE LOCATIONS**  
**FORMER CARR POINT SHOOTING RANGE**  
**AND STORAGE AREA SITES**  
**NAVSTA NEWPORT, RHODE ISLAND**



Narragansett Bay

MW08  
7.69 / 7.71  
-1.7 (C)

MW04  
6.47 / 6.46  
-17.5 (C)

Former Oil/Water Separator

MW07  
-1.8 (C)  
10.72 / 10.72

Former Material Storage

MW06  
-8.4 (C)  
10.00 / 9.99

Former Drum Storage

-4.0 (C)

Former Material Storage

-2.0 (C)

MW02  
4.01 / 4.11  
-10.6 (C)

Former Bldg 213

MW01  
-11.6 (C)  
4.75 / 4.77

ARC 1

MW-12  
-23.5 (C)

MW-12D

Existing Railroad Spur

MW-5S

MW05  
13.10 / 15.10  
-11.6 (C)

Existing Railroad

Former Bldg 212

MW03  
-8.3 (C)  
11.02 / 11.04

MW-9

Gated Vehicle Storage

Former Bldg 187

MW-1D

MW-11

MW-13

Tank Farm 4

Defense Highway



**Legend**

- SI Exceedences
- VOCs
- SVOCs
- Pesticides
- PCBs
- Metals
- TPH
- Potential Location of Former Buildings Based On Historical Drawings
- Prior Analysis of VOCs, SVOCs, pesticides, PCBs, metals, and TPH
- Proposed Shallow Monitoring Well
- Proposed Deep Monitoring Well (5 ft screen on bedrock in Till or weathered bedrock)
- Submarine Cable
- Former Drain Line
- Pole Mounted Transformer
- 8.3 (C) Presumed Competent Bedrock Elevation FT MSL
- 11.02 / 11.04 GW Elevation FT MSL (2-3 hrs after LOW / HI Tides)

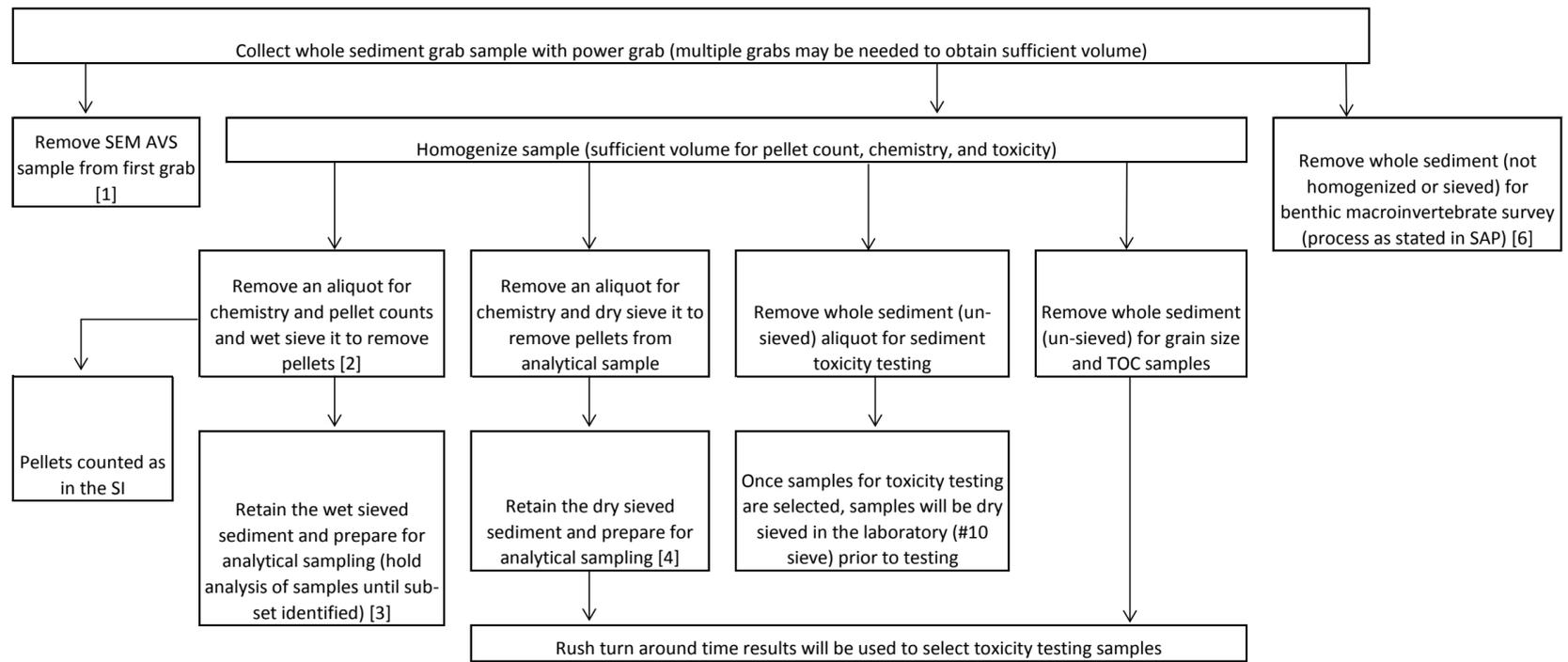
0 50 100 200  
Scale in Feet

**FIGURE 7**  
BEDROCK ELEVATION CONTOURS, GROUNDWATER ELEVATIONS, AND PROPOSED GROUNDWATER MONITORING WELLS

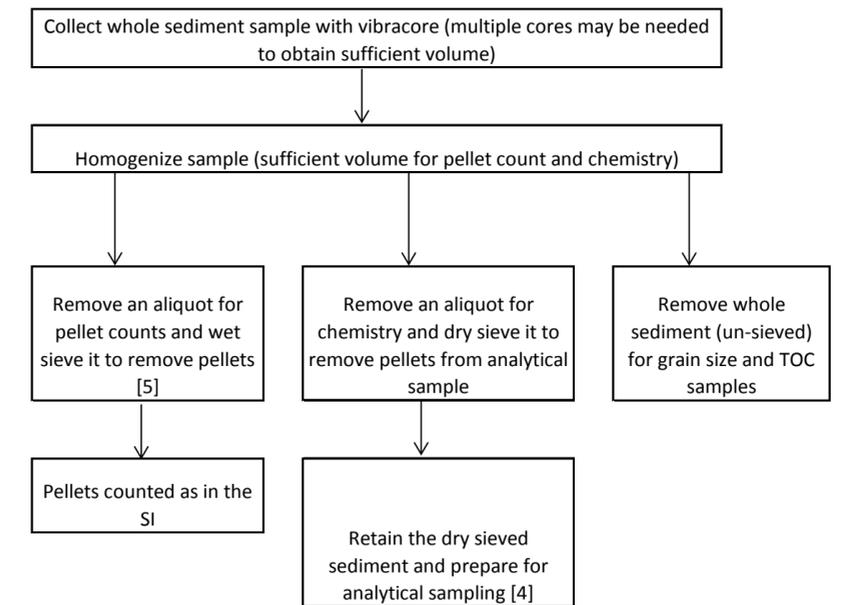
FORMER CARR POINT SHOOTING RANGE AND STORAGE AREA  
NAVSTA NEWPORT, RHODE ISLAND

**Figure 8**  
**Sediment Sampling Process for MRP Site 1 Surficial and Sub-Surficial Samples**  
**Former Carr Point Shooting Range**  
**NAVSTA, Newport, RI**

**Surficial Sampling - 24 locations (0 to 0.5 ft horizon)**



**Sub-Surficial Sampling - 24 locations**  
**(3 horizons; 0.5 to 1 ft, 1 to 2 ft, 2 to 3 ft)**



1 - Need to remove SEM AVS sample prior to homogenizing or sieving; metals may be elevated since pellets are not removed.

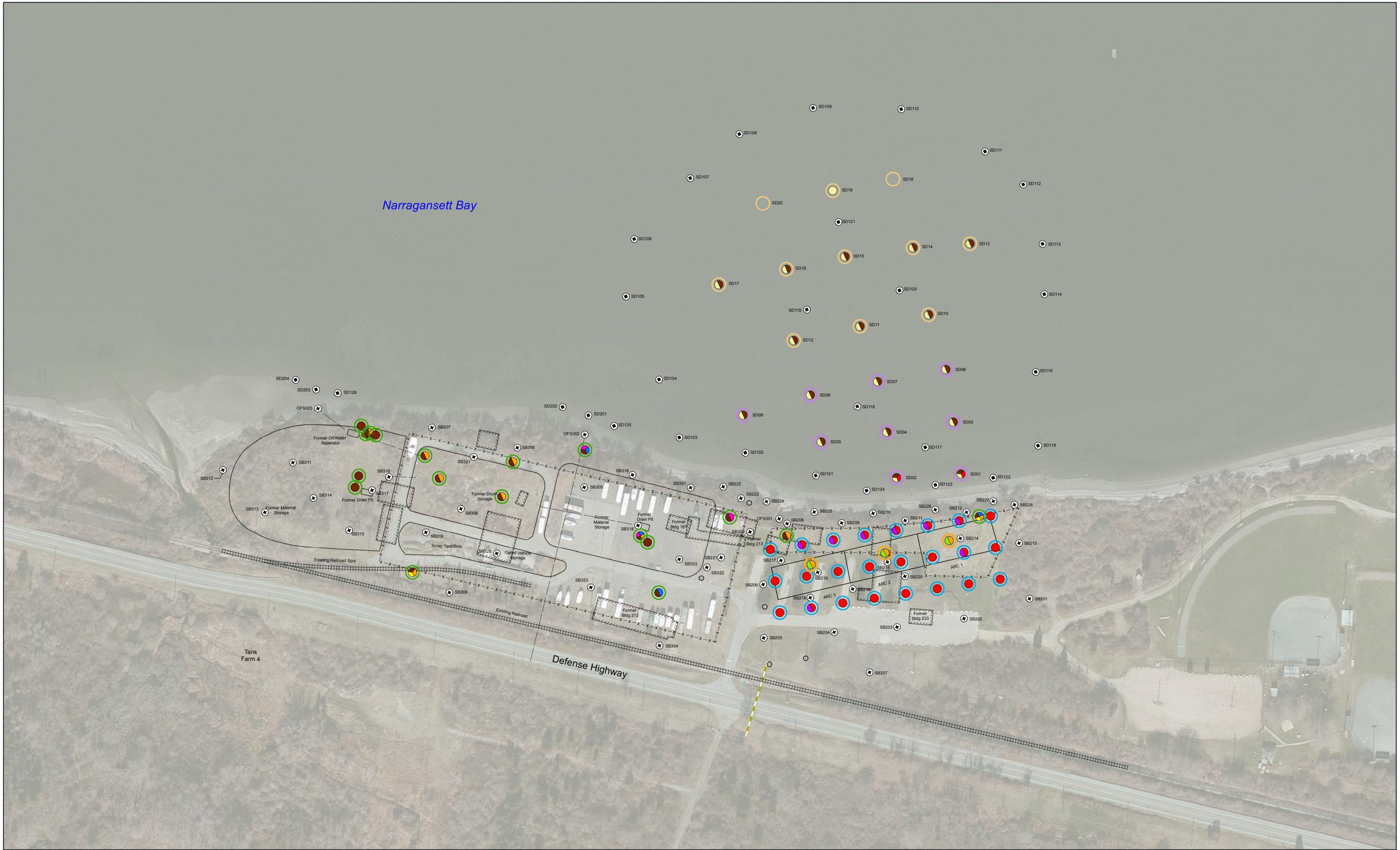
2 - Aliquot of known surface area and depth will be used to establish a pellet count per square foot.

3 - Sediment will be wet sieved with #10 sieve using minimal amounts of seawater. Sediment in seawater will be allowed to settle out, seawater will be siphoned out, and remaining fine sediments will be included in the sediment chemistry samples. Sub-set of samples will be analyzed for metals & PAHs.

4 - Dry sieved samples (#10 sieve) will form the basis of the analytical program. Sub-set of samples will also have wet sieved chemistry results. Sub-set likely to be consistent with toxicity testing samples, but may be modified to provide coverage of the full firing area.

5 - Wet sieved chemistry will not be collected from subsurface samples. Wet sieving will only be used to remove pellets for counting purposes. If sample volume is limited, pellets can be collected via dry sieving.

6 - Need to remove benthic invertebrate sample prior to homogenizing or sieving to avoid damaging invertebrates.



Narragansett Bay

Tank Farm 4

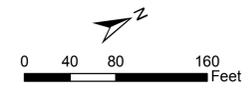
Defense Highway

**RESOLUTION CONSULTANTS**  
 Drawn: JB 06/18/2013  
 Approved: MC 06/18/2013  
 Project #: 60250336



**Legend**

- Proposed Sediment Sample
- Proposed Soil Boring
- SI Exceedences
  - VOCs
  - SVOCs
  - Pesticides
  - PCBs
  - Metals
  - TPH
  - PAHs
  - Lead
  - Propellants
- Analysis of VOCs, SVOCs, pesticides, PCBs, metals and TPH
- Analysis of PAHs and lead
- Analysis of SVOCs and Propellants
- Analysis of PAHs, metals and pellets
- Analysis of metals and pellets
- Submarine Cable
- Former Drain Line
- Pole Mounted Transformer
- Potential Location of Former Buildings Based On Historical Drawings



**FIGURE 9**  
**SAMPLING LOCATIONS**  
 FORMER CARR POINT STORAGE AREA  
 AND SHOOTING RANGE  
 NAVSTA NEWPORT, RHODE ISLAND

Path: W:\Govt\Projects\Navy CLEAN AECOM-EnSafe JV\Newport\GIS\Projects\Carr Point\Maps\SAP\Figure 9 - All SAP Figures.mxd

## **Appendix A**

### **Resolution Consultants SOPs**

# Utility Clearance

## Procedure 3-01

### 1.0 Purpose and Scope

- 1.1 This standard operating procedure (SOP) describes the process for determining the presence of subsurface utilities and other cultural features at locations where planned site activities involve the physical disturbance of subsurface materials.
- 1.2 This procedure is the Program-approved professional guidance for work performed by Resolution Consultants under the Comprehensive Long-Term Environmental Action Navy (CLEAN) contract (Contract Number N62470-11-D-8013).
- 1.3 The procedure applies to the following activities: soil gas surveying, excavating, trenching, drilling of borings and installation of monitoring and extraction wells, use of soil recovery or slide-hammer hand augers, and all other intrusive sampling activities.
- 1.4 The primary purpose of the procedure is to minimize the potential for damage to underground utilities and other subsurface features, which could result in physical injury, disruption of utility service, or disturbance of other subsurface cultural features.
- 1.5 If there are procedures, whether it be from Resolution Consultants, state, and/or federal, that are not addressed in this SOP and are applicable to utility clearance, those procedures should be added as an appendix to the project specific SAP.
- 1.6 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review.

### 2.0 Safety

- 2.1 Field and subcontractor personnel shall adhere to a site-specific health and safety plan (HASP).

### 3.0 Terms and Definitions

#### 3.1 Utility

For the purposes of this SOP, a utility is defined as a manmade underground line or conduit, cable, pipe, vault or tank that is, or was, used for the transmission of material or energy (e.g., gas, electrical, telephone, steam, water or sewage, product transfer lines, or underground storage tanks).

#### 3.2 As-Built Plans

As-built plans are plans or blueprints depicting the locations of structures and associated utilities on a property.

#### 3.3 One-Call

The Utility Notification Center is the one-call agency for nationwide call before you dig. The Utility Notification Center is open 24 hours a day, and accepts calls from anyone planning to dig. The phone number 811 is the designated call before you dig phone number that directly connects you to your local one-call center. Additional information can be found at [www.call811.com](http://www.call811.com).

Calling before you dig ensures that any publicly owned underground lines will be marked so that you can dig around them safely. Having the utility lines marked not only prevents accidental damage to the lines, but prevents property damage and personal injuries that could result in breaking a line.

The following information will need to be provided when a call is placed to One-Call:

- Your name, phone number, company name (if applicable), and mailing address.
- What type of work is being done.
- Who the work is being done for.
- The county and city the work is taking place in.
- The address or the street where the work is taking place.
- Marking instructions, (specific instructions as to where the work is taking place).

Under normal circumstances it takes between 2 to 5 days from the time you call (not counting weekends or holidays) to have the underground lines marked. Because these laws vary from state to state, exactly how long it will take depends on where your worksite is located. You will be given an exact start time and date when your locate request is completed, which will comply with the laws in your area.

In the event of an emergency (any situation causing damage to life or property, or a service outage), lines can be marked sooner than the original given time if requested.

#### 3.4 **Toning**

Toning is the process of surveying an area utilizing one or more surface geophysical methods to determine the presence or absence of underground utilities. Typically, toning is conducted after identifying the general location of utilities and carefully examining all available site utility plans. Each location is marked according to the type of utility being identified. In addition, areas cleared by toning are flagged or staked to indicate that all identified utilities in a given area have been toned.

### 4.0 **Training and Qualifications**

- 4.1 The **Contract Task Order (CTO) Manager** is responsible for verifying that these utility locating procedures are performed prior to the initiation of active subsurface exploration.
- 4.2 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.
- 4.3 The **Field Manager** is responsible for ensuring that all utility locating activities are performed in accordance with this procedure.
- 4.4 All **Field Personnel** are responsible for the implementation of this procedure.

### 5.0 **Equipment and Supplies**

- 5.1 Equipment and supplies necessary for locating subsurface utilities will be provided by the subcontractor; however, the project **Field Manager/Field Personnel** will provide any additional equipment and supplies as needed as well as maintain information regarding the utility clearance activities in the field logbook.

### 6.0 **Procedure**

Proceed with the following steps where subsurface exploration will include excavations, drilling, or any other subsurface investigative method that could damage utilities at a site. In addition to the steps outlined below, always exercise caution while conducting subsurface exploratory work.

### 6.1 **Prepare Preliminary Site Plan**

- Prepare a preliminary, scaled site plan depicting the proposed exploratory locations as part of the project specific Sampling and Analysis Plan (SAP) or Work Plan. Include as many of the cultural and natural features as practical in this plan.

### 6.2 **Review Background Information**

- Search existing plan files to review the as-built plans to identify the known location of utilities at the site. Plot the locations of utilities identified onto a preliminary, scaled site plan. Inform the CTO Manager if utilities lie within close proximity to a proposed exploration or excavation location. The CTO Manager will determine if it is necessary to relocate proposed sampling or excavation locations.
- Include the utility location information gathered during previous investigations (e.g., remedial investigation or remedial site evaluation) in the project design documents for removal or remedial actions. In this manner, information regarding utility locations collected during implementation of a CTO can be shared with the subcontractor during implementation of a particular task order. In many instances, this will help to reduce the amount of additional geophysical surveying work the subcontractor may have to perform.
- Conduct interviews with onsite and facility personnel familiar with the site to obtain additional information regarding the known and suspected locations of underground utilities. In addition, if appropriate, contact shall be made with local utility companies to request their help in locating underground lines. Pencil in the dimensions, orientation, and depth of utilities, other than those identified on the as-built plans, at their approximate locations on the preliminary plans. Enter the type of utility, the personnel who provided the information, and the date the information was provided into the field log.
- During the pre-field work interviewing process, the interviewer will determine which site personnel should be notified in the event of an incident involving damage to existing utilities. Record this information in the field logbook with the corresponding telephone numbers and addresses.

### 6.3 **Site Visit/Locate Utilities/Toning**

- Prior to the initiation of field activities, the Field Task Manager or similarly qualified field personnel shall visit the site and note existing structures and evidence of associated utilities, such as fire hydrants, irrigation systems, manhole and vault box covers, standpipes, telephone switch boxes, free-standing light poles, gas or electric meters, pavement cuts, and linear depression. Compare notes of the actual site configuration to the preliminary site plan. Note deviations in the field logbook and on the preliminary site plan. Accurately locate or survey and clearly mark with stakes, pins, flags, paint, or other suitable devices all areas where subsurface exploration is proposed. These areas shall correspond with the locations drawn on the preliminary site plan.
- Following the initial site visit by the Field Task Manager, a trained utility locating subcontractor will locate, identify, and tone all utilities depicted on the preliminary site plan. The Field Task Manager or similarly qualified field personnel shall visit the site and identify the areas of subsurface disturbance with white spray paint, chalk, white pin flags or some other easily identifiable marking. The utility locator should utilize appropriate sensing equipment to attempt to locate utilities that might not have appeared on the as-built plans. At a minimum, the utility subcontractor should utilize a metal detector and/or magnetometer; however, it is important to consider the possibility that non-metallic utilities or tanks might be present at the site. Use other appropriate surface geophysical methods such as Ground Penetrating Radar, Radiodetection, etc. as appropriate. Clear proposed exploration areas of all utilities in the immediate area where subsurface exploration is proposed. Clearly tone all anomalous areas. Clearly identify all toned areas on the preliminary site plan. All utilities near the area of subsurface disturbance should also be marked out by the utility subcontractor using the universal colors for subsurface utilities (i.e., red – electric; blue – water; green – sewer; yellow – gas; etc.). After toning the site and plotting all known or suspected buried utilities on the preliminary site plan, the utility locator shall provide the Field Task Manager with a copy of the completed preliminary

site plan. Alternatively, the Field Task Manager or designee shall document the results of the survey on the preliminary site plan.

- Report to the Field Task Manager anomalous areas detected and toned that are in close proximity to the exploration or excavation areas. The Field Task Manager shall determine the safe distance to maintain from the known or suspected utility. It may be necessary to relocate the proposed exploration or excavation areas. If this is required, the Field Task Manager or designee shall relocate them and clearly mark them using the methods described above. Completely remove the markings at the prior location. Plot the new locations on the site plan and delete the prior locations from the plan. In some instances, such as in areas extremely congested with subsurface utilities, it may be necessary to dig by hand or use techniques such as air knife to determine the location of the utilities.

#### 6.4 **Prepare Site Plan**

- Prior to the initiation of field activities, draft a final site plan that indicates the location of subsurface exploration areas and all known or suspected utilities present at the site. Provide copies of this site plan to the Navy Technical Representative (NTR), the CTO Manager, and the subcontractor who is to conduct the subsurface exploration/excavation work. Review the site plan with the NTR to verify its accuracy prior to initiating subsurface sampling activities.

### 7.0 **Quality Control and Assurance**

7.1 Utility locating must incorporate quality control measures to ensure conformance to these and the project requirements.

### 8.0 **Records, Data Analysis, Calculations**

8.1 A bound field logbook will be kept detailing all activities conducted during the utility locating procedure.

8.2 The logbook will describe any changes and modifications made to the original exploration plan. The trained utility locator shall prepare a report and keep it in the project file. Also, a copy of the final site plan will be kept in the project file.

### 9.0 **Attachments or References**

Department of Defense, United States (DoD). 2005. [Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual](http://www.epa.gov/fedfac/pdf/ufp_qapp_v1_0305.pdf). Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: [http://www.epa.gov/fedfac/pdf/ufp\\_qapp\\_v1\\_0305.pdf](http://www.epa.gov/fedfac/pdf/ufp_qapp_v1_0305.pdf).

Author	Reviewer	Revisions (Technical or Editorial)
Caryn DeJesus Senior Scientist	Bob Shoemaker Senior Scientist	Rev 0 – Initial Issue (June 2012)

# Logbooks

## Procedure 3-02

### 1.0 Purpose and Scope

- 1.1 This standard operating procedure (SOP) describes the activities and responsibilities pertaining to the identification, use, and control of logbooks and associated field data records.
- 1.2 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review.

### 2.0 Safety

- 2.1 In order to keep the logbook clean, store it in a clean location and use it only when outer gloves used for PPE have been removed.

### 3.0 Terms and Definitions

#### 3.1 Logbook

A logbook is a bound field notebook with consecutively numbered, water-repellent pages that is clearly identified with the name of the relevant activity, the person assigned responsibility for maintenance of the logbook, and the beginning and ending dates of the entries.

#### 3.2 Data Form

A data form is a predetermined format utilized for recording field data that may become, by reference, a part of the logbook (e.g., soil boring logs, trenching logs, surface soil sampling logs, groundwater sample logs, and well construction logs are data forms).

### 4.0 Training and Qualifications

- 4.1 The **Contract Task Order (CTO) Manager** or **designee** is responsible for determining which team members shall record information in field logbooks and for obtaining and maintaining control of the required logbooks. The **CTO Manager** shall review the field logbook on at least a monthly basis. The **CTO Manager** or **designee** is responsible for reviewing logbook entries to determine compliance with this procedure and to ensure that the entries meet the project requirements.
- 4.2 A knowledgeable individual such as the **Field Manager, CTO Manager, or Program Quality Manager** shall perform a technical review of each logbook at a frequency commensurate with the level of activity (weekly is suggested, or, at a minimum, monthly). Document these reviews by the dated signature of the reviewer on the last page or page immediately following the material reviewed.
- 4.3 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.
- 4.4 The **Field Manager** is responsible for ensuring that all **field personnel** follow these procedures and that the logbook is completed properly and daily. The **Field Manager** is also responsible for submitting copies to the **CTO Manager**, who is responsible for filing them and submitting a copy (if required by the CTO Statement of Work).
- 4.5 The **logbook user** is responsible for recording pertinent data into the logbook to satisfy project requirements and for attesting to the accuracy of the entries by dated signature. The **logbook user** is also responsible for safeguarding the logbook while having custody of it.

4.6 All **field personnel** are responsible for the implementation of this procedure.

## **5.0 Equipment and Supplies**

5.1 Field logbooks shall be bound field notebooks with water-repellent pages.

5.2 Pens shall have indelible black ink.

## **6.0 Procedure**

6.1 The field logbook serves as the primary record of field activities. Make entries chronologically and in sufficient detail to allow the writer or a knowledgeable reviewer to reconstruct the applicable events. Store the logbook in a clean location and use it only when outer gloves used for personal protective equipment (PPE) have been removed.

6.2 Individual data forms may be generated to provide systematic data collection documentation. Entries on these forms shall meet the same requirements as entries in the logbook and shall be referenced in the applicable logbook entry. Individual data forms shall reference the applicable logbook and page number. At a minimum, include names of all samples collected in the logbook even if they are recorded elsewhere.

6.3 Enter field descriptions and observations into the logbook, as described in Attachment 1, using indelible black ink.

6.4 Typical information to be entered includes the following:

- Dates (month/day/year) and times (military) of all on-site activities and entries made in logbooks/forms;
- Site name and description;
- Site location by longitude and latitude, if known;
- Weather conditions, including temperature and relative humidity;
- Fieldwork documentation, including site entry and exit times;
- Descriptions of, and rationale for, approved deviations from the work plan (WP) or field sampling plan;
- Field instrumentation readings;
- Names, job functions, and organizational affiliations of on-site personnel;
- Photograph references;
- Site sketches and diagrams made on site;
- Identification and description of sample morphology, collection locations, and sample numbers;
- Sample collection information, including dates (month/day/year) and times (military) of sample collections, sample collection methods and devices, station location numbers, sample collection depths/heights, sample preservation information, sample pH (if applicable), analysis requested (analytical groups), etc., as well as chain-of-custody (COC) information such as sample identification numbers cross-referenced to COC sample numbers;
- Sample naming convention;
- Field quality control (QC) sample information;
- Site observations, field descriptions, equipment used, and field activities accomplished to reconstruct field operations;

- Meeting information;
- Important times and dates of telephone conversations, correspondence, or deliverables;
- Field calculations;
- PPE level;
- Calibration records;
- Contractor and subcontractor information (address, names of personnel, job functions, organizational affiliations, contract number, contract name, and work assignment number);
- Equipment decontamination procedures and effectiveness;
- Laboratories receiving samples and shipping information, such as carrier, shipment time, number of sample containers shipped, and analyses requested; and
- User signatures.

6.5 The logbook shall reference data maintained in other logs, forms, etc. Correct entry errors by drawing a single line through the incorrect entry, then initialing and dating this change. Enter an explanation for the correction if the correction is more than for a mistake.

6.6 At least at the end of each day, the person making the entry shall sign or initial each entry or group of entries.

6.7 Enter logbook page numbers on each page to facilitate identification of photocopies.

6.8 If a person's initials are used for identification, or if uncommon acronyms are used, identify these on a page at the beginning of the logbook.

6.9 At least weekly and preferably daily, the **preparer** shall photocopy and retain the pages completed during that session for backup. This will prevent loss of a large amount of information if the logbook is lost.

## **7.0 Quality Control and Assurance**

7.1 Review per Section 4.2 shall be recorded.

## **8.0 Records, Data Analysis, Calculations**

8.1 Retain the field logbook as a permanent project record. If a particular CTO requires submittal of photocopies of logbooks, perform this as required.

8.2 Deviations from this procedure shall be documented in field records. Significant changes shall be approved by the **Program Quality Manager**.

## **9.0 Attachments or References**

9.1 Attachment 1 – Description of Logbook Entries

9.2 Department of Defense, United States (DoD). 2005. *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual*. Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: [http://www.epa.gov/fedfac/pdf/ufp\\_qapp\\_v1\\_0305.pdf](http://www.epa.gov/fedfac/pdf/ufp_qapp_v1_0305.pdf).

<b>Author</b>	<b>Reviewer</b>	<b>Revisions (Technical or Editorial)</b>
Mark Kromis Program Chemist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue

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# Attachment 1

## Description of Logbook Entries

Logbook entries shall be consistent with Section A.1.4 *Field Documentation SOPs* of the UFP-QAPP Manual (DoD 2005) and contain the following information, as applicable, for each activity recorded. Some of these details may be entered on data forms, as described previously.

Name of Activity	For example, Asbestos Bulk Sampling, Charcoal Canister Sampling, Aquifer Testing.
Task Team Members and Equipment	Name all members on the field team involved in the specified activity. List equipment used by serial number or other unique identification, including calibration information.
Activity Location	Indicate location of sampling area as indicated in the field sampling plan.
Weather	Indicate general weather and precipitation conditions.
Level of PPE	Record the level of PPE (e.g., Level D).
Methods	Indicate method or procedure number employed for the activity.
Sample Numbers	Indicate the unique numbers associated with the physical samples. Identify QC samples.
Sample Type and Volume	Indicate the medium, container type, preservative, and the volume for each sample.
Time and Date	Record the time and date when the activity was performed (e.g., 0830/08/OCT/89). Use the 24-hour clock for recording the time and two digits for recording the day of the month and the year.
Analyses	Indicate the appropriate code for analyses to be performed on each sample, as specified in the WP.
Field Measurements	Indicate measurements and field instrument readings taken during the activity.
Chain of Custody and Distribution	Indicate chain-of-custody for each sample collected and indicate to whom the samples are transferred and the destination.
References	If appropriate, indicate references to other logs or forms, drawings, or photographs employed in the activity.
Narrative (including time and location)	<p>Create a factual, chronological record of the team's activities throughout the day including the time and location of each activity. Include descriptions of general problems encountered and their resolution. Provide the names and affiliations of non-field team personnel who visit the site, request changes in activity, impact the work schedule, request information, or observe team activities. Record any visual or other observations relevant to the activity, the contamination source, or the sample itself.</p> <p>It should be emphasized that logbook entries are for recording data and chronologies of events. The logbook author must include observations and descriptive notations, taking care to be objective and recording no opinions or subjective comments unless appropriate.</p>
Recorded by	Include the signature of the individual responsible for the entries contained in the logbook and referenced forms.
Checked by	Include the signature of the individual who performs the review of the completed entries.

# Recordkeeping, Sample Labeling, and Chain-of-Custody

## Procedure 3-03

### 1.0 Purpose and Scope

- 1.1 The purpose of this standard operating procedure is to establish standard protocols for all field personnel for use in maintaining field and sampling activity records, writing sample logs, labeling samples, ensuring that proper sample custody procedures are utilized, and completing chain-of-custody/analytical request forms.
- 1.2 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review.

### 2.0 Safety

Not applicable.

### 3.0 Terms and Definitions

#### 3.1 Logbook

A logbook is a bound field notebook with consecutively numbered, water-repellent pages that is clearly identified with the name of the relevant activity, the person responsible for maintenance of the logbook, and the beginning and ending dates of the entries.

#### 3.2 Chain-of-Custody

Chain-of-custody (COC) is documentation of the process of custody control. Custody control includes possession of a sample from the time of its collection in the field to its receipt by the analytical laboratory, and through analysis and storage prior to disposal.

### 4.0 Training and Qualifications

- 4.1 The **CTO Manager** is responsible for determining which team members shall record information in the field logbook and for checking sample logbooks and COC forms to ensure compliance with these procedures. The **CTO Manager** shall review COC forms on a monthly basis at a minimum.
- 4.2 The **CTO Manager** and **Program Quality Manager** are responsible for evaluating project compliance with the Project Procedures Manual.
- 4.3 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.
- 4.4 The **Laboratory Project Manager** or **Sample Control Department Manager** is responsible for reporting any sample documentation or COC problems to the **CTO Manager** or **CTO Laboratory Coordinator** within 24 hours of sample receipt.
- 4.5 The **Field Manager** is responsible for ensuring that all **field personnel** follow these procedures. The **CTO Laboratory Coordinator** is responsible for verifying that the COC/analytical request forms have been completed properly and match the sampling and analysis plan. The **CTO Manager** or **CTO Laboratory Coordinator** is responsible for notifying the **laboratory, data managers, and data validators** in writing if analytical request changes are required as a corrective action. These small changes are different from change orders, which involve changes to the scope of the subcontract with

the laboratory and must be made in accordance with a respective contract (e.g., CLEAN remedial action contract).

- 4.6 All **field personnel** are responsible for following these procedures while conducting sampling activities. **Field personnel** are responsible for recording pertinent data into the logbook to satisfy project requirements and for attesting to the accuracy of the entries by dated signature.

## 5.0 Procedure

This procedure provides standards for documenting field activities, labeling the samples, documenting sample custody, and completing COC/analytical request forms. The standards presented in this section shall be followed to ensure that samples collected are maintained for their intended purpose and that the conditions encountered during field activities are documented.

### 5.1 Recordkeeping

The field logbook serves as the primary record of field activities. Make entries chronologically and in sufficient detail to allow the writer or a knowledgeable reviewer to reconstruct each day's events. Field logs such as soil boring logs and ground-water sampling logs will also be used. These procedures are described in Procedure 3-02, *Logbooks*.

### 5.2 Sample Labeling

Affix a sample label with adhesive backing to each individual sample container. Place clear tape over each label (preferably prior to sampling) to prevent the labels from tearing off, falling off, being smeared, and to prevent loss of information on the label. Record the following information with a waterproof marker on each label:

- Project name or number (optional);
- COC sample number;
- Date and time of collection;
- Sampler's initials;
- Matrix (optional);
- Sample preservatives (if applicable); and
- Analysis to be performed on sample (this shall be identified by the method number or name identified in the subcontract with the laboratory).

These labels may be obtained from the analytical laboratory or printed from a computer file onto adhesive labels.

### 5.3 Custody Procedures

For samples intended for chemical analysis, sample custody procedures shall be followed through collection, transfer, analysis, and disposal to ensure that the integrity of the samples is maintained. Maintain custody of samples in accordance with the U.S. Environmental Protection Agency (EPA) COC guidelines prescribed in EPA *NEIC Policies and Procedures*, National Enforcement Investigations Center, Denver, Colorado, revised May 1986; EPA *RCRA Ground Water Monitoring Technical Enforcement Guidance Document (TEGD)*; *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA OSWER Directive 9355 3-01); Appendix 2 of the *Technical Guidance Manual for Solid Waste Water Quality Assessment Test (SWAT) Proposals and Reports*; and *Test Methods for Evaluating Solid Waste* (EPA SW-846)

A description of sample custody procedures is provided below.

### 5.3.1 Sample Collection Custody Procedures

According to the U.S. EPA guidelines, a sample is considered to be in custody if one of the following conditions is met:

- It is in one's actual physical possession or view;
- It is in one's physical possession and has not been tampered with (i.e., it is under lock or official seal);
- It is retained in a secured area with restricted access; and
- It is placed in a container and secured with an official seal such that the sample cannot be reached without breaking the seal.

Place custody seals on sample containers immediately after sample collection and on shipping coolers if the cooler is to be removed from the sampler's custody. Place custody seals in such a manner that they must be broken to open the containers or coolers. Label the custody seals with the following information:

- Sampler's name or initials; and
- Date and time that the sample/cooler was sealed.

These seals are designed to enable detection of sample tampering. An example of a custody seal is shown in Attachment 1.

**Field personnel** shall also log individual samples onto COC forms (carbon copy or computer generated) when a sample is collected. These forms may also serve as the request for analyses. Procedures for completing these forms are discussed in Section 7.4, indicating sample identification number, matrix, date and time of collection, number of containers, analytical methods to be performed on the sample, and preservatives added (if any). The **samplers** will also sign the COC form signifying that they were the personnel who collected the samples. The COC form shall accompany the samples from the field to the laboratory. When a cooler is ready for shipment to the analytical laboratory, the **person delivering the samples for transport** will sign and indicate the date and time on the accompanying COC form. One copy of the COC form will be retained by the **sampler** and the remaining copies of the COC form shall be placed inside a self-sealing bag and taped to the inside of the cooler. Each cooler must be associated with a unique COC form. Whenever a transfer of custody takes place, **both parties** shall sign and date the accompanying carbon copy COC forms, and the **individual relinquishing the samples** shall retain a copy of each form. One exception is when the samples are shipped; the **delivery service personnel** will not sign or receive a copy because they do not open the coolers. The **laboratory** shall attach copies of the completed COC forms to the reports containing the results of the analytical tests. An example COC form is provided in Attachment 2.

### 5.3.2 Laboratory Custody Procedures

The following custody procedures are to be followed by an **independent laboratory** receiving samples for chemical analysis; the procedures in their Naval Facilities Engineering Service Center-evaluated Laboratory Quality Assurance Plan must follow these same procedures. A **designated sample custodian** shall take custody of all samples upon their arrival at the analytical laboratory. The **custodian** shall inspect all sample labels and COC forms to ensure that the information is consistent, and that each is properly completed. The **custodian** will also measure the temperature of the temperature blank in the coolers upon arrival using either a National Institute for Standards and Technology calibrated thermometer or an infra-red temperature gun. The **custodian** shall note the condition of the samples including:

- If the samples show signs of damage or tampering;
- If the containers are broken or leaking;
- If headspace is present in sample vials;
- If proper preservation of samples has occurred (made by pH measurement, except volatile organic compounds [VOCs] and purgeable total petroleum hydrocarbons [TPH] and temperature). The pH of VOC and purgeable TPH samples will be checked by the **laboratory analyst** after the sample aliquot has been removed from the vial for analysis; and
- If any sample holding times have been exceeded.

All of the above information shall be documented on a sample receipt sheet by the **custodian**.

Discrepancies or improper preservation shall be noted by the **laboratory** as an out-of-control event and shall be documented on an out-of-control form with corrective action taken. The out-of-control form shall be signed and dated by the **sample control custodian** and **any other persons** responsible for corrective action. An example of an out-of-control form is included as Attachment 4.

The **custodian** shall then assign a unique laboratory number to each sample and distribute the samples to secured storage areas maintained at 4 degrees Celsius (soil samples for VOC analysis are to be stored in a frozen state until analysis). The unique laboratory number for each sample, COC sample number, client name, date and time received, analysis due date, and storage shall also be manually logged onto a sample receipt record and later entered into the laboratory's computerized data management system. The **custodian** shall sign the shipping bill and maintain a copy.

**Laboratory personnel** shall be responsible for the care and custody of samples from the time of their receipt at the laboratory through their exhaustion or disposal. Samples should be logged in and out on internal laboratory COC forms each time they are removed from storage for extraction or analysis.

#### 5.4 **Completing COC/Analytical Request Forms**

COC form/analytical request form completion procedures are crucial in properly transferring the custody and responsibility of samples from field personnel to the laboratory. This form is important for accurately and concisely requesting analyses for each sample; it is essentially a release order from the analysis subcontract.

Attachment 2 is an example of a generic COC/analytical request form that may be used by **field personnel**. Multiple copies may be tailored to each project so that much of the information described below need not be handwritten each time. Attachment 3 is an example of a completed site-specific COC/analytical request form, with box numbers identified and discussed in text below.

COC forms tailored to each CTO can be drafted and printed onto multi-ply forms. This eliminates the need to rewrite the analytical methods column headers each time. It also eliminates the need to write the project manager, name, and number; QC Level; TAT; and the same general comments each time.

Complete one COC form per cooler. Whenever possible, place all VOC analyte vials into one cooler in order to reduce the number of trip blanks. Complete all sections and be sure to sign and date the COC form. One copy of the COC form must remain with the field personnel.

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Box 2 **Bill To:** List the name and address of the person/company to bill only if it is not in the subcontract with the laboratory.

Box 3 **Sample Disposal Instructions:** These instructions will be stated in the Master Service Agreement or each CTO statement of work with each laboratory.

**Shipment Method:** State the method of shipment (e.g., hand carry or air courier via FedEx or DHL).

**Comments:** This area shall be used by the field team to communicate observations, potential hazards, or limitations that may have occurred in the field or additional information regarding analysis (e.g., a specific metals list, samples expected to contain high analyte concentrations).

Box 4 **Cooler No.:** This will be written on the inside or outside of the cooler and shall be included on the COC. Some laboratories attach this number to the trip blank identification, which helps track samples for VOC analysis. If a number is not on the cooler, field personnel shall assign a number, write it on the cooler, and write it on the COC.

**QC Level:** Enter the reporting quality control (QC) requirements (e.g., Full Data Package, Summary Data Package).

**Turnaround time (TAT):** TAT will be determined by a sample delivery group (SDG), which may be formed over a 14-day period, not to exceed 20 samples. Once the SDG has been completed, standard TAT is 21 calendar days from receipt of the last sample in the SDG. Entering NORMAL or STANDARD in this field will be acceptable. If quicker TAT is required, it shall be in the subcontract with the laboratory and reiterated on each COC to remind the laboratory.

Box 5 **Type of Containers:** Write the type of container used (e.g., 1-liter glass amber, for a given parameter in that column).

**Preservatives:** Field personnel must indicate on the COC the correct preservative used for the analysis requested. Indicate the pH of the sample (if tested) in case there are buffering conditions found in the sample matrix.

Box 6 **Sample Identification (ID) Number:** This is typically a five-character alphanumeric identifier used by the contractor to identify samples. The use of this identifier is important since the laboratories are restricted to the number of characters they are able to use. Sample numbering shall be in accordance with the project-specific sampling and analysis plan.

**Description (Sample ID):** This name will be determined by the location and description of the sample, as described in the project-specific sampling and analysis plan. This sample identification should not be submitted to the laboratory, but should be left blank. If a computer COC version is used, the sample identification can be input, but printed with this block black. A cross-referenced list of the COC Sample Number and sample identification must be maintained separately.

**Date Collected:** Record the collection date in order to track the holding time of the sample. Note: For trip blanks, record the date it was placed in company with samples.

**Time Collected:** When collecting samples, record the time the sample is first collected. Use of the 24-hour military clock will avoid a.m. or p.m. designations (e.g., 1815 instead of 6:15 p.m.). Record local time; the laboratory is responsible for calculating holding times to local time.

**Lab ID:** This is for laboratory use only.

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- Box 7 **Matrix/QC:** Identify the matrix (e.g., water, soil, air, tissue, fresh water sediment, marine sediment, or product). If a sample is expected to contain high analyte concentrations (e.g., a tank bottom sludge or distinct product layer), notify the laboratory in the comment section. Mark an "X" for the sample(s) that have extra volume for laboratory QC matrix spike/matrix spike duplicate (MS/MSD) purposes. The sample provided for MS/MSD purposes is usually a field duplicate.
- Box 8 **Analytical Parameters:** Enter the parameter by descriptor and the method number desired (e.g., BTEX 8260B, PAHs 8270C, etc.). Whenever practicable, list the parameters as they appear in the laboratory subcontract to maintain consistency and avoid confusion.
- If the COC does not have a specific box for number of sample containers, use the boxes below the analytical parameter, to indicate the number of containers collected for each parameter.
- Box 9 **Sampler's Signature:** The person who collected samples must sign here.
- Relinquished By:** The person who turned over the custody of the samples to a second party other than an express mail carrier, such as FedEx or DHL, must sign and date here.
- Received By:** Typically, a representative of the receiving laboratory signs and dates here. Or, a field crew member who delivered the samples in person from the field to the laboratory might sign here. A courier, such as FedEx or DHL, does not sign here because they do not open the coolers. It must also be used by the prime contracting laboratory when samples are to be sent to a subcontractor.
- Relinquished By:** In the case of subcontracting, the primary laboratory will sign and date the Relinquished By space and fill out an additional COC to accompany the samples being subcontracted.
- Received By (Laboratory):** This space is for the final destination (e.g., at a subcontracted laboratory). A representative of the final destination (e.g., subcontracted laboratory) must sign and date here.
- Box 10 **Lab No. and Questions:** This box is to be filled in by the laboratory only.
- Box 11 **Control Number:** This number is the "COC" followed by the first contractor identification number in that cooler, or contained on that COC. This control number must be unique (i.e., never used twice). Record the date the COC is completed. It should be the same date the samples are collected.
- Box 12 **Total # of Containers:** Sum the number of containers in that row.
- Box 13 **Totals:** Sum the number of containers in each column. Because COC forms contain different formats depending on who produced the form, not all of the information listed in items 1 to 13 may be recorded; however, as much of this information as possible shall be included.
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## 6.0 Quality Control and Assurance

- 6.1 Recordkeeping, sample labeling, and chain-of-custody activities must incorporate quality control measures to ensure accuracy and completeness.
- 6.2 Deviations from this procedure or the project-specific CTO work plan shall be documented in field records. Significant changes shall be approved by the **Program Quality Manager**.

## 7.0 Records, Data Analysis, Calculations

- 7.1 The COC/analytical request form shall be faxed approximately daily to the **CTO Laboratory Coordinator** for verification of accuracy. Following the completion of sampling activities, the sample

logbook and COC forms will be transmitted to the **CTO Manager** for storage in project files. The **data validators** shall receive a copy also. The original COC/analytical request form shall be submitted by the **laboratory** along with the data delivered. Any changes to the analytical requests that are required shall be made in writing to the laboratory. A copy of this written change shall be sent to the data validators and placed in the project files. The reason for the change shall be included in the project files so that recurring problems can be easily identified.

- 7.2 Deviations from this procedure or the project-specific sampling and analysis plan shall be documented in the records. Significant changes shall be approved by the **Program Quality Manager**.

## 8.0 Attachments or References

- 8.1 Attachment 1 – Chain-of-Custody Seal
- 8.2 Attachment 2 – Generic Chain-of-Custody/Analytical Request Form
- 8.3 Attachment 3 – Sample Completed Chain-of-Custody
- 8.4 Attachment 4 – Sample Out-of-Control Form
- 8.5 Environmental Protection Agency, United States (EPA). 1988. *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*. Interim Final. EPA/540/G-89/004. Office of Emergency and Remedial Response. October.
- 8.6 EPA. 1992. *RCRA Groundwater Monitoring Draft Technical Guidance*. EPA/530/R-93/001. Office of Solid Waste. November.
- 8.7 EPA. 1997. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846. 3rd ed., Final Update IIIA. Office of Solid Waste.
- 8.8 Water Resources Control Board, State of California. 1988. *Technical Guidance Manual for Solid Waste Water Quality Assessment Test (SWAT) Proposals and Reports*. August.
- 8.9 Procedure 3-02, *Logbooks*.

Author	Reviewer	Revisions (Technical or Editorial)
Mark Kromis Program Chemist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue

# Attachment 1

## Chain-of-Custody Seal

### CHAIN-OF-CUSTODY SEAL

<i>[LABORATORY]</i>	SAMPLE NO.	DATE	SEAL BROKEN BY
	SIGNATURE		DATE
	PRINT NAME AND TITLE ( <i>Inspector, Analyst or Technician</i> )		

# Attachment 2 Generic Chain-of-Custody/Analytical Request Form

M901378

CHAIN OF CUSTODY RECORD												Page ____ of ____	
Client/Project Name:				Project Location:				Analysis Requested					
Project Number:				Field Logbook No.:									
Sampler: (Print Name)/Affiliation:				Chain of Custody Tape No.:									
Signature:				Send Results/Report to:									
Field Sample No./ Identification	Date	Time	Grab	Comp	Sample Container (Size/Mat)	Sample Type (Liquid, Sludge, Etc.)	Preservative	Field Filtered				Lab I.D.	Remarks
Relinquished by: (Print Name)				Date:	Received by: (Print Name)				Date:	Analytical Laboratory (Destination):			
Signature:				Time:	Signature:				Time:				
Relinquished by: (Print Name)				Date:	Received by: (Print Name)				Date:				
Signature:				Time:	Signature:				Time:				
Relinquished by: (Print Name)				Date:	Received by: (Print Name)				Date:				
Signature:				Time:	Signature:				Time:	Serial No.			



## Attachment 4 Sample Out-of-Control Form

<b>OUT OF CONTROL FORM</b>	Status	Date	Initial
	Noted OOC		
	Submit for CA*		
	Resubmit for CA*		
	Completed		

Date Recognized:	By:	Samples Affected (List by Accession AND Sample No.)
Dated Occurred:	Matrix	
Parameter (Test Code):	Method:	
Analyst:	Supervisor:	
1. Type of Event (Check all that apply)	2. Corrective Action (CA)* (Check all that apply)	
<input type="checkbox"/> Calibration Corr. Coefficient <0.995	<input type="checkbox"/> Repeat calibration	
<input type="checkbox"/> %RSD>20%	<input type="checkbox"/> Made new standards	
<input type="checkbox"/> Blank >MDL	<input type="checkbox"/> Reran analysis	
<input type="checkbox"/> Does not meet criteria:	<input type="checkbox"/> Sample(s) redigested and rerun	
<input type="checkbox"/> Spike	<input type="checkbox"/> Sample(s) reextracted and rerun	
<input type="checkbox"/> Duplicate	<input type="checkbox"/> Recalculated	
<input type="checkbox"/> LCS	<input type="checkbox"/> Cleaned system	
<input type="checkbox"/> Calibration Verification	<input type="checkbox"/> Ran standard additions	
<input type="checkbox"/> Standard Additions	<input type="checkbox"/> Notified	
<input type="checkbox"/> MS/MSD	<input type="checkbox"/> Other (please explain)	
<input type="checkbox"/> BS/BSD		
<input type="checkbox"/> Surrogate Recovery		
<input type="checkbox"/> Calculations Error		
<input type="checkbox"/> Holding Times Missed		
<input type="checkbox"/> Other (Please explain)	Comments:	

<b>3. Results of Corrective Action</b>	
<input type="checkbox"/>	Return to Control (indicated with)
<input type="checkbox"/>	Corrective Actions Not Successful - DATA IS TO BE FLAGGED with _____.

Analyst:	Date:
Supervisor:	Date:
QA Department:	Date:

# Sample Handling, Storage, and Shipping

## Procedure 3-04

### 1.0 Purpose and Scope

- 1.1 This standard operating procedure describes the actions to be used by personnel engaged in handling, storing, and transporting samples. The objective is to obtain samples of actual conditions with as little alteration as possible.
- 1.2 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review.

### 2.0 Safety

- 2.1 Avoid lifting heavy coolers with back muscles; instead, use leg muscles or dollies.
- 2.2 Wear proper gloves, such as blue nitrile and latex, as defined in the project-specific health and safety plan, when handling sample containers to avoid contacting any materials that may have spilled out of the sample containers.

### 3.0 Terms and Definitions

None.

### 4.0 Training and Qualifications

- 4.1 The **Contract Task Order (CTO) Manager** and the **Laboratory Project Manager** are responsible for identifying instances of non-compliance with this procedure and ensuring that future sample transport activities comply with this procedure.
- 4.2 The **Field Manager** is responsible for ensuring that all samples are shipped according to this procedure.
- 4.3 **Field personnel** are responsible for the implementation of this procedure.
- 4.4 The **Program Quality Manager** is responsible for ensuring that sample handling, storage, and transport activities conducted during all CTOs comply with this procedure.
- 4.5 All **field personnel** are responsible for the implementation of this procedure.

### 5.0 Procedure

#### 5.1 Handling and Storage

Immediately following collection, label all samples according to Procedure 3-03, *Recordkeeping, Sample Labeling, and Chain-of-Custody*. The lids of the containers shall not be sealed with duct tape, but may be covered with custody seals or placed directly into self-sealing bags. Place the sample containers in an insulated cooler with frozen gel packs (e.g., "blue ice") or ice in double, sealed self-sealing bags. Samples should occupy the lower portion of the cooler, while the ice should occupy the upper portion. Place an absorbent material (e.g., proper absorbent cloth material) on the bottom of the cooler to contain liquids in case of spillage. Fill all empty space between sample containers with Styrofoam® "peanuts" or other appropriate material. Prior to shipping, wrap glass sample containers on the sides, tops, and bottoms with bubble wrap or other appropriate padding and/or surround them in Styrofoam to

prevent breakage during transport. Pack all glass containers for water samples in an upright position, never stacked or on their sides. Prior to shipment, replace the ice or cold packs in the coolers so that samples will be maintained as close to 4 degrees Celsius (°C) as possible from the time of collection through transport to the analytical laboratory. Ship samples within 24 hours or on a schedule allowing the laboratory to meet holding times for analyses. The procedures for maintaining sample temperatures at 4°C pertain to all field samples.

## 5.2 **Shipping**

Follow all appropriate U.S. Department of Transportation regulations (e.g., 49 Code of Federal Regulations [CFR], Parts 171-179) for shipment of air, soil, water, and other samples. Elements of these procedures are summarized below.

### 5.2.1 **Hazardous Materials Shipment**

**Field personnel** must state whether any sample is suspected to be a hazardous material. A sample should be assumed hazardous unless enough evidence exists to indicate it is non-hazardous. If not suspected to be hazardous, shipments may be made as described in the Section 5.2.2 for non-hazardous materials. If hazardous, follow the procedures summarized below.

Any substance or material that is capable of posing an unreasonable risk to life, health, or property when transported is classified as hazardous. Perform hazardous materials identification by checking the list of dangerous goods for that particular mode of transportation. If not on that list, materials can be classified by checking the Hazardous Materials Table (49 CFR 172.102 including Appendix A) or by determining if the material meets the definition of any hazard class or division (49 CFR Part 173), as listed in Attachment 2.

All **persons shipping hazardous materials** must be properly trained in the appropriate regulations, as required by HM-126F, Training for Safe Transportation of Hazardous Materials (49 CFR HM-126F Subpart H). The training covers loading, unloading, handling, storing, and transporting of hazardous materials, as well as emergency preparedness in the case of accidents. **Carriers**, such as commercial couriers, must also be trained. Modes of shipment include air, highway, rail, and water.

When shipping hazardous materials, including bulk chemicals or samples suspected of being hazardous, the proper shipping papers (49 CFR 172 Subpart C), package marking (49 CFR 172 Subpart D), labeling (49 CFR 172 Subpart E), placarding (49 CFR 172 Subpart F, generally for carriers), and packaging must be used. Attachment 1 shows an example of proper package markings. Refer to a copy of 49 CFR each time hazardous materials/potentially hazardous samples are shipped.

According to Section 2.7 of the International Air Transport Association Dangerous Goods Regulations publication, very small quantities of certain dangerous goods may be transported without certain marking and documentation requirements as described in 49 CFR Part 172; however, other labeling and packing requirements must still be followed. Attachment 2 shows the volume or weight for different classes of substances. A "Dangerous Goods in Excepted Quantities" label must be completed and attached to the associated shipping cooler (Attachment 3). Certain dangerous goods are not allowed on certain airlines in any quantity.

As stated in item 4 of Attachment 4, the Hazardous Materials Regulations do not apply to hydrochloric acid (HCl), nitric acid (HNO<sub>3</sub>), sulfuric acid (H<sub>2</sub>SO<sub>4</sub>), and sodium hydroxide (NaOH) added to water samples if their pH or percentage by weight criteria is met. These samples may be shipped as non-hazardous materials as discussed below.

### 5.2.2 **Non-Hazardous Materials Shipment**

If the samples are suspected to be non-hazardous based on previous site sample results, field screening results, or visual observations, if applicable, then samples may be shipped as non-hazardous.

When a cooler is ready for shipment to the laboratory, place two copies of the chain-of-custody form inside a self-sealing bag and tape it to the inside of the insulated cooler. Then, seal the cooler with waterproof tape and label it with "Fragile," "This-End-Up" (or directional arrows pointing up), or other appropriate notices. Place chain-of-custody seals on the coolers as discussed in Procedure 3-03, *Recordkeeping, Sample Labeling, and Chain-of-Custody*.

### 5.2.3 Shipments from Outside the Continental United States

Shipment of sample coolers to the United States from locations outside the continental United States is controlled by the U.S. Department of Agriculture (USDA) and is subject to their inspection and regulation. A "USDA Soil Import Permit" is required to prove that the receiving analytical laboratory is certified by the USDA to receive and properly dispose of soil. In addition, all sample coolers must be inspected by a **USDA representative**, affixed with a label indicating that the coolers contain environmental samples, and accompanied by shipping forms stamped by the **USDA inspector** prior to shipment.

In addition, the U.S. Customs Service must clear samples shipped from U.S. territorial possessions or foreign countries upon entry into the United States. As long as the commercial invoice is properly completed (see below), shipments typically pass through U.S. Customs Service without the need to open coolers for inspection.

Completion and use of proper paperwork will, in most cases, minimize or eliminate the need for the USDA and U.S. Customs Service to inspect the contents. Attachment 5 shows an example of how paperwork may be placed on the outside of coolers for non-hazardous materials. For hazardous materials, refer to Section 5.2.1.

In summary, tape the paperwork listed below to the outside of the coolers to accompany sample shipments. If a shipment is made up of multiple pieces (e.g., more than one cooler), the paperwork need only be attached to one cooler, provided that the **courier** agrees. All other coolers in the shipment need only to be taped and have the address and chain-of-custody seals affixed.

1. **Courier Shipping Form & Commercial Invoice:** See Attachment 6 and Attachment 7 for examples of the information to be included on the commercial invoices for soil and water, respectively. Place the courier shipping form and commercial invoice inside a clear, plastic, adhesive-backed pouch that adheres to the package (typically supplied by the courier) and place it on the cooler lid as shown in Attachment 5.
2. **Soil Import Permit (soil only):** See Attachment 8 and Attachment 9 for examples of the soil import permit and soil samples restricted entry labels, respectively. The **laboratory** shall supply these documents prior to mobilization. The USDA often stops shipments of soil without these documents. Staple together the 2-inch × 2-inch USDA label (described below) and soil import permit, and place them inside a clear plastic pouch. The **courier** typically supplies the clear, plastic, adhesive-backed pouches that adhere to the package.

Placing one restricted entry label as shown in Attachment 5 (covered with clear packing tape) and one stapled to the actual permit is suggested.

The USDA does not control water samples, so the requirements for soil listed above do not apply.

3. **Chain-of-Custody Seals:** The **laboratory** should supply the seals. **CTO personnel** must sign and date these. At least two seals should be placed in such a manner that they stick to both the cooler lid and body. Placing the seals over the tape (as shown in Attachment 5), then covering it with clear packing tape is suggested. This prevents the seal from coming loose and enables detection of tampering.
4. **Address Label:** Affix a label stating the destination (laboratory address) to each cooler.
5. **Special Requirements for Hazardous Materials:** See Section 5.2.1.

Upon receipt of sample coolers at the laboratory, the **sample custodian** shall inspect the sample containers as discussed in Procedure 3-03, *Recordkeeping, Sample Labeling, and Chain-of-Custody*. The samples shall then be immediately extracted and/or analyzed, or stored in a refrigerated storage area until they are removed for extraction and/or analysis. Whenever the samples are not being extracted or analyzed, they shall be returned to refrigerated storage.

## 6.0 Quality Control and Assurance

- 6.1 Sample handling, storage, and shipping must incorporate quality control measures to ensure conformance to these and the project requirements.

## 7.0 Records, Data Analysis, Calculations

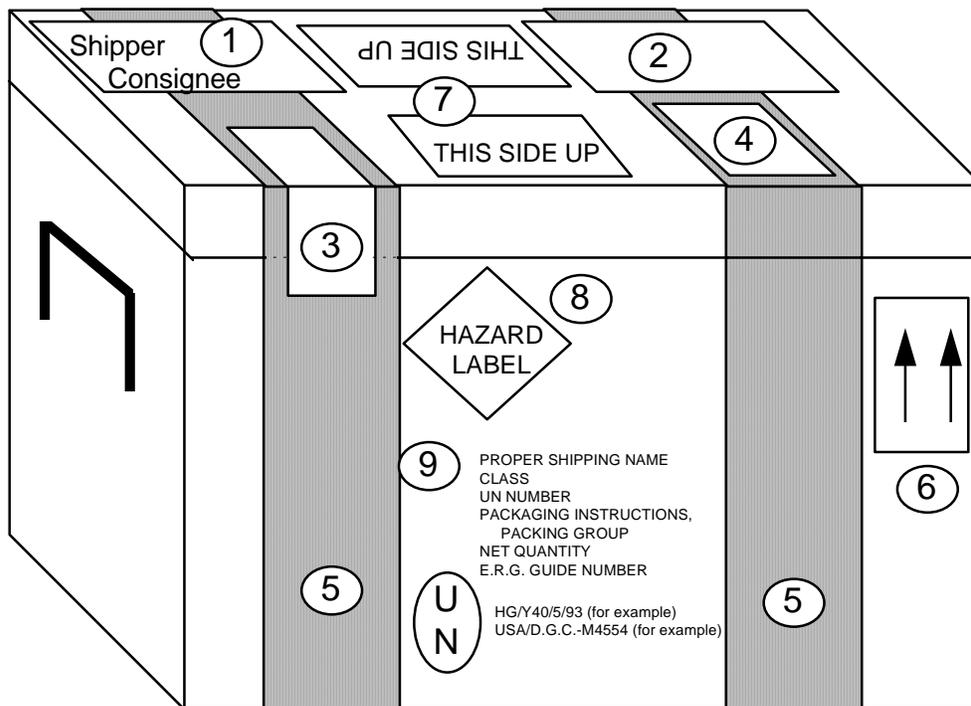
- 7.1 Maintain records as required by implementing these procedures.
- 7.2 Deviations from this procedure or the project-specific sampling and analysis plan shall be documented in field records. Significant changes shall be approved by the **Program Quality Manager**.

## 8.0 Attachments or Reference

- 8.1 Attachment 1 – Example Hazardous Material Package Marking
- 8.2 Attachment 2 – Packing Groups
- 8.3 Attachment 3 – Label for Dangerous Goods in Excepted Quantities
- 8.4 Attachment 4 – SW-846 Preservative Exception
- 8.5 Attachment 5 – Non-Hazardous Material Cooler Marking Figure for Shipment from Outside the Continental United States
- 8.6 Attachment 6 – Commercial Invoice – Soil
- 8.7 Attachment 7 – Commercial Invoice – Water
- 8.8 Attachment 8 – Soil Import Permit
- 8.9 Attachment 9 – Soil Samples Restricted Entry Labels
- 8.10 NAVSEA T0300-AZ-PRO-010. *Navy Environmental Compliance Sampling and Field Testing Procedures Manual*. August 2009.
- 8.11 Procedure 3-03, *Recordkeeping, Sample Labeling, and Chain-of-Custody*.

Author	Reviewer	Revisions (Technical or Editorial)
Mark Kromis Program Chemist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue

## Attachment 1 Example Hazardous Material Package Marking



- |  |   |
|--|---|
| ① AIR BILL/COMMERCIAL INVOICE                  | ⑥ DIRECTION ARROWS STICKER - TWO REQUIRED |
| ② USDA PERMIT (Letter to Laboratory from USDA) | ⑦ THIS SIDE UP STICKERS                   |
| ③ CUSTODY SEAL                                 | ⑧ HAZARD LABEL                            |
| ④ USDA 2" X 2" SOIL IMPORT PERMIT              | ⑨ HAZARDOUS MATERIAL INFORMATION          |
| ⑤ WATERPROOF STRAPPING TAPE                    | ⑩ PACKAGE SPECIFICATIONS                  |

## Attachment 2 Packing Groups

PACKING GROUP OF THE SUBSTANCE	PACKING GROUP I		PACKING GROUP II		PACKING GROUP III	
CLASS or DIVISION of PRIMARY or SUBSIDIARY RISK	Packagings		Packagings		Packagings	
	Inner	Outer	Inner	Outer	Inner	Outer
1: Explosives	----- Forbidden <sup>(Note A)</sup> -----					
2.1: Flammable Gas	----- Forbidden <sup>(Note B)</sup> -----					
2.2: Non-Flammable, non-toxic gas	----- See Notes A and B -----					
2.3: Toxic gas	----- Forbidden <sup>(Note A)</sup> -----					
3. Flammable liquid	30 mL	300 mL	30 mL	500 mL	30 mL	1 L
4.1 Self-reactive substances	Forbidden		Forbidden		Forbidden	
4.1: Other flammable solids	Forbidden		30 g	500 g	30 g	1 kg
4.2: Pyrophoric substances	Forbidden		Not Applicable		Not Applicable	
4.2 Spontaneously combustible substances	Not Applicable		30 g	500 g	30 g	1 kg
4.3: Water reactive substances	Forbidden		30 g or 30 mL	500 g or 500 mL	30 g or 30 mL	1 kg or 1 L
5.1: Oxidizers	Forbidden		30 g or 30 mL	500 g or 500 mL	30 g or 30 mL	1 kg or 1 L
5.2: Organic peroxides <sup>(Note C)</sup>	See Note A		30 g or 30 mL	500 g or 250 mL	Not Applicable	
6.1: Poisons - Inhalation toxicity	Forbidden		1 g or 1 mL	500 g or 500 mL	30 g or 30 mL	1 kg or 1 L
6.1: Poisons - oral toxicity	1 g or 1 mL	300 g or 300 mL	1 g or 1 mL	500 g or 500 mL	30 g or 30 mL	1 kg or 1 L
6.1: Poisons - dermal toxicity	1 g or 1 mL	300 g or 300 mL	1 g or 1 mL	500 g or 500 mL	30 g or 30 mL	1 kg or 1 L
6.2: Infectious substances	----- Forbidden <sup>(Note A)</sup> -----					
7: Radioactive material <sup>(Note D)</sup>	----- Forbidden <sup>(Note A)</sup> -----					
8: Corrosive materials	Forbidden		30 g or 30 mL	500 g or 500 mL	30 g or 30 mL	1 kg or 1 L
9: Magnetized materials	----- Forbidden <sup>(Note A)</sup> -----					
9: Other miscellaneous materials <sup>(Note E)</sup>	Forbidden		30 g or 30 mL	500 g or 500 mL	30 g or 30 mL	1 kg or 1 L

**Note A:** Packing groups are not used for this class or division.

**Note B:** For inner packagings, the quantity contained in receptacle with a water capacity of 30 mL. For outer packagings, the sum of the water capacities of all the inner packagings contained must not exceed 1 L.

**Note C:** Applies only to Organic Peroxides when contained in a chemical kit, first aid kit or polyester resin kit.

**Note D:** See 6.1.4.1, 6.1.4.2, and 6.2.1.1 through 6.2.1.7, radioactive material in excepted packages.

**Note E:** For substances in Class 9 for which no packing group is indicated in the List of Dangerous Goods, Packing Group II quantities must be used.



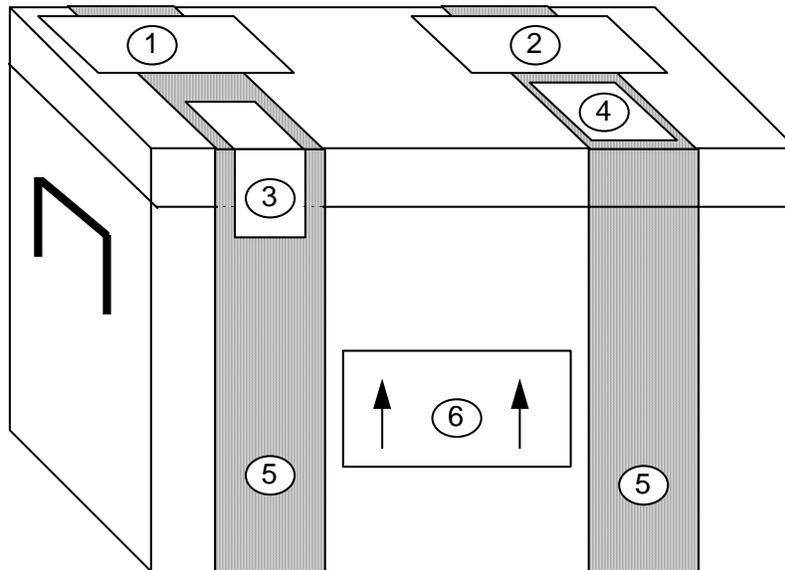
## Attachment 4

### SW-846 Preservative Exception

Measurement	Vol. Req. (mL)	Container <sup>2</sup>	Preservative <sup>3,4</sup>	Holding Time <sup>5</sup>
MBAS	250	P, G	Cool, 4°C	48 Hours
NTA	50	P, G	Cool, 4°C	24 Hours

1. More specific instructions for preservation and sampling are found with each procedure as detailed in this manual. A general discussion on sampling water and industrial wastewater may be found in ASTM, Part 31, p. 72-82 (1976) Method D-3370.
  2. Plastic (P) or Glass (G). For metals, polyethylene with a polypropylene cap (no liner) is preferred.
  3. Sample preservation should be performed immediately upon sample collection. For composite samples each aliquot should be preserved at the time of collection. When use of an automated sampler makes it impossible to preserve each aliquot, then samples may be preserved by maintaining at 4°C until compositing and sample splitting is completed.
4. When any sample is to be shipped by common carrier or sent through the United States Mail, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR Part 172). The person offering such material for transportation is responsible for ensuring such compliance. For the preservation requirements of Table 1, the Office of Hazardous Materials, Materials Transportation Bureau, Department of Transportation has determined that the Hazardous Materials regulations do not apply to the following materials: Hydrochloric acid (HCl) in water solutions at concentration of 0.04% by weight or less (pH about 1.96 or greater); Nitric acid (HNO<sub>3</sub>) in water solutions at concentrations of 0.15% by weight or less (pH about 1.62 or greater); Sulfuric acid (H<sub>2</sub>SO<sub>4</sub>) in water solutions at concentrations of 0.35% by weight or less (pH about 1.15 or greater); Sodium hydroxide (NaOH) in water solutions at concentrations of 0.080% by weight or less (pH about 12.30 or less).
5. Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still considered valid. Samples may be held for longer periods only if the permittee, or monitoring laboratory, has data on file to show that the specific types of sample under study are stable for the longer time, and has received a variance from the Regional Administrator. Some samples may not be stable for the maximum time period given in the table. A permittee, or monitoring laboratory, is obligated to hold the sample for a shorter time if knowledge exists to show this is necessary to maintain sample stability.
  6. Should only be used in the presence of residual chlorine.

## Attachment 5 Non-Hazardous Material Cooler Marking Figure for Shipment from Outside the Continental United States



- ① AIR BILL/COMMERCIAL INVOICE
- ② USDA PERMIT (Letter to Laboratory from USDA)
- ③ CUSTODY SEAL
- ④ USDA 2" X 2" SOIL IMPORT PERMIT
- ⑤ WATERPROOF STRAPPING TAPE
- ⑥ DIRECTION ARROWS STICKER - TWO REQUIRED

## Attachment 6 Commercial Invoice – Soil

DATE OF EXPORTATION <i>1/1/94</i>				EXPORT REFERENCES (i.e., order no., invoice no., etc.) <CJO #>				
SHIPPER/EXPORTER (complete name and address) <i>Joe Smith Ogden c/o &lt;hotel name&gt; &lt;hotel address&gt;</i>				CONSIGNEE <i>Sample Receipt &lt;Lab Name&gt; &lt;Lab Address&gt;</i>				
COUNTRY OF EXPORT <i>Guam, USA</i>				IMPORTER - IF OTHER THAN CONSIGNEE				
COUNTRY OF ORIGIN OF GOODS <i>Guam, USA</i>								
COUNTRY OF ULTIMATE DESTINATION <i>USA</i>								
INTERNATIONAL AIR WAYBILL NO.				<div style="border: 1px solid black; width: 200px; height: 30px; margin: 0 auto;"></div> (NOTE: All shipments must be accompanied by a Federal Express International Air Waybill)				
MARKS/NOS	NO. OF PKGS	TYPE OF PACKAGING	FULL DESCRIPTION OF GOODS	QTY	UNIT OF MEASURE	WEIGHT	UNIT VALUE	TOTAL VALUE
	<i>3</i>	<i>coolers</i>	<i>Soil samples for laboratory analysis only</i>				<i>\$1.00</i>	<i>\$3.00</i>
	TOTAL NO. OF PKGS.					TOTAL WEIGHT		TOTAL INVOICE VALUE
	<i>3</i>							<i>\$3.00</i>
Check one <input type="checkbox"/> F.O.B. <input type="checkbox"/> C&F <input type="checkbox"/> C.I.F.								

THESE COMMODITIES ARE LICENSED FOR THE ULTIMATE DESTINATION SHOWN.

DIVERSION CONTRARY TO UNITED STATES LAW IS PROHIBITED.

I DECLARE ALL THE INFORMATION CONTAINED IN THIS INVOICE TO BE TRUE AND CORRECT

SIGNATURE OF SHIPPER/EXPORTER (Type name and title and sign)

Joe Smith, Ogden

*Joe Smith*

*1/1/94*

Name/Title

Signature

Date

# Attachment 7 Commercial Invoice – Water

DATE OF EXPORTATION <i>1/1/94</i>				EXPORT REFERENCES (i.e., order no., invoice no., etc.) <CJO #>				
SHIPPER/EXPORTER (complete name and address) <i>Joe Smith Ogden c/o &lt;hotel name&gt; &lt;hotel address&gt;</i>				CONSIGNEE <i>Sample Receipt &lt;Lab Name&gt; &lt;Lab Address&gt;</i>				
COUNTRY OF EXPORT <i>Guam, USA</i>				IMPORTER - IF OTHER THAN CONSIGNEE				
COUNTRY OF ORIGIN OF GOODS <i>Guam, USA</i>								
COUNTRY OF ULTIMATE DESTINATION <i>USA</i>								
INTERNATIONAL AIR WAYBILL NO.					(NOTE: All shipments must be accompanied by a Federal Express International Air Waybill)			
MARKS/NOS	NO. OF PKGS	TYPE OF PACKAGING	FULL DESCRIPTION OF GOODS	QTY	UNIT OF MEASURE	WEIGHT	UNIT VALUE	TOTAL VALUE
	<i>3</i>	<i>coolers</i>	<i>Water samples for laboratory analysis only</i>				<i>\$1.00</i>	<i>\$3.00</i>
	TOTAL NO. OF PKGS.					TOTAL WEIGHT		TOTAL INVOICE VALUE
	<i>3</i>							<i>\$3.00</i>
Check one <input type="checkbox"/> F.O.B. <input type="checkbox"/> C&F <input type="checkbox"/> C.I.F.								

THESE COMMODITIES ARE LICENSED FOR THE ULTIMATE DESTINATION SHOWN.

DIVERSION CONTRARY TO UNITED STATES LAW IS PROHIBITED.

I DECLARE ALL THE INFORMATION CONTAINED IN THIS INVOICE TO BE TRUE AND CORRECT

SIGNATURE OF SHIPPER/EXPORTER (Type name and title and sign)

Joe Smith, Ogden

*Joe Smith*

*1/1/94*

# Attachment 8 Soil Import Permit



**UNITED STATES  
DEPARTMENT OF  
AGRICULTURE**

Animal and Plant  
Health Inspection  
Service

Plant Protection and  
Quarantine

## Soil Permit

Columbia Analytical Services  
(Lee Wolf)  
1317 S. 13th Avenue  
Kelso, Washington 98626  
TELEPHONE: (360) 577-7222

**Issued To:**

Under the authority of the Federal Plant Pest Act of May 23, 1957, permission is hereby granted to the facility/individual named above subject to the following conditions:

1. Valid for shipments of soil not heat treated at the port of entry, only if a compliance agreement (PPQ Form 519) has been completed and signed. Compliance Agreements and Soil permits are non-transferable. If you hold a Soil Permit and you leave your present employer or company, you must notify your local USDA office promptly.
2. To be shipped in sturdy, leakproof, containers.
3. To be released without treatment at the port of entry.
4. To be used only for analysis and only in the facility of the permittee at Columbia Analytical Services, located in Kelso, Washington.
5. No use of soil for growing purposes is authorized, including the isolation or culture of organisms imported in soil.
6. All unconsumed soil, containers, and effluent is to be autoclaved, incinerated, or heat treated by the permittee at the conclusion of the project as approved and prescribed by Plant Protection and Quarantine.
7. This permit authorizes shipments from all foreign sources, including Guam, Hawaii, Puerto Rico, and the U.S. Virgin Islands through any U.S. port of entry.

JUNE 30, 2006  
Expiration Date

*Deborah M. Knott*  
Approving Official DEBORAH M. KNOTT

**Permit Number:** S-52239

**WARNING:** Any alteration, forgery, or unauthorized use of this Federal form is subject to civil penalties of up to \$250,000 (7 U.S.C. s 7754(b)) or punishable by a fine of not more than \$10,000, or imprisonment of not more than 5 years, or both (18 U.S.C. s 1001).

PPQ FORM 525B (8/94)

Pt. 1 - PERMITTEE

# Attachment 9

## Soil Samples Restricted Entry Labels

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U.S. DEPARTMENT OF AGRICULTURE  
ANIMAL AND PLANT HEALTH INSPECTION  
SERVICE  
PLANT PROTECTION AND QUARANTINE  
HYATTSVILLE, MARYLAND 20782

**SOIL SAMPLES  
RESTRICTED ENTRY**

---

The material contained in this  
package is imported under authority  
of the Federal Plant Pest Act of May  
23, 1957.

---

For release without treatment  
if addressee is currently listed  
as approved by Plant  
Protection and Quarantine.

---

PPQ FORM 550      *Edition of 12/77 may be used*  
(JAN 83)

# Investigation Derived Waste Management

## Procedure 3-05

### 1.0 Purpose and Scope

This standard operating procedure (SOP) describes activities and responsibilities of the United States (U.S.) Navy Environmental Restoration (ER) Program, Naval Facilities Engineering Command, Atlantic (NAVFAC Atlantic) with regard to management of investigation-derived waste (IDW). The purpose of this procedure is to provide guidance for the minimization, handling, labelling, temporary storage, inventory, classification, and disposal of IDW generated under the ER Program. This procedure will also apply to personal protective equipment (PPE), sampling equipment, decontamination fluids, non-IDW trash, non-indigenous IDW, and hazardous waste generated during implementation of removal or remedial actions. The information presented will be used to prepare and implement work plans (WPs) for IDW-related field activities. The results from implementation of WPs will then be used to develop and implement final IDW disposal plans.

If there are procedures whether it be from Resolution Consultants, state and/or federal that are not addressed in this SOP and are applicable to IDW then those procedures may be added as an appendix to the project specific SAP.

This procedure applies to all Navy ER projects performed in the NAVFAC Atlantic Area of Responsibility.

This procedure shall serve as management-approved professional guidance for the ER Program and is consistent with protocol in the Uniform Federal Policy-Quality Assurance Project Plan (DoD 2005). As professional guidance for specific activities, this procedure is not intended to obviate the need for professional judgment during unforeseen circumstances. Deviations from this procedure while planning or executing planned activities must be approved by both the Contract Task Order (CTO) Manager and the Quality Assurance (QA) Manager or Technical Director, and documented.

This procedure was developed to serve as management-approved professional guidance for the management of IDW generated under the ER Program. It focuses on the requirements for minimizing, segregating, handling, labeling, storing, and inventorying IDW in the field. Certain drum inventory requirements related to the screening, sampling, classification, and disposal of IDW are also noted in this procedure.

### 2.0 Safety

The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, will be addressed in the project Health and Safety Plan (HASP). In the absence of a HASP, work will be conducted according to the CTO WP and/or direction from the **Site Safety Officer (SSO)**.

All **Field Personnel** responsible for IDW management must adhere to the HASP and must wear the PPE specified in the site-specific HASP. Generally, this includes, at a minimum, steel-toed boots or steel-toed rubber boots, safety glasses, American National Standards Institute-standard hard hats, and hearing protection (if heavy equipment is in operation). If safe alternatives are not achievable, discontinue site activities immediately.

### 3.0 Terms and Definitions

None.

## 4.0 Training and Qualifications

- 4.1 The **CTO Manager** is responsible for ensuring that IDW management activities comply with this procedure. The **CTO Manager** is responsible for ensuring that all personnel involved in IDW management shall have the appropriate education, experience, and training to perform their assigned tasks.
- 4.2 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.
- 4.3 The **Field Manager** is responsible for ensuring that all IDW is managed according to this procedure.
- 4.4 All **Field Personnel** are responsible for the implementation of this procedure.

## 5.0 Equipment and Supplies

The equipment and supplies required for implementation of this SOP include the following:

- Containers for waste (e.g., [U.S. Department of Transportation] DOT approved 55-gallon open and closed top drums) and material to cover waste to protect from weather (e.g., plastic covering);
- Hazardous /non-hazardous waste drum labels (weatherproof);
- Permanent marking pens;
- Inventory forms for project file;
- Plastic garbage bags, zip lock storage bags, roll of plastic sheeting; and
- Steel-toed boots, chemical resistant gloves, coveralls, safety glasses, and any other PPE required in the HASP.

## 6.0 Procedure

The following procedures are used to handle the IDW.

### 6.1 Drum Handling

- 6.1.1 IDW shall be containerized using DOT approved drums. The drums shall be made of steel or plastic, have a 55-gallon capacity, be completely painted or opaque, and have removable lids (i.e., United Nations Code 1A2 or 1H2). Typically 55-gallon drums are used, however small drums may be used depending on the amount of waste generated. New steel drums are preferred over recycled drums.
- 6.1.2 Recycled drums should not be used for hazardous waste, PCBs or other regulated shipments. For short-term storage of liquid IDW prior to discharge, double-walled bulk steel or plastic storage tanks may be used. For this scenario, consider the scheduling and cost-effectiveness of this type of bulk storage, treatment, and discharge system versus longer-term drum storage.
- 6.1.3 For long-term IDW storage at other project locations, the DOT approved drums with removable lids are recommended. Verify the integrity of the foam or rubber sealing ring located on the underside of some drum lids prior to sealing drums containing IDW liquids.
- 6.1.4 If the ring is only partially attached to the drum lid, or if a portion of the ring is missing, select another drum lid with a sealing ring that is in sound condition.
- 6.1.5 To prepare IDW drums for labeling, wipe clean the outer wall surfaces and drum lids of all material that might prevent legible and permanent labeling. If potentially contaminated material adheres to the outer surface of a drum, wipe that material from the drum, and segregate the paper towel or rag used to remove the material with visibly soiled PPE and

disposable sampling equipment. Label all IDW drums and place them on pallets prior to storage.

## 6.2 Labelling

- 6.2.1 Containers used to store IDW must be properly labelled. Two general conditions exist: 1) from previous studies or on-site data, waste characteristics are known to be either hazardous or nonhazardous; or 2) waste characteristics are unknown until additional data are obtained.
- 6.2.2 For situations where the waste characteristics are known, the waste containers should be packaged and labelled in accordance with state regulations and any federal regulations that may govern the labelling of waste.
- 6.2.3 The following information shall be placed on all non-hazardous waste labels:
- Description of waste (i.e., purge water, soil cuttings);
  - Contact information (i.e., contact name and telephone number);
  - Date when the waste was first accumulated.
- 6.2.4 The following information shall be placed on all hazardous waste labels:
- Description of waste (i.e., purge water, soil cuttings);
  - Generator information (i.e., name, address, contact telephone number);
  - EPA identification number (supplied by on-site client representative);
  - Date when the waste was first accumulated.
- 6.2.5 When the final characterization of a waste is unknown, a notification label should be placed on the drum with the words "waste characterization pending analysis" and the following information included on the label:
- Description of waste (i.e., purge water, soil cuttings);
  - Contact information (i.e., contact name and telephone number);
  - Date when the waste was first accumulated.
- 6.2.6 Once the waste has been characterized, the label should be changed as appropriate for a nonhazardous or hazardous waste.
- 6.2.7 Waste labels should be constructed of a weatherproof material and filled out with a permanent marker to prevent being washed off or becoming faded by sunlight. It is recommended that waste labels be placed on the side of the container, since the top is more subject to weathering. However, when multiple containers are accumulated together, it also may be helpful to include labels on the top of the containers to facilitate organization and disposal.
- 6.2.8 Each container of waste generated shall be recorded in the field notebook used by the person responsible for labelling the waste. After the waste is disposed of, either by transportation off-site or disposal on-site in an approved disposal area, an appropriate record shall be made in the same field notebook to document proper disposition of IDW.

### 6.3 **Types of Site Investigation Waste**

Several types of waste are generated during site investigations that may require special handling. These include solid, liquid, and used PPE, as discussed further below.

#### Solid Waste

Soil cuttings from boreholes will typically be placed in containers unless site specific requirements allow for soil cuttings to be placed back into the borehole after drilling is complete. Drilling mud generated during investigation activities shall be collected in containers. Covers should be included on the containers and must be secured at all times and only open during filling activities. The containers shall be labelled in accordance with this SOP. An inventory containing the source, volume, and description of material put in the containers shall be logged on prescribed forms and kept in the project file.

Non-hazardous solid waste can be disposed on-site in the designated site landfill or in a designated evaporation pond if it is liquefied. Hazardous wastes must be disposed off-site at an approved hazardous waste landfill.

#### Liquid Waste

Groundwater generated during monitoring well development, purging, and sampling can be collected in truck-mounted containers and/or other transportable containers (i.e., 55-gallon drums). Lids or bungs on drums must be secured at all times and only open during filling or pumping activities. The containers shall be labelled in accordance with this SOP. Non-hazardous liquid waste can be disposed of in one of the designated lined evaporation ponds on-site. Hazardous wastes must be handled separately and disposed off-site at an approved hazardous waste facility.

#### Personal Protective Equipment

PPE that is generated throughout investigation activities shall be placed in plastic garbage bags. If the solid or liquid waste that was being handled is characterized as hazardous waste, then the corresponding PPE should also be disposed as hazardous waste. If not, all PPE should be disposed as non-hazardous waste in the designated on-site landfill. Trash that is generated as part of field activities may be disposed of in the landfill as long as the trash was not exposed to hazardous media.

### 6.4 **Waste Accumulation On-Site**

6.4.1 Solid, liquid, or PPE waste generated during investigation activities that are classified as nonhazardous or "characterization pending analysis" should be disposed of as soon as possible. Until disposal, such containers should be inventoried, stored as securely as possible, and inspected regularly, as a general good practice.

6.4.2 Solid, liquid, or PPE waste generated during investigation activities that are classified as hazardous shall not be accumulated on-site longer than 90 days. All hazardous waste containers shall be stored in a secured storage area. The following requirements for the hazardous waste storage area must be implemented:

- Proper hazardous waste signs shall be posted as required by any state or federal statutes that may govern the labelling of waste;
- Secondary containment to contain spills;
- Spill containment equipment must be available;
- Fire extinguisher;
- Adequate aisle space for unobstructed movement of personnel.

6.4.3 Weekly storage area inspections shall be performed and documented to ensure compliance with these requirements. Throughout the project, an inventory shall be maintained to itemize the type and quantity of the waste generated.

## 6.5 Waste Disposal

6.5.1 Solid, liquid, and PPE waste will be characterized for disposal through the use of client knowledge, laboratory analytical data created from soil or groundwater samples gathered during the field activities, and/or composite samples from individual containers.

6.5.2 All waste generated during field activities will be stored, transported, and disposed of according to applicable state, federal, and local regulations. All wastes classified as hazardous will be disposed of at a licensed treatment storage and disposal facility or managed in other approved manners.

6.5.3 In general, waste disposal should be carefully coordinated with the facility receiving the waste. Facilities receiving waste have specific requirements that vary even for non-hazardous waste, so characterization should be conducted to support both applicable regulations and facility requirements.

## 6.6 Regulatory Requirements

The following federal and state regulations shall be used as resources for determining waste characteristics and requirements for waste storage, transportation, and disposal:

- Code of Federal Regulations (CFR), Title 40, Part 261;
- CFR, Title 49, Parts 172, 173, 178, and 179.

## 6.7 Waste Transport

A state-certified hazardous waste hauler shall transport all wastes classified as hazardous. Typically, the facility receiving any waste can coordinate a hauler to transport the waste. Shipped hazardous waste shall be disposed of in accordance with all RCRA/USEPA requirements. All waste manifests or bills of lading will be signed either by the client or the client's designee.

## 7.0 Quality Control and Assurance

7.1 Management of IDW must incorporate quality control measures to ensure conformance to these and the project requirements.

## 8.0 Records, Data Analysis, Calculations

8.1 Maintain records as required by implanting the procedures in this SOP.

8.2 Deviations from this procedure or the sampling and analysis plan shall be documented in field records. Significant changes shall be approved by the **Program Quality Manager**.

## 9.0 Attachments or References

Department of Defense, United States (DoD). 2005. *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual*. Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: [http://www.epa.gov/-fedfac/pdf/ufp\\_qapp\\_v1\\_0305.pdf](http://www.epa.gov/-fedfac/pdf/ufp_qapp_v1_0305.pdf).

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NAVFAC NW Standard Operating Procedure Number I-D-1, *Drum Sampling*.

NAVFAC NW Standard Operating Procedure Number I-F, *Equipment Decontamination*.

NAVFAC NW Standard Operating Procedure Number III-D, *Logbooks*.

Author	Reviewer	Revisions (Technical or Editorial)
Mark Kromis Program Chemist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue (May 2012)

# Equipment Decontamination

## Procedure 3-06

### 1.0 Purpose and Scope

- 1.1 This standard operating procedure (SOP) describes methods of equipment decontamination, to be used for activities where samples for chemical analysis are collected or where equipment will need to be cleaned before leaving the site or before use in subsequent activities.
- 1.2 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review.

### 2.0 Safety

It is the responsibility of the **Site Safety Officer (SSO)** to set up the site zones (i.e., exclusion, transition, and clean) and decontamination areas. Generally the decontamination area is located within the transition zone, upwind of intrusive activities, and serves as the washing area for both personnel and equipment to minimize the spread of contamination into the clean zone. Typically, for equipment, a series of buckets are set up on a visqueen-lined bermed area. Separate spray bottles containing cleaning solvents as described in this procedure or the Contract Task Order (CTO) Work Plan (WP) and distilled water are used for final rinsing of equipment. Depending on the nature of the hazards and the site location, decontamination of heavy equipment, such as augers, pump drop pipe, and vehicles, may be accomplished using a variety of techniques.

All **Field Personnel** responsible for equipment decontamination must adhere to the site-specific health and safety plan (HSP) and must wear the personal protective equipment (PPE) specified in the site-specific HSP. Generally this includes, at a minimum, Tyvek® coveralls, steel-toed boots with boot covers or steel-toed rubber boots, safety glasses, American National Standards Institute-standard hard hats, and hearing protection (if heavy equipment is in operation). Air monitoring by the **SSO** may result in an upgrade to the use of respirators and cartridges in the decontamination area; therefore, this equipment must be available on site. If safe alternatives are not achievable, discontinue site activities immediately.

In addition to the aforementioned precautions, the following sections describe safe work practices that will be employed.

#### 2.1 Chemical Hazards associated with Equipment Decontamination

- Avoid skin contact with and/or incidental ingestion of decontamination solutions and water.
- Utilize PPE as specified in the site-specific HSP to maximize splash protection.
- Refer to material safety data sheets, safety personnel, and/or consult sampling personnel regarding appropriate safety measures (i.e., handling, PPE including skin and respiratory).
- Take the necessary precautions when handling detergents and reagents.

#### 2.2 Physical Hazards associated with Equipment Decontamination

- To avoid possible back strain, it is recommended to raise the decontamination area 1 to 2 feet above ground level.
- To avoid heat stress, over exertion, and exhaustion, it is recommended to rotate equipment decontamination among all site personnel.

- Take necessary precautions when handling field sampling equipment.

### **3.0 Terms and Definitions**

None.

### **4.0 Training and Qualifications**

- 4.1 The **CTO Manager** is responsible for ensuring that decontamination activities comply with this procedure. The **CTO Manager** is responsible for ensuring that all personnel involved in equipment decontamination shall have the appropriate education, experience, and training to perform their assigned tasks.
- 4.2 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.
- 4.3 The **Field Manager** is responsible for ensuring that all field equipment is decontaminated according to this procedure.
- 4.4 All **Field Personnel** are responsible for the implementation of this procedure.

### **5.0 Procedure**

Decontamination of equipment used in soil/sediment sampling, groundwater monitoring, well drilling and well development, as well as equipment used to sample groundwater, surface water, sediment, waste, wipe, asbestos, and unsaturated zone, is necessary to prevent cross-contamination and to maintain the highest integrity possible in collected samples. Planning a decontamination program requires consideration of the following factors:

- Location where the decontamination procedures will be conducted
- Types of equipment requiring decontamination
- Frequency of equipment decontamination
- Cleaning technique and types of cleaning solutions appropriate to the contaminants of concern
- Method for containing the residual contaminants and wash water from the decontamination process
- Use of a quality control measure to determine the effectiveness of the decontamination procedure

The following subsections describe standards for decontamination, including the frequency of decontamination, cleaning solutions and techniques, containment of residual contaminants and cleaning solutions, and effectiveness.

#### **5.1 Decontamination Area**

Select an appropriate location for the decontamination area at a site based on the ability to control access to the area, the ability to control residual material removed from equipment, the need to store clean equipment, and the ability to restrict access to the area being investigated. Locate the decontamination area an adequate distance away and upwind from potential contaminant sources to avoid contamination of clean equipment.

#### **5.2 Types of Equipment**

Drilling equipment that must be decontaminated includes drill bits, auger sections, drill-string tools, drill rods, split barrel samplers, tremie pipes, clamps, hand tools, and steel cable. Decontamination of monitoring well development and groundwater sampling equipment includes submersible pumps, bailers, interface probes, water level meters, bladder pumps, airlift pumps, peristaltic pumps, and lysimeters. Other sampling equipment that requires decontamination includes, but is not limited to, hand trowels,

hand augers, slide hammer samplers, shovels, stainless-steel spoons and bowls, soil sample liners and caps, wipe sampling templates, composite liquid waste samplers, and dippers. Equipment with a porous surface, such as rope, cloth hoses, and wooden blocks, cannot be thoroughly decontaminated and shall be properly disposed of after one use.

### 5.3 **Frequency of Equipment Decontamination**

Decontaminate down-hole drilling equipment and equipment used in monitoring well development and purging prior to initial use and between each borehole or well. Down-hole drilling equipment, however, may require more frequent cleaning to prevent cross-contamination between vertical zones within a single borehole. When drilling through a shallow contaminated zone and installing a surface casing to seal off the contaminated zone, decontaminate the drilling tools prior to drilling deeper. Initiate groundwater sampling by sampling groundwater from the monitoring well where the least contamination is suspected. Decontaminate groundwater, surface water, and soil sampling devices prior to initial use and between collection of each sample to prevent the possible introduction of contaminants into successive samples.

### 5.4 **Cleaning Solutions and Techniques**

Decontamination can be accomplished using a variety of techniques and fluids. The preferred method of decontaminating major equipment, such as drill bits, augers, drill string, and pump drop-pipe, is steam cleaning. To steam clean, use a portable, high-pressure steam cleaner equipped with a pressure hose and fittings. For this method, thoroughly steam wash equipment and rinse it with potable tap water to remove particulates and contaminants.

A rinse decontamination procedure is acceptable for equipment such as bailers, water level meters, new and re-used soil sample liners, and hand tools. The decontamination procedure shall consist of the following: (1) wash with a non-phosphate detergent (Alconox®, Liquinox®, or other suitable detergent) and potable water solution; (2) rinse with potable water; (3) spray with laboratory-grade isopropyl alcohol; (4) rinse with deionized or distilled water; and (5) spray with deionized or distilled water. If possible, disassemble equipment prior to cleaning. Add a second wash at the beginning of the process if equipment is very soiled.

Decontaminating submersible pumps requires additional effort because internal surfaces become contaminated during usage. Decontaminate these pumps by washing and rinsing the outside surfaces using the procedure described for small equipment or by steam cleaning. Decontaminate the internal surfaces by recirculating fluids through the pump while it is operating. This recirculation may be done using a relatively long (typically 4 feet) large-diameter pipe (4-inch or greater) equipped with a bottom cap. Fill the pipe with the decontamination fluids, place the pump within the capped pipe, and operate the pump while recirculating the fluids back into the pipe. The decontamination sequence shall include: (1) detergent and potable water; (2) potable water rinse; (3) potable water rinse; and (4) deionized water rinse. Change the decontamination fluids after each decontamination cycle.

Solvents other than isopropyl alcohol may be used, depending upon the contaminants involved. For example, if polychlorinated biphenyls or chlorinated pesticides are contaminants of concern, hexane may be used as the decontamination solvent; however, if samples are also to be analyzed for volatile organics, hexane shall not be used. In addition, some decontamination solvents have health effects that must be considered. Decontamination water shall consist of distilled or deionized water. Steam-distilled water shall not be used in the decontamination process as this type of water usually contains elevated concentrations of metals. Decontamination solvents to be used during field activities will be specified in the CTO WP.

Rinse equipment used for measuring field parameters, such as pH (indicates the hydrogen ion concentration – acidity or basicity), temperature, specific conductivity, and turbidity with deionized or distilled water after each measurement. Also wash new, unused soil sample liners and caps with a fresh

detergent solution and rinse them with potable water followed by distilled or deionized water to remove any dirt or cutting oils that might be on them prior to use.

## 5.5 **Containment of Residual Contaminants and Cleaning Solutions**

A decontamination program for equipment exposed to potentially hazardous materials requires a provision for catchment and disposal of the contaminated material, cleaning solution, and wash water.

When contaminated material and cleaning fluids must be contained from heavy equipment, such as drill rigs and support vehicles, the area must be properly floored, preferably with a concrete pad that slopes toward a sump pit. If a concrete pad is impractical, planking can be used to construct solid flooring that is then covered by a nonporous surface and sloped toward a collection sump. If the decontamination area lacks a collection sump, use plastic sheeting and blocks or other objects to create a bermed area for collection of equipment decontamination water. Situate items, such as auger flights, which can be placed on metal stands or other similar equipment, on this equipment during decontamination to prevent contact with fluids generated by previous equipment decontamination. Store clean equipment in a separate location to prevent recontamination. Collect decontamination fluids contained within the bermed area and store them in secured containers as described below.

Use wash buckets or tubs to catch fluids from the decontamination of lighter-weight drilling equipment and hand-held sampling devices. Collect the decontamination fluids and store them on site in secured containers, such as U.S. Department of Transportation-approved drums, until their disposition is determined by laboratory analytical results. Label containers in accordance with Procedure 3-05, *IDW Management*.

## 6.0 **Quality Control and Assurance**

A decontamination program must incorporate quality control measures to determine the effectiveness of cleaning methods. Quality control measures typically include collection of equipment blank samples or wipe testing. Equipment blanks consist of analyte-free water that has been poured over or through the sample collection equipment after its final decontamination rinse. Wipe testing is performed by wiping a cloth over the surface of the equipment after cleaning. These quality control measures provide "after-the-fact" information that may be useful in determining whether or not cleaning methods were effective in removing the contaminants of concern.

## 7.0 **Records, Data Analysis, Calculations**

Any project where sampling and analysis is performed shall be executed in accordance with an approved sampling and analysis plan. This procedure may be incorporated by reference or may be incorporated with modifications described in the plan.

Deviations from this procedure or the sampling and analysis plan shall be documented in field records. Significant changes shall be approved by the **Program Quality Manager**.

## 8.0 **Attachments or References**

- 8.1 ASTM Standard D5088. 2008. *Standard Practice for Decontamination of Field Equipment Used at Waste Sites*. ASTM International, West Conshohocken, PA. 2008. DOI: 10.1520/D5088-02R08. [www.astm.org](http://www.astm.org).
- 8.2 NAVSEA T0300-AZ-PRO-010. *Navy Environmental Compliance Sampling and Field Testing Procedures Manual*. August 2009.
- 8.3 Procedure 3-05, *IDW Management*.

<b>Author</b>	<b>Reviewer</b>	<b>Revisions (Technical or Editorial)</b>
Mark Kromis Program Chemist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue

# Land Surveying

## Procedure 3-07

### 1.0 Purpose and Scope

- 1.1 The purpose of this document is to define the standard operating procedure (SOP) for acquiring land surveying data to facilitate the location and mapping of geologic, hydrologic, geotechnical data, and analytical sampling points and to establish topographic control over project sites.
- 1.2 This procedure is the Program-approved professional guidance for work performed by Resolution Consultants under the Comprehensive Long-Term Environmental Action Navy (CLEAN) contract (Contract Number N62470-11-D-8013).
- 1.3 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review. If there are procedures whether it be from Resolution Consultants, state and/or federal that are not addressed in this SOP and are applicable to surface water sampling then those procedures may be added as an appendix to the project specific SAP.
- 1.4 It is fully expected that the procedures outlined in this SOP will be followed. Procedural modifications may be warranted depending upon field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this SOP will be approved in advance by the Program Quality Manager. Deviations to this SOP will be documented in the field records.
- 1.5 If there are procedures, whether it be from Resolution Consultants, state and/or federal, that are not addressed in this SOP and are applicable to land surveying then those procedures may be added as an appendix to the project specific Sampling and Analysis Plan (SAP).

### 2.0 Safety

- 2.1 Depending upon the site-specific contaminants, various protective programs must be implemented prior to conducting fieldwork. All **field sampling personnel** must review the project-specific health and safety plan (HASP) paying particular attention to the control measures planned for the specific field tasks. Conduct preliminary area monitoring to determine the potential hazard to field sampling personnel. If significant contamination is observed, minimize contact with potential contaminants in both the vapor and liquid phase through the use of respirators and disposable clothing.
- 2.2 In addition, observe standard health and safety practices according to the project-specific HASP. Suggested minimum protection includes inner disposable vinyl gloves, outer chemical-protective nitrile gloves, rubberized steel-toed boots, and an American National Standards Institute-standard hard hat. Half-face respirators and cartridges and Tyvek® suits may be necessary depending on the contaminant concentrations, and shall always be available on site.
- 2.3 Daily safety briefs will be conducted at the start of each working day before any work commences. These daily briefs will be facilitated by the **Site Safety Officer (SSO)** or designee to discuss the day's events and any potential health risk areas covering every aspect of the work to be completed. Weather conditions are often part of these discussions. As detailed in the HASP, everyone on the field team has the authority to stop work if an unsafe condition is perceived until the conditions are fully remedied to the satisfaction of the SSO.
- 2.4 The health and safety considerations for the work associated with land surveying include:
  - Slip, trips and falls associated with work in the field;

- Biological hazards associated with work in the field; and,
- Potential hazards associated with contaminants of concern (COC) that may be located in the survey area,

### **3.0 Terms and Definitions**

#### **3.1 Boundary Survey**

Boundary surveys are conducted by Certified Land Surveyors in order to delineate a legal property line for a site or section of a site.

#### **3.2 Global Positioning System (GPS)**

A system of satellites, computers, and receivers that is able to determine the latitude and longitude of a receiver on Earth by calculating the time difference for signals from different satellites to reach the receiver.

### **4.0 Interferences**

- 4.1 Commercially available GPS units typically have a level of precision of ( $\pm$ ) 3 to 5 meters. Field corrections can be made as described in Section 8.3 below.

### **5.0 Training and Qualifications**

#### **5.1 Qualifications and Training**

- 5.1.1 The individual executing these procedures must have read, and be familiar with, the requirements of this SOP.

#### **5.2 Responsibilities**

- 5.2.1 The **Contract Task Order (CTO) Manager** is responsible for ensuring that land surveying activities comply with this procedure. The CTO Manager is responsible for ensuring that all field sampling personnel involved in land surveying shall have the appropriate education, experience, and training to perform their assigned tasks.
- 5.2.2 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.
- 5.2.3 The **Field Manager (FM)** is responsible for ensuring that all field personnel follow these procedures. In virtually all cases, subcontractors will conduct these procedures. The FM or designee is responsible for overseeing the activities of the subcontractor and ensuring that sampling points and topographic features are properly surveyed.

### **6.0 Equipment and Supplies**

- 6.1 The following equipment list contains materials that may be needed in carrying out the procedures outlined in this SOP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.
- Personal protective equipment (PPE) and other safety equipment, as required by the HASP;
  - Commercially available GPS unit; and,
  - Field Logbook.

## **7.0 Calibration or Standardization**

- 7.1 An authorized manufacturer's representative shall inspect and calibrate survey instruments in accordance with the manufacturer's specifications regarding procedures and frequencies. At a minimum, instruments shall be calibrated no more than six months prior to the start of the survey work.
- 7.2 Standards for all survey work shall be in accordance with National Oceanic and Atmospheric Administration standards and, at a minimum, with accuracy standards set forth below. The horizontal accuracy for the location of all grid intersection and planimetric features shall be ( $\pm$ ) 0.1 feet. The horizontal accuracy for boundary surveys shall be 1 in 10,000 feet (1:10,000). The vertical accuracy for ground surface elevations shall be ( $\pm$ ) 0.1 feet. Benchmark elevation accuracy and elevation of other permanent features, including monitoring wellheads, shall be ( $\pm$ ) 0.01 feet.

## **8.0 Procedure**

### **8.1 Theodolite/Electronic Distance Measurement (EDM)**

Follow the procedures listed below during theodolite/EDM land surveying conducted under the NAVFAC CLEAN Program:

- A land surveyor registered in the state or territory in which the work is being performed shall directly supervise all surveying work.
- Reference surveys to the local established coordinate systems and base all elevations and benchmarks established on U.S. Geological Survey datum, 1929 general adjustment.
- Reference surveyed points to Mean Sea Level (Lower Low Water Level).
- Jointly determine appropriate horizontal and vertical control points prior to the start of survey activities. If discrepancies in the survey (e.g., anomalous water level elevations) are observed, the surveyor may be required to verify the survey by comparison to a known survey mark. If necessary, a verification survey may be conducted by a qualified third party.
- All field notes, sketches, and drawings shall clearly identify the horizontal and vertical control points by number designation, description, coordinates, and elevations. Map all surveyed locations using a base map or other site mapping, as specified by the project Work Plan or SAP.
- Begin and end all surveys at the designated horizontal and vertical control points to determine the degree of accuracy of the surveys.
- Iron pins used to mark control points shall be made of reinforcement steel or an equivalent material and shall be 18 inches long with a minimum diameter of 5/8 inch. Drive pins to a depth of 18 inches into the soil.
- Stakes used to mark survey lines and points shall be made from 3-foot lengths of 2-inch by 2-inch lumber and pointed at one end. Clearly mark them with brightly colored weatherproof flagging and paint.
- Clearly mark the point on a monitoring well casing or well riser that is surveyed by filing grooves into the casing/riser on either side of the surveyed point, or by marking the riser with a permanent ink marker.

### **8.2 Global Positioning System (GPS) to Conduct Land Survey**

Follow the procedures listed below during land surveying using GPS:

- A land surveyor registered in the state or territory in which the work is being performed shall directly supervise all surveying work.
- Reference surveys to the local established coordinate systems and base all elevations and benchmarks established on U.S. Geological Survey datum, 1929 general adjustment.

- All field notes, sketches, and drawings shall clearly identify the horizontal and vertical control points by number designation, description, coordinates, and elevations. Map all surveyed locations using a base map or other site mapping, as specified in the project Work Plan or SAP.
- Begin and end all surveys at the designated horizontal and vertical control points (as applicable) to determine the degree of accuracy of the surveys.
- Iron pins used to mark control points shall be made of reinforcement steel or an equivalent material and shall be 18 inches long with a minimum diameter of 5/8 inch. Drive pins to a depth of 18 inches into the soil.
- Stakes used to mark survey lines and points shall be made from 3-foot lengths of 2-inch by 2-inch lumber and pointed at one end. Clearly mark them with brightly colored weatherproof flagging and paint.
- Clearly mark the point on a monitoring well casing that is surveyed by filing grooves into the casing on either side of the surveyed point.

### 8.3 **Global Positioning System (GPS) to Position Sample Locations or Locate Site Features**

Experienced field personnel may use a GPS system unit to position sample locations (e.g. grid positioned samples, soil boring locations) at a site. The decision to use field personnel or a licensed land surveyor will depend on the objectives of the survey (e.g. vertical elevation is not required) and the levels of precision required. Typically when a level of precision greater than ( $\pm$ ) 3 to 5 meters is required, a licensed surveyor will be required. When a level of precision of ( $\pm$ ) 3 to 5 meters is sufficient to meet project requirements (i.e. when laying sampling grids, identifying significant site features, or locating features identified in GIS figures) experienced field personnel may use commercially available, consumer-grade GPS units. Follow the procedures listed below to locate samples or site features using GPS:

- A commercially available GPS unit with Wide Angle Averaging System (WAAS), topographic map display, and waypoint storage capabilities should be used.
- If waypoints are to be imported into a GIS database, the same grid projection system should be used.
- If a permanent reference point near the site is available, it is recommended that a waypoint at this location be taken every day waypoints are stored.
- When laying out a sampling grid from a GIS map, upload the coordinates from GIS to the GPS unit, including coordinates for an easily identified, permanent, nearby feature (i.e. building corner, roadway intersection, or USGS benchmark).
- If during the initial site walk, the permanent feature identified does not overlay within ( $\pm$ ) 5 meters as identified in the GPS unit, field corrections of the waypoints should be made.
- Field corrections can be made by adding/subtracting the difference in x,y coordinates between the field measurement of the permanent site feature and the anticipated x,y coordinates. This correction should then be applied to the x,y coordinates for each sampling location to be marked. Corrected x,y coordinates can then be uploaded into the GPS unit.
- Sampling points and site features can then be located in the field using the GPS units "Go To" function. When the distance to the sampling point or feature remains close to zero, the location can be marked.
- If no field corrections to the sampling location need to be made, or if sampling locations are to be surveyed by a licensed surveyor at a later date, no additional waypoints need to be taken. If significant changes to the sampling location are made, GPS coordinates at the corrected location shall be stored and labeled.

- It is recommended that GPS coordinates be uploaded to a storage device such as PC at the end of each day.
- Field logs shall indicate manufacturer and model number for GPS unit used, map datum and projection used, and any field corrections made. If the GPS unit cannot lock onto a WAAS system at the site, this should also be noted.

## 9.0 Quality Control and Assurance

None.

## 10.0 Data and Records Management

The surveyor shall record field notes daily using generally accepted practices. The data shall be neat, legible, in indelible ink, and easily reproducible. Copies of the surveyor's field notes and calculation forms generated during the work shall be obtained and placed in the project files.

Surveyor's field notes shall, at a minimum, clearly indicate:

- The date of the survey;
- General weather conditions;
- The name of the surveying firm;
- The names and job titles of personnel performing the survey work;
- Equipment used, including serial numbers; and,
- Field book designations, including page numbers.

A land surveyor registered in the state or territory in which the work was done shall sign, seal, and certify the drawings and calculations submitted by the surveyor.

Dated records of land surveying equipment calibration shall be provided by the surveyor and placed in the project files. Equipment serial numbers shall be provided in the calibration records.

## 11.0 Attachments or References

Department of Defense, United States (DoD). 2005. *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual*. Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: [http://www.epa.gov/fedfac/pdf/ufp\\_qapp\\_v1\\_0305.pdf](http://www.epa.gov/fedfac/pdf/ufp_qapp_v1_0305.pdf).

<i>Author</i>	<i>Reviewer</i>	<i>Revisions (Technical or Editorial)</i>
Robert Shoemaker Senior Scientist	Naomi Ouellette, Project Manager	Rev 0 – Initial Issue

# Monitoring Well Installation

## Procedure 3-12

### 1.0 Purpose and Scope

- 1.1 This standard operating procedure (SOP) describes the methods to be used during the installation of groundwater monitoring wells. It describes the components of monitoring well design and installation and sets forth the rationale for use of various well installation techniques in specific situations.
- 1.2 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review.

### 2.0 Safety

- 2.1 The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, will be addressed in the project Health and Safety Plan (HASP). In the absence of a HASP, work will be conducted according to the Contract Task Order (CTO) Work Plan (WP) and/or direction from the **Site Safety Officer (SSO)**.
- 2.2 Before well installation commences, appropriate entities (e.g. DigSafe, local public works departments, company facilities) must be contacted to assure the anticipated well locations are marked for utilities, including electrical, telecommunications, water, sewer, and gas.
- 2.3 Physical Hazards Associated with Well Installation
- Stay clear of all moving equipment and avoid wearing loose fitting clothing.
  - When using an approved retractable-blade knife, always cut away from one self and make sure there are no other people in the cutting path or the retractable-blade knife.
  - To avoid slip/trip/fall conditions during drilling activities, keep the area clear of excess soil cuttings and groundwater. Use textured boots/boot cover bottoms in muddy areas.
  - To avoid heat/cold stress as a result of exposure to extreme temperatures and personal protective equipment (PPE), drink electrolyte replacement fluids (1 to 2 cups per hour is recommended) and, in cases of extreme cold, wear fitted insulating clothing.
  - To avoid hazards associated with subsurface utilities, ensure all sampling locations have been properly surveyed as described in SOP 3-01, Utility Clearance.
  - Be aware of restricted mobility caused by PPE.

### **3.0 Terms and Definitions**

- 3.1 **Annulus:** The annulus is the down-hole space between the borehole wall and the well casing and screen.
- 3.2 **Bridge:** A bridge is an obstruction in the drill hole or annulus. A bridge is usually formed by caving of the wall of the well bore, by the intrusion of a large boulder, or by the placement of filter pack materials during well completion. Bridging can also occur in the formation during well development.
- 3.3 **Filter Pack:** Filter pack is sand or gravel that is smooth, uniform, clean, well-rounded, and siliceous. It is placed in the annulus of the well between the borehole wall and the well screen to prevent formation materials from entering the well and to stabilize the adjacent formation.
- 3.4 **Grout:** Grout is a fluid mixture of cement and water that can be forced through a tremie pipe and emplaced in the annular space between the borehole and casing to form an impermeable seal. Various additives, such as sand, bentonite, and polymers, may be included in the mixture to meet certain requirements.
- 3.5 **Heaving (Running) Sands:** Loose sands in a confined water-bearing zone or aquifer which tend to rise up into the drill stem when the confining unit is breached by the drill bit. Heaving sands occur when the water in the aquifer has a pressure head great enough to cause upward flow into the drill stem with enough velocity to overcome the weight of the sand.
- 3.6 **Sieve Analysis:** Sieve analysis is the evaluation of the particle-size distribution of a soil, sediment, or rock by measuring the percentage of the particles that will pass through standard sieves of various sizes.

### **4.0 Interferences**

- 4.1 Heaving sands may be problematic in unconsolidated sands encountered below the water table.
- 4.2 Rotary drilling methods requiring bentonite-based drilling fluids should be used with caution to drill boreholes that will be used for monitoring well installation. The bentonite mud builds up on the borehole walls as a filter cake and permeates the adjacent formation, potentially reducing the permeability of the material adjacent to the well screen.
- 4.3 If water or other drilling fluids have been introduced into the boring during drilling or well installation, samples of these fluids should be obtained and analyzed for chemical constituents that may be of interest at the site. In addition, an attempt should be made to recover the quantity of fluid or water that was introduced, either by flushing the borehole prior to well installation and/or by overpumping the well during development.
- 4.4 Track-mounted drill rigs are suitable for travelling on many types of landscapes that truck-mounted units cannot access, but may have limitations on extremely uneven or soft terrain.
- 4.5 Care should be taken to prevent cross-contamination between well locations. All drilling equipment coming in contact with potentially contaminated soil and/or groundwater will be decontaminated by the drilling subcontractor prior to initial drilling activities and between drilling locations in accordance with SOP 3-06, Equipment Decontamination.

### **5.0 Training and Qualifications**

#### **5.1 Qualifications and Training**

The individual executing these procedures must have read, and be familiar with, the requirements of this SOP.

## 5.2 Responsibilities

- 5.2.1 **Contract Task Order (CTO) Managers** are responsible for issuing sampling and analysis plans (SAPs) that reflect the procedures and specifications presented in this procedure. Individual municipalities, county agencies, and possibly state regulatory agencies enforce regulations that may include well construction and installation requirements. The **CTO Manager** shall be familiar with current local and state regulations, and ensure that these regulations are followed. The **CTO Manager** is responsible for ensuring that all personnel involved in monitoring well installation shall have the appropriate education, experience, and training to perform their assigned tasks.
- 5.2.2 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.
- 5.2.3 The **Field Manager** is responsible for direct supervision of the installation of monitoring wells and ensuring that procedures and specifications are implemented in the field in accordance with the approved SAP and well installation permits. The qualifications for the **Field Manager** must be in accordance with local jurisdictions with authority over the operations conducted.
- 5.2.4 All field personnel are responsible for the implementation of this procedure.
- 5.2.5 The on-site hydrogeologist/engineer is expected to obtain a description of the lithologic samples obtained during the excavation and construction of a monitoring well. These data are often required to provide guidance regarding the installation of specific components of the monitoring well. Guidance for lithologic sample collection and sample description is contained within SOP 3-16, Soil and Rock Classification.

## 6.0 Equipment and Supplies

- 6.1 Materials provided by the drilling contractor may include:
- Drill rig, drill rods, hollow stem augers, etc.
  - Decontamination equipment (e.g., steam cleaner, high-pressure washer, brushes, etc.)
  - Decontamination pad materials
  - Well screen/riser pipe with flush-threaded couplings including riser and bottom caps
  - Clean, filter sand
  - Bentonite chips or pellets
  - Cement grout and tremie pipe
  - Portland cement for well pad completion
  - Steel protective riser covers and locking caps
  - Weighted calibrated tape
  - Split-spoon samplers
  - 55-gallon drums or containers for drill cuttings, decontamination fluids, etc.
- 6.2 In addition to those materials provided by the drilling contractor, equipment and materials required by the project geologist/engineer may include, but is not limited to, the following:
- Photoionization Detector (PID)
  - Spill kit, including at a minimum sorbent pads and shovel (if not provided by subcontractor)

- Plastic sheeting
- Teaspoon or spatula
- Resealable plastic bags
- Boring Log Records
- Decontamination materials (per SOP No. 3-06 - Equipment Decontamination)
- Weighted measuring tape for depth measurement
- Soil logging materials (e.g. USCS classification field card, millimeter rule, hand lens, etc.)
- Survey lathes or pin flags
- Digital camera
- PPE as required by the HASP
- Planning documents including the site-specific HASP and SAP
- Large indelible ink or paint pen
- Field logbook/field forms/site maps (water proof)

## **7.0 Procedure**

### **7.1 General Procedures**

- Specific drilling, sampling, and installation equipment and methodology will be dictated by the type of well to be installed (e.g., single case (Type II), double case (Type III), bedrock, etc.), geologic characteristics of the site, the type of contaminants being monitored, and local and state regulations.
- For access to locations when travelling over difficult terrain, an appropriate line should be chosen before mobilizing the drill rig or other support vehicles. If clearing of trees or ground cover is required, perform these activities in advance to avoid down time. Avoid wet or soft areas where possible or use ground mats and/or timbers to aid in supporting the rig as it travels. If drilling on soft material, place geomatting and ground mats under the rig tracks or stabilizers prior to drilling.
- A utility locate must be conducted to identify all underground utilities at the site prior to drilling (refer to SOP 3-01, Utility Clearance). Proper clearance procedures for aboveground/overhead utilities must also be followed as specified in the HASP.
- Although new well materials (well screen and riser pipe) generally arrive at the site boxed and sealed within plastic bags, it is sometimes necessary to decontaminate the materials prior to their use. Well materials should be inspected by the project geologist/engineer upon delivery to check for cleanliness. If the well materials appear dirty, or if local or regional regulatory guidance requires decontamination, then well material decontamination should be performed by the drilling subcontractor in accordance with SOP 3-06, Equipment Decontamination.
- The diameter of the borehole must be a minimum of 2 inches greater than the outside diameter of the well screen or riser pipe used to construct the well. This is necessary so that sufficient annular space is available to install filter packs, bentonite seals, and grout seals, and allow the passage of tremie pipe where grouting at depth is required. Bedrock wells may require reaming after coring in order to provide a large enough borehole diameter for well installation.
- When soil sampling is required (refer to the SAP), soil samples will be collected for visual logging by advancing split-spoon samplers through the augers. The soil will be visually logged by a field geologist and include lithologic characteristics (i.e., soil type, color, density, moisture content, etc.) using the the

methods described in SOP 3-16, Soil and Rock Classification. This information will be recorded on a boring/well log form, along with well construction details.

## 7.2 Drilling Techniques

Drilling of monitoring well boreholes may be accomplished by a variety of methods as described below. Preferred methods include those that temporarily case the borehole during drilling (i.e., hollow stem auger and sonic methods) using an override system. Other methods can be used where specific subsurface conditions or well design criteria dictate.

- Hollow stem auger (HSA) – Borings are advanced by rotating steel hollow stem augers with an attached cutting head. Soil cuttings are displaced by the cutting head and transported to the surface via continuous spiral flights attached to each auger stem. This method is widely used for unconsolidated soils that have a tendency to collapse within the boring. A bottom plug can be placed in the bottom auger to prevent soils from entering and clogging the auger, especially in the case of heaving sands. However, a bottom plug cannot be used when soil samples are to be collected through the augers. Soil plugs that accumulate in the bottom of the auger must be removed or knocked out prior to sampling or well installation.
- Solid stem auger – This type of drilling method is similar to HSA drilling using a solid stem or sealed hollow stem auger flights to advance the boring. Solid stem, continuous flight auger use is limited to semi-consolidated sediments or to cohesive or semi-cohesive unconsolidated sediments that don't have a tendency to collapse when disturbed.
- Sonic methods – Sonic drilling consists of advancing concentric hollow drill casings (inner and outer) using rotation in conjunction with axial vibration of the drill casing. Once the casings are advanced to the appropriate depth, the inner string is removed with a core of drill cuttings while the outer casing remains in place to keep the borehole open. Cuttings are removed from the inner casing relatively intact for logging or sampling purposes. This drilling method is used for a variety of soil types, from heaving sands to consolidated or indurated formations. Smearing of the formation along the borehole walls is minimal since moderate vibration and rotation techniques are used to advance the casings. Since the total borehole diameter in sonic drilling is only incrementally larger than the inner casing diameter, care should be taken during installation of the monitoring well to ensure the well is centered and adequate space is available for annular materials.
- Rotary methods (water or mud) – Rotary drilling methods consist of drill rods coupled to a drill bit that rotates and cuts through the soils to advance the borehole. Water or drilling fluid ("mud") is forced through the hollow drill rods and drill bit as the rods are rotated. The soil cuttings are forced up the borehole with the drilling fluids to the surface and the fluids recirculated. The drilling fluid provides a hydrostatic pressure that reduces or prevents the borehole from collapsing. Clean, potable water must be used for water-rotary drilling to prevent introducing trace contaminants. A sample of the potable water should be collected during the course of well installation for analysis of the same parameters defined for the groundwater samples. If mud-rotary is used to advance boreholes, potable water and bentonite drilling mud should only be used. No chemical additives shall be mixed in the drilling fluid to alter viscosity or lubricating properties. Adequate well development is essential for removal of drilling mud and fluids from the formation materials and ensure collection of representative groundwater samples.
- Rotary methods (Air) – Air rotary methods are similar to water rotary but use high air velocities in place of drilling fluids to rotate the drill bit and carry the soil cuttings up the borehole to the surface. Care must be taken to ensure that contaminants are not introduced into the air stream from compressor oils, etc. Most compressor systems are compatible with a coalescing filter system. Cuttings exiting the borehole under pressure must be controlled, especially when drilling in a zone of potential contamination. This can be accomplished by using an air diverter with hose or pipe to carry the cuttings to a waste container. Letting the cuttings blow uncontrolled from the borehole is not acceptable.

### 7.3 Well Construction and Installation

- If rotary drilling techniques are used, the borehole should be flushed or blown free of material prior to well installation. If hollow stem augers are used, the soil or bottom plug should be removed and the augers raised approximately six inches above the bottom of the borehole, while slowly rotating the augers to remove cuttings from the bottom of the boring. The depth of the borehole should be confirmed with a weighted, calibrated tape.
- The riser pipe and screen should be connected with flush-threaded joints and assembled wearing clean, disposable gloves. No solvent or anti-seize compound should be used on the connections. The full length of the slotted portion of the well screen and unslotted riser pipe should be measured and these measurements recorded on a well construction form (Attachment 1).
- If placed in an open borehole, the assembled well should be carefully lowered and centered in the borehole so that the well is true, straight, and vertical throughout. Centering can also be accomplished with the use of centralizers, if necessary. However, centralizers should be placed so that they do not inhibit the installation of filter sand, bentonite seal, and annular grout. Wells less than 50 deep generally do not require centralizers.
- If hollow stem augers are used, the well should be lowered through the augers and each auger flight removed incrementally as the filter sand, bentonite seal, and grout are tremmied or poured into the annular space of the well. The well should be temporarily capped before filter sand and other annular materials are installed.
- Clean, silica sand should be placed around the well screen to at least 1 foot above the top of the screen. The filter sand should be appropriately graded and compatible with the selected screen size and surrounding formation materials. In general, the filter pack should not extend more than 3 feet above the top of the screen to limit the thickness of the monitoring zone. As the filter pack is placed, a weighted tape should be lowered in the annular space to verify the depth to the top of the layer. This measurement will be recorded on the well construction form (Attachment 1). If necessary, to eliminate possible bridging or creation of voids, placement of the sand pack may require the use of a tremie pipe. Tremie pipe sandpack installations are generally suggested for deeper wells and for wells which are screened some distance beneath the water table.
- A minimum 2-foot thick layer of bentonite pellets or slurry seal will be installed immediately above the filter sand to prevent vertical flow within the boring from affecting the screened interval. Bentonite chips/pellets must be hydrated if placed above the water table prior to grouting. If bridging is of concern as in the case of deep wells, powdered bentonite may be mixed with water into a very thick slurry and a tremie pipe used to place the seal to the desired depth. Placement of the bentonite seal in the borehole will be recorded on the well construction form (Attachment 1).
- The remaining annular space around the well will be grouted from the top of the bentonite seal to the surface with a grout composed of neat cement, a bentonite cement mixture, or high solids sodium bentonite grout.
- Each well riser will be secured with an expandable, locking cap (vented if possible). Optionally, a hole can be drilled in the upper portion of the riser to allow venting of the well.
- The well will be completed within a concrete well pad consisting of a Portland cement/sand mixture. Well pads are generally 3 feet by 3 feet square but may be larger or smaller depending on site conditions and state-specific well construction standards. Round concrete well pads are also acceptable. A minimum of 1 inch of the finished pad should be below grade to prevent washing and undermining by soil erosion.
- If completed as a flush-mount well, the well riser will be cut off approximately 4 to 6 inches below ground surface and an expandable, locking cap placed on the well riser. The area around the riser is dug out and a steel well vault or manhole cover placed over the riser and set almost flush to the ground

to protect the well. The manhole cover should be water-tight and secured with bolts to prevent casual access. The well pad will then be constructed around the well vault and slightly mounded at the center and sloping away to prevent surface water from accumulating in the well vault.

- If completed as a stick-up well, the well riser is cut approximately 2.5 to 3 feet above the ground surface and an expandable, locking cap placed on the well riser. A steel guard pipe with hinged, locking cap is placed over the well riser as a protective casing. The bottom of the guard pipe will be set approximately 2 feet below ground surface and sealed by pouring concrete from the top of the annular grout around the pipe to grade. The concrete well pad should be completed at the same time. Weep holes will be drilled in the base of the guard pipe to facilitate draining of rainwater or purge water from inside the guard pipe.
- Bumper posts or bollards may be necessary for additional well protection, especially in high traffic areas. The bumper posts should be placed around the well pad in a configuration that provides maximum protection to the well and extend a minimum of 3 feet above the ground.

#### 7.4 **Double Cased Wells**

Under certain site conditions, the use of a double-cased or telescoping (Type III) well may be necessary. Installation of double-cased wells may be required to prevent the interconnection of two separate aquifers, seal off a perched aquifer without creating a vertical hydraulic conduit, prevent cross-contamination during construction of wells in deeper aquifers hydro-stratigraphically below impacted aquifers, or case off highly impacted soils present above the aquifer to prevent potential "dragging down" of contaminants.

Similar to conventional wells, construction of double-cased wells can be accomplished using a variety of drilling methods. Well construction is initiated by "keying" a large diameter, outer casing into a stratigraphic zone of low permeability (clay layer or bedrock). The size of the outer casing should be a minimum of 2 inches greater than the outside diameter of the inner casing to allow installation of annular seal materials during well completion. A pilot borehole should be drilled through the overburden soil and/or contaminated zone into a clay confining layer or bedrock. The borehole for the outer casing should be of sufficient size to contain the outer casing with a minimum of 2 inches around the outside diameter to allow sufficient annular space for tremie or pressure grouting. The boring should extend a minimum of 2 feet into a clay layer and a minimum of 1 foot into bedrock, if possible, to ensure an adequate seal. The boring should never breach a confining layer or keyed zone under any circumstances.

Once the boring is completed, the outer casing can be set in the borehole and sealed with grout. The outer casing can be set two ways, with or without a bottom cap. If no bottom cap is applied, the casing is usually driven approximately 6 inches into the clay confining unit. A grout plug is generally placed in the bottom of the casing and once set, standing water in the casing is evacuated prior to drilling below the casing. As an alternative, a cap can be placed on the bottom of the casing and if set below the water table, the casing can be filled with clean, potable water to hold down the casing in the boring. Grouting should be conducted using tremie-grouting or pressure-grouting methods by pumping grout into the annular space between the outer casing and the borehole wall from the bottom of the casing to the ground surface. Grout around the casing should be allowed to cure at least 24 hours before attempting to drill through the bottom.

Once the grout is cured, a smaller diameter drill pipe/bit is used to bore through the grout plug or bottom cap to the desired well depth. The well is then constructed as described in Section 7.3 above.

#### 7.5 **Post Installation Procedures**

- Wells should be permanently labelled or marked for identification. Well tags can be used to record the site name, well number, total depth, installation date, etc. At a minimum, the well number will be written in indelible marker or paint on both the outside of the protective casing and inside beneath the casing lid, as well as on the riser pipe.

- A measuring point will be marked on the top of the riser pipe for taking water level measurements. The measuring point can be notched using a knife or saw or can be marked with a waterproof marker or paint. The measuring point will also be the point which will be surveyed for vertical elevation data.
- Upon completion, the following measurements will be taken by the field geologist/engineer and recorded on the well construction diagram.
  - Depth to static water level
  - Depth of non-aqueous phase liquid (NAPL), if present
  - Total depth of well measured from top of casing (TOC)
  - Height of well casing above ground surface
  - Height of protective casing above ground surface
- All monitoring wells will be surveyed for horizontal and vertical control by a licensed surveyor.
- Investigation-derived waste (IDW) including drill cuttings, spent materials (e.g., PPE), and decontamination water should be properly managed in accordance with SOP 3-05, IDW Management.

## **8.0 Quality Control and Assurance**

- 8.1 Field personnel will follow specific quality assurance (QA) guidelines as outlined in the SAP. Certain quality control (QC) measures should be taken to ensure proper well installation and construction in accordance with this SOP, project specific SAP, and applicable well standards.
- 8.2 The borehole will be checked for total open depth, and extended by further drilling or shortened by backfilling, as required before installation of the well materials.
- 8.3 Water level and NAPL presence will be checked during well installation to ensure that the positions of well screen, filter sand, and seals relative to water level conform to project requirements
- 8.4 The depth to top of each layer of annular materials (i.e., filter sand, bentonite, grout) will be verified and adjusted as necessary for proper placement.

## **9.0 Records, Data Analysis, Calculations**

All field information will be recorded in the field logbook and/or standardized field forms by field personnel. Field data recorded will include drilling contractor information, drilling methods, well material and construction information provided on the boring logs and well construction forms, observations or problems encountered during drilling, fluid level data, and any deviations from the procedures in this SOP and other project plans. Well Construction Forms (Attachment 1) will provide visual and descriptive information the monitoring well and are often the most critical form of documentation generated during the installation of a monitoring well. The field logbook is kept as a general log of activities and should not be used in place of the boring log.

## **10.0 Attachments or References**

- 10.1 Attachment 1 – Monitoring Well Construction Form

- 10.2 Environmental Protection Agency, United States (EPA). 1987. *A Compendium of Superfund Field Operations Methods*. Office of Solid Waste and Emergency Response. EPA/540/P-87/001.
- 10.3 EPA. 1990. *Handbook of Suggested Practices for the Design and Installation of Groundwater Monitoring Wells*. EPA/600/4-89/034. Office of Research and Development, Washington. March.
- 10.4 EPA. 1992. *RCRA Groundwater Monitoring Draft Technical Guidance*. EPA/530/R-93/001. Office of Solid Waste. November.
- 10.5 EPA, 2008. *SESD Operating Procedure SESDGUID-101-R0: Design and Installation of Monitoring Wells*. USEPA, Science and Ecosystem Support Division (SESD), Athens, Georgia. Effective Date February 18, 2008.
- 10.6 U.S. Army Corps of Engineers. 2008. Manual No. EM 385-1-1. *Safety and Health Requirements*. 15 November 2008. [http://140.194.76.129/publications/eng-manuals/em385-1-1/2008\\_English/toc.html](http://140.194.76.129/publications/eng-manuals/em385-1-1/2008_English/toc.html).
- 10.7 SOP 3-01, *Utility Clearance*.
- 10.8 SOP 3-05, *IDW Management*
- 10.9 SOP 3-06, *Equipment Decontamination*.
- 10.10 SOP 3-16, *Soil and Rock Classification*.

<i>Author</i>	<i>Reviewer</i>	<i>Revisions (Technical or Editorial)</i>
Mark Kromis Program Chemist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue (May 2012)



# Monitoring Well Development

## Procedure 3-13

### 1.0 Purpose and Scope

- 1.1 This standard operating procedure (SOP) describes the procedures used for developing newly installed monitoring wells and/or redeveloping existing wells.
- 1.2 The purpose of well development is to remove interferences from a well to provide better connection between the well and the formation, to improve pumping performance of the well, and to be able to collect more representative information from the well (e.g., samples, test results, etc.). Proper well development will:
- Remove drilling residuals (e.g., water, mud) from the borehole and surrounding formations;
  - Improve or restore hydraulic conductivity of the surrounding formations which may have been disturbed during the drilling process;
  - Remove residual fines from the well screen and sand pack (filter pack) materials, thus reducing turbidity of groundwater and permitting the collection of more representative groundwater samples.
- 1.3 There may be circumstances where well development is not desirable, for example, in the presence of non-aqueous phase liquids (NAPL) or other significant contamination if development could worsen the contaminant impact. If NAPL begins to intrude during development, the development process will be halted. This situation will be considered a cause for sample modification requiring approval by the CTO Manager and other stakeholders, as applicable.
- 1.4 The applicable well development procedures for a particular site may be subject to State or local regulatory requirements. In all cases, the project team should consult their local regulatory requirements and document the selected well development procedure in the project-specific Sampling and Analysis Plan (SAP). For project-specific information refer to the SAP, which takes precedence over these procedures.
- 1.5 This procedure is the Program-approved professional guidance for work performed by Resolution Consultants under the Comprehensive Long-Term Environmental Action Navy (CLEAN) contract (Contract Number N62470-11-D-8013).
- 1.6 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review.

### 2.0 Safety

- 2.1 The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, will be addressed in the project Health and Safety Plan (HASP). In the absence of a HASP, work will be conducted according to the Contract Task Order (CTO) SAP and/or direction from the Site Safety Officer (SSO).
- 2.2 Monitoring well development may involve chemical hazards associated with potential contaminants in the soil or aquifer being characterized and may involve physical hazards associated with use of well development equipment.

### 3.0 Terms and Definitions

None.

## **4.0 Interferences**

- 4.1 Equipment/materials used for development may react with the groundwater during development. Appropriate development equipment has been selected for the anticipated condition of the groundwater.
- 4.2 Appropriate development methods such as using a surge-block to flush suspended fines in the groundwater in and out of the well screen can improve the yield of wells and improve their potential to be developed successfully. However, the effectiveness of development can be significantly reduced in wells that do not yield sufficient water to allow this flushing to take place.
- 4.3 For formations with a significant content of fine-grained materials (silts and clays), or wells with improperly sized screens, it may not be possible to reduce turbidity to commonly acceptable levels. Possible solutions may include collecting a sample even if excessively turbid, or installing a replacement well.
- 4.4 Development itself disturbs the surrounding formation and disrupts equilibrium conditions within the well. Groundwater samples will not be collected until a minimum of 24 hours after a well is developed to allow conditions to stabilize. For sites with fine-grained formations (silts and clays) and highly sorptive contamination, a longer time period between development and sampling should be considered.

## **5.0 Training and Qualifications**

### **5.1 Qualifications and Training**

The individual executing these procedures must have read, and be familiar with, the requirements of this SOP.

### **5.2 Responsibilities**

- 5.2.1 The **CTO Manager** is responsible for ensuring that well development activities comply with this procedure. The **CTO Manager** is responsible for ensuring that all personnel involved in well development shall have the appropriate education, experience, and training to perform their assigned tasks.
- 5.2.2 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.
- 5.2.3 The **Field Manager** is responsible for ensuring that all well development activities are conducted according to the either this procedure or the applicable procedure presented in the project-specific SAP.
- 5.2.4 **Field sampling personnel** are responsible for the implementation of this procedure.
- 5.2.5 The field sampler and/or task manager is responsible for directly supervising the well development procedures to ensure that they are conducted according to this procedure and for recording all pertinent data collected during sampling.

## **6.0 Equipment and Supplies**

- 6.1 This equipment list was developed to aid in field organization and should be used in planning and preparation. Depending on the site-specific requirements and the development method selected, additional or alternative material and equipment may be necessary. In addition, for sites where groundwater is expected to be contaminated, the materials to be placed down the well and in contact with groundwater should be evaluated so that they are compatible with the chemical conditions expected in the well.
- 6.2 Equipment and materials used for well development may include, but is not limited to:

### **Well development equipment**

- Surge block

- Disposable Teflon bailers, appropriate to the diameter of the well(s): 1-inch to 1.5-inch for 2-inch inside diameter (ID) monitoring wells.
- Watterra® footvalve
- Electric submersible pump
- 12-volt power source for electric pump
- High density polyethylene (HDPE) tubing appropriately sized for Watterra® footvalve and/or electric submersible pump
- Drums or containers for storage of purge water
- Nephelometer to measure turbidity
- Multi-parameter water quality meter(s) to measure temperature, pH, conductivity, dissolved oxygen (DO), oxidation reduction potential (ORP)
- Instrument calibration solutions
- Water level meter
- Oil/water interface probe

#### **General equipment**

- Project-specific plans including the site-specific HASP and SAP
- Field notebook/field forms/site maps
- Indelible markers/pens
- 5-gallon buckets

#### **Equipment decontamination supplies** (refer to SOP 3-06, Equipment Decontamination)

- Health and safety supplies, including personal protective equipment (PPE)
- Appropriate hand tools
- Keys or combinations to access monitoring wells
- Distilled/deionized water supply
- Disposable bailer string (polypropylene)
- Plastic trash bags

## **7.0 Procedure**

Development generally consists of removing water and entrained sediment from the well until the water is clear (to the extent feasible) and the turbidity is reduced, which indicates the well is in good hydraulic connection with the surrounding formation. In addition to simply removing water, development can be improved when flushing through the well screen and gravel pack takes place in both directions, that is, both into the well and into the formation. This action breaks down sediment bridges that can occur in the formation or sand pack, which reduce the connection between the well and the formation

### **7.1 General Preparation**

- All down-well equipment should be decontaminated prior to use and between well locations in accordance with SOP 3-06, Equipment Decontamination
- Although equipment is decontaminated between well locations, if wells are known or suspected to be contaminated based on observations during well installation, it is recommended that well development be conducted in order from the least contaminated to the most contaminated well to minimize the chances of cross-contamination.
- Management of investigation-derived waste (IDW), including development purge water and miscellaneous expendable materials generated during the development process, will be conducted in accordance with SOP 3-05, IDW Management.

- Prior to accessing the well, the wellhead should be cleared of debris and/or standing water. Nothing from the ground surface should be allowed to enter the well.
- The depth to water and total well depth should be measured with a water level meter and recorded in the field logbook or on a Well Development Record (Attachment 1). This information will be used to calculate the volume of standing water (i.e., the well volume) within the well, and plan the specific details of the well development. If wells are suspected to contain NAPL, an oil/water interface probe should be used to measure liquid levels and depth to bottom of the well.
- Permanent monitoring wells will be developed no sooner than 24 hours after well installation is completed in order to allow well completion materials to set properly.

## 7.2 Monitoring Well Development Procedures

Generally, development will begin by gently surging the well with a surge block or bailer as described in Sections 7.2.1 and 7.2.2, respectively. Surging can become more vigorous as development progresses but initially the well must be gently surged to allow material blocking the screen to become suspended without damaging the well. Next, a bailer can be used to remove the sediment settled at the base of the well. A bailer, Watterra<sup>®</sup> pump, or electric submersible pump will then be used to purge the well, per Sections 7.2.2, 7.2.3, or 7.2.4, respectively. The well will be purged until the removed water becomes less turbid or per the requirements of the project-specific SAP, or State or local requirements. At this point the well will be surged again with a surge block or bailer. The well can be surged more vigorously at this point. After surging, the well will be purged again until the turbidity once again decreases. The surge/purge cycle should be completed at least three times during the development process. After the last surge, the well will be purged until the development completion criteria outlined in 7.3.2 or per the project-specific SAP are met.

### 7.2.1 Surge Block

The default method of well development is the use of a surge block in conjunction with pumping or bailing to remove sediment-laden water.

- The construction of the surge block must be appropriate for the diameter of the well. The surge block must be mounted on rods or other stiff materials to extend it to the appropriate depths and to allow for the surge block to be moved up and down in the well.
- Insert the surge block into the well and lower it slowly to the screened or open interval below the static water level. Start the surge action by slowly and gently moving the surge block up and down in the well. A slow initial surging, using plunger strokes of approximately 1 meter or 3 feet, will allow material which is blocking the screen to separate and become suspended.
- After 5 to 10 plunger strokes, remove water from the well using a separate bailer (Section 7.2.2) or pumping techniques (Sections 7.2.3 or 7.2.4). The returned water should be heavily laden with suspended fines. The water will be discharged to 5-gallon buckets or 55-gallon drums to be managed per the requirements presented in the project-specific SAP.
- In some cases, the bailer or Watterra<sup>®</sup> foot valve can act as a surge block, flushing water in and out of the well screen as groundwater is removed.
- Repeat the process of surging and pumping/bailing. As development continues, slowly increase the depth of surging to the bottom of the well screen. Surging within the riser portion of the well is neither necessary nor effective.

### 7.2.2 Bailer

- Tie a string or other cable securely to the bailer. Lower it to the screened or open interval of the monitoring well below the static water level.
- The bailer may be raised and lowered repeatedly within the screened interval to attempt to simulate the action of a surge block by pulling fines through the well screen, and pushing water out into the formation to break down bridging.

- With the bailer full of water, remove it from the well and discharge the water into 5-gallon buckets or 55-gallon drums to be managed per the requirements presented in the project-specific SAP.
- The Watterra® system (Section 7.2.3) or electric submersible pump (Section 7.2.4) may be used as a complementary development method to the bailer, especially when removal of additional water at a faster rate is beneficial.
- Continue alternately surging and bailing, monitoring the purge water periodically (Section 7.3.1) until development completion criteria are met (Section 7.3.2).

#### 7.2.3 Watterra® system

- Attach high-density polyethylene (HDPE) tubing to the decontaminated Watterra® pump foot valve
- Lower the foot valve and tubing assembly near the bottom of the well.
- Lift and lower the tubing to allow water to enter the Watterra® foot valve and travel up the tubing and discharge the water into 5-gallon buckets or 55-gallon drums to be managed per the requirements presented in the project-specific SAP.
- The lifting and lowering action of the Watterra® system will cause some surging action to aid in breaking up fine material in the surrounding formation.
- A bailer (Section 7.2.2) may be used as a complementary development method to the Watterra® system, especially during the initial stages of development when a high volume of sediment may be required to be removed.
- An electric submersible pump (Section 7.2.4) may also be used as a complementary development method to the Watterra® system, especially when more volume of water is desired to be pumped or the turbidity criteria cannot be met due to the surging action of the Watterra® system.
- Continue alternately surging and pumping, monitoring the purge water periodically (Section 7.3.1) until well development completion criteria are met (Section 7.3.2).

#### 7.2.4 Electric Submersible Pump

- Attach HDPE tubing to the decontaminated electric submersible pump.
- Lower the pump and tubing assembly near the bottom of the well, at least a few inches above the well total depth.
- Begin pumping, discharging the water into 5-gallon buckets or 55-gallon drums to be managed per the requirements presented in the project-specific SAP.
- Continue alternately surging and pumping, monitoring the purge water discharge periodically (Section 7.3.1) until well development completion criteria are met (Section 7.3.2).

### 7.3 Discharge Monitoring

#### 7.3.1 Monitoring the Progress of Development

The progress of the development is evaluated through visual observation of the suspended sediment load and measurement of the turbidity and other parameters in the purged discharge water. As development progresses, the water should become clearer, measured turbidity should decrease, and specific capacity (pumping rate divided by drawdown) should stabilize. Water quality parameters, including DO, conductivity, ORP, pH, temperature, and turbidity may be measured and recorded periodically to determine the progress of development using the criteria outlined in Section 7.3.2 or per the project-specific SAP. Water quality parameters should be measured on each well volume removed.

#### 7.3.2 Completion of Development

The well will be considered developed when the following criteria are met or per the criteria set forth in the project-specific SAP:

- A minimum of three times the standing water volume in a well (to include the well screen and casing plus saturated annulus, assuming 30 percent porosity) is removed.

- Groundwater parameters for three consecutive standing water volumes are within the following:
  - pH – within  $\pm 0.2$  units
  - Specific conductivity – within  $\pm 3\%$
  - ORP – within  $\pm 10$  mV
  - Temperature – within  $\pm 1$  degree Celsius
  - Turbidity – at or below 10 nephelometric turbidity units (NTU) or within  $\pm 10\%$  if above 10 NTU.
- The sediment thickness remaining within the well is less than 1 percent of the screen length or less than 30 millimeters (0.1 ft) for screens equal to or less than 10 feet long.

Dissolved oxygen (DO) readings may be recorded but DO readings will not be used as development completion criteria because DO may not stabilize.

If the well has slow groundwater recharge and is purged dry, the well will be considered developed when bailed or pumped dry three times in succession and the turbidity has decreased, or per the requirements set forth in the project-specific SAP. Water quality parameters may be recorded if feasible using the flow-through cell.

If any water is added to the well's borehole during development or drilling, three times the volume of water added will also be removed during well development, or per the requirements set forth in the project-specific SAP.

#### 7.4 Development of Wells with Low Yield

Water is the primary mechanism to remove fines and flush water through the gravel pack for effective development. Therefore, development can be a challenge in wells that do not yield sufficient water to recharge when water is removed. However, often these wells are the most in need of development to improve their performance as they are typically installed in low permeability formations with a high content of fines. Development of these wells can improve their yield.

The surging portion of the development can be successfully performed in a well with standing water regardless of its yield. It is the subsequent removal of fine materials that is hindered when insufficient water is recharged to the well. When wells go dry or drawdown significantly during development, development can be performed intermittently, allowing sufficient water to recharge prior conducting the next stage of surging. These intermittent procedures can take place hours or even days apart, depending on project-specific time constraints.

#### 7.5 Wells containing NAPL

Additional care should be taken when planning development of wells that contain NAPL. If the NAPL is flammable, there are health and safety as well as handling issues to consider. If NAPL in excess of a persistent sheen is noted, the recharge rate will be evaluated through hand bailing. In most cases, it is generally preferable to remove NAPL by bailing to the extent practical prior to performing development. Groundwater parameters, excluding turbidity, will not be collected during well development if NAPL or excessive sheen is noticed in the purged water during development to ensure the meter probes are not fouled or destroyed. Well development will be halted.

Development by surging or pumping the well dry can result in the spreading of NAPL vertically in the soil column around the well. These methods can be used, if information exists describing the vertical thickness of the NAPL smear zone around the well, and if the methods do not result in mounding or drawdown that exceeds this thickness. Alternate methods such as bailing may also be used, but any method should not allow the well to be pumped dry or result in significant drawdown that would spread the NAPL vertically.

7.6 Temporary Well Points

For certain projects, temporary well points (TWPs) may be installed to collect groundwater samples at a site. Since no sand pack, bentonite chips, or bentonite grout are generally used in the construction of the TWPs, development can proceed as soon as sufficient water has entered the well to static conditions. Due to the small diameter of these wells, generally ¾-inch to 1-inch ID, development will be performed using either a small diameter (0.5-inch) bailer and/or a peristaltic pump with dedicated tubing. The TWPs will have minimal water column and may purge dry during development. However, attempts will be made to remove fines from the well prior to sampling. Purging and sampling may occur as soon as approximately 80% of the static water has re-entered the TWP, or per the requirements set forth in the project-specific SAP.

**8.0 Quality Control and Assurance**

- 8.1 Field personnel will follow specific quality assurance (QA) guidelines as outlined in the project-specific SAP.
- 8.2 Quality control (QC) requirements are dependent on project-specific sampling objectives. The project-specific SAP will provide requirements for equipment decontamination (frequency and materials) and IDW handling.

**9.0 Records, Data Analysis, Calculations**

- 9.1 All data and information (e.g., development method used) must be documented on field data sheets (Attachment 1) or within site logbooks with permanent ink. Data recorded may include the following:
  - Well Location
  - Weather conditions
  - Date and Time
  - Purge Method
  - Reading/measurements obtained

**10.0 Attachments or References**

Attachment 1 – Well Development Record  
 SOP 3-05, *IDW Management*.  
 SOP 3-06, *Equipment Decontamination*.

<i>Author</i>	<i>Reviewer</i>	<i>Revisions (Technical or Editorial)</i>
Shawn Dolan Senior Scientist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue (June 2012)

# Attachment 1 Well Development Record



## Well/Piezometer Development Record

Well ID: _____
----------------

Client: \_\_\_\_\_

Project No: \_\_\_\_\_ Date: \_\_\_\_\_ Developer: \_\_\_\_\_

Site Location: \_\_\_\_\_

### Well/Piezometer Data

Well  Piezometer  Diameter \_\_\_\_\_ Material \_\_\_\_\_

Measuring Point Description \_\_\_\_\_ Geology at Screen Interval \_\_\_\_\_  
(if known)

Depth to Top of Screen (ft.) \_\_\_\_\_

Depth to Bottom of Screen (ft.) \_\_\_\_\_ Time of Water Level Measurement \_\_\_\_\_

Total Well Depth (ft.) \_\_\_\_\_ Calculate Purge Volume (gal.) \_\_\_\_\_

Depth to Static Water Level (ft.) \_\_\_\_\_ Disposal Method \_\_\_\_\_

Headspace \_\_\_\_\_

Original Well Development  Redevelopment  Date of Original Development \_\_\_\_\_

### DEVELOPMENT METHOD

### PURGE METHOD

Time	Total Volume Purged (gal.)	Flow Rate (gpm)	Turbidity (NTU)	Color	pH	Temp	Other

### ACCEPTANCE CRITERIA (from workplan)

Minimum Purge Volume Required \_\_\_\_\_ gallons

Maximum Turbidity Allowed \_\_\_\_\_ NTUs

Stabilization of parameters \_\_\_\_\_ %

Has required volume been removed

Has required turbidity been reached

Has parameters stabilized

If no or N/A explain below:

Yes No N/A

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Signature \_\_\_\_\_

Date: \_\_\_\_\_

# Monitoring Well Sampling

## Procedure 3-14

### 1.0 Purpose and Scope

- 1.1 This standard operating procedure (SOP) describes the actions to be used during monitoring well sampling activities and establishes the method for sampling groundwater monitoring wells for water-borne contaminants and general groundwater chemistry. The objective is to obtain groundwater samples that are representative of aquifer conditions with as little alteration to water chemistry as possible.
- 1.2 This procedure is the Program-approved professional guidance for work performed by Resolution Consultants under the Comprehensive Long-Term Environmental Action Navy (CLEAN) contract (Contract Number N62470-11-D-8013).
- 1.3 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review.

### 2.0 Safety

- 2.1 Depending upon the site-specific contaminants, various protective programs must be implemented prior to sampling the first well. All field sampling personnel responsible for sampling activities must review the project-specific health and safety plan (HASP) paying particular attention to the control measures planned for the well sampling tasks. Conduct preliminary area monitoring of sampling wells to determine the potential hazard to field sampling personnel. If significant contamination is observed, minimize contact with potential contaminants in both the vapor phase and liquid matrix through the use of appropriate personal protective equipment (PPE).
- 2.2 Observe standard health and safety practices according to the project-specific HASP. Suggested minimum protection during well sampling activities includes inner disposable vinyl gloves, outer chemical-protective nitrile gloves and rubberized steel-toed boots. Half-face respirators and cartridges and Tyvek® suits may be necessary depending on the contaminant concentrations. Refer to the project-specific HASP for the required PPE.
- 2.3 Physical Hazards associated with Well Sampling
  - To avoid lifting injuries associated with pump and bailers retrieval, use the large muscles of the legs, not the back.
  - Stay clear of all moving equipment, and avoid wearing loose fitting clothing.
  - When using tools for cutting purposes, cut away from yourself. The use of appropriate, task specific cutting tools is recommended.
  - To avoid slip/trip/fall conditions as a result of pump discharge, use textured boots/boot cover bottoms.
  - To avoid heat/cold stress as a result of exposure to extreme temperatures and PPE, drink electrolyte replacement fluids (1 to 2 cups per hour is recommended) and, in cases of extreme cold, wear fitted insulating clothing.
  - Be aware of restricted mobility due to PPE.

### **3.0 Terms and Definitions**

None.

### **4.0 Interferences**

4.1 Potential interferences could result from cross-contamination between samples or sample locations. Minimization of the cross-contamination will occur through the following:

- The use of clean sampling tools at each location as necessary.
- Avoidance of material that is not representative of the media to be sampled.

### **5.0 Training and Qualifications**

#### **5.1 Qualifications and Training**

The individual executing these procedures must have read, and be familiar with, the requirements of this SOP.

#### **5.2 Responsibilities**

5.2.1 The **Contract Task Order (CTO) Manager** is responsible for ensuring that monitoring well sampling activities comply with this procedure. The **CTO Manager** is responsible for ensuring that all field sampling personnel involved in monitoring well sampling shall have the appropriate education, experience, and training to perform their assigned tasks.

5.2.2 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.

5.2.3 The **Field Manager** is responsible for ensuring that all field sampling personnel follow these procedures.

5.2.4 **Field sampling personnel** are responsible for the implementation of this procedure.

5.2.5 The field sampler and/or task manager is responsible for directly supervising the groundwater sampling procedures to ensure that they are conducted according to this procedure and for recording all pertinent data collected during sampling.

### **6.0 Equipment and Supplies**

#### **6.1 Purging and Sampling Equipment**

- Pump (Peristaltic, Portable Bladder, Submersible)
- Polyethylene or Teflon bladders (for portable bladder pumps)
- Bladder pump controller (for portable bladder pumps)
- Air compressor (for portable bladder pumps)
- Nitrogen cylinders (for portable bladder pumps)
- 12-volt power source
- Polyethylene inlet and discharge tubing (except for VOC analysis which requires Teflon tubing)
- Silicone tubing appropriate for peristaltic pump head
- Teflon bailer appropriately sized for well

- Disposable bailer string (polypropylene)
- Individual or multi-parameter water quality meter(s) with flow-through cell to measure temperature, pH, specific conductance, dissolved oxygen (DO), oxidation reduction potential (ORP), and/or turbidity
- Turbidity meter
- Water level meter
- Oil/water interface probe

## 6.2 General Equipment

- Sample kit (i.e., bottles, labels, preservatives, custody records and tape, cooler, ice)
- Sample Chain-of-Custody (COC) forms
- Sample Collection Records
- Sample packaging and shipping supplies
- Waterproof marker or paint
- Distilled/deionized water supply
- Water dispenser bottles
- Flow measurement cup or bucket
- 5-gallon buckets
- Instrument calibration solutions
- Stopwatch or watch
- Disposable Nitrile gloves
- Paper towels
- Trash bags
- Zipper-lock bags
- Equipment decontamination supplies
- Health and safety supplies (as required by the HASP)
- Approved plans such as: project-specific HASP and Sampling and Analysis Plan (SAP)
- Well keys or combinations
- Monitoring well location map(s)
- Field project logbook/pen

## 7.0 Calibration or Standardization

- 7.1 Field instruments will be calibrated daily according to the requirements of the SAP and manufacturer's specifications for each piece of equipment. Equipment will be checked daily with the calibration solutions at the end of use of the equipment. Calibration records shall be recorded in the field logbook or appropriate field form.
- 7.2 If readings are suspected to be inaccurate, the equipment shall be checked with the calibration solutions and/or re-calibrated.

## **8.0 Procedure**

### **8.1 Preparation**

#### **8.1.1 Site Background Information**

Establish a thorough understanding of the purposes of the sampling event prior to field activities. Conduct a review of all available data obtained from the site and pertinent to the water sampling. Review well history data including, but not limited to, well locations, sampling history, purging rates, turbidity problems, previously used purging methods, well installation methods, well completion records, well development methods, previous analytical results, presence of an immiscible phase, historical water levels, and general hydrogeologic conditions.

Previous groundwater development and sampling logs give a good indication of well purging rates and the types of problems that might be encountered during sampling, such as excessive turbidity and low well yield. They may also indicate where dedicated pumps are placed in the water column. To help minimize the potential for cross-contamination, well purging and sampling and water level measurement collection shall proceed from the least contaminated to the most contaminated well as indicated by previous analytical results. This order may be changed in the field if conditions warrant it, particularly if dedicated sampling equipment is used. A review of prior sampling procedures and results may also identify which purging and sampling techniques are appropriate for the parameters to be tested under a given set of field conditions.

#### **8.1.2 Groundwater Analysis Selection**

Establish the requisite field and laboratory analyses prior to water sampling. Decide on the types and numbers of quality assurance/quality control (QA/QC) samples to be collected (refer to the project-specific SAP), as well as the type and volume of sample preservatives, the type and number of sample containers, the number of coolers required, and the quantity of ice or other chilling materials. The field sampling personnel shall ensure that the appropriate number and size sample containers are brought to the site, including extras in case of breakage or unexpected field conditions. Refer to the project-specific SAP for the project analytical requirements.

### **8.2 Groundwater Sampling Procedures**

Groundwater sampling procedures at a site shall include:

- 1) An evaluation of the well security and condition prior to sampling;
- 2) Decontamination of equipment;
- 3) Measurement of well depth to groundwater;
- 4) Assessment of the presence or absence of an immiscible phase;
- 5) Assessment of purge parameter stabilization;
- 6) Purging of static water within the well and well bore; and
- 7) Obtaining a groundwater sample.

Each step is discussed in sequence below. Depending upon specific field conditions, additional steps may be necessary. As a rule, at least 24 hours should separate well development and well sampling events. In all cases, consult the State and local regulations for the site, which may require more stringent time separation between well development and sampling.

### 8.2.1 Well Security and Condition

At each monitoring well location, observe the conditions of the well and surrounding area. The following information may be noted on a Groundwater Sample Collection Record (Attachment 1) or in the field logbook:

- Condition of the well's identification marker.
- Condition of the well lock and associated locking cap.
- Integrity of the well – well pad condition, protective outer casing, obstructions or kinks in the well casing, presence of water in the annular space, and the top of the interior casing.
- Condition of the general area surrounding the well.

### 8.2.2 Decontamination of Equipment

Where possible, dedicated supplies should be used at each well location to minimize the potential for cross-contamination and minimize the amount of investigation derived waste (IDW) fluids resulting from the decontamination process. If decontamination is necessary, establish a decontamination station before beginning sampling. The station shall consist of an area of at least 4 feet by 2 feet covered with plastic sheeting and be located upwind of the well being sampled. The station shall be large enough to fit the appropriate number of wash and rinse buckets, and have sufficient room to place equipment after decontamination. One central cleaning area may be used throughout the entire sampling event. The area around the well being sampled shall also be covered with plastic sheeting to prevent spillage. Further details are presented in SOP 3-06, Equipment Decontamination.

Decontaminate each piece of equipment prior to entering the well. Also, conduct decontamination prior to sampling at a site, even if the equipment has been decontaminated subsequent to its last usage. Additionally, decontaminate each piece of equipment used at the site prior to leaving the site. It is only necessary to decontaminate dedicated sampling equipment prior to installation within the well. Do not place clean sampling equipment directly on the ground or other contaminated surfaces prior to insertion into the well. Dedicated sampling equipment that has been certified by the manufacturer as being decontaminated can be placed in the well without on-site decontamination.

### 8.2.3 Measurement of Static Water Level Elevation

Before purging the well, measure water levels in all of the wells within the zone of influence of the well being purged. The best practice, if possible, is to measure all site wells (or wells within the monitoring well network) prior to sampling. If the well cap is not vented, remove the cap several minutes before measurement to allow water levels to equilibrate to atmospheric pressure.

Measure the depth to standing water and the total depth of the well to the nearest 0.01 foot to provide baseline hydrologic data, to calculate the volume of water in the well, and to provide information on the integrity of the well (e.g., identification of siltation problems). If not already present, mark an easily identified reference point for water level measurements which will become the measuring point for all water level measurements. This location and elevation must be surveyed.

The device used to measure the water level surface and depth of the well shall be sufficiently sensitive and accurate in order to obtain a measurement to the nearest 0.01 foot reliably. An electronic water level meter will usually be appropriate for this measurement; however, when the groundwater within a particular well is highly contaminated, an inexpensive weighted tape measure can be used to determine well depth to prevent adsorption of contaminants onto the meter tape. The presence of light, non-aqueous phase liquids (LNAPLs) and/or dense, non-aqueous phase liquids (DNAPLs) in a well requires measurement of the elevation of the top and the bottom of the product, generally using an interface probe. Water levels in such wells must then be corrected for density effects to accurately determine the elevation of the water table.

At each location, measure water levels several times in quick succession to ensure that the well has equilibrated to atmospheric conditions prior to recording the measurement. As stated above, measure all site wells (or wells within the monitoring well network) prior to sampling whenever possible. This will provide a water level database that describes water levels across the site at one time (a synoptic sampling). Prior to sampling, measure the water level in each well immediately prior to purging the well to ascertain that static conditions have been achieved prior to sampling.

#### 8.2.4 Detection of Immiscible Phase Layers

Complete the following steps for detecting the presence of LNAPL and DNAPL before the well is purged for conventional sampling. These procedures may not be required for all wells. Consult the project-specific SAP to determine if assessing the presence of LNAPL and/or DNAPL is necessary.

- 1) Sample the headspace in the wellhead immediately after the well is opened for organic vapors using either a PID or an organic vapor analyzer, and record the measurements.
- 2) Lower an interface probe into the well to determine the existence of any immiscible layer(s), LNAPL and/or DNAPL, and record the measurements.
- 3) Confirm the presence or absence of an immiscible phase by slowly lowering a clear bailer to the appropriate depth, then visually observing the results after sample recovery.
- 4) In rare instances, such as when very viscous product is present, it may be necessary to utilize hydrocarbon- and water-sensitive pastes for measurement of LNAPL thickness. This is accomplished by smearing adjacent, thin layers of both hydrocarbon- and water-sensitive pastes along a steel measuring tape and inserting the tape into the well. An engineering tape showing tenths and hundredths of feet is required. Record depth to water, as shown by the mark on the water-sensitive paste, and depth to product, as shown by the mark on the product-sensitive paste. In wells where the approximate depth to water and product thickness are not known, it is best to apply both pastes to the tape over a fairly long interval (5 feet or more). Under these conditions, measurements are obtained by trial and error and may require several insertions and retrievals of the tape before the paste-covered interval of the tape encounters product and water. In wells where approximate depths of air-product and product-water interfaces are known, pastes may be applied over shorter intervals. Water depth measurements should not be used in preparation of water table contour maps until they are corrected for depression by the product.
- 5) If the well contains an immiscible phase, it may be desirable to sample this phase separately. Section 8.2.6 presents immiscible phase sampling procedures. It may not be meaningful to conduct water sample analysis of water obtained from a well containing LNAPLs or DNAPLs. Consult the **CTO Manager** and **Program Quality Manager** if this situation is encountered.

#### 8.2.5 Purging Equipment and Use

##### **General Requirements**

The water present in a well prior to sampling may not be representative of in situ groundwater quality and shall be removed prior to sampling. Handle all groundwater removed from potentially contaminated wells in accordance with the IDW handling procedures in SOP 3-05, IDW Management. Purging shall be accomplished by methods as indicated in the project-specific SAP or by those required by State requirements. For the purposes of this SOP, purging methods will be described by removing groundwater from the well using low-flow techniques.

According to the U.S. Environmental Protection Agency (EPA) (EPA, 1996), the rate at which groundwater is removed from the well during purging ideally should be less than 0.2 to 0.3 liters/minute. EPA further states that wells should be purged at rates below those used to develop the well to prevent further development of the well, to prevent damage to the well, and to avoid disturbing accumulated

corrosion or reaction products in the well. EPA also indicates that wells should be purged at or below their recovery rate so that migration of water in the formation above the well screen does not occur.

Realistically, the purge rate should be low enough that substantial drawdown in the well does not occur during purging. In addition, a low purge rate will reduce the possibility of stripping volatile organic compounds (VOCs) from the water, and will reduce the likelihood of increasing the turbidity of the sample due to mobilizing colloids in the subsurface that are immobile under natural flow conditions.

The field sampler shall ensure that purging does not cause formation water to cascade down the sides of the well screen. Wells should not be purged to dryness if recharge causes the formation water to cascade down the sides of the screen, as this will cause an accelerated loss of volatiles. This problem should be anticipated based on the results of either the well development task or historical sampling events. In general, place the intake of the purge pump in the middle of the saturated screened interval within the well to allow purging and at the same time minimize disturbance/overdevelopment of the screened interval in the well. Water shall be purged from the well at a rate that does not cause recharge water to be excessively agitated unless an extremely slow recharging well is encountered where complete evacuation is unavoidable. During the well purging procedure, collect water level and/or product level measurements to assess the hydraulic effects of purging. Sample the well when it recovers sufficiently to provide enough water for the analytical parameters specified. If the well is purged dry, allow the well to recover sufficiently to provide enough water for the specified analytical parameters, and then sample it.

Evaluate water samples on a regular basis during well purging and analyze them in the field preferably using in-line devices (i.e., flow through cell) for temperature, pH, specific conductivity, dissolved oxygen (DO), and oxidation-reduction (redox) potential. Turbidity should be measured separately (outside of the flow-through cell) with a nephelometer or similar device.

Readings should be taken every 2 to 5 minutes during the purging process. These parameters are measured to demonstrate that the natural character of the formation waters has been restored.

Purging shall be considered complete per the requirements set forth in the project-specific SAP, State requirements, or when three consecutive field parameter measurements of temperature, pH, specific conductivity, DO and ORP stabilize within approximately 10 percent and the turbidity is at or below 10 nephelometric turbidity units (NTU) or within  $\pm 10\%$  if above 10 NTU. This criterion may not be applicable to temperature if a submersible pump is used during purging due to the heating of the water by the pump motor. Enter all information obtained during the purging and sampling process into a groundwater sampling log. Attachment 1 shows an example of a groundwater sampling log and the information typically included in the form. Whatever form is used, all blanks need to be completed on the field log during field sampling.

Groundwater removed during purging shall be stored according to the project-specific SAP or per SOP 3-05, IDW Management.

### **Purging Equipment and Methods**

#### ***Submersible Pump***

A stainless steel submersible pump may be utilized for purging both shallow and deep wells prior to sampling the groundwater for semivolatile and non-volatile constituents, but are generally not preferred for VOCs unless there are no other options (e.g., well over 200 feet deep). For wells over 200 feet deep, the submersible pump is one of the few technologies available to feasibly accomplish purging under any yield conditions. For shallow wells with low yields, submersible pumps are generally inappropriate due to overpumpage of the wells (<1 gallon per minute), which causes increased aeration of the water within the well.

Steam clean or otherwise decontaminate the pump and discharge tubing prior to placing the pump in the well. The submersible pump shall be equipped with an anti-backflow check valve to limit the amount of

water that will flow back down the drop pipe into the well. Place the pump in the middle of the saturated screened interval within the well and maintain it in that position during purging.

#### ***Bladder Pump***

A stainless steel bladder pump can be utilized for purging and sampling wells up to 200 feet in depth for volatile, semivolatile, and non-volatile constituents. Use of the bladder pump is most effective in low to moderate yield wells and are often the preferred method for low-flow sampling. When sampling for VOCs and/or SVOCs, Teflon bladders should be used. Polyethylene bladders may be used when sampling for inorganics.

Either compressed dry nitrogen or compressed dry air, depending upon availability, can operate the bladder pump. The driving gas utilized must be dry to avoid damage to the bladder pump control box. Decontaminate the bladder pump prior to use.

#### ***Centrifugal, Peristaltic, or Diaphragm Pump***

A centrifugal, peristaltic, or diaphragm pump may be utilized to purge a well if the water level is within 20 feet of ground surface. New or dedicated tubing is inserted into the midpoint of the saturated screened interval of the well. Water should be purged at a rate that satisfies low-flow requirements (i.e., does not cause drawdown). Centrifugal, peristaltic, or diaphragm pump are generally discouraged for VOCs sampling; however, follow methods allowed per the project-specific SAP or State requirements.

#### ***Air Lift Pump***

Airlift pumps are not appropriate for purging or sampling.

#### ***Bailer***

Avoid using a bailer to purge a well because it can result in overdevelopment of the well and create excessive purge rates. If a bailer must be used, the bailer should either be dedicated or disposable. Teflon-coated cable mounted on a reel is recommended for lowering the bailer in and out of the well.

Lower the bailer below the water level of the well with as little disturbance of the water as possible to minimize aeration of the water in the well. One way to gauge the depth of water on the reel is to mark the depth to water on the bailer wire with a stainless steel clip. In this manner, less time is spent trying to identify the water level in the well.

### 8.2.6 Monitoring Well Sampling Methodologies

#### **Sampling Light, Non-Aqueous Phase Liquids (LNAPL)**

Collect LNAPL, if present, prior to any purging activities. The sampling device shall generally consist of a dedicated or disposable bailer equipped with a bottom-discharging device. Lower the bailer slowly until contact is made with the surface of the LNAPL, and to a depth less than that of the immiscible fluid/water interface depth as determined by measurement with the interface probe. Allow the bailer to fill with LNAPL and retrieve it.

When sampling LNAPLs, never drop bailers into a well and always remove them from the well in a manner that causes as little agitation of the sample as possible. For example, the bailer should not be removed in a jerky fashion or be allowed to continually bang against the well casing as it is raised. Teflon bailers should always be used when sampling LNAPL. The cable used to raise and lower the bailer shall be composed of an inert material (e.g., stainless steel) or coated with an inert material (e.g., Teflon).

#### **Sampling Dense, Non-Aqueous Phase Liquids (DNAPL)**

Collect DNAPL prior to any purging activities. The best method for collecting DNAPL is to use a double-check valve, stainless steel bailer, or a Kemmerer (discrete interval) sampler. The sample shall be collected by slow, controlled lowering of the bailer to the bottom of the well, activation of the closing device, and retrieval.

### **Groundwater Sampling Methodology**

The well shall be sampled when groundwater within it is representative of aquifer conditions per the methods described in Section 8.2.5. Prior to sampling the flow-through cell shall be removed and the samples collected directly from the purge tubing. Flow rates shall not be adjusted once aquifer conditions are met. Additionally, a period of no more than 2 hours shall elapse between purging and sampling to prevent groundwater interaction with the casing and atmosphere. This may not be possible with a slowly recharging well. Measure and record the water level prior to sampling in order to monitor drawdown when using low-flow techniques and gauge well volumes removed and recharged when using non-low-flow techniques.

Sampling equipment (e.g., especially bailers) shall never be dropped into the well, as this could cause aeration of the water upon impact. Additionally, the sampling methodology utilized shall allow for the collection of a groundwater sample in as undisturbed a condition as possible, minimizing the potential for volatilization or aeration. This includes minimizing agitation and aeration during transfer to sample containers, minimizing exposure to sunlight, and immediately placing the sample on ice once collected.

Sampling equipment shall be constructed of inert material. Equipment with neoprene fittings, polyvinyl chloride (PVC) bailers, Tygon® tubing, silicon rubber bladders, neoprene impellers, polyethylene, and Viton® are not acceptable when sampling for organics. If bailers are used, an inert cable/chain (e.g., fluorocarbon resin-coated wire or stainless steel wire or cable) shall be used to raise and lower the bailer. Dedicated equipment is highly recommended for all sampling programs.

#### ***Submersible Pumps***

The submersible pump must be specifically designed for groundwater sampling (i.e., pump composed of stainless steel and Teflon, sample discharge lines composed of Teflon) and must have a controller mechanism allowing the required low-flow rate. Adjust the pump rate so that flow is continuous and does not pulsate to avoid aeration and agitation within the sample discharge lines. Run the pump for several minutes at the low-flow rate used for sampling to ensure that the groundwater in the lines was obtained at the low-flow rate.

#### ***Bladder Pumps***

A gas-operated stainless steel bladder pump with adjustable flow control and equipped with a Teflon bladder and Teflon-lined tubing can be effectively utilized to collect a groundwater sample and is considered to be the best overall device for sampling inorganic and organic constituents. If only inorganics are being sampled, polyvinyl bladders and tubing may be used. Operate positive gas displacement bladder pumps in a continuous manner so that they minimize discharge pulsation that can aerate samples in the return tube or upon discharge.

When using a compressor, take several precautions. If the compressor is being powered by a gasoline generator, position the generator downwind of the well. Ground fault circuit interrupters (GFCIs) should always be used when using electric powered equipment. Do not connect the compression hose from the compressor to the pump controller until after the engine has been started.

When all precautions are completed and the compressor has been started, connect the compression hose to the pump controller. Slowly adjust the control knobs to discharge water in the shortest amount of time while maintaining a near constant flow. This does not mean that the compressor must be set to discharge the water as hard as possible. The optimal setting is one that produces the largest volume of purge water per minute (not per purge cycle) while maintaining a near constant flow rate.

Prior to sampling, adjust the flow rate (purge rate) to yield 100 to 300 mL/minute. Avoid settings that produce pulsating streams of water instead of a steady stream if possible. Operate the pump at this low flow rate for several minutes to ensure that drawdown is not occurring. At no time shall the sample flow rate exceed the flow rate used while purging.

For those samples requiring filtration, it is recommended to use an in-line high capacity filter after all non-filtered samples have been collected.

***Peristaltic Pumps:***

A peristaltic pump is a type of positive displacement pump that moves water via the process of peristalsis. The pump uses a flexible hose fitted inside a circular pump casing. A rotor with cams compresses the flexible tube as the rotor turns, which forces the water to be pumped to move through the tube. In peristaltic pumps, no moving parts of the pump are in contact with the water being pumped. Displacement is determined by tube size, so delivery rate can only be changed during operation by varying pump speed. Peristaltic pumps are simple and quite inexpensive for the flow rates they provide.

There are several methods available for transferring the sample into the laboratory containers. The selected method may vary based on State requirements and should be documented in the project-specific SAP. Samples typically can be collected directly from the discharge end of the Teflon tubing, after it has been disconnected from the flow through cell. For volatile analyses, the sampler should make sure that the pump is set such that a smooth laminar flow is achieved. In all cases, the project team should consult their local regulatory requirements and document the selected sample collection procedure in the project-specific SAP.

***Bailers***

A single- or double-check valve Teflon or stainless steel bailer equipped with a bottom discharging device can be utilized to collect groundwater samples. Bailers have a number of disadvantages, however, including a tendency to alter the chemistry of groundwater samples due to degassing, volatilization, and aeration; the possibility of creating high groundwater entrance velocities; differences in operator techniques resulting in variable samples; and difficulty in determining where in the water column the sample was collected. Therefore, use bailers for groundwater sampling only when other types of sampling devices cannot be utilized for technical, regulatory, or logistical reasons.

Dedicated or disposable bailers should always be used in order to eliminate the need for decontamination and to limit the potential of cross-contamination. Each time the bailer is lowered to the water table, lower it in such a way as to minimize disturbance and aeration of the water column within the well.

**8.2.7 Sample Handling and Preservation**

Many of the chemical constituents and physiochemical parameters to be measured or evaluated during groundwater monitoring programs are chemically unstable and require preservation. The U.S. EPA document entitled, *Test Methods for Evaluating Solid Waste – Physical/Chemical Methods (SW-846)* (EPA 1997), includes a discussion of appropriate sample preservation procedures. In addition, SW-846 provides guidance on the types of sample containers to use for each constituent or common set of parameters. In general, check with specific laboratory or State requirements prior to obtaining field samples. In many cases, the laboratory will supply the necessary sample bottles and required preservatives. In some cases, the field sampling personnel may add preservatives in the field.

Improper sample handling may alter the analytical results of the sample. Therefore, transfer samples in the field from the sampling equipment directly into the container that has been prepared specifically for that analysis or set of compatible parameters as described in the project-specific SAP. It is not an acceptable practice for samples to be composited in a common container in the field and then split in the laboratory, or poured first into a wide mouth container and then transferred into smaller containers.

Collect groundwater samples and place them in their proper containers in the order of decreasing volatility and increasing stability. A preferred collection order for some common groundwater parameters is:

1. VOCs and total organic halogens (TOX)

2. Dissolved gases, total organic carbon (TOC), total fuel hydrocarbons
3. Semivolatile organics, pesticides
4. Total metals, general minerals (unfiltered)
5. Dissolved metals, general minerals (filtered)
6. Phenols
7. Cyanide
8. Sulfate and chloride
9. Nitrate and ammonia
10. Radionuclides

When sampling for VOCs, collect water samples in vials or containers specifically designed to prevent loss of VOCs from the sample. The analytical laboratory performing the analysis shall provide these vials. Collect groundwater from the sampling device in vials by allowing the groundwater to slowly flow along the sides of the vial. Sampling equipment shall not touch the interior of the vial. Fill the vial above the top of the vial to form a positive meniscus with no overflow. No headspace shall be present in the sample container once the container has been capped. This can be checked by inverting the bottle once the sample is collected and tapping the side of the vial to dislodge air bubbles. Sometimes it is not possible to collect a sample without air bubbles, particularly water that has high concentrations of dissolved gasses. In these cases, the field sampling personnel shall document the occurrence in the field logbook and/or sampling worksheet at the time the sample was collected. Likewise, the analytical laboratory shall note in the laboratory analysis reports any headspace in the sample container(s) at the time of receipt by the laboratory.

### **Special Handling Considerations**

In general, samples for organic analyses should not be filtered. However, high turbidity samples for PCB analysis may require filtering. Consult the project-specific SAP for details on filtering requirements. Samples shall not be transferred from one container to another because this could cause aeration or a loss of organic material onto the walls of the container. TOX and TOC samples should be handled in the same manner as VOC samples.

When collecting total and dissolved metals samples, the samples should be collected sequentially. The total metals sample is collected from the pump unfiltered. The dissolved metals sample is collected after filtering with a 0.45-micron membrane in-line filter. Allow at least 500 mL of effluent to flow through the filter prior to sampling to ensure that the filter is thoroughly wetted and seated in the filter capsule. If required by the project-specific SAP, include a filter blank for each lot of filters used and always record the lot number of the filters.

### **Field Sampling Preservation**

Preserve samples immediately upon collection. Ideally, sampling containers will be pre-preserved with a known concentration and volume of preservative. Certain matrices that have alkaline pH (greater than 7) may require more preservative than is typically required. An early assessment of preservation techniques, such as the use of pH strips after initial preservation, may therefore be appropriate. Guidance for the preservation of environmental samples can be found in the U.S. EPA *Handbook for Sampling and Sample Preservation of Water and Wastewater* (EPA 1982). Additional guidance can be found in other U.S. EPA documents (EPA 1992, 1996).

### **Field Sampling Log**

A groundwater sampling log provided as Attachment 1 shall document the following:

- Identification of well

- Well depth
- Static water level depth and measurement technique
- Presence of immiscible layers and detection method
- Well yield
- Purge volume and pumping rate
- Time that the well was purged
- Sample identification numbers
- Well evacuation procedure/equipment
- Sample withdrawal procedure/equipment
- Date and time of collection
- Types of sample containers used
- Preservative(s) used
- Parameters requested for analysis
- Field analysis data
- Field observations on sampling event
- Name of sampler
- Weather conditions

## **9.0 Quality Control and Assurance**

- 9.1 Field personnel will follow specific quality assurance (QA) guidelines as outlined in the project-specific SAP. The goal of the QA program should be to ensure precision, accuracy, representativeness, completeness, and comparability in the project sampling program.
- 9.2 Quality control (QC) requirements for sample collection are dependent on project-specific sampling objectives. The project-specific SAP will provide requirements for sample preservation and holding times, container types, sample packaging and shipment, as well as requirements for the collection of various QC samples such as trip blanks, field blanks, equipment rinse blanks, and field duplicate samples.

## **10.0 Data and records management**

- 10.1 Records will be maintained in accordance with SOP 3-03, Recordkeeping, Sample Labelling, and Chain-of-Custody. Various forms are required to ensure that adequate documentation is made of the sample collection activities. These forms may include:
- Sample Collection Records;
  - Field logbook;
  - Chain-of-custody forms; and
  - Shipping labels.

- 10.2 Sample collection records (Attachment 1) will provide descriptive information for the purging process and the samples collected at each monitoring well.
- 10.3 The field logbook is kept as a general log of activities and should not be used in place of the sample collection record.
- 10.4 Chain-of-custody forms are transmitted with the samples to the laboratory for sample tracking purposes.
- 10.5 Shipping labels are required is sample coolers are to be transported to a laboratory by a third party (courier service).

## 11.0 Attachments or References

### Attachment 1 – Groundwater Sampling Collection Record

ASTM Standard D5088. 2008. *Standard Practice for Decontamination of Field Equipment Used at Waste Sites*. ASTM International, West Conshohocken, PA. 2008. DOI: 10.1520/D5088-02R08. [www.astm.org](http://www.astm.org).

Environmental Protection Agency, United States (EPA). 1982. *Handbook for Sampling and Sample Preservation of Water and Wastewater*. EPA-600/4-82-029. Cincinnati: EPA Office of Research and Development, Environmental Monitoring and Support Laboratory.

EPA. 1992. *RCRA Groundwater Monitoring Draft Technical Guidance*. EPA/530/R-93/001. Office of Solid Waste. November.

EPA. 1996. *Ground Water Issue: Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures*. EPA/540/S-95/504. Office of Solid Waste and Emergency Response. April.

EPA. 1997. *Test Methods for Evaluating Solid Waste, Physical/Chemical Method (SW-846)*. 3rd ed., Final Update IIIA. Office of Solid Waste. Online updates at: <http://www.epa.gov/epaoswer/hazwaste/test/new-meth.htm>.

NAVSEA T0300-AZ-PRO-010. *Navy Environmental Compliance Sampling and Field Testing Procedures Manual*. August 2009.

SOP 3-03, *Recordkeeping, Sample Labelling, and Chain-of-Custody*.

SOP 3-05, *IDW Management*.

SOP 3-06, *Equipment Decontamination*.

<i>Author</i>	<i>Reviewer</i>	<i>Revisions (Technical or Editorial)</i>
Mark Kromis Program Chemist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue (May 2012)





# Soil and Rock Classification

## Procedure 3-16

### 1.0 Purpose and Scope

- 1.1 The purpose of this document is to define the standard operating procedure (SOP) to thoroughly describe the physical characteristics of the sample and classify it according to the Unified Soil Classification System (USCS).
- 1.2 This procedure is the Program-approved professional guidance for work performed by Resolution Consultants under the Comprehensive Long-Term Environmental Action Navy (CLEAN) contract (Contract Number N62470-11-D-8013).
- 1.3 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review. If there are procedures whether it be from Resolution Consultants, state and/or federal that are not addressed in this SOP and are applicable to surface water sampling then those procedures may be added as an appendix to the project specific SAP.
- 1.4 It is fully expected that the procedures outlined in this SOP will be followed. Procedural modifications may be warranted depending upon field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this SOP will be approved in advance by the Program Quality Manager. Deviations to this SOP will be documented in the field records.

### 2.0 Safety

- 2.1 Depending upon the site-specific contaminants, various protective programs must be implemented prior to sampling. All **field sampling personnel** responsible for sampling activities must review the project-specific health and safety plan (HASP) paying particular attention to the control measures planned for the sampling tasks. Conduct preliminary area monitoring to determine the potential hazard to field sampling personnel. If significant contamination is observed, minimize contact with potential contaminants in both the vapor and liquid phase through the use of respirators and disposable clothing.
- 2.2 In addition, observe standard health and safety practices according to the project-specific HASP. Suggested minimum protection during well sampling activities includes inner disposable vinyl gloves, outer chemical-protective nitrile gloves, rubberized steel-toed boots, and an American National Standards Institute-standard hard hat. Half-face respirators and cartridges and Tyvek® suits may be necessary depending on the contaminant concentrations, and shall always be available on site.
- 2.3 Daily safety briefs will be conducted at the start of each working day before any work commences. These daily briefs will be facilitated by the **Site Safety Officer (SSO)** or designee to discuss the day's events and any potential health risk areas covering every aspect of the work to be completed. Weather conditions are often part of these discussions. As detailed in the HASP, everyone on the field team has the authority to stop work if an unsafe condition is perceived until the conditions are fully remedied to the satisfaction of the SSO.
- 2.4 The health and safety considerations for the work associated with soil classification include:

- At no time during classification activities are personnel to reach for debris near machinery that is in operation, place any samples in their mouth, or come in contact with the soils/rocks without the use of gloves.
- Stay clear of all moving equipment and be aware of pinch points on machinery. Avoid wearing loose fitting clothing.
- When using cutting tools, cut away from yourself. The use of appropriate, task specific cutting tools is recommended.
- To avoid heat/cold stress as a results of exposure to extreme temperatures and PPE, drink electrolyte replacement fluids (1 to 2 cups per hour is recommended) and in case of extreme cold, wear insulating clothing.

### **3.0 Terms and Definitions**

None.

### **4.0 Interference**

None.

### **5.0 Training and Qualifications**

- 5.1 The **Contract Task Order (CTO) Manager** is responsible for ensuring that the soil and rock classification procedures comply with this procedure. The **CTO Manager** is responsible for ensuring that all personnel involved in soil and rock classification shall have the appropriate education, experience, and training to perform their assigned tasks.
- 5.2 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.
- 5.3 The **Field Manager** is responsible for ensuring that all project **field personnel** follow these procedures.
- 5.4 Field personnel are responsible for the implementation of this procedure. Minimum qualifications for **field sampling personnel** require that one individual on the field team shall have a minimum of 6 months of experience with soil and rock classification.
- 5.5 The **project geologist** and/or **task manager** is responsible for directly supervising the soil and rock classification procedures to ensure that they are conducted according to this procedure, and for recording all pertinent data collected. If deviations from the procedure are required because of anomalous field conditions, they must first be approved by the **Program Quality Manager** and then documented in the field logbook and associated report or equivalent document.

### **6.0 Equipment and Supplies**

- 6.1 The following equipment list contains materials which may be needed in carrying out the procedures outlined in this SOP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.
- Personal protective equipment (PPE) and other safety equipment, as required by the HASP
  - Field log book and pen with indelible ink
  - Boring log

- Munsell Soil Color Chart
- Scoopula, spatula, and/or other small hand tools
- California Sampler
- Hand-held penetrometer

## **7.0 Calibration or Standardization**

None.

## **8.0 Procedure**

### **8.1 Soil Classification**

The basic purpose of the classification of soil is to thoroughly describe the physical characteristics of the sample and to classify it according to an appropriate soil classification system. The USCS was developed so that soils could be described on a common basis by different investigators and serve as a "shorthand" description of soil. A classification of a soil in accordance with the USCS includes not only a group symbol and name, but also a complete word description.

Describing soil on a common basis is essential so that soil described by different site qualified personnel is comparable. Site individuals describing soil as part of site activities *must* use the classification system described herein to provide the most useful geologic database for all present and future subsurface investigations and remedial activities.

The site geologist or other qualified individual shall describe the soil and record the description in a boring log, logbook, and/or electronic field data collection device. The essential items in any written soil description are as follows:

- Classification group name (e.g., silty sand)
- Color, moisture, and odor
- Range of particle sizes and maximum particle size
- Approximate percentage of boulders, cobbles, gravel, sand, and fines
- Plasticity characteristics of the fines
- In-place conditions, such as consistency, density, and structure
- USCS classification symbol

The USCS serves as "shorthand" for classifying soil into 15 basic groups:

GW<sup>1</sup> Well graded (poorly sorted) gravel (>50 percent gravel, <5percent fines)

GP<sup>1</sup> Poorly graded (well sorted) gravel (>50percent gravel, <5percent fines)

GM<sup>1</sup> Silty gravel (>50 percent gravel, >15 percent silt)

GC<sup>1</sup> Clayey gravel (>50 percent gravel, >15 percent clay)

SW<sup>1</sup> Well graded (poorly sorted) sand (>50 percent sand, <5 percent fines)

SP<sup>1</sup> Poorly graded (well sorted) sand (>50 percent sand, <5 percent fines)

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<sup>1</sup> If percentage of fine is 5 percent to 15 percent, a dual identification shall be given (e.g., a soil with more than 50 percent poorly sorted gravel and 10 percent clay is designated GW-GC).

SM <sup>1</sup>	Silty sand (>50 percent sand, >15 percent silt)
SC <sup>1</sup>	Clayey sand (>50 percent sand, >15 percent clay)
ML <sup>2</sup>	Inorganic, low plasticity silt (slow to rapid dilatancy, low toughness, and plasticity)
CL <sup>2</sup>	Inorganic, low plasticity (lean) clay (no or slow dilatancy, medium toughness and plasticity)
MH <sup>2</sup>	Inorganic elastic silt (no to slow dilatancy, low to medium toughness and plasticity)
CH <sup>2</sup>	Inorganic, high plasticity (fat) clay (no dilatancy, high toughness, and plasticity)
OL	Organic low plasticity silt or organic silty clay
OH	Organic high plasticity clay or silt
PT	Peat and other highly organic soil

Figure 8-1 defines the terminology of the USCS. Flow charts presented in Figure 8-2 and indicate the process for describing soil. The particle size distribution and the plasticity of the fines are the two properties of soil used for classification. In some cases, it may be appropriate to use a borderline classification (e.g., SC/CL) if the soil has been identified as having properties that do not distinctly place the soil into one group.

#### 8.1.1 Estimation of Particle Size Distribution

One of the most important factors in classifying a soil is the estimated percentage of soil constituents in each particle size range. Being proficient in estimating this factor requires extensive practice and frequent checking. The steps involved in determining particle size distribution are listed below:

1. Select a representative sample (approximately 1/2 of a 6-inch long by 2.5-inch diameter sample liner).
2. Remove all particles larger than 3 inches from the sample. Estimate and record the percent by volume of these particles. Only the fraction of the sample smaller than 3 inches is classified.
3. Estimate and record the percentage of dry mass of gravel (less than 3 inches and greater than 1/4 inch).
4. Considering the rest of the sample, estimate, and record the percentage of dry mass of sand particles (about the smallest particle visible to the unaided eye).
5. Estimate and record the percentage of dry mass of fines in the sample (do not attempt to separate silts from clays).
6. Estimate percentages to the nearest 5 percent. If one of the components is present in a quantity considered less than 5 percent, indicate its presence by the term "trace".
7. The percentages of gravel, sand, and fines must add up to 100 percent. "Trace" is not included in the 100 percent total.

#### 8.1.2 Soil Dilatancy, Toughness, and Plasticity

##### 8.1.2.1 Dilatancy

To evaluate dilatancy, follow these procedures:

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<sup>2</sup> If the soil is estimated to have 15 percent to 25 percent sand or gravel, or both, the words "with sand" or "with gravel" (whichever predominates) shall be added to the group name (e.g., clay with sand, CL; or silt with gravel, ML). If the soil is estimated to have 30 percent or more sand or gravel, or both, the words "sandy" or "gravely" (whichever predominates) shall be added to the group name (e.g., sandy clay, CL). If the percentage of sand is equal to the percent gravel, use "sandy."

1. From the specimen, select enough material to mold into a ball about 1/2 inch (12 millimeters [mm]) in diameter. Mold the material, adding water if necessary, until it has a soft, but not sticky, consistency.
2. Smooth the soil ball in the palm of one hand with the blade of a knife or small spatula. Shake horizontally, striking the side of the hand vigorously against the other hand several times. Note the reaction of water appearing on the surface of the soil. Squeeze the sample by closing the hand or pinching the soil between the fingers, and note the reaction as none, slow, or rapid in accordance with the criteria in Table 8-1. The reaction is the speed with which water appears while shaking, and disappears while squeezing.

**Table 8-1: Criteria for Describing Dilatancy**

Description	Criteria
None	No visible change in specimen.
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing.
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing.

#### 8.1.2.2 *Toughness*

Following the completion of the dilatancy test, shape the test specimen into an elongated pat and roll it by hand on a smooth surface or between the palms into a thread about 1/8 inch (3 mm) in diameter. (If the sample is too wet to roll easily, spread it into a thin layer and allow it to lose some water by evaporation.) Fold the sample threads and re-roll repeatedly until the thread crumbles at a diameter of about 1/8 inch. The thread will crumble at a diameter of 1/8 inch when the soil is near the plastic limit. Note the pressure required to roll the thread near the plastic limit. Also, note the strength of the thread. After the thread crumbles, lump the pieces together and knead it until the lump crumbles. Note the toughness of the material during kneading. Describe the toughness of the thread and lump as low, medium, or high in accordance with the criteria in Table 8-2.

**Table 8-2: Criteria for Describing Toughness**

Description	Criteria
Low	Only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and soft.
Medium	Medium pressure is required to roll the thread near the plastic limit. The thread and the lump have medium stiffness.
High	Considerable pressure is required to roll the thread near the plastic limit. The thread and the lump have very high stiffness.

DEFINITION OF TERMS							
MAJOR DIVISIONS		SYMBOLS		TYPICAL DESCRIPTIONS			
<b>COARSE GRAINED SOILS</b> More Than Half of Material is Larger Than No. 200 Sieve Size	<b>GRAVELS</b> More Than Half of Coarse Fraction is Smaller Than No. 4 Sieve	<b>CLEAN GRAVELS</b> (Less than 6% Fines)		<b>GW</b>	Well graded gravels, gravel-sand mixtures, little or no fines		
		<b>GRAVELS With Fines</b>		<b>GP</b>	Poorly graded gravels, gravel-sand mixtures, little or no fines		
				<b>GM</b>	Silty gravels, gravel-sand-silt mixtures, non-plastic fines		
			<b>GC</b>	Clayey gravels, gravel-sand-clay mixtures, plastic fines			
	<b>SANDS</b> More Than Half of Coarse Fraction is Smaller Than No. 4 Sieve	<b>CLEAN SANDS</b> (Less than 6% Fines)		<b>SW</b>	Well graded sands, gravelly sands, little or no fines		
		<b>SANDS With Fines</b>		<b>SP</b>	Poorly graded sands, gravelly sands, little or no fines		
				<b>SM</b>	Silty sands, sand-silt mixtures, non-plastic fines		
			<b>SC</b>	Clayey sands, sand-clay mixtures, plastic fines			
<b>FINE GRAINED SOILS</b> More Than Half of Material is Smaller Than No. 200 Sieve Size	<b>SILTS AND CLAYS</b> Liquid Limit is Less Than 50%		<b>ML</b>	Inorganic silts, rock flour, fine sandy silts or clays, and clayey silts with non- or slightly-plastic fines			
			<b>CL</b>	Inorganic clays of low to medium plasticity, gravelly clays, silty clays, sandy clays, lean clays			
			<b>OL</b>	Organic silts and organic silty clays of low plasticity			
	<b>SILTS AND CLAYS</b> Liquid Limit is Greater Than 50%		<b>MH</b>	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts, clayey silt			
			<b>CH</b>	inorganic clays of high plasticity, fat clays			
			<b>OH</b>	Organic clays of medium to high plasticity, organic silts			
<b>HIGHLY ORGANIC SOILS</b>			<b>PT</b>	Peat and other highly organic soils			

GRAIN SIZES								
SILTS AND CLAYS	SAND				GRAVEL		COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	COARSE			
	200	40	10	4	3/4"	3"	12"	
	U.S. STANDARD SERIES SIEVE				CLEAR SQUARE SIEVE OPENINGS			

**Figure8-1: Unclassified Soil Classification System (USCS)**

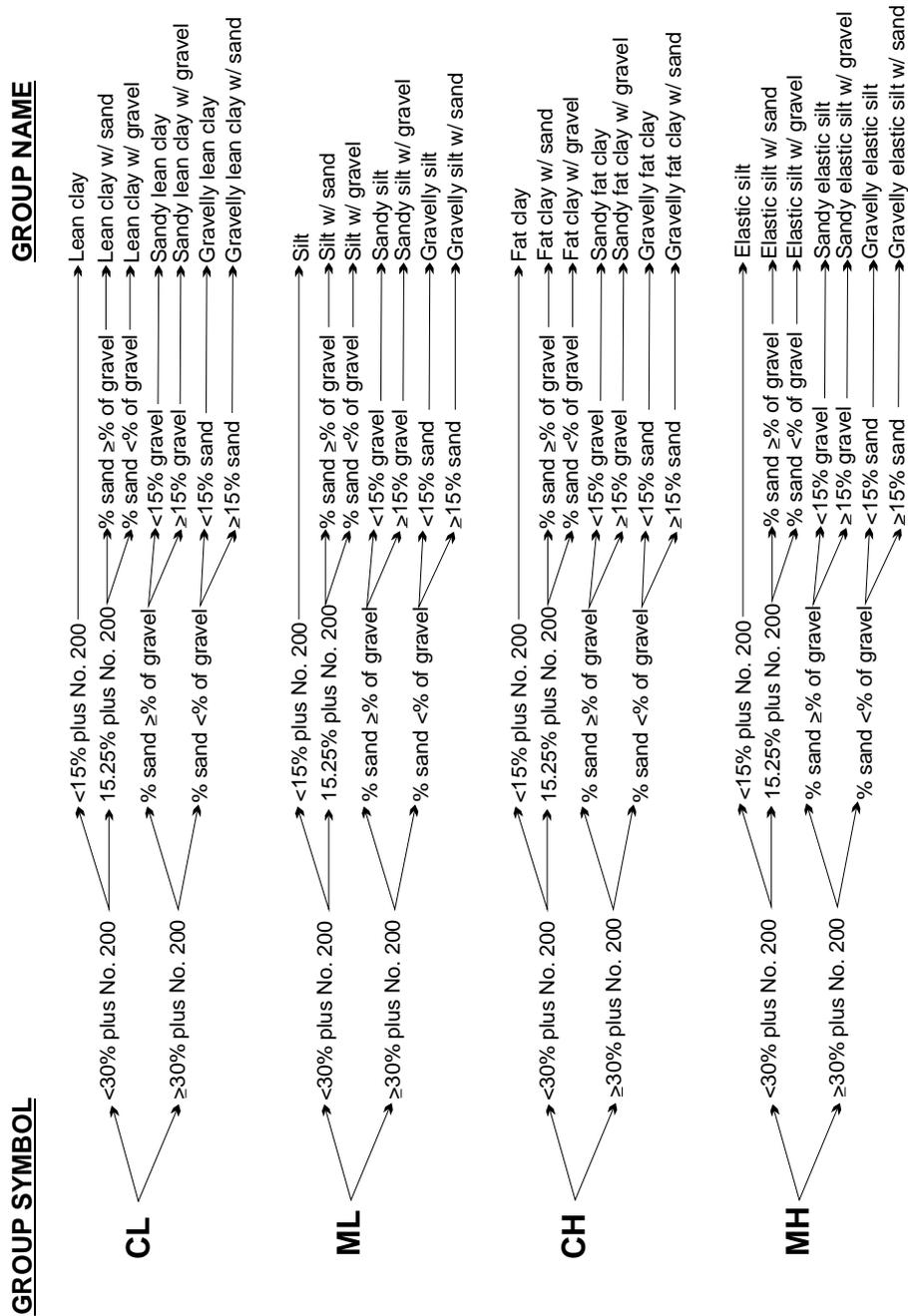


Figure 8-2: Flow Chart for Fine Grain Soil Classification



### 8.1.2.3 *Plasticity*

The plasticity of a soil is defined by the ability of the soil to deform without cracking, the range of moisture content over which the soil remains in a plastic state, and the degree of cohesiveness at the plastic limit. The plasticity characteristic of clays and other cohesive materials is defined by the liquid limit and plastic limit. The liquid limit is defined as the soil moisture content at which soil passes from the liquid to the plastic state as moisture is removed. The test for the liquid limit is a laboratory, not a field, analysis.

The plastic limit is the soil moisture content at which a soil passes from the plastic to the semi-solid state as moisture is removed. The plastic limit test can be performed in the field and is indicated by the ability to roll a 1/8-inch (0.125-inch) diameter thread of fines, the time required to roll the thread, and the number of times the thread can be re-rolled when approaching the plastic limit.

The plasticity tests are not based on natural soil moisture content, but on soil that has been thoroughly mixed with water. If a soil sample is too dry in the field, add water prior to performing classification. If a soil sample is too sticky, spread the sample thin and allow it to lose some soil moisture.

Table 8-3 presents the criteria for describing plasticity in the field using the rolled thread method.

**Table 8-3: Criteria for Describing Plasticity**

Description	Criteria
Non-Plastic	A 1/8-inch thread cannot be rolled.
Low Plasticity	The thread can barely be rolled.
Medium Plasticity	The thread is easy to roll and not much time is required to reach the plastic limit.
High Plasticity	It takes considerable time rolling the thread to reach the plastic limit.

### 8.1.3 **Angularity**

The following criteria describe the angularity of the coarse sand and gravel particles:

- **Rounded** particles have smoothly-curved sides and no edges.
- **Subrounded** particles have nearly plane sides, but have well-rounded corners and edges.
- **Subangular** particles are similar to angular, but have somewhat rounded or smooth edges.
- **Angular** particles have sharp edges and relatively plane sides with unpolished surfaces. Freshly broken or crushed rock would be described as angular.

### 8.1.4 **Color, Moisture, and Odor**

The natural moisture content of soil is very important. Table 8-4 shows the terms for describing the moisture condition and the criteria for each.

**Table 8-4: Soil Moisture Content Qualifiers**

Qualifier	Criteria
Dry	Absence of moisture, dry to the touch
Moist	Damp but no visible water
Wet	Visible water, usually soil is below water table

Color is described by hue and chroma using the Munsell Soil Color Chart (Munsell 2000). For uniformity, all site geologists shall utilize this chart for soil classification. Doing so will facilitate correlation of geologic units between boreholes logged by different geologists. The Munsell Color Chart is a small booklet of numbered color chips with names like "5YR 5/6, yellowish-red." Note mottling or banding of colors. It is particularly important to note and describe staining because it may indicate contamination.

In general, wear a respirator if strong organic odors are present. If odors are noted, describe them if they are unusual or suspected to result from contamination. An organic odor may have the distinctive smell of decaying vegetation. Unusual odors may be related to hydrocarbons, solvents, or other chemicals in the subsurface. An organic vapor analyzer may be used to detect the presence of volatile organic contaminants.

#### 8.1.5 **In-Place Conditions**

Describe the conditions of undisturbed soil samples in terms of their density/consistency (i.e., compactness), cementation, and structure utilizing the following guidelines:

##### 8.1.5.1 *Density/Consistency*

Density and consistency describe a physical property that reflects the relative resistance of a soil to penetration. The term “density” is commonly applied to coarse to medium-grained sediments (i.e., gravels, sands), whereas the term “consistency” is normally applied to fine-grained sediments (i.e., silts, clays). There are separate standards of measure for both density and consistency that are used to describe the properties of a soil.

The density or consistency of a soil is determined by observing the number of blows required to drive a 1 3/8-inch (35 mm) diameter split barrel sampler 18 inches using a drive hammer weighing 140 lbs (63.5 kilograms [kg]) dropped over a distance of 30 inches (0.76 meters). Record the number of blows required to penetrate each 6 inches of soil in the field boring log during sampling. The first 6 inches of penetration is considered to be a seating drive; therefore, the blow count associated with this seating drive is recorded, but not used in determining the soil density/consistency. The sum of the number of blows required for the second and third 6 inches of penetration is termed the “standard penetration resistance,” or the “N-value.” The observed number of blow counts must be corrected by an appropriate factor if a different type of sampling device (e.g., Modified California Sampler with liners) is used. For a 2 3/8-inch inner diameter (I.D.) Modified California Sampler equipped with brass or stainless steel liners and penetrating a cohesionless soil (sand/gravel), the N-value from the Modified California Sampler must be divided by 1.43 to provide data that can be compared to the 1 3/8-inch diameter sampler data.

For a cohesive soil (silt/clay), the N-value for the Modified California Sampler should be divided by a factor of 1.13 for comparison with 1 3/8-inch diameter sampler data.

Drive the sampler and record blow counts for each 6-inch increment of penetration until one of the following occurs:

- A total of 50 blows have been applied during any one of the three 6-inch increments; a 50-blow count occurrence shall be termed “refusal” and noted as such on the boring log.
- A total of 150 blows have been applied.
- The sampler is advanced the complete 18 inches without the limiting blow counts occurring, as described above.

If the sampler is driven less than 18 inches, record the number of blows per partial increment on the boring log. If refusal occurs during the first 6 inches of penetration, the number of blows will represent the N-value for this sampling interval. Table 8-5 and Table 8-6 present representative descriptions of soil density/consistency vs. N-values.

**Table 8-5: Measuring Soil Density with a California Sampler – Relative Density (Sands, Gravels)**

Description	Field Criteria (N-Value)	
	1 3/8 in. ID Sampler	2 in. ID Sampler using 1.43 factor
Very Loose	0–4	0–6
Loose	4–10	6–14
Medium Dense	10–30	14–43
Dense	30–50	43–71
Very Dense	> 50	> 71

**Table 8-6: Measuring Soil Density with a California Sampler – Fine Grained Cohesive Soil**

Description	Field Criteria (N-Value)	
	1 3/8 in. ID Sampler	2 in. ID Sampler using 1.13 factor
Very Soft	0–2	0–2
Soft	2–4	2–4
Medium Stiff	4–8	4–9
Stiff	8–16	9–18
Very Stiff	16–32	18–36
Hard	> 32	> 36

For undisturbed fine-grained soil samples, it is also possible to measure consistency with a hand-held penetrometer. The measurement is made by placing the tip of the penetrometer against the surface of the soil contained within the sampling liner or Shelby tube, pushing the penetrometer into the soil a distance specified by the penetrometer manufacturer, and recording the pressure resistance reading in pounds per square foot (psf). The values are as follows ( Table 8-7):

**Table 8-7: Measuring Soil Consistency with a Hand-Held Penetrometer**

Description	Pocket Penetrometer Reading (psf)
Very Soft	0–250
Soft	250–500
Medium Stiff	500–1000
Stiff	1000–2000
Very Stiff	2000–4000
Hard	>4000

Consistency can also be estimated using thumb pressure using Table 8-8.

**Table 8-8: Measuring Soil Consistency Using Thumb Pressure**

Description	Criteria
Very Soft	Thumb will penetrate soil more than 1 inch (25 mm)
Soft	Thumb will penetrate soil about 1 inch (25 mm)
Firm	Thumb will penetrate soil about 1/4 inch (6 mm)
Hard	Thumb will not indent soil but readily indented with thumbnail
Very Hard	Thumbnail will not indent soil

#### 8.1.5.2 *Cementation*

Cementation is used to describe the friability of a soil. Cements are chemical precipitates that provide important information as to conditions that prevailed at the time of deposition, or conversely, diagenetic effects that occurred following deposition. Seven types of chemical cements are recognized by Folk (1980). They are as follows:

- Quartz – siliceous
- Chert – chert-cemented or chalcedonic
- Opal – opaline
- Carbonate – calcitic, dolomitic, sideritic (if in doubt, calcareous should be used)
- Iron oxides – hematitic, limonitic (if in doubt, ferruginous should be used)
- Clay minerals – if the clay minerals are detrital or have formed by recrystallization of a previous clay matrix, they are not considered to be a cement. Only if they are chemical precipitates, filling previous pore space (usually in the form of accordion-like stacks or fringing radial crusts) should they be included as “kaolin-cemented,” “chlorite-cemented,” etc.
- Miscellaneous minerals – pyritic, collophane-cemented, glauconite-cemented, gypsiferous, anhydrite-cemented, baritic, feldspar-cemented, etc.

The degree of cementation of a soil is determined qualitatively by utilizing finger pressure on the soil in one of the sample liners to disrupt the gross soil fabric. The three cementation descriptors are as follows:

- Weak – friable; crumbles or breaks with handling or slight finger pressure
- Moderate – friable; crumbles or breaks with considerable finger pressure
- Strong – not friable; will not crumble or break with finger pressure

#### 8.1.5.3 *Structure*

This variable is used to qualitatively describe physical characteristics of soil that are important to incorporate into hydrogeological and/or geotechnical descriptions of soil at a site. Appropriate soil structure descriptors are as follows:

- Granular – spherically shaped aggregates with faces that do not accommodate adjoining faces
- Stratified – alternating layers of varying material or color with layers at least 6 mm (1/4 inch) thick; note thickness
- Laminated – alternating layers of varying material or color with layers less than 6 mm (1/4 inch) thick; note thickness
- Blocky – cohesive soil that can be broken down into small angular or subangular lumps that resist further breakdown
- Lensed – inclusion of a small pocket of different soil, such as small lenses of sand, should be described as homogeneous if it is not stratified, laminated, fissured, or blocky. If lenses of different soil are present, the soil being described can be termed homogeneous if the description of the lenses is included
- Prismatic or Columnar – particles arranged about a vertical line, ped is bounded by planar, vertical faces that accommodate adjoining faces; prismatic has a flat top; columnar has a rounded top
- Platy – particles are arranged about a horizontal plane

#### 8.1.5.4 *Other Features*

- Mottled – soil that appears to consist of material of two or more colors in blotchy distribution
- Fissured – breaks along definite planes of fracture with little resistance to fracturing (determined by applying moderate pressure to sample using thumb and index finger)
- Slickensided – fracture planes appear polished or glossy, sometimes striated (parallel grooves or scratches)

#### 8.1.6 **Development of Soil Description**

Develop standard soil descriptions according to the following examples. There are three principal categories under which all soil can be classified. They are described below.

##### 8.1.6.1 *Coarse-grained Soil*

Coarse-grained soil is divided into sands and gravels. A soil is classified as a sand if over 50 percent of the coarse fraction is “sand-sized.” It is classified as a gravel if over 50 percent of the coarse fraction is composed of “gravel-sized” particles.

The written description of a coarse-grained soil shall contain, in order of appearance: Typical name including the second highest percentage constituent as an adjective, if applicable (underlined); grain size of coarse fraction; Munsell color and color number; moisture content; relative density; sorting; angularity; other features, such as stratification (sedimentary structures) and cementation, possible formational name, primary USCS classification, secondary USCS classification (when necessary), and approximate percentages of minor constituents (i.e., sand, gravel, shell fragments, rip-up clasts) in parentheses.

Example: POORLY-SORTED SAND WITH SILT, medium- to coarse-grained, light olive gray, 5Y 6/2, saturated, loose, poorly sorted, subrounded clasts, SW/SM (minor silt with approximately 20 percent coarse-grained sand-sized shell fragments, and 80 percent medium-grained quartz sand, and 5 percent to 15 percent ML).

##### 8.1.6.2 *Fine-grained Soil*

Fine-grained soil is further subdivided into clays and silts according to its plasticity. Clays are rather plastic, while silts have little or no plasticity.

The written description of a fine-grained soil should contain, in order of appearance: Typical name including the second highest percentage constituent as an adjective, if applicable (underlined); Munsell color; moisture content; consistency; plasticity; other features, such as stratification, possible formation name, primary USCS classification, secondary USCS classification (when necessary), and the percentage of minor constituents in parentheses.

Example: SANDY LEAN CLAY, dusky red, 2.5 YR 3/2, moist, firm, moderately plastic, thinly laminated, CL (70 percent fines, 30 percent sand, with minor amounts of disarticulated bivalves [about 5 percent]).

##### 8.1.6.3 *Organic Soil*

For highly organic soil, describe the types of organic materials present as well as the type of soil constituents present using the methods described above. Identify the soil as an organic soil, OL/OH, if the soil contains enough organic particles to influence the soil properties. Organic soil usually has a dark brown to black color and may have an organic odor. Often, organic soils will change color, (e.g., from black to brown) when exposed to air. Some organic soils will lighten in color significantly when air-dried. Organic soils normally will not have a high toughness or plasticity. The thread for the toughness test will be spongy.

8.2 Example: ORGANIC CLAY, black, 2.5Y, 2.5/1, wet, soft, low plasticity, organic odor, OL (100 percent fines), weak reaction to HCl.

#### 8.3 **Rock Classification**

The purpose of rock classification is to thoroughly describe the physical and mineralogical characteristics of a specimen and to classify it according to an established system. The generalized rock classification system described below was developed because, unlike the USCS for soils, there is no universally accepted rock classification system. In some instances, a more detailed and thorough rock classification system may be appropriate. Any modifications to this classification system, or the use of an alternate classification system should be considered during preparation of the site work plan. Both the CTO Manager and the QA Manager or Technical Director must approve any modifications to this classification system, or the use of another classification system.

Describing rock specimens on a common basis is essential so that rocks described by different site geologists are comparable. Site geologists describing rock specimens as a part of investigative activities must use the classification system described herein, or if necessary, another more detailed classification system. Use of a common classification system provides the most useful geologic database for all present and future subsurface investigations and remedial activities.

In order to provide a more consistent rock classification between geologists, a rock classification template has been designated as shown in **Error! Reference source not found.**. The template includes classification of rocks by origin and mineralogical composition. When classifying rocks, all site geologists shall use this template.

The site geologist shall describe the rock specimen and record the description in a boring log or logbook. The items essential for classification include (i.e., metamorphic foliated):

- Classification Name (i.e., schist)
- Color
- Mineralogical composition and percent
- Texture/Grain size (i.e., fine-grained, pegmatitic, aplitic, glassy)
- Structure (i.e., foliated, fractured, lenticular)
- Rock Quality Designation (sum of all core pieces greater than two times the diameter of the core divided by the total length of the core run, expressed as a percentage)
- Classification symbol (i.e., MF)

Example: Metamorphic foliated schist: Olive gray, 5Y, 3/2, Garnet 25 percent, Quartz 45 percent, Chlorite 15 percent, Tourmaline 15 percent, Fine-grained with Pegmatite garnet, highly foliated, slightly wavy, MF.

## **9.0 Quality Control and Assurance**

None

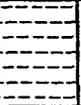
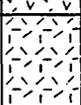
DEFINITION OF TERMS					
PRIMARY DIVISIONS		SYMBOLS		SECONDARY DIVISIONS	
<b>SEDIMENTARY ROCKS</b>	<b>Clastic Sediments</b>	<b>CONGLOMERATE</b>		<b>CG</b>	Coarse-grained Clastic Sedimentary Rock types including: Conglomerates and Breccias
		<b>SANDSTONE</b>		<b>SS</b>	Clastic Sedimentary Rock types including: Sandstone, Arkose and Greywacke
		<b>SHALE</b>		<b>SH</b>	Fine-grained Clastic Sedimentary Rock types including: Shale, Siltstone, Mudstone and Claystone
	<b>Chemical Precipitates</b>	<b>CARBONATES</b>		<b>LS</b>	Chemical Precipitates including: Limestone, Crystalline Limestone, Fossiliferous Limestone Micrite and Dolomite
		<b>EVAPORITES</b>		<b>EV</b>	Evaporites including: Anhydrite, Gypsum, Halite, Travertine and Caliche
<b>IGNEOUS ROCKS</b>	<b>EXTRUSIVE (Volcanic)</b>		<b>IE</b>	Volcanic Rock types including: Basalt, Andesite, Rhyolite, Volcanic Tuff, and Volcanic Breccia	
	<b>INTRUSIVE (Plutonic)</b>		<b>II</b>	Plutonic Rock types including: Granite, Diorite and Gabbro	
<b>METAMORPHIC ROCKS</b>	<b>FOLIATED</b>		<b>MF</b>	Foliated Rock types including: Slate, Phyllite, Schist and Gneiss	
	<b>NON-FOLIATED</b>		<b>MN</b>	Non-foliated Rock types including: Metaconglomerate, Quartzite and Marble	

Figure 8-4: Rock Classification System

## 10.0 Data and Records Management

- 10.1 Document soil classification information collected during soil sampling onto the field boring logs, field trench logs, and into the field notebook. Copies of this information shall be sent to the **CTO Manager** for the project files.
- 10.2 Field notes will be kept during coring activities in accordance with SOP 3-03 – Recordkeeping, Sample Labeling, and Chain of Custody. The information pertinent to soil classification activities includes chronology of events, sample locations (x,y,z), time/date, sampler name, methods (including type of core liner/barrel, if applicable), sampler penetration and acceptability, sample observations, and the times and type of equipment decontamination. Deviations to the procedures detailed in the SOP should be recorded in the field logbook.

## 11.0 Attachments or References

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<i>Author</i>	<i>Reviewer</i>	<i>Revisions (Technical or Editorial)</i>
Robert Shoemaker Senior Scientist	Naomi Ouellette, Project Manager	Rev 0 – Initial Issue

# Direct Push Sampling Techniques

## Procedure 3-17

### 1.0 Purpose and Scope

- 1.1 This standard operating procedure (SOP) provides guidance on the use of direct push techniques for the United States Navy Environmental Restoration (ER) Program, Naval Facilities Engineering Command, Atlantic (NAVFAC Atlantic).
- 1.2 This procedure is the Program-approved professional guidance for work performed by Resolution Consultants under the Comprehensive Long-Term Environmental Action Navy (CLEAN) contract (Contract Number N62470-11-D-8013).
- 1.3 This procedure shall serve as management-approved professional guidance for the ER Program and is consistent with protocol in the Uniform Federal Policy-Quality Assurance Project Plan (DoD 2005). As professional guidance for specific activities, this procedure is not intended to obviate the need for professional judgment during unforeseen circumstances. Deviations from this procedure while planning or executing planned activities must be approved by both the Contract Task Order (CTO) Manager and the Quality Assurance (QA) Manager or Technical Director, and documented.
- 1.4 If there are procedures whether it be from Resolution Consultants, state and/or federal that are not addressed in this SOP and are applicable to direct push sampling then those procedures may be added as an appendix to the project specific SAP.

### 2.0 Safety

- 2.1 Field personnel shall perform work in accordance with the site-specific health and safety plan (HASP). During monitoring well installation, subcontractors in direct contact with potentially contaminated media shall wear the proper personal protective equipment (PPE) as outlined in the site-specific health and safety plan. Failure to comply will result in disciplinary action.
- 2.2 If circumstances warrant, a real-time immediate response instrument, such as a Miniram Dust Monitor, organic vapor analyzer, HNu, Thermo, Draeger or Sensidyne tubes, or explosimeter, should be used to monitor the work area. When real/time instrument response exceeds the permissible exposure limit, personnel shall don the appropriate PPE and alternate control measures to ensure personnel safety. If safe control measures are not achievable, field activities shall be discontinued immediately. Company-specific HASPs offer guidelines on air surveillance and on selection of PPE. In addition, the site-specific HASP includes an air monitoring program and suggested PPE.
- 2.3 In addition to the aforementioned precautions and depending upon the type of contaminant expected, employ the following safe work practices:
  - Particulate or Metal Compounds
    1. Avoid skin contact and/or incidental ingestion of soil.
    2. Wear protective clothing, steel-toed boots, gloves, safety glasses, and hearing protection as warranted.
  - VOCs
    1. Avoid breathing constituents venting from holes by approaching upwind, and/or by use of respiratory protection.

2. Pre-survey the area with a flame ionization detector (FID) or photoionization detector (PID) prior to sampling.
3. If monitoring results indicate organic vapors that exceed action levels as specified in the site-specific HASP, sampling activities may need to be conducted in Level C protection. At a minimum, skin protection will be required by use of gloves and Tyvek or other media that is protective against the media being encountered.

#### Flammable or Explosive Conditions

1. Monitor explosive gases as continuously as possible using an explosimeter and oxygen meter.
2. Place all ignition sources upwind or crosswind of the borehole.
3. If explosive gases exceed the designated action levels as specified in the site-specific HASP, cease operations and evaluate conditions.

#### Physical Hazards Associated With Soil Sampling

1. To avoid possible back strain associated with sample collection, use the large muscles of the legs, not the back, when retrieving soil samplers.
2. Stay clear of all moving equipment, and avoid wearing loose fitting clothing.
3. To avoid slip/trip/fall hazards, be wary of open trenches, pits, or holes.
4. Be aware of restricted mobility due to PPE.
5. To avoid hand, wrist, arm, shoulder, and back trauma due to the use of slide hammers or hand augers, rotate sampling among field personnel

### **3.0 Terms and Definitions**

- 3.1 Direct push techniques are methods for subsurface sampling or monitoring that involve the application of downward pressure (usually supplied through hydraulic means) without the benefit of cutting tool rotation to enter soil. A variety of systems are available under several trade names, such as GeoProbe®. Equipment may be skid-mounted, trailered, or mounted directly on the frame of a vehicle.

### **4.0 Interferences**

- 4.1 Potential interferences could result from cross-contamination between samples or sample locations. Minimization of the cross contamination will occur through the following:
  - The use of clean sampling tools at each location as necessary.
  - Avoidance of material that is not representative of the media to be sampled.

### **5.0 Training and Qualifications**

#### **5.1 Qualifications and Training**

The individual executing these procedures must have read, and be familiar with, the requirements of this SOP.

#### **5.2 Responsibilities**

- 5.2.1 The **CTO Manager** is responsible for ensuring that these standard direct push technique procedures are followed during projects conducted under the ER Program and that a qualified individual conducts or supervises the projects. A qualified individual for subsurface sampling or monitoring using direct push techniques is defined as a person with a degree in geology, hydrogeology, or geotechnical/civil engineering with at least 1 year of experience supervising soil boring construction using conventional drilling or direct push techniques. The CTO Manager

or designee is responsible for ensuring that all personnel involved in direct push sampling techniques shall have the appropriate education, experience, and training to perform their assigned tasks as specified in Chief of Naval Operations Instruction 5090.1c (DON 2007).

- 5.2.2 The Program Quality Manager is responsible for ensuring overall compliance with this procedure.
- 5.2.3 The Field Manager is responsible for ensuring that all field personnel follow these procedures.
- 5.2.4 All Field Personnel are responsible for the implementation of this procedure.
- 5.2.5 The Field Personnel and/or Field Manager is responsible for directly supervising the direct push sampling procedures to ensure that they are conducted according to this procedure, and for recording all pertinent data collected during sampling.

## **6.0 Equipment and Supplies**

In addition to those materials provided by the subcontractor, the project **Field Manager/Field Personnel** will require:

- Boring Logs;
- Spoons or scoops;
- Sample kit (bottles, labels, custody records and tape, cooler, ice), if laboratory analysis is required;
- Sample collection pan;
- Folding rule or tape measure;
- Plastic sheeting;
- Utility knife;
- Equipment decontamination materials (as described in SOP 3-06, *Equipment Decontamination*);
- Health and safety equipment (as required by HASP); and
- Field project notebook/pen.

## **7.0 Procedure**

Direct push techniques may be used as a cost-effective alternative to conventional drilling techniques for obtaining subsurface soil and groundwater samples and for monitoring subsurface conditions.

### **7.1 Method Selection**

Base the decision to use direct push techniques on: (1) their ability to achieve the required information at the required level of quality control and (2) their cost-effectiveness compared to conventional drilling methods. Major limitations of direct push techniques are their inability to penetrate rock or cobbles and a shallow maximum depth of penetration. The capabilities of direct push systems vary significantly among vendors. Consider these differences in capabilities when evaluating the method for a subsurface exploration program.

Use direct push techniques to obtain groundwater samples for confirmatory analyses only if the screen placement method protects the screen from clogging during installation and allows the installation of a sand-pack around the exterior of the well screen.

### **7.2 Inspection of Equipment**

Inspect direct push equipment prior to use for signs of fluid leakage, which could introduce contaminants to the soil. If, at any time during equipment operation, fluid is observed leaking from the rig, cease

operations and immediately repair or contain the leak. Collect, containerize, and label soil and other materials affected by the leak for proper disposal (see SOP 3-05, *IDW Management*).

### 7.3 **Preparation of Work Site**

Inspect the work site prior to commencing operations to ensure that no overhead hazards exist that could impact the direct push equipment, and the work area should be cleared and/or marked by the local underground utility locating service (e.g., DigSafe). In addition, clear locations planned for subsurface exploration using either geophysical methods and/or hand excavate locations to a depth of 2 to 3 feet prior to soil penetration, unless it is certain (by virtue of subsurface clearing activities) that no utilities or other hazardous obstructions will be encountered in the first 2 to 3 feet. Hand excavation may be waived when it is not practical.

Locate the direct push rig so that it is downslope from the penetration point, if the work is to be performed on a grade. Locate the rig downwind or crosswind of the penetration point, if possible. Cover the area surrounding, and in the vicinity of, the penetration point with plastic. Establish required exclusion zones using plastic tape or cones to designate the various areas.

### 7.4 **Equipment Decontamination**

To avoid cross-contamination, thoroughly decontaminate equipment used for direct push exploration and sampling as described in SOP 3-06, *Equipment Decontamination*. Decontaminate sampling tools and downhole equipment between each sampling event and between penetration points. At a minimum, steam clean or wash and rinse the equipment. Collect, containerize, and label all wash and rinse water for proper disposal. Clean equipment (e.g., drive rods and samplers) shall not come into contact with contaminated soils or other contaminated materials. Keep equipment on plastic or protect it in another suitable fashion. Store push rods and other equipment removed from a hole on plastic sheeting until properly decontaminated.

### 7.5 **Soil Sampling**

This SOP assumes that the subcontractor will perform sampling; therefore, detailed procedures regarding sample acquisition are not provided. Vendors of direct push equipment offer a variety of sampling systems designed specifically for their equipment. Both continuous and discrete soil samples may be obtained using sampling equipment similar to that described in Procedure 3-21, *Surface and Subsurface Soil Sampling*. The preferred methods for soil sampling using direct push techniques use brass or stainless steel split-tube samplers that are driven through the horizon to be sampled. Use plastic sample tubes (e.g., Macro-Core Samplers) only for screening purposes or, in the case of confirmatory sampling, if samples will not be analyzed for volatile organic compounds (VOCs) or semivolatile organic compounds (SVOCs).

### 7.6 **Groundwater Sampling**

Direct push vendors offer numerous methods for obtaining groundwater samples. Key differences among methods involve: (1) the maximum well diameter achievable; (2) the ability to protect the well screen from exposure to contaminated overburden soils during installation; (3) the ability to install packing around the screen; (4) flexibility in the size, materials of construction, and design of well screens; and (5) the ability to convert sampling points into permanent monitoring wells. The limitations and abilities of a given system must be thoroughly understood and matched to the needs of the project before committing to the collection of groundwater samples using direct push techniques.

Use direct push techniques only to collect screening samples unless it is confirmed that the system:

1. Effectively protects the well screen from exposure to contaminated overburden soils during installation
2. Allows the installation of effective packing around the well screen

3. Allows the well screen to be effectively sealed against the downward infiltration of overlying groundwater or surface precipitation
4. Is constructed of materials compatible with the intended sampling and analysis goals of the project
5. Allows the use of a well screen properly sized and slotted for the needs of the project

Additional information on the collection of groundwater samples can be found in SOP 3-14 Monitoring Well Sampling.

It is the responsibility of the **CTO Manager** to evaluate and determine the appropriateness of direct push systems prior to committing to their use on any project involving groundwater sampling. As part of this evaluation, it is recommended to obtain concurrence from regulatory authorities in advance for the method selection.

## 7.7 **Borehole Abandonment**

Methods for abandoning boreholes created with direct push systems will vary among vendors. Coordinate the desired method for abandonment with the vendor in the planning stages of the project to ensure proper abandonment.

Some direct push boreholes will close naturally as the drive rods and sampling tools are withdrawn. This may occur in loose, unconsolidated soils, such as sands. Close all boreholes using one of the procedures described in this procedure, unless natural caving precludes such closure.

The three methods for closing direct push boreholes are:

1. Add granulated or pelletized bentonite and hydrate in layers, proceeding from the bottom of the hole to the surface.
2. Pour premixed cement/water (or cement/water/bentonite) mixture into the hole.
3. Fill the entire hole with granular or pelletized bentonite and hydrate by means of a previously emplaced water tube that is gradually withdrawn as water is supplied to the bentonite.

The second method is recommended. For shallow holes less than 10 feet in depth, pour a cement/water/bentonite mix directly into the opening using a funnel. For deeper holes, use a conductor (tremie) pipe to carry the grout mix to the far reaches of the borehole. Lower the conductor pipe to within 2 inches of the bottom and gradually withdraw it as grout is added, keeping the lower end of the pipe submerged in grout at all times.

The recommended grout mixture for well abandonment is 7 to 9 gallons of water per 94-pound bag of Portland cement, with 3 percent to 5 percent by weight of powdered bentonite added to the mixture. Commercial products, such as Volcay are acceptable with pre-approval of the **CTO Manager**.

Seal boreholes to within 0.5 to 2.0 feet of the surface. Inspect the abandoned borehole after 24 hours to ensure that grout shrinkage does not occur. If significant shrinkage has occurred, re-grout the borehole. Fill the remaining portion of the hole with local topsoil or appropriate paving materials.

## 8.0 **Quality Control and Assurance**

- 8.1 Collection of representative samples will be ensured through adherence to the procedures in this SOP and the sampling strategy outlined in the SAP. The field quality control samples identified in the SAP must be collected. These samples may include field duplicates, equipment rinse blanks, trip blanks, and matrix spike/matrix spike duplicates

## 9.0 **Records, Data Analysis, Calculations**

- 9.1 Various forms are required to ensure that adequate documentation is made of the sample collection activities. These forms may include:

- Boring logs;
- Field logbook;
- Sample collection records;
- Chain-of-custody forms; and
- Shipping labels.

- 9.2 Boring logs (Attachment 1) will provide visual and descriptive information for samples collected at each soil boring and are often the most critical form of documentation generated during a soil sampling program.
- 9.3 The field logbook is kept as a general log of activities and should not be used in place of the boring log.
- 9.4 Chain-of-custody forms are transmitted with the samples to the laboratory for sample tracking purposes.
- 9.5 Shipping labels are required if sample coolers are to be transported to a laboratory by a third party (courier service).

## 10.0 Attachments or References

- 10.1 Attachment 1 – Boring Log
- 10.2 NAVSEA T0300-AZ-PRO-010. *Navy Environmental Compliance Sampling and Field Testing Procedures Manual*. August 2009.
- 10.3 Department of Defense, United States (DoD). 2005. *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual*. Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: [http://www.epa.gov/fedfac/pdf/ufp\\_qapp\\_v1\\_0305.pdf](http://www.epa.gov/fedfac/pdf/ufp_qapp_v1_0305.pdf).
- 10.4 Department of the Navy (DON). 2007. *Navy Environmental and Natural Resources Program Manual*. OPNAV Instruction 5090.1c. October.
- 10.5 SOP 3-05, *IDW Management*.
- 10.6 SOP 3-06, *Equipment Decontamination*.
- 10.7 SOP 3-21, *Surface and Subsurface Soil Sampling*.

Author	Reviewer	Revisions (Technical or Editorial)
Mark Kromis Program Chemist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue (May 2012)

# Attachment 1 Boring Log

							<b>Boring ID:</b> <div style="border: 1px solid black; width: 100%; height: 15px;"></div>	
Project Name:			Drilling Company:		Type of Surface Material:			
Project Number:			Drilling Method:		Patching Material:			
Date Started Drilling:			Rig Type:		Drilling Water Level:			
Date Finished Drilling:			Core Size:		Boring Total Depth (bgs):			
Physical Location:						Logged By:		
(Note: bgs = below ground surface)								
Depth Range	Recovery ft/ft	PID (ppm)	Moisture Content	GA Class.	USCS	GA Class: Garfield Avenue Sites classification & Modified Unified Soil Classification System		
						Ground Surface Cover and Thickness:		Sample name & #:
0-1								
1-2								
2-3								
3-4								
4-5								
5-6								
6-7								
7-8								
8-9								
9-10								
10-11								
11-12								
12-13								
13-14								
14-15								
15-16								
16-17								
17-18								
18-19								
19-20								
<b>Stratigraphic Unit Intervals:</b>						<b>Comments:</b>		
1.)		5.)						
2.)		6.)						
5.)		6.)						

# Field Analysis of Ferrous Iron Using the HACH DR890 Colorimeter and HACH Method 8146

## Procedure 3-18

### 1.0 Purpose and Scope

- 1.1 This standard operating procedure (SOP) is applicable for the field analysis of water, wastewater, and seawater for ferrous iron ( $\text{Fe}^{+2}$ ). Concentrations ranging up to 3.00 mg/L can be analyzed, with higher concentrations analyzed by diluting the samples. The estimated detection limit is 0.03 mg/L. The presence of ferrous iron is indicative of a reducing state, therefore measurement of ferrous iron is useful in determining whether site conditions are reducing.
- 1.2 The 1,10-phenanthroline indicator in the AccuVac ampul reacts with ferrous iron ( $\text{Fe}^{+2}$ ) in the sample to form an orange color in proportion to the iron concentration. Ferric iron ( $\text{Fe}^{+3}$ ) does not react. The ferric iron concentration can be determined by subtracting the ferrous iron concentration from results of a total iron test.
- 1.3 Samples are analyzed immediately after collection because ferrous iron readily oxidizes to ferric iron upon exposure to air. A minimum volume of approximately 100 mL of sample is required to complete this analysis. A HACH "AccuVac" ampul (a vacuum-sealed glass ampul containing 1,10-phenanthroline reagent) is broken, tip down in the sample, and allowed to react for the required three minutes. The colorimeter is zeroed and the sample analyzed. The instrument must be zeroed with a sample water blank prior to each analysis.

### 2.0 Safety

- 2.1 The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, will be addressed in the project Health and Safety Plan (HASP). In the absence of a HASP, work will be conducted according to the Contract Task Order (CTO) Work Plan (WP) and/or direction from the Site Safety Officer (SSO).
- 2.2 Caution should be taken when working with all chemicals. Refer to the Material Safety Data Sheets (MSDSs) for the chemicals to be used.
- 2.3 Caution should be taken by the analyst with the sharp, broken glass that results after activating the AccuVac ampul.

### 3.0 Terms and Definitions

None.

### 4.0 Interferences

- 4.1 Ferrous iron ( $\text{Fe}^{+2}$ ) oxidizes into ferric iron ( $\text{Fe}^{+3}$ ) rapidly on exposure to air and addition of oxidants. Samples must be analyzed immediately after sample collection.
- 4.2 Color development due to the reaction of ferrous iron with 1,10-phenanthroline is time dependent. Therefore, it is critical that the reaction time allowed between addition of the reagent from the AccuVac vial and color measurement be consistent for all analyses and carefully timed.
- 4.3 Care should be taken to avoid cross-contamination between field samples. The analyst should change gloves each time before handling the field sample for analysis. Sample color and turbidity will interfere

with colorimetric measurement. The colorimeter is therefore blank corrected with sample water prior to sample analysis and measurement.

## **5.0 Training and Qualifications**

### **5.1 Qualifications and Training**

The individual executing these procedures must have read, and be familiar with, the requirements of this SOP.

### **5.2 Responsibilities**

5.2.1 The CTO Manager is responsible for ensuring that field analysis activities comply with this procedure. The CTO Manager is responsible for ensuring that all personnel involved in the field analysis shall have the appropriate education, experience, and training to perform their assigned tasks.

5.2.2 The Program Quality Manager is responsible for ensuring overall compliance with this procedure.

5.2.3 The Field Manager is responsible for ensuring that all field analysis is conducted according to this procedure.

5.2.4 All Field Personnel are responsible for the implementation of this procedure.

## **6.0 Equipment and Supplies**

### **6.1 Equipment**

- HACH DR/890 colorimeter;
- 3 HACH "AccuVac ampuls" (to allow for diluted analyses if required) per well;
- HACH colorimeter sample cell (for the blank) 10-20-25 mL, with cap;
- Plastic cups and lids;
- Graduated cylinders;
- Kimwipes®;
- Pipetter; and
- Deionized ultra-filtered water (DIUF) for dilutions.

## **7.0 Procedure**

### **7.1 Sample Analysis Procedure**

Approximately 100 mL of sample will be collected in a plastic cup. Some sample is poured into the HACH 10-20-25 mL sample cell as a blank, and the instrument is zeroed with the blank. An AccuVac ampul is broken into the remainder of the sample in the cup, and set to react for 3 minutes. The sample is then analyzed. The procedures are outlined below.

7.1.1 Turn on the colorimeter by pressing EXIT. Press PRGM. When prompted, enter 33 and press ENTER.

7.1.2 Check historical ferrous iron concentrations for the sample location if available, and determine if sample dilution is necessary: If the anticipated concentration is above 3.00 mg/L, the upper end of the operating range of the colorimeter, a dilution is necessary. Prepare an appropriate dilution with DIUF using the graduated cylinder and pipette as needed. Do not use the volume indicators on the sample cell as these are not sufficiently accurate. Place the required volume of sample into the graduated cylinder, and fill to the desired volume with DIUF to the total volume. Swirl the cylinder by grasping the top with three fingers, and swinging in a circle three times. Record the volumes of sample and DIUF used for the dilution.

- 7.1.3 Pour at least 10 mL of the sample or diluted sample water into the 10-20-25 mL sample cell (not an AccuVac ampul). This will be used for the blank to zero the colorimeter.
- 7.1.4 Clean the sample cell with a damp Kimwipe, followed by a dry Kimwipe.
- 7.1.5 Place the 10-20-25 mL sample cell in the colorimeter, using the same orientation each time.
- 7.1.6 Cover, and press ZERO.
- 7.1.7 Pour at least 10mL of the unused sample or diluted sample into a plastic cup. Immerse an inverted AccuVac ampul in the sample water and snap off the tip on the bottom of the cup. Hold the ampul in place until water is no longer entering the ampul (about 4 seconds).
- 7.1.8 Remove the ampul from the cup, and quickly invert several times to mix. It is not necessary to block the top of the ampul as the liquid will not leak out.
- 7.1.9 Press TIMER, and the press ENTER on the colorimeter. A three minute reaction period will begin. During this reaction period, wipe off the AccuVac ampul with a Kimwipe.
- 7.1.10 When the 3-minute timer is up (colorimeter will beep), put the ampul in the colorimeter, cover tightly with the colorimeter cap, press READ, and record the reading.
- 7.1.11 Record the colorimeter reading on the sample worksheet.
- 7.1.12 If the reading is >3.00, collect more sample, dilute the sample, and repeat steps 4 through 12. If the sample was diluted and the reading is <0.03, collect more sample, prepare at a lower dilution, and reanalyze.

## **8.0 Quality Control and Assurance**

### **8.1 Precision, Accuracy, and Contamination**

- 8.1.1 Precision and sample variability is assessed through analysis of 1 field duplicate sample per day, or per 20 field samples, whichever is more frequent. Precision of 30% RPD is considered acceptable for field duplicate analyses. Note that the rapid oxidation of ferrous iron precludes replicate analysis of a sample.
- 8.1.2 Potential contamination is assessed through the analysis of blanks. The colorimeter must be zeroed with a sample water blank prior to analysis of each sample. For diluted sample analyses, the blank should consist of the diluted sample water at the same dilution as the sample.

### **8.2 Sample Collection, Preservation, and Storage**

- 8.2.1 Sample preservation and storage is not possible since ferrous iron oxidizes rapidly. Samples should be analyzed immediately after collection.
- 8.2.2 Use a clean, unused plastic jar to transfer sample.

### **8.3 Method Performance**

The HACH DR/890 colorimeter has an estimated detection limit of 0.03 mg/l Fe<sup>+2</sup> and an analytical standard deviation (single operator) of 0.009 mg/l Fe<sup>+2</sup>.

### **8.4 Pollution Prevention**

All dilutions will be carefully recorded and tabulated for use in future site analyses to minimize the number of dilutions and analyses required.

### **8.5 Waste Management**

- 8.5.1 Unused sample must be disposed of as per the sampling and analysis plan, quality assurance project plan, and/or work plan.

- 8.5.2 The reacted AccuVac ampul should be placed in the AccuVac Vial Destruct Unit (AVDU) (a 1-L HDPE sample bottle with a large rock), and shaken to break the ampul. Replace the lid of the AVDU with the lid that has holes punctured in the top, and drain all remaining liquid from the AVDU into a container with the sample water for drumming, disposal, etc. Dispose of the glass-filled AVDU as unregulated solid waste.
- 8.5.3 Liquids drained from the test kits should be diluted five-fold with tap water for discharge to drain, or diluted with purge water and drummed with the purge water for disposal according to the sampling and analysis plan and/or work plan.

## 9.0 Records, Data Analysis, Calculations

- 9.1 Results should be reviewed prior to leaving the field to be sure field duplicates were within acceptance range and results did not exceed the instrument's range (3.00 mg/l).
- 9.2 The dilution factor is calculated as follows:
- 9.3  $DF = (\text{Volume of DIUF water} + \text{Volume of sample water}) \div \text{Volume of sample water}$
- 9.4 Concentration of ferrous iron in sample water = reading on colorimeter x DF
- 9.5 Example: If 10 mL of sample are diluted with 90 mL of DIUF water and the colorimeter reading was 2.3 mg/L, then:
- 9.6 Ferrous Iron Concentration (mg/L) = 2.3 mg/L x 10 = 23 mg/L
- 9.7 Unanticipated changes to the procedures or materials described in this POP (deviations) will be appropriately documented in the project records.
- 9.8 Records associated with the activities described in this POP will be maintained according to the document management policy for the project.

## 10.0 Attachments or References

- 10.1 United States Environmental Protection Agency. 2001. Guidance for Preparing Standard Operating Procedures (SOPs). EPA QA/G-6. EPA/240/B-01/004. USEPA Office of Environmental Information, Washington, DC. March 2001.
- 10.2 *Hach DR/890 Colorimeter Procedures Manual*, Edition 7, HACH Company, December 2005.
- 10.3 *Hach DR/820, DR/850, DR890 Portable Datalogging Colorimeter Instrument Manual*, Revision 5, HACH Company, 1997 1999.

Author	Reviewer	Revisions (Technical or Editorial)
Robert Shoemaker Senior Scientist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue (May 2012)

# Headspace Screening for Total VOCs

## Procedure 3-19

### 1.0 Purpose and Scope

- 1.1 This standard operating procedure (SOP) describes the basic techniques for using headspace analysis to screen for volatile organics in contaminated soils using a portable Photo Ionization Detector (PID) or Flame Ionization Detector (FID).
- 1.2 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review.

### 2.0 Safety

- 2.1 The health and safety considerations for the work associated with this SOP will be addressed in the project Health and Safety Plan (HASP). In the absence of a HASP, work will be conducted according to the Contract Task Order (CTO) Work Plan (WP) and/or direction from the **Site Safety Officer (SSO)**. Note that headspace screening usually requires Level D personal protection unless there is a potential for airborne exposure to site contaminants. Under circumstances where potential airborne exposure is possible respiratory protective equipment may be required based on personal air monitoring results. Upgrades to Level C will be coordinated with the Site Safety Officer (SSO) or **CTO Manager**.
- 2.2 Health and safety hazards and corresponding precautions include, but are not limited to, the following:
  - 2.2.1 Dermal contact with contaminated soil. Personnel should treat all soil as potentially contaminated and wear chemically impervious gloves. Minimize skin contact with soil by using sampling instruments such as stainless steel spades or spoons. Do not touch any exposed skin with contaminated gloves.
  - 2.2.2 Inhalation hazards. Appropriate air monitoring should be conducted to ensure that organic vapor concentrations in the breathing zone do not exceed action levels as specified in the Site-Specific HASP. When ambient temperatures are low enough to require warming samples using the vehicle heater, the vehicle's windows should be opened enough to prevent the build-up of any organic vapors. Use the PID or FID to verify the airborne concentrations in the vehicle remain below applicable action levels. Note that many volatile organic compounds (VOCs) are flammable and all precautions must be observed to eliminate any potential ignition sources.
  - 2.2.3 Shipping limitations. Follow applicable regulations when shipping FID/PID equipment. When shipping an FID by air, the hydrogen tank must be bled dry. Calibration gas canisters are considered dangerous goods and must be shipped according to IATA and DOT regulations. Consult your EHS Coordinator and check with your shipping company to determine the correct shipping procedures

### 3.0 Terms and Definitions

None.

### 4.0 Interferences

- 4.1 Regardless of which gas is used for calibration, the instrument will respond to all analytes present in the sample that can be detected by the type of lamp used in the PID.
- 4.2 Moisture will generate a positive interference in the concentration measured for a PID and is characterized by a slow increase in the reading as the measurement is made. Care must be taken to

minimize uptake of moisture to the extent possible. Refer to the manufacturers' instructions for care, cleaning, and maintenance.

- 4.3 Uptake of soil into the PID must be avoided as it will compromise instrument performance by blocking the probe, causing a positive interference, or dirtying the PID lamp. Refer to the manufacturers' instructions for care, cleaning, and maintenance.
- 4.4 The user should listen to the pitch of the sampling pump. Any changes in pitch may indicate a blockage and corrective action should be initiated.

## **5.0 Training and Qualifications**

### **5.1 Qualifications and Training**

The individual executing these procedures must have read, and be familiar with, the requirements of this SOP.

### **5.2 Responsibilities**

- 5.2.1 The CTO Manager is responsible for ensuring that the collection of headspace readings comply with this procedure. The CTO Manager is responsible for ensuring that all personnel involved in the collection of headspace readings shall have the appropriate education, experience, and training to perform their assigned tasks.
- 5.2.2 The Program Quality Manager is responsible for ensuring overall compliance with this procedure.
- 5.2.3 The Field Manager is responsible for ensuring that all headspace readings are conducted according to this procedure as well as verifying that the PID/FID is in proper operating condition prior to use and for implementing the calibration.
- 5.2.4 All Field Personnel are responsible for the implementation of this procedure.

## **6.0 Equipment and Supplies**

6.1 The following materials must be on hand in good operating condition and/or in sufficient quantity to ensure that proper field analysis procedures may be followed:

- Calibrated PID/FID instrument;
- Top-sealing "Zip-Loc" type plastic bags – or – 16 ounces of soil or "mason-" type glass jars and aluminum foil;
- Project field book and/or boring logs;
- Personal Protective Equipment (PPE) as specified in the project HASP; and
- Material Safety Data Sheets (MSDSs) for any chemicals or site-specific contaminants.

## **7.0 Procedure**

### **7.1 Preparation**

Review available project information to determine the types of organic vapors that will likely be encountered to select the right instrument. The two basic types of instruments are FIDs and PIDs.

FIDs work well with organic compounds that have relatively lightweight molecules, but may have problems detecting halogenated compounds or heavier organic compounds; FIDs can detect methane for example. Since the FID uses a flame to measure organic compounds, ensure that work is conducted in an atmosphere, which is free of combustible vapors. If ambient temperatures are below 40°F, the flame of the FID may be difficult to light.

When using a PID, select an instrument that can measure the ionization potential of the anticipated contaminants of concern. PIDs work well with a range of organic compounds and can detect some halogenated hydrocarbons; PIDs cannot detect methane. The correct ultraviolet (UV) light bulb must be selected according to the types of organic vapors that will likely be encountered. The energy of the UV light must equal or exceed the ionization potential of the organic molecules that the PID will measure. The NIOSH Pocket Guide to Chemical Hazards is one source for determining ionization potentials for different chemicals. Bulbs available for PIDs include 9.4 eV, 10.6 (or 10.2) eV, and 11.7 eV bulbs. The 10.6 eV bulb is most commonly used as it detects a fairly large range of organic molecules and does not burn out as easily as the 11.7 eV bulb. The 9.4 eV bulb is the most rugged, but detects only a limited range of compounds. Under very humid or very cold ambient conditions, the window covering the UV light may fog up, causing inaccurate readings. Ask the **SSO** about correction factors when high humidity conditions exist.

After selecting the correct instrument, calibrate the PID/FID according to the manufacturer's instructions. Record background/ambient levels of organic vapors measured on the PID/FID after calibration and make sure to subtract the background concentration (if any) from your readings. Check the PID/FID readings against the calibration standard every 20 readings or at any time when readings are suspected to be inaccurate, and recalibrate, if necessary. Be aware that, after measuring highly contaminated soil samples, the PID/FID may give artificially high readings for a time.

## 7.2 **Top-Sealing Plastic Bag**

Place a quantity of soil in a top-sealing plastic bag and seal the bag immediately. The volume of soil to be used should be determined by the **CTO Manager** or **Field Manager**. The volume of soil may vary between projects but should be consistent for all samples collected for one project. Ideally, the bag should be at least 1/10th-filled with soil and no more than half-filled with soil. Once the bag is sealed, shake the bag to distribute the soil evenly. If the soil is hard or clumpy, use your fingers to gently work the soil (through the bag) to break up the clumps. Do not use a sampling instrument or a rock hammer since this may create small holes in the plastic bag and allow organic vapors to escape. Alternatively, the sample may be broken up before it is placed in the bag. Use a permanent marker to record the following information on the outside of the bag:

- Site identification information (i.e., borehole number);
- Depth interval; and
- Time the sample was collected. For example: "SS-12, 2-4 ft, @1425".

Headspace should be allowed to develop before organic vapors are measured with a PID/FID. The amount of time required for sufficient headspace development will be determined by the project-specific sampling plan and the ambient temperature. Equilibration time should be the same for all samples to allow an accurate comparison of organic vapor levels between samples. However, adjustments to equilibration times may be necessary when there are large variations in ambient temperature from day to day. When ambient temperatures are below 32°F, headspace development should be within a heated building or vehicle. When heating samples, be sure there is adequate ventilation to prevent the build-up or organic vapors above action levels.

Following headspace development, open a small opening in the seal of the plastic bag. Insert the probe of a PID/FID and seal the bag back up around the probe as tightly as possible. Alternatively, the probe can be inserted through the bag to avoid loss of volatiles. Since PIDs and FIDs are sensitive to moisture, avoid touching the probe to the soil or any condensation that has accumulated inside of the bag. Since the PID/FID consumes organic vapors, gently agitate the soil sample during the reading to release fresh organic vapors from the sample. Erratic meter response may occur at high organic vapor concentrations or conditions of elevated headspace moisture, in which case, headspace data should be discounted. Record the highest reading on the field form or in the field notebook as described in Section 9.

### 7.3 Jar and Aluminum Foil (Alternate Method)

Half-fill a clean glass jar with the soil sample to be screened. Quickly cover the jar's opening with one to two sheets of clean aluminum foil and apply the screw cap to tightly seal the jar. Allow headspace development for at least ten minutes. Vigorously shake the jar for 15 seconds, both at the beginning and at the end of the headspace development period. Where ambient temperatures are below 32°F (0°C), headspace development should be within a heated area. When heating samples, be sure there is adequate ventilation to prevent the build-up of organic vapors above action levels.

Subsequent to headspace development, remove the jar lid and expose the foil seal. Quickly puncture the foil seal with the instrument sampling probe, to a point about one-half of the headspace depth. Exercise care to avoid uptake of water droplets or soil particulates. As an alternative, use a syringe to withdraw a headspace sample, and then inject the sample into the instrument probe or septum-fitted inlet. This method is acceptable contingent upon verification of methodology accuracy using a test gas standard. Following probe insertion through the foil seal or sample injection to probe, record the highest meter response on the field form or in the field notebook. Using foil seal/probe insertion method, maximum response should occur between two and five seconds. Erratic meter response may occur at high organic vapor concentrations or conditions of elevated headspace moisture, in which case, headspace data should be discounted.

## 8.0 Quality Control and Assurance

Quality Assurance/Quality Control (QA/QC) will include the collection of duplicate samples. In general, one duplicate will be collected per 20 samples. Organic vapor concentrations measured in the primary and duplicate samples should be similar within plus or minus 20 percent. The frequency of headspace duplicate collection will be determined by the project manager/task manager. The PID/FID instrument must be calibrated according to the manufacturer's instructions before beginning screening, and checked or recalibrated every 20 analyses or when readings are suspected to be inaccurate. Record ambient organic vapor levels in the field notebook and on the field form. Periodically check ambient organic vapor levels. If ambient levels have changed more than 20 percent, recalibrate the PID/FID. Make sure readings are not collected near a vehicle exhaust or downwind of a drill rig exhaust. If grossly contaminated soil is encountered, decontaminate sampling instruments between samples and/or change contaminated gloves to avoid cross contaminating less contaminated samples.

## 9.0 Records, Data Analysis, Calculations

9.1 All data generated (results and duplicate comparisons) will be recorded in the field notebook and/or on the field form. Any deviation from the outlined procedure will also be noted. Field conditions (ambient temperature, wind, etc.) should also be recorded in the field notebook.

9.2 Readings may be recorded in a field notebook, on a boring log, or on an appropriate form specific to the project. The form should include the following information:

- When the PID/FID was calibrated (date/time) and calibration standard used;
- Background/ambient concentrations measured after PID/FID calibration;
- Location of sample (i.e., bore-hole number);
- Depth interval of sample measured;
- Lithology of material measured; and
- PID/FID reading and units of measure.

9.3 Note that if PID/FID measurements are recorded on a boring log, it is not necessary to duplicate information in the column where the PID/FID readings are recorded (e.g., borehole number, depth interval, lithology type).

9.4 All documentation will be stored in the project files and retained following completion of the project.

## 10.0 Attachments or References

SOP 3-20 Operation and Calibration of a Photoionization Detector

Author	Reviewer	Revisions (Technical or Editorial)
Robert Shoemaker Senior Scientist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue (May 2012)

# Operation and Calibration of a Photoionization Detector

## Procedure 3-20

### 1.0 Purpose and Scope

#### 1.1 Purpose and Applicability

- 1.1.1 This standard operating procedure (SOP) describes the procedures that will be followed by field staff for operation and calibration of a photoionization detector (PID). The PID is primarily used by AECOM personnel for safety and survey monitoring of ambient air, determining the presence of volatiles in soil and water, and detecting leakage of volatiles.
- 1.1.2 PIDs routinely used by field personnel include the Photovac Microtip, Thermoelectron 580EZ, and MiniRAE 2000. Personnel responsible for using the PID should first read and thoroughly familiarize themselves with the instrument instruction manual.

#### 1.2 Principle of Operation

- 1.2.1 The PID is a non-specific vapor/gas detector. The unit generally consists of a hand-held probe that houses a PID, consisting of an ultraviolet (UV) lamp, two electrodes, and a small fan which pulls ambient air into the probe inlet tube. The probe is connected to a readout/control box that consists of electronic control circuits, a readout display, and the system battery. Units are available with UV lamps having an energy from 9.5 electron volts (eV) to 11.7 eV.
- 1.2.2 The PID analyzer measures the concentration of trace gas present in the atmosphere by photoionization. Photoionization occurs when an atom or molecule absorbs a photon of sufficient energy to release an electron and become a positive ion. This will occur when the ionization potential of the molecule (in electron volts (eV)) is less than the energy of the photon. The source of photons is an ultraviolet lamp in the probe unit. Lamps are available with energies ranging from 9.5 eV to 11.7 eV. All organic and inorganic vapor/gas compounds having ionization potentials lower than the energy output of the UV lamp are ionized and the resulting potentiometric change is seen as a positive reading on the unit. The reading is proportional to the concentration of organics and/or inorganics in the vapor.
- 1.2.3 Sample gases enter the probe through the inlet tube and enter the ion chamber where they are exposed to the photons emanating from the UV lamp. Ionization occurs for those molecules having ionization potentials near to or less than that of the lamp. A positive-biased polarizing electrode causes these positive ions to travel to a collector electrode in the chamber. Thus the ions create an electrical current which is amplified and displayed on the meter. This current is proportional to the concentration of trace gas present in the ion chamber and to the sensitivity of that gas to photoionization.
- 1.2.4 In service, the analyzer is first calibrated with a gas of known composition equal to, close to, or representative of that to be measured. Gases with ionization potentials near to or less than the energy of the lamp will be ionized. These gases will thus be detected and measured by the analyzer. Gases with ionization potentials greater than the energy of the lamp will not be detected. The ionization potentials of the major components of air, i.e., oxygen, nitrogen, and carbon dioxide, range from about 12.0 eV to 15.6 eV and are not ionized by any of the lamps available. Gases with ionization potentials near to or slightly higher than the lamp are partially ionized, with low sensitivity.

#### 1.3 Specifications

- 1.3.1 Refer to the manufacturer's instructions for the technical specifications of the instrument being used. The operating concentration range is typically 0.1 to 2,000 ppm isobutylene equivalent.

## **2.0 Safety**

- 2.1 The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, will be addressed in the project Health and Safety Plan (HASP). In the absence of a HASP, work will be conducted according to the Contract Task Order (CTO) Work Plan (WP) and/or direction from the **Site Safety Officer (SSO)**.
- 2.2 Only PIDs stamped Division I Class I may be used in explosive atmospheres. Refer to the project HASP for instructions pertaining to instrument use in explosive atmospheres.

## **3.0 Terms and Definitions**

None.

## **4.0 Interferences**

- 4.1 Regardless of which gas is used for calibration, the instrument will respond to all analytes present in the sample that can be detected by the type of lamp used in the PID.
- 4.2 Moisture will generate a positive interference in the concentration measured for a PID and is characterized by a slow increase in the reading as the measurement is made. Care must be taken to minimize uptake of moisture to the extent possible. Refer to the manufacturers' instructions for care, cleaning, and maintenance.
- 4.3 Uptake of soil into the PID must be avoided as it will compromise instrument performance by blocking the probe, causing a positive interference, or dirtying the PID lamp. Refer to the manufacturers' instructions for care, cleaning, and maintenance.
- 4.4 The user should listen to the pitch of the sampling pump. Any changes in pitch may indicate a blockage and corrective action should be initiated.

## **5.0 Training and Qualifications**

### **5.1 Qualifications and Training**

The individual executing these procedures must have read, and be familiar with, the requirements of this SOP.

### **5.2 Responsibilities**

- 5.2.1 The CTO Manager is responsible for ensuring that the operation and calibration activities comply with this procedure. The CTO Manager is responsible for ensuring that all personnel involved in the operation and calibration shall have the appropriate education, experience, and training to perform their assigned tasks.
- 5.2.2 The Program Quality Manager is responsible for ensuring overall compliance with this procedure.
- 5.2.3 The Field Manager is responsible for ensuring that all operation and calibration activities are conducted according to this procedure.
- 5.2.4 All Field Personnel are responsible for the implementation of this procedure.

## **6.0 Equipment and Supplies**

- Calibration Gas: Compressed gas cylinder of isobutylene in air or similar stable gas mixture of known concentration. The selected gas should have an ionization potential similar to that of the vapors to be monitored, if known. The concentration should be at 50-75% of the range in which the instrument is to be calibrated;

- Regulator for calibration gas cylinder;
- Approximately 6 inches of Teflon® tubing;
- Tedlar bag (optional);
- Commercially-supplied zero grade air (optional);
- "Magic Marker" or "Sharpie" or other waterproof marker;
- Battery charger;
- Moisture traps;
- Spare lamps;
- Manufacturer's instructions; and
- Field data sheets or logbook/pen.

## **7.0 Procedure**

### **7.1 Preliminary Steps**

- 7.1.1 Preliminary steps (battery charging, check-out, calibration, maintenance) should be conducted in a controlled or non-hazardous environment.

### **7.2 Calibration**

- 7.2.1 The PID must be calibrated in order to display concentrations in units equivalent to ppm. First a supply of zero air (ambient air or from a supplied source), containing no ionizable gases or vapors is used to set the zero point. A span gas, containing a known concentration of a photoionizable gas or vapor, is then used to set the sensitivity.
- 7.2.2 Calibrate the instrument according to the manufacturer's instructions. Record the instrument model and identification number, the initial and adjusted meter readings, the calibration gas composition and concentration, and the date and the time in the field records.
- 7.2.3 If the calibration cannot be achieved or if the span setting resulting from calibration is 0.0, then the lamp must be cleaned (Section 7.4).

### **7.3 Operation**

- 7.3.1 Turn on the unit and allow it to warm up (minimum of 5 minutes). Check to see if the intake fan is functioning; if so, the probe will vibrate slightly and a distinct sound will be audible when holding the probe casing next to the ear. Also, verify on the readout display that the UV lamp is lit.
- 7.3.2 Calibrate the instrument as described in Section 7.2, following the manufacturer's instructions. Record the calibration information in the field records.
- 7.3.3 The instrument is now operational. Readings should be recorded in the field records.
- 7.3.4 When the PID is not being used or between monitoring intervals, the unit may be switched off to conserve battery power and UV lamp life; however, a "bump" test should be performed each time the unit is turned on and prior to taking additional measurements. To perform a bump test, connect the outlet tubing from a Tedlar bag containing a small amount of span gas to the inlet tubing on the unit and record the reading. If the reading is not within the tolerance specified in the project plan, the unit must be recalibrated.
- 7.3.5 At the end of each day, recheck the calibration. The check will follow the same procedures as the initial calibration (Section 7.2) except that no adjustment will be made to the instrument. Record the information in the field records.

- 7.3.6 Recharge the battery after each use (Section 7.4).
- 7.3.7 When transporting, ensure that the instrument is packed in its stored condition in order to prevent damage.

#### 7.4 **Routine Maintenance**

- 7.4.1 Routine maintenance associated with the use of the PID includes charging the battery, cleaning the lamp window, replacing the detector UV lamp, replacing the inlet filter, and replacing the sample pump. Refer to the manufacturer's instructions for procedures and frequency.
- 7.4.2 All routine maintenance should be performed in a non-hazardous environment.

#### 7.5 **Troubleshooting Tips**

- 7.5.1 One convenient method for periodically confirming instrument response is to hold the sensor probe next to the tip of a magic marker. A significant reading should readily be observed.
- 7.5.2 Air currents or drafts in the vicinity of the probe tip may cause fluctuations in readings.
- 7.5.3 A fogged or dirty lamp, due to operation in a humid or dusty environment, may cause erratic or fluctuating readings. The PID should never be operated without the moisture trap in place.
- 7.5.4 Moving the instrument from a cool or air-conditioned area to a warmer area may cause moisture to condense on the UV lamp and produce unstable readings.
- 7.5.5 A zero reading on the meter should not necessarily be interpreted as an absence of air contaminants. The detection capabilities of the PID are limited to those compounds that will be ionized by the particular probe used.
- 7.5.6 Many volatile compounds have a low odor threshold. A lack of meter response in the presence of odors does not necessarily indicate instrument failure.
- 7.5.7 When high vapor concentrations enter the ionization chamber in the PID the unit can become saturated or "flooded". Remove the unit to a fresh air environment to allow the vapors to be completely ionized and purged from the unit.

## 8.0 **Quality Control and Assurance**

- 8.1 The end use of the data will determine the quality assurance requirements that are necessary to produce data of acceptable quality. These quality assurance requirements will be defined in the site-specific workplan or Sampling and Analysis Plan (SAP), hereafter referred to as the project plan.
- 8.2 Calibration of the PID will be conducted at the frequency specified in the project plan. In the absence of project-specific guidance, calibration will be performed at the beginning of each day of sampling and will be checked at the end of the sampling day or whenever instrument operation is suspect. The PID will sample a calibration gas of known concentration. The instrument must agree with the calibration gas within  $\pm 10\%$ . If the instrument responds outside this tolerance, it must be recalibrated.
- 8.3 Checks of the instrument response (Section 7.5) should be conducted periodically and documented in the field records.

## 9.0 **Records, Data Analysis, Calculations**

Safety and survey monitoring with the PID will be documented in a bound field logbook, or on standardized forms, and retained in the project files. The following information is to be recorded:

- Project name and number;
- Instrument manufacturer, model, and identification number;

- Operator's signature;
- Date and time of operation;
- Calibration gas used;
- Calibration check at beginning and end of day (meter readings before adjustment);
- Span setting after calibration adjustment;
- Meter readings (monitoring data obtained);
- Instances of erratic or questionable meter readings and corrective actions taken; and
- Instrument checks and response verifications – e.g., battery check, magic marker response (Section 7.5) or similar test.

## 10.0 Attachments or References

United States Environmental Protection Agency. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM). USEPA, Region 4, SESD, Enforcement and Investigations Branch, Athens, GA. November 2001.

Author	Reviewer	Revisions (Technical or Editorial)
Robert Shoemaker Senior Scientist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue (May 2012)

# Surface and Subsurface Soil Sampling Procedures

## Procedure 3-21

### 1.0 Purpose and Scope

- 1.1 This standard operating procedure (SOP) describes the procedures for soil sampling. The procedure includes surface and subsurface sampling by various methods using hand auguring, test pit, direct-push, and split-spoon equipment.
- 1.2 The procedure includes soil sampling for volatile organic compounds (VOCs). For project specific information (e.g. sampling depths, equipment to be used, and frequency of sampling), refer to the Sampling and Analysis Plan (SAP), which takes precedence over these procedures. Surface soil sampling, typically considered to be up to two feet below ground surface by EPA standards, is typically accomplished using hand tools such as shovels or hand augers. Test pit samples are considered subsurface samples, although normally collected via hand tools similar to surface soil sampling or by excavation machinery. Direct-push and split-spoon sampling offer the benefit of collecting soil samples from a discrete or isolated subsurface interval, without the need of extracting excess material above the target depth. These methods dramatically reduce time and cost associated with disposal of material from soil cuttings when compared to test pit sampling. In addition, direct-push and split-spoon sampling methods can obtain samples at targeted intervals greater than 15 feet in depth, allowing for discrete depth soil sampling while speeding up the sampling process. Direct-push methods work best in medium to fine-grained cohesive materials such as medium to fine sands, silts, and silty clay soils. Split-spoon sampling works well in all types of soil, but is somewhat slower than direct-push methods. Samples are composited so that each sample contains a homogenized representative portion of the sample interval. Due to potential loss of analytes, samples for volatile analysis are not composited. Samples for chemical analysis can be collected by any of the above-mentioned sampling methods, as disturbed soil samples. Undisturbed samples are collected, sealed, and sent directly to the laboratory for analysis. For undisturbed samples, the samples are not homogenized.

### 2.0 Safety

- 2.1 The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, will be addressed in the project Health and Safety Plan (HASP). In the absence of a HASP, work will be conducted according to the Contract Task Order (CTO) Work Plan (WP) and/or direction from the **Site Safety Officer (SSO)**.
- 2.2 Before soil sampling commences, appropriate entities (e.g. DigSafe, local public works departments, company facilities) must be contacted to assure the anticipated soil sampling locations are marked for utilities, including electrical, telecommunications, water, sewer, and gas.

### 3.0 Terms and Definitions

None.

### 4.0 Interferences

- 4.1 Low recovery of soil from sampling equipment will prevent an adequate representation of the soil profile and sufficient amount of soil sample. If low recovery is a problem, the hole may be offset and re-advanced, terminated, or continued using a larger diameter sampler.

- 4.2 Asphalt in soil samples can cause false positive results for hydrocarbons. To ensure samples are free of asphalt, do not collect samples that may contain asphalt. If the collection of samples potentially containing asphalt is unavoidable, note the sampling depths at which the presence of asphalt are suspected.
- 4.3 Instrumentation interferences addressed in SOPs for Calibration of the Photoionization Detector (PID), Headspace Screening for Total Volatile Organics, and Equipment Decontamination must also be considered.
- 4.4 Cross contamination from sampling equipment must be prevented by using sampling equipment constructed of stainless steel that is adequately decontaminated between samples.

## **5.0 Training and Qualifications**

### **5.1 Qualifications and Training**

The individual executing these procedures must have read, and be familiar with, the requirements of this SOP.

### **5.2 Responsibilities**

- 5.2.1 The CTO Manager is responsible for ensuring that soil sampling activities comply with this procedure. The CTO Manager is responsible for ensuring that all personnel involved in soil sampling shall have the appropriate education, experience, and training to perform their assigned tasks.
- 5.2.2 The Program Quality Manager is responsible for ensuring overall compliance with this procedure.
- 5.2.3 The Field Manager is responsible for ensuring that all soil sampling activities are conducted according to this procedure.
- 5.2.4 All Field Personnel are responsible for the implementation of this procedure.

## **6.0 Equipment and Supplies**

The depth at which samples will be collected and the anticipated method of sample collection (direct-push, split-spoon, hand auger, shovel, or test pits) will be presented in the SAP. The following details equipment typically needed for soil sampling, based on the various methods. See the SAP for specific detail of equipment and supply needs.

- 6.1 Depending on the nature of suspected contamination, field screening instrumentation may be used for direct sampling. Appropriate instrumentation and calibration standards should be available. If volatile organic contaminants are suspected and a PID will be used, refer to the equipment and instrumentation listed in SOP 3-20 Operation and Calibration of a Photoionization Detector. Equipment in this SOP includes but is not limited to:
- PID/FID;
  - Calibration gas; and
  - Tedlar® gas bags (for calibration).
- 6.2 If field screening methods include jar headspace screening for volatile organics, refer to the equipment and procedure in SOP 3-19 Headspace Screening for Total VOCs. Equipment in this SOP includes but is not limited to:
- Clean soil ("drillers jars") jars; and
  - Aluminium foil.

- 6.3 Appropriate decontamination procedures must be followed for sampling equipment. Refer to SOP 3-06 Equipment Decontamination. Equipment in this SOP includes but is not limited to:
- Phosphate-free detergent;
  - Isopropyl Alcohol;
  - Tap water;
  - Deionized Ultra-Filtered (DIUF) Water;
  - Plastic buckets or washbasins;
  - Brushes; and
  - Polyethylene sheeting.
- 6.4 The following general equipment is needed for all soil sampling, regardless of method:
- Stainless steel bowls;
  - Stainless steel trowels;
  - Appropriate sample containers for laboratory analysis;
  - Personal Protective Equipment (PPE);
  - Logbook;
  - Cooler and ice for preservation; and
  - Stakes and flagging to document sampling location.
- 6.5 The following additional equipment is needed for volatile organic sampling:
- Electronic pan scale and weights for calibration; and
  - Syringes or other discrete soil core samplers.
- 6.6 The following additional equipment may be needed for surface and test pit soil sampling:
- Hand Auger
- 6.7 The following additional equipment may be needed for soil sampling from direct push and/or split-spoon equipment:
- Tape measure or folding carpenter's rule for recording the length of soil recovered.

Note: All subsurface drilling equipment will be provided and maintained by the subcontractor.

## **7.0 Procedure**

### **7.1 General Soil Sampling Procedure for All Soil Sampling Methods**

- 7.1.1 Record the weather conditions and other relevant on-site conditions.
- 7.1.2 Select the soil sampling location, clear vegetation if necessary, and record the sampling location identification number and pertinent location details.
- 7.1.3 Verify that the sampling equipment is properly decontaminated, in working order, and situated at the intended sampling location.

- 7.1.4 Place polyethylene sheeting on the ground and assemble all necessary sampling equipment on top of it. Cover surfaces onto which soils or sampling equipment will be placed (i.e. tables with polyethylene sheeting).
- 7.1.5 Follow the appropriate procedures listed below for either surface, split-spoon, direct push, or test pit sample collection (7.2, 7.3, 7.4, and 7.5 respectively).
- 7.1.6 Collect soil samples according to procedures listed in Section 7.6 depending on project specific analyses.
- 7.1.7 Record date/time, sample ID, and sample descriptions in the field logbook or field form. A sketch or description of the location may also be recorded so the sample location can be re-constructed, especially if the location will not be recorded using global positioning satellite (GPS) equipment.
- 7.1.8 Immediately label the sample containers and place them on ice, if required for preservation. Complete the chain-of-custody form(s) as soon as possible.
- 7.1.9 Dispose of all excess excavated soil in accordance with the SAP.
- 7.1.10 If required, mark the sample location with a clearly labelled wooden stake or pin flag. If the location is on a paved surface, the location may be marked with spray paint.
- 7.1.11 Decontaminate the sampling equipment according to SOP 3-06 Equipment Decontamination.

## 7.2 **Surface Sampling**

- 7.2.1 The criteria used for selecting surface soil locations for sampling may include the following:
- Visual observations (soil staining, fill materials);
  - Other relevant soil characteristics;
  - Site features;
  - Screening results;
  - Predetermined sampling approach (i.e. grid or random); and
  - Sampling objectives as provided in the SAP.
- 7.2.2 The following procedures are to be used to collect surface soil samples. Surface soils are considered to be soils that are up to two feet below ground surface, though state regulations and project objectives may define surface soils differently; therefore, the SAP should be consulted for direction on the depth from which to collect the surface soil samples. Sampling and other pertinent data and information will be recorded in the field logbook and/or on field forms. Photographs may be taken as needed or as specified in the SAP.
1. Gently scrape any vegetative covering until soil is exposed. Completely remove any pavement.
  2. Remove soil from the exposed sampling area with a trowel, hand auger, or shovel. Put soils within the sampling interval in a stainless steel bowl for homogenizing. Monitor the breathing zone and sampling area as required in the HASP.
  3. For VOC analyses, collect representative soil samples directly from the recently-exposed soil using a syringe or other soil coring device (e.g., TerraCore®, EnCore®). Follow procedures in Section 7.6.1 for VOC sampling.
  4. Collect sufficient soil to fill all remaining sample jars into a stainless steel bowl. Homogenize the soil samples to obtain a uniform soil composition which is representative of the total soil sample collected according to the following procedure:
    - a) Remove all rocks and non-soil objects using a stainless steel spoon or scoop.

- b) Form a cone shaped mound with the sample material, then flatten the cone and split the sample into quarters.
- c) Use the stainless steel spoon/scoop to mix the quarter samples that are opposite.
- d) After mixing the opposite quarters, reform the cone shaped mound.
- e) Repeat this procedure a minimum of five (5) times, removing any non-soil objects and breaking apart any clumps.

### 7.3 **Split-Spoon Sampling**

- 7.3.1 At each boring location, the frequency and depth of split-spoon samples will be determined from the SAP. Split-spoon samples may be collected continuously, intermittently, or from predetermined depths.
- 7.3.2 Split-spoon samplers shall be driven into undisturbed soil by driving the spoon ahead of the drill augers/casing. In cohesive soils, or soils where the borehole remains open (does not collapse), two split-spoon samples may be taken prior to advancing the augers/casing.
- 7.3.3 After split-spoons are retrieved, open the split-spoon and measure the recovery of soil. If a PID will be used for screening, immediately scan the recovered sample for VOCs using the PID. Scan the recovered soil boring by making a hole in the soil with a decontaminated trowel and placing the PID inlet very close to the hole. Be very careful not to get soil on the tip of the PID. Take PID readings every 6 inches along the split-spoon and/or in any areas of stained or disturbed soil. Record the highest PID reading and the depth at which it was observed along with all other pertinent observations. If required in the SAP, VOC and headspace samples should be collected (see Section 7.6.1) prior to logging the sample.
- 7.3.4 If headspace screening for VOCs is required in the SAP, collect a soil sample (as defined in the SAP) and perform headspace screening according to SOP 3-19 Headspace Screening for Total VOCs.
- 7.3.5 Soils collected using the split-spoon sampler will be logged by the field representative using the procedure required in the SAP.
- 7.3.6 Collect the remainder of the sample volume required into a stainless steel bowl. Homogenize the soil so the material is uniform in composition and representative of the total soil sample collected. Follow homogenizing techniques as described in Section 7.2.
- 7.3.7 The SAP may specify that intervals to be sent to the laboratory be determined by visual observation and/or highest PID screening or headspace results, which can only be determined once the boring is complete. In this instance, a VOC sample should be collected at each interval. The remainder of the soil from that interval will be set aside in a clearly labelled stainless steel bowl covered with aluminium foil. Once the boring has been completed and the sample interval has been determined, the remainder of the soil can be homogenized according to Section 7.2 and submitted for laboratory analysis.
- 7.3.8 Once a boring is complete and all required samples have been collected, the boring must be completed as specified in the SAP (e.g., completed as a monitoring well, backfilled with bentonite, etc).

### 7.4 **Direct Push Sampling**

At each boring location, the frequency of direct-push samples will be determined from the SAP. Typically, samples with direct-push equipment are collected in 4 foot (ft) intervals, but smaller (e.g., 2 ft) and larger (e.g., 5 ft) intervals are also possible.

1. Sample using Macro-Core samplers with acetate liners to obtain discrete soil samples at the depths specified in the SAP.
2. Cut open the acetate liner. If required in the SAP, immediately scan the recovered soil boring for VOCs using a PID by making a hole in the soil with a decontaminated trowel and placing the PID inlet very close to the hole. Be very careful not to get soil on the tip of the PID. Take PID readings every 6 inches along the split-spoon and/or in any areas of stained or disturbed soil. Record the

highest PID reading and the depth at which it was observed along with all other pertinent observations. VOC and headspace samples, if required in the SAP should be collected (see Section 7.6.1) prior to logging the sample.

3. If required in the SAP, collect a soil sample (as defined in the SAP) and perform headspace screening according to SOP 3-19 Headspace Screening for Total VOCs.
4. Soils collected using the direct-push sampler will be logged by the by the field representative using the procedure required in the SAP.
5. Collect the remainder of the sample into a stainless steel bowl. Homogenize the soil collected so that the material is uniform in composition and representative of the total soil sample collected. Follow homogenizing techniques as described in Section 7.2.
6. Once a boring is complete and all required samples have been collected, the boring must be completed as specified in the SAP (e.g., completed as a monitoring well, backfilled with bentonite, etc).

## 7.5 Test Pit Sampling

7.5.1 Excavate the test pit to the desired depth.

7.5.2 Using the excavator bucket, collect soil samples as specified in the SAP. Collect a sample and perform screening analyses as required by the SAP. If VOCs contamination is suspected, perform headspace screening according to SOP 3-19 Headspace Screening for Total VOCs.

7.5.3 Collect the sample from center of the bucket to avoid potential contamination from the bucket.

7.5.4 VOC samples should also be collected from an undisturbed section soil in the excavator bucket. The top layer of exposed soil should be scraped away just prior to collecting the VOC samples.

7.5.5 Collect the remainder of the sample volume required into a stainless steel bowl. Homogenize the soil so the material is uniform in composition and representative of the total soil sample collected. Follow homogenizing techniques as described in Section 7.2.

7.5.6 Dispose of all excavated soil according to the SAP.

## 7.6 Sample Collection Methods

### 7.6.1 Volatile Organics Sampling

For soils collected for analyses of volatile organics, including Volatile Petroleum Hydrocarbons (VPH) or other purgable compounds, a closed system is maintained. From collection through analysis, the sample bottles are not opened. The bottle kit for a routine field sample for these analyses will typically include three 40-mL VOA vials and one soil jar. Two 40-mL VOA vials will contain either 5 mL reagent water or 5 mL sodium bisulfate and magnetic stir bars (i.e., low level vials). The third VOA vial will contain 15 mL methanol with no magnetic stir bar (i.e., high level vial). These vials are usually provided by the laboratory and are pre-weighed, with the tare weight recorded on the affixed sample label. No additional sample labels are affixed to the VOA vials, as addition of a label would alter the vial weight. All information is recorded directly on the sample label using an indelible marker. The soil jar is provided for percent solids determination. For VOC or VPH analyses, samples are collected prior to sample homogenization. Collect the VOC sample in accordance with the procedure described below.

1. Determine the soil volume necessary for the required sample weight, typically 5 grams:
  - a) Prepare a 5 mL sampling corer (e.g., Terra Core®) or cut-off plastic syringe.
  - b) Tare the sampler by placing it on the scale, and zeroing the scale.
  - c) Draw back the plunger to the 5 gram mark or 5mL (5cc) mark on cut-off syringe, and insert the open end of the sampler into an undisturbed area of soil with a twisting motion, filling the

sampler with soil. Note the location of the plunger with respect to the milliliter (cc) or other graduation printed on the sampler.

- d) Weigh the filled sampler, and remove or add soil until the desired weight is obtained. Note the location of the plunger which corresponds to this weight. Do not use this sample for laboratory analysis.
2. Once the required soil volume has been determined, pull the plunger back to this mark and hold it there while filling the syringe for each sample.
3. Collect 5 grams of soil using the cut-off syringe or Terra Core® sample device. Extrude the 5-grams of soil into one of the low level 40-mL VOA vials. Quickly wipe any soil from the threads of the VOA vial with a clean Kimwipe® and immediately close the vial. It is imperative that the threads be free from soil or other debris prior to replacing the cap on the vial in order to maintain the closed system necessary for the analysis.
4. Gently swirl the vial so that all of the soil is fully wetted with the preservative.
5. Fill the other low level 40 mL VOA vial in this manner.
6. Repeat the process for the high level VOA vials, only for the high level VOA vial three 5 gram aliquots (i.e., 15 grams total) should be extruded into the high level VOA vial.

NOTE: Depending on the laboratory, some high level VOA vials only contain 5 mL or 10 mL of methanol. If this is the case, either 5 grams total or 10 grams total, respectively, should be extruded into the high level VOA vial. In other words, the mass of soil in grams should be identical to the volume of methanol in mL (i.e., 1:1 ratio of soil to methanol).

7. Collect any additional QC sample collected (e.g., field duplicate, MS, and MSD) in the same manner as above.
8. Fill the 4-oz glass jar with soil from the same area for percent moisture determination.

#### 7.6.2 Soil Sampling Method (All other analyses except VOC/VPH)

When all the required soil for a sampling location has been obtained, the soil can be homogenized as described in section 7.2. Collect sufficient volume to fill all of the remaining sample containers at least  $\frac{3}{4}$  full for all other analyses. Homogenize the soil in a decontaminated stainless steel bowl, removing rocks, sticks, or other non-soil objects and breaking apart any lumps of soil prior to filling the remaining sample containers.

NOTE: Soil samples must contain greater than 30% solids for the data to be considered valid.

## 8.0 Quality Control and Assurance

- 8.1 Sampling personnel should follow specific quality assurance guidelines as outlined in the SAP. Proper quality assurance requirements should be provided which will allow for collection of representative samples from representative sampling points. Quality assurance requirements outlined in the SAP typically suggest the collection of a sufficient quantity of field duplicate, field blank, and other samples.
- 8.2 Quality control requirements are dependent on project-specific sampling objectives. The SAP will provide requirements for equipment decontamination (frequency and materials), sample preservation and holding times, sample container types, sample packaging and shipment, as well as requirements for the collection of various quality assurance samples such as trip blanks, field blanks, equipment blanks, and field duplicate samples.

## 9.0 Records, Data Analysis, Calculations

All data and information (e.g., sample collection method used) must be documented on field data sheets, boring logs, or within site logbooks with permanent ink. Data recorded may include the following:

- Weather conditions;
- Arrival and departure time of persons on site;
- Instrument type, lamp (PID), make, model and serial number;
- Calibration gas used;
- Date, time and results of instrument calibration and calibration checks;
- Sampling date and time;
- Sampling location;
- Samples collected;
- Sampling depth and soil type;
- Deviations from the procedure as written; and
- Readings obtained.

## 10.0 Attachments or References

SOP 3-06, *Equipment Decontamination*

SOP 3-19, *Headspace Screening for Total VOCs*

SOP 3-20, *Operation and Calibration of a Photoionization Detector*

Author	Reviewer	Revisions (Technical or Editorial)
Robert Shoemaker Senior Scientist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue (May 2012)

# Sediment Sampling

## Procedure 3-22

### 1.0 Purpose and Scope

1.1 Sediment contamination is a widespread environmental problem that can pose a threat to a variety of aquatic ecosystems. Sediment functions as a reservoir for common contaminants such as pesticides, herbicides, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), and metals such as lead, mercury, and arsenic. Contaminated sediments represent a hazard to aquatic life through direct toxicity, as well as to aquatic life, wildlife, and human health through bioaccumulation. Accurate assessment of environmental hazards posed by sediment contamination depends in large part on the accuracy and representativeness of sediment collection and analyses (U.S. EPA, 2001).

1.2 Selection and proper use of sediment sampling equipment is essential to the collection of accurate, representative sediment data that will meet the project Data Quality Objectives (DQOs). Most sediment collection devices are designed to isolate and consistently retrieve a specified volume and surface area of sediment, from a required depth below the sediment surface, with minimal disruption of the integrity of the sample and no contamination of the sample. Maintaining the integrity of the collected sediment, for the purposes of the measurements intended, is a primary concern in most studies because disruption of the sediment's structure could change its physiochemical and biological characteristics, thereby influencing the bioavailability of contaminants and the potential toxicity of the sediment (U.S. EPA, 2001).

When selecting the type of sediment sampling equipment to be used for an event, the project DQOs as well as the sediment characteristics should be considered. Related to the project DQOs is the desired depth of sediment sampling. For monitoring and assessment studies where historical contamination is not the focus, the upper 10 to 15 centimeters (cm) is typically the horizon of interest, as this is the horizon that generally contains the most recently deposited sediments and most epifaunal and infaunal organisms (U.S. EPA, 2001). The 0-6 inches interval for sediments with less than two feet of water is also used for human health risk assessment purposes. Sampling of these horizons can usually be done with grab samplers. However, if sediment contamination is being related to organism exposures (e.g. benthic macroinvertebrates and/or fish), or if characterization of deeper sediments is important for comparison of recent surficial versus historical contamination, then more precise sampling of sediment depths might be needed, and a hand corer may be more suitable (U.S. EPA, 2001).

1.3 This standard operating procedure (SOP) describes the procedure for the collection of sediment samples using the Petite Ponar<sup>®</sup> Grab Sampler, Ekman Bottom Grab Sampler, Wildco<sup>®</sup> Hand Corer, and Power Grab Sampler (or similar sampling devices). The applicability of each of the sediment samplers is described below.

The Petite Ponar<sup>®</sup> Grab Sampler is used to collect sediment samples in:

- Firm, hard bottoms such as sand, gravel, consolidated marl, and clay
- Mixtures of sand, stones, and coarse debris
- Soft or mucky sediments

The Ekman Bottom Grab Sampler is used to collect sediment samples in:

- Soft, finely divided littoral bottoms free from vegetation and intermixtures of sand, stones, and other coarse debris
- Bottoms composed of finely divided mulch, mud, muck, or submerged fine peaty materials

The Wildco<sup>®</sup> Hand Corer is used:

- To collect sediment samples for geological characterizations and dating
- To collect sediment samples for programs where it is important to maintain an oxygen-free environment for the sample during collection
- To collect sediment samples from a deeper depth than a grab sampler, and to characterize the depth of contamination at a site
- To investigate the historical input of contaminants to aquatic systems
- To collect sediment samples in semi-consolidated and soft sediment

The Power Grab Sampler (Pneumatic) is used to collect large volume sediment samples in:

- Firm, hard bottoms such as sand, gravel, consolidated marl, and clay
- Mixtures of sand, stones, and coarse debris
- Soft or mucky sediments

Pictures and exploded diagrams of the Petite Ponar Grab Sampler, Ekman Bottom Grab Sampler, Wildco<sup>®</sup> Hand Corer, and Power Grab Sampler are presented in Figures 1, 2, 3, and 4 respectively.

- 1.4 This procedure is the Program-approved professional guidance for work performed by Resolution Consultants under the Comprehensive Long-Term Environmental Action Navy (CLEAN) contract (Contract Number N62470-11-D-8013).
- 1.5 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review.

## **2.0 Safety**

- 2.1 Depending upon the site-specific contaminants, various protective programs must be implemented prior to sampling the first location. All **field sampling personnel** responsible for sampling activities must review the project-specific health and safety plan (HASP) paying particular attention to the control measures planned for the sampling tasks. Conduct preliminary area monitoring of sample locations to determine the potential hazard to field sampling personnel. If significant contamination is observed, minimize contact with potential contaminants in both the vapor phase and solid or liquid matrix through the use of respirators and disposable clothing.
- 2.2 Observe standard health and safety practices according to the project-specific HASP. Suggested minimum protection during sediment sampling activities includes inner disposable vinyl gloves, outer chemical-protective nitrile gloves, and waders (if applicable). Refer to the project-specific HASP for the required PPE.
- 2.3 Handle all sediments removed from potentially contaminated locations in accordance with the IDW handling procedures in SOP 3-05, IDW Management.
- 2.4 Depending upon the type of contaminant expected or determined in previous sampling efforts, employ the following safe work practices:
- If sampling from a boat, all sampling personnel should wear personal flotation devices (PFDs) when in the boat, and should follow all health and safety protocols for working in a boat presented in the project-specific HASP.
  - Lifting the samplers into the boat, dumping its contents, and washing those contents may require leaning over the side of the boat. Care should be taken to keep the boat in proper balance at all times during sampling.

- Severe injury to fingers or hands can be caused by movement of the lever arms of the Petite Ponar® Grab Sampler. Do not handle or move the Petite Ponar® Grab Sampler unless the safety pin is fully inserted in the locking holes.
- Severe injury to fingers or hands can be caused by the closing of the sharpened scoops of the Ekman Bottom Grab Sampler. Handle the Ekman Bottom Grab Sampler very carefully when the springs are set and the cable loops are hooked (armed) on the Twin-Pin™ pins on the release mechanism. Do not “arm” the Ekman Bottom Grab Sampler until the sampler is ready to be used. The Ekman Bottom Grab Sampler spring-loaded jaws are potentially dangerous; extreme care must be exercised when setting the jaws. To prevent injury (and to extend the life of the springs), unhook both springs from their scoop buttons after each sampling session.

### **3.0 Terms and Definitions**

None.

### **4.0 Training and Qualifications**

- 4.1 The **Contract Task Order (CTO) Manager** is responsible for ensuring that sediment sampling activities comply with this procedure. The **CTO Manager** is responsible for ensuring that all field sampling personnel involved in sediment sampling shall have the appropriate education, experience, and training to perform their assigned tasks.
- 4.2 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.
- 4.3 The **Field Manager** is responsible for ensuring that all field sampling personnel follow these procedures.
- 4.4 **Field sampling personnel** are responsible for the implementation of this procedure.
- 4.5 The field sampler and/or task manager is responsible for directly supervising the sediment sampling procedures to ensure that they are conducted according to this procedure, and for recording all pertinent data collected during sampling.

### **5.0 Equipment and Supplies**

- 5.1 For sediment sampling using all types of equipment, the following supplies are required:
- Stainless steel bowls
  - Stainless steel hand trowels, spoons, spatulas, and scoops
  - Munsell Color Chart
  - Particle size chart
- 5.2 Petite Ponar® Grab Sampler
- 3/16” braided polyester line
  - Auxiliary weights
- 5.3 Ekman Bottom Grab Sampler
- 11 oz split messenger
  - 3/16” braided polyester line
  - Extension Handle
  - Auxiliary weights
- 5.4 Power Grab Sampler
- Approximately 5/16” braided wire rope
  - Pneumatic actuator switch

- Boat mounted davit/ winch (with approximate 300 lb capacity)
- Sampler frame/ stand
- Air compressor

#### 5.5 Wildco® Hand Corer

- 3/16" braided polyester line
- Extension handle
- Stainless steel core catchers (for normal sediments)
- Eggshell™ core catchers (for wet sediments)
- Stainless steel nose piece
- Cellulose acetate butyrate (CAB) liners
- Core liner end caps
- Core liner cutter
- Geologists table
- Auxiliary weights

## 6.0 Procedure

6.1 Depending on the characteristics of the site being investigated, sediment samples may be collected from a boat, or by sampling personnel in waders. In all instances, sediment sampling should begin from the most downstream location and proceed to the most upstream location. If sediment samples are collocated with surface water samples, the surface water sample should be collected prior to the sediment sample in order to avoid increased turbidity from displaced sediment. Regardless of the type of sediment sampling equipment used, documentation of field observations and collection activities should be recorded on the sediment sampling sheet or electronic data collection device. The following observations should be recorded on the sediment sampling form (see example form; Attachment 1) for all sediment sampling activities:

- Sample location
- Weather conditions and other relevant site conditions
- Depth of water to the nearest 0.1 foot. A surveyor rod may be used. If the surveyor rod is used, minimize water turbulence and do not disturb any sediment.
- Physical characteristics of the water body such as estimated current speed (stagnant, slow, medium, or fast) and direction, odor, color, presence of any dead vegetation, surface sheens, etc.
- Sediment color according to the Munsell Color Chart
- Sediment grain size according to a particle size chart

Specific procedures for the collection of sediment samples using the Petite Ponar® Grab Sampler, Ekman Bottom Grab Sampler, Wildco® Hand Corer, and Power Grab Sampler are presented below.

#### 6.2 Petite Ponar® Grab Sampler

- 6.2.1 Inspect the sampler to ensure all parts are in good working condition.
- 6.2.2 Decontaminate the sampler according to the procedures in SOP 3-06, Equipment Decontamination.
- 6.2.3 Attach the 3/16" braided polyester line to the sampler by looping the line through the clevis at the top center of the lever arms and tying securely. Tie the other end of the line to the boat (if applicable), or make sure to hold on to the other end of the line. Strong, tight knots (e.g. bowline, two half hitches) are essential for operator safety and to prevent losing the sampler. If necessary, attach the auxiliary weights to the sampler according to the manufacturer's directions.

- 6.2.4 Insert the Pinch-Pin™ into its hole in the lever arms, making sure to firmly push the Pinch-Pin™ into the hole. As long as the line is taught, the Pinch-Pin™ will stay in its place. When the line becomes the least bit slack (e.g. when the sampler hits the bottom), the Pinch-Pin™ spring will force the Pinch-Pin™ out of its hole, allowing the scoops to close.
- 6.2.5 Just before lowering the grab into the water, and with the line taught, remove the safety pin so the closing mechanism will release when the sampler is on the bottom. Make sure to keep the line taught, as any loss of tension in the line will cause the Pinch-Pin™ to pop out, closing the sampler.
- 6.2.6 Lower the sampler into the water in a slow and controlled fashion, especially during the final 1-2', such that the bow wave is minimized, thus minimizing the dispersal of fine material on the sediment surface. At no time should the sampler be allowed to "free fall" down through the water column.
- 6.2.7 Once the sampler has reached the bottom, release the tension on the line, and allow the sampler to sink into the sediment momentarily. The release of tension on the line will cause the Pinch-Pin™ to pop out.
- 6.2.8 Collect the sample by pulling on the line, which will cause the lever arms to drive the scoops into the sediment in a closing motion. Keep pulling on the line in a controlled fashion until the scoops drive through the sediment and close.
- 6.2.9 Once the sampler scoops have closed, continue pulling on the line in a controlled fashion in order to retrieve the sampler back to the surface. When the sampler reaches the surface, lift it clear and bring it above a decontaminated stainless steel bowl. Inspect the sampler to ensure that an acceptable sample has been collected (See Figure 5). If the sample is not acceptable, discard the sample in an area that is not proximal or upstream to the area or subsequent areas that are being sampled. At a minimum, the sample should not be discarded until the area being sampled is complete.
- 6.2.10 Prior to sampling and sample homogenization, the overlying water in the sampler should be siphoned off, and not decanted (U.S. EPA 2001).
- 6.2.11 If acid volatile sulfide/simultaneously extracted metals (AVS/SEM) samples are to be collected, open the top screens of the sampler and collect the AVS/SEM sample directly from the sediment contained in the sampler according to the procedures specified in the project-specific SAP.
- 6.2.12 If volatile organic compound (VOC) samples are to be collected, open the top screens of the sampler and collect the VOC samples by inserting a syringe, Terra Core sampler, or other VOC sampling device directly into the undisturbed sediment contained within the sampler, making sure to follow all VOC sampling procedures specified in the project-specific SAP. Once the VOC samples have been collected, collect an additional aliquot for the VOC percent solids sample directly from the undisturbed sediment contained within the sampler.
- 6.2.13 Once the AVS/SEM and VOC samples have been collected (or if AVS/SEM and VOC samples are not required), open the sampler by pulling the two scoops open, taking care to keep hands and fingers away from the sharpened edges of the scoops, and allow the sediment to exit the sampler into the decontaminated stainless steel bowl.
- 6.2.14 If additional aliquots are necessary to provide adequate sample volume, repeat steps 6.2.3 through 6.2.12 until an adequate sample volume has been collected, taking care to deploy the sampler to an area that is proximal and upstream, but not on top of, the previous sample location.
- 6.2.15 Once an adequate sample volume has been collected, homogenize the sample in the stainless steel bowl, record the sediment sample information on the sediment sampling form (see

example form; Attachment 1), and collect the sediment samples according to the procedures specified in the project-specific SAP (typically in order of decreasing volatility).

- 6.3 Ekman Bottom Grab Sampler with the 11 oz Split Messenger
- 6.3.1 Inspect the sampler to ensure all parts are in good working condition.
  - 6.3.2 Decontaminate the sampler according to the procedures in SOP 3-06, Equipment Decontamination.
  - 6.3.3 Attach the 3/16" braided polyester line to the sampler by passing the line through the trip mechanism and knotting it securely below the underlying plate. Thread the 11 oz split messenger on the line, and tie the other end of the line to the boat (if applicable), or make sure to hold on to the other end of the line. Strong, tight knots (e.g. bowline, two half hitches) are essential to prevent losing the sampler. If necessary, attach the auxiliary weights to the sampler according to the manufacturer's directions.
  - 6.3.4 Set the spring on the side of the sampler by hooking the end of the spring onto one scoop button and stretching the spring to reach the second scoop button. Repeat this procedure with the spring on the other side of the sampler.
  - 6.3.5 Arm the scoops by hooking one cable loop to one Twin-Pin™ pin in the trip assembly on the top of the sampler. The white ball on the cable can be used as a hand grip to assist getting the cable loop hooked onto the Twin-Pin™ pin. Repeat for the opposite cable loop. The sampler is now armed and dangerous. Do not allow anything to come in contact with the trip assembly at the top of the sampler, as this may cause a sudden and unexpected closure of the sampler.
  - 6.3.6 Lower the sampler into the water in a slow and controlled fashion, especially during the final 1-2', such that the bow wave is minimized, thus minimizing the dispersal of fine material on the sediment surface. At no time should the sampler be allowed to "free fall" down through the water column.
  - 6.3.7 Once the sampler has reached the bottom, allow the sampler to settle momentarily. Once the sampler has settled, hold the line with just enough tension to keep it straight, and send the 11 oz split messenger down the line. Once the 11 oz split messenger impacts Twin-Pin™ strike pad in the trip assembly on the top of the sampler, the two cable loops will be released from the Twin-Pin™ pins, and the spring-loaded scoops of the sampler will automatically close.
  - 6.3.8 Retrieve the sampler by pulling up the line in with a moderate, steady speed. When the sampler reaches the surface, lift it clear and bring it above a decontaminated stainless steel bowl. Inspect the sampler to ensure that an acceptable sample has been collected (See Figure 5). If the sample is not acceptable, discard the sample in an area that is not proximal or upstream to the area or subsequent areas that are being sampled. At a minimum, the sample should not be discarded until the area being sampled is complete.
  - 6.3.9 Prior to sampling and sample homogenization, the overlying water in the sampler should be siphoned off, and not decanted (U.S. EPA 2001).
  - 6.3.10 If AVS/SEM samples are to be collected, open the top lids of the sampler and collect the AVS/SEM sample directly from the sediment contained in the sampler according to the procedures specified in the project-specific SAP.
  - 6.3.11 If VOC samples are to be collected, open the top lids of the sampler and collect the VOC samples by inserting a syringe, Terra Core sampler, or other VOC sampling device directly into the undisturbed sediment contained within the sampler, making sure to follow all VOC sampling procedures specified in the project-specific SAP. Once the VOC samples have been collected, collect an additional aliquot for the VOC percent solids sample directly from the undisturbed sediment contained within the sampler.

- 6.3.12 Once the AVS/SEM and VOC samples have been collected (or if AVS/SEM and VOC samples are not required), open the sampler by pulling on the white balls on both cables, opening the spring-loaded scoops and allowing the sediment to exit the sampler into the decontaminated stainless steel bowl. While the spring-loaded scoops are being held open, do not place hands or fingers inside or underneath the sampler.
- 6.3.13 If additional aliquots are necessary to provide adequate sample volume, repeat steps 6.3.4 through 6.3.11 until an adequate sample volume has been collected, taking care to deploy the sampler to an area that is proximal and upstream, but not on top of, the previous sample location.
- 6.3.14 Once an adequate sample volume has been collected, homogenize the sample in the stainless steel bowl, record the sediment sample information on the sediment sampling form (see example form; Attachment 1), and collect the sediment samples according to the procedures specified in the project-specific SAP (typically in order of decreasing volatility).
- 6.4 Ekman Bottom Grab Sampler with the Extension Handle
- 6.4.1 Inspect the sampler to ensure all parts are in good working condition.
- 6.4.2 Decontaminate the sampler according to the procedures in SOP 3-06, Equipment Decontamination.
- 6.4.3 Attach the extension handle to the top of the sampler with machine bolts.
- 6.4.4 Arm the sampler according to the procedures described in steps 6.3.3 and 6.3.4 above.
- 6.4.5 Using the extension handle, lower the sampler to a point 4-6" above the sediment surface, and drop the sampler to the sediment, keeping the sampler vertical at all times.
- 6.4.6 Trigger the trip assembly by depressing the button on the upper end of the extension handle. This will cause the two cable loops to be released from the Twin-Pin™ pins, and the spring-loaded scoops of the sampler will automatically close.
- 6.4.7 While keeping the sampler vertical, bring the sampler over to a decontaminated stainless steel bowl. Inspect the sampler to ensure that an acceptable sample has been collected (See Figure 5). If the sample is not acceptable, discard the sample in an area that is not proximal or upstream to the area or subsequent areas that are being sampled. At a minimum, the sample should not be discarded until the area being sampled is complete.
- 6.4.8 Collect samples according to the procedures described in steps 6.3.8 through 6.3.13 above.
- 6.5 Wildco® Hand Corer with the Push Handles
- 6.5.1 Inspect the sampler to ensure all parts are in good working condition:
- Assemble and disassemble the core tube from the head and nose piece to make sure the threads are not binding. If the threads are binding, consult the manufacturer's directions.
  - Make sure that the CAB plastic liner can slide easily in and out of the core tube.
  - Make sure the bottom edge of the core tube and nose piece are sharp and free from nicks or dents. If necessary, file smooth using a round file.
  - Check the flutter valve for ease of movement.
  - Check the flutter valve seat to make sure it is clear of any obstruction, disfigurement, grease, and/or oil that could prevent a tight closure.
- 6.5.2 Decontaminate the sampler according to the procedures in SOP 3-06, Equipment Decontamination.
- 6.5.3 Screw the corer head onto the core tube, and screw the two handles onto the corer head.

- 6.5.4 Insert a CAB plastic liner into the core tube, insert a core catcher onto the end of the CAB plastic liner (stainless steel for normal sediments, Eggshell™ for wet sediments), and screw the stainless steel nose piece onto the core tube. If using the hand corer from a boat, bridge, high dock, etc., be sure that the appropriate extension handle (5', 10' or 15') is attached to the corer head.
- 6.5.5 Get in position over the sampling location. If wading in shallow water, be sure to approach the sample location from the downstream side. Line up the sampler, aiming it vertically for the point where the sample is being taken, and push the hand corer in a smooth continuous motion through the water and into the sediment. Increase the thrust as necessary to obtain the penetration desired. Do not hammer or pound the corer into the sediment.
- 6.5.6 Retrieve the sample by pulling straight up on the handles, keeping the corer as vertical as possible. If the corer has not been completely submerged, close the flutter valve by hand and press it shut while the sample is being retrieved. The flutter valve must be kept very wet if it is to seal properly and prevent sample washout. If the substrate is gripping the corer too tightly, gently rock the top of the corer back and forth horizontally to increase the size of the hole created by the corer and reduce the pull-out suction.
- 6.5.7 Unscrew the nose piece from the corer and cap the bottom end of the CAB core liner. Release the flutter valve to free the CAB core liner, and slide the CAB core liner from the core tube. Cap the top of the CAB core liner and inspect the CAB core liner for recovery. If the recovery is adequate, proceed to step 6.5.8. If the recovery is not adequate, resample the location by repeating steps 6.5.3 through 6.5.7.
- 6.5.8 Bring the CAB core liner with the sediment sample over to the geologist table, keeping the core vertical. Place the CAB core liner on the geologist table and cut open with a core liner cutter. If AVS/SEM samples are to be collected, collect the AVS/SEM sample directly from the sediment contained in the core liner according to the procedures specified in the project-specific SAP. If VOC samples are to be collected, collect the VOC samples by inserting a syringe, Terra Core sampler, or other VOC sampling device directly into the sediment core. Consult the project-specific SAP for project-specific VOC sediment sampling procedures. Once the VOC samples have been collected, collect an additional aliquot for the VOC percent solids sample directly from the sediment core.
- 6.5.9 Once the AVS/SEM and VOC samples have been collected (or if AVS/SEM and VOC samples are not required), use a decontaminated stainless steel spoon to transfer the remaining sediment core into a decontaminated stainless steel bowl.
- 6.5.10 If additional aliquots are necessary to provide adequate sample volume, repeat steps 6.5.3 through 6.5.8 until an adequate sample volume has been collected, taking care to deploy the corer to an area that is proximal, but not on top of, the previous sample location. At a minimum, the sample should not be discarded until the area being sampled is complete.
- 6.5.11 Once an adequate sample volume has been collected, homogenize the sample in the stainless steel bowl, record the sediment sample information on the sediment sampling form (see example form; Attachment 1), and collect the sediment samples according to the procedures specified in the project-specific SAP (typically in order of decreasing volatility).
- 6.6 Wildco® Hand Corer with the Clevis and Line
- 6.6.1 Inspect the corer as described in step 6.5.1 above.
- 6.6.2 Decontaminate the sampler according to the procedures in SOP 3-06, Equipment Decontamination.
- 6.6.3 Screw the corer head onto the core tube. Attach the 3/16" braided polyester line to the corer by passing the line through the clevis in the corer head and knotting it securely. Strong, tight knots

- are essential to prevent losing the corer. If necessary, attach the auxiliary weights to the sampler according the manufacturer's directions.
- 6.6.4 Insert a CAB plastic liner into the core tube, insert a core catcher onto the end of the CAB plastic liner (stainless steel for normal sediments, Eggshell™ for soupy sediments), and screw the stainless steel nose piece onto the core tube.
  - 6.6.5 Position the corer over the drop point and steady momentarily, making sure to keep the corer vertical at all times. Make sure to arrange the 3/16" braided polyester line to run freely. Since the corer's penetration is by simple gravity, it is important that there be no restraint on the corer during descent by stricture on the line. Keep a firm hold on the free end of the line, or tie it to the boat (if applicable) or some other permanent fixture.
  - 6.6.6 Drop the corer into the water, and allow the corer to free fall until it hits the sediment surface. The corer should not be dropped to depths greater than 20' to 30'. Dropping the corer to depths greater than 20' to 30' may result in the corer striking the sediment surface at an angle less than 90°, resulting in an unsatisfactory sample.
  - 6.6.7 Once the corer has entered the sediment and is no longer falling, draw the line taut, and then pull on the line to pull the corer from the sediment. Once the corer has been pulled free from the sediment, bring the corer back to the surface by pulling up the line, using a smooth, hand-over-hand fashion. This movement automatically causes the flutter valve to close, preventing sample washout in all but the soupiest of sediments.
  - 6.6.8 Once the corer has been returned to the surface, lift the corer clear of the water, being careful to keep the corer as vertical as possible at all times.
  - 6.6.9 Collect the sediment sample according to the procedures outlined in steps 6.5.6 through 6.5.11 above.
- 6.7 Power Grab Sampler
- 6.7.1 Inspect the sampler to ensure all parts are in good working condition.
  - 6.7.2 Decontaminate the sampler according to the procedures in SOP 3-06, Equipment Decontamination.
  - 6.7.3 Attach the grab sampler and pneumatic hose to the 5/16" wire rope by passing a shackle through eye splice and fastening it securely to the frame of the sampler. Using a cable tie and electrical tape, secure the shackle pin to prevent losing the sampler.
  - 6.7.4 Power up the air compressor and open the jaws of the sampler via the pneumatic switch.
  - 6.7.5 The sampler is now armed and ready to sample. Do not allow anything to come in contact near the jaws of the sampler in the event of a sudden and unexpected closure of the sampler.
  - 6.7.6 Using a winch or davit, hoist the sampler of the frame and lower the sampler into the water in a slow and controlled fashion, especially during the final 1-2', such that the bow wave is minimized, thus minimizing the dispersal of fine material on the sediment surface. At no time should the sampler be allowed to "free fall" down through the water column.
  - 6.7.7 Once the sampler has reached the bottom, allow the sampler to settle momentarily. Once the sampler has settled, hold the line with just enough tension to keep it straight, and actuate the pneumatic ram. Allow a minimum of 30 seconds to elapse in order to allow the jaws of the sampler to completely close.
  - 6.7.8 Retrieve the sampler with the winch or davit starting slowly, and increasing to a moderate, steady speed. When the sampler reaches the surface, lift it clear, place on stand, and bring it above a decontaminated stainless steel bowl. Remove the access doors on top of the sampler and inspect the sampler to ensure that an acceptable sample has been collected (See Figure

- 5). If the sample is not acceptable, discard the sample in an area that is not proximal or upstream to the area or subsequent areas that are being sampled. At a minimum, the sample should not be discarded until the area being sampled is complete.
- 6.7.9 Prior to sampling and sample homogenization, the overlying water in the sampler should be siphoned off, and not decanted (U.S. EPA 2001).
- 6.7.10 If AVS/SEM samples are to be collected, open the top lids of the sampler and collect the AVS/SEM sample directly from the sediment contained in the sampler according to the procedures specified in the project-specific SAP.
- 6.7.11 If VOC samples are to be collected, open the top lids of the sampler and collect the VOC samples by inserting a syringe, Terra Core sampler, or other VOC sampling device directly into the undisturbed sediment contained within the sampler, making sure to follow all VOC sampling procedures specified in the project-specific SAP. Once the VOC samples have been collected, collect an additional aliquot for the VOC percent solids sample directly from the undisturbed sediment contained within the sampler.
- 6.7.12 Once the AVS/SEM and VOC samples have been collected (or if AVS/SEM and VOC samples are not required), open the sampler by pulling on the white balls on both cables, opening the spring-loaded scoops and allowing the sediment to exit the sampler into the decontaminated stainless steel bowl. While the spring-loaded scoops are being held open, do not place hands or fingers inside or underneath the sampler.
- 6.7.13 If additional aliquots are necessary to provide adequate sample volume, repeat steps 6.7.4 through 6.7.11 until an adequate sample volume has been collected, taking care to deploy the sampler to an area that is proximal and upstream, but not on top of, the previous sample location.
- 6.7.14 Once an adequate sample volume has been collected, homogenize the sample in the stainless steel bowl, record the sediment sample information on the sediment sampling form (see example form; Attachment 1), and collect the sediment samples according to the procedures specified in the project-specific SAP (typically in order of decreasing volatility).

## **7.0 Quality Control and Assurance**

- 7.1 Field personnel will follow specific quality assurance (QA) guidelines as outlined in the project-specific SAP. The goal of the QA program should be to ensure precision, accuracy, representativeness, completeness, and comparability in the project sampling program.
- 7.2 Quality control (QC) requirements for sample collection are dependent on project-specific sampling objectives. The project-specific SAP will provide requirements for sample preservation and holding times, container types, sample packaging and shipment, as well as requirements for the collection of various QC samples such as trip blanks, field blanks, equipment rinse blanks, and field duplicate samples.

## **8.0 Records, Data Analysis, Calculations**

- 8.1 Records will be maintained in accordance with SOP 3-03, Recordkeeping, Sample Labelling, and Chain-of-Custody. Various forms are required to ensure that adequate documentation is made of the sample collection activities. These forms may include:
- Sample collection records;
  - Field logbook;

- Chain-of-custody forms; and
- Shipping labels.

- 8.2 Sample collection records (see example form; Attachment 1) will provide descriptive information for the sediment samples collected at each location.
- 8.3 The field logbook is kept as a general log of activities and should not be used in place of the sample collection record.
- 8.4 Chain-of-custody forms are transmitted with the samples to the laboratory for sample tracking purposes.
- 8.5 Shipping labels are required is sample coolers are to be transported to a laboratory by a third party (courier service).

## **9.0 Attachments or References**

Attachment 1 – Example Sediment Sample Collection Record

Figure 1 – Petite Ponar® Grab Sampler and Exploded Diagram

Figure 2 – Ekman Bottom Grab Sampler (Large, Tall, and Standard Sizes) and Exploded Diagram

Figure 3 – Wildco® Hand Corer (with Case and Accessories) and Exploded Diagram

Figure 4 – Power Grab Sampler (typical)

Figure 5 – Illustrations of Acceptable and Unacceptable Grab Samples

NAVSEA T0300-AZ-PRO-010. *Navy Environmental Compliance Sampling and Field Testing Procedures Manual*. August 2009.

U.S. Environmental Protection Agency (U.S. EPA). 2001. *Methods for Collection, Storage and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manual*. October.

Wildlife Supply Company. 2003. 2424- Hand Corer Instructions.

Wildlife Supply Company. 2004. Ekman Bottom Grabs Instructions and Maintenance.

Wildlife Supply Company. 2004. 1728-G30/ 1728-G40 Petite Ponar® Grab.

SOP 3-05, *IDW Management*.

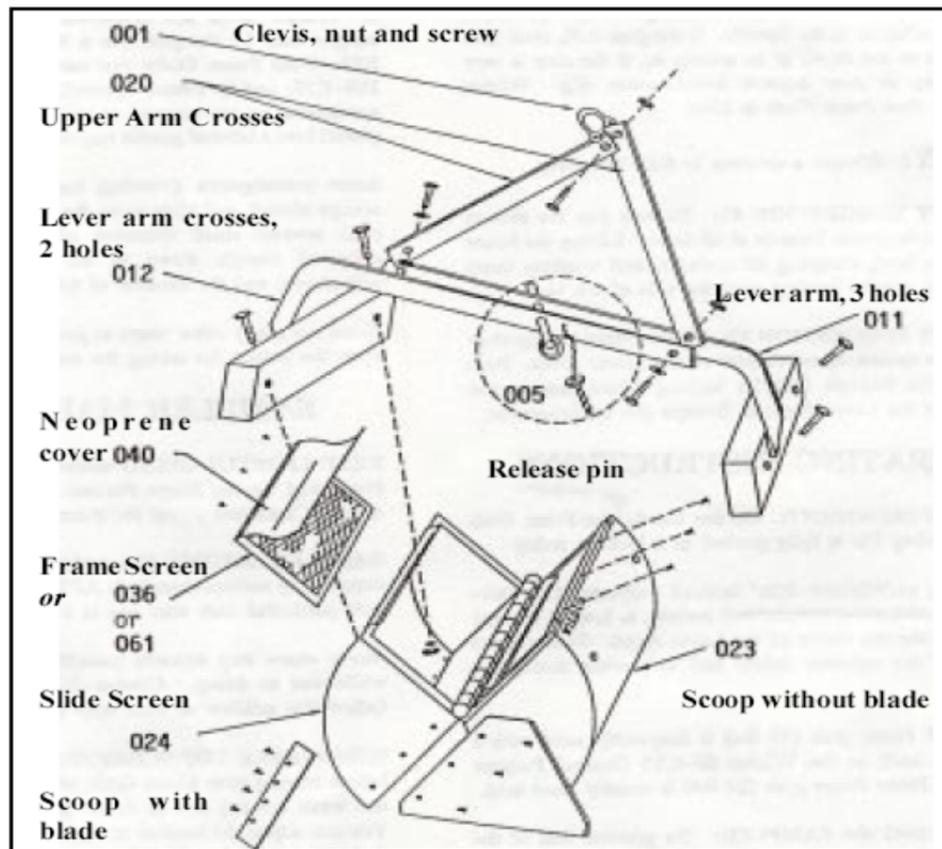
SOP 3-06, *Equipment Decontamination*.

**Attachment 1  
Example Sediment Sample Collection Record**

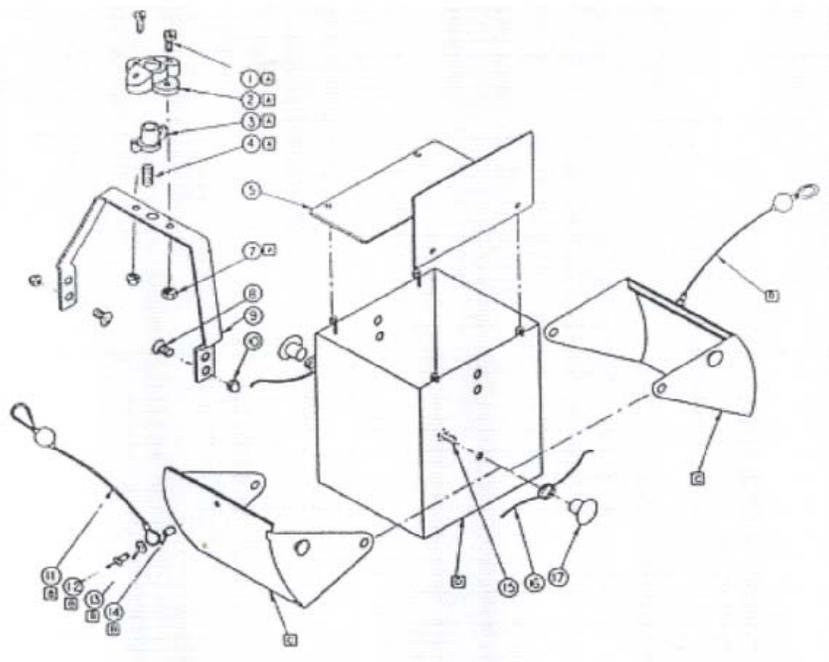
**SEDIMENT SAMPLE COLLECTION FORM**

Project Name:		
Date(s):		
Project #:		Date:
Sample Location ID:		Time:
Sample #:		Weather:
Samplers:		
<b>Sample Information:</b>		
Sample Depth:		Sampling Device:
Water Depth:		
Distance from River Bank:		
River Flow Rate:		
Field Decon:	Yes      No Dedicated	Sample Type:      Grab      Composite
Munsell Color:		
Sample Description:		
Other physical characteristics of water body at sample location: (Water color, turbidity, odor, presence of sheens, dead/stressed vegetation)		
Sample Comments/Description:		

**Figure 1**  
**Petite Ponar® Grab Sampler and Exploded Diagram**



**Figure 2**  
**Ekman Bottom Grab Sampler (Large, Tall, and Standard Sizes) and Exploded Diagram**



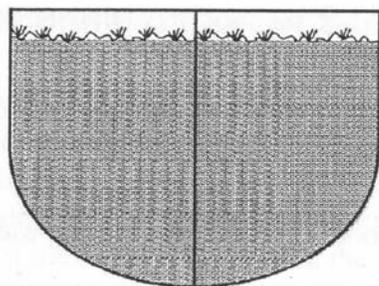
**Figure 3**  
**Wildco® Hand Corer (with Case and Accessories) and Exploded Diagram**



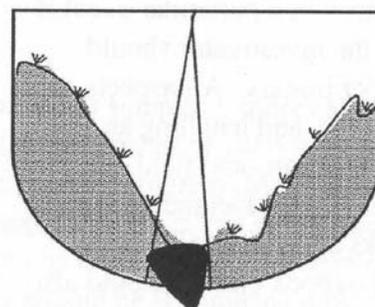
**Figure 4  
Power Grab Sampler (typical)**



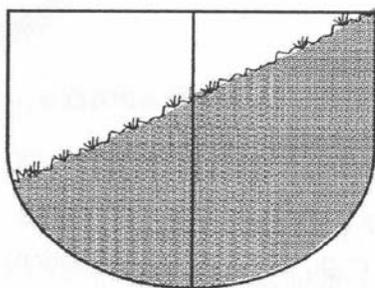
**Figure 5**  
**Illustrations of Acceptable and Unacceptable Grab Samples**



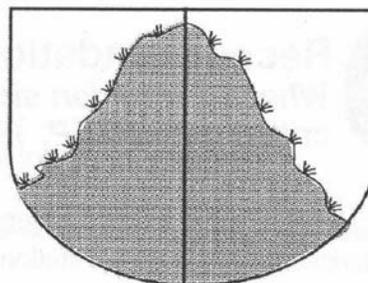
Acceptable if Minimum  
Penetration Requirement Met  
and Overlying Water is Present



Unacceptable  
(Washed, Rock Caught in Jaws)



Unacceptable (Canted with  
Partial Sample)



Unacceptable  
(Washed)

**Standard Operating Procedure SOP-3-24**  
**Water Quality Parameter Testing for Groundwater Sampling**

## **1.0 PURPOSE**

This standard operating procedure (SOP) represents minimum standard of practice. State and federal requirements may vary, and this SOP does not replace state and federal requirements that must be consulted before work begins. Further, if a project-specific work plan has been created, the work plan should be considered the ruling document. This SOP may be modified to meet specific regulatory, client, or project specific criteria.

If there are procedures whether it be from Resolution Consultants, state and/or federal that are not addressed in this SOP and are applicable to water quality parameter testing, then those procedures may be added as an appendix to the project-specific Sampling and Analysis Plan (SAP).

## **2.0 SCOPE**

This procedure provides guidance for expected sampling methods and protocols by all personnel related to the measurement of water quality parameters.

Field measurements of water quality parameters are commonly performed to evaluate surface water and groundwater. These tests are often performed to evaluate basic water quality parameters, to evaluate natural attenuation parameters, and to assess the presence of pore water entering a well.

As professional guidance for specific activities, this procedure is not intended to obviate the need for professional judgment during unforeseen circumstances. Deviations from this procedure while planning or executing planned activities must be approved by either the Contract Task Order (CTO) Manager or the Quality Assurance (QA) Manager, and documented.

## **3.0 DEFINITIONS**

### **3.1 Barometric Pressure (BP)**

The density of the atmosphere, which varies according to altitude and weather conditions.

### **3.2 Conductivity/Specific Conductance**

A measure of the ability of water to pass electrical current, which increases with the amount of dissolved ionic substances (i.e., salts). Conductivity is inversely related to the resistance of a solution and is measured in units of mhos per centimeter (mhos/cm) (inverse ohms/cm, Siemens/cm). The conductivity of water increases with increasing temperature.

*Specific Conductance is corrected for 25 degrees Celsius (°C); for this reason, it is best to record Specific Conductance. If Conductivity is recorded, the temperature of the sample MUST recorded.*

### **3.3 Dissolved Oxygen (DO)**

The amount of oxygen present in water and available for respiration. DO is typically measured in milligrams per liter (mg/L). Oxygen is less soluble in warm and salty waters, so the instrument compensates the apparent percent saturation for changes in temperature and conductivity. Most probes measure the current resulting from the electrochemical reduction of oxygen (at a gold cathode) diffusing through a selective membrane. Because oxygen is being removed from the sample to perform the measurement, sample flow is required to prevent false low readings due to depletion of oxygen in the solution in front of the probe. Optical DO probes do not remove oxygen from the sample and are less affected by salts. The common range of DO in groundwater is 0.0 to 3.0 mg/L. Measurements outside of this range suggest that the meter may not be operating correctly.

### **3.4 Nephelometric Turbidity Unit (NTU)**

The measurement of light passing through a sample based on the scattering of light caused by suspended particles.

### **3.5 pH**

A measure of acidity and alkalinity of a solution using a logarithmic scale on which a value of 7 represents neutrality, lower numbers indicate increasing acidity, and higher numbers are increasingly basic.

### **3.6 Oxidation-Reduction Potential (ORP)**

Also known as redox or eH, ORP is a measurement of the potential for a reaction to occur, which generally indicates the oxygen status of a sample. The probe consists of a platinum electrode, the potential of which is measured with respect to a reference electrode that rapidly equilibrates with the potential of the sample solution. A positive value indicates that oxygen is present. A negative value indicates an anaerobic environment or reducing condition. For this reason, negative ORP readings should be associated with DO readings of less than 0.5 mg/l; with negative ORP readings the water may exhibit a sulfur odor or gray color. Positive ORP readings should be associated with DO readings greater than 0.5 mg/L and lack of sulfur odors. Because of the complex relationship between ORP and temperature, no compensation is attempted; it is thus best to report both the ORP and temperature of a water sample.

### **3.7 Total Dissolved Solids**

A measure of the quantity of materials in water that are either dissolved or too small to be filtered.

### **3.8 Turbidity**

Measure of the clarity of water in NTUs. Potable water typically has NTU values between 0.0 and 0.3 NTUs, depending on the state or regulatory program.

## **4.0 RESPONSIBILITIES**

The CTO Manager, or designee, is responsible for ensuring that these standard groundwater sampling activities are followed and shall review all groundwater sampling forms at the conclusion of a sampling event. The CTO Manager is responsible for ensuring that all personnel involved in monitoring well sampling shall have the appropriate education, experience, and training to perform their assigned tasks. The QA Manager or Technical Director is responsible for ensuring overall compliance with this procedure. The Field Manager is responsible for ensuring that all project field staff follows these procedures.

Field sampling personnel are responsible for the implementation of this procedure. Personnel are required to be knowledgeable of the procedures in this SOP. Training and familiarization with this SOP shall be documented in the training file for each employee. The field sampler and/or Field Manager is responsible for directly supervising the calibration procedures to ensure that they are conducted according to this procedure, and for recording all pertinent data. If deviations from the procedure are required because of anomalous field conditions, they must first be approved by the CTO Manager, QA Manager, or Technical Director and then documented in the field logbook and associated report or equivalent document.

## **5.0 PROCEDURES**

### **5.1 Purpose**

The procedures will vary depending on parameters being measured, method of sampling, and the method of measurement used. The information here is a general guidance and the site-specific documents and manufacturer manuals supersede these procedures.

### **5.2 Cautions**

Improper use of water quality testing equipment could result in equipment damage or compromised sampling results. Personnel should be trained to operate the test equipment being used for a field operation and should be trained in the proper techniques for collecting and

logging water quality parameters. Personnel should also be able to recognize problems with test equipment and have someone available for basic troubleshooting and repair.

### **5.3 Interferences**

During field testing, water quality data that is documented from field testing equipment may be influenced by certain outside factors that are unrelated to the actual site water quality. Such parameters and equipment include the following:

#### **pH Meters**

- Coatings of oils, greases, and particles may impair the electrode's response. Pat the electrode bulb dry with lint-free paper or cloth and rinse with de-ionized water. For cleaning hard-to-remove films, use isopropyl alcohol very sparingly so that the electronic surface is not damaged.
- Poorly buffered solutions with low specific conductance (less than 200 microsiemens per centimeter) may cause fluctuations in the pH readings. Equilibrate electrode by immersing in several aliquots of sample before taking pH.

#### **Dissolved Oxygen**

- Dissolved gases (e.g., hydrogen sulfide, halogens, sulfur dioxide) are a factor with the performance of DO probes. The effect is less pronounced on optical DO meters. Meter type and potential interferences should be considered based on potential sulfate/sulfide or nitrate/nitrite reducing environments.
- Exposure of the sample to the atmosphere will cause elevated DO measurements.

#### **Turbidity Meter**

- If the weather is warm and humidity is high, condensation may collect on the cuvet. To avoid this, allow the sample to warm and dry the outside of the cuvet before making the measurement. One method used to accomplish this is to place the cuvet against one's body (armpits work well).

#### **Temperature**

- Sample temperature will change rapidly when there are significant differences between the sample and ambient air.

### 5.4 Apparatus and Materials

Field personnel shall consult the site work plan and SAP to review the equipment requirements for the sampling procedures to be followed during the sampling effort. The specific apparatus and materials required will depend on the water quality parameters being monitored. Table 1 shows the common equipment used in water quality parameter testing.

**Table 1**  
**Water Quality Parameter Testing — Common Equipment**

Water Quality Parameter Instrument	Calibration Standards Required	Other Equipment
pH Meter	Yes - 2 or 3 Point Standards depending on groundwater range. Calibration must cover the range to be measured. If samples are above or below typical buffer standards (4, 7 and 10), special order buffers that fall outside groundwater pH range.	Container or flow thru cell for holding sample
Specific Conductance	Yes	Container or flow thru cell for holding sample
ORP Meter	Yes	Container or flow thru cell for holding sample
Turbidity Meter	Yes	Container or flow thru cell for holding sample
DO	No	Container or flow thru cell for holding sample
Thermometer	No	Container or flow thru cell for holding sample
Flow Rate	No	Calibrated Container

**Notes:**

ORP = Oxidation-Reduction Potential  
 DO = Dissolved Oxygen

### 5.5 Instrument or Method Calibration

Most monitoring instruments require calibration before use, and this calibration must be conducted in the field under the ambient climatic conditions that will be present during field sampling. Calibration of monitoring instruments shall be performed in accordance with the manufacturer’s specifications and recorded in the provided form in Attachment 1. Site-specific instrument calibration requirements should be specified in the SAP. The following minimum calibration requirements apply to the various types of meters used to gather water quality measurements.

**Initial Calibration (IC):** Before use, the instrument or meter electronics are adjusted (manually or automatically) to a theoretical value (e.g., DO saturation) or a known value of a

calibration standard. An IC is performed in preparation for the first use of an instrument or if a calibration verification does not meet acceptance criteria.

**Initial Calibration Verification (ICV):** The instrument or meter calibration is checked or verified directly following IC by measuring a calibration standard of known value as if it were a sample and comparing the measured result to the calibration acceptance criteria for the instrument/parameter. If an ICV fails to meet acceptance criteria, immediately recalibrate the instrument using the applicable initial calibration procedure or remove it from service.

**Continuing Calibration Verification (CCV):** After use, the instrument or meter calibration is checked or verified by measuring a calibration standard of known value as if it were a sample and comparing the measured result to the calibration acceptance criteria for the instrument/parameter.

### 5.5.1 Calibration Checks

Calibration checks are conducted by measuring a known standard. They must be completed after calibration and should be performed at least one other time (i.e., after lunch) and anytime suspect measurements are encountered. Table 2 provides general acceptance ranges to be used during calibration checks. If a meter is found to be outside of the acceptance range, the meter **must** be recalibrated. If the meter remains out of range, the project manager and/or the supplier of the meter should be contacted to determine alternative measures.

**Table 2  
Calibration Check Acceptance Limits**

<b>Parameter</b>	<b>Acceptance Criteria</b>
Dissolved Oxygen	±0.3 mg/L of the theoretical oxygen solubility
Oxidation-Reduction Potential	±10 mv from the theoretical standard value at that temperature
pH	±0.2 Standard pH Units
Specific Conductance	±5% of the standard
Turbidity	0.1 to 10 NTU: ±10% of the standard 11 to 40 NTU: ±8% of the standard 41 to 100 NTU: ±6.5% of the standard

**Notes:**

- mg/L = milligrams per liter
- mv = millivolts
- NTU = nephelometric turbidity units

### 5.5.2 Possible and Suspected Ranges

The concentration for each parameter range should be known so that concentrations outside of the range can be noted. Table 3 presents the maximum range of the parameter in groundwater. The table also presents the suspected range. Measurements outside of the maximum/minimum range should be considered in error and the measurement method should be checked. Concentrations outside the normal range should be treated as suspect but may be the result of contaminant impact. For example, a pH of 2.0 would be out of the normally suspected range for groundwater but not at a site impacted with an acid.

**Table 3  
Minimum and Maximum Result Ranges**

Parameter	Units	Possible Min	Possible Max	Normal Min	Normal Max	Notes
						The colder the sample, the higher the DO reading.
Dissolved Oxygen	mg/L	0.0	14.6 (0°C) 10.1 (15°C) 8.3 (2°C)	0.0	5	DO greater than 1 mg/L, ORP positive should not have sulfur odor, sulfide, ferrous iron and/or gray color.  DO less than 1 mg/L, ORP negative, may have sulfur odor, sulfide, ferrous iron and/or gray color.
pH	SU	0	14	5	9	pH values exceeding 10 could indicate grout contamination
ORP	mv					DO greater than 1 mg/L, ORP positive should not have sulfur odor, sulfide, ferrous iron and/or gray color.  DO less than 1 mg/L, ORP negative, may have sulfur odor, sulfide, ferrous iron and/or gray color.
Specific Conductance	µS/cm			varies	varies	
Temperature	°C	0	100	5	30	
Turbidity	NTU	0	Greater than 1,000	0	Greater than 1,000	50 NTU or greater suggests cloudiness.

**Notes:**

- mg/L = milligrams per liter
- °C = degrees Celsius
- DO = dissolved oxygen
- SU = standard units
- ORP = oxidation reduction potential
- mv = millivolts
- mS/cm = micro Siemens per cm
- NTU = nephelometric turbidity units

### 5.5.3 Field Instruments and Calibration Criteria

The calibration acceptance criteria for each instrument are summarized in Table 4 along with special considerations related to each field instrument.

**Table 4  
 Calibration Check Acceptance Limits**

Parameter	Acceptance Criteria
Dissolved Oxygen	±0.3 mg/L of the theoretical oxygen solubility.
Oxidation-Reduction Potential	±10 mv from the theoretical standard value at that temperature.
pH	±0.2 Standard pH Units
Specific Conductance	±5% of the standard
Turbidity	0.1 to 10 NTU: ±10% of the standard 11 to 40 NTU: ±8% of the standard 41 to 100 NTU: ±6.5% of the standard

**Notes:**

- mg/L = milligrams per liter
- mv = millivolts
- NTU = nephelometric turbidity units

#### pH Meters

- For the most accurate of pH measurements, pH meters should receive a three-point calibration. However, if a two-point calibration will bracket the groundwater pH of the site, a two-point calibration is acceptable. Three-point calibrations typically include calibrating to solutions of pH 7.00, 4.00, and 10.00. If groundwater pH is outside the calibration range of the solution standards, special buffers must be ordered to bracket the pH. Some meters will report the slope of the calibration and this may be used in checking the meter calibration (refer to the meter’s manual). When performing an ICV, the result must be within +/- 0.2 pH units of the stated buffer value.
- pH meters should be calibrated across the range of values to be measured. The maximum and minimum calibration solutions shall be outside the range of anticipated values. For example, if the expected range is between 7.50 and 9.00, the 7.00 and the 10.00 standard should be used for calibration. Perform the IC using at least two buffers, and always use the pH 7.00 buffer first. A reading that is above the maximum (or below the minimum) calibration standard is an estimate only and is not valid. This condition requires obtaining a new standard that is above (or below) the reported value, depending on the measurement.

- A percent slope of less than 90 percent indicates a bad electrode that must be changed or repaired. If percent slope cannot be determined, or the manufacturer's optimum specifications are different, follow the manufacturer's recommendation for maintaining optimum meter performance.

### **Specific Conductivity Meters**

- For IC, when the sample measurements are expected to be 100 microsiemens per centimeter ( $\mu\text{S}/\text{cm}$ ) or greater, use two standard potassium chloride (KCl) solutions that bracket the range of expected sample conductivities. Calibrate the instrument with the first standard. Verify the calibration of the instrument with the second standard, bracketing the range of expected sample values.
- If the instrument can be calibrated with more than one standard, choose additional calibration standards within the range of expected sample values.
- When the sample measurements are expected to be less than 100  $\mu\text{S}/\text{cm}$ , a lower bracket is not required, but one standard (KCl) solution that is within the range of expected measurements must be used for the IC and the ICV.
- Accept the calibration if the meter reads within +/- 5 percent of the value of any calibration standard used to verify the calibration.
- Most field instruments read conductivity directly. Record all readings and calculations in the calibration records.
- For CCV, check the meter with at least one KCl standard with a specific conductance in the range of conductivity measured in environmental samples. The reading for the calibration verification must also be within +/- 5 percent of the standard value.
- If new environmental samples are encountered outside the range of the IC, verify the instrument calibration with two standards bracketing the range of sample values. If these calibration verifications fail, recalibrate the instrument.

### **Dissolved Oxygen Meters**

- Before calibrating, check the probe membrane for bubbles, tears, or wrinkles. These conditions require replacement of the membrane in accordance with the manufacturer's directions.
- If the meter provides readings that are off-scale, will not calibrate, or drift, check the leads, contacts, etc., for corrosion and/or short circuits. These conditions require replacement maintenance in accordance with the manufacturer's directions.
- Most DO meters must be calibrated based on an environment of 100 percent humidity and a known elevation and barometric pressure (BP).
- For 100 percent humidity, place the probe in the calibration container with a moist towel and allow the probe to remain, undisturbed, for 10 to 20 minutes.
- The IC is an air calibration at 100% saturation. Before use, verify the meter calibration in water-saturated air to make sure it is properly calibrated and operating correctly. Make a similar verification at the end of the day or sampling event. Follow the manufacturer's instructions for your specific instrument. Allow an appropriate warm up period before IC. Wet the inside of the calibration chamber with water, pour out the excess water (leave a few drops), wipe any droplets off the membrane/sensor and insert the sensor into the chamber (this ensures 100 percent humidity). Allow adequate time for the DO sensor and the air inside the calibration chamber to equilibrate. Once the probe/calibration chamber is stable at ambient temperature, check the air temperature and determine, from the DO versus temperature table (see Attachment 2) what DO should measure. The acceptance criterion for DO ICV is +/- 0.3 mg/L.
- Use the same procedure as above for CCV.

### **ORP Meters**

- Verify electrode response before use in the field.
- Equilibrate the standard solution to the temperature of the sample. The standard solution is based on a 25°C temperature; however, the calibration solution standard's value will require adjustment based on the temperature.

- Immerse the electrodes and gently stir the standard solution in a beaker (or flow cell). Turn the meter on, placing the function switch in the millivolt (mv) mode.
- Let the electrode equilibrate and record the reading to the nearest millivolt. The reading must be within  $\pm 10$  mv from the theoretical redox standard value at that temperature. If not, determine the problem and correct it before proceeding. Switch to temperature display and read the value.
- Record the mv reading and temperature in the field notebook or in form. Rinse the electrode with distilled water and proceed with the sample measurement, unless using a flow cell. If a flow cell is used, rinse between sample locations.

### **Turbidity Meters**

- Perform an initial calibration using at least two primary standards.
- If the instrument cannot be calibrated with two standards, calibrate the instrument with one standard and verify with a second standard.
- Perform an ICV by reading at least one primary standard as a sample. The acceptance criterion for the ICV depends on the range of turbidity of the standard value:
  1. Standard Value = 0.1 to 10 NTU: the response must be within 10 percent of the standard;
  2. Standard Value = 11 to 40 NTU: the response must be within 8 percent of the standard;
  3. Standard Value = 41 to 100 NTU: the response must be within 6.5 percent of the standard; and
  4. Standard Value greater than 100 NTU: the response must be within 5 percent of the standard.
- Determining the Values of Secondary Standards: Use only those certified by the manufacturer for a specific instrument. Secondary standards may be used for CCVs.

To initially determine the value of a secondary standard, assign the value that is determined immediately after an ICV or verification with primary standards. This is done by reading the secondary standard as a sample. This result must be within the manufacturer's stated tolerance range and +/- 10 percent of the assigned standard value. If the +/- 10 percent criterion is not met, assign this reading as the value of the standard. If the reading is outside the manufacturer's stated tolerance range, discard the secondary standard.

- CCV: Perform a CCV using at least one primary or secondary standard. The calibration acceptance criteria are the same as those for an ICV.

## **5.6 Direct Measurements**

Direct measurements with meters are the most common methods and can be accomplished by placing a sample in a container with the probe or by allowing the water to flow past the probe in a flow cell. The use of a flow-through cell improves measurement quality by allowing the constant flow of water over the probes and reduces interaction of the sample with the atmosphere. Sample cups should be avoided. The quantity of samples, timing, and methodology should be described in the project SAP.

Following calibration of required probes, connect the bottom flow-cell port to the discharge line of the pump. Connect the top port to a discharge line directed to a bucket to collect the purge water. Allow the flow cell to completely fill. As the water flows over the probe, record the measurements. Continue to record the measurements at regular intervals, as specified in the SAP.

When the ambient air temperatures are much higher or lower than the temperature of the water sample, it is best to keep the length of tubing between the wellhead and the flow cell as short as possible to prevent heating or cooling of the water. Tubing and flow-through cell should not be exposed to direct sunlight, particularly in the summer, if at all possible, to avoid heating of water samples.

## **5.7 Data Acquisitions, Calculations, and Data Reduction**

### **5.7.1 Specific Conductivity Correction Factors**

If the meter does not automatically correct for temperature (i.e., read Specific Conductivity) record Conductivity and adjust for temperature upon returning to the office. The following equation can be used to convert Conductivity to Specific Conductivity.

$$K = \frac{(Km)(C)}{1 + 0.0191(T - 25)}$$

Where:

- K = Conductivity in  $\mu\text{mhos/cm}$  at 25°C
- Km = Measured conductivity in  $\mu\text{mhos/cm}$  at T degrees Celsius
- C = Cell constant
- T = Measured temperature of the sample in degrees Celsius;

If the cell constant is 1, the formula for determining conductivity becomes:

$$K = \frac{(Km)}{1 + 0.0191(T - 25)}$$

### 5.7.2 Percentage Difference Calculation

For evaluating slope of readings from either a flow cell or a sample cup.

$$\%Difference = \frac{(Highest\ Value - Lowest\ Value)}{(Highest\ Value)} \times 100$$

### 5.7.3 Convert mm mercury (mmHG) to inches mercury (inHG)

$$mmHG = inHG \times 25.4$$

### 5.7.4 True Barometric Pressure

For converting BP obtained from a public domain source that is expressed in BP at sea level to BP at the subject site.

$$TrueBP = (BP) - \frac{(2.5 \times [Local\ Altitude])}{100}$$

Where: BP is in mmHG and Local Altitude is in feet

Example: BP at site A is 30.49 inHg and elevation is 544 feet, calculate TrueBP

Convert inHG to mmHG:

$$\text{mmHg} = 30.49 \text{ inHg} \times 25.4 = 774.4 \text{ mmHg}$$

Calculate True BP:

$$\text{TrueBP} = (774.4 \text{ mmHg}) - [2.5 * (544 / 100)] = 774.4 - 13.6 = 760.8 \text{ mmHg}$$

## **6.0 RECORDS**

Data will be recorded promptly, legibly, and in indelible ink on the appropriate logbooks and forms. At the completion of a field effort, all logbooks, field data forms, and calibration logs shall be scanned and made electronically available to the project team. The original field forms, calibrations logs, and log book will be maintained in the project file.

## **7.0 HEALTH AND SAFETY**

Detailed Health and Safety requirements can be found in the site specific Health and Safety Plan. Ensure that a Safe Work Assessment and Permit form is filled out daily prior to any work in the field and reviewed with all project personnel in a daily safety brief.

Safety glasses with side shields or goggles and disposable gloves shall be worn during calibration activities.

## **8.0 REFERENCES**

None

## **9.0 ATTACHMENTS**

Attachment 1: Example Field Instrument Calibration Form

Attachment 2: Solubility of Oxygen at Given Temperatures

Attachment 3: Example Field Data Form

**Attachment 1**  
**Example Field Instrument Calibration Form**

### Field Instrument Calibration Form

Calibrated by: \_\_\_\_\_  
Date: \_\_\_\_\_

Equipment (Make/Model/Serial#): \_\_\_\_\_  
Equipment (Make/Model/Serial#): \_\_\_\_\_

pH (su) <span style="float: right;">Standard: ± 0.2 standard units</span>				DO (mg/L) <span style="float: right;">Standard: ± 0.3 mg/L of theoretical*</span>			
Initial Calibration		Initial Calibration Verification		IC (Temp: _____)		ICV (Temp: _____)	
Hach SL	Reading	Pine SL	Reading	Saturation (%)	Reading (%)	Theoretical (mg/L)	Reading (mg/L)
pH7	<input type="text"/>	<input type="text"/>	<input type="text"/>	100	<input type="text"/>	<input type="text"/>	<input type="text"/>
pH4	<input type="text"/>	<input type="text"/>	<input type="text"/>				
Continuing Calibration Verification				CCV (Temp: _____)			
Hach SL	Reading	Deviation	Acceptable Variance (Y/N)	Saturation (%)	Reading (%)	Deviation	Acceptable Variance (Y/N)
pH7	<input type="text"/>	<input type="text"/>	<input type="text"/>	100	<input type="text"/>	<input type="text"/>	<input type="text"/>
pH4	<input type="text"/>	<input type="text"/>	<input type="text"/>	Theoretical (mg/L)	Reading (mg/L)	Deviation	Acceptable Variance (Y/N)
	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
ORP (mV) <span style="float: right;">Standard: NA</span>				Turbidity (ntu) <span style="float: right;">Standard: ±10% of Standard</span>			
IC (Zobell SL: _____)		ICV (Pine SL: _____)		Initial Calibration			
TCS (Std/Temp)	Reading	TCS (Std/Temp)	Reading	Standard	Reading		
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>		
CCV (Zobell SL: _____)				Continuing Calibration Verification			
TCS (Std/Temp)	Reading	Deviation	Acceptable Variance (Y/N)	Standard	Reading	Deviation	Acceptable Variance (Y/N)
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Conductivity (ms <sup>c</sup> /cm) <span style="float: right;">Standard: ± 5% of standard value</span>				Comments:			
IC (YSI SL: _____)		ICV (Pine SL: _____)					
Standard	Reading	Standard	Reading				
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>				
CCV (YSI SL: _____)							
Standard	Reading	Deviation	Acceptable Variance (Y/N)				
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>				

Notes:

SL	solution lot	su	standard units	ntu	Nephelometric Turbidity Units
TCS	temperature corrected standard	mV	millivolts	°C	degrees Celsius
Std	standard	%	percent	ms <sup>c</sup> /cm	millisiemens per centimeter (temperature corrected)
Temp	temperature	mg/L	milligrams per liter	*	Theoretical value

**Attachment 2**  
**Solubility of Oxygen at Given Temperatures**

## Field Measurement of Dissolved Oxygen

<b>Solubility of Oxygen in Water at Atmospheric Pressure</b>			
<b>Temperature</b>	<b>Oxygen Solubility</b>	<b>Temperature</b>	<b>Oxygen Solubility</b>
°C	mg/L	°C	mg/L
0.0	14.621	26.0	8.113
1.0	14.216	27.0	7.968
2.0	13.829	28.0	7.827
3.0	13.460	29.0	7.691
4.0	13.107	30.0	7.559
5.0	12.770	31.0	7.430
6.0	12.447	32.0	7.305
7.0	12.139	33.0	7.183
8.0	11.843	34.0	7.065
9.0	11.559	35.0	6.950
10.0	11.288	36.0	6.837
11.0	11.027	37.0	6.727
12.0	10.777	38.0	6.620
13.0	10.537	39.0	6.515
14.0	10.306	40.0	6.412
15.0	10.084	41.0	6.312
16.0	9.870	42.0	6.213
17.0	9.665	43.0	6.116
18.0	9.467	44.0	6.021
19.0	9.276	45.0	5.927
20.0	9.092	46.0	5.835
21.0	8.915	47.0	5.744
22.0	8.743	48.0	5.654
23.0	8.578	49.0	5.565
24.0	8.418	50.0	5.477
25.0	8.263		

**Notes:**

The table provides three decimals to aid interpolation

Under equilibrium conditions, the partial pressure of oxygen in air-saturated water is equal to that of the oxygen in water saturated

°C = degrees Celsius

mg/L = milligrams per liter

**Attachment 3**  
**Example Field Data Form**

WELL DEVELOPMENT & GROUNDWATER SAMPLING FORM		
DATE:	JOB NUMBER:	EQUIPMENT (Make/Model #/Serial #):
PROJECT:	EVENT:	/ /
WELL ID:	LOCATION:	/ /
WEATHER CONDITIONS:	AMBIENT TEMP:	/ /
REVIEWED BY:	PERSONNEL:	/ /

WELL DIA:	WELL DEVELOPMENT	
TOTAL DEPTH from TOC (ft.):	START:	FINISH:
DEPTH TO WATER from TOC (ft.):	VOLUME PURGED (gal):	
LENGTH OF WATER COL. (ft.):	GROUNDWATER SAMPLING	
1 VOLUME OF WATER (gal):	START:	FINISH:
3 VOLUMES OF WATER (gal):	VOLUME PURGED (gal):	
	ANALYSIS:	

WELL DEVELOPMENT PARAMETERS	GW SAMPLING PARAMETERS
Temperature: ± 1.0° C	Temperature: ± 0.2° C
pH: ± 0.5 standard units	pH: ± 0.2 standard units
Specific Conductance: ± 10% of the past measurement	Specific Conductance: ± 5% of the past measurement
Turbidity: relatively stable	DO: ≤ 20% saturation
	ORP: ± 10 millivolts
	Turbidity: ≤ 10 NTU

**IN-SITU TESTING**

Circle one:	DEVELOPMENT	SAMPLING	<input type="checkbox"/> Bailer	<input type="checkbox"/> Pump	Description:
Time (hh:mm):					
pH (units):					
Conductivity (mS/cm):					
Turbidity (NTU):					
DO (mg/L): YSI 556					
DO (mg/L): YSI 550					
Temperature (C°):					
ORP (mV):					
Volume Purged (gal):					
Depth to Water (ft):					
					Well Goes Dry While Purging <input type="checkbox"/>

**SAMPLE DATA**

Sample ID	Date (m/d/y)	Time (hh:mm)	<input type="checkbox"/> Bailer	<input type="checkbox"/> Pump	Description:

Purging/Sampling Device Decon Process:

**COMMENTS:**

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# Sediment Field Sieving and Pellet Removal/Counting

## Procedure 3-30

### 1.0 Purpose and Scope

- 1.1 This standard operating procedure (SOP) describes the procedure for the inspection of sediment samples for the presence of lead pellets using field sieving and subsequent collection of lead pellets and sediment for laboratory analysis.
- 1.2 Samples will be collected for chemical analyses. The project-specific analytes will be specified in the Sampling and Analysis Plan (SAP).
- 1.3 It is assumed that the sampling activities described in this SOP will be conducted in conjunction with SOP 3-32 Sediment Sampling Using a Vibracore.
- 1.4 This procedure is the Program-approved professional guidance for work performed by Resolution Consultants under the Comprehensive Long-Term Environmental Action Navy (CLEAN) contract (Contract Number N62470-11-D-8013).
- 1.5 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review.
- 1.6 It is fully expected that the procedures outlined in this SOP will be followed. Procedural modifications may be warranted depending upon field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this SOP will be approved in advance by the Program Quality Manager. Deviations to this SOP will be documented in the field records.

### 2.0 Safety

- 2.1 Depending upon the site-specific contaminants, various protective programs must be implemented prior to sampling the first location. All **field sampling personnel** responsible for sampling activities must review the project-specific health and safety plan (HASP) paying particular attention to the control measures planned for the sampling tasks. Conduct preliminary area monitoring to determine the potential hazard to field sampling personnel. If significant contamination is observed, minimize contact with potential contaminants in both the vapor and liquid phase through the use of respirators and disposable clothing.
- 2.2 Observe standard health and safety practices according to the project-specific HASP. Suggested minimum protection during well sampling activities includes inner disposable vinyl gloves, outer chemical-protective nitrile gloves, rubberized steel-toed boots, and an American National Standards Institute-standard hard hat. Half-face respirators and cartridges and Tyvek® suits may be necessary depending on the contaminant concentrations, and shall always be available on site.
- 2.3 Daily safety briefs will be conducted at the start of each working day before any work commences. These daily briefs will be facilitated by the **Site Safety Officer (SSO)** or designee to discuss the day's events and any potential health risk areas covering every aspect of the work to be completed. Weather conditions are often part of these discussions. As detailed in the HASP, everyone on the field team has the authority to stop work if an unsafe condition is perceived until the conditions are fully remedied to the satisfaction of the SSO.
- 2.4 Any retrieved material not placed back in the sampling location or sent for laboratory analysis will be handled in accordance with the IDW handling procedures in SOP 3-05, IDW Management.

### 3.0 Terms and Definitions

None.

### 4.0 Interferences

- 4.1 Debris (e.g., twigs, trash, roots, etc.) that is not removed from the soil prior to and during screening can lead to high bias in the amount retained for each screen.
- 4.2 Stainless steel sieves only should be used. Brass sieves may contain small amounts of lead and could interfere with subsequent laboratory testing of samples.

### 5.0 Training and Qualifications

#### 5.1 Qualifications and Training

- 5.1.1 The individual executing these procedures must have read, and be familiar with, the requirements of this SOP.

#### 5.2 Responsibilities

- 5.2.1 The **Contract Task Order (CTO) Manager** is responsible for ensuring that the sediment sampling activities comply with this procedure. The CTO Manager or designee shall review all sediment sampling forms on a minimum monthly basis. The CTO Manager is responsible for ensuring that all field sampling personnel involved in sediment sampling shall have the appropriate education, experience, and training to perform their assigned tasks.
- 5.2.2 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.
- 5.2.3 The **Field Manager** is responsible for ensuring that all field sampling personnel follow these procedures.
- 5.2.4 **Field sampling personnel** are responsible for the implementation of this procedure. Minimum qualifications for field sampling personnel require that one individual on the field team shall have a minimum of 6 months of experience with sediment sampling.
- 5.2.5 The **field sampler and/or task manager** is responsible for directly supervising the sediment sampling procedures to ensure that they are conducted according to this procedure, and for recording all pertinent data collected during sampling. If deviations from the procedure are required because of anomalous field conditions, they must first be approved by the Program Quality Manager and then documented in the field logbook and associated report or equivalent document.

### 6.0 Equipment and Supplies

- Previously collected and homogenized sediment samples. These samples were collected and prepared pursuant to SOP 3-32 Sediment Sampling Using a Vibracore and the site SAP and sampled for VOCs prior to starting the procedure described herein.
- Small stainless steel spoon or rubber spatula
- 2mm (No. 10) stainless steel sieve screen
- A funnel with diameter slightly greater than that of the sieve frame
- Stainless steel bowl to capture rinsate water (also must be large than sieve frame and large enough to capture all rinsate water)
- Two stainless steel mixing bowls (for homogenizing of "fine" and "coarse" samples)
- Squirt bottle filled with seawater for rinsate
- Decanting equipment

- Sediment Sampling Log
- Field logbook and pen
- Chain-of-custody form
- PPE (Tyvek, gloves, safety glasses, grade 1 CSA approved boots, hard hat, face shield, etc.)
- Site HASP
- Project Sampling and Analysis Plan (SAP)
- Camera (optional)

## **7.0 Procedure**

- 7.1 Don the Level D PPE as instructed in the site-specific HASP.
- 7.2 Decontaminate all collection materials (shovels, sieves, funnel, bowls, etc.) prior to and between each sample.
- 7.3 Use scale to weigh the homogenized 0-6 inch sediment sample from the first sample location. Record weight on field form to the nearest gram.
- 7.4 Place a No. 10 mesh size sieve in a funnel, with a bowl underneath. Moisten the sieve using a light spray of seawater.
- 7.5 Use the shovel to place a small amount of sediment onto the No. 10 sieve. Remove any debris (e.g., sticks, trash, roots, large particles, etc).
- 7.6 Thoroughly rinse any residue from the shovel into the sieve.
- 7.7 Wash the sediment on to the sieve with seawater using a water squirt bottle having low water pressure and gentle agitation of the sieve. Aggregates can be gently broken using a rubber spatula or spoon. Care should be taken to ensure that all material passed through the sieve is captured in the stainless steel bowl beneath.
- 7.8 Continue wet sieving until only clear water passes through the sieve. Note on the field form the presence of lead pellets or any other anomalies.
- 7.9 If necessary, a camera can be used to photo-document lead pellets or other anomalies.
- 7.10 Repeat steps 7.5 through 7.9 until all sediment from the composite sample location has been processed.
- 7.11 When all fines have been passed through the sieve and the rinsate is rinsing clear, the samples will be allowed to sit for a minimum of 5 minutes to allow fines to settle. The seawater rinsate that was flushed over the sample will then be decanted by gently tipping the container to drain the rinsate liquid off the surface. Care should be taken to ensure fines are not lost during this process.
- 7.12 Homogenize all fine material that passed through the sieve in a decontaminated stainless steel mixing bowl and prepare sediment samples for this composite sample location in appropriate sample containers.
- 7.13 The coarse material that does not pass through the sieve that may contain or potentially consists of lead pellets in a separate decontaminated stainless steel bowl. Place all coarse material into an appropriately sized and labelled glass jar. Samples will be sent to a subcontracted laboratory for lead shot count analysis.
- 7.14 Repeat steps 7.2 through 7.13 for each composite sampling location.

## 8.0 Quality Control and Assurance

- 8.1 Field personnel will follow specific quality assurance (QA) guidelines as outlined in the project-specific SAP. The goal of the QA program should be to ensure precision, accuracy, representativeness, completeness, and comparability in the project sampling program.
- 8.2 Quality control (QC) requirements for sample collection are dependent on project-specific sampling objectives. The project-specific SAP will provide requirements for sample preservation and holding times, container types, sample packaging and shipment, as well as requirements for the collection of various QC samples such as trip blanks, field blanks, equipment rinse blanks, and field duplicate samples.
- 8.3 The field forms and field notes generated from this procedure will be reviewed by the sampling team leader, CTO manager, or designee.

## 9.0 Data and Records Management

- 9.1 Records will be maintained in accordance with SOP 3-03, Recordkeeping, Sample Labelling, and Chain-of-Custody. Various forms are required to ensure that adequate documentation is made of the sample collection activities. These forms may include:
- Sample Collection Records;
  - Field logbook;
  - Chain-of-custody forms; and
  - Shipping labels.
- 9.2 The Sediment Sampling Log will provide descriptive information for the samples collected at each square foot grid.
- 9.3 The field logbook is kept as a general log of activities and should not be used in place of the sample collection record.
- 9.4 Chain-of-custody forms are transmitted with the samples to the laboratory for sample tracking purposes.
- 9.5 Shipping labels are required to be placed on sample containers and samples are required to be placed into sample coolers. The coolers are to be transported to a laboratory by a third party (courier service).
- 9.6 Unanticipated changes to the procedures or materials described in this SOP (deviations) will be appropriately documented in the project records.
- 9.7 Records associated with the activities described in this SOP will be maintained according to the document management policy for the project.

## 10.0 Attachments or References

SOP 3-03, *Recordkeeping, Sample Labelling, and Chain-of-Custody*

SOP 3-05, *IDW Management*.

SOP 3-06, *Equipment Decontamination*.

Author	Reviewer	Revisions (Technical or Editorial)
Naomi Ouellette, Project Manager	Ryan McCarthy, Environmental Scientist	Rev 0 – Initial Issue (August 2012)

## Sediment Coring Using a Vibracorer

### Procedure 3-32

#### 1.0 Purpose and Scope

- 1.1 The purpose of this document is to define the standard operating procedure (SOP) for collecting cores using a vibracoring device. This SOP describes the equipment, field procedures, materials, and documentation procedures necessary to collect cores using a vibracore. Specific information regarding coring locations can be found in the associated Sampling and Analysis Plan (SAP).
- 1.2 This procedure is the Program-approved professional guidance for work performed by Resolution Consultants under the Comprehensive Long-Term Environmental Action Navy (CLEAN) contract (Contract Number N62470-11-D-8013).
- 1.3 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review. If there are procedures whether it be from Resolution Consultants, state and/or federal that are not addressed in this SOP and are applicable to surface water sampling then those procedures may be added as an appendix to the project specific SAP.
- 1.4 It is fully expected that the procedures outlined in this SOP will be followed. Procedural modifications may be warranted depending upon field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this SOP will be approved in advance by the Program Quality Manager. Deviations to this SOP will be documented in the field records.

#### 2.0 Safety

- 2.1 Depending upon the site-specific contaminants, various protective programs must be implemented prior to sampling with a Vibracorer. All **field sampling personnel** responsible for sampling activities must review the project-specific health and safety plan (HASP) paying particular attention to the control measures planned for the sampling tasks. Conduct preliminary area monitoring to determine the potential hazard to field sampling personnel. If significant contamination is observed, minimize contact with potential contaminants in both the vapor and liquid phase through the use of respirators and disposable clothing.
- 2.2 In addition, observe standard health and safety practices according to the project-specific HASP. Suggested minimum protection during well sampling activities includes inner disposable vinyl gloves, outer chemical-protective nitrile gloves, rubberized steel-toed boots, and an American National Standards Institute-standard hard hat. Half-face respirators and cartridges and Tyvek® suits may be necessary depending on the contaminant concentrations, and shall always be available on site.
- 2.3 Daily safety briefs will be conducted at the start of each working day before any work commences. These daily briefs will be facilitated by the **Site Safety Officer (SSO)** or designee to discuss the day's events and any potential health risk areas covering every aspect of the work to be completed. Weather conditions are often part of these discussions. As detailed in the HASP, everyone on the field team has the authority to stop work if an unsafe condition is perceived until the conditions are fully remedied to the satisfaction of the SSO.
- 2.4 The health and safety considerations for the work associated with vibracoring include:
  - The physical hazards of handling heavy equipment,
  - Overhead lifting hazards using boat-based winches and A-frames,
  - Marine safety aspects of the program,

- The specific chemical hazards related to the sediments, and
- Sharp edges of cut aluminum tubing.

### 3.0 Terms and Definitions

None.

### 4.0 Interferences

- 4.1 In some cases, the addition of a piston to the corer may be appropriate and in all cases field personnel should continually monitor the core progression and ensure that the core sample is not vibrated excessively if the downward progression has ceased.
- 4.2 In hard bottom or shallow areas inaccessible by a vibracoring barge platform, a Little Champ Vibracorer or portable two-person Vibracorer may be utilized.
- 4.3 Common interferences encountered during core driving are listed below:

Interference	Possible Effect	Action Taken to Minimize Effect
Vibratory action	Consolidate/compact sediment during driving	Vibrate only as needed to advance the tube; use of a piston to improve recovery; establish minimum acceptance criteria
Loss of material out bottom	Less drive length achieved; gaps in retained sediment	Use core catcher
Blocking	Material doesn't enter core tube or lessens recovery	Move off station and re-drive; establish minimum acceptance criteria
Angled entry	Drive length less than expected and fore-shortened	Make sure that wire line is vertical during core driving
GPS satellite accuracy is low	Less confidence in station location	Wait until GPS accuracy returns to acceptable limits and resume or use a buoy marker or land-survey techniques to confirm sample location.

### 5.0 Training and Qualifications

#### 5.1 Qualifications and Training

- 5.1.1 The individual executing these procedures must have read, and be familiar with, the requirements of this SOP.

#### 5.2 Responsibilities

- 5.2.1 The **Contract Task Order (CTO) Manager** is responsible for ensuring that monitoring well sampling activities comply with this procedure. The **CTO Manager** is responsible for ensuring that all field sampling personnel involved in Vibracorer sediment sampling shall have the appropriate education, experience, and training to perform their assigned tasks.
- 5.2.2 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.
- 5.2.3 The **Field Manager (FM)** is responsible for ensuring that all field sampling personnel follow these procedures.
- 5.2.4 **Field sampling personnel** are responsible for the implementation of this procedure. Minimum qualifications for field sampling personnel require that one individual on the field team shall have a minimum of 6 months of experience with sampling monitoring wells.

- 5.2.5 The **field sampler and/or task manager** is responsible for directly supervising the Vibracorer sampling procedures to ensure that they are conducted according to this procedure, and for recording all pertinent data collected during sampling. If deviations from the procedure are required because of anomalous field conditions, they must first be approved by the Program Quality Manager and then documented in the field logbook and associated report or equivalent document.
- 5.2.6 Actual vibracoring operations will be conducted only by personnel experienced with the equipment, but subsequent manipulations, measurements, cutting and labeling procedures are relatively simple and can be implemented by personnel without specialized training. It is recommended that initial core manipulations and handling activities be supervised by more experienced personnel.
- 5.2.7 Sampling personnel will also be health and safety trained and certified as specified in the HASP.

## **6.0 Equipment and Supplies**

- 6.1 The following equipment list contains materials that may be needed in carrying out the procedures outlined in this SOP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.
- Personal protective equipment (PPE) and other safety equipment, as required by the HASP;
  - Navigation charts and Core Locations figure;
  - Sampling vessel adequate for task at hand and weather conditions;
  - Marine VHF radio;
  - Positioning equipment;
  - Vibracoring device;
  - Deployment equipment (e.g., A-frames, winches, generator);
  - Decontaminated polybutyrate (plastic Lexan) core tube liners;
  - Decontaminated aluminum core barrels (for Little Champ Vibracorer or portable two-person vibracorer only);
  - Decontaminated stainless steel core cutter/catcher;
  - Hacksaw;
  - Tubing cutter;
  - Decontaminated hacksaw blades;
  - Decontaminated drill bits and/or Unibits;
  - Drill;
  - Daily Activity Log;
  - Yuma or comparable portable tablet/computer outfitted with appropriate software for record keeping;
  - Core Log Form;
  - Core storage racks to hold cores vertical and cold during temporary storage on-board coring vessel;
  - Assorted nautical equipment (e.g., anchors, lines, personal flotation devices [PFDs]);
  - Waterproof logbooks, pens, and labels;
  - Permanent marker or grease pencil;
  - Echo sounder with a resolution of 0.1 foot;

- Weighted line or survey rod, with graduations of 0.1 foot;
- Depth measuring plate;
- Tape measure and ruler;
- Submersible pump and hose;
- Decontaminated core tube caps;
- Electrical tape, duct tape, PVC pipe tape, or “Gorilla” tape;
- Camera; and,
- Decontamination equipment/supplies (refer to 3-06 – Equipment Decontamination).

## **7.0 Calibration or Standardization**

- 7.1 Field instruments will be calibrated daily according to the requirements of the SAP and manufacturer’s specifications for each piece of equipment. Equipment will be checked daily with the calibration solutions at the end of use of the equipment. Calibration records shall be recorded in the field logbook or appropriate field form.
- 7.2 If readings are suspected to be inaccurate, the equipment shall be checked with the calibration solutions and/or re-calibrated.

## **8.0 Procedure**

Cores will be collected using a vibracoring device. Following collection, cores will be transported to the sample processing area.

### **8.1 Sampling procedures**

This section gives the step-by-step procedures for collecting cores using a vibracore. Observations made during sediment core collection should be recorded on the Core Log Form and/or the electronic data recording device.

#### **8.1.1 Decontamination of equipment**

Decontamination of the polybutyrate core liners or aluminum core barrels, core caps, stainless steel core cutter/catcher, hacksaw blades, drill bits, and assemblies will be performed prior to vessel departure in accordance with procedures outlined in SOP 3-06 – Equipment Decontamination. The decontamination activities will occur on shore and will be conducted with enough time before vessel departure to allow for the decontamination activities to be completed (including drying of decontaminated equipment). A sufficient amount of decontamination equipment and supplies will be brought on the coring vessel to accommodate the need for miscellaneous, unforeseen decontamination. The hacksaw blade used to cut the core will be decontaminated between each segment.

#### **8.1.2 Locating coring position**

1. The coring schedule for the day will be established prior to vessel departure and sufficient equipment to complete the work will be on board the sampling vessel. The coring crew will be informed prior to departure of the coring locations and the number of cores required at each location. The number of cores to be recovered at each location will be determined by the sample volume requirements of the project analytical program. As necessary, coring locations will be probed prior to the day of coring to check for obstructions, and, where hard bottom conditions are suspected, to confirm the suitability of the sediment surface for coring.

2. If hard bottom (such as gravel) sediments are found at a river station, probing may be performed within the target area and in the direction of the alternate core locations (20 feet up- and down-stream, or as specified in the SAP) to assess whether movement of the core location is warranted.
3. Upon collection of a sample, the actual sampling site will be documented by a back pack DGPS unit or by a physical measurement from a fixed feature if satellite reception cannot be acquired.

#### 8.1.3 **Collection of core samples (boat based)**

4. Initiate the Core Log Form.
5. Don PPE as required by the HASP.
6. Activate the submersible pump in preparation for cleaning the vibracore and coring tube, upon retrieval.
7. At the start of the coring program, two attempts will be made at coring without the use of a core catcher. If the sediment cannot be retained in the core tube, then core catchers will be used for the remainder of the program at stations with similar materials.
8. Slowly winch the vibracore into its deployment orientation.
9. Obtain water depth (to nearest 0.1 foot) from the echo sounder or via deployment of a weighted line or survey rod with graduations of 0.1 foot. Record on Core Log Form (Attachment 1).
10. Slowly lower the vibracore into the water using the winch or other deployment equipment.
11. Slowly lower the vibracore through the water column to the sediment surface using the water depth reading.
12. Record the “zero” mark on the winch cable.
13. Turn motor of vibracorer on. Slowly lower vibracore into sediment to penetrate the sediment to the red-brown clay layer, sand or refusal. Record the start time on the Core Log Form.
14. Lower vibracore approximately 1 foot more to obtain a “plug” at the bottom of the core (i.e., to minimize loss of sediment from core). Record the end time on the Core Log Form.
15. On completion of the required penetration, or upon vibracore refusal, de-energize the vibracore and allow the core to stabilize for a period of 10 minutes. If a core catcher is used, the 10 minute residence time is not necessary. Record the vibracore penetration depth on the Core Log Form.
16. Record the final core location coordinates on the Core Log Form.
17. Slowly raise the vibracore, while maintaining the core in a vertical position as field conditions allow.
18. Bring vibracore to sampling vessel deck while maintaining the core in a vertical position. Remove core cutter and core catcher, replace with cap, and secure cap with duct tape.
19. Clean the vibracore barrel and coring assembly by hosing down the equipment with river water. Apply the typical equipment decontamination procedures described in SOP 3-06 – Equipment Decontamination, as provided for other similar equipment.
20. Remove the core tube from the vibracore barrel and place a cap on bottom of the coring tube, keeping the core tube in an upright position, as field conditions allow.
21. Return the vibracore device to its onboard, deck storage location.
22. Clean the core tube by hosing it down with river water. Care should be taken not to direct water into the open end of the core tube.

23. Evaluate whether core penetration and recovery are acceptable using the procedures outlined in Sections 8.1.6 and 8.1.7, respectively. [Note: When red-brown sand or clay or refusal is encountered prior to achieving the target depth, procedures used to determine acceptable core penetration will no longer be applicable. For example, if a clay plug is encountered during the first attempt, no additional attempts shall be made. In cases where coring personnel believe that clay was encountered prior to achieving the target depth, but a clay plug was not recovered in the core, up to 3 attempts may be made at that location to obtain a clay plug.]
24. Keeping the core tube upright, as field conditions allow, use a hacksaw with a decontaminated blade or drill with a decontaminated drill bit to make a cut/hole in the core tube approximately 1 to 2 inches below the water level and allow the excess water to drain out. Continue to lower the water level in 1 or 2 inch increments until 3 to 4 inches of water remain above the sediment.
25. Cap the cut end of the tube with decontaminated core cap, secure cap with duct tape, and draw an arrow toward the cap on the coring tube with permanent marker. Label "top" to indicate the top of the core. Also label the core with the location ID, date, and time, and record this information on the Core Log Form.
26. Mark the side of the core to indicate the sediment-water interface. Measure the recovered length of the sediment in the core tube (to the nearest 0.1 foot to the extent possible) and record it on the Core Log Form. The distance between the top of the sediment in the coring tube and the bottom of the coring tube corresponds to the recovered length. Apparent gaps should be noted on the Core Log Form and the length and location(s) of the gap(s) should be noted. The total gap length will be subtracted from the total recovery length.
27. Store the core vertically in a core storage rack (capable of keeping cores cold) while on the vessel until it can be transported to the sample processing area. Cores greater than 5.5 feet will be segmented on the vessel to allow for storage and transportation. Cut these cores at the location of a planned sample segmentation using a hacksaw with a decontaminated blade and recap the exposed ends. Add appropriate markings to indicate the location and unique identification of each segment. (Segments will be identified as AB, BC, CD, etc., with the first letter marked just below the upper cut, and the second letter marked just above the lower cut).

#### 8.1.4 **Collection of core samples (Little Champ Vibracorer or portable two-person vibracorer.)**

1. Initiate the Core Log Form.
2. Don PPE as required by the HASP.
3. At the start of the coring program, two attempts will be made at coring without the use of a core catcher. If the sediment cannot be retained in the core tube, then core catchers will be used for the remainder of the program at stations with similar materials.
4. Raise the vibracore into its deployment orientation.
5. Energize the vibracore and drive the barrel to a full penetration depth. Record the start time on the Core Log Form.
6. On completion of the required penetration, or upon vibracore refusal, de-energize the vibracore. Record the vibracore penetration depth on the Core Log Form.
7. Record the core location coordinates on the Core Log Form.
8. Slowly raise the vibracore, while maintaining the core in a vertical position as field conditions allow.
9. Cap the bottom of the aluminum barrel and secure with plastic tape.
10. Tap the outside of the aluminum barrel with a metal object to determine the elevation of the sediments in the barrel (as indicated by the change in pitch).

11. Evaluate whether core penetration and recovery are acceptable using the procedures outlined in Sections 8.1.6 and 8.1.7, respectively. [Note: When clay or refusal is encountered prior to achieving the target depth, procedures used to determine acceptable core penetration will no longer be applicable. For example, if a clay plug is encountered during the first attempt, no additional attempts shall be made. In cases where coring personnel believe that clay was encountered prior to achieving the target depth, but a clay plug was not recovered in the core, up to 3 attempts may be made at that location to obtain a clay plug.]
12. Keeping the core tube upright, as field conditions allow, use a unibit to make a cut/hole in the core tube approximately 3 to 4 inches below the water level (as determined by Step 10) and allow the excess water to drain out. Continue to lower the water level in 1 or 2 inch increments until 3 to 4 inches of water remain above the sediment.
13. Cut away the excess aluminum liner using a tubing cutter. Cap the cut end of the tube, secure the cap with duct tape (or equivalent), and draw an arrow toward the cap on the coring tube with permanent marker and label "top" to indicate the top of the core. Also label the core with the location ID, date, and time, and record this information on the Core Log Form.
14. Mark the side of the core to indicate the sediment-water interface. Measure the recovered length of the sediment in the core tube (to the nearest 0.1 foot to the extent possible) and record it on the Core Log Form. The distance between the top of the sediment in the coring tube and the bottom of the coring tube corresponds to the recovered length.
15. Store the core vertically in a core storage rack (capable of keeping cores cold) while on the vessel, until it can be transported to the sample processing area. At locations where a vessel is not used, transport the core back to the support vehicle for vertical cold storage prior to transfer to the processing area. Cores greater than 5.5 feet will be segmented to allow for storage and transportation. Cut these cores at the location of a planned sample segmentation using a tubing cutter and recap the exposed ends. Add appropriate markings to indicate the location and unique identification of each segment. (Segments will be identified as AB, BC, CD, etc., with the first letter marked just below the upper cut, and the second letter marked just above the lower cut).

#### 8.1.5 **Collection of samples without corer**

If site conditions preclude the collection of a core sample, then a sample of any available sediment suitable for analysis will be collected using a decontaminated stainless steel spoon/ utensil. The sediment will be collected from an area exposed at low tide and placed into a Teflon-lined 1-gallon bucket and delivered on ice to the field facility for processing. The sample will be of available sediment material and may not be of sufficient quantity for all analytes (the prioritization of analyte collection described in the SAP will be utilized or will be determined in consultation with the CTO Manager).

#### 8.1.6 **Procedures for determining acceptable core penetration**

1. Calculate penetration percentage using the following equation:

$$\text{Penetration (\%)} = \frac{\text{actual penetration (feet)}}{\text{target penetration (feet)}} \times 100$$

2. Actual penetration is the depth advanced into the sediment not including the depth advanced to form a plug.
3. Record penetration percentage on the Core Log Form.
4. If penetration is  $\geq 80\%$ , then penetration is acceptable. Proceed to Section 8.1.7, Procedures for Determining Acceptable Core Recovery.
5. If penetration is  $< 80\%$ , then (a) retain core and (b) record on the Core Log Form if due to refusal. Record additional penetration notes at the Notes section of the Core Log Form. Adjust the vessel

location slightly prior to next sampling attempt. Upon three unsuccessful attempts to obtain >80% penetration, contact the Field Manager to determine if additional cores should be attempted (Section 8.1.7.4, below). Proceed to Section 8.1.7, Procedures for determining acceptable core recovery, below.

#### 8.1.7 **Procedures for determining acceptable core recovery**

1. Calculate recovery percentage by the following equation:

$$\text{Recovery (\%)} = \frac{\text{recovery (feet)} - \text{gaps (feet)}}{\text{actual penetration (feet)}} \times 100$$

2. Record recovery percentage on the Core Log Form.
3. If recovery is  $\geq 80\%$ , then recovery is acceptable, provided that the core reached the target depth. Continue processing core, then move to a new core location. Proceed to Step 2 of Sections 8.1.3 and 8.1.4 for collection of second core. If the recovery  $< 80\%$ , proceed to Step 4.
4. If recovery is  $< 80\%$ , then (a) retain core and (b) adjust vessel location slightly prior to the next attempt. Upon three unsuccessful attempts to obtain  $> 80\%$  recovery, contact the Field Manager to determine if additional cores should be attempted. The vessel will proceed to next station. The Field Manager will provide the field team with two alternate station locations; one directly upstream and one directly downstream of the original station location at a distance to be determined of up to 20 feet (or as specified in the SAP). One attempt at sample collection will be made at the first alternate location. If this attempt does not yield an acceptable sample, then one attempt will be made at the second alternate location. No further attempts at that station will be performed if after occupying both of the alternate stations an acceptable sample has not been recovered. Record all attempts on the Core Log Form. Communications with the Field Manager will be documented in the field logbook. Failure to collect a core at a specified location will also be recorded field logbook.
5. Upon collection of acceptable core(s) proceed to Section 8.1.8, Management of cores, below.

#### 8.1.8 **Management of cores**

1. Containerize excess sediment on the vessel. The field crew will make reasonable attempts to containerize "gross" sediment material produced from coring. Sediment residuals generated from rinsing operations will not be included in such containerization. Dispose of solid material (e.g., core tube, caps, sediment) in accordance with SOP 3-05 – IDW Management.
2. Verify that the lengths of the core tubes, water depth, and positioning data have been recorded on the Core Collection Form.
3. Prior to transit to the next coring location or return to the marina, decontaminate the coring equipment and sampling vessel as described in SOP 3-06 – Equipment Decontamination.
4. Proceed to next core location specified for that day and repeat above procedures.
5. Completed Core Log Forms will be provided to the field processing personnel when relinquishing cores for processing.

### 9.0 **Quality Control and Assurance**

- 9.1 Field personnel will follow specific quality assurance (QA) guidelines as outlined in the project-specific SAP. The goal of the QA program should be to ensure precision, accuracy, representativeness, completeness, and comparability in the project sampling program.
- 9.2 Quality control (QC) requirements for sample collection are dependent on project-specific sampling objectives. The project-specific SAP will provide requirements for sample preservation and holding times, container types, sample packaging and shipment, as well as requirements for the collection of

various QC samples such as trip blanks, field blanks, equipment rinse blanks, and field duplicate samples.

- 9.3 Completing the Core Log Form provided in Attachment 1 will document that the process is being followed and that pertinent information is being collected and recorded in accordance with the procedures outlined in this SOP.
- 9.4 Entries on the forms and in the field logbook will be double-checked by the samplers to verify the information is correct. Completed forms will be reviewed periodically by the Field Manager or designee to verify that the requirements are being met.

## **10.0 Data and Records Management**

- 10.1 Information collected during monitoring vibracore sampling shall be documented on the Core Log Form in indelible ink (Attachment 1). Copies of this information shall be sent to the CTO Manager for the project files.
- 10.2 Field notes will be kept during coring activities in accordance with SOP 3-03 – Recordkeeping, Sample Labeling, and Chain of Custody. The information pertinent to coring activities includes chronology of events, sample locations (x,y,z), time/date, sampler name, methods (including type of core liner/barrel, if applicable), sampler penetration and acceptability, sample observations, and the times and type of equipment decontamination. This information will be recorded in the field logbook or Core Log Form, as appropriate.
- 10.3 Deviations to the procedures detailed in the SOP should be recorded in the field logbook.

## **11.0 Attachments or References**

- 11.1 NAVSEA T0300-AZ-PRO-010. *Navy Environmental Compliance Sampling and Field Testing Procedures Manual*. August 2009.

<i>Author</i>	<i>Reviewer</i>	<i>Revisions (Technical or Editorial)</i>
Robert Shoemaker Senior Scientist	Naomi Ouellette, Project Manager	Rev 0 – Initial Issue

# Subsurface Soil Sampling by Split Spoon

## Procedure 3-33

### 1.0 Purpose and Scope

- 1.1 This standard operating procedure (SOP) describes the methods used in obtaining subsurface soil samples using a split spoon for physical and/or chemical analysis. Subsurface soil samples are obtained in conjunction with soil boring programs and provide information as to the physical and/or chemical makeup of the subsurface environment. Specific information regarding sampling locations can be found in the associated Sampling and Analysis Plan (SAP).
- 1.2 The purpose of this SOP is to provide a description of a specific method or procedure to be used in the collection of subsurface soil samples. Subsurface soil is defined as unconsolidated material which may consist of one or a mixture of the following materials: sand, gravel, silt, clay, peat (or other organic soils), and fill material. Subsurface soil sampling, conducted in accordance with this SOP will promote consistency in sampling and provide a basis for sample representativeness.
- 1.3 This SOP covers subsurface soil sampling by split-spoon only, as this is the means most often used for obtained samples of unconsolidated deposits. Other types of equipment are available for use in subsurface soil sampling, including thin-wall tube samplers (Shelby tubes), piston samplers, and continuous core barrel samplers. Information on the use of these other sampling devices may be found in several available drilling handbooks and respective state and/or federal agency technical guidance documents. The American Society for Testing and Materials (ASTM) also provides procedures for use of split-spoon and other sampling devices.
- 1.4 Split-spoon subsurface soil sampling generally requires use of a drilling rig and typically the hollow-stem auger (HSA) or other common drilling method to generate a borehole in which to use the split-spoon sampler. The split-spoon sampler is inserted through the augers (or other type of drill casing) then is driven into the subsurface soil with a weighted hammer. The sampler is then retrieved and opened to reveal the recovered soil sample. Soil samples may be collected at a continuous interval or at pre-selected vertically spaced intervals within the borehole.
- 1.5 This procedure is the Program-approved professional guidance for work performed by Resolution Consultants under the Comprehensive Long-Term Environmental Action Navy (CLEAN) contract (Contract Number N62470-11-D-8013).
- 1.6 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review. If there are procedures whether it be from Resolution Consultants, state and/or federal that are not addressed in this SOP and are applicable to surface water sampling then those procedures may be added as an appendix to the project specific SAP.
- 1.7 It is fully expected that the procedures outlined in this SOP will be followed. Procedural modifications may be warranted depending upon field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this SOP will be approved in advance by the Program Quality Manager. Deviations to this SOP will be documented in the field records.

## **2.0 Safety**

- 2.1** Depending upon the site-specific contaminants, various protective programs must be implemented prior to sampling the first location. All **field sampling personnel** responsible for sampling activities must review the project-specific health and safety plan (HASP) paying particular attention to the control measures planned for the sampling tasks. Conduct preliminary area monitoring to determine the potential hazard to field sampling personnel. If significant contamination is observed, minimize contact with potential contaminants in both the vapor and liquid phase through the use of respirators and disposable clothing.
- 2.2** In addition, observe standard health and safety practices according to the project-specific HASP. Suggested minimum protection during well sampling activities includes inner disposable vinyl gloves, outer chemical-protective nitrile gloves, rubberized steel-toed boots, and an American National Standards Institute-standard hard hat. Half-face respirators and cartridges and Tyvek® suits may be necessary depending on the contaminant concentrations, and shall always be available on site.
- 2.3** Daily safety briefs will be conducted at the start of each working day before any work commences. These daily briefs will be facilitated by the **Site Safety Officer (SSO)** or designee to discuss the day's events and any potential health risk areas covering every aspect of the work to be completed. Weather conditions are often part of these discussions. As detailed in the HASP, everyone on the field team has the authority to stop work if an unsafe condition is perceived until the conditions are fully remedied to the satisfaction of the SSO.
- 2.4** The health and safety considerations for the work associated with split spoon sampling include:
- To avoid lifting injuries associated with carrying split spoons and associated drilling/sampling equipment, use large muscles of the legs, not the back.
  - Stay clear of all moving equipment, and avoid wearing loose fitting clothing.
  - To avoid heat/cold stress as a result of exposure to extreme temperatures and PPE, drink electrolyte replacement fluids (1 to 2 cups per hour is recommended) and in case of extreme cold, wear fitted insulated clothing.
  - Be aware of restricted mobility due to PPE.
  - At no point should soil samples be put into the mouth.

## **3.0 Terms and Definitions**

None.

## **4.0 Interference**

Potential interferences could result from cross-contamination between samples or sample locations. Minimization of the cross contamination will occur through the following:

- The use of clean sampling tools at each location as necessary.
- Avoidance of material that is not representative of the media to be sampled.
- Extreme temperatures or humidity can affect the reliability of certain field screening equipment, such as photoionization detectors (PID).
- If screening soil samples for headspace readings in extreme cold temperatures, samples may need to be warmed slightly prior to screening.

## **5.0 Training and Qualifications**

### **5.1 Qualifications and Training**

5.1.1 The individual executing these procedures must have read, and be familiar with, the requirements of this SOP.

### **5.2 Responsibilities**

5.2.1 The **Contract Task Order (CTO) Manager** is responsible for ensuring that split spoon sampling activities comply with this procedure. The **CTO Manager** is responsible for ensuring that all field sampling personnel involved in split spoon sampling shall have the appropriate education, experience, and training to perform their assigned tasks.

5.2.2 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.

5.2.3 The **Field Manager (FM)** is responsible for ensuring that all field sampling personnel follow these procedures.

5.2.4 **Field sampling personnel** are responsible for the implementation of this procedure. Minimum qualifications for field sampling personnel require that one individual on the field team shall have a minimum of 6 months of experience with split spoon sampling.

5.2.5 The **field sampler and/or task manager** is responsible for conducting split spoon soil sampling in a manner which is consistent with this SOP. The field sampler or designee will observe all activities pertaining to split spoon soil sampling to ensure that the SOP is followed, and to record all pertinent data onto a boring log. It is also the responsibility of the field sampler or designee to indicate the specific targeted sampling depth or sampling interval to the drilling subcontractor. The field sampler or designee is also responsible for the collection of representative environmental or stratigraphic characterization samples once the sampling device has been retrieved and opened. Additional sample collection responsibilities include labelling, handling, and storage of samples until further chain-of-custody procedures are implemented. If deviations from the procedure are required because of anomalous field conditions, they must first be approved by the Program Quality Manager and then documented in the field logbook and associated report or equivalent document.

5.2.6 It will be the responsibility of the **drilling subcontractor** to provide the necessary materials for obtaining subsurface soil samples. This generally includes one or more split-spoon samplers in good operating condition and sample containers used for stratigraphic characterization samples (sample containers for environmental samples should be provided by the designated analytical laboratory). It is the drilling subcontractor's responsibility to provide and maintain their own boring logs if desired. Equipment decontamination materials should also be supplied by the subcontractor and should meet project specifications.

5.2.7 Sampling personnel will also be health and safety trained and certified as specified in the HASP.

## **6.0 Equipment and Supplies**

In addition to those materials provided by the subcontractor, the following equipment list contains materials which may be needed in carrying out the procedures outlined in this SOP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- SAP and HASP
- Personal protective equipment (PPE) and other safety equipment, as required by the HASP
- Boring logs
- Teaspoon or spatula (stainless steel is recommended)

- Sample kit (bottles, labels, custody records and tape, cooler with ice)
- Folding rule or tape measure
- Equipment decontamination materials
- Geologist Table
- Field logbook and pen with indelible ink

## **7.0 Calibration or Standardization**

Field screening instruments (eg. PIDs) should be calibrated following manufacturer's instructions prior to the start of work and as a set time interval throughout the day. Calibration information should be recorded in the field log book or on a calibration log form.

## **8.0 Procedure**

### **8.1 General Method Description**

Split-spoon sampling devices are typically constructed of steel and are most commonly available in lengths of 18 and 24 inches and diameters of 1.5 to 3 inches. The split-spoon consists of a tubular body with two halves that split apart lengthwise, a drive head on the upper end with a ball-check valve for venting, and a hardened steel cutting shoe at the bottom. The soil sample enters the split-spoon through the cutting shoe as the device is driven into the ground. A replaceable plastic or metal basket is often inserted into the shoe to assist with retaining samples. Once the sampler is retrieved, the drive head and cutting shoes are removed and the split-spoon halves are then separated, revealing the sample.

Sample depth intervals are usually defined on a project-specific basis with these requirements specified in the project sampling plan. Sampling intervals typically range from one (1) sample per five (5) feet of drilling to continuous sampling where the entire drilled interval is sampled.

Subsurface soil sampling is usually accomplished as part of a drilling program where a soil boring is advanced with drilling equipment to the designated depth prior to collection of a representative sample. The general procedures outlined briefly in the following section provide requirements for advancing drill casing/augers in preparation for sampling.

### **8.2 General Procedures - Borehole Preparation**

#### **8.2.1 Advancing Casing/Augers**

Soil borings that are completed for soil sampling purposes are typically advanced using hollow-stem augers and sometimes drive-and-wash or other casing methods. The casing/augers must be of sufficient diameter to allow for soil sampling at a minimum. The casing/augers will be advanced according to project requirements to the required depth for sampling. If hollow-stem augers are used, a temporary plug shall be used in the lead auger to prevent the auger from becoming filled with drill cuttings while drilling is in progress.

#### **8.2.2 Obstructions**

For those borings which encounter obstructions, the casing/augers will be advanced past or through the obstruction if possible. Caution should be exercised when obstructions are encountered and an effort made to identify the obstruction before drilling is continued. If the obstruction is not easily drilled through or removed, the boring should be relocated to an adjacent location.

#### **8.2.3 Use of Added Water**

The use of added or recirculated water during drilling is permitted when necessary. Use of extraneous water should be minimized or avoided if possible as it may impact sample quality. Water usage should be documented in the field notebook. Sampling and analysis of added or recirculated water may be

required for quality assurance purposes (refer to SAP). If a well is installed within the completed borehole, removal of the added water may be required. State and/or local permitting may be required for adding water to the subsurface.

### **8.3 Sampling Procedure**

#### **8.3.1 Equipment Decontamination**

Each split-spoon must be decontaminated prior to its initial use and following collection of each soil sample. Equipment decontamination procedures should be performed in accordance with SOP 3-06 – Equipment Decontamination. Any additional site-specific requirements for equipment decontamination will be outlined in the SAP.

#### **8.3.2 Standard Penetration Test**

The drilling subcontractor will lower the split-spoon into the borehole. Samples are generally obtained using the Standard Penetration Test (SPT) in accordance with ASTM standards (ASTM D 1586-84). Following this method, the sampler will be driven using the 140-pound hammer with a vertical free drop of 30 inches using two turns of the rope on the cathead. The number of hammer blows required for every 6 inches of penetration will be recorded on the boring log. Blowcount information is used as an indicator of soil density for geotechnical as well as stratigraphic logging purposes. Once the split-spoon has been driven to its fullest extent, or to refusal, it will be removed from the borehole.

#### **8.3.3 Sample Recovery**

The split-spoon will be immediately opened upon removal from the casing/auger. The open sampler should be screened for volatile organics with a photoionization device (PID) if required by the SAP. If the SAP also requires individual soil sample headspace screening for volatile organic compounds (VOCs), the procedure should be performed according to SOP 3-19 Headspace Screening for VOCs.

Sample recovery will be determined by the project geologist or designee who will examine the soil core once the sampler is opened. The length of sample shall then be measured with a folding rule or tape measure. Any portion of the split-spoon contents which are not considered part of the true sample (i.e., heaved soils) will be discarded. If the sample recovery is considered inadequate for sample characterization or analytical testing purposes, another sample should be collected from the next vertical interval if possible before drilling is reinitiated.

Adequate sample recovery for stratigraphic logging and/or headspace screening for VOCs purposes should be approximately 6 inches. Adequate sample recovery for analytical testing purposes should be a minimum of 12 inches and is somewhat dependent on the type of analytical testing required. In some cases, continuous sampling over a short interval, and compositing of the sample, may be required to satisfy analytical testing requirements. Larger diameter samplers may be used if large volumes of soil are required for analytical testing.

#### **8.3.4 Sample Containment - General**

Once retrieved, the sample will be removed from the split-spoon with a teaspoon or spatula and placed into the appropriate sample container. The sample will be split if necessary to meet sampling program requirements. Sample splitting may be necessary to provide individual samples for headspace testing, visual characterization, physical testing, analytical testing, or simply for archiving purposes. In general, most sampling programs are structured around environmental characterization needs; therefore, sample portions required for analytical testing should be collected first. The SAP will provide specific sample container requirements for each type of sample and should be referred to for guidance.

Once filled, the sample containers should be properly capped, cleaned, and labeled, and chain-of-custody and sample preservation procedures initiated. Sampling equipment should then be properly decontaminated.

### 8.3.5 Sample Containment - Volatile Organic Analyses

Collection of subsurface soil samples for VOCs is more complex than collection of samples for other routine chemical or physical testing primarily because of the concern for the potential loss of volatiles during the sample collection procedure. To limit the potential for loss of volatiles, the soil sample needs to be obtained as quickly and as directly as possible from the split-spoon. This generally means that the VOC sample is collected and placed into the appropriate sample container first. The VOC sample should also be obtained from a discrete portion of the entire sample interval and not composited or homogenized. The remainder of the recovered sample can then be composited, homogenized or split to meet the other testing requirements. The boring log and/or sample logbook should be filled out to indicate actual sample collection depths for both VOA samples and other portions of the sample which may have been composited over a larger vertical interval.

## 9.0 Quality Control and Assurance

- 9.1** Sampling personnel should follow specific quality assurance guidelines as outlined in the site-specific SAP. Proper quality assurance requirements should be provided which will allow for collection of representative samples from representative sampling points. Quality assurance requirements outlined in the SAP typically suggest the collection of a sufficient quantity of field duplicate, field blank, and other samples.
- 9.2** Quality control requirements are dependent on project-specific sampling objectives. The SAP will provide requirements for sample preservation and holding times, sample container types, sample packaging and shipment, as well as requirements for the collection of various quality assurance samples such as trip blanks, field blanks, equipment blanks, and field duplicate samples.

## 10.0 Data Records and Management

- 10.1** Records will be maintained in accordance with SOP 3-03 Recordkeeping, Sample Labelling, and Chain-of-Custody. Various forms are required to ensure that adequate documentation is made of sample collection activities. These forms include:
- Boring logs and/or electronic data collection devices
  - Field log books
  - Chain-of-custody records
  - Shipping labels
- Original copies of these records should be maintained in the appropriate project files.
- 10.2** Boring logs (Attachment 1) will provide visual and descriptive information for each sample collected and are often the most critical form of documentation generated during a sampling program. Field electronic data collection devices (e.g., Yuma Tablet, Toughbook Laptop) with data collection software may also be used to record boring log information.
- 10.3** The field log book is kept as a general log of activities.
- 10.4** Chain-of-custody forms are transmitted with the samples to the laboratory for sample tracking purposes.
- 10.5** Shipping labels are required if sample coolers are to be transported to the laboratory by a third party (courier service).

## 11.0 Attachments or References

Attachment 1 – Boring Log

ASTM D 1586-84 Subsurface Exploration Using the Standard Penetration Test and the Cone Penetrometer Test

SOP 3-03 Recordkeeping, Sample Labeling, and Chain-of-Custody

SOP 3-06 Equipment Decontamination

<i>Author</i>	<i>Reviewer</i>	<i>Revisions (Technical or Editorial)</i>
Robert Shoemaker Senior Scientist	Naomi Ouellette, Project Manager	Rev 0 – Initial Issue

# Attachment 1 Boring Log

 <b>RESOLUTION CONSULTANTS</b>		Client:				Boring ID:					
		Project Number:									
		Site Location:									
		Coordinates:		Elevation:		Sheet: 1 of 1					
		Drilling Method:				Monitoring Well Installed:					
		Sample Type(s):		Boring Diameter:		Screened Interval:					
Weather:				Logged By:		Date/Time Started:		Depth of Boring:			
Drilling Contractor:				Ground Elevation:		Date/Time Finished:		Water Level:			
Depth (ft)	Geologic sample ID	Sample Depth (ft)	Blows per 6"	Recovery (inches)	Headspace (ppm)	U.S.C.S	MATERIALS: Color, size, range, MAIN COMPONENT, minor component(s), moisture content, structure, angularity, maximum grain size, odor, and Geologic Unit (if Known)	Lab Sample ID	Lab Sample Depth (ft.)		
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											
NOTES:						Date		Time		Depth to groundwater while drilling	
Checked by: _____						Date: _____					

# In-Situ Hydraulic Conductivity Testing via Rising or Falling Head Slug Testing

## Procedure 3-35

### 1.0 Purpose and Scope

- 1.1 This Standard Operating Procedure (SOP) describes the methods used to obtain in-situ hydraulic conductivity test data via rising or falling head slug testing (also commonly referred to as variable head testing). Slug tests are performed to assess the hydraulic conductivity of the soil or rock surrounding the tested monitoring well. Hydraulic conductivity is a measure of the ease of flow of water through a specific porous medium or fracture when subjected to a hydraulic gradient.

Hydraulic conductivity values are used:

- To estimate rates of groundwater flow;
- To estimate responses of aquifers to applied stresses, such as pumping;
- To estimate the rate of movement of various chemicals in subsurface zones; and
- To construct and calibrate groundwater flow models.

Specific information regarding the slug testing scope of work can be found in the associated Sampling and Analysis Plan (SAP).

- 1.2 The purpose of this SOP is to provide a description of a specific method or procedure to obtain in-situ hydraulic conductivity test results. In-situ hydraulic conductivity tests can be conducted in open boreholes or in monitoring wells and they can be performed using constant head or variable head test (i.e., slug test) methods. During a constant head test, water levels are maintained at a pre-determined level (relative to static conditions) and the groundwater flow is monitored. During a variable head test (slug test), as it applies to this SOP, a sudden (instantaneous) rising or falling of the static water level in a borehole or monitoring well is produced by injecting or withdrawing a volume or slug of water or solid cylinder. Water levels are monitored and recorded until the water level has returned to static conditions or sufficient data is collected to perform the hydraulic conductivity calculations. The change in water levels can be produced by displacing a known volume of water using a slug. The response of water levels to the test can be monitored using a water level tape or with computerized data loggers. Data loggers are preferred because they can collect many measurements in a short period of time, which is important for evaluating the early-time response of the aquifer to the slug. For the purpose of this SOP and the field program outlined in the SAP, the method to perform a variable head (slug test) in a monitoring well using a computerized data logger will be outlined.
- 1.3 This procedure is the Program-approved professional guidance for work performed by Resolution Consultants under the Comprehensive Long-Term Environmental Action Navy (CLEAN) contract (Contract Number N62470-11-D-8013).
- 1.4 As guidance for specific activities, this procedure does not obviate the need for professional judgment or state-specific requirements. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review.
- 1.5 It is fully expected that the procedures outlined in this SOP will be followed. Procedural modifications may be warranted depending upon field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this SOP will be approved in advance by the Program Quality Manager. Deviations to this SOP will be documented in the field records.

## 2.0 Safety

- 2.1 Depending upon the site-specific contaminants, various protective programs must be implemented prior to performing any hydraulic conductivity tests at the first location. All **field testing personnel** responsible for performing any hydraulic conductivity test activities must review the project-specific health and safety plan (HASP) paying particular attention to the control measures planned for the tasks. Conduct preliminary area monitoring to determine the potential hazard to field sampling personnel. If significant contamination is observed, minimize contact with potential contaminants in both the vapor and liquid phase through the use of respirators and disposable clothing.
- 2.2 Observe standard health and safety practices according to the project-specific HASP. Suggested minimum protection during hydraulic conductivity testing activities includes inner disposable vinyl gloves, outer chemical-protective nitrile gloves, rubberized steel-toed boots, and an American National Standards Institute-standard hard hat. Half-face respirators and cartridges and Tyvek® suits may be necessary depending on the contaminant concentrations, and shall always be available on site.
- 2.3 Daily safety briefs will be conducted at the start of each working day before any work commences. These daily briefs will be facilitated by the **Site Safety Officer (SSO)** or designee to discuss the day's events and any potential health risk areas covering every aspect of the work to be completed. Weather conditions are often part of these discussions. As detailed in the HASP, everyone on the field team has the authority to stop work if an unsafe condition is perceived until the conditions are fully remedied to the satisfaction of the SSO.
- 2.4 Hydraulic conductivity testing may involve chemical hazards associated with exposure to groundwater and the testing equipment that comes in contact with the groundwater. When conducting hydraulic conductivity tests, adequate health and safety measures must be taken to protect field personnel. These measures are addressed in the project HASP. All work will be conducted in accordance with the HASP.

## 3.0 Terms and Definitions

None.

## 4.0 Interferences

Many potential interferences can occur during the performance and analysis of slug tests. For this reason, appropriately trained personnel shall perform the tests in the field and conduct the data analysis. Data and analysis will be reviewed by a professional geologist, or other qualified professional in accordance with state-specific requirements.

Well construction is a common cause of physical slug test interference. For wells screened across the water table where an unsaturated zone of soil is exposed, falling head slug tests (i.e., the instantaneous rise in static groundwater levels) may not provide accurate measures of hydraulic conductivity. While falling head slug tests may be conducted in such wells, the results will not be used quantitatively unless the data analysis indicates that an accurate measurement of hydraulic conductivity has been obtained.

## 5.0 Training and Qualifications

### 5.1 Qualifications and Training

- 5.1.1 The individual(s) executing these procedures must have read, and be familiar with, the requirements of this SOP.

### 5.2 Responsibilities

- 5.2.1 The **Contract Task Order (CTO) Manager** is responsible for ensuring that the hydraulic conductivity testing activities comply with this procedure. The CTO Manager or designee shall review all hydraulic conductivity forms prior to use. The CTO Manager is responsible for ensuring that all field personnel

involved in hydraulic conductivity testing and data analysis shall have the appropriate education, experience, and training to perform their assigned tasks.

- 5.2.2 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.
- 5.2.3 The **Field Manager** is responsible for ensuring that all field personnel involved in hydraulic conductivity testing follow these procedures.
- 5.2.4 **Field testing personnel** are responsible for the implementation of this procedure. Minimum qualifications for field testing personnel require that one individual on the field team shall should be familiar with the theory and practice of slug testing and analysis, as well as with all necessary equipment and field software. Geologists, hydrogeologist, other personnel with geologic or hydrogeologic experience, or other qualifications based on state-specific requirements, should supervise hydraulic conductivity testing.
- 5.2.5 **Data analysis personnel** are responsible for the review of data associated with this procedure. Minimum qualifications for data analysis personnel require the individual be familiar with the theory and practice of slug testing and analysis, as well as with all necessary software. Geologists, hydrogeologist, other personnel with geologic or hydrogeologic experience, or other qualifications based on state-specific requirements, should review the hydraulic conductivity test results and data interpretation.
- 5.2.6 The **field testing personnel and/or task manager** is responsible for directly supervising the hydraulic conductivity field testing to ensure that the testing is conducted in accordance with this procedure and state-specific requirements, should they apply, and for recording all pertinent data collected during testing. If deviations from the procedure are required because of anomalous field conditions, they must first be approved by the Program Quality Manager and then documented in the field logbook and associated report or equivalent document.

## 6.0 Equipment and Supplies

General field supplies to perform the slug testing include the following items:

- Boring logs (if available)
- Well construction diagrams (if available)
- Well development logs (if available)
- Water level meter
- Slug (bailer or solid cylinder)
- Nylon string
- Water level indicator
- Pressure transducer(s)
- Data logger(s)
- Computer with appropriate software
- Plastic sheeting
- Equipment decontamination materials (as required by Resolution Consultants SOP No. 3-06 – Equipment Decontamination)
- Health and safety supplies (as required by the HASP)
- Approved plans (e.g., HASP, SAP, QAPP)
- Field project logbook/pen

## **7.0 Procedure**

### **7.1 General Preparation**

The boreholes or monitoring wells to be tested should have been previously developed and had sufficient time to equilibrate before the testing process proceeds (minimum of one week). Well construction diagrams are necessary to determine the depth of the monitoring well and the screened interval.

All equipment that will come into contact with the groundwater will be decontaminated and tested prior to the start of field activities. Any sharp edges of the well casing will be covered with duct tape to protect transducer cables.

An initial round of static water level measurements will be collected prior to initiating the slug test. Wells will be gauged (and subsequently tested) from least contaminated to most contaminated, if known/possible. The static water level in each well will be measured and recorded in the field logbook or field form.

The slug diameter and length to be used in the monitoring well will be determined based on the diameter of the well and the length of the water column. In general, the larger the volume of the slug, the greater the displacement of head and the better the definition of response in the resulting data. However, the slug must be short enough to be completely submerged beneath the static water level, and there must be room beneath the bottom of the slug for the transducer. The transducer and cable should be installed in the well at least two feet from the bottom of the well and be held in place using duct tape to keep the transducer at a constant depth. Therefore, a minimum of seven feet of water within the monitoring well is typically necessary for conducting the test. The transducer will then be connected to the data-logging device and the initial water level recorded. The slug length and diameter will be recorded in the field logbook or field form for use in the data analysis.

Either a pressure transducer connected to a data logger or a programmable down-hole data logger will be used to record the changes in water level during the test. The transducer must be set at least one slug length below the water surface so the slug does not disturb the transducer; several feet deeper is preferable, if possible. After the water level has equilibrated to the static level, the data logger will be programmed according to manufacture's instructions. The data logger will be programmed to record water levels at logarithmically increasing intervals, because early-response data is important for the data analysis.

A measured length of nylon string will be tied to the slug. The line will be of a length that will allow the top of the slug to be submerged beneath the static water level without touching the transducer.

### **7.2 Falling Head Test**

The slug will be lowered part way into the well so that the bottom of the slug is just above the water surface. The data logger will be started and the slug will be simultaneously lowered into the water, so that the top of the slug is below the static water level. Care will be taken to lower the slug fast enough to produce as close to an instantaneous rise in the water level as possible, but not so fast as to produce a wave when the slug enters the water.

When the water level returns to the static level, the falling head test is complete and the rising head test can be started. The data should be saved and a new test set up on the data logger.

If the hydraulic conductivity is low, it may take hours (or more) for the water level to return to static conditions. In this situation, the Field Manager should determine a maximum duration for each test (typically 30 minutes).

The falling head test may not be accurate for wells with screens that bracket the stabilized water table. These tests may be performed in water table wells, but the results will not be used quantitatively unless the data analysis indicates that an accurate measurement of hydraulic conductivity has been obtained.

### 7.3 **Rising Head Test**

After the data logger is reset following the falling head test, the test will be started by activating the logger and simultaneously removing the slug. The slug will be quickly removed from the water so that an instantaneous drop in the water level will occur, but it will be done smoothly enough to not disturb the transducer when removing the slug. When the water has returned to a static condition or the maximum duration of time has elapsed (typically 30 minutes), the test will be terminated.

### 7.4 **Data Download**

At the completion of the test(s), the data from the slug tests will be downloaded to a laptop computer. If feasible, this data will be plotted on a graph of time versus water level to see if it is acceptable (i.e., adequate water level displacement, sufficient number of data points, a straight-line fit to data, no extraneous fluctuations resulting from inadvertent slug movement and/or pressure waves). If the data are not acceptable, the test(s) will be repeated once water levels have stabilized.

### 7.5 **Equipment Decontamination**

All equipment that comes into contact with groundwater (e.g., slugs, transducer, and water level meter) will be decontaminated in accordance with Resolution Consultants SOP No. 3-06 - Equipment Decontamination before moving to the next location. The string should be properly discarded and disposed of.

## 8.0 **QUALITY CONTROL AND QUALITY ASSURANCE**

Quality assurance requirements typically suggest the collection of both the rising head and falling head data. Rising head data are preferred for wells screened across the water table because the hydraulic conductivity of the saturated portion of the aquifer is reflected, whereas falling head data may reflect the hydraulic conductivity of the unsaturated zone and capillary fringe.

For quality control purposes, the transducer data logging will be started immediately prior to lowering or removing the slug. The transducer should be activated approximately 1 second prior to ensure that the transducer is recording water level changes and that the transducer is taking readings at frequent intervals during the early part of the well response curve. Care must be taken when lowering or removing the slug to avoid splashing or generating wave effects that would obscure the early-time data.

Data from the rising and falling head tests should be inspected in graphical format to ensure that adequate water level displacement was achieved for both tests, that the data logger recorded all data from the test, and that no fluctuations exist in the data due to violent slug movement.

Both rising and falling head tests may be conducted to help draw attention to any inconsistencies in the data. If the rising and falling head results are not comparable, the data should be investigated to assess which test may more accurately reflect the hydraulic properties of the aquifer, or whether the pressure transducer recorded accurate data. Knowledge of the boring logs is essential to assessing whether the measured response is consistent with the expected response. If a consistent response is not obtained, the tests should be run again.

If applicable per state-specific requirements, the work performed under this SOP will be conducted under the direction of and reviewed by the required trained, certified or licensed personnel.

## 9.0 **Data and Records Management**

### 9.1 **Records Management**

Records will be maintained in accordance with SOP 3-03, Recordkeeping, Sample Labelling, and Chain-of-Custody. A field logbook will be maintained to ensure that adequate documentation is made of hydraulic conductivity testing activities. Information, such as background information such as well diameter, depth, and screened interval, will be documented from existing monitoring well construction

logs in the field logbook or other site-specific test log, if applicable. These data will be used in the calculation of hydraulic conductivity, based on the test data. The slug length, slug diameter, water level, well identification number, test type (rising or falling), file name, and time will also be recorded. The actual data of time versus water level will be recorded on the data logger and transferred to a laptop computer. In addition, any problems or unusual conditions that may have occurred during the testing process will also be recorded.

Software files associated with the hydraulic conductivity testing activities will be saved in the associated project files upon completion of the field activities.

The records generated in this procedure will become part of the permanent record supporting the associated fieldwork. All documentation will be retained in the project files following project completion.

The field logbook is kept as a general log of activities and should not be used in place of any site-specific test log, if applicable.

Unanticipated changes to the procedures or materials described in this SOP (deviations) will be appropriately documented in the project records.

Records associated with the activities described in this SOP will be maintained according to the document management policy for the project.

## 9.2 **Data Analysis**

Several methods are available for analyzing data obtained from in-situ hydraulic conductivity tests. Most methods incorporate graphical techniques, such as semi-log and log-log plots, to evaluate the data and select values for the calculations.

Inherent in the analytical methods are several simplifying assumptions concerning the aquifer properties and test methods. When selecting a particular analytical method, it is important to consider the basic assumptions that underlie the mathematical expressions. In many cases, it may be advisable to evaluate the data using several methods and examine the range of hydraulic conductivity values that are obtained. For this project, it is expected that the data will be analyzed using appropriate methodologies (e.g., Bouwer and Rice, 1976; Kansas Geological Survey methods [Hyder, et al., 1994]; Cooper, et al, 1967).

## 10.0 **Attachments and References**

### 10.1 **Attachments**

SOP 3-03, *Recordkeeping, Sample Labelling, and Chain-of-Custody*

SOP 3-06, *Equipment Decontamination*

### 10.2 **References**

Bouwer, H and RC Rice. 1976. A slug test for determining hydraulic conductivity of unconfined aquifers with completely or partially penetrating wells. *Water Resources Research*, Vol. 12, pp. 423-428.

Cooper, H Jr., D Bredehoeft, and S Papadopoulos. 1967. Response of a Finite-Diameter Well to an Instantaneous Charge of Water. *Water Resources Research*, Vol. 3, No. 1.

Hyder, Z, JJ Butler, Jr, CD McElwee, and W Liu. 1994. Slug tests in partially penetrating wells. *Water Resources Research*, Vol. 30, No. 11: 2945-2957.

USEPA SOP#2046, Slug Tests, October 3, 1994.

Author	Reviewer	Revisions (Technical or Editorial)
Naomi Ouellette, Environmental Scientist	Lauren Roberts, Environmental Scientist	Rev 0 – Initial Issue (November 2012)

# Benthic Grab Sampling

## Procedure 3-36

### 1.0 Purpose and Scope

The purpose of this Standard Operating Procedure (SOP) is to establish the shipboard procedures for the collection, handling, and packaging of benthic infaunal samples.

### 2.0 Required Equipment

- 0.04m<sup>2</sup> van Veen grab
- Wooden stand
- Mud shoe
- Weights
- 37% Formaldehyde (+ MSDS Safety Sheet)
- 0.3 or 0.5-mm sieve
- Sieve table
- Buckets
- Squirt bottle
- Borax
- Nalgene jars
- Whirlpaks
- Waterproof paper
- Electrical Tape
- Clear packing tape
- Scissors
- Funnel
- Clear plastic rulers
- Siphon hose
- Scrub brush
- Heavy duty coolers
- Absorbent packing material
- Heavy duty plastic bags

## **3.0 Procedure**

### **3.1 Sample Collection**

A 0.04-m<sup>2</sup> Ted Young-modified Van Veen grab sampler will be used to collect soft-bottom sediment samples for infaunal analysis. Sufficient weight will be added to the grab frame to allow sufficient penetration. In extremely soft sediment, a mud-shoe will be attached to the underside of the grab and the total weight added adjusted accordingly.

Once the survey vessel is on station and coordinates have been verified, the grab will be deployed. When slack in the winch wire indicates that the grab is on the bottom, the grab and captured sample will be brought back to the surface and gently set on the grab stand. Upon retrieval of the grab, the sample will be inspected for acceptability. The grab sampler must contain sediment to a depth of at least 7 cm (out of a possible 10 cm). The surface must be relatively undisturbed and the grab must be holding water. Any sample with low penetration or where sediment has washed out of the side due to improper closer of the grab sample jaws will be discarded. The grab sampler will be rinsed, and redeployed following this same procedure.

Once a collected sample is deemed acceptable, the parameters will be recorded in the field log:

- penetration depth,
- sediment texture,
- sediment color,
- odor,
- infauna, and
- depth of the aRPD

The apparent redox discontinuity depth (aRPD) depth will be estimated visually, by examining the sediment surface. If the surface of the grab sample is black, with few or no infaunal organisms visible, and an odor of hydrogen sulfide is detected, then the sample has no measurable aRPD layer and is considered to be anoxic. If the surface is oxidized, a clear, plastic ruler marked in millimeters will be pushed into the sediment and pulled out toward the investigator. This action creates a vertical profile that can be examined and allows the aRPD to be measured to the nearest millimeter. Alternatively, the same ruler may be used to gently scrape off the surface layers, in millimeter fractions, until the gray-to-black anoxic sediment layer is exposed. The distance from the surface to the uppermost portion of the gray-to-black subsurface sediments is the depth of the aRPD. Any sediment adhering to the surface of the ruler will be rinsed back into the grab for processing with the remainder of the sample. The volume of the grab will be estimated by comparing the measured penetration depth with a prepared table of penetration depths versus grab volumes (Table 3.1). These data will be recorded in the field log.

**Table 3.1. Values used to convert Grab penetration to Sediment Volume.**

Grab Penetration	Sediment Volume (L)	Sediment Volume (L)
3.5–4.0	1.0	
5.0	1.5	
6.0–6.5	2.0	
7.0	2.25	4.5
7.5	2.5	5.5
8.0	2.75	6.5
8.5–9.0	3.0	7.5
> 9.5 (over penetration) 0.04-m <sup>2</sup> grab	3.25	8.0
10		9.0
11		9.5
12		10.0
>15 (over penetration ) 0.1-m <sup>2</sup> grab		11.0

Once these parameters are recorded, the grab will be placed over a bucket, the jaws opened, and the sample emptied into the bucket. Filtered seawater will be used to gently wash the sample into the bucket using a squirt bottle. Once thoroughly washed (if necessary), the grab will be redeployed until the required numbers of acceptable samples have been obtained for infaunal analysis.

### 3.2 Sample Processing

A sample jar of appropriate size will be selected for the sample (larger jars for sand or gravel samples). Sample jars will be Nalgene or other sturdy plastic jars with screw-capped lids. A teaspoon of Borax will be added to each jar to buffer the preservative. The Borax should be dissolved with a small amount of water prior to the addition of any sample to the jar. An internal label written in pencil on waterproof paper will be added to the jar and an external label will be taped to the side of the jar. Both labels will contain:

- Project name,
- Sample date,
- Station ID, and
- Sieve size.

The bucket containing the collected sample will be placed on the sieve table. The sample will be gently washed over the appropriate sieve size (0.3 or 0.5-mm) using 5- $\mu$ m-filtered seawater through a hose. Water pressure will be regulated to allow breaking up of the sediment clumps without causing damage to the organisms. The portion retained on the screens will be rinsed into labeled jars using a squirt bottle of filtered water. Any large mucous excreting or fragile organisms (burrowing anemones, brittle stars, etc.) will be placed in a whirlpak bag, a small amount of formalin and seawater will be added, the bag will be closed, labeled, and placed within the larger sample jar prior to bulk sample fixation. Once the jar is approximately half-full of sediment, 8% buffered formalin will be added to the jar (80-ml per 1-L). Samples should be preserved as quickly as possible to halt the deterioration of the animals. An uppercase "F" will be written on the lid of the jar with a grease pencil to denote that formalin was added to the sample.

If more than one jar is needed, the jar labels and lids will clearly be marked "jar 1 of 2", "jar 2 of 2", etc. and this information will be recorded in the log book.

The jar will be gently turned around on its side to distribute the formalin evenly throughout the sample. The time formalin was added, the total number of jars/whirlpaks, and the technician sieving each sample will be identified by his or her initials and will be recorded in the survey log.

Sieves and buckets will be thoroughly scrubbed and washed between samples.

### 3.3 **Sample Handling**

The lids on the sample jars will be taped with electrical tape and the jars inserted into large zip-locked bags. These individual bags will then be placed in tied plastic bags lined with absorbent padding. They will be packed into sturdy coolers with packing material to prevent shifting of the jars during transport. The COC will be placed in a ziplock bag and taped to the inside lid of the cooler. The cooler will be taped shut and chain-of-custody seals will be affixed in opposite corners. Level 2 Shipper training is not required for the packaging of formalin containing samples as long as the overall concentration of formalin remains below 10%.

### 3.4 **Sample Archiving**

Sample residues will be archived until the acceptance of the data by the client but not exceeding six-months. Identified material will be archived until the data is accepted by the client but not to exceed one-year.

A reference collection will not be generated unless specifically contracted by the client.

## 4.0 **Special Training**

## 5.0 **Attachments**

5.1 **37% Formaldehyde MSDS**

5.2 **Chain of Custody Record Form**

Author	Reviewer	Revisions (Technical or Editorial)
Stacy Doner Marine Ecologist	James Blake Senior Marine Ecologist	Rev 0



Ingestion	May be fatal or cause blindness if swallowed. Causes burns. May cause central nervous system effects. May cause adverse liver effects. May cause adverse kidney effects.
Chronic Effects	May cause cancer. Tumorigenic effects have been reported in experimental animals.. Experiments have shown reproductive toxicity effects on laboratory animals. May cause adverse liver effects. May cause adverse kidney effects. Repeated contact may cause allergic reactions in very susceptible persons. Component substance is listed on California Proposition 65 as a developmental hazard.

See Section 11 for additional Toxicological information.

Aggravated Medical Conditions	Central nervous system disorders. Gastrointestinal tract. Preexisting eye disorders. Skin disorders.
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### 3. COMPOSITION/INFORMATION ON INGREDIENTS

**Haz/Non-haz**

Component	CAS-No	Weight %
Water	7732-18-5	45 - 48
Formaldehyde	50-00-0	37 - 40
Methyl alcohol	67-56-1	15

### 4. FIRST AID MEASURES

Eye Contact	Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Immediate medical attention is required.
Skin Contact	Wash off immediately with plenty of water for at least 15 minutes. Immediate medical attention is required.
Inhalation	Move to fresh air. If breathing is difficult, give oxygen. Do not use mouth-to-mouth resuscitation if victim ingested or inhaled the substance; induce artificial respiration with a respiratory medical device. Immediate medical attention is required.
Ingestion	Do not induce vomiting. Call a physician or Poison Control Center immediately.
Notes to Physician	Treat symptomatically.

### 5. FIRE-FIGHTING MEASURES

Flash Point	50°C / 122°F
Method	No information available.
Autoignition Temperature	No information available.
Explosion Limits	
Upper	No data available
Lower	No data available
Suitable Extinguishing Media	Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.
Unsuitable Extinguishing Media	No information available.
Hazardous Combustion Products	No information available.

Sensitivity to mechanical impact  
Sensitivity to static discharge

No information available.  
No information available.

**Specific Hazards Arising from the Chemical**

Flammable. Risk of ignition. Vapors may form explosive mixtures with air. Vapors may travel to source of ignition and flash back. Containers may explode when heated.

**Protective Equipment and Precautions for Firefighters**

Thermal decomposition can lead to release of irritating gases and vapors.

NFPA

Health 3

Flammability 2

Instability 0

Physical hazards N/A

**6. ACCIDENTAL RELEASE MEASURES**

**Personal Precautions**

Use personal protective equipment. Remove all sources of ignition. Evacuate personnel to safe areas. Keep people away from and upwind of spill/leak. Take precautionary measures against static discharges. Do not get in eyes, on skin, or on clothing.

**Environmental Precautions**

Should not be released into the environment.

**Methods for Containment and Clean Up**

Remove all sources of ignition. Soak up with inert absorbent material. Take precautionary measures against static discharges. Keep in suitable, closed containers for disposal..

**7. HANDLING AND STORAGE**

**Handling**

Use only under a chemical fume hood. Remove all sources of ignition. Keep away from open flames, hot surfaces and sources of ignition. Take precautionary measures against static discharges. Do not breathe vapors or spray mist. Do not get in eyes, on skin, or on clothing.

**Storage**

Keep containers tightly closed in a dry, cool and well-ventilated place. Keep away from heat and sources of ignition. Flammables area.

**8. EXPOSURE CONTROLS/PERSONAL PROTECTION**

**Engineering Measures**

Use only under a chemical fume hood. Ensure adequate ventilation, especially in confined areas. Use explosion-proof electrical/ventilating/lighting/equipment. Ensure that eyewash stations and safety showers are close to the workstation location.

**Exposure Guidelines**

Component	ACGIH TLV	OSHA PEL	NIOSH IDLH
Formaldehyde	Ceiling: 0.3 ppm	(Vacated) TWA: 3 ppm (Vacated) STEL: 10 ppm (Vacated) Ceiling: 5 ppm TWA: 0.75 ppm STEL: 2 ppm	IDLH: 20 ppm TWA: 0.016 ppm Ceiling: 0.1 ppm
Methyl alcohol	TWA: 200 ppm STEL: 250 ppm Skin	(Vacated) TWA: 200 ppm (Vacated) TWA: 260 mg/m <sup>3</sup> (Vacated) STEL: 250 ppm (Vacated) STEL: 325 mg/m <sup>3</sup> Skin TWA: 200 ppm TWA: 260 mg/m <sup>3</sup>	IDLH: 6000 ppm TWA: 200 ppm TWA: 260 mg/m <sup>3</sup> STEL: 250 ppm STEL: 325 mg/m <sup>3</sup>

Component	Quebec	Mexico OEL (TWA)	Ontario TWAEV
Formaldehyde	Ceiling: 2 ppm Ceiling: 3 mg/m <sup>3</sup>	Peak: 2 ppm Peak: 3 mg/m <sup>3</sup>	STEL: 1.0 ppm CEV: 1.5 ppm
Methyl alcohol	TWA: 200 ppm TWA: 262 mg/m <sup>3</sup> STEL: 250 ppm STEL: 328 mg/m <sup>3</sup> Skin	TWA: 200 ppm TWA: 260 mg/m <sup>3</sup> STEL: 250 ppm STEL: 310 mg/m <sup>3</sup>	TWA: 200 ppm STEL: 250 ppm Skin

NIOSH IDLH: Immediately Dangerous to Life or Health

**Personal Protective Equipment**

**Eye/face Protection**

Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166

**Skin and body protection**

Wear appropriate protective gloves and clothing to prevent skin exposure

**Respiratory Protection**

Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced

**9. PHYSICAL AND CHEMICAL PROPERTIES**

**Physical State**

Liquid

**Appearance**

Colorless

**odor**

pungent

**Odor Threshold**

No information available.

**pH**

No information available.

**Vapor Pressure**

No information available.

**Vapor Density**

> 1.0

**Viscosity**

No information available.

**Boiling Point/Range**

101°C / 213.8°F

**Melting Point/Range**

0°C / 32°F

**Decomposition temperature**

No information available.

**Flash Point**

50°C / 122°F

**Evaporation Rate**

No information available.

**Specific Gravity**

No information available.

### 9. PHYSICAL AND CHEMICAL PROPERTIES

Solubility Soluble in water  
log Pow No data available

### 10. STABILITY AND REACTIVITY

Stability Stable under normal conditions.  
Conditions to Avoid Incompatible products. Heat, flames and sparks.  
Incompatible Materials Strong oxidizing agents, Strong bases, nitriles, Acids, Isocyanates, Acid anhydrides, Metals, Acid chlorides  
Hazardous Decomposition Products Carbon monoxide (CO), Carbon dioxide (CO<sub>2</sub>), Hydrogen, Formaldehyde  
Hazardous Polymerization Hazardous polymerization does not occur  
Hazardous Reactions . None under normal processing.

### 11. TOXICOLOGICAL INFORMATION

#### Acute Toxicity

Product Information No acute toxicity information is available for this product

#### Component Information

Component	LD50 Oral	LD50 Dermal	LC50 Inhalation (Dust)
Formaldehyde	500 mg/kg ( Rat )	Not listed	0.578 mg/L ( Rat ) 4 h
Methyl alcohol	5628 mg/kg ( Rat )	15800 mg/kg ( Rabbit )	64000 ppm ( Rat ) 4 h 83.2 mg/L ( Rat ) 4 h

Irritation Causes burns by all exposure routes

Toxicologically Synergistic Products No information available.

#### Chronic Toxicity

Carcinogenicity The table below indicates whether each agency has listed any ingredient as a carcinogen.

Component	ACGIH	IARC	NTP	OSHA	Mexico
Formaldehyde	A2	Group 1	Reasonably Anticipated	X	A2

ACGIH: (American Conference of Governmental Industrial Hygienists)  
A1 - Known Human Carcinogen  
A2 - Suspected Human Carcinogen  
A3 - Animal Carcinogen  
ACGIH: (American Conference of Governmental Industrial Hygienists)

IARC: (International Agency for Research on Cancer)  
 IARC: (International Agency for Research on Cancer)  
 Group 1 - Carcinogenic to Humans  
 Group 2A - Probably Carcinogenic to Humans  
 Group 2B - Possibly Carcinogenic to Humans  
 NTP: (National Toxicity Program)  
 NTP: (National Toxicity Program)  
 Known - Known Carcinogen  
 Reasonably Anticipated - Reasonably Anticipated to be a Human Carcinogen

<b>Sensitization</b>	May cause sensitization by skin contact
<b>Mutagenic Effects</b>	Mutagenic effects have occurred in humans.
<b>Reproductive Effects</b>	Experiments have shown reproductive toxicity effects on laboratory animals.
<b>Developmental Effects</b>	Developmental effects have occurred in experimental animals. Component substance is listed on California Proposition 65 as a developmental hazard.
<b>Teratogenicity</b>	Teratogenic effects have occurred in experimental animals..
<b>Other Adverse Effects</b>	Tumorigenic effects have been reported in experimental animals.. See actual entry in RTECS for complete information.
<b>Endocrine Disruptor Information</b>	No information available

## 12. ECOLOGICAL INFORMATION

### Ecotoxicity

. Do not empty into drains.

Component	Freshwater Algae	Freshwater Fish	Microtox	Water Flea
Formaldehyde	Not listed	Leuciscus idus: LC50 = 15 mg/L 96h	Not listed	EC50 = 20 mg/L 96h EC50 = 2 mg/L 48h
Methyl alcohol	Not listed	Pimephales promelas: LC50 > 10000 mg/L 96h	EC50 = 39000 mg/L 25 min EC50 = 40000 mg/L 15 min EC50 = 43000 mg/L 5 min	EC50 > 10000 mg/L 24h

**Persistence and Degradability** No information available

**Bioaccumulation/ Accumulation** No information available

### Mobility

Component	log Pow
Formaldehyde	-0.35
Methyl alcohol	-0.74

## 13. DISPOSAL CONSIDERATIONS

**Waste Disposal Methods** Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification

Component	RCRA - U Series Wastes	RCRA - P Series Wastes
Formaldehyde - 50-00-0	U122	-
Methyl alcohol - 67-58-1	U154	-

**14. TRANSPORT INFORMATION**

**DOT**

UN-No UN1198  
 Proper Shipping Name FORMALDEHYDE, SOLUTIONS, FLAMMABLE  
 Hazard Class 3  
 Subsidiary Hazard Class 8  
 Packing Group III

**TDG**

UN-No UN1198  
 Proper Shipping Name FORMALDEHYDE, SOLUTIONS, FLAMMABLE  
 Hazard Class 3  
 Subsidiary Hazard Class 8  
 Packing Group III

**IATA**

UN-No UN1198  
 Proper Shipping Name FORMALDEHYDE, SOLUTIONS, FLAMMABLE  
 Hazard Class 3  
 Subsidiary Hazard Class 8  
 Packing Group III

**IMDG/IMO**

UN-No UN1198  
 Proper Shipping Name FORMALDEHYDE, SOLUTIONS, FLAMMABLE  
 Hazard Class 3  
 Subsidiary Hazard Class 8  
 Packing Group III

**15. REGULATORY INFORMATION**

**International Inventories**

Component	TSCA	DSL	NDSL	EINECS	ELINCS	NLP	PICCS	ENCS	AICS	CHINA	KECL
Water	X	X	-	231-791-2	-		X	-	X	X	X
Formaldehyde	X	X	-	200-001-8	-		X	X	X	X	X
Methyl alcohol	X	X	-	200-659-6	-		X	X	X	X	X

**Legend:**

X - Listed

E - Indicates a substance that is the subject of a Section 5(e) Consent order under TSCA.

F - Indicates a substance that is the subject of a Section 5(f) Rule under TSCA.  
 N - Indicates a polymeric substance containing no free-radical initiator in its inventory name but is considered to cover the designated polymer made with any free-radical initiator regardless of the amount used.  
 P - Indicates a commenced PMN substance  
 R - Indicates a substance that is the subject of a Section 6 risk management rule under TSCA.  
 S - Indicates a substance that is identified in a proposed or final Significant New Use Rule  
 T - Indicates a substance that is the subject of a Section 4 test rule under TSCA.  
 XU - Indicates a substance exempt from reporting under the Inventory Update Rule, i.e. Partial Updating of the TSCA Inventory Data Base Production and Site Reports (40 CFR 710(B)).  
 Y1 - Indicates an exempt polymer that has a number-average molecular weight of 1,000 or greater.  
 Y2 - Indicates an exempt polymer that is a polyester and is made only from reactants included in a specified list of low concern reactants that comprises one of the eligibility criteria for the exemption rule.

U.S. Federal Regulations

TSCA 12(b) Not applicable

SARA 313

Component	CAS-No	Weight %	SARA 313 - Threshold Values %
Formaldehyde	50-00-0	37 - 40	0.1
Methyl alcohol	67-56-1	15	1.0

SARA 311/312 Hazardous Categorization

Acute Health Hazard	Yes
Chronic Health Hazard	Yes
Fire Hazard	Yes
Sudden Release of Pressure Hazard	No
Reactive Hazard	No

Clean Water Act

Component	CWA - Hazardous Substances	CWA - Reportable Quantities	CWA - Toxic Pollutants	CWA - Priority Pollutants
Formaldehyde	X	100 lb	-	-

Clean Air Act

Component	HAPS Data	Class 1 Ozone Depletors	Class 2 Ozone Depletors
Formaldehyde	X		-
Methyl alcohol	X		-

OSHA

Component	Specifically Regulated Chemicals	Highly Hazardous Chemicals
Formaldehyde	2 ppm STEL 0.5 ppm Action Level 0.75 ppm TWA	TQ: 1000 lb

CERCLA

This material, as supplied, contains one or more substances regulated as a hazardous substance under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302)

Component	Hazardous Substances RQs	CERCLA EHS RQs
Formaldehyde	100 lb	100 lb

Thermo Fisher Scientific - Formaldehyde solution 37%

Revision Date 05-Jun-2012

Component	Hazardous Substances RQs	CERCLA EHS RQs
Methyl alcohol	5000 lb	-

**California Proposition 65**

This product contains the following Proposition 65 chemicals:

Component	CAS-No	California Prop. 65	Prop 65 NSRL
Formaldehyde	50-00-0	Carcinogen	40 µg/day
Methyl alcohol	67-56-1	Methanol	-

**State Right-to-Know**

Component	Massachusetts	New Jersey	Pennsylvania	Illinois	Rhode Island
Formaldehyde	X	X	X	X	X
Methyl alcohol	X	X	X	X	X

**U.S. Department of Transportation**

Reportable Quantity (RQ): Y  
 DOT Marine Pollutant N  
 DOT Severe Marine Pollutant N

**U.S. Department of Homeland Security**

This product contains the following DHS chemicals:

Component	DHS Chemical Facility Anti-Terrorism Standard
Formaldehyde	11250 lb STQ (solution)

**Other International Regulations**

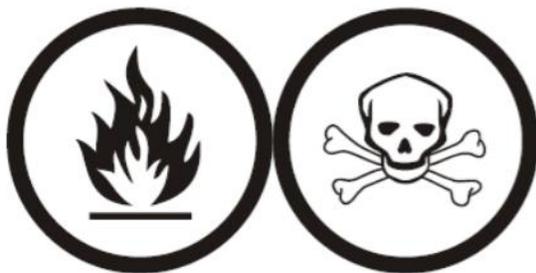
Mexico - Grade Moderate risk, Grade 2

Canada

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all the information required by the CPR.

**WHMIS Hazard Class**

B3 Combustible liquid  
 D1A Very toxic materials  
 D2A Very toxic materials  
 D2B Toxic materials  
 E Corrosive material





## 16. OTHER INFORMATION

Prepared By Regulatory Affairs  
Thermo Fisher Scientific  
Email: EMSDS.RA@thermofisher.com

Creation Date 08-Feb-2010

Print Date 05-Jun-2012

Revision Summary "\*\*\*\*", and red text indicates revision

### Disclaimer

The information provided on this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guide for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered as a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other material or in any process, unless specified in the text.

End of MSDS

**Attachment 5.2  
Sample Chain-Of-Custody**

CHAIN OF CUSTODY RECORD												Page ____ of ____
Client/Project Name:		Project Location:		Analysis Requested				Container Type P – Plastic A – Amber Glass V – Vial Glass O – Other E – Encore  Matrix Codes: DW – Drinking Water WW – Wastewater GW – Groundwater SW – Surface Water ST – Storm Water W – Water  S – Soil SL – Sludge SD – Sediment A – Air L – Liquid P – Product				
Project Number:		Field Logbook No.:										
Sampler (Print Name)/(Affiliation):		Chain of Custody Tape Nos.:		# Vials to be identified to species				Preservation 1 – HCl, 4" 2 – H2SO4, 4" 3 – HNO3, 4" 4 – NaOH, 4" 5 – NaOH/Na2S2O8, 4" 6 – NaOH/Na2CO3, 4" 7 – 4"				
Signature:		Send Report to:										
Site ID	Cove #	Sample Date	Sample Time	Sample Container (Size/Mat'l)	Matrix	Preserv.	Field Filtered	Lab I.D.      Remarks				
TAT:												
Relinquished by: (Print Name)/(Affiliation)		Date:		Received by: (Print Name)/(Affiliation)		Date:		Analytical Laboratory (Destination):				
Signature:		Time:		Signature:		Time:						
Relinquished by: (Print Name)/(Affiliation)		Date:		Received by: (Print Name)/(Affiliation)		Date:		Sample Shipped Via: UPS    FedEx    Courier    Other    Yes    No				
Signature:		Time:		Signature:		Time:						
Relinquished by: (Print Name)/(Affiliation)		Date:		Received by: (Print Name)/(Affiliation)		Date:						
Signature:		Time:		Signature:		Time:						

Serial No. 11090971

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# Shellfish Tissue Sampling

## Procedure 3-38

### 1.0 Purpose and Scope

- 1.1 Sediment contamination is a widespread environmental problem that can pose a threat to a variety of aquatic ecosystems. Sediment functions as a reservoir for common contaminants such as pesticides, herbicides, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), and metals such as lead, mercury, and arsenic. Contaminated sediments represent a hazard to aquatic life through direct toxicity, as well as to aquatic life, wildlife, and human health through bioaccumulation. Tissue contaminant monitoring enables state agencies to detect levels of contamination in fish and shellfish tissue that may be harmful to human consumers (EPA 2000).
- 1.2 Selection and proper use of sampling equipment is essential to the collection of accurate, representative tissue data that will meet the project Data Quality Objectives (DQOs). Procedures are described here for the collection and processing of tissues from oysters, clams, and mussels. Although not required, it is recommended that the processing of the shellfish to extract the tissue from the shell be carried out at the laboratory or at a field office with appropriate conditions for this work. This step, however, is also described in this SOP. In general, only the edible tissue is submitted for analysis and compositing is employed because single organisms do not provide enough tissue mass to satisfy the analytical requirements (EPA 2000).
- 1.3 Unless specifically exempted in research projects, the collection of shellfish for these purposes must always satisfy any legal requirements of harvest size or weight, or at least be of consumable size if no legal harvest requirements are in effect.
- 1.4 Prior to the collection of any shellfish tissue samples, the requisite Scientific Collector's Permit (or equivalent) will be obtained from the local agency with jurisdiction.
- 1.5 This standard operating procedure (SOP) describes the procedure for the active collection of shellfish tissue samples using a Grab Sampler and SCUBA divers. The applicability of each of the methods is described below.

The Grab Sampler (Ponar, Eckman, or equivalent) is used to collect shellfish tissue samples in:

- Soft to semi-soft substrates
- Sand, silt, or clay substrates
- Deeper waters (> 30.0')

SCUBA diving to collect samples by hand is employed when:

- Shallow waters (< 30.0')
- Areas that are otherwise inaccessible by boat
- Hard bottom substrates that prevent proper operation of a grab sampler

Pictures and diagrams of a typical Grab Sampler and an AECOM Scientific SCUBA diver are presented in Figures 1, and 2 respectively.

- 1.6 This procedure is the Program-approved professional guidance for work performed by Resolution Consultants under the Comprehensive Long-Term Environmental Action Navy (CLEAN) contract (Contract Number N62470-11-D-8013).

- 1.7 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review.

## **2.0 Safety**

- 2.1 Depending upon the site-specific contaminants, various protective programs must be implemented prior to sampling the first location. All **field sampling personnel** responsible for sampling activities must review the project-specific health and safety plan (HASP) paying particular attention to the control measures planned for the sampling tasks. Conduct preliminary area monitoring of sample locations to determine the potential hazard to field sampling personnel. If significant contamination is observed, minimize contact with potential contaminants in both the vapor phase and solid or liquid matrix through the use of respirators and disposable clothing.
- 2.2 Observe standard health and safety practices according to the project-specific HASP. Suggested minimum protection during sediment sampling activities includes inner disposable vinyl gloves, outer chemical-protective nitrile gloves, and waders (if applicable). Refer to the project-specific HASP for the required PPE.
- 2.3 Handle all waste generated during the Site investigation in accordance with the IDW handling procedures in SOP 3-05, IDW Management.
- 2.4 Depending upon the type of contaminant expected or determined in previous sampling efforts, employ the following safe work practices:
- If sampling from a boat, all sampling personnel should wear personal flotation devices (PFDs) when in the boat, and should follow all health and safety protocols for working in a boat presented in the project-specific HASP.
  - Lifting the samplers into the boat, dumping its contents, and washing those contents may require leaning over the side of the boat. Care should be taken to keep the boat in proper balance at all times during sampling.
  - Severe injury to fingers or hands can be caused by movement of the lever arms of the Petite Ponar<sup>®</sup> Grab Sampler. Do not handle or move the Petite Ponar<sup>®</sup> Grab Sampler unless the safety pin is fully inserted in the locking holes.
  - Severe injury to fingers or hands can be caused by the closing of the sharpened scoops of the Ekman Bottom Grab Sampler. Handle the Ekman Bottom Grab Sampler very carefully when the springs are set and the cable loops are hooked (armed) on the Twin-Pin<sup>™</sup> pins on the release mechanism. Do not “arm” the Ekman Bottom Grab Sampler until the sampler is ready to be used. The Ekman Bottom Grab Sampler spring-loaded jaws are potentially dangerous; extreme care must be exercised when setting the jaws. To prevent injury (and to extend the life of the springs), unhook both springs from their scoop buttons after each sampling session.
  - Ensure that all SCUBA diving activities are carried out in accordance with the approved dive plan (to be drafted, submitted, and approved prior to any field activities), and applicable NAVY regulations as well as any site specific guidance that may be applicable.

## **3.0 Terms and Definitions**

None.

## **4.0 Training and Qualifications**

- 4.1 The **Contract Task Order (CTO) Manager** is responsible for ensuring that shellfish sampling activities comply with this procedure. The **CTO Manager** is responsible for ensuring that all field sampling

personnel involved in shellfish sampling shall have the appropriate education, experience, and training to perform their assigned tasks.

- 4.2 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.
- 4.3 The **Field Manager** is responsible for ensuring that all field sampling personnel follow these procedures.
- 4.4 **Field sampling personnel** are responsible for the implementation of this procedure.
- 4.5 The field sampler and/or task manager is responsible for directly supervising the sediment sampling procedures to ensure that they are conducted according to this procedure, and for recording all pertinent data collected during sampling.

## **5.0 Equipment and Supplies**

5.1 For shellfish tissue sampling using all types of equipment, the following supplies are required:

- Stainless steel bowls
- Stainless steel hand trowels, spoons, spatulas, and scoops
- Nets
- Species identification chart
- Stainless steel shucking knife
- Kevlar glove
- Laboratory balance
- Nitrile gloves
- Aluminium foil
- Large zip top bags
- DI water for rinsing (in plastic or Teflon bottles)

5.2 Grab Sampler

- 11 oz split messenger (if necessary)
- 3/16" braided polyester line
- Auxiliary weights

5.3 SCUBA Diving (list below is typical/general, may vary by Site specific conditions)

- Full face mask
- Divers secondary air supply
- Bail out bottle
- Underwater light
- Air gauge
- Diver communication system (if used)
- Weights (belt/ankle)
- Buoyancy Compensator Device (BCD)
- Survey tools (mesh bag, shell gauge, cloth measuring tape)
- Boat based emergency tools
- Dive flags
- Dive Plan
- Watch
- Underwater compass
- Dive Tables

## **6.0 Procedure**

6.1 Depending on the characteristics of the site being investigated, shellfish tissue samples may be collected from a boat, or by sampling personnel in SCUBA gear. In all instances, shellfish tissue sampling will be co-located with sediment sampling activities and therefore, should begin from the most downstream location and proceed to the most upstream location. Regardless of the type of sampling technique used, documentation of field observations and collection activities should be recorded on the sampling data sheet or electronic data collection device. The following observations should be recorded on the shellfish tissue sampling form for all sampling activities:

- Sample location
- Weather conditions and other relevant site conditions
- Depth of water to the nearest 0.1 foot. A surveyor rod may be used. If the surveyor rod is used, minimize water turbulence and do not disturb any sediment.
- Physical characteristics of the water body such as estimated current speed (stagnant, slow, medium, or fast) and direction, odor, color, presence of any dead vegetation, surface sheens, etc.
- Shellfish species according to the species identification chart
- Description of sediment surface (if visible)

Specific procedures for the collection of shellfish tissue samples using a Grab Sampler, and via SCUBA diving are presented below.

6.2 Petite Ponar<sup>®</sup> Grab Sampler (for operation of Eckman Grab Sampler, see SOP 3-22 Sediment Sampling).

- 6.2.1 Inspect the sampler to ensure all parts are in good working condition.
- 6.2.2 Decontaminate the sampler according to the procedures in SOP 3-06, Equipment Decontamination.
- 6.2.3 Attach the 3/16" braided polyester line to the sampler by looping the line through the clevis at the top center of the lever arms and tying securely. Tie the other end of the line to the boat (if applicable), or make sure to hold on to the other end of the line. Strong, tight knots (e.g. bowline, two half hitches) are essential for operator safety and to prevent losing the sampler. If necessary, attach the auxiliary weights to the sampler according the manufacturer's directions.
- 6.2.4 Insert the Pinch-Pin™ into its hole in the lever arms, making sure to firmly push the Pinch-Pin™ into the hole. As long as the line is taught, the Pinch-Pin™ will stay in its place. When the line becomes the least bit slack (e.g. when the sampler hits the bottom), the Pinch-Pin™ spring will force the Pinch-Pin™ out of its hole, allowing the scoops to close.
- 6.2.5 Just before lowering the grab into the water, and with the line taught, remove the safety pin so the closing mechanism will release when the sampler is on the bottom. Make sure to keep the line taught, as any loss of tension in the line will cause the Pinch-Pin™ to pop out, closing the sampler.
- 6.2.6 Lower the sampler into the water in a slow and controlled fashion, especially during the final 1-2', such that the bow wave is minimized, thus minimizing the dispersal of fine material on the sediment surface. At no time should the sampler be allowed to "free fall" down through the water column.
- 6.2.7 Once the sampler has reached the bottom, release the tension on the line, and allow the sampler to sink into the sediment momentarily. The release of tension on the line will cause the Pinch-Pin™ to pop out.
- 6.2.8 Collect the sample by pulling on the line, which will cause the lever arms to drive the scoops into the sediment in a closing motion. Keep pulling on the line in a controlled fashion until the scoops drive through the sediment and close.

- 6.2.9 Once the sampler scoops have closed, continue pulling on the line in a controlled fashion in order to retrieve the sampler back to the surface. When the sampler reaches the surface, lift it clear and bring it above a decontaminated stainless steel bowl. Inspect the sampler to determine if any shellfish have been collected. Keep only organisms of target species and discard the remainder. Discard the sample in an area that is not proximal or upstream to the area or subsequent areas that are being sampled. At a minimum, the sample should not be discarded until the area being sampled is complete.
- 6.2.10 Measure the dimension of each organism to a precision of 0.1 cm; the relevant dimension for bivalves is the height, which is the distance from the umbo to the anterior (ventral) shell margin. Weigh each selected organism to a precision of 0.01 g. Record these measurements on the appropriate data form.
- 6.2.11 Weigh several shellfish per species whole (shell-on) and record the data. The organisms will then be opened so the soft tissue can be removed and weighed to determine an approximate ratio of whole weight to soft tissue weight. The field team will employ this ratio, and whole animal weights, to determine the requisite number of individuals required to form a composite sample. Each composite sample will include only one species of shellfish. Each complete composite sample will consist of at least 50 g of soft tissue.
- 6.2.12 Regardless of the individuals in the composite sample, the individual shellfish should all be of similar size so that the height of the smallest individual is no less than 75% of the height of the largest individual in the composite sample.
- 6.2.13 Place all shellfish in plastic bags and into ice chests containing wet ice immediately after collection or measurement. The individual shellfish (shell-on) shall be rinsed with deionized water to remove sediment, wrapped in extra heavy-duty aluminium foil, euthanized using wet ice, and sent to the laboratory for opening, processing, and tissue residue analysis.

### 6.3 SCUBA Diving

- 6.3.1 Have SCUBA divers enter the water at a targeted sediment sampling location and descend to the sediment surface.
- 6.3.2 Visually inspect the substrate within a 3 meter radius to determine if there are any target shellfish species present.
- 6.3.3 Using the shell gauge, collect all legal size shellfish on the sediment surface and place them in the mesh bag.
- 6.3.4 When all individual shellfish in an area have been collected, return to the surface, and hand off samples to support staff.
- 6.3.5 Following sample processing according to the procedures described in steps 6.2.10 through 6.2.13 above.

## 7.0 Quality Control and Assurance

- 7.1 Field personnel will follow specific quality assurance (QA) guidelines as outlined in the project-specific SAP. The goal of the QA program should be to ensure precision, accuracy, representativeness, completeness, and comparability in the project sampling program.
- 7.2 Quality control (QC) requirements for sample collection are dependent on project-specific sampling objectives. The project-specific SAP will provide requirements for sample preservation and holding times, container types, sample packaging and shipment, as well as requirements for the collection of various QC samples such as trip blanks, field blanks, equipment rinse blanks, and field duplicate samples.

## **8.0 Records, Data Analysis, Calculations**

- 8.1 Records will be maintained in accordance with SOP 3-03, Recordkeeping, Sample Labelling, and Chain-of-Custody. Various forms are required to ensure that adequate documentation is made of the sample collection activities. These forms may include:
- Sample Collection Records;
  - Field logbook;
  - Chain-of-custody forms; and
  - Shipping labels.
- 8.2 Sample collection records will provide descriptive information for the shellfish samples collected at each location.
- 8.3 The field logbook is kept as a general log of activities and should not be used in place of the sample collection record.
- 8.4 Chain-of-custody forms are transmitted with the samples to the laboratory for sample tracking purposes.
- 8.5 Shipping labels are required if sample coolers are to be transported to a laboratory by a third party (courier service).

## **9.0 Attachments or References**

Figure 1 – Petite Ponar® Grab Sampler and Exploded Diagram

Figure 2 – AECOM SCUBA Diver Conducting Scientific Sampling Task (typical)

NAVSEA T0300-AZ-PRO-010. *Navy Environmental Compliance Sampling and Field Testing Procedures Manual*. August 2009.

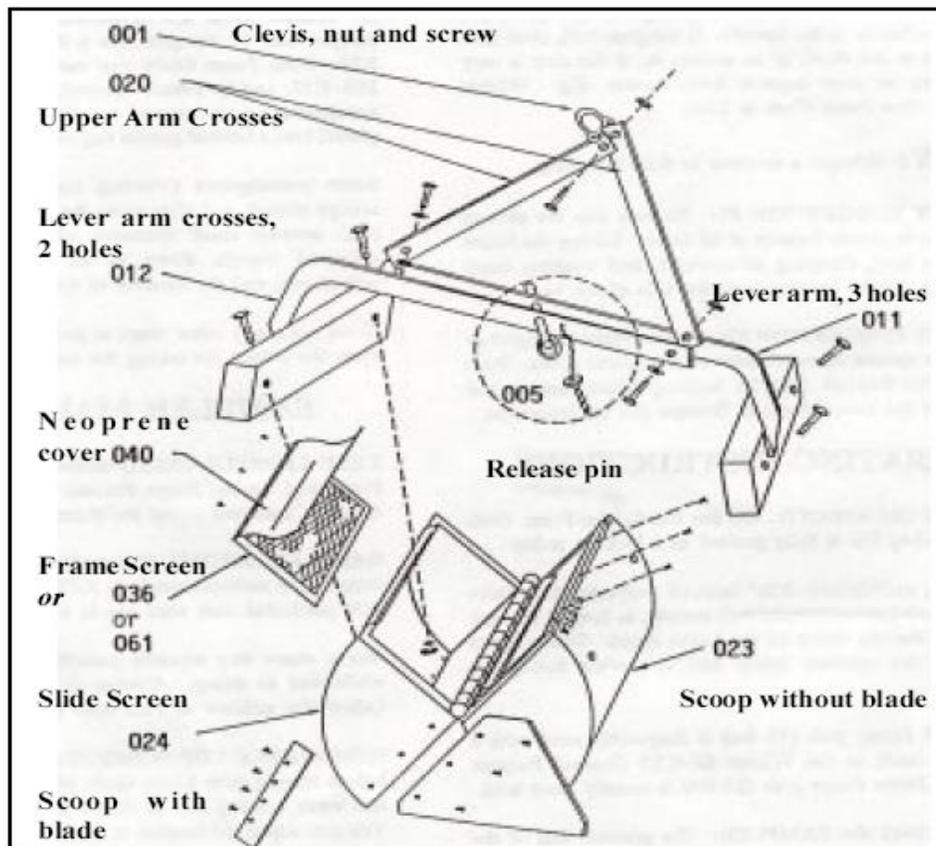
U.S. Environmental Protection Agency (U.S. EPA). 2000. *Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories Volume 1. Fish Sampling and Analysis*. Third Edition

SOP 3-05, *IDW Management*.

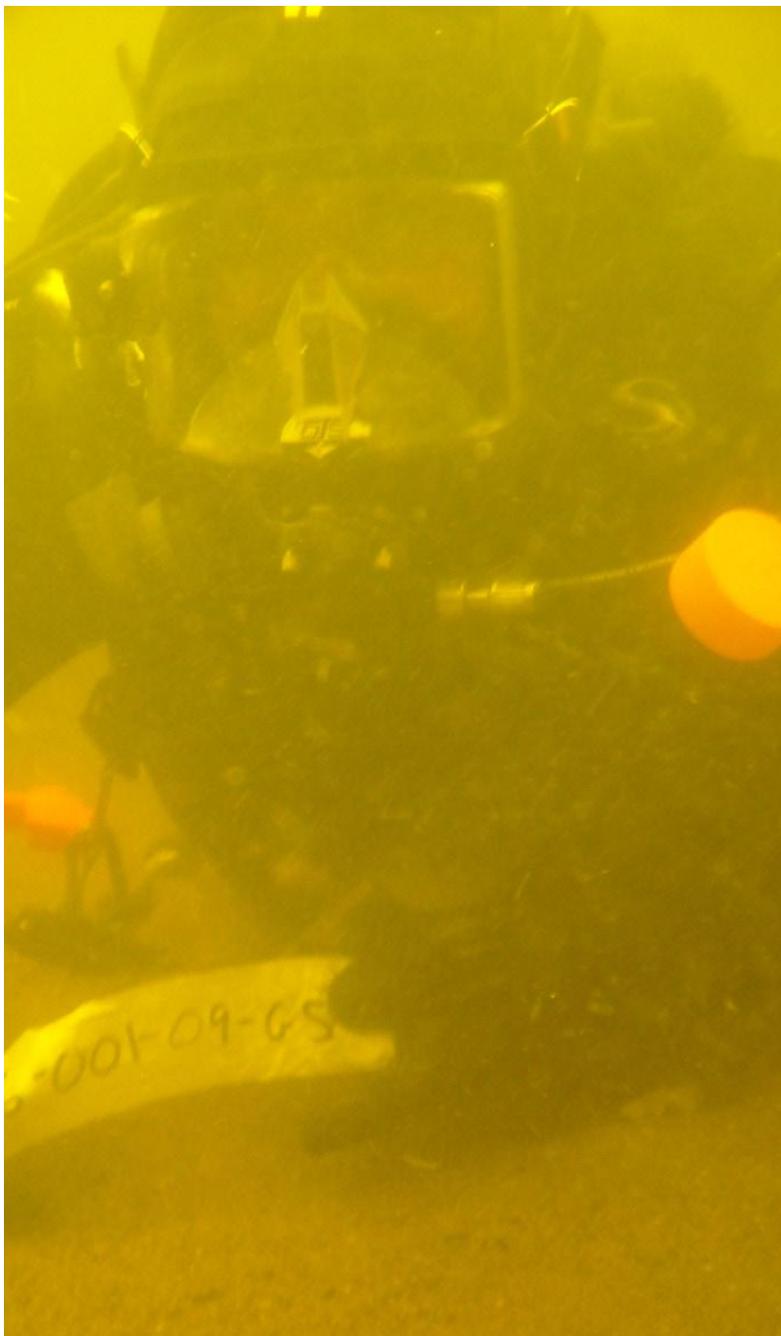
SOP 3-06, *Equipment Decontamination*.

SOP 3-22, *Sediment Sampling*.

**Figure 1**  
**Petite Ponar<sup>®</sup> Grab Sampler and Exploded Diagram**



**Figure 2**  
**AECOM SCUBA Diver Conducting Scientific Sampling Task (typical).**



## **Appendix B**

### **Laboratory Certifications**



# PERRY JOHNSON LABORATORY ACCREDITATION, INC.

## Certificate of Accreditation

*Perry Johnson Laboratory Accreditation, Inc. has assessed the Laboratory of:*

***Columbia Analytical Services, Inc.***  
*1317 South 13<sup>th</sup> Avenue, Kelso, WA 98626*

*(Hereinafter called the Organization) and hereby declares that Organization has met the requirements of ISO/IEC 17025:2005 “General Requirements for the competence of Testing and Calibration Laboratories” and the DoD Quality Systems Manual for Environmental Laboratories Version 4.2 4/22/2009 and is accredited in accordance with the:*

**United States Department of Defense  
Environmental Laboratory Accreditation Program  
(DoD-ELAP)**

***This accreditation demonstrates technical competence for the defined scope:  
Environmental Testing  
(As detailed in the supplement)***

Accreditation claims for such testing and/or calibration services shall only be made from addresses referenced within this certificate. This Accreditation is granted subject to the system rules governing the Accreditation referred to above, and the Organization hereby covenants with the Accreditation body’s duty to observe and comply with the said rules.

For PJLA:

<i>Initial Accreditation Date:</i>	<i>Issue Date:</i>	<i>Accreditation No.:</i>	<i>Certificate No.:</i>
July 19, 2011	March 1, 2012	65188	L12-28

Tracy Szerszen  
President/Operations Manager

Perry Johnson Laboratory  
Accreditation, Inc. (PJLA)  
755 W. Big Beaver, Suite 1325  
Troy, Michigan 48084

*The validity of this certificate is maintained through ongoing assessments based on a continuous accreditation cycle. The validity of this certificate should be confirmed through the PJLA website: [www.pjilabs.com](http://www.pjilabs.com)*



*Certificate of Accreditation: Supplement*  
ISO/IEC 17025:2005 and DoD-ELAP

**Columbia Analytical Services, Inc.**

1317 South 13<sup>th</sup> Avenue, Kelso, WA 98626

Julie Gish Phone: 360-577-7222

*Accreditation is granted to the facility to perform the following testing:*

<b>Matrix</b>	<b>Standard / Method</b>	<b>Technology</b>	<b>Analyte</b>
Aqueous	EPA 1631E	CVAFS	Mercury (Low level)
Aqueous	EPA 1664A	Gravimetry	Hexane Extractable Material (HEM)
Aqueous	EPA 1664A	Gravimetry	Total Petroleum Hydrocarbons (TPH)
Aqueous	EPA 180.1	Nephelometer	Turbidity
Aqueous	EPA 2340B	Calculation by 6010	Hardness as CaCO <sub>3</sub> )
Aqueous	EPA 245.1	CVAA	Mercury
Aqueous	EPA 300.0	IC	Bromide
Aqueous	EPA 300.0	IC	Chloride
Aqueous	EPA 300.0	IC	Fluoride
Aqueous	EPA 300.0	IC	Nitrate + Nitrite as N
Aqueous	EPA 300.0	IC	Nitrate as N
Aqueous	EPA 300.0	IC	Nitrite as N
Aqueous	EPA 300.0	IC	Sulfate
Aqueous	EPA 353.2	Automated Colorimetry	Nitrate + Nitrite as N
Aqueous	EPA 7196A	Colorimetry	Chromium VI
Aqueous	EPA 7470A	CVAA	Mercury
Aqueous	EPA 8260C SIM	GC-MS	1,1,2,2-Tetrachloroethane
Aqueous	EPA 8260C SIM	GC-MS	1,1,2-Trichloroethane
Aqueous	EPA 8260C SIM	GC-MS	1,1-Dichloroethene
Aqueous	EPA 8260C SIM	GC-MS	1,2-Dibromoethane (EDB)
Aqueous	EPA 8260C SIM	GC-MS	1,2-Dichloroethane
Aqueous	EPA 8260C SIM	GC-MS	1,3 Butadine
Aqueous	EPA 8260C SIM	GC-MS	1,4-Dichlorobenzene
Aqueous	EPA 8260C SIM	GC-MS	Bromodichloromethane
Aqueous	EPA 8260C SIM	GC-MS	Carbon Tetrachloride
Aqueous	EPA 8260C SIM	GC-MS	Chlorodibromomethane
Aqueous	EPA 8260C SIM	GC-MS	Chloroform
Aqueous	EPA 8260C SIM	GC-MS	Chloromethane
Aqueous	EPA 8260C SIM	GC-MS	cis-1,2-Dichloroethene
Aqueous	EPA 8260C SIM	GC-MS	Dichloromethane (Methylene Chloride)
Aqueous	EPA 8260C SIM	GC-MS	Tetrachloroethene
Aqueous	EPA 8260C SIM	GC-MS	trans-1,2-Dichloroethene
Aqueous	EPA 8260C SIM	GC-MS	Trichloroethene



**Certificate of Accreditation: Supplement**  
ISO/IEC 17025:2005 and DoD-ELAP

**Columbia Analytical Services, Inc.**

1317 South 13<sup>th</sup> Avenue, Kelso, WA 98626  
Julie Gish Phone: 360-577-7222

*Accreditation is granted to the facility to perform the following testing:*

<b>Matrix</b>	<b>Standard / Method</b>	<b>Technology</b>	<b>Analyte</b>
Aqueous	EPA 8260C SIM	GC-MS	Vinyl chloride
Aqueous	EPA 9020B	Microcoulometric-titration detector	Total Organic Halides (TOX)
Aqueous	EPA 9040C	pH Meter	pH
Aqueous	EPA 9060A	TOC Meter	Total Organic Carbons (TOC)
Aqueous	SM 2130B	Nephelometer	Turbidity
Aqueous	SM 4500 CN- G	Colorimetry	Cyanide, Amenable
Aqueous	SM 4500 P-E	Colorimetry	ortho-phosphorous
Aqueous	SM 4500 S2 D	Distillation Unit	Sulfide
Aqueous	SM2320B	Titrimetry	Total Alkalinity (as CaCO <sub>3</sub> )
Aqueous	SM2510B	Conductivity Meter	Specific Conductance
Aqueous	SM2540B	Balance	Solids, Total
Aqueous	SM2540C	Balance	Solids, Total Dissolved
Aqueous	SM2540D	Balance	Solids, Total Suspended
Aqueous	SM4500CN E	Colorimetry	Total Cyanide
Aqueous	SM4500CN-G	Colorimetry	Cyanide, Amenable
Aqueous	SM4500NH3 G	Colorimetry	Ammonia
Aqueous	SM5220C	Titrimetry	Chemical Oxygen Demand (COD)
Aqueous	SM5310C	TOC Meter	Total Organic Carbons (TOC)
Aqueous	SOP-LCP-PFC	HPLC/MS/MS	Perfluor-n butanoic acid (PFBA)
Aqueous	SOP-LCP-PFC	HPLC/MS/MS	Perfluor-n octanesulfonate (PFOS)
Aqueous	SOP-LCP-PFC	HPLC/MS/MS	Perfluor-n octanoic acid (PFOA)
Aqueous/Drinking Water	EPA 200.9	GFAA	Antimony
Aqueous/Drinking Water	EPA 200.9	GFAA	Selenium
Aqueous/Drinking Water	EPA 200.9	GFAA	Thallium
Aqueous/Drinking Water	EPA 200.9	GFAA	Arsenic
Aqueous/Drinking Water	EPA 200.9	GFAA	Lead
Aqueous/Solid	ASTM D 1426-93B	ISE	Nitrogen, Total Kjeldahl (TKN)
Aqueous/Solid	EPA 1630	CVAFS	Methyl Mercury
Aqueous/Solid	EPA 1020A	Closed Cup Flashpoint	Ignitability
Aqueous/Solid	EPA 314.0	IC	Perchlorate
Aqueous/Solid	EPA 350.1	Colorimetry	Ammonia
Aqueous/Solid	EPA 365.3	Colorimetry	Total Phosphorus
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Aluminum



*Certificate of Accreditation: Supplement*  
ISO/IEC 17025:2005 and DoD-ELAP

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Julie Gish Phone: 360-577-7222

*Accreditation is granted to the facility to perform the following testing:*

<b>Matrix</b>	<b>Standard / Method</b>	<b>Technology</b>	<b>Analyte</b>
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Antimony
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Arsenic
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Barium
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Beryllium
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Boron
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Cadmium
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Calcium
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Chromium, total
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Cobalt
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Copper
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Iron
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Lead
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Magnesium
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Manganese
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Molybdenum
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Nickel
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Potassium
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Selenium
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Silver
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Sodium
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Strontium
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Thallium
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Tin
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Titanium
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Vanadium
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Zinc
Aqueous/Solid	EPA 6020, A/200.8	ICP-MS	Aluminum
Aqueous/Solid	EPA 6020, A/200.8	ICP-MS	Antimony
Aqueous/Solid	EPA 6020, A/200.8	ICP-MS	Arsenic
Aqueous/Solid	EPA 6020, A/200.8	ICP-MS	Barium
Aqueous/Solid	EPA 6020, A/200.8	ICP-MS	Beryllium
Aqueous/Solid	EPA 6020, A/200.8	ICP-MS	Boron
Aqueous/Solid	EPA 6020, A/200.8	ICP-MS	Cadmium
Aqueous/Solid	EPA 6020, A/200.8	ICP-MS	Chromium, total



# Certificate of Accreditation: Supplement

ISO/IEC 17025:2005 and DoD-ELAP

## Columbia Analytical Services, Inc.

1317 South 13<sup>th</sup> Avenue, Kelso, WA 98626  
Julie Gish Phone: 360-577-7222

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Matrix	Standard / Method	Technology	Analyte
Aqueous/Solid	EPA 6020, A/200.8	ICP-MS	Cobalt
Aqueous/Solid	EPA 6020, A/200.8	ICP-MS	Copper
Aqueous/Solid	EPA 6020, A/200.8	ICP-MS	Iron
Aqueous/Solid	EPA 6020, A/200.8	ICP-MS	Lead
Aqueous/Solid	EPA 6020, A/200.8	ICP-MS	Manganese
Aqueous/Solid	EPA 6020, A/200.8	ICP-MS	Molybdenum
Aqueous/Solid	EPA 6020, A/200.8	ICP-MS	Nickel
Aqueous/Solid	EPA 6020, A/200.8	ICP-MS	Selenium
Aqueous/Solid	EPA 6020, A/200.8	ICP-MS	Silver
Aqueous/Solid	EPA 6020, A/200.8	ICP-MS	Strontium
Aqueous/Solid	EPA 6020, A/200.8	ICP-MS	Thallium
Aqueous/Solid	EPA 6020, A/200.8	ICP-MS	Tin
Aqueous/Solid	EPA 6020, A/200.8	ICP-MS	Titanium
Aqueous/Solid	EPA 6020, A/200.8	ICP-MS	Vanadium
Aqueous/Solid	EPA 6020, A/200.8	ICP-MS	Zinc
Aqueous/Solid	EPA 7010	GFAA	Antimony
Aqueous/Solid	EPA 7010	GFAA	Arsenic
Aqueous/Solid	EPA 7010	GFAA	Chromium, total
Aqueous/Solid	EPA 7010	GFAA	Lead
Aqueous/Solid	EPA 7010	GFAA	Selenium
Aqueous/Solid	EPA 7010	GFAA	Thallium
Aqueous/Solid	EPA 7742	AA, Borohydride Reduction; GFAA	Selenium
Aqueous/Solid	EPA 8015C/AK103-RRO	GC-FID	Residual Range Organics (RRO)
Aqueous/Solid	EPA 8015C; AK101-GRO; NWTPH-G <sub>x</sub>	GC-FID	Gasoline Range Organics (GRO)
Aqueous/Solid	EPA 8015C; AK102-DRO; NWTPH-D <sub>x</sub>	GC-FID	Diesel Range Organics (DRO)
Aqueous/Solid	EPA 8021B	GC-FID	Benzene
Aqueous/Solid	EPA 8021B	GC-FID	Ethyl Benzene
Aqueous/Solid	EPA 8021B	GC-FID	Toluene
Aqueous/Solid	EPA 8021B	GC-FID	Xylene, total
Aqueous/Solid	EPA 8081A, B	GC-ECD	Aldrin
Aqueous/Solid	EPA 8081A, B	GC-ECD	Alpha-BHC



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<b>Matrix</b>	<b>Standard / Method</b>	<b>Technology</b>	<b>Analyte</b>
Aqueous/Solid	EPA 8081A, B	GC-ECD	DDD (4,4)
Aqueous/Solid	EPA 8081A, B	GC-ECD	DDE (4,4)
Aqueous/Solid	EPA 8081A, B	GC-ECD	DDT (4,4)
Aqueous/Solid	EPA 8081A, B	GC-ECD	delta-BHC
Aqueous/Solid	EPA 8081A, B	GC-ECD	Dieldrin
Aqueous/Solid	EPA 8081A, B	GC-ECD	Endosulfan I
Aqueous/Solid	EPA 8081A, B	GC-ECD	Endosulfan II
Aqueous/Solid	EPA 8081A, B	GC-ECD	Endosulfan sulfate
Aqueous/Solid	EPA 8081A, B	GC-ECD	Endrin
Aqueous/Solid	EPA 8081A, B	GC-ECD	Endrin aldehyde
Aqueous/Solid	EPA 8081A, B	GC-ECD	Endrin ketone
Aqueous/Solid	EPA 8081A, B	GC-ECD	gamma-BHC
Aqueous/Solid	EPA 8081A, B	GC-ECD	gamma-Chlordane
Aqueous/Solid	EPA 8081A, B	GC-ECD	Heptachlor
Aqueous/Solid	EPA 8081A, B	GC-ECD	Heptachlor Epoxide (beta)
Aqueous/Solid	EPA 8081A, B	GC-ECD	Methoxychlor
Aqueous/Solid	EPA 8081A, B	GC-ECD	Toxaphene (total)
Aqueous/Solid	EPA 8081B	GC-ECD	2,4-DDD
Aqueous/Solid	EPA 8081B	GC-ECD	2,4-DDE
Aqueous/Solid	EPA 8081B	GC-ECD	2,4-DDT
Aqueous/Solid	EPA 8081B	GC-ECD	Chlorpyrifos
Aqueous/Solid	EPA 8081B	GC-ECD	cis-Nonachlor
Aqueous/Solid	EPA 8081B	GC-ECD	Hexachlorobenzene
Aqueous/Solid	EPA 8081B	GC-ECD	Hexachlorobutadiene
Aqueous/Solid	EPA 8081B	GC-ECD	Hexachloroethane
Aqueous/Solid	EPA 8081B	GC-ECD	Isodrin
Aqueous/Solid	EPA 8081B	GC-ECD	Mirex
Aqueous/Solid	EPA 8081B	GC-ECD	Oxychlordane
Aqueous/Solid	EPA 8081B	GC-ECD	trans-Nonachlor
Aqueous/Solid	EPA 8082, A	GC-ECD	2,2,3,3,4,4,5,5,6-Nonachlorobiphenyl (PCB 206)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,2,3,3,4,4,5,6-Octachlorobiphenyl (PCB 195)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,2,3,3,4,4,5-Heptachlorobiphenyl (PCB 170)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,2,3,3,4,4-Hexachlorobiphenyl (PCB 128)



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<b>Matrix</b>	<b>Standard / Method</b>	<b>Technology</b>	<b>Analyte</b>
Aqueous/Solid	EPA 8082, A	GC-ECD	2,2,3,4,4,5,5-Heptachlorobiphenyl (PCB180)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,2,3,4,4,5,6-Heptachlorobiphenyl (PCB 183)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,2,3,4,4,5-Hexachlorobiphenyl (PCB 138)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,2,3,4,4,6,6-Heptachlorobiphenyl (PCB 184)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,2,3,4,4,5,6-Heptachlorobiphenyl (PCB 187)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,2,3,4,5-Pentachlorobiphenyl (PCB87)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,2,3,4,5-Pentachlorobiphenyl (PCB90)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,2,3,5-Tetrachlorobiphenyl (PCB44)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,2,4,4,5,5-Hexachlorobiphenyl (PCB153)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,2,4,5,5-Pentachlorobiphenyl (PCB 101)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,2,5,5-Tetrachlorobiphenyl (PCB 53)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,2,5-Trichlorobiphenyl (PCB18)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,3,3,4,4,5,5-Heptachlorobiphenyl (PCB 189)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,3,3,4,4,5-Hexachlorobiphenyl (PCB 156)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,3,3,4,4,5-Hexachlorobiphenyl (PCB 157)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,3,3,4,4,6-Hexachlorobiphenyl (PCB 158)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,3,3,4,4-Pentachlorobiphenyl (PCB 105)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,3,4,4,5,5 Hexachlorobiphenyl (PCB 167)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,3,4,4,5,6-Hexachlorobiphenyl (PCB 168)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,3,4,4,5-Pentachlorobiphenyl (PCB 114)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,3,4,4,5-Pentachlorobiphenyl (PCB 118)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,3,4,4,5-Pentachlorobiphenyl (PCB 123)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,3,4,4-Tetrachlorobiphenyl (PCB60)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,3,4,4-Tetrachlorobiphenyl (PCB66)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,4,4-Trichlorobiphenyl (PCB 28)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,4-Dichlorobiphenyl (PCB8)
Aqueous/Solid	EPA 8082, A	GC-ECD	3,3,4,4,5,5-Hexachlorobiphenyl (PCB 169)
Aqueous/Solid	EPA 8082, A	GC-ECD	3,3,4,4,5-Pentachlorobiphenyl (PCB 126)
Aqueous/Solid	EPA 8082, A	GC-ECD	3,3,4,4-Tetrachlorobiphenyl (PCB 77)
Aqueous/Solid	EPA 8082, A	GC-ECD	3,4,4,5-Tetrachlorobiphenyl (PCB 81)
Aqueous/Solid	EPA 8082, A	GC-ECD	Aroclor 1016
Aqueous/Solid	EPA 8082, A	GC-ECD	Aroclor 1221
Aqueous/Solid	EPA 8082, A	GC-ECD	Aroclor 1232



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<b>Matrix</b>	<b>Standard / Method</b>	<b>Technology</b>	<b>Analyte</b>
Aqueous/Solid	EPA 8082, A	GC-ECD	Aroclor 1242
Aqueous/Solid	EPA 8082, A	GC-ECD	Aroclor 1248
Aqueous/Solid	EPA 8082, A	GC-ECD	Aroclor 1254
Aqueous/Solid	EPA 8082, A	GC-ECD	Aroclor 1260
Aqueous/Solid	EPA 8082, A	GC-ECD	Aroclor 1262
Aqueous/Solid	EPA 8082, A	GC-ECD	Aroclor 1268
Aqueous/Solid	EPA 8082, A	GC-ECD	Decachlorobiphenyl (PC B209)
Aqueous/Solid	EPA 8151A	GC-ECD	2,4,5-T
Aqueous/Solid	EPA 8151A	GC-ECD	2,4,5-TP (Silvex)
Aqueous/Solid	EPA 8151A	GC-ECD	2,4-D
Aqueous/Solid	EPA 8151A	GC-ECD	2,4-DB
Aqueous/Solid	EPA 8151A	GC-ECD	Dalapon
Aqueous/Solid	EPA 8151A	GC-ECD	Dicamba
Aqueous/Solid	EPA 8151A	GC-ECD	Dichloroprop
Aqueous/Solid	EPA 8151A	GC-ECD	Dinoseb
Aqueous/Solid	EPA 8151A	GC-ECD	MCPA
Aqueous/Solid	EPA 8151A	GC-ECD	MCPP
Aqueous/Solid	EPA 8260B, C	GC-MS	1-phenylpropane
Aqueous/Solid	EPA 8260B, C	GC-MS	Benzene
Aqueous/Solid	EPA 8260B, C	GC-MS	DIPE
Aqueous/Solid	EPA 8260B, C	GC-MS	ETBE
Aqueous/Solid	EPA 8260B, C	GC-MS	Ethyl Benzene
Aqueous/Solid	EPA 8260B, C	GC-MS	Freon 11
Aqueous/Solid	EPA 8260B, C	GC-MS	Freon 113
Aqueous/Solid	EPA 8260B, C	GC-MS	MTBE
Aqueous/Solid	EPA 8260B, C	GC-MS	TAME
Aqueous/Solid	EPA 8260B, C	GC-MS	tert-Butyl alcohol
Aqueous/Solid	EPA 8260B, C	GC-MS	Toluene
Aqueous/Solid	EPA 8260B, C	GC-MS	Xylene, total
Aqueous/Solid	EPA 8260B, C	GC-MS	1,1,1,2-Tetrachloroethane
Aqueous/Solid	EPA 8260B, C	GC-MS	1,1,1-Trichloroethane
Aqueous/Solid	EPA 8260B, C	GC-MS	1,1,2,2-Tetrachloroethane
Aqueous/Solid	EPA 8260B, C	GC-MS	1,1,2-Trichloroethane



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<b>Matrix</b>	<b>Standard / Method</b>	<b>Technology</b>	<b>Analyte</b>
Aqueous/Solid	EPA 8260B, C	GC-MS	1,1-Dichloroethane
Aqueous/Solid	EPA 8260B,C	GC-MS	1,1-Dichloroethene
Aqueous/Solid	EPA 8260B,C	GC-MS	1,1-Dichloropropene
Aqueous/Solid	EPA 8260B,C	GC-MS	1,2,3-Trichlorobenzene
Aqueous/Solid	EPA 8260B,C	GC-MS	1,2,3-Trichloropropane
Aqueous/Solid	EPA 8260B,C	GC-MS	1,2,4-Trichlorobenzene
Aqueous/Solid	EPA 8260B,C	GC-MS	1,2,4-Trimethylbenzene
Aqueous/Solid	EPA 8260B, C	GC-MS	1,2-Dibromoethane (EDB)
Aqueous/Solid	EPA 8260B, C	GC-MS	1,2-Dichlorobenzene
Aqueous/Solid	EPA 8260B, C	GC-MS	1,2-Dichloroethane
Aqueous/Solid	EPA 8260B, C	GC-MS	1,2-Dichloropropane
Aqueous/Solid	EPA 8260B, C	GC-MS	1,3,5-Trimethylbenzene
Aqueous/Solid	EPA 8260B, C	GC-MS	1,3-Dichlorobenzene
Aqueous/Solid	EPA 8260B, C	GC-MS	1,3-Dichloropropane
Aqueous/Solid	EPA 8260B, C	GC-MS	1,4-Dichlorobenzene
Aqueous/Solid	EPA 8260B, C	GC-MS	2,2-Dichloropropane
Aqueous/Solid	EPA 8260B, C	GC-MS	2-Butanone (MEK)
Aqueous/Solid	EPA 8260B, C	GC-MS	2-Chloroethylvinlether
Aqueous/Solid	EPA 8260B, C	GC-MS	2-Chlorotoluene
Aqueous/Solid	EPA 8260B, C	GC-MS	2-Hexanone
Aqueous/Solid	EPA 8260B, C	GC-MS	4-Chlorotoluene
Aqueous/Solid	EPA 8260B, C	GC-MS	4-Isopropyltoluene
Aqueous/Solid	EPA 8260B, C	GC-MS	4-Methyl-2-pentanone (MIBK)
Aqueous/Solid	EPA 8260B, C	GC-MS	Acetone
Aqueous/Solid	EPA 8260B, C	GC-MS	Acetonitrile
Aqueous/Solid	EPA 8260B, C	GC-MS	Acrolein
Aqueous/Solid	EPA 8260B, C	GC-MS	Acrylonitrile
Aqueous/Solid	EPA 8260B, C	GC-MS	Benzene
Aqueous/Solid	EPA 8260B, C	GC-MS	Bromobenzene
Aqueous/Solid	EPA 8260B, C	GC-MS	Bromochloromethane
Aqueous/Solid	EPA 8260B, C	GC-MS	Bromodichloromethane
Aqueous/Solid	EPA 8260B, C	GC-MS	Bromoform
Aqueous/Solid	EPA 8260B, C	GC-MS	Bromomethane



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<b>Matrix</b>	<b>Standard / Method</b>	<b>Technology</b>	<b>Analyte</b>
Aqueous/Solid	EPA 8260B, C	GC-MS	Carbon disulfide
Aqueous/Solid	EPA 8260B, C	GC-MS	Carbon Tetrachloride
Aqueous/Solid	EPA 8260B, C	GC-MS	Chlorobenzene
Aqueous/Solid	EPA 8260B, C	GC-MS	Chlorodibromomethane
Aqueous/Solid	EPA 8260B, C	GC-MS	Chloroethane
Aqueous/Solid	EPA 8260B, C	GC-MS	Chloroform
Aqueous/Solid	EPA 8260B, C	GC-MS	Chloromethane
Aqueous/Solid	EPA 8260B, C	GC-MS	cis-1,2-Dichloroethene
Aqueous/Solid	EPA 8260B, C	GC-MS	cis-1,3-Dichloropropene
Aqueous/Solid	EPA 8260B, C	GC-MS	Dibromomethane
Aqueous/Solid	EPA 8260B, C	GC-MS	Dichlorodifluoromethane
Aqueous/Solid	EPA 8260B, C	GC-MS	Dichloromethane (Methylene Chloride)
Aqueous/Solid	EPA 8260B, C	GC-MS	Di-isopropylether (DIPE)
Aqueous/Solid	EPA 8260B, C	GC-MS	Ethylbenzene
Aqueous/Solid	EPA 8260B, C	GC-MS	Hexachlorobutadiene
Aqueous/Solid	EPA 8260B, C	GC-MS	Isopropylbenzene
Aqueous/Solid	EPA 8260B, C	GC-MS	Methyl-tert-butylether (MTBE)
Aqueous/Solid	EPA 8260B, C	GC-MS	Naphthalene
Aqueous/Solid	EPA 8260B, C	GC-MS	n-Butylbenzene
Aqueous/Solid	EPA 8260B, C	GC-MS	n-Propylbenzene
Aqueous/Solid	EPA 8260B, C	GC-MS	sec-Butylbenzene
Aqueous/Solid	EPA 8260B, C	GC-MS	Styrene
Aqueous/Solid	EPA 8260B, C	GC-MS	tert-amylmethylether (TAME)
Aqueous/Solid	EPA 8260B, C	GC-MS	tert-butylbenzene
Aqueous/Solid	EPA 8260B, C	GC-MS	Tetrachloroethene
Aqueous/Solid	EPA 8260B, C	GC-MS	Toluene
Aqueous/Solid	EPA 8260B, C	GC-MS	trans-1,2-Dichloroethene
Aqueous/Solid	EPA 8260B, C	GC-MS	trans-1,3-Dichloropropene
Aqueous/Solid	EPA 8260B, C	GC-MS	Trichloroethene
Aqueous/Solid	EPA 8260B, C	GC-MS	Trichlorofluoromethane (Freon 11)
Aqueous/Solid	EPA 8260B, C	GC-MS	Vinyl acetate
Aqueous/Solid	EPA 8260B, C	GC-MS	Vinyl chloride
Aqueous/solid	EPA 8260B, C	GC-MS	Xylenes, total



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<b>Matrix</b>	<b>Standard / Method</b>	<b>Technology</b>	<b>Analyte</b>
Aqueous/Solid	EPA 8270C, D	GC-MS	1,2,4-Trichlorobenzene
Aqueous/Solid	EPA 8270C, D	GC-MS	1,2-Dichlorobenzene
Aqueous/Solid	EPA 8270C, D	GC-MS	1,3-Dichlorobenzene
Aqueous/Solid	EPA 8270C, D	GC-MS	1,4-Dichlorobenzene
Aqueous/Solid	EPA 8270C, D	GC-MS	2,4,5-Trichlorophenol
Aqueous/Solid	EPA 8270C, D	GC-MS	2,4,6-Trichlorophenol
Aqueous/Solid	EPA 8270C, D	GC-MS	2,4-Dichlorophenol
Aqueous/Solid	EPA 8270C, D	GC-MS	2,4-Dimethylphenol
Aqueous/Solid	EPA 8270C, D	GC-MS	2,4-Dinitrophenol
Aqueous/Solid	EPA 8270C, D	GC-MS	2,4-Dinitrotoluene
Aqueous/Solid	EPA 8270C, D	GC-MS	2,6-Dichlorophenol
Aqueous/Solid	EPA 8270C, D	GC-MS	2,6-Dinitrotoluene
Aqueous/Solid	EPA 8270C, D	GC-MS	2-Chloronaphthalene
Aqueous/Solid	EPA 8270C, D	GC-MS	2-Chlorophenol
Aqueous/Solid	EPA 8270C, D	GC-MS	2-Methyl-4,6-Dinitrophenol
Aqueous/Solid	EPA 8270C, D	GC-MS	2-Methylnaphthalene
Aqueous/Solid	EPA 8270C, D	GC-MS	2-Methylphenol
Aqueous/Solid	EPA 8270C, D	GC-MS	2-Nitroaniline
Aqueous/Solid	EPA 8270C, D	GC-MS	2-Nitrophenol
Aqueous/Solid	EPA 8270C, D	GC-MS	3,3-Dichlorobenzidine
Aqueous/Solid	EPA 8270C, D	GC-MS	3-Nitroaniline
Aqueous/Solid	EPA 8270C, D	GC-MS	4-Bromophenyl-phenylether
Aqueous/Solid	EPA 8270C, D	GC-MS	4-Chloro-3-methylphenol
Aqueous/Solid	EPA 8270C, D	GC-MS	4-Chloroaniline
Aqueous/Solid	EPA 8270C, D	GC-MS	4-Chlorophenyl-phenylether
Aqueous/Solid	EPA 8270C, D	GC-MS	4-Methylphenol (and/or 3-Methylphenol)
Aqueous/Solid	EPA 8270C, D	GC-MS	4-Nitroaniline
Aqueous/Solid	EPA 8270C, D	GC-MS	4-Nitrophenol
Aqueous/Solid	EPA 8270C, D	GC-MS	Acenaphthene
Aqueous/Solid	EPA 8270C, D	GC-MS	Acenaphthylene
Aqueous/Solid	EPA 8270C, D	GC-MS	Aniline
Aqueous/Solid	EPA 8270C, D	GC-MS	Anthracene
Aqueous/Solid	EPA 8270C, D	GC-MS	Azinphos-methyl (Guthion)



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Julie Gish Phone: 360-577-7222

*Accreditation is granted to the facility to perform the following testing:*

<b>Matrix</b>	<b>Standard / Method</b>	<b>Technology</b>	<b>Analyte</b>
Aqueous/Solid	EPA 8270C, D	GC-MS	Benzidine
Aqueous/Solid	EPA 8270C, D	GC-MS	Benzo(a)anthracene
Aqueous/Solid	EPA 8270C, D	GC-MS	Benzo(a)pyrene
Aqueous/Solid	EPA 8270C, D	GC-MS	Benzo(b)fluoranthene
Aqueous/Solid	EPA 8270C, D	GC-MS	Benzo(g,h,i)perylene
Aqueous/Solid	EPA 8270C, D	GC-MS	Benzo(k)fluoranthene
Aqueous/Solid	EPA 8270C, D	GC-MS	Benzoic acid
Aqueous/Solid	EPA 8270C, D	GC-MS	Benzyl alcohol
Aqueous/Solid	EPA 8270C, D	GC-MS	bis(2-Chloroethoxy)methane
Aqueous/Solid	EPA 8270C, D	GC-MS	bis(2-Chloroethyl)ether
Aqueous/Solid	EPA 8270C, D	GC-MS	bis(2-Chloroisopropyl)ether
Aqueous/Solid	EPA 8270C, D	GC-MS	bis(2-ethylhexy)phthalate
Aqueous/Solid	EPA 8270C, D	GC-MS	Butyl benzyl phthalate
Aqueous/Solid	EPA 8270C, D	GC-MS	Carbazole
Aqueous/Solid	EPA 8270C, D	GC-MS	Chlorpyrifos
Aqueous/Solid	EPA 8270C, D	GC-MS	Chrysene
Aqueous/Solid	EPA 8270C, D	GC-MS	Demeton O & S
Aqueous/Solid	EPA 8270C, D	GC-MS	Diazinon
Aqueous/Solid	EPA 8270C, D	GC-MS	Dibenzo(a,h)anthracene
Aqueous/Solid	EPA 8270C, D	GC-MS	Dibenzofuran
Aqueous/Solid	EPA 8270C, D	GC-MS	Dichlorvos
Aqueous/Solid	EPA 8270C, D	GC-MS	Diethyl phthalate
Aqueous/Solid	EPA 8270C, D	GC-MS	dimethoate
Aqueous/Solid	EPA 8270C, D	GC-MS	Dimethylphthalate
Aqueous/Solid	EPA 8270C, D	GC-MS	di-n-butylphthalate
Aqueous/Solid	EPA 8270C, D	GC-MS	Di-n-octylphthalate
Aqueous/Solid	EPA 8270C, D	GC-MS	Disulfoton
Aqueous/Solid	EPA 8270C, D	GC-MS	Ethoprop
Aqueous/Solid	EPA 8270C, D	GC-MS	Fluoranthene
Aqueous/Solid	EPA 8270C, D	GC-MS	Fluorene
Aqueous/Solid	EPA 8270C, D	GC-MS	Hexachlorobenzene
Aqueous/Solid	EPA 8270C, D	GC-MS	Hexachlorobutadiene
Aqueous/Solid	EPA 8270C, D	GC-MS	Hexachlorocyclopentadiene



**Certificate of Accreditation: Supplement**  
ISO/IEC 17025:2005 and DoD-ELAP

**Columbia Analytical Services, Inc.**

1317 South 13<sup>th</sup> Avenue, Kelso, WA 98626  
Julie Gish Phone: 360-577-7222

*Accreditation is granted to the facility to perform the following testing:*

<b>Matrix</b>	<b>Standard / Method</b>	<b>Technology</b>	<b>Analyte</b>
Aqueous/Solid	EPA 8270C, D	GC-MS	Hexachloroethane
Aqueous/Solid	EPA 8270C, D	GC-MS	Indeno(1,2,3, cd)pyrene
Aqueous/Solid	EPA 8270C, D	GC-MS	Isophorone
Aqueous/Solid	EPA 8270C, D	GC-MS	Naphthalene
Aqueous/Solid	EPA 8270C, D	GC-MS	Nitrobenzene
Aqueous/Solid	EPA 8270C, D	GC-MS	N-Nitrosodiethylamine
Aqueous/Solid	EPA 8270C, D	GC-MS	N-Nitrosodimethylamine
Aqueous/Solid	EPA 8270C, D	GC-MS	N-Nitroso-di-n-propylamine
Aqueous/Solid	EPA 8270C, D	GC-MS	N-Nitrosodiphenylamine
Aqueous/Solid	EPA 8270C, D	GC-MS	o-Toluidine
Aqueous/Solid	EPA 8270C, D	GC-MS	Parathion, ethyl
Aqueous/Solid	EPA 8270C, D	GC-MS	Parathion, methyl
Aqueous/Solid	EPA 8270C, D	GC-MS	Pentachlorobenzene
Aqueous/Solid	EPA 8270C, D	GC-MS	Pentachlorophenol
Aqueous/Solid	EPA 8270C, D	GC-MS	Phenanthrene
Aqueous/Solid	EPA 8270C, D	GC-MS	Phenol
Aqueous/Solid	EPA 8270C, D	GC-MS	Phorate
Aqueous/Solid	EPA 8270C, D	GC-MS	Pyrene
Aqueous/Solid	EPA 8270C, D	GC-MS	Pyridine
Aqueous/Solid	EPA 8270C, D	GC-MS	Ronnel
Aqueous/Solid	EPA 8270C, D	GC-MS	Stirophos
Aqueous/Solid	EPA 8270C, D	GC-MS	Sulfotepp
Aqueous/Solid	EPA 8270C, D	GC-MS	2,3,4,6-Tetrachlorophenol
Aqueous/Solid	EPA 8270C,D	GC-MS	1,2,4,5-Tetrachlorobenzene
Aqueous/Solid	EPA 8270SIM	GC-MS	2-Methylnaphthalene
Aqueous/Solid	EPA 8270SIM	GC-MS	Acenaphthene
Aqueous/Solid	EPA 8270SIM	GC-MS	Acenaphthylene
Aqueous/Solid	EPA 8270SIM	GC-MS	Anthracene
Aqueous/Solid	EPA 8270SIM	GC-MS	Benzo(a)anthracene
Aqueous/Solid	EPA 8270SIM	GC-MS	Benzo(a)pyrene
Aqueous/Solid	EPA 8270SIM	GC-MS	Benzo(b)fluoranthene
Aqueous/Solid	EPA 8270SIM	GC-MS	Benzo(g,h,i)perylene
Aqueous/Solid	EPA 8270SIM	GC-MS	Benzo(k)fluoranthene



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*Accreditation is granted to the facility to perform the following testing:*

<b>Matrix</b>	<b>Standard / Method</b>	<b>Technology</b>	<b>Analyte</b>
Aqueous/Solid	EPA 8270SIM	GC-MS	Chrysene
Aqueous/Solid	EPA 8270SIM	GC-MS	Dibenzo(a,h)anthracene
Aqueous/Solid	EPA 8270SIM	GC-MS	Fluoranthene
Aqueous/Solid	EPA 8270SIM	GC-MS	Fluorene
Aqueous/Solid	EPA 8270SIM	GC-MS	Indeno(1,2,3, cd)pyrene
Aqueous/Solid	EPA 8270SIM	GC-MS	Naphthalene
Aqueous/Solid	EPA 8270SIM	GC-MS	p-Dioxane
Aqueous/Solid	EPA 8270SIM	GC-MS	Phenanthrene
Aqueous/Solid	EPA 8270SIM	GC-MS	Pyrene
Aqueous/Solid	EPA 8330B	HPLC	1,3,5-Trinitrobenzene
Aqueous/Solid	EPA 8330B	HPLC	1,3-Dinitrobenzene
Aqueous/Solid	EPA 8330B	HPLC	2,4,6-Trinitrotoluene
Aqueous/Solid	EPA 8330B	HPLC	2,4-Dinitrotoluene
Aqueous/Solid	EPA 8330B	HPLC	2,6-Dinitrotoluene
Aqueous/Solid	EPA 8330B	HPLC	2-Amino-4,6-dinitrotoluene
Aqueous/Solid	EPA 8330B	HPLC	2-Nitrotoluene
Aqueous/Solid	EPA 8330B	HPLC	3,5-Dinitroaniline
Aqueous/Solid	EPA 8330B	HPLC	3-Nitrotoluene
Aqueous/Solid	EPA 8330B	HPLC	4-Amino-2,6-dinitrotoluene
Aqueous/Solid	EPA 8330B	HPLC	4-Nitrotoluene
Aqueous/Solid	EPA 8330B	HPLC	HMX (Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine)
Aqueous/Solid	EPA 8330B	HPLC	Nitrobenzene
Aqueous/Solid	EPA 8330B	HPLC	Nitroglycerin
Aqueous/Solid	EPA 8330B	HPLC	Pentachloronitrobenzene
Aqueous/Solid	EPA 8330B	HPLC	Pentaerythritoltetranitrate
Aqueous/Solid	EPA 8330B	HPLC	RDX (hexahydro-1,3,5-trinitro-1,3,5-triazine)
Aqueous/Solid	EPA 8330B	HPLC	Tetryl (methyl-2,4,6-trinitrophenylnitramine)
Aqueous/Solid	EPA 9012B,	Colorimetry	Total Cyanide
Aqueous/Solid	EPA 9030B	Distillation Unit	Sulfide
Aqueous/Solid	EPA 9056A	IC	Bromide
Aqueous/Solid	EPA 9056A	IC	Chloride
Aqueous/Solid	EPA 9056A	IC	Fluoride



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Aqueous/Solid	EPA 9056A	IC	Sulfate
Aqueous/Solid	EPA 9065	Spectrophotometer	Total Phenolics
Aqueous/Solid	LCP-NITG	HPLC/UV	Nitroguanidine
Aqueous/Solid	SM4500 NH3 G	Colorimetry	Ammonia
Aqueous/Solid	SOC-OTTO	GC-ECD	Otto Fuel
Aqueous/Solid	SOC-Butyl	GC-FPD	Di-n-butyltin
Aqueous/Solid	SOC-Butyl	GC-FPD	n-Butyltin
Aqueous/Solid	SOC-Butyl	GC-FPD	Tetra-n-butyltin
Aqueous/Solid	SOC-Butyl	GC-FPD	Tri-n-butyltin
Aqueous/Solid	SOC-PESTMS2	GC/MS/MS/MS	Aldrin
Aqueous/Solid	SOC-PESTMS2	GC/MS/MS/MS	Alpha-BHC
Aqueous/Solid	SOC-PESTMS2	GC/MS/MS/MS	beta-BHC
Aqueous/Solid	SOC-PESTMS2	GC/MS/MS/MS	DDD (4,4)
Aqueous/Solid	SOC-PESTMS2	GC/MS/MS/MS	DDE (4,4)
Aqueous/Solid	SOC-PESTMS2	GC/MS/MS/MS	DDT (4,4)
Aqueous/Solid	SOC-PESTMS2	GC/MS/MS/MS	delta-BHC
Aqueous/Solid	SOC-PESTMS2	GC/MS/MS/MS	Dieldrin
Aqueous/Solid	SOC-PESTMS2	GC/MS/MS/MS	Endosulfan I
Aqueous/Solid	SOC-PESTMS2	GC/MS/MS/MS	Endosulfan II
Aqueous/Solid	SOC-PESTMS2	GC/MS/MS/MS	Endosulfan sulfate
Aqueous/Solid	SOC-PESTMS2	GC/MS/MS/MS	Endrin
Aqueous/Solid	SOC-PESTMS2	GC/MS/MS/MS	Endrin aldehyde
Aqueous/Solid	SOC-PESTMS2	GC/MS/MS/MS	Endrin ketone
Aqueous/Solid	SOC-PESTMS2	GC/MS/MS/MS	gamma-BHC
Aqueous/Solid	SOC-PESTMS2	GC/MS/MS/MS	Heptachlor
Aqueous/Solid	SOC-PESTMS2	GC/MS/MS/MS	Heptachlor Epoxide (beta)
Aqueous/Solid	SOC-PESTMS2	GC/MS/MS/MS	Methoxychlor
Drinking Water	EPA 504	GC-ECD	1,2-Dibromo-3-chloropropane (DBCP)
Drinking Water	EPA 504	GC-ECD	1,2-Dibromoethane (EDB)
Drinking Water	EPA 524.2	GC-MS	1,1,1,2-Tetrachloroethane
Drinking Water	EPA 524.2	GC-MS	1,1,1-Trichloroethane
Drinking Water	EPA 524.2	GC-MS	1,1,2,2-Tetrachloroethane
Drinking Water	EPA 524.2	GC-MS	1,1-Dichloroethane
Drinking Water	EPA 524.2	GC-MS	1,1-Dichloroethene



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*Accreditation is granted to the facility to perform the following testing:*

<b>Matrix</b>	<b>Standard / Method</b>	<b>Technology</b>	<b>Analyte</b>
Drinking Water	EPA 524.2	GC-MS	1,1-Dichloropropene
Drinking Water	EPA 524.2	GC-MS	1,2,3-Trichlorobenzene
Drinking Water	EPA 524.2	GC-MS	1,2,3-Trichloropropane
Drinking Water	EPA 524.2	GC-MS	1,2,4-Trichlorobenzene
Drinking Water	EPA 524.2	GC-MS	1,2,4-Trimethylbenzene
Drinking Water	EPA 524.2	GC-MS	1,2-Dibromoethane (EDB)
Drinking Water	EPA 524.2	GC-MS	1,2-Dichlorobenzene
Drinking Water	EPA 524.2	GC-MS	1,2-Dichloroethane
Drinking Water	EPA 524.2	GC-MS	1,2-Dichloropropane
Drinking Water	EPA 524.2	GC-MS	1,3,5-Trimethylbenzene
Drinking Water	EPA 524.2	GC-MS	1,3-Dichlorobenzene
Drinking Water	EPA 524.2	GC-MS	1,3-Dichloropropane
Drinking Water	EPA 524.2	GC-MS	1,4-Dichlorobenzene
Drinking Water	EPA 524.2	GC-MS	2,2-Dichloropropane
Drinking Water	EPA 524.2	GC-MS	2-Chlorotoluene
Drinking Water	EPA 524.2	GC-MS	4-Chlorotoluene
Drinking Water	EPA 524.2	GC-MS	4-Isopropyltoluene
Drinking Water	EPA 524.2	GC-MS	Benzene
Drinking Water	EPA 524.2	GC-MS	Bromobenzene
Drinking Water	EPA 524.2	GC-MS	Bromochloromethane
Drinking Water	EPA 524.2	GC-MS	Bromodichloromethane
Drinking Water	EPA 524.2	GC-MS	Bromoform
Drinking Water	EPA 524.2	GC-MS	Bromomethane
Drinking Water	EPA 524.2	GC-MS	Carbon Tetrachloride
Drinking Water	EPA 524.2	GC-MS	Chlorobenzene
Drinking Water	EPA 524.2	GC-MS	Chlorodibromomethane
Drinking Water	EPA 524.2	GC-MS	Chloroethane
Drinking Water	EPA 524.2	GC-MS	Chloroform
Drinking Water	EPA 524.2	GC-MS	Chloromethane
Drinking Water	EPA 524.2	GC-MS	cis-1,2-Dichloroethene
Drinking Water	EPA 524.2	GC-MS	cis-1,3-Dichloropropene
Drinking Water	EPA 524.2	GC-MS	Dibromomethane
Drinking Water	EPA 524.2	GC-MS	Dichlorodifluoromethane
Drinking Water	EPA 524.2	GC-MS	Dichloromethane (Methylene Chloride)



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*Accreditation is granted to the facility to perform the following testing:*

<b>Matrix</b>	<b>Standard / Method</b>	<b>Technology</b>	<b>Analyte</b>
Drinking Water	EPA 524.2	GC-MS	Ethylbenzene
Drinking Water	EPA 524.2	GC-MS	Hexachlorobutadiene
Drinking Water	EPA 524.2	GC-MS	Isopropylbenzene
Drinking Water	EPA 524.2	GC-MS	m+p-Xylene
Drinking Water	EPA 524.2	GC-MS	Naphthalene
Drinking Water	EPA 524.2	GC-MS	n-Butylbenzene
Drinking Water	EPA 524.2	GC-MS	n-Propylbenzene
Drinking Water	EPA 524.2	GC-MS	o-Xylene
Drinking Water	EPA 524.2	GC-MS	sec-Butylbenzene
Drinking Water	EPA 524.2	GC-MS	Styrene
Drinking Water	EPA 524.2	GC-MS	tert-butylbenzene
Drinking Water	EPA 524.2	GC-MS	Tetrachloroethene
Drinking Water	EPA 524.2	GC-MS	Toluene
Drinking Water	EPA 524.2	GC-MS	trans-1,2-Dichloroethene
Drinking Water	EPA 524.2	GC-MS	trans-1,3-Dichloropropene
Drinking Water	EPA 524.2	GC-MS	Trichlorofluoromethane (Freon 11)
Drinking Water	EPA 524.2	GC-MS	Vinyl chloride
Drinking Water	EPA 524.2	GC-MS	Xylenes, total
Solid	ASTMD4129-92M, Lloyd Kahn	TOC Meter	Total Organic Carbons (TOC)
Solid	EPA 160.3M	Gravimetry	Solids, Total
Solid	EPA 7471A, B	CVAA	Mercury
Solid	EPA 9045D	pH Meter	pH
Solid	EPA 9056A	IC	Nitrate as N
Solid	EPA 9056A	IC	Nitrite as N
Solid	EPA 9071B	Gravimetry	Hexane Extractable Material (HEM)
Solid	GEN-AVS	Colorimetry	Acid Volatile Sulfides
Solid	GEN-NCEL	Colorimetry	Nitrocellulose
Solid	LCP-LCMS4	HPLC/MS/MS	1,3,5-Trinitrobenzene
Solid	LCP-LCMS4	HPLC/MS/MS	1,3-Dinitrobenzene
Solid	LCP-LCMS4	HPLC/MS/MS	2,4,6-Trinitrotoluene
Solid	LCP-LCMS4	HPLC/MS/MS	2,4-Dinitrotoluene
Solid	LCP-LCMS4	HPLC/MS/MS	2,6-Dinitrotoluene
Solid	LCP-LCMS4	HPLC/MS/MS	2-Amino-4,6-dinitrotoluene
Solid	LCP-LCMS4	HPLC/MS/MS	3,5-Dinitroaniline



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Matrix	Standard / Method	Technology	Analyte
Solid	LCP-LCMS4	HPLC/MS/MS	4-Amino-2,6-dinitrotoluene
Solid	LCP-LCMS4	HPLC/MS/MS	HMX (Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine)
Solid	LCP-LCMS4	HPLC/MS/MS	Pentaerythritoltetranitrate
Solid	LCP-LCMS4	HPLC/MS/MS	RDX (hexahydro-1,3,5-trinitro-1,3,5-triazine)
Solid	LCP-LCMS4	HPLC/MS/MS	Tetryl (methyl-2,4,6-trinitrophenylnitramine)
Solid	LCP-Nitro	HPLC/MS/MS	2,4-Dinitrophenol
Solid	LCP-Nitro	HPLC/MS/MS	Picramic Acid
Solid	LCP-Nitro	HPLC/MS/MS	Picric Acid
Solid	PSEP	Gravimetry	Particle Size

Matrix	Standard / Method	Technology	Analyte
Aqueous	EPA 1640	Reductive Metals Precipitation	Prep Method
Aqueous	EPA 3010A	Acid Digestion	Metals Digestion
Aqueous	EPA 3020A	Acid Digestion	Metals Digestion
Aqueous	EPA 3520C	Continuous Liquid-Liquid Extraction	Extractable Prep
Aqueous	EPA 3535A	Solid Phase Extraction	Prep Method
Aqueous	EPA 5030B	Purge and Trap for Volatiles	Volatile Prep
Aqueous	SOP-MET-DIG	Acid Digestion	Metals Digestion
Aqueous/Solids	EPA 1311	TCLP Extraction	Physical Extraction
Aqueous/Solids	EPA 3620C	Florisil clean up	Extractable Cleanup
Aqueous/Solids	EPA 3630C	Silica gel clean up	Extractable Prep
Aqueous/Solids	EPA 3640A	Gel-Permeation Clean-up	Extractable Cleanup
Aqueous/Solids	EPA 3660	Sulfur Clean-up	Extractable Prep
Aqueous/Solids	EPA 3665A	Acid clean up	Extractable Cleanup
Aqueous/Solids	ASTM D3590-89	Digestion	TKN
Solid	EPA 3050B	Acid Digestion	Metals Digestion
Solid	EPA 3060	Alkaline Digestion for Cr(VI)	Alkaline Digestion for Cr(VI) only
Solid	EPA 3541	Automated Soxhlet Extraction	Extractable Prep
Solid	EPA 3550B	Ultrasonic Extraction	Extractable Prep
Solid	EPA 5035A	Purge and Trap for Volatiles	Voc Organics
Solid	EPA 5050	Bomb Digestion	Prep Method
Solids	EPA 9013	Midi-Distillation	Cyanides

## Scope of Accreditation For EnviroSystems, Inc

1 Lafayette Rd  
Hampton, NH 03842  
Kenneth Simon  
603-926-3345

In recognition of a successful assessment to ISO/IEC 17025:2005 and the requirements of the DoD Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in the DoD Quality Systems Manual for Environmental Laboratories (DoD QSM v4.2) based on the National Environmental Laboratory Accreditation Conference Chapter 5 Quality Systems Standard (NELAC Voted Revision June 5, 2003), accreditation is granted to **EnviroSystems, Inc** to perform the following tests:

Accreditation granted through: **November 28, 2015**

### Testing - Environmental

Non-Potable Water		
Technology	Method	Analyte
ICP-MS	EPA 200.8	Aluminum
ICP-MS	EPA 200.8	Antimony
ICP-MS	EPA 200.8	Arsenic
ICP-MS	EPA 200.8	Barium
ICP-MS	EPA 200.8	Beryllium
ICP-MS	EPA 200.8	Boron
ICP-MS	EPA 200.8	Cadmium
ICP-MS	EPA 200.8	Calcium
ICP-MS	EPA 200.8	Chromium
ICP-MS	EPA 200.8	Cobalt
ICP-MS	EPA 200.8	Copper
ICP-MS	EPA 200.8	Iron
ICP-MS	EPA 200.8	Lead
ICP-MS	EPA 200.8	Magnesium
ICP-MS	EPA 200.8	Manganese
ICP-MS	EPA 200.8	Molybdenum
ICP-MS	EPA 200.8	Nickel
ICP-MS	EPA 200.8	Potassium
ICP-MS	EPA 200.8	Selenium

<b>Non-Potable Water</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
ICP-MS	EPA 200.8	Silver
ICP-MS	EPA 200.8	Sodium
ICP-MS	EPA 200.8	Thallium
ICP-MS	EPA 200.8	Vanadium
ICP-MS	EPA 200.8	Zinc
CVAF	EPA 245.7	Mercury
Colormetric	SM-3500 Cr D	Hexavalent Chromium
Colormetric	EPA 310.2	Alkalinity
Gravimetric	EPA 1664 A (HEM)	Oil and Grease
Gravimetric	EPA 1664 A (SGT-HEM)	Mineral Oil and Grease
Colormetric	SM-4500 NH3 G	Ammonia
Colormetric	SM-4500 NH3 G	Total Kjeldahl Nitrogen
Gravimetric	SM 2540 B	Residue, total (TS)
Gravimetric	SM 2540 C	Residue, filterable (TSS)
Gravimetric	SM 2540 D	Residue, non-filterable (TDS)
Titration	SM 4500 Cl C	Chloride
Distillation/Colormetric	SM 4500 CN E	Total Cyanide
Colormetric	SM 4500 NO3 F	Nitrate-Nitrite
Colormetric	SM 4500P E	Orthophosphate as P
Digestion/Colormetric	SM 4500 P	Total Phosphorus
Empirical	SM 5210 B	Biological Oxygen Demand
Empirical	SM 5210 B	Carbonaceous Oxygen Demand
Titration	SM 5220 C	Chemical Oxygen Demand
Combustion/IR	SM 5310 C	Total Organic Carbon
Gravimetric	SM 4500 SO4 E	Sulfate
GC-ECD	EPA 8082B	Arochlor 1016
GC-ECD	EPA 8082B	Arochlor 1221
GC-ECD	EPA 8082B	Arochlor 1232
GC-ECD	EPA 8082B	Arochlor 1242
GC-ECD	EPA 8082B	Arochlor 1248
GC-ECD	EPA 8082B	Arochlor 1254
GC-ECD	EPA 8082B	Arochlor 1260
GC-Mass Spectrometer	EPA 680 modified (SIM)	PCB Congeners
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,4'-dichlorobiphenyl (PCB 8)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,2',5'-trichlorobiphenyl (PCB 18)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,4,4'-trichlorobiphenyl (PCB 28)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,2',3,5'-tetrachlorobiphenyl (PCB 44)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,2',4,5'-tetrachlorobiphenyl (PCB 49)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,2',5,5'-tetrachlorobiphenyl (PCB 52)

<b>Non-Potable Water</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,3',4,4'-tetrachlorobiphenyl (PCB 66)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,2',3,4,5'-pentachlorobiphenyl (PCB 87)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,2',4,5,5'-pentachlorobiphenyl (PCB 101)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,3,3',4,4'-pentachlorobiphenyl (PCB 105)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,3',4,4',5-pentachlorobiphenyl (PCB 118)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,2',3,3',4,4'-hexachlorobiphenyl (PCB 128)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,2',3,3',4,4'-hexachlorobiphenyl (PCB 128)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,2',4,4',5,5'-hexachlorobiphenyl (PCB 153)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,2',3,3',4,4',5-heptachlorobiphenyl (PCB 170)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,2',3,4,4',5,5'-heptachlorobiphenyl (PCB 180)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,2',3,4,4',5,6-heptachlorobiphenyl (PCB 183)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,2',3,4,4',6,6'-heptachlorobiphenyl (PCB 184)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,2',3,4,5,5',6-heptachlorobiphenyl (PCB 187)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,2',3,3',4,4',5,6-octachlorobiphenyl (PCB 195)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,2',3,3',4,4',5,5',6-nonachlorobiphenyl (PCB 206)
GC-Mass Spectrometer	EPA 680 modified (SIM)	Decachlorobiphenyl (PCB 209)

<b>Drinking Water</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
ICP-MS	EPA 200.8	Aluminum
ICP-MS	EPA 200.8	Antimony
ICP-MS	EPA 200.8	Arsenic
ICP-MS	EPA 200.8	Barium
ICP-MS	EPA 200.8	Beryllium
ICP-MS	EPA 200.8	Boron
ICP-MS	EPA 200.8	Cadmium
ICP-MS	EPA 200.8	Chromium
ICP-MS	EPA 200.8	Cobalt
ICP-MS	EPA 200.8	Copper
ICP-MS	EPA 200.8	Iron
ICP-MS	EPA 200.8	Lead
ICP-MS	EPA 200.8	Manganese
ICP-MS	EPA 200.8	Molybdenum
ICP-MS	EPA 200.8	Nickel
ICP-MS	EPA 200.8	Selenium
ICP-MS	EPA 200.8	Silver
ICP-MS	EPA 200.8	Thallium

<b>Drinking Water</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
ICP-MS	EPA 200.8	Vanadium
ICP-MS	EPA 200.8	Zinc

<b>Solid and Chemical Materials</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
ICP-MS	EPA 6020B	Aluminum
ICP-MS	EPA 6020B	Antimony
ICP-MS	EPA 6020B	Arsenic
ICP-MS	EPA 6020B	Barium
ICP-MS	EPA 6020B	Beryllium
ICP-MS	EPA 6020B	Boron
ICP-MS	EPA 6020B	Cadmium
ICP-MS	EPA 6020B	Calcium
ICP-MS	EPA 6020B	Chromium
ICP-MS	EPA 6020B	Cobalt
ICP-MS	EPA 6020B	Copper
ICP-MS	EPA 6020B	Iron
ICP-MS	EPA 6020B	Lead
ICP-MS	EPA 6020B	Magnesium
ICP-MS	EPA 6020B	Manganese
ICP-MS	EPA 6020B	Molybdenum
ICP-MS	EPA 6020B	Nickel
ICP-MS	EPA 6020B	Potassium
ICP-MS	EPA 6020B	Selenium
ICP-MS	EPA 6020B	Silver
ICP-MS	EPA 6020B	Sodium
ICP-MS	EPA 6020B	Thallium
ICP-MS	EPA 6020B	Vanadium
ICP-MS	EPA 6020B	Zinc
CVAF	EPA 245.7	Mercury
GC-ECD	EPA 8082B	Arochlor 1016
GC-ECD	EPA 8082B	Arochlor 1221
GC-ECD	EPA 8082B	Arochlor 1232
GC-ECD	EPA 8082B	Arochlor 1242
GC-ECD	EPA 8082B	Arochlor 1248
GC-ECD	EPA 8082B	Arochlor 1254
GC-ECD	EPA 8082B	Arochlor 1260

<b>Solid and Chemical Materials</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC-Mass Spectrometer	EPA 680 modified (SIM)	PCB Congeners
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,4'-dichlorobiphenyl (PCB 8)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,2',5'-trichlorobiphenyl (PCB 18)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,4,4'-trichlorobiphenyl (PCB 28)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,2',3,5'-tetrachlorobiphenyl (PCB 44)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,2',4,5'-tetrachlorobiphenyl (PCB 49)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,2',5,5'-tetrachlorobiphenyl (PCB 52)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,3',4,4'-tetrachlorobiphenyl (PCB 66)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,2',3,4,5'-pentachlorobiphenyl (PCB 87)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,2',4,5,5'-pentachlorobiphenyl (PCB 101)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,3,3',4,4'-pentachlorobiphenyl (PCB 105)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,3',4,4',5'-pentachlorobiphenyl (PCB 118)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,2',3,3',4,4'-hexachlorobiphenyl (PCB 128)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,2',3,3',4,4'-hexachlorobiphenyl (PCB 128)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,2',4,4',5,5'-hexachlorobiphenyl (PCB 153)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,2',3,3',4,4',5'-heptachlorobiphenyl (PCB 170)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,2',3,4,4',5,5'-heptachlorobiphenyl (PCB 180)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,2',3,4,4',5',6'-heptachlorobiphenyl (PCB 183)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,2',3,4,4',6,6'-heptachlorobiphenyl (PCB 184)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,2',3,4',5,5',6'-heptachlorobiphenyl (PCB 187)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,2',3,3',4,4',5,6'-octachlorobiphenyl (PCB 195)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,2',3,3',4,4',5,5',6'-nonachlorobiphenyl (PCB 206)
GC-Mass Spectrometer	EPA 680 modified (SIM)	Decachlorobiphenyl (PCB 209)
Combustion/IR	EPA 9060	Total Organic Carbon
<b>Preparation</b>	<b>Method</b>	<b>Type</b>
Acid Digestion	EPA 3050B	

<b>Biological Tissue</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
ICP-MS	EPA 6020B	Aluminum
ICP-MS	EPA 6020B	Antimony
ICP-MS	EPA 6020B	Arsenic
ICP-MS	EPA 6020B	Barium
ICP-MS	EPA 6020B	Beryllium
ICP-MS	EPA 6020B	Boron
ICP-MS	EPA 6020B	Cadmium
ICP-MS	EPA 6020B	Calcium

<b>Biological Tissue</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
ICP-MS	EPA 6020B	Chromium
ICP-MS	EPA 6020B	Cobalt
ICP-MS	EPA 6020B	Copper
ICP-MS	EPA 6020B	Iron
ICP-MS	EPA 6020B	Lead
ICP-MS	EPA 6020B	Magnesium
ICP-MS	EPA 6020B	Manganese
ICP-MS	EPA 6020B	Molybdenum
ICP-MS	EPA 6020B	Nickel
ICP-MS	EPA 6020B	Potassium
ICP-MS	EPA 6020B	Selenium
ICP-MS	EPA 6020B	Silver
ICP-MS	EPA 6020B	Sodium
ICP-MS	EPA 6020B	Thallium
ICP-MS	EPA 6020B	Vanadium
ICP-MS	EPA 6020B	Zinc
CVAF	EPA 245.7	Mercury
GC-ECD	EPA 8082B	Arochlor 1016
GC-ECD	EPA 8082B	Arochlor 1221
GC-ECD	EPA 8082B	Arochlor 1232
GC-ECD	EPA 8082B	Arochlor 1242
GC-ECD	EPA 8082B	Arochlor 1248
GC-ECD	EPA 8082B	Arochlor 1254
GC-ECD	EPA 8082B	Arochlor 1260
GC-Mass Spectrometer	EPA 680 modified (SIM)	PCB Congeners
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,4'-dichlorobiphenyl (PCB 8)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,2',5'-trichlorobiphenyl (PCB 18)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,4,4'-trichlorobiphenyl (PCB 28)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,2',3,5'-tetrachlorobiphenyl (PCB 44)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,2',4,5'-tetrachlorobiphenyl (PCB 49)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,2',5,5'-tetrachlorobiphenyl (PCB 52)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,3',4,4'-tetrachlorobiphenyl (PCB 66)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,2',3,4,5'-pentachlorobiphenyl (PCB 87)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,2',4,5,5'-pentachlorobiphenyl (PCB 101)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,3,3',4,4'-pentachlorobiphenyl (PCB 105)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,3',4,4',5'-pentachlorobiphenyl (PCB 118)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,2',3,3',4,4'-hexachlorobiphenyl (PCB 128)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,2',3,3',4,4'-hexachlorobiphenyl (PCB 128)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,2',4,4',5,5'-hexachlorobiphenyl (PCB 153)

<b>Biological Tissue</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,2',3,3',4,4',5-heptachlorobiphenyl (PCB 170)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,2',3,4,4',5,5'-heptachlorobiphenyl (PCB 180)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,2',3,4,4',5,6-heptachlorobiphenyl (PCB 183)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,2',3,4,4',6,6'-heptachlorobiphenyl (PCB 184)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,2',3,4',5,5',6-heptachlorobiphenyl (PCB 187)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,2',3,3',4,4',5,6-octachlorobiphenyl (PCB 195)
GC-Mass Spectrometer	EPA 680 modified (SIM)	2,2',3,3',4,4',5,5',6-nonachlorobiphenyl (PCB 206)
GC-Mass Spectrometer	EPA 680 modified (SIM)	Decachlorobiphenyl (PCB 209)
<b>Preparation</b>	<b>Method</b>	<b>Type</b>
Acid Digestion	EPA 3050B	

<b>Toxicology- Whole Effluent Testing</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
Bioassay	EPA-821-R-02-013, Method 1000	Fathead Minnow Larval Survival & Growth, Chronic Assay
Bioassay	EPA-821-R-02-013, Method 1002	Ceriodaphnia dubia Survival & Reproduction, Chronic Assay
Bioassay	EPA-821-R-02-014, Method 1007	Mysidopsis bahia Survival, Growth, & Fecundity, Chronic Assay
Bioassay	EPA-821-R-02-014, Method 1005	Sheepshead Minnow Larval Survival & Growth, Chronic Assay
Bioassay	EPA-821-R-02-014, Method 1008	Arbacia punctulata Sperm Immobilization, Chronic Assay
Bioassay	EPA-821-R-02-014, Method 1006	Menidia beryllina Larval Survival & Growth, Chronic Assay
Bioassay	EPA-821-R-02-012, Method 2000	Fathead Minnow, Acute Assay
Bioassay	EPA-821-R-02-012, Method 2002	Ceriodaphnia dubia, Acute Assay
Bioassay	EPA-821-R-02-012, Method 2021	Daphnia pulex, Acute Assay
Bioassay	EPA-821-R-02-012, Method 2007	Americamysis bahia, Acute Assay
Bioassay	EPA-821-R-02-012, Method 2006	Menidia beryllina, Acute Assay
Bioassay	EPA-821-R-02-012, Method 2004	Cyprinodon variegatus, Acute Assay

<b>Toxicology – Sediment and Soil</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
Bioassay	ASTM E 1706 EPA 600-R-99-064, Method 100.1	Hyalella azteca 10-day Acute Exposure Assay
Bioassay	ASTM E 1706 EPA 600-R-99-064, Method 100.2	Chironomus dilutus 10-day Acute Exposure Assay
Bioassay	EPA 600-R-99-064, Method 100.3	Lumbriculus variegatus 28-day Bioaccumulation Assay
Bioassay	EPA 600-R-99-064, Method 100.4	Hyalella azteca 28/42-day Chronic Exposure Assay
Bioassay	ASTM E 1706 EPA 600-R-99-064, Method 100.5	Chironomus dilutus Life Cycle Chronic Exposure Assay with 20 day endpoint
Bioassay	ASTM E 1367 EPA 600/R-01/020	Leptocheirus plumulosus 10-day Chronic Exposure Assay
Bioassay	EPA 600/R-01/020	Leptocheirus plumulosus 28-day Chronic Exposure Assay
Bioassay	ASTM E 1563	Echinoderm Embryo Acute Exposure Assay (eg. Arbacia punctulata)
Bioassay	ASTM E1611	Marine Polychaete Sediment Toxicity Test (Neanthes arenaceodentata)
Bioassay	ASTM E 1688	Benthic Invertebrate Bioaccumulation Evaluation (eg. Nereis virens, Macoma nasuta, Eiseinia fetida, Lumbriculus variegatus)
Bioassay	EPA 823-B-98-004	Acute Exposure, 10-day, Marine Sediment Evaluation (eg. Leptocheirus plumulosus, Ampelisca abdita)
Bioassay	EPA 823-B-98-004	Acute Exposure Water Column, Suspended Particulate Phase, Invertebrate Assays
Bioassay	EPA 823-B-98-004	Benthic Invertebrate Bioaccumulation Evaluation (eg. Nereis virens, Macoma nasuta)
Bioassay	ASTM E1963	Terrestrial Plant Acute and Chronic Exposure Toxicity Testing (eg. Brassica rapa, Lolium perenne, Lactuca sativa, Trifolium pratense and Lemna minor.)
Bioassay	ASTM E1676	Soil toxicity or bioaccumulation test with earthworms (eg. Eisenia fetida)

**Notes:**

- 1) This laboratory offers commercial testing service.

Approved by:   
R. Douglas Leonard  
Chief Technical Officer

Date: June 12, 2013

Issued: 11/28/12      Revised: 11/29/12      Revised: 6/12/13



**LABORATORY  
ACCREDITATION  
BUREAU**



# Certificate of Accreditation

ISO/IEC 17025:2005

Certificate Number L2340

**EnviroSystems, Inc**  
1 Lafayette Rd  
Hampton, NH 03842

has met the requirements set forth in L-A-B's policies and procedures, all requirements of ISO/IEC 17025:2005 "General Requirements for the competence of Testing and Calibration Laboratories" and the U.S. Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP).\*

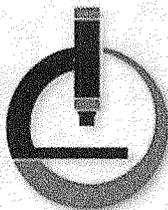
The accredited lab has demonstrated technical competence to a defined "Scope of Accreditation" and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009).

Accreditation valid through: November 28, 2015

**R. Douglas Leonard, Jr., President, COO**  
**Laboratory Accreditation Bureau**  
**Presented the 28th of November 2012**

\*See the laboratory's Scope of Accreditation for details of accredited parameters

\*\*Laboratory Accreditation Bureau is found to be in compliance with ISO/IEC 17011:2004 and recognized by ILAC (International Laboratory Accreditation Cooperation) and NACLA (National Cooperation for Laboratory Accreditation).



**LABORATORY  
ACCREDITATION  
BUREAU**



# Certificate of Accreditation

**ISO/IEC 17025:2005**

**Certificate Number L2223**

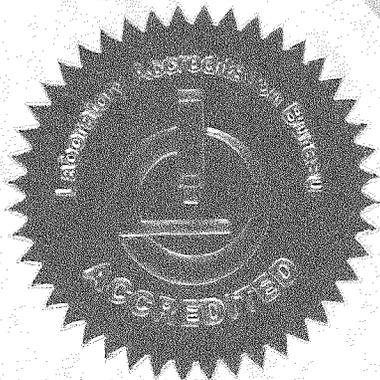
## **Katahdin Analytical Services, Inc.**

600 Technology Way  
Scarborough ME 04074

has met the requirements set forth in L-A-B's policies and procedures, all requirements of ISO/IEC 17025:2005 "General Requirements for the competence of Testing and Calibration Laboratories" and the U.S. Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP).\*

The accredited lab has demonstrated technical competence to a defined "Scope of Accreditation" and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009).

Accreditation valid through: February 1, 2016



**R. Douglas Leonard, Jr., President, COO**  
**Laboratory Accreditation Bureau**  
**Presented the 1<sup>st</sup> of February 2013**

\*See the laboratory's Scope of Accreditation for details of accredited parameters

\*\*Laboratory Accreditation Bureau is found to be in compliance with ISO/IEC 17011:2004 and recognized by ILAC (International Laboratory Accreditation Cooperation) and NACLA (National Cooperation for Laboratory Accreditation).

## Scope of Accreditation For Katahdin Analytical Services, Inc.

600 Technology Way  
Scarborough, ME 04074  
Leslie Dimond  
207-874-2400

In recognition of a successful assessment to ISO/IEC 17025:2005 and the requirements of the DoD Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in the DoD Quality Systems Manual for Environmental Laboratories (DoD QSM v4.2) based on the National Environmental Laboratory Accreditation Conference Chapter 5 Quality Systems Standard (NELAC Voted Revision June 5, 2003), accreditation is granted to Katahdin Analytical Services to perform the following tests:

Accreditation granted through: February 1, 2016

### Testing - Environmental

Non-Potable Water		
Technology	Method	Analyte
GC/ECD	EPA 8081B	2, 4'-DDD
GC/ECD	EPA 8081B	2, 4'-DDE
GC/ECD	EPA 8081B	2, 4'-DDT
GC/ECD	EPA 608; EPA 8081B	4, 4'-DDD
GC/ECD	EPA 608; EPA 8081B	4, 4'-DDE
GC/ECD	EPA 608; EPA 8081B	4, 4'-DDT
GC/ECD	EPA 608; EPA 8081B	Aldrin
GC/ECD	EPA 608; EPA 8081B	alpha-BHC (alpha-Hexachlorocyclohexane)
GC/ECD	EPA 8081B	Alpha-Chlordane
GC/ECD	EPA 608; EPA 8081B	beta-BHC (beta-Hexachlorocyclohexane)
GC/ECD	EPA 8081B	Cis-Nonaclor
GC/ECD	EPA 608; EPA 8081B	Chlordane (tech.)
GC/ECD	EPA 608; EPA 8081B	delta-BHC
GC/ECD	EPA 608; EPA 8081B	Dieldrin
GC/ECD	EPA 608; EPA 8081B	Endosulfan I
GC/ECD	EPA 608; EPA 8081B	Endosulfan II

<b>Non-Potable Water</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC/ECD	EPA 608; EPA 8081B	Endosulfan sulfate
GC/ECD	EPA 608; EPA 8081B	Endrin
GC/ECD	EPA 608; EPA 8081B	Endrin aldehyde
GC/ECD	EPA 8081B	Endrin Ketone
GC/ECD	EPA 8081B	gamma-BHC (Lindane gamma-Hexachlorocyclohexane)
GC/ECD	EPA 8081B	gamma-Chlordane
GC/ECD	EPA 608; EPA 8081B	Heptachlor
GC/ECD	EPA 608; EPA 8081B	Heptachlor epoxide
GC/ECD	EPA 8081B	Hexachlorobenzene
GC/ECD	EPA 8081B	Methoxychlor
GC/ECD	EPA 8081B	Mirex
GC/ECD	EPA 8081B	Oxychlordane
GC/ECD	EPA 608; EPA 8081B	Toxaphene (Chlorinated camphene)
GC/ECD	EPA 8081B	trans-Nonachlor
GC/ECD	EPA 608; EPA 8082A	Aroclor-1016 (PCB-1016)
GC/ECD	EPA 608; EPA 8082A	Aroclor-1221 (PCB-1221)
GC/ECD	EPA 608; EPA 8082A	Aroclor-1232 (PCB-1232)
GC/ECD	EPA 608; EPA 8082A	Aroclor-1242 (PCB-1242)
GC/ECD	EPA 608; EPA 8082A	Aroclor-1248 (PCB-1248)
GC/ECD	EPA 608; EPA 8082A	Aroclor-1254 (PCB-1254)
GC/ECD	EPA 608; EPA 8082A	Aroclor-1260 (PCB-1260)
GC/ECD	EPA 8082A MOD	Aroclor-1262 (PCB-1262)
GC/ECD	EPA 8082A MOD	Aroclor-1268 (PCB-1268)
GC/ECD	EPA 8082A	2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl (BZ 206)
GC/ECD	EPA 8082A	2,2',3,3',4,4',5,6-Octachlorobiphenyl (BZ 195)
GC/ECD	EPA 8082A	2,2',3,3',4,4',5-Heptachlorobiphenyl (BZ 170)
GC/ECD	EPA 8082A	2,2',3,3',4,4'-Hexachlorobiphenyl (BZ 128)
GC/ECD	EPA 8082A	2, 2', 3, 4, 4', 5, 5'-Heptachlorobiphenyl (BZ 180)
GC/ECD	EPA 8082A	2, 2', 3, 4, 4', 5', 6-Heptachlorobiphenyl (BZ 183)
GC/ECD	EPA 8082A	2, 2', 3, 4, 4', 5-Hexachlorobiphenyl (BZ 138)
GC/ECD	EPA 8082A	2, 2', 3, 4, 4', 6, 6'-Heptachlorobiphenyl (BZ 184)

<b>Non-Potable Water</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC/ECD	EPA 8082A	2, 2', 3, 4', 5, 5', 6-Heptachlorobiphenyl (BZ 187)
GC/ECD	EPA 8082A	2, 2', 3, 4, 5'-Pentachlorobiphenyl (BZ 87)
GC/ECD	EPA 8082A	2, 2', 3, 5'-Tetrachlorobiphenyl (BZ 44)
GC/ECD	EPA 8082A	2, 2', 4, 4', 5, 5'-Hexachlorobiphenyl (BZ 153)
GC/ECD	EPA 8082A	2, 2', 4, 5, 5'-Pentachlorobiphenyl (BZ 101)
GC/ECD	EPA 8082A	2, 2', 4, 5-Tetrachlorobiphenyl (BZ 48)
GC/ECD	EPA 8082A	2, 2', 4, 5'-Tetrachlorobiphenyl (BZ 49)
GC/ECD	EPA 8082A	2, 2', 5, 5'-Tetrachlorobiphenyl (BZ 52)
GC/ECD	EPA 8082A	2, 2', 5-Trichlorobiphenyl (BZ 18)
GC/ECD	EPA 8082A	2, 3, 3', 4, 4', 5-Hexachlorobiphenyl (BZ 156)
GC/ECD	EPA 8082A	2, 3, 3', 4, 4', 5'-Hexachlorobiphenyl (BZ 157)
GC/ECD	EPA 8082A	2, 3, 3', 4, 4'-Pentachlorobiphenyl (BZ 105)
GC/ECD	EPA 8082A	2, 3, 3', 4, 4', 5, 5'-Heptachlorobiphenyl (BZ 189)
GC/ECD	EPA 8082A	2, 3', 4, 4', 5, 5'-Hexachlorobiphenyl (BZ 167)
GC/ECD	EPA 8082A	2, 3', 4, 4', 5-Pentachlorobiphenyl (BZ 118)
GC/ECD	EPA 8082A	2, 3', 4, 4', 5'-Pentachlorobiphenyl (BZ 123)
GC/ECD	EPA 8082A	2, 3', 4, 4'-Tetrachlorobiphenyl (BZ 66)
GC/ECD	EPA 8082A	2, 3, 4, 4', 5-Pentachlorobiphenyl (BZ 114)
GC/ECD	EPA 8082A	2, 4, 4'-Trichlorobiphenyl (BZ 28)
GC/ECD	EPA 8082A	2, 4'-Dichlorobiphenyl (BZ 8)
GC/ECD	EPA 8082A	3, 3', 4, 4', 5, 5'-Hexachlorobiphenyl (BZ 169)
GC/ECD	EPA 8082A	3, 3', 4, 4', 5-Pentachlorobiphenyl (BZ 126)
GC/ECD	EPA 8082A	3, 3', 4, 4'-Tetrachlorobiphenyl (BZ 77)
GC/ECD	EPA 8082A	3, 4, 4', 5-Tetrachlorobiphenyl (BZ 81)
GC/ECD	EPA 8082A	Decachlorobiphenyl (BZ 209)
GC/ECD	EPA 8151A	2, 4, 5-T
GC/ECD	EPA 8151A	2, 4-D
GC/ECD	EPA 8151A	2, 4-DB
GC/ECD	EPA 8151A	Dalapon
GC/ECD	EPA 8151A	Dicamba
GC/ECD	EPA 8151A	Dichloroprop

<b>Non-Potable Water</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC/ECD	EPA 8151A	Dinoseb
GC/ECD	EPA 8151A	MCPA
GC/ECD	EPA 8151A	MCPPP
GC/ECD	EPA 8151A	Pentachlorophenol
GC/ECD	EPA 8151A	Silvex (2, 4, 5-TP)
GC/FID	EPA 8015C/D MOD	Diesel range organics (DRO)
GC/FID	EPA 8015C/D MOD	Total Petroleum Hydrocarbon (TPH)
GC/FID	EPA 8015C/D MOD	Gasoline range organics (GRO)
GC/FID/PID	MA DEP VPH	Volatile Organic Hydrocarbons
GC/FID	MA DEP EPH	Extractable Petroleum Hydrocarbons
GC/FID	CT ETPH	Total Petroleum Hydrocarbons
GC/FID	TNRCC Method 1005	Total Petroleum Hydrocarbons
GC/FID	FL-PRO	Petroleum Range Organics
GC/ECD	EPA 8011; EPA 504	1, 2-Dibromoethane (EDB)
GC/ECD	EPA 8011; EPA 504	1, 2-Dibromo-3-chloropropane
GC/FID	RSK-175	Methane Ethane Ethene
GC/MS	EPA 8260B/C; EPA 524.2	1, 1, 1, 2-Tetrachloroethane
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	1, 1, 1-Trichloroethane
GC/MS	EPA 624; 8260B/C; EPA 524.2	1, 1, 2, 2-Tetrachloroethane
GC/MS	EPA 8260B/C	1,1,2-Trichloro-1,2,2-trifluoroethane
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	1, 1, 2-Trichloroethane
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	1, 1-Dichloroethane
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	1, 1-Dichloroethene
GC/MS	EPA 8260B/C; EPA 524.2	1, 1-Dichloropropene
GC/MS	EPA 8260B/C; EPA 524.2	1, 2, 3-Trichlorobenzene
GC/MS	EPA 8260B/C; EPA 524.2	1, 2, 3-Trichloropropane
GC/MS	EPA 8260B/C	1,2,3-Trimethylbenzene
GC/MS	EPA 8260B/C; EPA 524.2	1, 2, 4-Trichlorobenzene
GC/MS	EPA 8260B/C; EPA 524.2	1, 2, 4-Trimethylbenzene

<b>Non-Potable Water</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC/MS	EPA 8260B/C; EPA 524.2	1, 2-Dibromo-3-chloropropane
GC/MS	EPA 8260B/C; EPA 524.2	1, 2-Dibromoethane (EDB)
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	1, 2-Dichlorobenzene
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	1, 2-Dichloroethane
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	1, 2-Dichloropropane
GC/MS	EPA 8260B/C	1,3,5-Trichlorobenzene
GC/MS	EPA 8260B/C; EPA 524.2	1, 3, 5-Trimethylbenzene
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	1, 3-Dichlorobenzene
GC/MS	EPA 8260B/C; EPA 524.2	1, 3-Dichloropropane
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	1, 4-Dichlorobenzene
GC/MS	EPA 8260B/C	1, 4-Dioxane
GC/MS	EPA 8260B/C	1-Chlorohexane
GC/MS	EPA 8260B/C; EPA 524.2	2, 2-Dichloropropane
GC/MS	EPA 8260B/C; EPA 524.2	2-Butanone
GC/MS	EPA 624; EPA 8260B/C	2-Chloroethyl vinyl ether
GC/MS	EPA 8260B/C; EPA 524.2	2-Chlorotoluene
GC/MS	EPA 8260B/C; EPA 524.2	2-Hexanone
GC/MS	EPA 8260B/C; EPA 524.2	4-Chlorotoluene
GC/MS	EPA 8260B/C; EPA 524.2	4-Methyl-2-pentanone
GC/MS	EPA 8260B/C; EPA 524.2	Acetone
GC/MS	EPA 8260B/C	Acetonitrile
GC/MS	EPA 624; EPA 8260B/C	Acrolein
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Acrylonitrile
GC/MS	EPA 8260B/C; EPA 524.2	Allyl chloride
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Benzene
GC/MS	EPA 8260B/C	Benzyl chloride
GC/MS	EPA 8260B/C; EPA 524.2	Bromobenzene
GC/MS	EPA 8260B/C; EPA 524.2	Bromochloromethane

<b>Non-Potable Water</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Bromodichloromethane
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Bromoform
GC/MS	EPA 8260B/C; EPA 524.2	Carbon disulfide
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Carbon tetrachloride
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Chlorobenzene
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Chloroethane
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Chloroform
GC/MS	EPA 8260B/C	Chloroprene
GC/MS	EPA 8260B/C; EPA 524.2	cis-1, 2-Dichloroethene
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	cis-1, 3-Dichloropropene
GC/MS	EPA 8260B/C	Cis-1,4-Dichloro-2-butene
GC/MS	EPA 8260B/C	Cyclohexane
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Dibromochloromethane
GC/MS	EPA 8260B/C; EPA 524.2	Dibromomethane
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Dichlorodifluoromethane
GC/MS	EPA 8260B/C; EPA 524.2	Diethyl ether
GC/MS	EPA 8260B/C	Di-isopropylether
GC/MS	EPA 8260B/C; EPA 524.2	Ethyl methacrylate
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Ethylbenzene
GC/MS	EPA 8260B/C	Ethyl-t-butylether
GC/MS	EPA 8260B/C; EPA 524.2	Hexachlorobutadiene
GC/MS	EPA 8260B/C	Iodomethane
GC/MS	EPA 8260B/C	Isobutyl alcohol
GC/MS	EPA 8260B/C	Isopropyl alcohol
GC/MS	EPA 8260B/C; EPA 524.2	Isopropyl benzene
GC/MS	EPA 8260B/C; EPA 524.2	m p-xylenes
GC/MS	EPA 8260B/C	Methyl acetate

<b>Non-Potable Water</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC/MS	EPA 8260B/C; EPA 524.2	Methacrylonitrile
GC/MS	EPA 624 / 8260B,C	Methyl bromide (Bromomethane)
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Methyl chloride (Chloromethane)
GC/MS	EPA 8260B/C; EPA 524.2	Methyl methacrylate
GC/MS	EPA 8260B/C; EPA 524.2	Methyl tert-butyl ether
GC/MS	EPA 8260B/C	Methylcyclohexane
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Methylene chloride
GC/MS	EPA 8260B/C; EPA 524.2	Naphthalene
GC/MS	EPA 8260B/C; EPA 524.2	n-Butylbenzene
GC/MS	EPA 8260B/C; EPA 524.2	n-Propylbenzene
GC/MS	EPA 8260B/C; EPA 524.2	o-Xylene
GC/MS	EPA 8260B/C	Pentachloroethane
GC/MS	EPA 8260B/C; EPA 524.2	p-Isopropyltoluene
GC/MS	EPA 8260B/C; EPA 524.2	Propionitrile
GC/MS	EPA 8260B/C; EPA 524.2	sec-butylbenzene
GC/MS	EPA 8260B/C; EPA 524.2	Styrene
GC/MS	EPA 8260B/C	t-Amylmethylether
GC/MS	EPA 8260B/C; EPA 524.2	tert-Butyl alcohol
GC/MS	EPA 8260B/C	tert-Butylbenzene
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Tetrachloroethene (Perchloroethylene)
GC/MS	EPA 8260B/C; EPA 524.2	Tetrahydrofuran
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Toluene
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	trans-1, 2-Dichloroethylene
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	trans-1, 3-Dichloropropylene
GC/MS	EPA 8260B/C; EPA 524.2	trans-1, 4-Dichloro-2-butene
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Trichloroethene (Trichloroethylene)
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Trichlorofluoromethane
GC/MS	EPA 8260B/C	Vinyl acetate



Non-Potable Water		
Technology	Method	Analyte
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Vinyl chloride
GC/MS	EPA 624 / 8260B,C	Xylene
GC/MS	EPA 8260B/C SIM	1,1,1,2-Tetrachloroethane
GC/MS	8260B, C SIM	1,1,1-Trichloroethane
GC/MS	EPA 8260B/C SIM	1,1,2,2-Tetrachloroethane
GC/MS	EPA 8260B/C SIM	1, 1, 2-Trichloroethane
GC/MS	EPA 8260B/C SIM	1,2,3-Trichloropropane
GC/MS	EPA 8260B/C SIM	1,1-Dichloroethane
GC/MS	EPA 8260B/C SIM	1,1-Dichloroethene
GC/MS	EPA 8260B/C SIM	1,2,4-Trichlorobenzene
GC/MS	EPA 8260B/C SIM	1,2,4-Trimethylbenzene
GC/MS	EPA 8260B/C SIM	1,2-Dibromo-3-chloropropane
GC/MS	EPA 8260B/C SIM	1,2-Dibromoethane
GC/MS	EPA 8260B/C SIM	1,2-Dichlorobenzene
GC/MS	EPA 8260B/C SIM	1,2-Dichloroethane
GC/MS	EPA 8260B/C SIM	1,2-Dichloropropane
GC/MS	EPA 8260B/C SIM	1,3-Dichlorobenzene
GC/MS	EPA 8260B/C SIM	1,3-Dichloropropane
GC/MS	EPA 8260B/C SIM	1,4-Dichlorobenzene
GC/MS	EPA 8260B/C SIM	2-Hexanone
GC/MS	EPA 8260B/C SIM	4-Methyl-2-pentanone
GC/MS	EPA 8260B/C SIM	Benzene
GC/MS	EPA 8260B/C SIM	Bromodichloromethane
GC/MS	EPA 8260B/C SIM	Carbon Tetrachloride
GC/MS	EPA 8260B/C SIM	Chloroform
GC/MS	EPA 8260B/C SIM	Chloromethane
GC/MS	EPA 8260B/C SIM	cis-1,2-Dichloroethene
GC/MS	EPA 8260B/C SIM	cis-1,3-Dichloropropene
GC/MS	EPA 8260B/C SIM	Dibromochloromethane
GC/MS	EPA 8260B/C SIM	Ethylbenzene
GC/MS	EPA 8260B/C SIM	Isopropylbenzene

<b>Non-Potable Water</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC/MS	EPA 8260B/C SIM	Hexachlorobutadiene
GC/MS	EPA 8260B/C SIM	Methylcyclohexane
GC/MS	EPA 8260B/C SIM	m,p-Xylene
GC/MS	EPA 8260B/C SIM	o-Xylene
GC/MS	EPA 8260B/C SIM	Tetrachloroethene
GC/MS	EPA 8260B/C SIM	trans-1,2-Dichloroethene
GC/MS	EPA 8260B/C SIM	Trans-1,3-Dichloropropene
GC/MS	EPA 8260B/C SIM	Trichloroethene
GC/MS	EPA 8260B/C SIM	Trichlorofluoromethane
GC/MS	EPA 8260B/C SIM	Vinyl Chloride
GC/MS	EPA 8260B/C SIM	Xylenes (total)
GC/MS	EPA 8270C/D	1, 2, 4, 5-Tetrachlorobenzene
GC/MS	EPA 625; EPA 8270C/D	1, 2, 4-Trichlorobenzene
GC/MS	EPA 625; EPA 8270C/D	1, 2-Dichlorobenzene
GC/MS	EPA 8270C/D	1, 2-Diphenylhydrazine
GC/MS	EPA 8270C/D	1, 3, 5-Trinitrobenzene
GC/MS	EPA 625; EPA 8270C/D	1, 3-Dichlorobenzene
GC/MS	EPA 8270C/D	1, 3-Dinitrobenzene
GC/MS	EPA 625; EPA 8270C/D	1, 4-Dichlorobenzene
GC/MS	EPA 8270C/D	1, 4-Dioxane
GC/MS	EPA 8270C/D	1, 4-Naphthoquinone
GC/MS	EPA 8270C/D	1, 4-Phenylenediamine
GC/MS	EPA 8270C/D	1-Chloronaphthalene
GC/MS	EPA 8270C/D	1-Methylnaphthalene
GC/MS	EPA 8270C/D	1-Naphthylamine
GC/MS	EPA 8270C/D	2, 3, 4, 6-Tetrachlorophenol
GC/MS	EPA 8270C/D	2, 4, 5-Trochlorophenol
GC/MS	EPA 625; EPA 8270C/D	2, 4, 6-Trichlorophenol
GC/MS	EPA 625; EPA 8270C/D	2, 4-Dichlorophenol
GC/MS	EPA 625; EPA 8270C/D	2, 4-Dimethylphenol
GC/MS	EPA 625; EPA 8270C/D	2, 4-Dinitrophenol

<b>Non-Potable Water</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC/MS	EPA 625; EPA 8270C/D	2, 4-Dinitrotoluene (2, 4-DNT)
GC/MS	EPA 8270C/D	2, 6-Dichlorophenol
GC/MS	EPA 625; EPA 8270C/D	2, 6-Dinitrotoluene (2, 6-DNT)
GC/MS	EPA 8270C/D	2-Acetylaminofluorene
GC/MS	EPA 625; EPA 8270C/D	2-Chloronaphthalene
GC/MS	EPA 625; EPA 8270C/D	2-Chlorophenol
GC/MS	EPA 625; EPA 8270C/D	2-Methyl-4 6-dinitrophenol
GC/MS	EPA 8270C/D	2-Methylnaphthalene
GC/MS	EPA 8270C/D	2-Methylphenol
GC/MS	EPA 8270C/D	2-Naphthylamine
GC/MS	EPA 8270C/D	2-Nitroaniline
GC/MS	EPA 625; EPA 8270C/D	2-Nitrophenol
GC/MS	EPA 8270C/D	2-Picoline
GC/MS	EPA 8270C/D	3-Methylcholanthrene
GC/MS	EPA 8270C/D	3-Nitroaniline
GC/MS	EPA 8270C/D	4-Aminobiphenyl
GC/MS	EPA 625; EPA 8270C/D	4-Bromophenyl phenyl ether
GC/MS	EPA 625; EPA 8270C/D	4-Chloro-3-methylphenol
GC/MS	EPA 8270C/D	4-Chloroaniline
GC/MS	EPA 625; EPA 8270C/D	4-Chlorophenyl phenylether
GC/MS	EPA 8270C/D	4-Dimethyl aminoazobenzene
GC/MS	EPA 8270C/D	3, 4-Methylphenol
GC/MS	EPA 8270C/D	4-Nitroaniline
GC/MS	EPA 625; EPA 8270C/D	4-Nitrophenol
GC/MS	EPA 8270C/D	4-Nitroquinoline-1-oxide
GC/MS	EPA 8270C/D	5-Nitro-o-toluidine
GC/MS	EPA 8270C/D	7, 12-Dimethylbenz(a)anthracene
GC/MS	EPA 8270C/D	a a-Dimethylphenethylamine
GC/MS	EPA 625; EPA 8270C/D	Acenaphthene
GC/MS	EPA 625; EPA 8270C/D	Acenaphthylene
GC/MS	EPA 8270C/D	Acetophenone

<b>Non-Potable Water</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC/MS	EPA 8270C/D	Aniline
GC/MS	EPA 625; EPA 8270C/D	Anthracene
GC/MS	EPA 8270C/D	Aramite
GC/MS	EPA 8270C/D	Atrazine
GC/MS	EPA 8270C/D	Azobenzene
GC/MS	EPA 8270C/D	Benzaldehyde
GC/MS	EPA 625; EPA 8270C/D	Benzidine
GC/MS	EPA 625; EPA 8270C/D	Benzo(a)anthracene
GC/MS	EPA 625; EPA 8270C/D	Benzo(a)pyrene
GC/MS	EPA 625; EPA 8270C/D	Benzo(b)fluoranthene
GC/MS	EPA 625; EPA 8270C/D	Benzo(g h i)perylene
GC/MS	EPA 625; EPA 8270C/D	Benzo(k)fluoranthene
GC/MS	EPA 8270C/D	Benzoic Acid
GC/MS	EPA 8270C/D	Benzyl alcohol
GC/MS	EPA 8270C/D	1,1-Biphenyl
GC/MS	EPA 625; EPA 8270C/D	bis(2-Chloroethoxy)methane
GC/MS	EPA 625; EPA 8270C/D	bis(2-Chloroethyl) ether
GC/MS	EPA 625; EPA 8270C/D	bis(2-Chloroisopropyl) ether (2, 2'-Oxybis(1-chloropropane)
GC/MS	EPA 625; EPA 8270C/D	bis(2-Ethylhexyl)adipate
GC/MS	EPA 625; EPA 8270C/D	bis(2-Ethylhexyl) phthalate (DEHP)
GC/MS	EPA 625; EPA 8270C/D	Butyl benzyl phthalate
GC/MS	EPA 8270C/D	Caprolactam
GC/MS	EPA 8270C/D	Carbazole
GC/MS	EPA 8270C/D	Chlorobenzilate
GC/MS	EPA 625; EPA 8270C/D	Chrysene
GC/MS	EPA 8270C/D	Diallate
GC/MS	EPA 8270C/D	Dibenzo(a,j)acridine
GC/MS	EPA 625; EPA 8270C/D	Dibenz(a h)anthracene
GC/MS	EPA 8270C/D	Dibenzofuran
GC/MS	EPA 8270C/D	Diethyladipate
GC/MS	EPA 625; EPA 8270C/D	Diethyl phthalate

<b>Non-Potable Water</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC/MS	EPA 8270C/D	Dimethoate
GC/MS	EPA 625; EPA 8270C/D	Dimethyl phthalate
GC/MS	EPA 625; EPA 8270C/D	Di-n-butyl phthalate
GC/MS	EPA 625; EPA 8270C/D	Di-n-octyl phthalate
GC/MS	EPA 8270C/D	Dinoseb
GC/MS	EPA 8270C/D	Disulfoton
GC/MS	EPA 8270C/D	Ethyl methanesulfonate
GC/MS	EPA 8270C/D	Ethyl parathion
GC/MS	EPA 8270C/D	Ethyl methacrylate
GC/MS	EPA 8270C/D	Famfur
GC/MS	EPA 625; EPA 8270C/D	Fluoranthene
GC/MS	EPA 625; EPA 8270C/D	Fluorene
GC/MS	EPA 625; EPA 8270C/D	Hexachlorobenzene
GC/MS	EPA 625; EPA 8270C/D	Hexachlorobutadiene
GC/MS	EPA 625; EPA 8270C/D	Hexachlorocyclopentadiene
GC/MS	EPA 625; EPA 8270C/D	Hexachloroethane
GC/MS	EPA 8270C/D	Hexachlorophene
GC/MS	EPA 8270C/D	Hexachloropropene
GC/MS	EPA 625; EPA 8270C/D	Indeno(1, 2, 3-cd)pyrene
GC/MS	EPA 8270C/D	Isodrin
GC/MS	EPA 625; EPA 8270C/D	Isophorone
GC/MS	EPA 8270C/D	Isosafrole
GC/MS	EPA 8270C/D	Kepone
GC/MS	EPA 8270C/D	Methapyriline
GC/MS	EPA 8270C/D	Methy methanesulfonate
GC/MS	EPA 8270C/D	Methyl parathion
GC/MS	EPA 625; EPA 8270C/D	Naphthalene
GC/MS	EPA 625; EPA 8270C/D	Nitrobenzene
GC/MS	EPA 8270C/D	Nitroquinoline-1-oxide
GC/MS	EPA 8270C/D	n-Nitrosodiethylamine
GC/MS	EPA 625; EPA 8270C/D	n-Nitrosodimethylamine

<b>Non-Potable Water</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC/MS	EPA 8270C/D	n-Nitroso-di-n-butylamine
GC/MS	EPA 625; EPA 8270C/D	n-Nitrosodi-n-propylamine
GC/MS	EPA 625; EPA 8270C/D	n-Nitrosodiphenylamine
GC/MS	EPA 8270C/D	n-Nitrosomethylethylamine
GC/MS	EPA 8270C/D	n-Nitrosomorpholine
GC/MS	EPA 8270C/D	n-Nitrosopiperidine
GC/MS	EPA 8270C/D	n-Nitrosopyrrolidine
GC/MS	EPA 8270C/D	O,O,O-Triethyl phosphorothioate
GC/MS	EPA 8270C/D	o,o-Diethyl o-2pyrazinyl phosphorothioate
GC/MS	EPA 8270C/D	o-Toluidine
GC/MS	EPA 8270C/D	Pentachlorobenzene
GC/MS	EPA 8270C/D	Pentachloronitrobenzene
GC/MS	EPA 625; EPA 8270C/D	Pentachlorophenol
GC/MS	EPA 8270C/D	Phenacetin
GC/MS	EPA 625; EPA 8270C/D	Phenanthrene
GC/MS	EPA 625; EPA 8270C/D	Phenol
GC/MS	EPA 8270C/D	Phorate
GC/MS	EPA 8270C/D	Pronamide
GC/MS	EPA 625; EPA 8270C/D	Pyrene
GC/MS	EPA 8270C/D	Pyridine
GC/MS	EPA 8270C/D	Safrole
GC/MS	EPA 8270C/D	Sulfotepp
GC/MS	EPA 8270C/D	Thionazin
GC/MS	EPA 625; EPA 8270C/D	3, 3'-Dichlorobenzidine
GC/MS	EPA 8270C/D	3, 3'-Dimethylbenzidine
GC/MS	EPA 8270C/D SIM	1,1'-Biphenyl
GC/MS	EPA 8270C/D SIM	1,2,4,5-Tetrachlorobenzene
GC/MS	EPA 8270C/D SIM	1,4-Dioxane
GC/MS	EPA 8270C/D SIM	1-Methylnaphthalene
GC/MS	EPA 8270C/D SIM	2,2'-Oxybis(1-chloropropane
GC/MS	EPA 8270C/D SIM	2,3,4,6-Tetrachlorophenol

<b>Non-Potable Water</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC/MS	EPA 8270C/D SIM	2,4,5-Trichlorophenol
GC/MS	EPA 8270C/D SIM	2,4,6-Trichlorophenol
GC/MS	EPA 8270C/D SIM	2,4-Dichlorophenol
GC/MS	EPA 8270C/D SIM	2,4-Dimethylphenol
GC/MS	EPA 8270C/D SIM	2,4-Dinitrophenol
GC/MS	EPA 8270C/D SIM	2,4-Dinitrotoluene
GC/MS	EPA 8270C/D SIM	2,6-Dinitrotoluene
GC/MS	EPA 8270C/D SIM	2-Chloronaphthalene
GC/MS	EPA 8270C/D SIM	2-Chlorophenol
GC/MS	EPA 8270C/D SIM	2-Methylnaphthalene
GC/MS	EPA 8270C/D SIM	2-Methylphenol
GC/MS	EPA 8270C/D SIM	2-Nitroaniline
GC/MS	EPA 8270C/D SIM	2-Nitrophenol
GC/MS	EPA 8270C/D SIM	3&4-Methylphenol
GC/MS	EPA 8270C/D SIM	3,3'-Dichlorobenzidine
GC/MS	EPA 8270C/D SIM	3-Nitroaniline
GC/MS	EPA 8270C/D SIM	4,6-Dinitro-2-methylphenol
GC/MS	EPA 8270C/D SIM	4-Bromophenyl-phenylether
GC/MS	EPA 8270C/D SIM	4-Chloro-3-methylphenol
GC/MS	EPA 8270C/D SIM	4-Chloroaniline
GC/MS	EPA 8270C/D SIM	4-Chlorophenyl-phenylether
GC/MS	EPA 8270C/D SIM	4-Nitroaniline
GC/MS	EPA 8270C/D SIM	4-Nitrophenol
GC/MS	EPA 8270C/D SIM	Acenaphthene
GC/MS	EPA 8270C/D SIM	Acenaphthylene
GC/MS	EPA 8270C/D SIM	Acetophenone
GC/MS	EPA 8270C/D SIM	Anthracene
GC/MS	EPA 8270C/D SIM	Atrazine
GC/MS	EPA 8270C/D SIM	Benzaldehyde
GC/MS	EPA 8270C/D SIM	Benzo(a)anthracene
GC/MS	EPA 8270C/D SIM	Benzo(a)pyrene



Non-Potable Water		
Technology	Method	Analyte
GC/MS	EPA 8270C/D SIM	Benzo(b)fluoranthene
GC/MS	EPA 8270C/D SIM	Benzo(g,h,i)perylene
GC/MS	EPA 8270C/D SIM	Benzo(k)fluoranthene
GC/MS	EPA 8270C/D SIM	Bis(2-chloroethoxy)methane
GC/MS	EPA 8270C/D SIM	Bis(2-chloroethyl)ether
GC/MS	EPA 8270C/D SIM	Bis(2-ethylhexyl)phthalate
GC/MS	EPA 8270C/D SIM	Butylbenzylphthalate
GC/MS	EPA 8270C/D SIM	Caprolactam
GC/MS	EPA 8270C/D SIM	Carbazole
GC/MS	EPA 8270C/D SIM	Chrysene
GC/MS	EPA 8270C/D SIM	Dibenzo(a,h)anthracene
GC/MS	EPA 8270C/D SIM	Dibenzofuran
GC/MS	EPA 8270C/D SIM	Diethylphthalate
GC/MS	EPA 8270C/D SIM	Dimethyl phthalate
GC/MS	EPA 8270C/D SIM	Di-n-butylphthalate
GC/MS	EPA 8270C/D SIM	Di-n-octylphthalate
GC/MS	EPA 8270C/D SIM	Fluoranthene
GC/MS	EPA 8270C/D SIM	Fluorene
GC/MS	EPA 8270C/D SIM	Hexachlorobenzene
GC/MS	EPA 8270C/D SIM	Hexachlorobutadiene
GC/MS	EPA 8270C/D SIM	Hexachlorocyclopentadiene
GC/MS	EPA 8270C/D SIM	Hexachloroethane
GC/MS	EPA 8270C/D SIM	Indeno(1,2,3-cd)pyrene
GC/MS	EPA 8270C/D SIM	Isophorone
GC/MS	EPA 8270C/D SIM	Naphthalene
GC/MS	EPA 8270C/D SIM	Nitrobenzene
GC/MS	EPA 8270C/D SIM	n-Nitroso-di-n-propylamine
GC/MS	EPA 8270C/D SIM	n-Nitrosodiphenylamine
GC/MS	EPA 8270C/D SIM	Pentachlorophenol
GC/MS	EPA 8270C/D SIM	Phenanthrene
GC/MS	EPA 8270C/D SIM	Phenol

<b>Non-Potable Water</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC/MS	EPA 8270C/D SIM	Pyrene
HPLC/UV	EPA 8330A/B	1, 3, 5-Trinitrobenzene
HPLC/UV	EPA 8330A/B	1, 3-Dinitrobenzene
HPLC/UV	EPA 8330A/B	2, 4, 6-Trinitrotoluene
HPLC/UV	EPA 8330A/B	2, 4-Dinitrotoluene
HPLC/UV	EPA 8330A/B	2, 6-Dinitrotoluene
HPLC/UV	EPA 8330A/B	2-Amino-4, 6 -Dinitrotoluene
HPLC/UV	EPA 8330A/B	2-Nitrotoluene
HPLC/UV	EPA 8330A/B	3-Nitrotoluene
HPLC/UV	EPA 8330A/B	3,5-Dinitroaniline
HPLC/UV	EPA 8330A/B	4-Amino-2, 6-Dinitrotoluene
HPLC/UV	EPA 8330A/B	4-Nitrotoluene
HPLC/UV	EPA 8330A/B	Ethylene glycol dinitrate (EGDN)
HPLC/UV	EPA 8330A/B	Hexahydro-1, 3, 5-trinitro-1, 3, 5-triazine (RDX)
HPLC/UV	EPA 8330A/B	Nitrobenzene
HPLC/UV	EPA 8330A MOD	Nitroglycerin
HPLC/UV	EPA 8330B	Nitroglycerin
HPLC/UV	EPA 8330A/B	Octahydro-1, 3, 5, 7-tetrazocine (HMX)
HPLC/UV	EPA 8330A/B	Pentaerythritol Tetranitrate (PETN)
HPLC/UV	EPA 8330A/B	Tetryl
CVAA	EPA 245.1; EPA 7470A	Mercury
CVAF	EPA 1631E	Low Level Mercury
ICP/AES	EPA 200.7; EPA 6010B/C	Aluminum
ICP/AES	EPA 200.7; EPA 6010B/C	Antimony
ICP/AES	EPA 200.7; EPA 6010B/C	Arsenic
ICP/AES	EPA 200.7; EPA 6010B/C	Barium
ICP/AES	EPA 200.7; EPA 6010B/C	Beryllium
ICP/AES	EPA 200.7; EPA 6010B/C	Boron
ICP/AES	EPA 200.7; EPA 6010B/C	Cadmium
ICP/AES	EPA 200.7; EPA 6010B/C	Calcium
ICP/AES	EPA 200.7; EPA 6010B/C	Chromium

<b>Non-Potable Water</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
ICP/AES	EPA 200.7; EPA 6010B/C	Cobalt
ICP/AES	EPA 200.7; EPA 6010B/C	Copper
ICP/AES	EPA 200.7; EPA 6010B/C	Iron
ICP/AES	EPA 200.7; EPA 6010B/C	Lead
ICP/AES	EPA 200.7; EPA 6010B/C	Magnesium
ICP/AES	EPA 200.7; EPA 6010B/C	Manganese
ICP/AES	EPA 200.7; EPA 6010B/C	Molybdenum
ICP/AES	EPA 200.7; EPA 6010B/C	Nickel
ICP/AES	EPA 200.7; EPA 6010B/C	Potassium
ICP/AES	EPA 200.7; EPA 6010B/C	Selenium
ICP/AES	EPA 200.7; EPA 6010B/C	Silicon
ICP/AES	EPA 200.7; EPA 6010B/C	Silver
ICP/AES	EPA 200.7; EPA 6010B/C	Sodium
ICP/AES	EPA 6010B/C	Strontium
ICP/AES	EPA 200.7; EPA 6010B/C	Thallium
ICP/AES	EPA 200.7; EPA 6010B/C	Tin
ICP/AES	EPA 200.7; EPA 6010B/C	Titanium
ICP/AES	EPA 200.7; EPA 6010B/C	Vanadium
ICP/AES	EPA 200.7; EPA 6010B/C	Zinc
ICP/MS	EPA 200.8; EPA 6020A	Aluminum
ICP/MS	EPA 200.8; EPA 6020A	Antimony
ICP/MS	EPA 200.8; EPA 6020A	Arsenic
ICP/MS	EPA 200.8; EPA 6020A	Barium
ICP/MS	EPA 200.8; EPA 6020A	Beryllium
ICP/MS	EPA 200.8; EPA 6020A	Boron
ICP/MS	EPA 200.8; EPA 6020A	Cadmium
ICP/MS	EPA 200.8; EPA 6020A	Calcium
ICP/MS	EPA 200.8; EPA 6020A	Chromium
ICP/MS	EPA 200.8; EPA 6020A	Cobalt
ICP/MS	EPA 200.8; EPA 6020A	Copper
ICP/MS	EPA 200.8; EPA 6020A	Iron

<b>Non-Potable Water</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
ICP/MS	EPA 200.8; EPA 6020A	Lead
ICP/MS	EPA 200.8; EPA 6020A	Magnesium
ICP/MS	EPA 200.8; EPA 6020A	Manganese
ICP/MS	EPA 200.8; EPA 6020A	Molybdenum
ICP/MS	EPA 200.8; EPA 6020A	Nickel
ICP/MS	EPA 200.8; EPA 6020A	Potassium
ICP/MS	EPA 200.8; EPA 6020A	Selenium
ICP/MS	EPA 200.8; EPA 6020A	Silicon
ICP/MS	EPA 200.8; EPA 6020A	Silver
ICP/MS	EPA 200.8; EPA 6020A	Sodium
ICP/MS	EPA 6020A	Strontium
ICP/MS	EPA 200.8; EPA 6020A	Thallium
ICP/MS	EPA 200.8; EPA 6020A	Tin
ICP/MS	EPA 200.8; EPA 6020A	Titanium
ICP/MS	EPA 200.8; EPA 6020A	Tungsten
ICP/MS	EPA 200.8	Uranium
ICP/MS	EPA 200.8; EPA 6020A	Vanadium
ICP/MS	EPA 200.8; EPA 6020A	Zinc
IC	EPA 300.0; EPA 9056A	Bromide
IC	EPA 300.0; EPA 9056A	Chloride
IC	EPA 300.0; EPA 9056A	Fluoride
IC	EPA 300.0; EPA 9056A	Nitrate as N
IC	EPA 300.0; EPA 9056A	Nitrite as N
IC	EPA 300.0; EPA 9056A	Nitrate + Nitrite
IC	EPA 300.0; EPA 9056A	Orthophosphate as P
IC	EPA 300.0; EPA 9056A	Sulfate
IC	SOP CA-776	Lactic Acid
IC	SOP CA-776	Acetic Acid
IC	SOP CA-776	Propionic Acid
IC	SOP CA-776	Formic Acid
IC	SOP CA-776	Butyric Acid

<b>Non-Potable Water</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
IC	SOP CA-776	Pyruvic Acid
IC	SOP CA-776	i-Pentanoic Acid
IC	SOP CA-776	Pentanoic Acid
IC	SOP CA-776	i-Hexanoic Acid
IC	SOP CA-776	Hexanoic Acid
Titration	EPA 310.1; SM 2320B	Alkalinity
Calculation	SM 2340B	Hardness
Gravimetric	EPA 1664A; EPA 9070A	Oil and Grease, Oil and Grease with SGT
Gravimetric	SM 2540B/C/D	Solids
ISE	EPA 120.1; SM 2510B	Conductivity
ISE	SM 2520B	Practical Salinity
ISE	SM 4500F- C	Fluoride
ISE	SM 4500H+ B	pH
ISE	SM 5210B	TBOD / CBOD
Physical	EPA 1010A	Ignitability
Physical	EPA 9040C	pH
Titration	SM 2340C	Hardness
Titration	SM 4500SO <sub>3</sub> B	Sulfite
Titration	EPA 9034; SM 4500S <sup>2-</sup> F	Sulfide
Titration	EPA SW-846 Chapter 7.3.4	Reactive Sulfide
IR	EPA 9060A; SM 5310B	Total organic carbon
Turbidimetric	EPA 180.1; SM 2130B	Turbidity
Turbidimetric	EPA 9038; ASTM 516-02	Sulfate
UV/VIS	EPA 335.4; EPA 9012B; SM 4500-CN G	Amenable cyanide
UV/VIS	EPA 350.1; SM 4500NH <sub>3</sub> H	Ammonia as N
UV/VIS	SM 3500Fe D	Ferrous Iron
UV/VIS	EPA 351.2	Kjeldahl nitrogen - total
UV/VIS	EPA 353.2; SM 4500NO <sub>3</sub> F	Nitrate + Nitrite
UV/VIS	EPA 353.2; SM 4500NO <sub>3</sub> F	Nitrate as N
UV/VIS	EPA 353.2; SM 4500NO <sub>3</sub> F	Nitrite as N
UV/VIS	EPA 365.2; SM 4500P E	Orthophosphate as P

<b>Non-Potable Water</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
UV/VIS	EPA 365.4	Phosphorus total
UV/VIS	EPA 821/R-91-100	AVS-SEM
UV/VIS	EPA 410.4	COD
UV/VIS	EPA 420.1; EPA 9065	Total Phenolics
UV/VIS	SM 4500Cl G	Total Residual Chlorine
UV/VIS	SM 5540C	MBAS
UV/VIS	EPA 7196A; SM 3500-Cr D	Chromium VI
UV/VIS	EPA 9012B; EPA 335.4	Total Cyanide
UV/VIS	EPA 9251; SM 4500Cl E	Chloride
UV/VIS	EPA SW-846 Chapter 7.3.4	Reactive Cyanide

<b>Preparation</b>	<b>Method</b>	<b>Type</b>
Cleanup Methods	EPA 3640A	Gel Permeation Clean-up
Cleanup Methods	EPA 3630C	Silica Gel
Cleanup Methods	EPA 3660B	Sulfur Clean-Up
Cleanup Methods	EPA 3665A	Sulfuric Acid Clean-Up
Organic Preparation	EPA 3510C	Separatory Funnel Extraction
Organic Preparation	EPA 3520C	Continuous Liquid-Liquid Extraction
Inorganic Preparation	EPA 3010A	Hotblock
Volatile Organic Preparation	EPA 5030C	Purge and Trap

<b>Solid and Chemical Waste</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC/ECD	EPA 8081B	2,4'-DDD
GC/ECD	EPA 8081B	2,4'-DDE
GC/ECD	EPA 8081B	2,4'-DDT
GC/ECD	EPA 8081B	4, 4'-DDD
GC/ECD	EPA 8081B	4, 4'-DDE
GC/ECD	EPA 8081B	4, 4'-DDT
GC/ECD	EPA 8081B	Aldrin

<b>Solid and Chemical Waste</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC/ECD	EPA 8081B	alpha-BHC (alpha-Hexachlorocyclohexane)
GC/ECD	EPA 8081B	Alpha-Chlordane
GC/ECD	EPA 8081B	beta-BHC (beta-Hexachlorocyclohexane)
GC/ECD	EPA 608; EPA 8081B	Chlordane (tech.)
GC/ECD	EPA 8081B	Cis-Nonachlor
GC/ECD	EPA 8081B	delta-BHC
GC/ECD	EPA 8081B	Dieldrin
GC/ECD	EPA 8081B	Endosulfan I
GC/ECD	EPA 8081B	Endosulfan II
GC/ECD	EPA 8081B	Endosulfan sulfate
GC/ECD	EPA 8081B	Endrin
GC/ECD	EPA 8081B	Endrin aldehyde
GC/ECD	EPA 8081B	Endrin Ketone
GC/ECD	EPA 8081B	gamma-BHC (Lindane gamma-Hexachlorocyclohexane)
GC/ECD	EPA 8081B	gamma-Chlordane
GC/ECD	EPA 8081B	Heptachlor
GC/ECD	EPA 8081B	Heptachlor epoxide
GC/ECD	EPA 8081B	Hexachlorobenzene
GC/ECD	EPA 8081B	Methoxychlor
GC/ECD	EPA 8081B	Mirex
GC/ECD	EPA 8081B	Oxychlordane
GC/ECD	EPA 8081B	Toxaphene (Chlorinated camphene)
GC/ECD	EPA 8081B	Trans-Nonachlor
GC/ECD	EPA 8082A	Aroclor-1016 (PCB-1016)
GC/ECD	EPA 8082A	Aroclor-1221 (PCB-1221)
GC/ECD	EPA 8082A	Aroclor-1232 (PCB-1232)
GC/ECD	EPA 8082A	Aroclor-1242 (PCB-1242)
GC/ECD	EPA 8082A	Aroclor-1248 (PCB-1248)
GC/ECD	EPA 8082A	Aroclor-1254 (PCB-1254)
GC/ECD	EPA 8082A	Aroclor-1260 (PCB-1260)
GC/ECD	EPA 8082A MOD	Aroclor-1262 (PCB-1262)

<b>Solid and Chemical Waste</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC/ECD	EPA 8082A MOD	Aroclor-1268 (PCB-1268)
GC/ECD	EPA 8082A	2, 2', 3, 3', 4, 4', 5, 5', 6-Nonachlorobiphenyl (BZ 206)
GC/ECD	EPA 8082A	2, 2', 3, 3', 4, 4', 5, 6-Octachlorobiphenyl (BZ 195)
GC/ECD	EPA 8082A	2, 2', 3, 3', 4, 4', 5-Heptachlorobiphenyl (BZ 170)
GC/ECD	EPA 8082A	2, 2', 3, 3', 4, 4'-Hexachlorobiphenyl (BZ 128)
GC/ECD	EPA 8082A	2, 2', 3, 4, 4', 5, 5'-Heptachlorobiphenyl (BZ 180)
GC/ECD	EPA 8082A	2, 2', 3, 4, 4', 5', 6-Heptachlorobiphenyl (BZ 183)
GC/ECD	EPA 8082A	2, 2', 3, 4, 4', 5-Hexachlorobiphenyl (BZ 138)
GC/ECD	EPA 8082A	2, 2', 3, 4, 4', 6, 6'-Heptachlorobiphenyl (BZ 184)
GC/ECD	EPA 8082A	2, 2', 3, 4', 5, 5', 6-Heptachlorobiphenyl (BZ 187)
GC/ECD	EPA 8082A	2, 2', 3, 4, 5'-Pentachlorobiphenyl (BZ 87)
GC/ECD	EPA 8082A	2, 2', 3, 5'-Tetrachlorobiphenyl (BZ 44)
GC/ECD	EPA 8082A	2, 2', 4, 4', 5, 5'-Hexachlorobiphenyl (BZ 153)
GC/ECD	EPA 8082A	2, 2', 4, 5, 5'-Pentachlorobiphenyl (BZ 101)
GC/ECD	EPA 8082A	2, 2', 4, 5-Tetrachlorobiphenyl (BZ 48)
GC/ECD	EPA 8082A	2, 2', 4, 5'-Tetrachlorobiphenyl (BZ 49)
GC/ECD	EPA 8082A	2, 2', 5, 5'-Tetrachlorobiphenyl (BZ 52)
GC/ECD	EPA 8082A	2, 2', 5-Trichlorobiphenyl (BZ 18)
GC/ECD	EPA 8082A	2, 3, 3', 4, 4', 5-Hexachlorobiphenyl (BZ 156)
GC/ECD	EPA 8082A	2, 3, 3', 4, 4', 5'-Hexachlorobiphenyl (BZ 157)
GC/ECD	EPA 8082A	2, 3, 3', 4, 4'-Pentachlorobiphenyl (BZ 105)
GC/ECD	EPA 8082A	2, 3, 3', 4, 4', 5, 5'-Heptachlorobiphenyl (BZ 189)
GC/ECD	EPA 8082A	2, 3', 4, 4', 5, 5'-Hexachlorobiphenyl (BZ 167)
GC/ECD	EPA 8082A	2, 3', 4, 4', 5-Pentachlorobiphenyl (BZ 118)
GC/ECD	EPA 8082A	2, 3', 4, 4',5'-Pentachlorobiphenyl (BZ 123)
GC/ECD	EPA 8082A	2, 3', 4, 4'-Tetrachlorobiphenyl (BZ 66)
GC/ECD	EPA 8082A	2, 3, 4, 4', 5-Pentachlorobiphenyl (BZ 114)
GC/ECD	EPA 8082A	2, 4, 4'-Trichlorobiphenyl (BZ 28)
GC/ECD	EPA 8082A	2, 4'-Dichlorobiphenyl (BZ 8)
GC/ECD	EPA 8082A	3, 3', 4, 4', 5, 5'-Hexachlorobiphenyl (BZ 169)
GC/ECD	EPA 8082A	3, 3', 4, 4', 5-Pentachlorobiphenyl (BZ 126)

<b>Solid and Chemical Waste</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC/ECD	EPA 8082A	3, 3', 4, 4'-Tetrachlorobiphenyl (BZ 77)
GC/ECD	EPA 8082A	3, 4, 4', 5-Tetrachlorobiphenyl (BZ 81)
GC/ECD	EPA 8082A	Decachlorobiphenyl (BZ 209)
GC/ECD	EPA 8151A	2, 4, 5-T
GC/ECD	EPA 8151A	2, 4-D
GC/ECD	EPA 8151A	2, 4-DB
GC/ECD	EPA 8151A	Dalapon
GC/ECD	EPA 8151A	Dicamba
GC/ECD	EPA 8151A	Dichloroprop
GC/ECD	EPA 8151A	Dinoseb
GC/ECD	EPA 8151A	MCPA
GC/ECD	EPA 8151A	MCPP
GC/ECD	EPA 8151A	Pentachlorophenol
GC/ECD	EPA 8151A	Silvex (2, 4, 5-TP)
GC/FID	EPA 8015C/D	Diesel range organics (DRO)
GC/FID	EPA 8015C/D	Total Petroleum Hydrocarbons (TPH)
GC/FID	EPA 8015C/D	Gasoline range organics (GRO)
GC/FID/PID	MA DEP VPH	Volatile Organic Hydrocarbons
GC/FID	MA DEP EPH	Extractable Petroleum Hydrocarbons
GC/FID	MA DEP EPH EPA 3546	Extractable Petroleum Hydrocarbons Microwave Extraction Preparation
GC/FID	CT-ETPH	Total Petroleum Hydrocarbons
GC/FID	TNRCC Method 1005	Total Petroleum Hydrocarbons
GC/FID	FL-PRO	Petroleum Range Organics
GC/ECD	EPA 8011	1, 2-Dibromoethane (EDB)
GC/ECD	EPA 8011	1, 2-Dibromo-3-chloropropane
GC/MS	EPA 8260B/C	1, 1, 1, 2-Tetrachloroethane
GC/MS	EPA 8260B/C	1,1,2-Trichloro-1,2,2-trifluoroethane
GC/MS	EPA 8260B/C	1, 1, 1-Trichloroethane
GC/MS	EPA 8260B/C	1, 1, 2, 2-Tetrachloroethane
GC/MS	EPA 8260B/C	1, 1, 2-Trichloroethane
GC/MS	EPA 8260B/C	1, 1-Dichloroethane

<b>Solid and Chemical Waste</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC/MS	EPA 8260B/C	1, 1-Dichloroethylene
GC/MS	EPA 8260B/C	1, 1-Dichloropropene
GC/MS	EPA 8260B/C	1, 2, 3-Trichlorobenzene
GC/MS	EPA 8260B/C	1, 2, 3-Trichloropropane
GC/MS	EPA 8260B/C	1,2,3-Trimethylbenzene
GC/MS	EPA 8260B/C	1, 2, 4-Trichlorobenzene
GC/MS	EPA 8260B/C	1, 2, 4-Trimethylbenzene
GC/MS	EPA 8260B/C	1, 2-Dibromo-3-chloropropane
GC/MS	EPA 8260B/C	1, 2-Dibromoethane
GC/MS	EPA 8260B/C	1, 2-Dichlorobenzene
GC/MS	EPA 8260B/C	1, 2-Dichloroethane
GC/MS	EPA 8260B/C	1, 2-Dichloropropane
GC/MS	EPA 8260B/C	1,3,5-Trichlorobenzene
GC/MS	EPA 8260B/C	1, 3, 5-Trimethylbenzene
GC/MS	EPA 8260B/C	1, 3-Dichlorobenzene
GC/MS	EPA 8260B/C	1, 3-Dichloropropane
GC/MS	EPA 8260B/C	1, 4-Dichlorobenzene
GC/MS	EPA 8260B/C	1, 4-Dioxane
GC/MS	EPA 8260B/C	1-Chlorohexane
GC/MS	EPA 8260B/C	2, 2-Dichloropropane
GC/MS	EPA 8260B/C	2-Butanone
GC/MS	EPA 8260B/C	2-Chloroethyl vinyl ether
GC/MS	EPA 8260B/C	2-Chlorotoluene
GC/MS	EPA 8260B/C	2-Hexanone
GC/MS	EPA 8260B/C	4-Chlorotoluene
GC/MS	EPA 8260B/C	4-Methyl-2-pentanone
GC/MS	EPA 8260B/C	Acetone
GC/MS	EPA 8260B/C	Acetonitrile
GC/MS	EPA 8260B/C	Acrolein
GC/MS	EPA 8260B/C	Acrylonitrile
GC/MS	EPA 8260B/C	Allyl chloride

<b>Solid and Chemical Waste</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC/MS	EPA 8260B/C	Benzene
GC/MS	EPA 8260B/C	Benzyl chloride
GC/MS	EPA 8260B/C	Bromobenzene
GC/MS	EPA 8260B/C	Bromochloromethane
GC/MS	EPA 8260B/C	Bromodichloromethane
GC/MS	EPA 8260B/C	Bromoform
GC/MS	EPA 8260B/C	Carbon disulfide
GC/MS	EPA 8260B/C	Carbon tetrachloride
GC/MS	EPA 8260B/C	Chlorobenzene
GC/MS	EPA 8260B/C	Chloroethane
GC/MS	EPA 8260B/C	Chloroform
GC/MS	EPA 8260B/C	Chloroprene
GC/MS	EPA 8260B/C	cis-1, 2-Dichloroethene
GC/MS	EPA 8260B/C	cis-1, 3-Dichloropropene
GC/MS	EPA 8260B/C	cis-1,3-Dichloro-2-butene
GC/MS	EPA 8260B/C	Cyclohexane
GC/MS	EPA 8260B/C	Dibromochloromethane
GC/MS	EPA 8260B/C	Dibromomethane
GC/MS	EPA 8260B/C	Dichlorodifluoromethane
GC/MS	EPA 8260B/C	Diethyl ether
GC/MS	EPA 8260B/C	Di-isopropylether
GC/MS	EPA 8260B/C	1,2-Dibromoethane (EDB)
GC/MS	EPA 8260B/C	Ethyl methacrylate
GC/MS	EPA 8260B/C	Ethylbenzene
GC/MS	EPA 8260B/C	Ethyl-t-butylether
GC/MS	EPA 8260B/C	Hexachlorobutadiene
GC/MS	EPA 8260B/C	Iodomethane
GC/MS	EPA 8260B/C	Isobutyl alcohol
GC/MS	EPA 8260B/C	Isopropyl alcohol
GC/MS	EPA 8260B/C	Isopropyl benzene
GC/MS	EPA 8260B/C	m p-xylenes

<b>Solid and Chemical Waste</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC/MS	EPA 8260B, C	Methyl acetate
GC/MS	EPA 8260B/C	Methacrylonitrile
GC/MS	EPA 8260B/C	Methyl bromide (Bromomethane)
GC/MS	EPA 8260B/C	Methyl chloride (Chloromethane)
GC/MS	EPA 8260B/C	Methyl methacrylate
GC/MS	EPA 8260B/C	Methyl tert-butyl ether
GC/MS	EPA 8260B/C	Methylcyclohexane
GC/MS	EPA 8260B/C	Methylene chloride
GC/MS	EPA 8260B/C	Naphthalene
GC/MS	EPA 8260B/C	n-Butylbenzene
GC/MS	EPA 8260B/C	n-propylbenzene
GC/MS	EPA 8260B/C	o-Xylene
GC/MS	EPA 8260B/C	pentachloroethane
GC/MS	EPA 8260B/C	p-Isopropyltoluene
GC/MS	EPA 8260B/C	Propionitrile
GC/MS	EPA 8260B/C	sec-butylbenzene
GC/MS	EPA 8260B/C	Styrene
GC/MS	EPA 8260B/C	t-Amylmethylether
GC/MS	EPA 8260B/C	tert-Butyl alcohol
GC/MS	EPA 8260B/C	tert-Butylbenzene
GC/MS	EPA 8260B/C	Tetrachloroethylene (Perchloroethylene)
GC/MS	EPA 8260B/C	Tetrahydrofuran
GC/MS	EPA 8260B/C	Toluene
GC/MS	EPA 8260B/C	trans-1, 2-Dichloroethylene
GC/MS	EPA 8260B/C	trans-1, 3-Dichloropropylene
GC/MS	EPA 8260B/C	Trans-1, 4-Dichloro-2-butene
GC/MS	EPA 8260B/C	Trichloroethene (Trichloroethylene)
GC/MS	EPA 8260B/C	Trichlorofluoromethane
GC/MS	EPA 8260B/C	Vinyl acetate
GC/MS	EPA 8260B/C	Vinyl chloride
GC/MS	EPA 8260B/C	Xylene

<b>Solid and Chemical Waste</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC/MS	EPA 8260B/C SIM	1,1,1,2-Tetrachloroethane
GC/MS	EPA 8260B/C SIM	1,1,1-Trichloroethane
GC/MS	EPA 8260B/C SIM	1,1,2,2-Tetrachloroethane
GC/MS	EPA 8260B/C SIM	1, 1, 2-Trichloroethane
GC/MS	EPA 8260B/C SIM	1,2,3-Trichloropropane
GC/MS	EPA 8260B/C SIM	1,1-Dichloroethane
GC/MS	EPA 8260B/C SIM	1,1-Dichloroethene
GC/MS	EPA 8260B/C SIM	1,2,4-Trichlorobenzene
GC/MS	EPA 8260B/C SIM	1,2,4-Trimethylbenzene
GC/MS	EPA 8260B/C SIM	1,2-Dibromo-3-chloropropane
GC/MS	EPA 8260B/C SIM	1,2-Dibromoethane
GC/MS	EPA 8260B/C SIM	1,2-Dichlorobenzene
GC/MS	EPA 8260B/C SIM	1,2-Dichloroethane
GC/MS	EPA 8260B/C SIM	1,2-Dichloropropane
GC/MS	EPA 8260B/C SIM	1,3-Dichlorobenzene
GC/MS	EPA 8260B/C SIM	1,3-Dichloropropane
GC/MS	EPA 8260B/C SIM	1,4-Dichlorobenzene
GC/MS	EPA 8260B/C SIM	2-Hexanone
GC/MS	EPA 8260B/C SIM	4-Methyl-2-pentanone
GC/MS	EPA 8260B/C SIM	Benzene
GC/MS	EPA 8260B/C SIM	Bromodichloromethane
GC/MS	EPA 8260B/C SIM	Carbon Tetrachloride
GC/MS	EPA 8260B/C SIM	Chloroform
GC/MS	EPA 8260B/C SIM	Chloromethane
GC/MS	EPA 8260B/C SIM	cis-1,2-Dichloroethene
GC/MS	EPA 8260B/C SIM	cis-1,3-Dichloropropene
GC/MS	EPA 8260B/C SIM	Dibromochloromethane
GC/MS	EPA 8260B/C SIM	Ethylbenzene
GC/MS	EPA 8260B/C SIM	Isopropylbenzene
GC/MS	EPA 8260B/C SIM	Hexachlorobutadiene
GC/MS	EPA 8260B/C SIM	Methylcyclohexane

<b>Solid and Chemical Waste</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC/MS	EPA 8260B/C SIM	m,p-Xylene
GC/MS	EPA 8260B/C SIM	o-Xylene
GC/MS	EPA 8260B/C SIM	Tetrachloroethene
GC/MS	EPA 8260B/C SIM	trans-1,2-Dichloroethene
GC/MS	EPA 8260B/C SIM	Trans-1,3-Dichloropropene
GC/MS	EPA 8260B/C SIM	Trichloroethene
GC/MS	EPA 8260B/C SIM	Trichlorofluoromethane
GC/MS	EPA 8260B/C SIM	Vinyl Chloride
GC/MS	EPA 8260B/C SIM	Xylenes (total)
GC/MS	EPA 8270C/D	1, 2, 4, 5-Tetrachlorobenzene
GC/MS	EPA 8270C/D	1, 2, 4-Trichlorobenzene
GC/MS	EPA 8270C/D	1, 2-Dichlorobenzene
GC/MS	EPA 8270C/D	1, 2-Diphenylhydrazine
GC/MS	EPA 8270C/D	1, 3, 5-Trinitrobenzene
GC/MS	EPA 8270C/D	1, 3-Dichlorobenzene
GC/MS	EPA 8270C/D	1, 3-Dinitrobenzene
GC/MS	EPA 8270C/D	1, 4-Dichlorobenzene
GC/MS	EPA 8270C/D	1, 4-Dioxane
GC/MS	EPA 8270C/D	1, 4-Naphthoquinone
GC/MS	EPA 8270C/D	1, 4-Phenylenediamine
GC/MS	EPA 8270C/D	1,1-Biphenyl
GC/MS	EPA 8270C/D	1-Chloronaphthalene
GC/MS	EPA 8270C/D	1-Methylnaphthalene
GC/MS	EPA 8270C/D	1-Naphthylamine
GC/MS	EPA 8270C/D	2, 3, 4, 6-Tetrachlorophenol
GC/MS	EPA 8270C/D	2, 4, 5-Trochlorophenol
GC/MS	EPA 8270C/D	2, 4, 6-Trichlorophenol
GC/MS	EPA 8270C/D	2, 4-Dichlorophenol
GC/MS	EPA 8270C/D	2, 4-Dimethylphenol
GC/MS	EPA 8270C/D	2, 4-Dinitrophenol
GC/MS	EPA 8270C/D	2, 4-Dinitrotoluene (2 4-DNT)

<b>Solid and Chemical Waste</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC/MS	EPA 8270C/D	2, 6-Dichlorophenol
GC/MS	EPA 8270C/D	2, 6-Dinitrotoluene (2 6-DNT)
GC/MS	EPA 8270C/D	2-Acetylaminofluorene
GC/MS	EPA 8270C/D	2-Chloronaphthalene
GC/MS	EPA 8270C/D	2-Chlorophenol
GC/MS	EPA 8270C/D	2-Methyl-4, 6-dinitrophenol
GC/MS	EPA 8270C/D	2-Methylnaphthalene
GC/MS	EPA 8270C/D	2-Methylphenol
GC/MS	EPA 8270C/D	2-Naphthylamine
GC/MS	EPA 8270C/D	2-Nitroaniline
GC/MS	EPA 8270C/D	2-Nitrophenol
GC/MS	EPA 8270C/D	2-Picoline
GC/MS	EPA 8270C/D	3, 3'-Dichlorobenzidine
GC/MS	EPA 8270C/D	3, 3'-Dimethylbenzidine
GC/MS	EPA 8270C/D	3,4-Methylphenol
GC/MS	EPA 8270C/D	3-Methylcholanthrene
GC/MS	EPA 8270C/D	3-Nitroaniline
GC/MS	EPA 8270C/D	4-Aminobiphenyl
GC/MS	EPA 8270C/D	4-Bromophenyl phenyl ether
GC/MS	EPA 8270C/D	4-Chloro-3-methylphenol
GC/MS	EPA 8270C/D	4-Chloroaniline
GC/MS	EPA 8270C/D	4-Chlorophenyl phenylether
GC/MS	EPA 8270C/D	4-Dimethyl aminoazobenzene
GC/MS	EPA 8270C/D	4-Nitroaniline
GC/MS	EPA 8270C/D	4-Nitrophenol
GC/MS	EPA 8270C/D	4-Nitroquinoline-1-oxide
GC/MS	EPA 8270C/D	5-Nitro-o-toluidine
GC/MS	EPA 8270C/D	7,12-Dimethylbenz(a)anthracene
GC/MS	EPA 8270C/D	a a-Dimethylphenethylamine
GC/MS	EPA 8270C/D	Acenaphthene
GC/MS	EPA 8270C/D	Acenaphthylene

<b>Solid and Chemical Waste</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC/MS	EPA 8270C/D	Acetophenone
GC/MS	EPA 8270C/D	Aniline
GC/MS	EPA 8270C/D	Anthracene
GC/MS	EPA 8270C/D	Aramite
GC/MS	EPA 8270C/D	Atrazine
GC/MS	EPA 8270C/D	Azobenzene
GC/MS	EPA 8270C/D	Benzaldehyde
GC/MS	EPA 8270C/D	Benzidine
GC/MS	EPA 8270C/D	Benzo(a)anthracene
GC/MS	EPA 8270C/D	Benzo(a)pyrene
GC/MS	EPA 8270C/D	Benzo(b)fluoranthene
GC/MS	EPA 8270C/D	Benzo(g h i)perylene
GC/MS	EPA 8270C/D	Benzo(k)fluoranthene
GC/MS	EPA 8270C/D	Benzoic Acid
GC/MS	EPA 8270C/D	Benzyl alcohol
GC/MS	EPA 8270C/D	bis(2-Chloroethoxy)methane
GC/MS	EPA 8270C/D	bis(2-Chloroethyl) ether
GC/MS	EPA 8270C/D	bis(2-Chloroisopropyl) ether (2, 2'-Oxybis(1-chloropropane))
GC/MS	EPA 8270C/D	bis(2-Ethylhexyl) phthalate (DEHP)
GC/MS	EPA 625; EPA 8270C/D	Bis(2-Ethylhexyl)adipate
GC/MS	EPA 8270C/D	Butyl benzyl phthalate
GC/MS	EPA 8270C/D	Caprolactam
GC/MS	EPA 8270C/D	Carbazole
GC/MS	EPA 8270C/D	Chlorobenzilate
GC/MS	EPA 8270C/D	Chrysene
GC/MS	EPA 8270C/D	Diallate
GC/MS	EPA 8270C/D	Dibenz(a h)anthracene
GC/MS	EPA 8270C/D	Dibenzo(a,j)acridine
GC/MS	EPA 8270C/D	Dibenzofuran
GC/MS	EPA 8270C/D	Diethyl phthalate
GC/MS	EPA 8270C/D	Diethyladipate

<b>Solid and Chemical Waste</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC/MS	EPA 8270C/D	Dimethoate
GC/MS	EPA 8270C/D	Dimethyl phthalate
GC/MS	EPA 8270C/D	Di-n-butyl phthalate
GC/MS	EPA 8270C/D	Di-n-octyl phthalate
GC/MS	EPA 8270C/D	Dinoseb
GC/MS	EPA 8270C/D	Disulfoton
GC/MS	EPA 8270C/D	Ethyl methacrylate
GC/MS	EPA 8270C/D	Ethyl methanesulfonate
GC/MS	EPA 8270C/D	Ethyl parathion
GC/MS	EPA 8270C/D	Famfur
GC/MS	EPA 8270C/D	Fluoranthene
GC/MS	EPA 8270C/D	Fluorene
GC/MS	EPA 8270C/D	Hexachlorobenzene
GC/MS	EPA 8270C/D	Hexachlorobutadiene
GC/MS	EPA 8270C/D	Hexachlorocyclopentadiene
GC/MS	EPA 8270C/D	Hexachloroethane
GC/MS	EPA 8270C/D	Hexachlorophene
GC/MS	EPA 8270C/D	Hexachloropropene
GC/MS	EPA 8270C/D	Indeno(1, 2, 3-cd)pyrene
GC/MS	EPA 8270C/D	Isodrin
GC/MS	EPA 8270C/D	Isophorone
GC/MS	EPA 8270C/D	Isosafrole
GC/MS	EPA 8270C/D	Kepone
GC/MS	EPA 8270C/D	Methapyriline
GC/MS	EPA 8270C/D	Methyl methanesulfonate
GC/MS	EPA 8270C/D	Methyl parathion
GC/MS	EPA 8270C/D	Naphthalene
GC/MS	EPA 8270C/D	Nitrobenzene
GC/MS	EPA 8270C/D	n-Nitrosodiethylamine
GC/MS	EPA 8270C/D	n-Nitrosodimethylamine
GC/MS	EPA 8270C/D	n-Nitroso-di-n-butylamine

<b>Solid and Chemical Waste</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC/MS	EPA 8270C/D	n-Nitrosodi-n-propylamine
GC/MS	EPA 8270C/D	n-Nitrosodiphenylamine
GC/MS	EPA 8270C/D	n-Nitrosomethylethylamine
GC/MS	EPA 8270C/D	n-Nitrosomorpholine
GC/MS	EPA 8270C/D	n-Nitrosopiperidine
GC/MS	EPA 8270C/D	n-Nitrosopyrrolidine
GC/MS	EPA 8270C/D	O, O, O-Triethyl phosphorothioate
GC/MS	EPA 8270C/D	o,o-Diethyl o-2-pyrazinyl phosphorothioate
GC/MS	EPA 8270C/D	o-Toluidine
GC/MS	EPA 8270C/D	Pentachlorobenzene
GC/MS	EPA 8270C/D	Pentachloronitrobenzene
GC/MS	EPA 8270C/D	Pentachlorophenol
GC/MS	EPA 8270C/D	Phenacetin
GC/MS	EPA 8270C/D	Phenanthrene
GC/MS	EPA 8270C/D	Phenol
GC/MS	EPA 8270C/D	Phorate
GC/MS	EPA 8270C/D	Pronamide
GC/MS	EPA 8270C/D	Pyrene
GC/MS	EPA 8270C/D	Pyridine
GC/MS	EPA 8270C/D	Safrole
GC/MS	EPA 8270C/D	Sulfotepp
GC/MS	EPA 8270C/D	Thionazin
GC/MS	EPA 8270C/D SIM	1,1'-Biphenyl
GC/MS	EPA 8270C/D SIM	1,2,4,5-Tetrachlorobenzene
GC/MS	EPA 8270C/D SIM	1,4-Dioxane
GC/MS	EPA 8270C/D SIM	1-Methylnaphthalene
GC/MS	EPA 8270C/D SIM	2,2'-Oxybis(1-chloropropane
GC/MS	EPA 8270C/D SIM	2,3,4,6-Tetrachlorophenol
GC/MS	EPA 8270C/D SIM	2,4,5-Trichlorophenol
GC/MS	EPA 8270C/D SIM	2,4,6-Trichlorophenol
GC/MS	EPA 8270C/D SIM	2,4-Dichlorophenol

<b>Solid and Chemical Waste</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC/MS	EPA 8270C/D SIM	2,4-Dimethylphenol
GC/MS	EPA 8270C/D SIM	2,4-Dinitrophenol
GC/MS	EPA 8270C/D SIM	2,4-Dinitrotoluene
GC/MS	EPA 8270C/D SIM	2,6-Dinitrotoluene
GC/MS	EPA 8270C/D SIM	2-Chloronaphthalene
GC/MS	EPA 8270C/D SIM	2-Chlorophenol
GC/MS	EPA 8270C/D SIM	2-Methylnaphthalene
GC/MS	EPA 8270C/D SIM	2-Methylphenol
GC/MS	EPA 8270C/D SIM	2-Nitroaniline
GC/MS	EPA 8270C/D SIM	2-Nitrophenol
GC/MS	EPA 8270C/D SIM	3&4-Methylphenol
GC/MS	EPA 8270C/D SIM	3,3'-Dichlorobenzidine
GC/MS	EPA 8270C/D SIM	3-Nitroaniline
GC/MS	EPA 8270C/D SIM	4,6-Dinitro-2-methylphenol
GC/MS	EPA 8270C/D SIM	4-Bromophenyl-phenylether
GC/MS	EPA 8270C/D SIM	4-Chloro-3-methylphenol
GC/MS	EPA 8270C/D SIM	4-Chloroaniline
GC/MS	EPA 8270C/D SIM	4-Chlorophenyl-phenylether
GC/MS	EPA 8270C/D SIM	4-Nitroaniline
GC/MS	EPA 8270C/D SIM	4-Nitrophenol
GC/MS	EPA 8270C/D SIM	Acenaphthene
GC/MS	EPA 8270C/D SIM	Acenaphthylene
GC/MS	EPA 8270C/D SIM	Acetophenone
GC/MS	EPA 8270C/D SIM	Anthracene
GC/MS	EPA 8270C/D SIM	Atrazine
GC/MS	EPA 8270C/D SIM	Benzaldehyde
GC/MS	EPA 8270C/D SIM	Benzo(a)anthracene
GC/MS	EPA 8270C/D SIM	Benzo(a)pyrene
GC/MS	EPA 8270C/D SIM	Benzo(b)fluoranthene
GC/MS	EPA 8270C/D SIM	Benzo(g,h,i)perylene
GC/MS	EPA 8270C/D SIM	Benzo(k)fluoranthene

<b>Solid and Chemical Waste</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC/MS	EPA 8270C/D SIM	Bis(2-chloroethoxy)methane
GC/MS	EPA 8270C/D SIM	Bis(2-chloroethyl)ether
GC/MS	EPA 8270C/D SIM	Bis(2-ethylhexyl)phthalate
GC/MS	EPA 8270C/D SIM	Butylbenzylphthalate
GC/MS	EPA 8270C/D SIM	Caprolactam
GC/MS	EPA 8270C/D SIM	Carbazole
GC/MS	EPA 8270C/D SIM	Chrysene
GC/MS	EPA 8270C/D SIM	Dibenzo(a,h)anthracene
GC/MS	EPA 8270C/D SIM	Dibenzofuran
GC/MS	EPA 8270C/D SIM	Diethylphthalate
GC/MS	EPA 8270C/D SIM	Dimethyl phthalate
GC/MS	EPA 8270C/D SIM	Di-n-butylphthalate
GC/MS	EPA 8270C/D SIM	Di-n-octylphthalate
GC/MS	EPA 8270C/D SIM	Fluoranthene
GC/MS	EPA 8270C/D SIM	Fluorene
GC/MS	EPA 8270C/D SIM	Hexachlorobenzene
GC/MS	EPA 8270C/D SIM	Hexachlorobutadiene
GC/MS	EPA 8270C/D SIM	Hexachlorocyclopentadiene
GC/MS	EPA 8270C/D SIM	Hexachloroethane
GC/MS	EPA 8270C/D SIM	Indeno(1,2,3-cd)pyrene
GC/MS	EPA 8270C/D SIM	Isophorone
GC/MS	EPA 8270C/D SIM	Naphthalene
GC/MS	EPA 8270C/D SIM	Nitrobenzene
GC/MS	EPA 8270C/D SIM	n-Nitroso-di-n-propylamine
GC/MS	EPA 8270C/D SIM	n-Nitrosodiphenylamine
GC/MS	EPA 8270C/D SIM	Pentachlorophenol
GC/MS	EPA 8270C/D SIM	Phenanthrene
GC/MS	EPA 8270C/D SIM	Phenol
GC/MS	EPA 8270C/D SIM	Pyrene
HPLC/UV	EPA 8330A	1,3,5-Trinitrobenzene
HPLC/UV	EPA 8330A	1,3-Dinitrobenzene

<b>Solid and Chemical Waste</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
HPLC/UV	EPA 8330A	2, 4, 6-Trinitrotoluene
HPLC/UV	EPA 8330A	2, 4-Dinitrotoluene
HPLC/UV	EPA 8330A	2, 6-Dinitrotoluene
HPLC/UV	EPA 8330A	2-Amino-4, 6-dinitrotoluene
HPLC/UV	EPA 8330A	2-Nitrotoluene
HPLC/UV	EPA 8330A	3-Nitrotoluene
HPLC/UV	EPA 8330A	3,5-Dinitroaniline
HPLC/UV	EPA 8330A	4-Amino-2,6-dinitrotoluene
HPLC/UV	EPA 8330A	4-Nitrotoluene
HPLC/UV	EPA 8330A	Ethylene glycol dinitrate (EGDN)
HPLC/UV	EPA 8330A	Hexahydr-1, 3, 5-trinitro-1, 3, 5-triazine (RDX)
HPLC/UV	EPA 8330A	Nitrobenzene
HPLC/UV	EPA 8330A MOD	Nitroglycerin
HPLC/UV	EPA 8330A	Octahydro-1, 3, 5, 7-tetrazocine (HMX)
HPLC/UV	EPA 8330A	Pentaerythritol Tetranitrate (PETN)
HPLC/UV	EPA 8330A	Tetryl
HPLC/UV	8330B (W/O Soil Grinding)	1, 3, 5-Trinitrobenzene
HPLC/UV	8330B (W/O Soil Grinding)	1, 3-Dinitrobenzene
HPLC/UV	8330B (W/O Soil Grinding)	2, 4, 6-Trinitrotoluene
HPLC/UV	8330B (W/O Soil Grinding)	2, 4-Dinitrotoluene
HPLC/UV	8330B (W/O Soil Grinding)	2, 6-Dinitrotoluene
HPLC/UV	8330B (W/O Soil Grinding)	2-Amino-4, 6 –Dinitrotoluene
HPLC/UV	8330B (W/O Soil Grinding)	2-Nitrotoluene
HPLC/UV	8330B (W/O Soil Grinding)	3-Nitrotoluene
HPLC/UV	8330B (W/O Soil Grinding)	3,5-Dinitroaniline
HPLC/UV	8330B (W/O Soil Grinding)	4-Amino-2,3-Dinitrotoluene
HPLC/UV	8330B (W/O Soil Grinding)	4-Nitrotoluene
HPLC/UV	8330B (W/O Soil Grinding)	Ethylene glycol dinitrate (EGDN)
HPLC/UV	8330B (W/O Soil Grinding)	Hexahydr-1, 3, 5-trinitro-1, 3, 5-triazine (RDX)
HPLC/UV	8330B (W/O Soil Grinding)	Nitrobenzene
HPLC/UV	8330B (W/O Soil Grinding)	Nitroglycerin

<b>Solid and Chemical Waste</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
HPLC/UV	8330B (W/O Soil Grinding)	Octahydro-1, 3, 5, 7-tetrazocine (HMX)
HPLC/UV	8330B (W/O Soil Grinding)	Pentaerythritol Tetranitrate (PETN)
HPLC/UV	8330B (W/O Soil Grinding)	Tetryl
CVAA	EPA 7471B	Mercury
CVAF	EPA 1631E	Low Level Mercury
ICP/AES	EPA 6010B/C	Aluminum
ICP/AES	EPA 6010B/C	Antimony
ICP/AES	EPA 6010B/C	Arsenic
ICP/AES	EPA 6010B/C	Barium
ICP/AES	EPA 6010B/C	Beryllium
ICP/AES	EPA 6010B/C	Boron
ICP/AES	EPA 6010B/C	Cadmium
ICP/AES	EPA 6010B/C	Calcium
ICP/AES	EPA 6010B/C	Chromium
ICP/AES	EPA 6010B/C	Cobalt
ICP/AES	EPA 6010B/C	Copper
ICP/AES	EPA 6010B/C	Iron
ICP/AES	EPA 6010B/C	Lead
ICP/AES	EPA 6010B/C	Magnesium
ICP/AES	EPA 6010B/C	Manganese
ICP/AES	EPA 6010B/C	Molybdenum
ICP/AES	EPA 6010B/C	Nickel
ICP/AES	EPA 6010B/C	Potassium
ICP/AES	EPA 6010B/C	Selenium
ICP/AES	EPA 6010B/C	Silicon
ICP/AES	EPA 6010B/C	Silver
ICP/AES	EPA 6010B/C	Sodium
ICP/AES	EPA 6010B/C	Strontium
ICP/AES	EPA 6010B/C	Thallium
ICP/AES	EPA 6010B/C	Tin
ICP/AES	EPA 6010B/C	Titanium

<b>Solid and Chemical Waste</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
ICP/AES	EPA 6010B/C	Vanadium
ICP/AES	EPA 6010B/C	Zinc
ICP/MS	EPA 6020A	Aluminum
ICP/MS	EPA 6020A	Antimony
ICP/MS	EPA 6020A	Arsenic
ICP/MS	EPA 6020A	Barium
ICP/MS	EPA 6020A	Beryllium
ICP/MS	EPA 6020A	Boron
ICP/MS	EPA 6020A	Cadmium
ICP/MS	EPA 6020A	Calcium
ICP/MS	EPA 6020A	Chromium
ICP/MS	EPA 6020A	Cobalt
ICP/MS	EPA 6020A	Copper
ICP/MS	EPA 6020A	Iron
ICP/MS	EPA 6020A	Lead
ICP/MS	EPA 6020A	Magnesium
ICP/MS	EPA 6020A	Manganese
ICP/MS	EPA 6020A	Molybdenum
ICP/MS	EPA 6020A	Nickel
ICP/MS	EPA 6020A	Potassium
ICP/MS	EPA 6020A	Selenium
ICP/MS	EPA 6020A	Silver
ICP/MS	EPA 6020A	Sodium
ICP/MS	EPA 6020A	Strontium
ICP/MS	EPA 6020A	Thallium
ICP/MS	EPA 6020A	Tin
ICP/MS	EPA 6020A	Titanium
ICP/MS	EPA 6020A	Tungsten
ICP/MS	EPA 6020A	Vanadium
ICP/MS	EPA 6020A	Zinc
IC	EPA 9056A	Chloride

<b>Solid and Chemical Waste</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
IC	EPA 9056A	Fluoride
IC	EPA 9056A	Nitrate as N
IC	EPA 9056A	Nitrite as N
IC	EPA 9056A	Orthophosphate
IC	EPA 9056A	Sulfate
Gravimetric	EPA 9071A; EPA 9071B	Oil and Grease, Oil and Grease with SGT
Physical	EPA 1010A	Ignitability
Physical	EPA 9045D	pH
Titration	EPA SW-846 Chapter 7.3.4	Reactive Sulfide
Titration	Walkley-Black	Total Organic Carbon
IR	Lloyd Kahn	Total organic carbon
Turbidimetric	EPA 9038; ASTM 516-02	Sulfate
UV/VIS	EPA 350.1; SM 4500NH3 H	Ammonia as N
UV/VIS	EPA 9251; SM 4500Cl E	Chloride
UV/VIS	EPA SW-846 Chapter 7.3.4	Reactive Cyanide
UV/VIS	EPA 821/R-91-100	AVS-SEM
UV/VIS	SM 3500Fe D	Ferrous Iron
Cleanup Methods	EPA 3630C	Silica Gel
UV/VIS	EPA 7196	Chromium VI
UV/VIS	EPA 7196A	Chromium VI
UV/VIS	EPA 9012B	Total cyanide
<b>Preparation</b>	<b>Method</b>	<b>Type</b>
Preparation	EPA 1311	Toxicity Characteristic Leaching Procedure
Preparation	EPA 1312	Synthetic Precipitation Leaching Procedure
Cleanup Methods	EPA 3660B	Sulfur Clean-up
Cleanup Methods	EPA 3620C	Florsil Clean-up
Cleanup Methods	EPA 3630C	Silica Gel Clean-up
Cleanup Methods	EPA 3640A	GPC Clean-up
Organic Preparation	EPA 3540C	Soxhlet Extraction
Organic Preparation	EPA 3545A	Pressurized Fluid Extraction

<b>Solid and Chemical Waste</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
Organic Preparation	EPA 3546	Microwave Extraction Preparation for EPA 8082A, 8081B and 8270C, D
Organic Preparation	EPA 3550C	Sonication
Inorganics Preparation	EPA 3050B	Hotblock
Inorganics Preparation	EPA 3060A	Alkaline Digestion
Volatile Organics Preparation	EPA 5035/5035A	Closed System Purge and Trap

<b>Air</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC/MS	EPA TO-15	Propene
GC/MS	EPA TO-15	1, 1, 1-Trichloroethane
GC/MS	EPA TO-15	1, 1, 2, 2-Tetrachloroethane
GC/MS	EPA TO-15	1, 1, 2-Trichloroethane
GC/MS	EPA TO-15	1, 1-Dichloroethane
GC/MS	EPA TO-15	1, 1-Dichloroethylene
GC/MS	EPA TO-15	1, 2, 4-Trichlorobenzene
GC/MS	EPA TO-15	1, 2, 4-Trimethylbenzene
GC/MS	EPA TO-15	1, 2-Dibromoethane (EDB)
GC/MS	EPA TO-15	1,2-Dichloro-1,1,2,2-tetrafluoroethane (Freon 114)
GC/MS	EPA TO-15	1, 2-Dichlorobenzene
GC/MS	EPA TO-15	1, 2-Dichloroethane
GC/MS	EPA TO-15	1, 2-Dichloroethenes (Total)
GC/MS	EPA TO-15	1, 2-Dichloropropane
GC/MS	EPA TO-15	1, 3, 5-Trimethylbenzene
GC/MS	EPA TO-15	1, 3-Butadiene
GC/MS	EPA TO-15	1, 3-Dichlorobenzene
GC/MS	EPA TO-15	1, 4-Dichlorobenzene
GC/MS	EPA TO-15	1,4-Difluorobenzene
GC/MS	EPA TO-15	1, 4-Dioxane
GC/MS	EPA TO-15	2-Butanone
GC/MS	EPA TO-15	2-Hexanone

<b>Air</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC/MS	EPA TO-15	2-Propanol
GC/MS	EPA TO-15	4-Ethyltoluene
GC/MS	EPA TO-15	4-Methyl-2-pentanone
GC/MS	EPA TO-15	Acetone
GC/MS	EPA TO-15	Acrolein
GC/MS	EPA TO-15	Benzene
GC/MS	EPA TO-15	Benzyl chloride
GC/MS	EPA TO-15	Bromochloromethane
GC/MS	EPA TO-15	Bromodichloromethane
GC/MS	EPA TO-15	Bromoform
GC/MS	EPA TO-15	Carbon disulfide
GC/MS	EPA TO-15	Carbon tetrachloride
GC/MS	EPA TO-15	Chlorobenzene
GC/MS	EPA TO-15	Chloroethane
GC/MS	EPA TO-15	Chloroform
GC/MS	EPA TO-15	Cis-1, 2-Dichloroethene
GC/MS	EPA TO-15	Cis-1, 3-Dichloropropene
GC/MS	EPA TO-15	Cyclohexane
GC/MS	EPA TO-15	Dibromochloromethane
GC/MS	EPA TO-15	Dichlorodifluoromethane (Freon 12)
GC/MS	EPA TO-15	Ethanol
GC/MS	EPA TO-15	Ethyl acetate
GC/MS	EPA TO-15	Ethylbenzene
GC/MS	EPA TO-15	Hexachlorobutadiene
GC/MS	EPA TO-15	Isopropyl alcohol
GC/MS	EPA TO-15	m, p-Xylene
GC/MS	EPA TO-15	Methyl bromide (Bromomethane)
GC/MS	EPA TO-15	Methyl chloride (Chloromethane)
GC/MS	EPA TO-15	Methyl methacrylate
GC/MS	EPA TO-15	Methyl tert-butyl ether
GC/MS	EPA TO-15	Methylene chloride

<b>Air</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC/MS	EPA TO-15	Naphthalene
GC/MS	EPA TO-15	n-Heptane
GC/MS	EPA TO-15	n-Hexane
GC/MS	EPA TO-15	o-Xylene
GC/MS	EPA TO-15	Styrene
GC/MS	EPA TO-15	Tetrachloroethylene (Perchloroethylene)
GC/MS	EPA TO-15	Tetrahydrofuran
GC/MS	EPA TO-15	Toluene
GC/MS	EPA TO-15	trans-1, 2-Dichloroethylene
GC/MS	EPA TO-15	trans-1, 3-Dichloropropylene
GC/MS	EPA TO-15	Trichloroethene (Trichloroethylene)
GC/MS	EPA TO-15	Trichlorofluoromethane (Freon 11)
GC/MS	EPA TO-15	1,1,2-Trichloro1,2,2-trifluoroethane (Freon 113)
GC/MS	EPA TO-15	Vinyl acetate
GC/MS	EPA TO-15	Vinyl chloride
GC/MS	EPA TO-15	Xylenes (Total)
GC/MS	MA DEP APH	Aliphatic C5-C8 range
GC/MS	MA DEP APH	Aliphatic C9-C12 range
GC/MS	MA DEP APH	Aromatic C9-C10 range
GC/MS	MA DEP APH	1,3-Butadiene
GC/MS	MA DEP APH	Benzene
GC/MS	MA DEP APH	Ethylbenzene
GC/MS	MA DEP APH	m+p-Xylene
GC/MS	MA DEP APH	Methyl tert-butyl ether
GC/MS	MA DEP APH	Naphthalene
GC/MS	MA DEP APH	o-Xylene
GC/MS	MA DEP APH	Toluene



Notes:

- 1) This laboratory offers commercial testing service.



Approved by: \_\_\_\_\_

R. Douglas Leonard  
Chief Technical Officer

Date: March 13, 2013

Re-issued: 2/1/13

Revised: 3/13/13



**LABORATORY  
ACCREDITATION  
BUREAU**



# Certificate of Accreditation

ISO/IEC 17025:2005

Certificate Number L2336

**TestAmerica Laboratories, Inc.**

30 Community Drive, Suite 11  
South Burlington VT 05403

has met the requirements set forth in L-A-B's policies and procedures, all requirements of ISO/IEC 17025:2005 "General Requirements for the competence of Testing and Calibration Laboratories" and the U.S. Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP).\*

The accredited lab has demonstrated technical competence to a defined "Scope of Accreditation" and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009).

Accreditation valid through: October 26, 2013

**R. Douglas Leonard, Jr., President, COO  
Laboratory Accreditation Bureau  
Presented the 26<sup>th</sup> of October 2012**

\*See the laboratory's Scope of Accreditation for details of accredited parameters

\*\*Laboratory Accreditation Bureau is found to be in compliance with ISO/IEC 17011:2004 and recognized by ILAC (International Laboratory Accreditation Cooperation) and NACLA (National Cooperation for Laboratory Accreditation).

## Scope of Accreditation For TestAmerica Burlington

30 Community Drive, Suite 11  
South Burlington, VT 05403  
Kirstin Daigle  
802-660-1990

In recognition of a successful assessment to ISO/IEC 17025:2005 and the requirements of the DoD Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in the DoD Quality Systems Manual for Environmental Laboratories (DoD QSM v4.2) based on the National Environmental Laboratory Accreditation Conference Chapter 5 Quality Systems Standard (NELAC Voted Revision June 5, 2003), accreditation is granted to TestAmerica Burlington to perform the following tests:

Accreditation granted through: **October 26, 2013**

### Testing - Environmental

Non-Potable Water		
Technology	Method	Analyte
GC/FID	EPA RSK-175	Methane
GC/FID	EPA RSK-175	Ethane
GC/FID	EPA RSK-175	Ethene
GC/TCD	EPA RSK-175	Carbon Dioxide
HPLC	EPA 6850	Perchlorate
HPLC	EPA 8330B	1,3,5-Trinitrobenzene
HPLC	EPA 8330B	1,3-Dinitrobenzene
HPLC	EPA 8330B	2,4,6-Trinitrophenol
HPLC	EPA 8330B	2,4,6-Trinitrotoluene
HPLC	EPA 8330B	2,4-diamino-6-nitrotoluene
HPLC	EPA 8330B	2,4-Dinitrotoluene
HPLC	EPA 8330B	2,6-diamino-4-nitrotoluene
HPLC	EPA 8330B	2,6-Dinitrotoluene
HPLC	EPA 8330B	2-Amino-4,6-dinitrotoluene
HPLC	EPA 8330B	4-Amino-2,6-dinitrotoluene
HPLC	EPA 8330B	HMX
HPLC	EPA 8330B	m-Nitrotoluene
HPLC	EPA 8330B	Nitrobenzene
HPLC	EPA 8330B	Nitroglycerin
HPLC	EPA 8330B	o-Nitrotoluene
HPLC	EPA 8330B	PETN

<b>Non-Potable Water</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
HPLC	EPA 8330B	p-Nitrotoluene
HPLC	EPA 8330B	RDX
HPLC	EPA 8330B	Tetryl
GC/MS	EPA 8260B	1,1,1,2-Tetrachloroethane
GC/MS	EPA 8260B	1,1,1-Trichloroethane
GC/MS	EPA 8260B	1,1,2,2-Tetrachloroethane
GC/MS	EPA 8260B	1,1,2-Trichloroethane
GC/MS	EPA 8260B	1,1-Dichloroethane
GC/MS	EPA 8260B	1,1-Dichloroethene
GC/MS	EPA 8260B	1,1-Dichloropropene
GC/MS	EPA 8260B	1,2,3-Trichlorobenzene
GC/MS	EPA 8260B	1,2,3-Trichloropropane
GC/MS	EPA 8260B	1,2,4-Trichlorobenzene
GC/MS	EPA 8260B	1,2,4-Trimethylbenzene
GC/MS	EPA 8260B	1,2-Dibromo-3-Chloropropane
GC/MS	EPA 8260B	1,2-Dibromoethane
GC/MS	EPA 8260B	1,2-Dichlorobenzene
GC/MS	EPA 8260B	1,2-Dichloroethane
GC/MS	EPA 8260B	1,2-Dichloroethene, Total
GC/MS	EPA 8260B	1,2-Dichloropropane
GC/MS	EPA 8260B	1,3,5-Trimethylbenzene
GC/MS	EPA 8260B	1,3-Dichlorobenzene
GC/MS	EPA 8260B	1,3-Dichloropropane
GC/MS	EPA 8260B	1,4-Dichlorobenzene
GC/MS	EPA 8260B	1,4-Dioxane
GC/MS	EPA 8260B	2,2-Dichloropropane
GC/MS	EPA 8260B	2-Butanone
GC/MS	EPA 8260B	2-Chloroethyl vinyl ether
GC/MS	EPA 8260B	2-Chlorotoluene
GC/MS	EPA 8260B	2-Hexanone
GC/MS	EPA 8260B	4-Chlorotoluene
GC/MS	EPA 8260B	4-Isopropyltoluene
GC/MS	EPA 8260B	4-Methyl-2-pentanone
GC/MS	EPA 8260B	Acetone
GC/MS	EPA 8260B	Benzene
GC/MS	EPA 8260B	Bromochloromethane
GC/MS	EPA 8260B	Bromodichloromethane
GC/MS	EPA 8260B	Bromoform
GC/MS	EPA 8260B	Bromomethane
GC/MS	EPA 8260B	Carbon disulfide
GC/MS	EPA 8260B	Carbon tetrachloride



Non-Potable Water		
Technology	Method	Analyte
GC/MS	EPA 8260B	Chlorobenzene
GC/MS	EPA 8260B	Chloroethane
GC/MS	EPA 8260B	Chloroform
GC/MS	EPA 8260B	Chloromethane
GC/MS	EPA 8260B	cis-1,2-Dichloroethene
GC/MS	EPA 8260B	cis-1,3-Dichloropropene
GC/MS	EPA 8260B	Cyclohexane
GC/MS	EPA 8260B	Dibromochloromethane
GC/MS	EPA 8260B	Dibromomethane
GC/MS	EPA 8260B	Dichlorodifluoromethane
GC/MS	EPA 8260B	Ethylbenzene
GC/MS	EPA 8260B	Freon TF
GC/MS	EPA 8260B	Hexachlorobutadiene
GC/MS	EPA 8260B	Isobutyl alcohol
GC/MS	EPA 8260B	Isopropylbenzene
GC/MS	EPA 8260B	m&p-Xylene
GC/MS	EPA 8260B	Methyl acetate
GC/MS	EPA 8260B	Methyl iodide
GC/MS	EPA 8260B	Methyl t-butyl ether
GC/MS	EPA 8260B	Methylcyclohexane
GC/MS	EPA 8260B	Methylene Chloride
GC/MS	EPA 8260B	Naphthalene
GC/MS	EPA 8260B	n-Butylbenzene
GC/MS	EPA 8260B	n-Propylbenzene
GC/MS	EPA 8260B	o-Xylene
GC/MS	EPA 8260B	sec-Butylbenzene
GC/MS	EPA 8260B	Styrene
GC/MS	EPA 8260B	tert-Butylbenzene
GC/MS	EPA 8260B	Tetrachloroethene
GC/MS	EPA 8260B	Tetrahydrofuran
GC/MS	EPA 8260B	Toluene
GC/MS	EPA 8260B	trans-1,2-Dichloroethene
GC/MS	EPA 8260B	trans-1,3-Dichloropropene
GC/MS	EPA 8260B	Trichloroethene
GC/MS	EPA 8260B	Trichlorofluoromethane
GC/MS	EPA 8260B	Vinyl acetate
GC/MS	EPA 8260B	Vinyl chloride
GC/MS	EPA 8260B	Xylenes, Total
ICP-AES	EPA 6010C	Aluminum
ICP-AES	EPA 6010C	Antimony
ICP-AES	EPA 6010C	Boron



<b>Non-Potable Water</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
ICP-AES	EPA 6010C	Beryllium
ICP-AES	EPA 6010C	Cadmium
ICP-AES	EPA 6010C	Calcium
ICP-AES	EPA 6010C	Cobalt
ICP-AES	EPA 6010C	Copper
ICP-AES	EPA 6010C	Iron
ICP-AES	EPA 6010C	Lead
ICP-AES	EPA 6010C	Magnesium
ICP-AES	EPA 6010C	Manganese
ICP-AES	EPA 6010C	Nickel
ICP-AES	EPA 6010C	Molybdenum
ICP-AES	EPA 6010C	Potassium
ICP-AES	EPA 6010C	Selenium
ICP-AES	EPA 6010C	Silver
ICP-AES	EPA 6010C	Sodium
ICP-AES	EPA 6010C	Thallium
ICP-AES	EPA 6010C	Vanadium
ICP-AES	EPA 6010C	Zinc
Combustion	EPA 9060A	Total Organic Carbon
<b>Preparation</b>	<b>Method</b>	<b>Type</b>
Digestate	EPA 3010A	Acid Digestion
Solvent	EPA 5030B	Purge and Trap

<b>Solid and Chemical Materials</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
HPLC	EPA 6850	Perchlorate
HPLC	EPA 8330B	1,3,5-Trinitrobenzene
HPLC	EPA 8330B	1,3-Dinitrobenzene
HPLC	EPA 8330B	2,4,6-Trinitrophenol
HPLC	EPA 8330B	2,4,6-Trinitrotoluene
HPLC	EPA 8330B	2,4-diamino-6-nitrotoluene
HPLC	EPA 8330B	2,4-Dinitrotoluene
HPLC	EPA 8330B	2,6-diamino-4-nitrotoluene
HPLC	EPA 8330B	2,6-Dinitrotoluene
HPLC	EPA 8330B	2-Amino-4,6-dinitrotoluene
HPLC	EPA 8330B	4-Amino-2,6-dinitrotoluene
HPLC	EPA 8330B	HMX
HPLC	EPA 8330B	m-Nitrotoluene
HPLC	EPA 8330B	Nitrobenzene

<b>Solid and Chemical Materials</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
HPLC	EPA 8330B	Nitroglycerin
HPLC	EPA 8330B	o-Nitrotoluene
HPLC	EPA 8330B	PETN
HPLC	EPA 8330B	p-Nitrotoluene
HPLC	EPA 8330B	RDX
HPLC	EPA 8330B	Tetryl
GC/MS	EPA 8260B	1,1,1,2-Tetrachloroethane
GC/MS	EPA 8260B	1,1,1-Trichloroethane
GC/MS	EPA 8260B	1,1,2,2-Tetrachloroethane
GC/MS	EPA 8260B	1,1,2-Trichloroethane
GC/MS	EPA 8260B	1,1-Dichloroethane
GC/MS	EPA 8260B	1,1-Dichloroethene
GC/MS	EPA 8260B	1,1-Dichloropropene
GC/MS	EPA 8260B	1,2,3-Trichlorobenzene
GC/MS	EPA 8260B	1,2,3-Trichloropropane
GC/MS	EPA 8260B	1,2,4-Trichlorobenzene
GC/MS	EPA 8260B	1,2,4-Trimethylbenzene
GC/MS	EPA 8260B	1,2-Dibromo-3-Chloropropane
GC/MS	EPA 8260B	1,2-Dibromoethane
GC/MS	EPA 8260B	1,2-Dichlorobenzene
GC/MS	EPA 8260B	1,2-Dichloroethane
GC/MS	EPA 8260B	1,2-Dichloroethene, Total
GC/MS	EPA 8260B	1,2-Dichloropropane
GC/MS	EPA 8260B	1,3,5-Trimethylbenzene
GC/MS	EPA 8260B	1,3-Dichlorobenzene
GC/MS	EPA 8260B	1,3-Dichloropropane
GC/MS	EPA 8260B	1,4-Dichlorobenzene
GC/MS	EPA 8260B	1,4-Dioxane
GC/MS	EPA 8260B	2,2-Dichloropropane
GC/MS	EPA 8260B	2-Butanone
GC/MS	EPA 8260B	2-Chloroethyl vinyl ether
GC/MS	EPA 8260B	2-Chlorotoluene
GC/MS	EPA 8260B	2-Hexanone
GC/MS	EPA 8260B	4-Chlorotoluene
GC/MS	EPA 8260B	4-Isopropyltoluene
GC/MS	EPA 8260B	4-Methyl-2-pentanone
GC/MS	EPA 8260B	Acetone
GC/MS	EPA 8260B	Benzene
GC/MS	EPA 8260B	Bromochloromethane
GC/MS	EPA 8260B	Bromodichloromethane
GC/MS	EPA 8260B	Bromoform

<b>Solid and Chemical Materials</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC/MS	EPA 8260B	Bromomethane
GC/MS	EPA 8260B	Carbon disulfide
GC/MS	EPA 8260B	Carbon tetrachloride
GC/MS	EPA 8260B	Chlorobenzene
GC/MS	EPA 8260B	Chloroethane
GC/MS	EPA 8260B	Chloroform
GC/MS	EPA 8260B	Chloromethane
GC/MS	EPA 8260B	cis-1,2-Dichloroethene
GC/MS	EPA 8260B	cis-1,3-Dichloropropene
GC/MS	EPA 8260B	Cyclohexane
GC/MS	EPA 8260B	Dibromochloromethane
GC/MS	EPA 8260B	Dibromomethane
GC/MS	EPA 8260B	Dichlorodifluoromethane
GC/MS	EPA 8260B	Ethylbenzene
GC/MS	EPA 8260B	Freon TF
GC/MS	EPA 8260B	Hexachlorobutadiene
GC/MS	EPA 8260B	Isobutyl alcohol
GC/MS	EPA 8260B	Isopropylbenzene
GC/MS	EPA 8260B	m&p-Xylene
GC/MS	EPA 8260B	Methyl acetate
GC/MS	EPA 8260B	Methyl iodide
GC/MS	EPA 8260B	Methyl t-butyl ether
GC/MS	EPA 8260B	Methylcyclohexane
GC/MS	EPA 8260B	Methylene Chloride
GC/MS	EPA 8260B	Naphthalene
GC/MS	EPA 8260B	n-Butylbenzene
GC/MS	EPA 8260B	n-Propylbenzene
GC/MS	EPA 8260B	o-Xylene
GC/MS	EPA 8260B	sec-Butylbenzene
GC/MS	EPA 8260B	Styrene
GC/MS	EPA 8260B	tert-Butylbenzene
GC/MS	EPA 8260B	Tetrachloroethene
GC/MS	EPA 8260B	Tetrahydrofuran
GC/MS	EPA 8260B	Toluene
GC/MS	EPA 8260B	trans-1,2-Dichloroethene
GC/MS	EPA 8260B	trans-1,3-Dichloropropene
GC/MS	EPA 8260B	Trichloroethene
GC/MS	EPA 8260B	Trichlorofluoromethane
GC/MS	EPA 8260B	Vinyl acetate
GC/MS	EPA 8260B	Vinyl chloride
GC/MS	EPA 8260B	Xylenes, Total



<b>Solid and Chemical Materials</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
ICP-AES	EPA 6010C	Aluminum
ICP-AES	EPA 6010C	Antimony
ICP-AES	EPA 6010C	Boron
ICP-AES	EPA 6010C	Beryllium
ICP-AES	EPA 6010C	Cadmium
ICP-AES	EPA 6010C	Calcium
ICP-AES	EPA 6010C	Cobalt
ICP-AES	EPA 6010C	Copper
ICP-AES	EPA 6010C	Iron
ICP-AES	EPA 6010C	Lead
ICP-AES	EPA 6010C	Magnesium
ICP-AES	EPA 6010C	Manganese
ICP-AES	EPA 6010C	Nickel
ICP-AES	EPA 6010C	Molybdenum
ICP-AES	EPA 6010C	Potassium
ICP-AES	EPA 6010C	Selenium
ICP-AES	EPA 6010C	Silver
ICP-AES	EPA 6010C	Sodium
ICP-AES	EPA 6010C	Thallium
ICP-AES	EPA 6010C	Vanadium
ICP-AES	EPA 6010C	Zinc
<b>Preparation</b>	<b>Method</b>	<b>Type</b>
Digestate	EPA 3050B	Acid Digestion
Solvent	EPA 5035 /5035A	Purge and Trap

<b>Air and Emissions</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC/MS	TO15	1,1,1-Trichloroethane
GC/MS	TO15	1,1,2,2-Tetrachloroethane
GC/MS	TO15	1,1,2-Trichloroethane
GC/MS	TO15	1,1-Dichloroethane
GC/MS	TO15	1,1-Dichloroethene
GC/MS	TO15	1,2,4-Trichlorobenzene
GC/MS	TO15	1,2,4-Trimethylbenzene
GC/MS	TO15	1,2-Dibromoethane
GC/MS	TO15	1,2-Dichlorobenzene
GC/MS	TO15	1,2-Dichloroethane
GC/MS	TO15	1,2-Dichloroethene, Total
GC/MS	TO15	1,2-Dichlorotetrafluoroethane

<b>Air and Emissions</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC/MS	TO15	1,3,5-Trimethylbenzene
GC/MS	TO15	1,3-Butadiene
GC/MS	TO15	1,3-Dichlorobenzene
GC/MS	TO15	1,4-Dichlorobenzene
GC/MS	TO15	1,4-Dioxane
GC/MS	TO15	2,2,4-Trimethylpentane
GC/MS	TO15	2-Chlorotoluene
GC/MS	TO15	3-Chloropropene
GC/MS	TO15	4-Ethyltoluene
GC/MS	TO15	4-Isopropyltoluene
GC/MS	TO15	Acetone
GC/MS	TO15	Benzene
GC/MS	TO15	Benzyl chloride
GC/MS	TO15	Bromodichloromethane
GC/MS	TO15	Bromoethene(Vinyl Bromide)
GC/MS	TO15	Bromoform
GC/MS	TO15	Bromomethane
GC/MS	TO15	Carbon disulfide
GC/MS	TO15	Carbon tetrachloride
GC/MS	TO15	Chlorobenzene
GC/MS	TO15	Chloroethane
GC/MS	TO15	Chloroform
GC/MS	TO15	Chloromethane
GC/MS	TO15	cis-1,2-Dichloroethene
GC/MS	TO15	cis-1,3-Dichloropropene
GC/MS	TO15	Cumene
GC/MS	TO15	Cyclohexane
GC/MS	TO15	Dibromochloromethane
GC/MS	TO15	Dichlorodifluoromethane
GC/MS	TO15	Ethylbenzene
GC/MS	TO15	Freon 22
GC/MS	TO15	Freon TF
GC/MS	TO15	Hexachlorobutadiene
GC/MS	TO15	Isopropyl alcohol
GC/MS	TO15	m,p-Xylene
GC/MS	TO15	Methyl Butyl Ketone (2-Hexanone)
GC/MS	TO15	Methyl Ethyl Ketone
GC/MS	TO15	Methyl isobutyl ketone
GC/MS	TO15	Methyl methacrylate
GC/MS	TO15	Methyl tert-butyl ether
GC/MS	TO15	Methylene Chloride



Air and Emissions		
Technology	Method	Analyte
GC/MS	TO15	Naphthalene
GC/MS	TO15	n-Butane
GC/MS	TO15	n-Butylbenzene
GC/MS	TO15	n-Heptane
GC/MS	TO15	n-Hexane
GC/MS	TO15	n-Propylbenzene
GC/MS	TO15	o-Xylene-
GC/MS	TO15	sec-Butylbenzene
GC/MS	TO15	Styrene
GC/MS	TO15	tert-Butyl alcohol
GC/MS	TO15	tert-Butylbenzene
GC/MS	TO15	Tetrachloroethene
GC/MS	TO15	Tetrahydrofuran
GC/MS	TO15	Toluene
GC/MS	TO15	trans-1,2-Dichloroethene
GC/MS	TO15	trans-1,3-Dichloropropene
GC/MS	TO15	Trichloroethene
GC/MS	TO15	Trichlorofluoromethane
GC/MS	TO15	Vinyl chloride
GC/MS	TO15	Xylene, Total

Notes:

- 1) This laboratory offers commercial testing service.

Approved by:   
R. Douglas Leonard  
Chief Technical Officer

Date: October 29, 2012

## **Appendix C**

### **Laboratory Chain of Custody**



### Cooler Receipt and Preservation Form

Client / Project: \_\_\_\_\_ Service Request **K13**

Received: \_\_\_\_\_ Opened: \_\_\_\_\_ By: \_\_\_\_\_ Unloaded: \_\_\_\_\_ By: \_\_\_\_\_

- Samples were received via? *Mail Fed Ex UPS DHL PDX Courier Hand Delivered*
- Samples were received in: (circle) *Cooler Box Envelope Other \_\_\_\_\_ NA*
- Were custody seals on coolers? *NA Y N* If yes, how many and where? \_\_\_\_\_  
If present, were custody seals intact? *Y N* If present, were they signed and dated? *Y N*

Raw Cooler Temp	Corrected Cooler Temp	Raw Temp Blank	Corrected Temp Blank	Corr. Factor	Thermometer ID	Cooler/COC ID	Tracking Number	NA	Filed

- Packing material: *Inserts Baggies Bubble Wrap Gel Packs Wet Ice Dry Ice Sleeves \_\_\_\_\_*
- Were custody papers properly filled out (ink, signed, etc.)? *NA Y N*
- Did all bottles arrive in good condition (unbroken)? *Indicate in the table below.* *NA Y N*
- Were all sample labels complete (i.e analysis, preservation, etc.)? *NA Y N*
- Did all sample labels and tags agree with custody papers? *Indicate major discrepancies in the table on page 2.* *NA Y N*
- Were appropriate bottles/containers and volumes received for the tests indicated? *NA Y N*
- Were the pH-preserved bottles (*see SMO GEN SOP*) received at the appropriate pH? *Indicate in the table below* *NA Y N*
- Were VOA vials received without headspace? *Indicate in the table below.* *NA Y N*
- Was C12/Res negative? *NA Y N*

Sample ID on Bottle	Sample ID on COC	Identified by:

Sample ID	Bottle Count	Out of	Head-	Broke	pH	Reagent	Volume	Reagent Lot	Initials	Time
	Bottle Type	Temp	space				added	Number		

Notes, Discrepancies, & Resolutions: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_



## SAMPLE RECEIPT AND CONDITION DOCUMENTATION

STUDY NO: 00000

SDG No:

Project:

Delivered via:

Date and Time Received:

Date and Time Logged into Lab:

Received By:

Logged into Lab by:

Air bill / Way bill:

Air bill included in folder if received?

Cooler on ice/packs:

Custody Seals present?

Cooler Blank Temp (C) at arrival:

Custody Seals intact?

Number of COC Pages:

COC Serial Number(s):

COC Complete:

Does the info on the COC match the samples?

    Sampled Date:

Were samples received within holding time?

    Field ID complete:

Were all samples properly labeled?

    Sampled Time:

Were proper sample containers used?

    Analysis request:

Were samples received intact? (none broken or leaking)

COC Signed and dated:

Were sample volumes sufficient for requested analysis?

Were all samples received?

Were VOC vials free of headspace?

Client notification/authorization:

Field ID	Lab ID	Mx	Analysis Requested	Bottle	Req'd Pres'n	Verified Pres'n
Field ID	LabID	M	Analyses Requested	CTR	PRES	

Notes and qualifications:



**Katahdin Analytical Services, Inc.**

**Sample Receipt Condition Report**

Client:		KAS PM:	Sampled By:
Project:		KIMS Entry By:	Delivered By:
KAS Work Order#:		KIMS Review By:	Received By:
SDG #:	Cooler: _____ of _____	Date/Time Rec.:	

Receipt Criteria	Y	N	EX*	NA	Comments and/or Resolution
1. Custody seals present / intact?					
2. Chain of Custody present in cooler?					
3. Chain of Custody signed by client?					
4. Chain of Custody matches samples?					
5. Temperature Blanks present? If not, take temperature of any sample w/ IR gun.					Temp (°C):
Samples received at <6 °C w/o freezing?					Note: Not required for metals analysis.
Ice packs or ice present?					The lack of ice or ice packs (i.e. no attempt to begin cooling process) may not meet certain regulatory requirements and may invalidate certain data.
If temp. out, has the cooling process begun (i.e. ice or packs present) and sample collection times <6hrs., but samples are not yet cool?					Note: No cooling process required for metals analysis.
6. Volatiles free of headspace: <b>Aqueous:</b> No bubble larger than a pea <b>Soil/Sediment:</b> Received in airtight container? Received in methanol? Methanol covering soil?					
7. Trip Blank present in cooler?					
8. Proper sample containers and volume?					
9. Samples within hold time upon receipt?					
10. Aqueous samples properly preserved? Metals, COD, NH3, TKN, O/G, phenol, TPO4, N+N, TOC, DRO, TPH – pH <2 Sulfide - >9 Cyanide – pH >12					

\* Log-In Notes to Exceptions: document any problems with samples or discrepancies or pH adjustments



CHAIN OF CUSTODY RECORD

Client/Project Name:				Project Location:				Analysis Requested										<b>Container Type</b> P - Plastic A - Amber Glass G - Clear Glass V - VOA Vial O - Other E - Encore		<b>Preservation</b> 1 - HCl, 4° 2 - H2SO4, 4° 3 - HNO3, 4° 4 - NaOH, 4° 5 - NaOH/ZnAc, 4° 6 - Na2S2O3, 4° 7 - 4°	
Project Number:				Field Logbook No.:														# vials to be identified to species		<b>Matrix Codes:</b> DW - Drinking Water WW - Wastewater GW - Groundwater SW - Surface Water ST - Storm Water W - Water	
Sampler (Print Name)/(Affiliation):				Chain of Custody Tape Nos.:																	
Signature:				Send Report to:			TAT:			Lab I.D.      Remarks											
Site ID	Cove #	Sample Date	Sample Time		Sample Container (Size/Mat'l)	Matrix	Preserv.	Field Filtered													
Relinquished by: (Print Name)/(Affiliation)			Date:		Received by: (Print Name)/(Affiliation)			Date:		Analytical Laboratory (Destination):											
Signature:			Time:		Signature:			Time:													
Relinquished by: (Print Name)/(Affiliation)			Date:		Received by: (Print Name)/(Affiliation)			Date:													
Signature:			Time:		Signature:			Time:		Sample Shipped Via:					Temp blank						
Relinquished by: (Print Name)/(Affiliation)			Date:		Received by: (Print Name)/(Affiliation)			Date:							UPS   FedEx   Courier   Other		Yes   No				
Signature:			Time:		Signature:			Time:													







**Appendix D**

**Risk Assessment Work Plan Technical Memorandum**

**Risk Assessment Work Plan  
Technical Memorandum  
NAVSTA Newport, Rhode Island**

**FINAL**

**Prepared for:**



**Department of the Navy  
Naval Facilities Engineering Command, Mid-Atlantic  
9742 Maryland Ave.  
Norfolk, VA 23511-3095**

**Contract Number N62470-11-D-8013**

**CTO WE06**

**Prepared by:**



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**October 11, 2013**

## CONTENTS

1.0	Introduction.....	2
2.0	Data Selection and Evaluation.....	3
3.0	Human Health Risk Assessment.....	7
4.0	Ecological Risk Assessment.....	19
5.0	References.....	31

## **1.0 Introduction**

This technical memorandum describes the methods that will be used by the Naval Facilities Engineering Command (NAVFAC) for site-specific human health risk assessments (HHRAs) and ecological risk assessments (ERAs) at the Naval Station (NAVSTA), Newport, Rhode Island. This document is intended to supplement site-specific Sampling and Analysis Plans (SAPs) and Work Plans prepared for specific NAVSTA Newport sites. This document presents the general framework for conducting risk assessments at NAVSTA Newport, while site-specific SAPs and Work Plans provide more site-specific details when risk assessments are to be performed. The Navy's HHRA and ERA approach at NAVSTA Newport is to implement the Navy's policies for conducting risk assessments (refer to Section 5.0 for specific references), while considering guidance and agreements specific to NAVSTA Newport. At NAVSTA Newport, the Navy's risk assessment policies will be supplemented with consideration of specific dispute resolutions achieved under the Federal Facility Agreement (FFA), guidance issued by the United States Environmental Protection Agency (USEPA), and guidance provided by the Rhode Island Department of Environmental Management (RIDEM).

This technical memorandum is intended to be a "living" document that will be updated as new guidance, reference values, matrices, exposure scenarios, or exposure pathways are identified that warrant an update. In cases where more current reference sources and/or values are available at the time of HHRA or ERA calculations, the more current sources and values will be applied.

### **1.1 Site Description/Conceptual Site Model (CSM)**

The complete CSM for specific sites is typically presented in the SAP or Work Plan. CSM figures for specific sites are also presented in the SAP or Work Plan. These CSMs are expected to include the following site-specific information to identify site-specific receptors, exposure scenarios, and applicable exposure pathways:

- Site description;
- Current and anticipated or likely future use of the site;
- Habitat and ecology;
- Topography and geology;
- Hydrology and hydrogeology;
- Nature and extent of site-related constituents;
- Identification and discussion of potential human and ecological receptors;
- Identification and discussion of potentially complete exposure pathways; and
- Identification of site-specific exposure areas.

## **2.0 Data Selection and Evaluation**

Analytical data for site media determined to be appropriate for evaluation in the site-specific SAP will be evaluated in the HHRAs or ERAs, as discussed in Sections 3 and 4, as applicable in accordance with the site-specific CSM. Available data will be reviewed and grouped into exposure areas for evaluation in the risk assessments. These areas are shown on Figures presented in the SAP (Worksheet #10) or Work Plan.

It is anticipated that NAVSTA Newport sites, in general, will require the evaluation of soil and groundwater data. Therefore, this technical memorandum discusses the evaluation of likely soil and groundwater exposures. It is anticipated that the evaluation of sediment data may also be applicable for ecological receptors at certain NAVSTA Newport sites. However, exposure to sediment or fish/shellfish by human receptors is not considered to be a common occurrence. Therefore, evaluation of sediment and fish/shellfish exposure by human receptors are not included in this technical memorandum. If the sediment contact or fish/shellfish ingestion pathways are relevant for evaluation of human exposure in the HHRA for a specific site, they will be added into the site-specific SAP as appropriate.

The evaluation of surface water data is not included in this technical memorandum for human health or ecological receptor evaluation because contact with surface water is not considered to be a complete exposure pathway for the majority of NAVSTA Newport sites. Exposure to surface water in Narragansett Bay is not considered to be a significant pathway of exposure to site-related chemicals for site receptors due to the tidal influence. If the surface water contact pathway is relevant for a specific site, it will be added into the site-specific SAP as appropriate. If complete exposure pathways associated with media discussed in this technical memorandum are not applicable for a specific site, this will also be discussed in the site-specific SAP.

Soil samples will be divided into two different depth intervals of 0 to 1 feet below ground surface (ft bgs) (i.e., surface soil) and 1 to 12 ft bgs, or the depth to the saturated zone/groundwater (USEPA, 1995), whichever is shallower (i.e., subsurface soil). In general, receptors at the former base are not assumed to be exposed to soil at depths deeper than 12 ft bgs.

Sediment data evaluated in the ecological risk assessment will be collected from the top 6 inches.

Indoor air, soil vapor, and/or groundwater data will be collected and evaluated on a site-specific basis to assess the potential vapor intrusion pathway.

## **2.1 Summary Statistics**

For each exposure area and medium, the data will be compiled into summary statistics as discussed below for evaluation in the HHRA and ERA. For each chemical detected at least once within an

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area/media, the summary statistics will include the minimum and maximum detected concentrations, location of maximum detected concentration, detection frequency, and the range of detection limits. The following guidance documents will be used to develop the summary statistics:

- Navy Human Health Risk Assessment Guidance (DON, 2008);
- Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual, Parts A and D (USEPA, 1989 and 2001a).

Treatment of Duplicates: For sample locations in which a duplicate sample was also collected, the duplicate sample results for each chemical/medium/area combination will be processed for use in the calculation of summary statistics. Duplicates will be resolved as follows: 1) where both the sample and the duplicate are not detected, the resulting values will be the higher of the limit of detection (LOD); 2) where both the sample and the duplicate are detected, the resulting values will be the higher of the detected results; and 3) where one of the pair is reported as not detected and the other is detected, the detected concentration will be used.

Detection Frequency: The detection frequency will be reported as the number of detected samples out of the total number of samples analyzed for a specific chemical, after resolution of duplicates as described above. The number of samples that will be used to calculate the detection frequency reflects the treatment of non-detects described above.

Minimum Detected Concentration: This is the minimum detected concentration for each chemical/medium/depth interval/area combination, after resolution of duplicates as described above.

Maximum Detected Concentration: This is the maximum detected concentration for each chemical/medium/depth interval/area combination, after resolution of duplicates as described above.

Location of Maximum Detected Concentration: This is the sample location associated with the maximum detected concentration, as defined above, for each chemical/medium/depth interval/area combination.

In addition to individual chemicals, summary statistics will be calculated for several groups of chemicals including polycyclic aromatic hydrocarbons (PAHs), low molecular weight (LMW) PAHs, high molecular weight (HMW) PAHs, polychlorinated biphenyls (PCBs) Aroclors, polychlorinated dibenzo-p-dioxins/polychlorinated dibenzofurans (PCDDs/PCDFs) (i.e., dioxin and furans), and xylenes (i.e., o-, m-, and p-xylenes). Totals will be calculated for these groups of chemicals as follows:

- For samples with at least one detect, only the detected results will be summed to calculate the total concentration;
- Where a sample does not have any detections of individual chemicals, then the total concentration will be considered a non-detect with an LOD equal to the maximum LOD of the individual chemicals.

## 2.2 Background Evaluation

A background dataset of metals in soil was generated in 2007 to define typical metals conditions in soil at NAVSTA Newport (Tetra Tech, 2007). There are also background data available from NAVSTA Newport that was collected during other site-specific investigations. Additional background samples may be collected for site media (e.g., reference sediment locations or upgradient groundwater) to better distinguish background conditions from site-specific impacts. As part of the risk assessment and data evaluation process, all relevant available background data will be compiled and compared with site-specific data to distinguish site-related impacts from non-site-related background conditions (naturally occurring or anthropogenic). A statistical background comparison will be conducted for consideration in the HHRA and ERA using the following guidance:

- USEPA Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Sites (USEPA, 2002b);
- Navy Policy on the Use of Background Chemical Levels (DON, 2004);
- Navy Guidance for Environmental Background Analysis, Volume I: Soil, Volume II: Sediment, Volume III: Groundwater, and Volume IV: Vapor Intrusion Pathway (NAVFAC, 2002, 2003, 2004, and 2011).

The data compiled in the Basewide Background Study Report (Tetra Tech, 2007) will be used in the upland (soil) evaluation. The Basewide Background Study Report evaluated soil from six different soil types at the base and determined that these soil types represent very different concentrations of background inorganic constituents. The Basewide Background Study Report recommends that the data may be used one of two ways to evaluate consistency of site data with basewide background data: comparison using statistical tests to evaluate consistency between means or an upper prediction limit (UPL) using geochemical statistics on all soil types are included in the calculations. The choice to use comparative or geochemical statistics will depend on the data collected from the sites. It is preferable to use comparative statistics, but geochemical statistics may be used to augment the evaluation, or if the site data are not conducive to comparative statistics.

Data collected from the Site will be evaluated to determine:

- which constituents require comparison to background (i.e., exceedence of risk-based values);
- whether the constituents that require comparison to background are naturally occurring or have anthropogenic constituent sources;
- if the samples collected from each Site are from the same soil or sediment type. If so, for soil, if that soil type matches one from the Background Report;
- distribution of the data (i.e., are the data normally distributed).

Analyses conducted will be consistent with USEPA (2002b), NAVFAC (2002) and USEPA (2010).

The results of the background evaluation will be used in the HHRA and ERA as discussed in Sections 3.0 and 4.0, respectively.

### 3.0 Human Health Risk Assessment

The primary objective of the baseline HHRA for the site is to evaluate whether exposure to chemicals of potential concern (COPCs) attributable to past operations, as well as waste generated and disposed of at the site, has impacted the environment at concentrations that may pose risk to human health above USEPA target levels. The HHRA will be conducted in accordance with Navy Human Health Risk Assessment Guidance (2008) and will also be consistent with Risk Assessment Guidance for Superfund (RAGS) (USEPA, 1989) and other related guidance. Additional guidance documentation includes, but is not limited to, the following:

- Navy Policy for Conducting Human Health Risk Assessments Under the Environmental Restoration Program (DON, 2001);
- Department of the Navy Environmental Restoration Program (NERP) Manual (DON, 2006);
- Navy Human Health Risk Assessment Guidance (DON, 2008);
- Navy Policy on the Use of Background Chemical Levels (DON, 2004);
- Risk Assessment Guidance for Superfund (RAGS), Volume 1, Human Health Evaluation Manual (Parts A, B, D, E, and F) (USEPA 1989, 1991a, 2001a, 2004a, 2009a);
- Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors, Memorandum (USEPA, 1991b);
- Exposure Factors Handbook (EFH) (USEPA, 1997a) [An update to the EFH was published by USEPA in 2011. However, EPA Region 1 has not implemented the use the 2011 EFH document until direction from EPA Headquarters is provided. Therefore, the 2011 EFH document is not currently proposed for use in the HHRA];
- Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (USEPA, 2002c);
- Human Health Toxicity Values in Superfund Risk Assessments (USEPA, 2003a);
- Department of Defense (DoD) Vapor Intrusion Handbook (DoD, 2009).

References cited in this technical memorandum are based on the most current versions of sources available as of the date of this memorandum. However, in the case that updates to references become available, the most current version of the references available at the time the HHRA is initiated will be used and appropriately referenced in the HHRA.

### **3.1 HHRA Process**

Pursuant to Navy Policy 5090 Ser N453E/1U5951 (DON, 2001), the determination of human health risk at a site is clearly prescribed to ensure sufficient resources are allocated for the protection of human health. The Navy Policy for conducting HHRAs identifies a three-tiered approach that may be implemented in its entirety depending upon the level and magnitude of incremental risk or hazard that is determined in prior tiers. The tiers of evaluation that will be followed to conduct the HHRA are as follows.

#### **Tier IA – Human Health Risk-Based Screening Evaluation**

The Tier IA will include the following:

- Identification and summarization of relevant datasets.
- Development of a CSM. The CSM will identify potentially complete exposure pathways for both current and future land uses.
- Identification of COPCs for further quantitative evaluation in the site-specific risk assessment (Tier II).

The Tier IB, Site-Specific Risk-Based Screening Evaluation is an optional tier which allows for development of and comparison to site-specific risk-based screening levels. This tier of evaluation will typically not be conducted for the HHRA, unless specifically indicated in the site-specific SAP.

#### **Tier II - Baseline Human Health Risk Assessment**

The Tier II will include the following:

- Data Evaluation and Reduction. Conducted in Tier IA.
- Exposure Assessment. Includes reevaluation of the CSM, if appropriate and necessary, and identification of potential receptors, pathways, and intake factors for both current and future land uses.
- Toxicity Assessment. Includes the hazard identification and dose-response assessment processes in which it is determined whether exposure to a chemical can cause an adverse health effect in humans; and where toxicity values and chemical-specific values for carcinogenic and non-carcinogenic COPCs are identified.
- Risk Characterization. Integrates the toxicity and exposure assessments to estimate risk associated with COPCs at the site and identifies risk-based chemicals of concern (COCs) above target risk/hazard levels.

- Uncertainty Analysis. Discusses the uncertainty associated with all aspects of the HHRA or limitations that may have a significant impact on the outcome of the HHRA due to an under- or over-estimation of risk.

### **Tier III – Risk Evaluation of Remedial Alternatives**

A Tier III Risk Evaluation of Remedial Alternatives (RERA) is initiated when the results of the Tier I or Tier II assessment identify site-related risk-based COCs for the site. The Tier III will include the following:

- An evaluation of the potential human health risks associated with remedial alternatives.
- The development of site-specific risk-based cleanup levels (RBCLs) as necessary.

The site-specific details related to conducting each of the HHRA Tiers are discussed in further detail in the following sections.

### **3.2 Tier IA - Human Health Risk-Based Screening Evaluation**

As discussed in Section 2.0, the HHRA will evaluate soil, groundwater, indoor air, and/or sub-slab/exterior soil vapor as appropriate based on the site-specific CSM, within each of the exposure areas. The CSM for specific sites is typically discussed in the SAP (Worksheet#10) or Work Plan. The COPC selection process will be based on screening on the basis of toxicity and a comparison to background as discussed below:

#### **3.2.1 Toxicity**

Screening on the basis of toxicity will be done by comparing the maximum detected site concentrations per exposure area against appropriate risk-based screening levels. The risk-based screening levels that will be used to select COPCs are discussed by media below. Essential nutrients (calcium, magnesium, potassium, and sodium) will not be retained as COPCs.

#### **Soil**

For each soil dataset, the maximum detected concentration of each chemical will be compared to the most current version of the USEPA Regional Screening Levels (RSLs; USEPA, 2012a) for residential and industrial soil. The RSLs are based on a target excess lifetime cancer risk (ELCR) of  $1 \times 10^{-6}$  and hazard quotient (HQ) of 1. RSLs for non-carcinogenic chemicals will be divided by ten to account for potential cumulative effects on the same target organ. Chemicals detected above these screening levels will be identified as COPCs for further evaluation in the Tier II HHRA.

Residential screening levels will be used to select COPCs for the residential and trespasser receptors. Industrial screening levels will be used to select COPCs for the worker receptors.

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Groundwater data will be evaluated directly in the HHRA to evaluate groundwater quality. Therefore, the USEPA SSLs will not be used to select COPCs for evaluation in the HHRA.

#### Groundwater

For each groundwater dataset, the maximum detected concentration of each chemical will be compared to the following screening levels:

- USEPA Maximum Contaminant Levels (MCLs) (USEPA, 2012b);
- USEPA Tap Water RSLs (USEPA, 2012a); RSLs for non-carcinogenic chemicals will be divided by ten to account for cumulative effects on the same target organ.

The lower of the USEPA MCLs and USEPA Tap Water RSLs will be used to select COPCs for further evaluation of the incidental ingestion, dermal contact, and inhalation via contact during excavation.

If groundwater data is determined to be appropriate for evaluation of the vapor intrusion pathway, maximum detected groundwater concentrations will also be compared to the USEPA Target Groundwater Concentrations (USEPA, 2012d) to select COPCs for further evaluation of the volatilization to indoor air (i.e., vapor intrusion) pathway.

#### Indoor Air

The maximum detected indoor air concentration measured within each building/exposure area, or as applicable for a site, will be compared to the USEPA Target Indoor Air Concentrations (USEPA, 2012d) to select COPCs for further evaluation of the vapor intrusion pathway. RSLs for non-carcinogenic chemicals will be divided by ten to account for cumulative effects on the same target organ.

#### Subslab Vapor/Exterior Soil Vapor

The maximum detected subslab vapor or exterior soil vapor concentration measured within each exposure area will be compared to the USEPA Target Subslab and Exterior Soil Gas Concentrations (USEPA, 2012d) to select COPCs for further evaluation of the vapor intrusion pathway. RSLs for non-carcinogenic chemicals will be divided by ten to account for cumulative effects on the same target organ.

### **3.2.2 Background**

COPCs identified based on the comparison to risk-based screening levels (discussed in Section 3.2.1) that are also determined to be consistent with background, based on the results of the background evaluation performed in accordance with the methods presented in Section 2.2, will be

identified as non-site-related COPCs and further evaluated in the Tier II HHRA separately from site-related COPCs, as described in Section 3.3.3.

### **3.3 Tier II – Baseline Human Health Risk Assessment**

COPCs selected in the Tier IA Risk-Based Screening Evaluation will be further evaluated in the Tier II baseline HHRA. The Tier II baseline HHRA includes four components as described in Section 3.1: the Exposure Assessment, Toxicity Assessment, Risk Characterization, and Uncertainty Analysis.

#### **3.3.1 Exposure Assessment**

##### ***IDENTIFICATION OF POTENTIAL EXPOSURE SCENARIOS***

The receptors and exposure pathways that will be evaluated in the HHRA based on current and potential future land use are based on the site-specific CSM discussed in the SAP (Worksheet#10) or Work Plan. For future land-use scenarios, it is assumed that there would be some level of construction to convert the area to the desired use. Therefore, it is assumed that current subsurface soils may be brought to the surface and become available for exposure by future receptors. The typical receptors that are likely to be evaluated at NAVSTA Newport sites are listed below. **Tables 1 through 4** provide the quantitative exposure assumptions associated with the evaluation of the receptors listed below.

##### Current/Future Construction/Utility Worker

- Exposure to combined surface and subsurface soil from ground surface to maximum likely depth of excavation (0-12 ft, or to depth at which groundwater is encountered) through incidental ingestion, dermal contact and inhalation of airborne particles (i.e., fugitive dust) in outdoor air; and
- Exposure to groundwater in an excavation trench through incidental ingestion, dermal contact, and inhalation of excavation air. Inhalation of excavation trench air will only be evaluated where volatiles in groundwater are identified as COPCs.

##### Future On-Site Worker

- Exposure to combined surface and subsurface soil (0-12 ft, or depth at which groundwater is encountered) through incidental ingestion, dermal contact and inhalation of airborne particles (i.e., fugitive dust) in outdoor air;
- Exposure to indoor air via volatilization from the subsurface (i.e., vapor intrusion); and
- Exposure to groundwater through ingestion of drinking water.

### Current Trespassing Teenager

- Exposure to surface soil (0-1 ft) through incidental ingestion, dermal contact and inhalation of airborne particles (i.e., fugitive dust) in outdoor air.

### Future Trespassing Teenager

- Exposure to combined surface and subsurface soil (0-12 ft, or depth at which groundwater is encountered) through incidental ingestion, dermal contact and inhalation of airborne particles (i.e., fugitive dust) in outdoor air.

### Hypothetical Future On-Site Resident

- Exposure to combined surface and subsurface soil (0-12 ft, or depth at which groundwater is encountered) through incidental ingestion, dermal contact and inhalation of airborne particles (i.e., fugitive dust) in outdoor air;
- Exposure to groundwater through ingestion of drinking water and dermal contact and inhalation during bathing; and
- Exposure to indoor air via volatilization from the subsurface (i.e., vapor intrusion).

Any of these receptors and/or exposure pathways that are not relevant for a particular site will not be included in the site-specific HHRA. Any additional site-specific receptors and/or exposure pathways described in a SAP or Work Plan will be included in the site-specific HHRA. Site-specific adjustments to receptors and/or exposure assumptions will be modified as necessary based on the site-specific CSM presented in the SAP or Work Plan.

### ***CALCULATION OF EXPOSURE POINT CONCENTRATIONS***

Exposure point concentrations (EPCs) for evaluation of the reasonable maximum exposure (RME) and central tendency exposure (CTE) scenarios for each dataset will be calculated as described below.

Soil EPCs and groundwater EPCs for evaluation of the construction/utility worker exposure pathways will be equal to the 95% upper confidence limit (95% UCL) on the arithmetic mean concentration or the maximum concentration, whichever is lower (USEPA, 2002a). Consideration will be given to ensure that the presence of potential hot spots is not overlooked when calculating EPCs. If a hot spot is determined to exist, the hot spot area will be evaluated using an EPC calculated separately from the rest of the exposure area (for the RME scenario). However, if the data evaluation concludes that there are no hot spots present, the EPC calculated based on the entire exposure area is considered appropriate. USEPA's ProUCL Version 4.1.01 software (USEPA, 2011) will be used to calculate the 95% UCL. Based on information presented in the ProUCL

guidance (USEPA, 2010) regarding minimum sample size and frequency of detection, UCLs will be calculated where at least 10 samples and at least 6 detects are available. ProUCL version 4.1.01 recommends 10 to 15 or more distinct results for the most accurate and reliable UCL calculation. When the minimum sample size and number of detects are not met for a dataset the maximum detected concentration will be used as the EPC.

Groundwater EPCs for evaluation of the on-site worker and hypothetical future on-site residential exposure pathways will be calculated on a well-by-well basis. Results from multiple sampling events may be averaged within a well to account for potential variations in concentration over time.

EPCs for COPCs in fugitive dust (outdoor air) will be predicted by combining soil EPCs with a particulate emission factor (PEF) calculated in accordance with USEPA guidance (2002c).

For sites with volatiles in shallow groundwater, excavation trench air concentrations of COPCs resulting from volatilization from groundwater infiltrating an excavation trench will be modeled by the use of the method recommended by USEPA (USEPA, 1994) for predicting volatilization from standing water. The attenuation factors are then multiplied by groundwater concentrations to predict the concentrations of VOCs in outdoor air of an excavation trench. The excavation air concentrations will be used to evaluate the construction worker receptor.

For evaluation of the bathing/showering pathway, concentrations of volatiles in the shower will be calculated using a model developed by Andelman as modified by Schaum (Schaum et al., 1994).

Indoor air EPCs for use in evaluation of the vapor intrusion pathway will be equal to the maximum detected indoor air concentration measured within an existing building (if it is determined to be appropriate to measure indoor air directly based on the site-specific CSM) or will be predicted based on measured subsurface concentrations including subslab vapor, exterior soil vapor, and/or groundwater. The specific approach for evaluation of the vapor intrusion pathway will be selected based on the site-specific CSM. Where subslab vapor samples are determined to be the most appropriate for evaluation of the vapor intrusion pathway, indoor air EPCs will be predicted by multiplying the maximum detected subslab vapor concentration by an attenuation factor. The appropriate attenuation factor will be selected using USEPA's Vapor Intrusion Database (USEPA, 2012e), unless use of an alternate attenuation factor is discussed in the site-specific SAP.

For sites where the use of groundwater data or soil vapor data collected external to a building is determined to be most appropriate for evaluation of the vapor intrusion pathway, indoor air EPCs will be predicted based on the maximum detected concentration of COPCs in shallow groundwater or soil vapor using the USEPA Johnson and Ettinger (JE) Model Spreadsheets and User's Guide (USEPA, 2004b and c). Project-specific information will be used in the model where available.

EPCs for evaluation of lead will be equal to the arithmetic mean concentration in accordance with USEPA guidance (USEPA, 2003b and 2007a).

### 3.3.2 Toxicity Assessment

The USEPA’s guidance regarding the hierarchy of sources of human health dose-response values in risk assessment will be followed (USEPA, 2003a, USEPA, 2012c). Sources of the published dose-response values in this risk assessment include:

- Tier 1: USEPA’s Integrated Risk Information System (IRIS) (USEPA, 2012c);
- Tier 2: Provisional Peer-Reviewed Toxicity Values (PPRTVs) obtained from USEPA via the USEPA National Center for Environmental Assessment (NCEA) in Cincinnati, Ohio;
- Tier 3: Other sources of dose-response values including, but are not limited to California EPA’s Office of Environmental Health and Hazard Assessment (OEHHA) Toxicity Criteria Database (CalEPA, 2012), Minimal Risk Levels (MRLs) published by the Agency for Toxic Substances and Disease Registry (ATSDR, 2012), and the Health Effects Assessment Summary Tables (HEAST) (USEPA, 1997b);
- Where published dose-response values are not available for a chemical, dose-response values will be selected based on surrogate chemicals (i.e., chemicals with structural similarities) will be identified. The chosen surrogate will be referenced in the summary table of dose-response values. Common, but certainly not all, surrogates are listed in the following table.

Surrogate Chemical	Target Chemical
acenaphthene	Acenaphthylene
alpha-BHC	delta-BHC
chlordane	alpha- or gamma-chlordane
1,3-dichloropropene	cis- or trans-1,3-dichloropropene
endrin	endrin aldehyde, endrin ketone
endosulfan	endosulfan I, endosulfan II, endosulfan aldehyde
pyrene	benzo(g,h,i)perylene, phenanthrene
1,2,4-trichlorobenzene	1,2,3-trichlorobenzene

#### Evaluation of Mutagenic Mode of Action

USEPA guidance for early life exposure to carcinogens (USEPA, 2005a) requires that risks from chemicals that act by a mutagenic mode of action be calculated differently than chemicals that do not act via a mutagenic mode of action. Therefore, the age-dependent adjustment factors (ADAFs)

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will be applied to all COPCs that have been identified by USEPA to act via a mutagenic mode of action unless otherwise specified in accordance with the guidance, as follows:

- Age 0 to 2 years (2 year interval from birth until 2<sup>nd</sup> birthday) – ADAF = 10
- Ages 2 to 16 years (14 year interval from 2<sup>nd</sup> birthday to 16<sup>th</sup> birthday) – ADAF = 3
- Ages 16 and up (after 16<sup>th</sup> birthday) – no adjustment - ADAF = 1

Four age groups will be evaluated for a residential exposure scenario, consistent with the USEPA's guidance for early life exposure to carcinogens (USEPA, 2005a) and the ADAFs presented above. The age groups include (0 to <2 years; 2 to <6 years; 6 to <16 years; and 16 to <30 years). The USEPA recommended age-range of 2 to 16 years will be divided into two age groups (i.e., 2 to <6 years and 6 to <16 years) for the exposure assessment, to account for differences in exposure inputs over the 14 year period.

#### Chemical-Specific Information

- Chromium – Chromium is most commonly present in the environment in the trivalent state because typical conditions in the environment favor the reduction of chromium from the hexavalent to the trivalent state. A subset of samples per media may be analyzed for hexavalent chromium, in addition to total chromium, to provide information on whether the hexavalent form of chromium is present in Site media. The hexavalent chromium data will be evaluated in HHRA, and will also be used to determine whether total chromium results will be evaluated as hexavalent or trivalent chromium in the HHRA. In the absence of speciated chromium data, chromium will be conservatively evaluated as hexavalent chromium in the HHRA, as requested by USEPA.
- Lead - If lead is identified as a COPC in soil, the following models will be used to further evaluate lead in the HHRA:
  - USEPA's Integrated Exposure Uptake Biokinetic (IEUBK) Model (USEPA, 2007a and 2009c) will be used to assess exposure to lead in soil for the residential child exposure scenario. As children are more sensitive to the effects of lead than adults, the screening level will also be protective of the residential adult exposure scenario.
  - USEPA's Adult Lead Model (USEPA, 2003b, 2005b) will be used to assess exposure to lead in soil for non-resident adult exposures.
  - For evaluation of a trespassing teenager scenario, USEPA's model for evaluating Intermittent or Variable Exposures at Lead Sites (USEPA, 2003d) Equation 8 will be used to derive a screening level for lead protective of a trespassing teenager's exposure. The use of this equation is appropriate for situations in which the

receptor is exposed to a background level of lead at home and a different concentration of lead at a site. The equation allows for the modification of the default residential lead screening level of 400 mg/kg by using a weighted exposure time and frequency to account for the varying exposures. If the lead EPC exceeds the associated screening level, lead will be considered a COC for the trespassing teenager exposure scenario.

The determination of whether there is unacceptable risk associated with lead in soil will be based on the results of the modeling. USEPA's target blood lead level of 10 microgram per deciliter (ug/dl) will be used in the lead models (USEPA, 1998b). A sensitivity analysis will be conducted using a target blood lead level of 5 ug/dl based on the Center of Disease Control and Prevention (CDC) Advisory Committee on Childhood Lead Poisoning Prevention (ACCLPP) report (USEPA, 2012f) which recommends that a blood lead level of 5 ug/dl be used to identify children with elevated blood lead levels. The USEPA has not adopted this blood lead level and continues to use a target level of 10 ug/dl.

- PAHs – PAHs will be evaluated individually in the HHRA (acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene, fluoranthene, fluorene, naphthalene, phenanthrene, and pyrene) and in accordance with USEPA guidance (1993a).
- PCBs – PCB Aroclors will be evaluated individually in the HHRA.
- Dioxins/Furans – Dioxin/furan concentrations will be evaluated in the HHRA as a 2,3,7,8-tetrachloro-dibenzo-p-dioxin toxic equivalent (2,3,7,8-TCDD-TEQ). 2,3,7,8-TCDD-TEQ is a toxicity-weighted total based on the sum of each constituent concentration multiplied by its corresponding toxic equivalency factor (TEF). The toxicity weighted total will be based on the sum of the detected constituent parameters multiplied by their respective TEFs (non-detect parameters will be treated as zeros). If none of the constituent parameters within the toxicity-weighted total are detected, the total will be flagged as non-detected (U-qualified) and the TEQ value will be the highest toxicity-weighted LOD. Mammalian TEFs recommended by the World Health Organization (WHO) (Van den Berg et al., 2006) and USEPA (2010) will be used to calculate 2,3,7,8-TCDD-TEQ.
- Xylenes (i.e., o-, m-, and p-xylenes) will be evaluated as Total Xylenes in the HHRA.

### 3.3.3 Risk Characterization

The Tier II BHHRA will include the evaluation of both the RME and CTE scenarios. The cumulative cancer risk and total hazard index (HI) for each media/area/receptor combination will be calculated separately for both site-related and non-site-related COPCs (i.e., COPCs determined to be

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consistent with background) in addition to the cumulative cancer risk and total HI based on both site-related and non-site-related COPCs. The cumulative site-related cancer risk estimates will be compared to the USEPA's target risk range of  $1 \times 10^{-4}$  to  $1 \times 10^{-6}$ . The total site-related HIs will be compared to the USEPA target HI of 1. If the total site-related HI is greater than 1, a more detailed evaluation of potential non-carcinogenic effects based on specific health or target endpoints (e.g., liver effects, neurotoxicity) will be performed (USEPA, 1989). The target HI is 1 on a per target endpoint basis. Site-related COPCs that cause the cumulative potential ELCR and/or HI to be above target levels will be identified as 'risk-based chemicals of concern (COC)' for further evaluation in the FS using the Tier III HHRA protocols. Non-site related COPCs that cause the cumulative potential ELCR and/or HI to be above target levels will be discussed in the uncertainty section.

### **3.3.4 Uncertainty Analysis**

Within any of the steps of the HHRA process, assumptions must be made due to a lack of absolute scientific knowledge. Some of the assumptions are supported by considerable scientific evidence, while others have less support. Every assumption introduces some degree of uncertainty into the risk assessment process. Regulatory risk assessment methodology requires that conservative assumptions be made throughout the risk assessment to ensure that public health is protected. Therefore, when all of the assumptions are combined, it is much more likely that risks are overestimated rather than underestimated.

The assumptions that introduce the greatest amount of uncertainty in the HHRA, both site-specific and those inherent to the HHRA process, will be discussed in the Uncertainty Analysis of the HHRA. Examples of site-specific uncertainties are those associated with sampling/analysis methods, the COPC selection process, estimation of EPCs, representativeness of the exposure scenarios and input parameters, the availability of toxicity values, etc. Examples of uncertainties inherent to the HHRA process are the extrapolation of toxicity from animal studies to humans, from high to low doses, and the specific models used to develop dose-response values; the combination of upper-bound exposure estimates with upper-bound toxicity estimates, etc.

The majority of the uncertainties associated with the HHRA will be discussed in qualitative terms, because for most of the assumptions there is not enough information to assign a numerical value to the uncertainty that can be factored into the calculation of risk.

### **3.4 Tier III - Risk Evaluation of Remedial Alternatives**

The Tier III risk evaluation of remedial alternatives (RERA) will be performed as part of the FS only if the Tier II Baseline HHRA identifies site-related risk-based COCs (i.e., site-related chemicals that cause the cumulative potential site-related ELCR and/or HI to be above target levels). The Tier III RERA will include an evaluation of the potential human health risks associated with remedial alternatives and the development of site-specific RBCLs for site-related risk-based COCs identified.

The Tier III RERA will heavily reference the contents of the FS with a supplemental risk evaluation. RBCLs will be developed for site-related risk-based COCs per media based on a target ELCR of  $1 \times 10^{-6}$ ,  $1 \times 10^{-5}$ , and  $1 \times 10^{-4}$  and a target HI of 1. The lower of the RBCL developed based on potential cancer and non-cancer effects will be the selected RBCL.

In accordance with the Formal Dispute Resolution Agreement (January 12, 2012) between the Navy, USEPA, and RIDEM, state Applicable or Relevant and Appropriate Requirements (ARARs) need to be addressed under CERCLA if the HHRA identifies an unacceptable site-related cumulative ELCR and/or total HI for a site. Therefore, as part of the FS, if the HHRA identifies any site-related risk-based COCs (as defined in Section 3.3.3) for the site, concentrations of chemicals detected on-site will be compared to RIDEM's Method 1 Direct Exposure Criteria for Soil and RIDEMs' Method 1 Groundwater Objectives (RIDEM, 2011) for the projected land use. If a chemical is detected at a concentration above RIDEM's Remedial Objectives, it will be identified as an ARAR-based COC. As acknowledged in the Formal Dispute Resolution Agreement, this may result in the development of RBCLs for chemicals that are not identified as risk drivers or COCs based on the HHRA.

#### **4.0 Ecological Risk Assessment**

The primary objective of the ERA for the site is to evaluate whether COPCs attributable to past operations, as well as the wastes generated and disposed of at the site, have the potential to cause unacceptable adverse risk to ecological receptors. The ERA will be conducted in accordance with *Navy Policy for Conducting Ecological Risk Assessments* and *Navy Guidance for Conducting Ecological Risk Assessments* (DON, 1999a,b). This approach is consistent with the eight step tiered approach to ERA presented in *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments, Interim Final* (USEPA, 1997c). Additional guidance documentation includes, but is not limited to, the following:

- Department of the Navy Environmental Restoration Program (NERP) Manual (DON, 2006);
- Navy Policy on the Use of Background Chemical Levels (DON, 2004);
- Navy Policy on Sediment Site Investigation and Response Action (DON, 2002);
- Guidelines for Ecological Risk Assessment (USEPA, 1998a);
- The Role of Screening-Level Risk Assessments and Refining Contaminants of Concern in Baseline Ecological Risk Assessments (USEPA, 2001b).

#### **4.1 ERA Process**

As described in Navy guidance (DON, 1999), a three tiered approach that incorporates different levels of assessment complexity is used to evaluate the potential for ecological risk. The tiered approach may be implemented in its entirety depending upon the level and magnitude of risk that is determined in prior tiers. This approach consists of the following tiers:

- Tier 1 – Ecological Screening Risk Assessment (SRA);
- Tier 2 – Baseline Ecological Risk Assessment (BERA); and
- Tier 3 – Risk Evaluation of Remedial Alternatives.

The tiers of evaluation that will be followed to conduct the ERA are summarized below. The ERA has been structured according to U.S. Navy policy (DON, 1999) so that it fulfills both the requirements of an eight step EPA ERA (USEPA, 1997c) and a U.S. Navy ERA.

#### **Tier 1 – Ecological Screening Risk Assessment**

The primary objective for a Tier 1 SRA is to determine which, if any, exposure pathways and COPCs warrant immediate action or require further evaluation in a more refined ERA. The Tier 1 SRA includes the elements of Steps 1 and 2 of the eight step EPA ERA (USEPA, 1997c) process.

The Tier 1 SRA will include the following:

- Identification and summarization of relevant datasets.
- Development of a preliminary CSM which will identify potentially complete exposure pathways for ecological receptors.
- Comparison of EPCs to screening ecotoxicity values (SEVs) to identify COPCs for further quantitative evaluation in the Tier 2 BERA.

### **Tier 2 - Baseline Ecological Risk Assessment**

The Tier 2 objectives focus on identifying unacceptable risks to ecological receptors and the BERA includes the elements of Steps 3 through 7 of the eight step EPA ERA (USEPA, 1997c) process.

The Tier 2 BERA will include the following:

- Step 3a refinement of the conservative assumptions and resulting risk estimates in the Tier 1 SRA.
- Completion of Steps 3b through 7 for pathways and COPCs retained after the completion of Step 3a. These steps include identifying endpoints to be evaluated, the laboratory and field methods to be used to collect additional data, the statistical analyses to be used for evaluating data, and the methods to be used for estimating and characterizing the ecological risks.

### **Tier 3 – Risk Evaluation of Remedial Alternatives**

The Tier 3 objectives focus on the evaluation of remedial alternatives relative to risk reduction and environmental impacts. The Tier 3 evaluation will be performed only if the Tier 2 BERA identifies COCs in site media. The Tier 3 will include the following:

- Development of ecologically-based preliminary remedial goals (PRGs), as needed.
- An evaluation of the effectiveness of the remedial alternatives for reducing ecological risks to acceptable levels.
- An evaluation of the potential ecological impact risks associated with remedy implementation.
- An evaluation of the residual risks associated with the remedial alternatives.

The following sections provide additional details related to conducting each of the ERA Tiers. Site-specific details are provided as needed in the SAP based on the CSM discussed in the SAP (Worksheet #10) or Work Plan.

## 4.2 Tier 1 – Ecological Screening Risk Assessment

The SRA process can be described in two steps. Step 1 of the SRA is equivalent to Step 1 of the EPA ERA eight step process and includes a site description, pathway identification/problem formulation, and toxicity evaluation. The goals of this step are to describe the ecological setting of the site and determine whether complete ecological exposure pathways are complete. Step 2 of the SRA is equivalent to Step 2 of the EPA ERA process. First, potential exposure is evaluated based on conservative assumptions. Then, risk is estimated by comparing the chemical concentrations detected in each medium of concern to conservative, screening-level, medium-specific benchmark criteria.

Existing knowledge of the site and the preliminary CSM is presented in the site-specific SAP (Worksheet #10) or Work Plan. Typically, it is anticipated that ecological receptors may come in contact with surface soil (0 to 1 ft bgs) and surface sediment (0 to 0.5 ft bgs) within the exposure areas. Ecological receptors are not exposed to groundwater so the pathway to this medium is not complete and will not be evaluated in the SRA. Exposure to site-related constituents in the waters of Narragansett Bay are assumed to be *de minimus* and will not typically be evaluated in the SRA.

The following exposure pathways may typically be evaluated in the SRA:

- Soil invertebrates and plants directly exposed to site-related compounds in surface soil.
- Birds and mammals exposed to site-related compounds through incidental ingestion of surface soil and by ingestion of contaminated prey items impacted by surface soil.
- Benthic invertebrates directly exposed to site-related compounds in surface sediment in Narragansett Bay.
- Birds and mammals exposed to site-related compounds through incidental ingestion of sediment and by ingestion of contaminated prey items impacted by sediment in Narragansett Bay.

Any of these ecological receptors that are not relevant for a particular site will not be included in the site-specific ERA. Any additional site-specific ecological receptors described in a SAP or Work Plan will be included in the site-specific ERA. Site-specific adjustments to ecological receptors and/or exposure assumptions will be modified as necessary based on the site-specific CSM and will be documented in the SAP or Work Plan.

Based on the identification of potentially complete exposure pathways identified in the site-specific CSM, assessment endpoints and measures of effect are identified. Assessment endpoints describe the characteristics of an ecosystem that have an intrinsic environmental value that is to be protected (e.g., protection of warm-water fish community). Typically, assessment endpoints and

receptors are selected for their potential exposure, ecological significance, economic importance, and/or societal relevance. Because the SRA represents a very conservative screening level assessment, the assessment endpoints are stated in generic terms. More specific assessment endpoints will be developed in Tier 2, as needed.

Because assessment endpoints often cannot be measured directly, measures of effect are a set of surrogate endpoints used to provide a quantitative metric for evaluating potential effects of chemicals on the ecosystem components potentially at risk. The identified assessment endpoints and measures of effect are used to further refine the CSM.

Based on the general exposure pathways described above, the following assessment endpoints, and their associated measures of effect, will be typically addressed in the SRA through comparison of media concentrations to appropriate screening values or through food web modeling. If needed, site-specific adjustments of these assessment endpoints and measures of effect are documented in the SAP (Worksheet #14) or Work Plan.

<b>Assessment Endpoint</b>	<b>Measure of Effect</b>
Protection and maintenance of indigenous terrestrial plant and soil invertebrate communities in upland habitat areas at levels similar to those of nearby populations not exposed to site-related chemicals.	Comparison of on-site concentrations of chemicals in surface soil to soil screening values derived for the protection of plants and soil invertebrates.
Protection and maintenance of terrestrial wildlife receptors within upland habitat areas at levels similar to those of nearby populations not exposed to site-related chemicals.	Comparison of on-site concentrations of chemicals in surface soil to soil screening values derived for the protection of birds and mammals.  Comparison of calculated total daily dose (TDD) for avian and mammalian receptors from exposure to chemicals in surface soil and ingestion of contaminated prey items to chemical-specific toxicity reference values (TRVs).
Protection and maintenance of benthic invertebrate communities in Narragansett Bay at levels similar to those of nearby populations not exposed to site-related chemicals.	Comparison of Narragansett Bay sediment concentrations collected in the vicinity of the site to marine sediment screening values.
Protection and maintenance of semi-aquatic wildlife receptors (i.e., wildlife receptors expected to forage within Narragansett Bay) at levels similar to those of nearby populations not exposed to site-related chemicals.	Comparison of calculated TDD for avian and mammalian receptors from exposure to chemicals in sediments and ingestion of contaminated prey items to chemical-specific TRVs.

Screening on the basis of direct toxicity in the SRA will be done by comparing the maximum detected site concentrations per exposure area against appropriate risk-based screening levels. The risk-based screening levels that will be used to select COPCs for lower trophic level receptors are discussed by media below. Comparisons to risk-based screening levels and food chain models (discussed below) will be used to assess risks to mammals and birds due to bioaccumulation.

PAHs typically occur in the environment as complex mixtures, rather than as single chemicals, and the mode of toxicity of individual PAHs is similar and is assumed to be additive. Therefore, in addition to evaluating the individual PAHs, the ERA will evaluate Total PAHs, Total LMW PAHs, and Total HMW PAHs. These totals will be calculated as the sum of the detected concentrations for individual PAHs. Similarly, PCB Aroclors will also be evaluated as individual detected Aroclors and Total PCBs.

### Surface Soil

For each surface soil dataset, the maximum detected concentration of each chemical will be compared to ecological screening levels to assess the potential for risks to the plant and soil invertebrate communities. Chemicals detected above these screening levels will be identified as COPCs for further evaluation in the Tier 2 BERA. Screening levels will be selected from the following hierarchy of sources:

- USEPA Ecological Soil Screening Levels (Eco-SSLs) for plants and soil invertebrates derived according to USEPA guidance (2005c).
- Plant and invertebrate based soil screening values developed by the Oak Ridge National Laboratory (ORNL; Efrogmson, et al., 1997a,b).

Soil screening values from alternate sources (e.g., CCME, 2002, USEPA, 2003c; USEPA, 2001c) will be considered when values are not available from the sources listed above. **Table 5** identifies the surface soil screening values identified for a number of inorganic and organic constituents that may be relevant to typical site investigations. The sources described above will be used to supplement this table if additional constituents are potentially present at a site.

### Sediment

For each sediment dataset, the maximum detected concentration of each chemical will be compared to ecological screening levels to assess the potential for risks to the benthic invertebrate community. For sediments collected from Narragansett Bay, marine screening values will be selected preferentially; however, freshwater values will be used when marine values are not available. Chemicals detected above these screening levels will be identified as COPCs for further evaluation in the Tier 2 BERA.

The primary source for sediment screening values will be the Effects Range Low (ERL) values derived by Long, et al. (1995). Additional screening values from alternate sources (e.g., Buchman, 2008; USEPA, 2006a,b) will be considered when ERL values are not available. **Table 6** identifies the sediment screening values identified for a number of inorganic and organic constituents that may be relevant to site investigations. The sources described above will be used to supplement this table if additional constituents are potentially present at a site.

Risks to mammals and birds from exposure to chemicals in surface soil and sediment will be determined using food chain models to estimate the Total Daily Dose (TDD) which will be compared to TRVs representing acceptable daily doses in mg/kg-day. Constituents will be evaluated using a food chain model if they exceed the wildlife-based benchmarks identified in **Table 6**. These values were identified from the Eco-SSLs for birds and mammals derived according to USEPA guidance (2005c) and alternate sources (USEPA, 2003c; CCME, 2002; Buchman, 2008) when Eco-SSLs were not available.

TRVs used in the SRA will be based on no observed adverse effect levels (NOAELs) identified in the USEPA Eco-SSL derivation documentation and in the ORNL *Toxicological Benchmarks for Wildlife: 1996 Revision* (Sample et al., 1996) and will be supplemented with other toxicity information when necessary. **Table 7** presents the TRVs identified for constituents that may warrant food chain modeling and **Table 8** provides additional supporting information related to the derivation of these TRVs.

In the absence of site-specific tissue data, chemical concentrations in food items will be calculated using bioaccumulation factors (BAFs) and other uptake factors from published sources or regression equations from the USEPA Eco-SSL Guidance (USEPA, 2007b) and other literature sources (e.g., Bechtel Jacobs, 1998a,b). **Table 9** presents uptake factors for plants, earthworms, and small mammals and **Table 10** presents uptake factors for benthic invertebrates and fish. When tissue data is available it will be used preferentially over predicted values.

Exposure assumptions (e.g., body weights, relative consumption of food items, foraging range, exposure duration, etc.) for wildlife species will generally be obtained from the USEPA's *Wildlife Exposure Factors Handbook* (USEPA, 1993b). Allometric equations (Nagy, 2001) will be used to estimate food ingestion rates.

In the SRA food chain model, birds and mammals are considered to be exposed to the maximum reported concentration of a COPC 100% of the time. The SRA food chain model exposure estimates will use maximum ingestion rates and minimum body weights, and it is assumed that all COPCs are 100% bioavailable. For birds and mammals that feed on more than one food type, the diet in the SRA will be considered to consist of whichever type of food is most contaminated.

The following receptors will be evaluated in the SRA food chain model:

- Herbivorous upland mammal - meadow vole;
- Herbivorous upland bird - bobwhite quail;
- Insectivorous upland mammal - short-tailed shrew;
- Insectivorous upland bird - American robin;
- Omnivorous semi-aquatic mammal - raccoon (in the SRA, the raccoon diet will be assumed to be 100% of its most contaminated prey item);
- Piscivorous/insectivorous semi-aquatic bird - herring gull (in the SRA, the gull diet will be assumed to be 100% of its most contaminated prey item).

**Table 11** presents the exposure parameters for the birds and mammals to be included in the Tier 1 SRA food chain model.

To estimate risks to plants, soil invertebrates, and benthic invertebrates in the SRA, screening level hazard quotients (HQs) will be calculated by comparing the maximum detected concentration for each chemical in each medium (i.e., an estimate of exposure) to the appropriate SEV (i.e., an estimate of effects) using the following formula:

$$\text{HQ} = \text{Maximum detected concentration/SEV}$$

For higher trophic level wildlife receptors, the risk estimate is also based on the HQ, defined as the ingested dose divided by the species-specific TRV:

$$\text{HQ} = \text{TDD/TRV}$$

Due to the consistently applied conservative assumptions implicit in a Tier 1 SRA the presence of HQs above 1 does not necessarily constitute ecological risk; only that additional consideration is warranted.

Analytes which exceed their respective screening benchmarks (i.e., HQs > 1) and analytes without screening benchmarks will be retained as COPCs. Essential nutrients (calcium, magnesium, potassium, and sodium) will not be retained as COPCs.

At the end of the Tier 1 SRA, a Scientific/Management Decision Point (SMDP) is normally reached to determine whether exit criteria for Tier 1 have been met. The potential outcomes of the SMDP are as follows:

- The site passes the ecological SRA based on an absence of complete exposure pathways and/or an absence of unacceptable risks (i.e., all maximum concentrations less than

benchmarks). Under these conditions, the decision is made that the site poses no unacceptable risks to ecological resources, further ERA or site remediation is unwarranted, and the site may be closed out for ecological concerns.

- The site fails the ecological SRA on the basis that complete pathways and unacceptable risks are indicated for at least one chemical. Under these conditions, the decision is made to either initiate interim cleanup or proceed to Tier 2 of the ERA process. The Tier 1 process also identifies those chemicals that should be retained for further consideration and those chemicals that can be eliminated from the risk assessment.

A comparison of the LODs for chemicals not detected within each media and exposure area to the Tier I screening levels will be performed to assess the appropriateness of the LODs for evaluation in the risk assessment. The results of this comparison will be discussed in the uncertainty analysis.

#### **4.3 Tier 2 – Baseline Ecological Risk Assessment**

COPCs selected in the Tier 1 SRA will be further evaluated in the Tier 2 BERA in order to determine whether site remediation is warranted from an ecological perspective. The five steps that make up Tier 2 are consistent with Steps 3 through 7 of the USEPA Superfund process for ERA (USEPA, 1997c).

The Tier 2 BERA begins (Step 3a) with a refinement of the conservative exposure assumptions employed in the Tier 1 SRA and a recalculation of the Tier 1 risk estimates. In addition to the refinement of conservative assumptions (e.g., using alternative low effect toxicity values), this re-evaluation may include considerations of background chemical concentrations, sample detection frequency, contaminant bioavailability, and site-specific exposure scenarios. The results of the Step 3a refinement are then evaluated and a decision is made on whether to exit from the ERA process or proceed with Tier 2.

Following the completion of the Step 3a refinement, the available data will be reviewed to determine whether additional evaluation warranted. If further evaluation is needed to support the BERA, it is anticipated that the project team will discuss the appropriate path forward to complete the ERA.

##### **4.3.1 Step 3a COPC Refinement of Conservative Exposure Assumptions**

The purpose of Tier 2 Step 3a is to reevaluate COPCs that were retained in Tier 1 for further evaluation in a Tier 2 BERA, and to identify and eliminate from further consideration those COPCs that were retained because of the use of very conservative exposure scenarios. Using less conservative (but more site-specific) assumptions and measures of effect, the Tier 1 ecological SRA risk estimates will be recalculated in Step 3a.

These recalculated risk estimates will be used to refine the list of COPCs identified in the Tier 1 ecological SRA to remove some or all of the COPCs from further consideration and focus remaining Tier 2 activities on COPCs likely to pose an unacceptable risk to ecological receptors. The following questions for Step 3a of Tier 2 help refine the Tier 1 ecological SRA:

- Do site concentrations exceed background levels?
- Are high concentrations and risks widespread across the site or limited to discrete locations (magnitude and extent of contamination and risk)?
- Could the COPC be in a chemical form that is less hazardous (bioavailability of the COPC)?
- Are the conservative exposure assumptions used in Tier 1 representative of site-specific exposure?

Although it is currently unknown which pathways and COPCs will be retained following Tier 1, the Step 3a reevaluation will generally follow these steps:

- Background evaluation - As described in Section 2.2, background data will be compared with site-specific data to distinguish site-related chemicals from non-site-related background chemicals (naturally occurring and anthropogenic). COPCs determined to be consistent with background will be identified as non-site-related COPCs and will not be further evaluated in the risk assessment process. However, the uncertainty analysis will include a qualitative discussion of the background chemicals at the site, to aid in understanding the presence of background concentrations (DON, 2004).
- Detection frequency evaluation - The detection frequency will be reviewed to identify COPCs with low detection frequencies (and sufficient data for acceptable site characterization) and these COPCs will be eliminated from further evaluation. If a COPC was detected in only a very small percentage of the samples collected (5% or less), the risk identified in the SRA may be overestimated and further evaluation of the COPC is not warranted. Consideration to spatial representation and concentration will be given to ensure that the presence of potential hot spots is not overlooked when eliminating COPCs based on a low detection frequency.
- Bioavailability evaluation - COPCs which are likely to be biologically unavailable will be eliminated from further evaluation. The Tier 1 SRA conservatively assumed that COPCs were 100% bioavailable; however, several physical and chemical processes strongly affect bioavailability, and it may be much less than 100% for many COPCs (bioavailability may be determined based on site-specific information [e.g., toxicity testing] or a literature review).
- Revise SRA assumptions - Exposure factor assumptions and toxicity data will be reviewed and revised to reflect more site-specific assumptions.

- Recalculate risks - Doses and HQ risk estimates are recalculated to include the more site-specific data and COPCs with HQs < 1.0 are eliminated from further evaluation.

Similar to the Tier 1 ecological SRA process, Tier 2 Step 3a utilizes existing data with additional information obtained primarily from existing literature. Additionally, Step 3a employs the same dose models and risk characterization methods as those used in the Tier 1 SRA, with changes to the measures of effect and the values of some input parameters.

Measures of effect for all media in Step 3a will consider whether site concentrations are within the range of background concentrations. As stated above, COPCs which are consistent with background, based on the results of the background evaluation performed in accordance with the methods presented in Section 2.2, will be proposed for elimination from further evaluation.

As appropriate, the measures of effect in Step 3a will also consider alternate EPCs (i.e., the average and/or the UCL on the mean) and toxicity values (as opposed to the maximum detected concentrations and no effect based toxicity values used in the SRA). The use of alternate EPCs and toxicity values will be determined based on the receptor being evaluated (e.g., the use of an average EPC may not be appropriate for an immobile plant located within a hot spot). **Table 6** presents alternate sediment toxicity values for evaluating potential impacts to benthic invertebrates. These values may be incorporated into the Step 3a evaluation. Alternate screening values for soil have not been identified.

The refinement of the SRA food chain model may include re-estimation of risk using the UCL on the arithmetic mean and average EPCs in place of maximum media concentrations, use of mean body weights and food ingestion rates, use of dietary fractions typical of each representative species as identified in the literature, use of the 50<sup>th</sup> percentile incidental soil ingestion rate (USEPA, 2007b), inclusion of a site use factor (calculated as the area of contamination divided by the home range of the receptor), use of lowest observed adverse effect levels (LOAELs) as TRVs, and/or adjustments to bioavailability assumptions. **Table 7** presents alternate TRVs based on lowest observed effect levels (LOAELs) and **Tables 9** and **10** present alternate uptake factors for terrestrial and aquatic exposures, respectively. **Table 11** presents the refined exposure parameters for the birds and mammals to be included in the Step 3a food chain model.

If warranted, additional data may be collected to provide more site-specific information for use in Step 3a. For example, to further evaluate the potential for risks to benthic invertebrates, sediment samples may be collected for bulk sediment analysis, toxicity testing (28 day tests with the amphipod *Leptocheirus plumulosus*), and macroinvertebrate community surveys. The results of these analyses will be used to refine the conservative SRA approach to evaluating risks to benthic invertebrates and to provide more site-specific measures of effect.

Bioavailability of COPCs in sediment to benthic invertebrates may be assessed by several methods including considering the impact of total organic carbon (TOC) (e.g., adjusting TOC dependent screening values) and by evaluating simultaneously extracted metals (SEM) and acid volatile sulfide (AVS) data. The results of toxicity tests and macroinvertebrate community surveys may also be used to assess the bioavailability and toxicity of COPCs in sediment on benthic invertebrates and the presence or absence of a benthic community. Results for samples collected adjacent to the site will be evaluated relative to results for samples collected from background locations to assess whether site-related chemicals are likely to be impacting the benthic invertebrate community.

Collection of site-specific tissue residues may also be warranted to further refine bioaccumulation assumptions. These data can be incorporated into food chain modeling and may allow the calculation of site-specific uptake factors (when sampled with co-located abiotic media).

After the re-evaluation/refinement, the decision criteria for Tier 2, Step 3a include the following:

- If the re-evaluation of the conservative exposure assumptions (including considerations of background, detection frequency, and other factors) used in the ecological SRA supports an acceptable risk determination for all COPCs, then a no further action designation is warranted, and the site exits the ERA process.
- If the re-evaluation of the conservative exposure assumptions does not support an acceptable risk for all chemicals, then the site continues to Tier 2 Step 3b or remediation.

#### **4.3.2 Completing Tier 2 Steps 3b through Step 7**

The COPCs retained at the end of Step 3a will continue through the remaining steps of Tier 2. Step 3b Problem Formulation focuses the scope and magnitude of the BERA and provides the basis for study design. The intent of Step 3b is to ensure that the assessment (and associated study design and data collection activities) focus on the important (i.e., most at risk) ecological and contaminant concerns for the site, and ultimately to provide for a scientifically defensible risk assessment that will support risk management decisions.

Problem Formulation identifies the objectives for the remaining Tier 2 evaluation, describes the fate and transport processes for the COPCs, describes the ecological resources associated with the site, identifies the ecological endpoints to be evaluated by the BERA, and identifies data gaps to be addressed through site-specific investigations. At the end of Step 3b Problem Formulation, a SMDP is reached to obtain agreement on the COPCs, site-specific assessment endpoints, exposure pathways and risk questions and hypotheses to be included in the BERA.

Steps 4 and 5 include the development and verification of a BERA Work Plan and SAP which identify the study design, data quality objectives, and any proposed sampling for the BERA, if needed. If

further sampling is needed, a brief BERA Work Plan and SAP will be prepared to describe the proposed sampling and the use of the data and to obtain agency concurrence on the approach for completing the ERA. Step 6 includes the site investigation and data analysis, and Step 7 includes the risk characterization incorporating all available data for the COPCs and pathways. For each assessment endpoint, the risk characterization will include a risk estimate, determination of ecological significance and risk acceptability, and an evaluation of the uncertainties.

Two exit criteria are identified to be used in selecting a risk management decision for the site following the completion of the BERA. These criteria are:

- No further evaluation and no remediation from an ecological perspective are warranted because the site does not pose unacceptable risk, or
- The site poses unacceptable ecological risks and additional evaluation in the form of remedy development and evaluation (Tier 3) is appropriate.

If the characterization results support a “no further evaluation and no remediation” decision, the site exits the ERA process.

#### **4.4 Tier 3 – Evaluation of Remedial Alternatives**

The Tier 3 objectives focus on the evaluation of remedial alternatives relative to risk reduction and environmental impacts, if warranted. The Tier 3 evaluation will be performed as part of the FS only if the Tier 2 BERA identifies unacceptable risks due to site-related COCs in site media. As warranted, ecologically-based PRGs may be developed using site-specific data collected for the BERA (e.g., toxicity tests) or by setting the HQ equal to 1 and identifying an acceptable media concentration associated with that HQ (e.g., soil level associated with HQ of 1 for wildlife receptor in food chain model).

The Tier 3 evaluation will include a qualitative evaluation of the potential ecological risks associated with the implementation of each of the remedial alternatives and the will estimate risk reduction provided by each alternative. Tier 3 evaluates each remedial alternative from an ecological perspective against the nine CERCLA remedy evaluation criteria identified in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (40 CFR §300.430(e)(9)(iii)), which require evaluation and balancing of short-term and long-term risks and benefits, including residual risk.

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## Tables

TABLE 1  
SUMMARY OF POTENTIAL EXPOSURE ASSUMPTIONS - CURRENT/FUTURE CONSTRUCTION/UTILITY WORKER  
HUMAN HEALTH RISK ASSESSMENT  
NEWPORT, RHODE ISLAND

Parameter	Current/Future Construction/Utility Worker			
	RME		CTE	
Parameters Used in the Outdoor Air (Fugitive Dust and Excavation Air) Inhalation Pathway				
Exposure Time (hr/day)	8	(a)	8	(a)
Exposure Frequency (days/year)	250	(b)	130	(g)
Exposure Duration (yr)	1	(c)	0.5	(c)
Parameters Used in the Soil Pathway				
Exposure Frequency (days/year)	250	(b)	130	(g)
Exposure Duration (yr)	1	(c)	0.5	(c)
Soil Ingestion Rate (mg/day)	330	(f)	330	(f)
Exposed Skin Surface Area (cm <sup>2</sup> )	3300	(e)(f)	3300	(e)(f)
Adherence Factor (mg/cm <sup>2</sup> )	0.3	(h)	0.1	(h)
Body Weight (kg)	70	(f)	70	(f)
Parameters Used in the Groundwater Contact Pathway				
Exposure Time (hr/day)	1	(i)	1	(i)
Exposure Frequency (days/year)	250	(b)	130	(g)
Exposure Duration (yr)	1	(c)	0.5	(c)
Water Ingestion Rate (l/day)	0.005	(d)	0	(j)
Exposed Skin Surface Area (cm <sup>2</sup> )	3300	(e)	3300	(e)
Body Weight (kg)	70	(f)	70	(f)
Notes:				
RME - Reasonable Maximum Exposure.				
CTE - Central Tendency Exposure.				
USEPA, 2004. Risk Assessment Guidance for Superfund, Supplemental Guidance for Dermal Risk Assessment.				
(a) Based on a typical 8 hour workday.				
(b) Exposure frequency is equivalent to 5 days per week for the exposure duration.				
(c) Construction activities are assumed to occur within a 1 year period (for RME scenario) and for a 6 month period (for CTE scenario) based on professional judgment.				
(d) Based on professional judgment and USEPA, 1989, Risk Assessment Guidance for Superfund, Volume I. Value is one-tenth of that assumed to occur during a swimming event via incidental ingestion. Assumes drinking water is obtained offsite.				
(e) USEPA, 2004. Exhibit 3-5, recommended value.				
(f) USEPA, 2002. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. Exhibit 1-2.				
(g) Exposure frequency is equivalent to 5 days per week for exposure duration (26 weeks).				
(h) USEPA, 2004. Exhibit 3-3, recommended values for construction workers.				
(i) Assumes that contact with water occurs only for a fraction of the total exposure duration and time.				
(j) Assumes construction workers obtain their drinking water offsite and that incidental ingestion to groundwater is trivial.				

TABLE 2  
SUMMARY OF POTENTIAL EXPOSURE ASSUMPTIONS - FUTURE ON-SITE WORKER  
HUMAN HEALTH RISK ASSESSMENT  
NEWPORT, RHODE ISLAND

Parameter	Future On-Site Worker			
	RME		CTE	
Parameters Used in the Outdoor Air (Fugitive Dust) Inhalation Pathway				
Exposure Time (hr/day)	4	(d)	4	(d)
Exposure Frequency (days/year)	250	(a)	219	(c)
Exposure Duration (yr)	25	(b)	7	(e)
Parameters Used in the Indoor Air Inhalation Pathway				
Exposure Time (hr/day)	4	(d)	4	(d)
Exposure Frequency (days/year)	250	(a)	219	(c)
Exposure Duration (yr)	25	(a)(b)	7	(e)
Parameters Used in the Soil Pathway				
Exposure Frequency (days/year)	250	(a)	219	(c)
Exposure Duration (yr)	25	(a)(b)	7	(e)
Ingestion Rate (mg/day)	100	(a)	50	(f)
Exposed Skin Surface Area (cm <sup>2</sup> )	3300	(c)	3300	(c)
Adherence Factor (mg/cm <sup>2</sup> )	0.2	(c)	0.02	(c)
Body Weight (kg)	70	(a)	70	(a)
Parameters Used in the Groundwater Ingestion Pathway				
Exposure Frequency (days/year)	250	(a)	219	(c)
Exposure Duration (yr)	25	(a)(b)	7	(e)
Water Ingestion Rate (l/day)	1	(a)	0.7	(g)
Body Weight (kg)	70	(a)	70	(a)
Notes:				
RME - Reasonable Maximum Exposure.				
CTE - Central Tendency Exposure.				
USEPA, 1997. USEPA Exposure Factors Handbook. Volume I. August 1997.				
USEPA, 2004. Risk Assessment Guidance for Superfund, Supplemental Guidance for Dermal Risk Assessment. July 2004.				
(a) USEPA, 1991. Standard Default Exposure Factors.				
(b) USEPA, 2002. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, December, 2002.				
(c) USEPA, 2004. Exhibit 3-5, recommended value.				
(d) Based on professional judgment assuming an onsite worker performs both indoor and outdoor maintenance activities for a typical 8 hour workday.				
(e) USEPA, 1997. Recommended value for median occupational tenure, average of values for men and women. (Table 15-158).				
(f) USEPA, 1997. Mean value for the adult population (Table 4-23).				
(g) One-half of the recommended mean value for the ingestion of drinking water for the associated age range (USEPA, 1997. Table 3-30), assuming workers get one-half of their daily drinking water at work.				

TABLE 3  
SUMMARY OF POTENTIAL EXPOSURE ASSUMPTIONS - CURRENT/FUTURE TRESPASSING TEENAGER  
HUMAN HEALTH RISK ASSESSMENT  
NEWPORT, RHODE ISLAND

Parameter	Trespassing Teenager (7 to <16 years)			
	RME		CTE	
Parameters Used in the Outdoor Air Inhalation Pathway				
Exposure Time (hr/day)	4	(e)	2	(a)
Exposure Frequency (days/year)	52	(h)	26	(b)
Exposure Duration (yr)	9	(c)	9	(c)
Parameters Used in the Soil Pathway				
Exposure Frequency (days/year)	52	(h)	26	(b)
Exposure Duration (yr)	9	(c)	9	(c)
Ingestion Rate (mg/day)	100	(i)	50	(f)
Exposed Skin Surface Area (cm <sup>2</sup> )	4286	(d)	4286	(d)
Adherence Factor (mg/cm <sup>2</sup> )	0.2	(j)	0.04	(j)
Body Weight (kg)	43	(g)	43	(g)
Notes:				
RME - Reasonable Maximum Exposure.				
CTE - Central Tendency Exposure.				
USEPA, 2004. Risk Assessment Guidance for Superfund, Supplemental Guidance for Dermal Risk Assessment.				
USEPA, 1997. USEPA Exposure Factors Handbook. Volume I. August 1997.				
(a) Assumes a trespasser is on-site for 2 hours per day. Based on professional judgment.				
(b) 1 day per week for 26 weeks (6 warmer months) of the year.				
(c) Duration reflects age-range.				
(d) USEPA, 1997. Tables 6-6, 6-7, and 6-8. Represents 50th percentile surface area for males and females. Contact is assumed to occur with the hands, forearms, lower legs, and head, consistent with USEPA's (2004) assumptions for the adult.				
(e) Assumes a trespasser is on-site for 4 hours per day. Based on professional judgment.				
(f) USEPA, 1997. Mean value for the adult population (Table 4-23).				
(g) USEPA, 2002. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, December, 2002.				
(h) 2 days per week for 26 weeks (6 warmer months) of the year.				
(i) USEPA, 1991. Standard Default Exposure Factors.				
(j) USEPA, 2004. Exhibit 3-5, recommended value.				

TABLE 4  
SUMMARY OF POTENTIAL EXPOSURE ASSUMPTIONS - HYPOTHETICAL FUTURE RESIDENT  
HUMAN HEALTH RISK ASSESSMENT  
HUMAN HEALTH RISK ASSESSMENT  
NEWPORT, RHODE ISLAND

Parameter	RME					CTE				
	Assumptions for Noncarcinogenic Evaluation	Assumptions for Carcinogenic Evaluation				Assumptions for Noncarcinogenic Evaluation	Assumptions for Carcinogenic Evaluation			
	Young Child (0 to 6 yrs)	Young Child (0 to <2 yrs)	Older Child (2 to <6 yrs)	Adolescent (6 to <16)	Adult	Young Child (0 to 6 yrs)	Young Child (0 to <2 yrs)	Older Child (2 to <6 yrs)	Adolescent (6 to <16)	Adult
Parameters Used in the Outdoor Air Inhalation Pathway										
Exposure Time (hr/day)	5 (d)	5 (d)	5 (d)	5 (d)	5 (d)	5 (d)	5 (d)	5 (d)	5 (d)	5 (d)
Exposure Frequency (days/year)	350 (a)	350 (a)	350 (a)	350 (a)	350 (a)	234 (f)	234 (f)	234 (f)	234 (f)	234 (f)
Exposure Duration (yr)	6 (a)	2 (h)	4 (h)	10 (h)	14 (h)	6 (a)	2 (h)	4 (h)	10 (h)	9 (h)
Parameters Used in the Indoor Air Inhalation Pathway										
Exposure Time (hr/day)	19 (k)	19 (k)	19 (k)	19 (k)	19 (k)	17 (b)	17 (b)	17 (b)	17 (b)	17 (b)
Exposure Frequency (days/year)	350 (a)	350 (a)	350 (a)	350 (a)	350 (a)	234 (f)	234 (f)	234 (f)	234 (f)	234 (f)
Exposure Duration (yr)	6 (a)	2 (h)	4 (h)	10 (h)	14 (h)	6 (a)	2 (h)	4 (h)	10 (h)	9 (h)
Parameters Used in the Soil Pathway										
Exposure Frequency (days/year)	350 (a)	350 (a)	350 (a)	350 (a)	350 (a)	234 (f)	234 (f)	234 (f)	234 (f)	234 (f)
Exposure Duration (yr)	6 (a)	2 (h)	4 (h)	10 (h)	14 (h)	6 (a)	2 (h)	4 (h)	10 (h)	9 (h)
Ingestion Rate (mg/day)	200 (a)(c)	200 (a)(c)	200 (a)(c)	100 (a)(c)	100 (a)(c)	100 (a)(c)	100 (a)(c)	100 (a)(c)	50 (a)(c)	50 (a)(c)
Exposed Skin Surface Area (cm <sup>2</sup> )	2800 (i)(g)	2600 (i)	2939 (i)	4156 (i)	5700 (i)(g)	2800 (i)(g)	2600 (i)	2939 (i)	4156 (i)	5700 (i)(g)
Adherence Factor (mg/cm <sup>2</sup> )	0.2 (g)	0.2 (g)	0.2 (g)	0.07 (g)	0.07 (g)	0.04 (g)	0.04 (g)	0.04 (g)	0.01 (g)	0.01 (g)
Body Weight (kg)	15 (l)	8 (l)	18 (l)	41 (l)	70 (a)	15 (l)	8 (l)	18 (l)	41 (l)	70 (a)
Parameters Used in the Groundwater Contact Pathway										
Exposure Frequency (days/year)	350 (a)	350 (a)	350 (a)	350 (a)	350 (a)	234 (f)	234 (f)	234 (f)	234 (f)	234 (f)
Exposure Duration (yr)	6 (a)	2 (h)	4 (h)	10 (h)	14 (h)	6 (a)	2 (h)	4 (h)	10 (h)	9 (h)
Water Ingestion Rate (l/day)	1 (a)	1 (a)	2 (a)	2 (a)	2 (a)	0.6 (j)	0.6 (j)	1.4 (j)	1.4 (j)	1.4 (j)
Body Weight (kg)	15 (l)	8 (l)	18 (l)	41 (l)	70 (a)	15 (l)	8 (l)	18 (l)	41 (l)	70 (a)
Parameters Used in the Showering/Bathing Pathway										
Exposure Time (hr/day)	1 (e)	1 (e)	1 (e)	0.58 (e)	0.58 (e)	0.33 (e)	0.33 (e)	0.33 (e)	0.25 (e)	0.25 (e)
Exposure Frequency (days/year)	350 (a)	350 (a)	350 (a)	350 (a)	350 (a)	234 (f)	234 (f)	234 (f)	234 (f)	234 (f)
Exposure Duration (yr)	6 (a)	2 (h)	4 (h)	10 (h)	14 (h)	6 (a)	2 (h)	4 (h)	10 (h)	9 (h)
Exposed Skin Surface Area (cm <sup>2</sup> )	6600 (e)(m)	5910 (m)	6880 (m)	12346 (m)	18000 (e)(m)	6600 (e)(m)	5910 (m)	6880 (m)	12346 (m)	18000 (e)(m)
Body Weight (kg)	15 (l)	8 (l)	18 (l)	41 (l)	70 (a)	15 (l)	8 (l)	18 (l)	41 (l)	70 (a)

TABLE 4  
SUMMARY OF POTENTIAL EXPOSURE ASSUMPTIONS - HYPOTHETICAL FUTURE RESIDENT  
HUMAN HEALTH RISK ASSESSMENT  
HUMAN HEALTH RISK ASSESSMENT  
NEWPORT, RHODE ISLAND

Parameter	RME					CTE																
	Assumptions for Noncarcinogenic Evaluation	Assumptions for Carcinogenic Evaluation				Assumptions for Noncarcinogenic Evaluation	Assumptions for Carcinogenic Evaluation															
	Young Child (0 to 6 yrs)	Young Child (0 to <2 yrs)	Older Child (2 to <6 yrs)	Adolescent (6 to <16)	Adult	Young Child (0 to 6 yrs)	Young Child (0 to <2 yrs)	Older Child (2 to <6 yrs)	Adolescent (6 to <16)	Adult												
<p>Notes:</p> <p>RME - Reasonable Maximum Exposure.  CTE - Central Tendency Exposure.  USEPA, 1991. Standard Default Exposure Factors.  USEPA, 1993. USEPA Superfund's Standard Default Exposure Factors For the Central Tendency and Reasonable Maximum Exposure. Preliminary Review Draft. May 5, 1993.  USEPA, 1997. Exposure Factors Handbook. Volume I. August 1997.  USEPA, 2004. Risk Assessment Guidance for Superfund, Supplemental Guidance for Dermal Risk Assessment. July 2004.  (a) USEPA, 1991.  (b) USEPA, 1997. Value for time spent indoors (at residence) (Table 15-176).  (c) USEPA, 1993.  (d) Adult and child residents are assumed to spend 5 out of 16 waking hours (or 30% of their time) outdoors (USEPA, 1991).  (e) USEPA, 2004. Exhibit 3-2, recommended value.  (f) Value recommended by USEPA (1993) for CTE scenario.  (g) USEPA, 2004. Exhibit 3-5, recommended value.  (h) Duration reflects the age range being evaluated for the RME scenario for a combined lifetime exposure duration of 30 years. The breakdown for age ranges is as follows:</p> <table border="0"> <tr> <td>Age range</td> <td>Total Years</td> </tr> <tr> <td>0 to &lt;2 yrs</td> <td>= 2 yrs</td> </tr> <tr> <td>2 to &lt;6 yrs</td> <td>= 4 yrs</td> </tr> <tr> <td>6 to &lt;16 yrs</td> <td>= 10 yrs</td> </tr> <tr> <td>&gt; 16 yrs</td> <td>= 14 yrs</td> </tr> <tr> <td></td> <td>30 yrs</td> </tr> </table> <p>For the CTE the children exposure remains the same but the adult is reduced to 9 years based on a total residence time of 25 years (USEPA, 1997, Tab 15-174).  (i) USEPA, 1997. Tables 6-6, 6-7, and 6-8. Represents 50th percentile surface area for males and females. For the child age groups, contact is assumed to occur with the hands, forearms, lower legs, feet, and head, consistent with USEPA (2004). For the adolescent and adult, contact is assumed to occur with the hands, forearms, lower legs, and head, consistent with USEPA's (2004) assumptions for the adult.  (j) USEPA, 1997. Recommended mean value for the ingestion of drinking water for the associated age range (Table 3-30).  (k) Based on professional judgment; Conservatively assumes that a resident spends 24 hours per day at the residence. Equals 24 hours minus 5 hours spent outdoors as recommended by USEPA (1991) (d).  (l) USEPA, 1997. Recommended mean body weights. Weighted average of associated age ranges (Tables 7-1, 7-3).  (m) USEPA, 1997. Represents the 50th percentile total body surface area for males and females.</p>											Age range	Total Years	0 to <2 yrs	= 2 yrs	2 to <6 yrs	= 4 yrs	6 to <16 yrs	= 10 yrs	> 16 yrs	= 14 yrs		30 yrs
Age range	Total Years																					
0 to <2 yrs	= 2 yrs																					
2 to <6 yrs	= 4 yrs																					
6 to <16 yrs	= 10 yrs																					
> 16 yrs	= 14 yrs																					
	30 yrs																					

TABLE 5  
 ECOLOGICAL SCREENING VALUES - SOIL  
 ECOLOGICAL RISK ASSESSMENT  
 NEWPORT, RHODE ISLAND

Chemical	ECOLOGICAL SCREENING LEVELS FOR SOIL					
	Invertebrates		Plants		Wildlife	
<b>INORGANICS</b>						
Aluminum	pH<5.5	Eco-SSL	pH<5.5	Eco-SSL	pH<5.5	Eco-SSL
Antimony	78	Eco-SSL (inverts)	5	ORNL (plants)	0.27	Eco-SSL (mammals)
Arsenic	60	ORNL (inverts)	18	Eco-SSL (plants)	43	Eco-SSL (birds)
Barium	330	Eco-SSL (inverts)	500	ORNL (plants)	2000	Eco-SSL (mammals)
Beryllium	40	Eco-SSL (inverts)	10	ORNL (plants)	21	Eco-SSL (mammals)
Cadmium	140	Eco-SSL (inverts)	32	Eco-SSL (plants)	0.36	Eco-SSL (mammals)
Calcium	NV		NV		NV	
Chromium	0.4	ORNL (inverts)	1	ORNL (plants)	26	Eco-SSL (birds)
Cobalt	20	USEPA R4 (unspecified)	13	Eco-SSL (plants)	120	Eco-SSL (birds)
Copper	80	Eco-SSL (inverts)	70	Eco-SSL (plants)	28	Eco-SSL (birds)
Iron	200	USEPA R4 (unspecified)	pH<5, pH>8	Eco-SSL	NV	
Lead	1700	Eco-SSL (inverts)	120	Eco-SSL (plants)	11	Eco-SSL (birds)
Magnesium	NV		NV		NV	
Manganese	450	Eco-SSL (inverts)	220	Eco-SSL (plants)	4000	Eco-SSL (mammals)
Mercury	0.1	ORNL (inverts)	0.3	ORNL (plants)	0.00158 (x)	USEPA R5 (shrew/vole)
Nickel	280	Eco-SSL (inverts)	38	Eco-SSL (plants)	130	Eco-SSL (mammals)
Potassium	NV		NV		NV	
Selenium	4.1	Eco-SSL (inverts)	0.52	Eco-SSL (plants)	0.63	Eco-SSL (mammals)
Silver	2	USEPA R4 (unspecified)	560	Eco-SSL (plants)	4.2	Eco-SSL (birds)
Sodium	NV		NV		NV	
Thallium	1	USEPA R4 (unspecified)	1	ORNL (plants)	0.057	USEPA R5 (shrew/vole)
Vanadium	2	USEPA R4 (unspecified)	2	ORNL (plants)	7.8	Eco-SSL (birds)
Zinc	120	Eco-SSL (inverts)	160	Eco-SSL (plants)	46	Eco-SSL (birds)
<b>SEMI VOLATILE ORGANIC COMPOUNDS</b>						
1,2-Dichlorobenzene	20 (k)	ORNL (inverts)	0.05 (n)	USEPA R4 (unspecified)	3.0	USEPA R5 (shrew/vole)
1,2-Diphenylhydrazine	NV		NV		NV	
1,3-Dichlorobenzene	20 (k)	ORNL (inverts)	0.05 (n)	USEPA R4 (unspecified)	37.7	USEPA R5 (shrew/vole)
1,4-Dichlorobenzene	20	ORNL (inverts)	0.05 (n)	USEPA R4 (unspecified)	0.55	USEPA R5 (shrew/vole)
2,4,6-Trichlorophenol	9	ORNL (inverts)	4	ORNL (plants)	14.1	USEPA R5 (shrew/vole)
2,4,6-Trichlorophenol	10	ORNL (inverts)	4 (d)	ORNL (plants)	9.9	USEPA R5 (shrew/vole)
2,4-Dichlorophenol	20 (g)	ORNL (inverts)	20 (g)	ORNL (plants)	87.5	USEPA R5 (shrew/vole)
2,4-Dimethylphenol	NV		0.01	USEPA R5 (plants)	NV	
2,4-Dinitrophenol	NV		20	ORNL (plants)	0.061	USEPA R5 (shrew/vole)
2,4-Dinitrotoluene	0.05 (q)	USEPA R4 (unspecified)	200 (q)	ORNL (plants)	1.3	USEPA R5 (shrew/vole)
2,6-Dichlorophenol	20 (g)	ORNL (inverts)	20 (g)	ORNL (plants)	1.2	USEPA R5 (shrew/vole)
2,6-Dinitrotoluene	0.05 (q)	USEPA R4 (unspecified)	200 (q)	ORNL (plants)	0.033	USEPA R5 (shrew/vole)
2-Chloronaphthalene	NV		NV		0.012	USEPA R5 (shrew/vole)
2-Chlorophenol	10 (f)	ORNL (inverts)	7 (f)	ORNL (plants)	0.24	USEPA R5 (shrew/vole)
2-Methylnaphthalene	18 (f)	Eco-SSL (inverts)	20 (f)	ORNL (plants)	1.1 (f)	Eco-SSL (mammals)
2-Methylphenol	NV		NV		40.4	USEPA R5 (shrew/vole)
2-Nitroaniline	NV		NV		74.1	USEPA R5 (shrew/vole)
2-Nitrophenol	7 (j)	ORNL (inverts)	NV		1.6	USEPA R5 (shrew/vole)
3,3'-Dichlorobenzidine	NV		NV		0.65	USEPA R5 (shrew/vole)
3-Methylphenol & 4-Methylphenol	NV		NV		NV	
3-Nitroaniline	NV		NV		3.2	USEPA R5 (shrew/vole)
4,6-Dintro-2-methylphenol	NV		NV		0.14	USEPA R5 (shrew/vole)
4-Bromophenyl phenyl ether	NV		NV		NV	
4-Chloro-3-methylphenol	NV		NV		8.0	USEPA R5 (shrew/vole)
4-Chloroaniline	30 (e)	ORNL (inverts)	20 (e)	ORNL (plants)	1.1	USEPA R5 (shrew/vole)
4-Chlorophenyl phenyl ether	NV		NV		NV	
4-Nitroaniline	NV		NV		21.9	USEPA R5 (shrew/vole)
4-Nitrophenol	7	ORNL (inverts)	NV		5.1	USEPA R5 (shrew/vole)
Benzidine	NV		NV		NV	
Benzoic acid	NV		NV		NV	
Benzyl alcohol	NV		NV		65.8	USEPA R5 (shrew/vole)
Bis(2-chlorethoxy)methane	NV		NV		0.30	USEPA R5 (shrew/vole)
Bis(2-chloroethyl) ether	NV		NV		23.7	USEPA R5 (shrew/vole)
Bis(2-chloroisopropyl) ether	NV		NV		19.9	USEPA R5 (shrew/vole)
Bis(2-Ethylhexyl)phthalate	0.1 (a)	USEPA R4 (unspecified)	0.1 (a)	USEPA R4 (unspecified)	0.93	USEPA R5 (shrew/vole)
Butyl benzyl phthalate	0.1 (a)	USEPA R4 (unspecified)	0.1 (a)	USEPA R4 (unspecified)	0.24	USEPA R5 (shrew/vole)
Caprolactam	NV		NV		NV	
Carbazole	NV		NV		NV	
Dibenzofuran	NV		NV		NV	
Diethyl phthalate	200 (i)	ORNL (inverts)	100	ORNL (plants)	24.8	USEPA R5 (shrew/vole)
Dimethyl phthalate	200	ORNL (inverts)	100 (b)	ORNL (plants)	734	USEPA R5 (shrew/vole)
Di-n-butyl phthalate	200	USEPA R4 (unspecified)	200	ORNL (plants)	0.15	USEPA R5 (shrew/vole)
Di-n-octyl phthalate	200 (c)	USEPA R4 (unspecified)	200 (c)	ORNL (plants)	709	USEPA R5 (shrew/vole)
Hexachlorobenzene	0.0025	USEPA R4 (unspecified)	0.0025	USEPA R4 (unspecified)	0.20	USEPA R5 (shrew/vole)
Hexachlorobutadiene	NV		NV		0.040	USEPA R5 (shrew/vole)
Hexachloroethane	NV		NV		0.60	USEPA R5 (shrew/vole)
Isophorone	NV		NV		139	USEPA R5 (shrew/vole)
Nitrobenzene	NV		NV		1.3	USEPA R5 (shrew/vole)
N-Nitrosodimethylamine	NV		NV		0.0000321	USEPA R5 (shrew/vole)
N-Nitrosodi-n-propylamine	NV		NV		0.54	USEPA R5 (shrew/vole)
N-Nitrosodiphenylamine	20	ORNL (inverts)	20	USEPA R4 (unspecified)	0.55	USEPA R5 (shrew/vole)
N-Nitrosopyrrolidine	NV		NV		0.013	USEPA R5 (shrew/vole)
Pentachlorophenol	31	Eco-SSL (inverts)	5	Eco-SSL (plants)	2.1	Eco-SSL (birds)
Phenol	30	ORNL (inverts)	70	ORNL (plants)	120	USEPA R5 (shrew/vole)

TABLE 5  
 ECOLOGICAL SCREENING VALUES - SOIL  
 ECOLOGICAL RISK ASSESSMENT  
 NEWPORT, RHODE ISLAND

Chemical	ECOLOGICAL SCREENING LEVELS FOR SOIL					
	Invertebrates		Plants		Wildlife	
Acenaphthene	29	(s) Eco-SSL (inverts)	20	(l) ORNL (plants)	100	(s) Eco-SSL (mammals)
Acenaphthylene	29	(s) Eco-SSL (inverts)	20	(l) ORNL (plants)	100	(s) Eco-SSL (mammals)
Anthracene	29	(s) Eco-SSL (inverts)	20	(l) ORNL (plants)	100	(s) Eco-SSL (mammals)
Benzo(a)anthracene	18	(r) Eco-SSL (inverts)	20	(l) ORNL (plants)	1.1	(r) Eco-SSL (mammals)
Benzo(a)pyrene	18	(r) Eco-SSL (inverts)	20	(l) ORNL (plants)	1.1	(r) Eco-SSL (mammals)
Benzo(b)fluoranthene	18	(r) Eco-SSL (inverts)	20	(l) ORNL (plants)	1.1	(r) Eco-SSL (mammals)
Benzo(g,h,i)perylene	18	(r) Eco-SSL (inverts)	20	(l) ORNL (plants)	1.1	(r) Eco-SSL (mammals)
Benzo(k)fluoranthene	18	(r) Eco-SSL (inverts)	20	(l) ORNL (plants)	1.1	(r) Eco-SSL (mammals)
Chrysene	18	(r) Eco-SSL (inverts)	20	(l) ORNL (plants)	1.1	(r) Eco-SSL (mammals)
Dibenzo(a,h)anthracene	18	(r) Eco-SSL (inverts)	20	(l) ORNL (plants)	1.1	(r) Eco-SSL (mammals)
Fluoranthene	29	(s) Eco-SSL (inverts)	20	(l) ORNL (plants)	100	(s) Eco-SSL (mammals)
Fluorene	29	(s) Eco-SSL (inverts)	20	(l) ORNL (plants)	100	(s) Eco-SSL (mammals)
Indeno(1,2,3-cd)pyrene	18	(r) Eco-SSL (inverts)	20	(l) ORNL (plants)	1.1	(r) Eco-SSL (mammals)
Naphthalene	29	(s) Eco-SSL (inverts)	20	(l) ORNL (plants)	100	(s) Eco-SSL (mammals)
Phenanthrene	29	(s) Eco-SSL (inverts)	20	(l) ORNL (plants)	100	(s) Eco-SSL (mammals)
Pyrene	18	(r) Eco-SSL (inverts)	20	(l) ORNL (plants)	1.1	(r) Eco-SSL (mammals)
Total PAHs	NV		NV		NV	
Total LMW PAHs	29	Eco-SSL (inverts)	NV		100	Eco-SSL (mammals)
Total HMW PAHs	18	Eco-SSL (inverts)	NV		1.1	Eco-SSL (mammals)
<b>VOLATILE ORGANIC COMPOUNDS</b>						
1,1,1,2-Tetrachloroethane					225	USEPA R5 (shrew/vole)
1,1,1-Trichloroethane	NV		NV		29.8	USEPA R5 (shrew/vole)
1,1,2,2-Tetrachloroethane	NV		NV		0.13	USEPA R5 (shrew/vole)
1,1,2-Trichloroethane	NV		NV		28.6	USEPA R5 (shrew/vole)
1,1-Biphenyl	NV		60	ORNL (plants)	NV	
1,1-Dichloroethane	NV		NV		20.1	USEPA R5 (shrew/vole)
1,1-Dichloroethene	NV		NV		8.3	USEPA R5 (shrew/vole)
1,1-Dichloropropene	NV		NV		NV	
1,2,3-Trichlorobenzene	20	ORNL (inverts)	0.05	(n) USEPA R4 (unspecified)	11.1	(w) USEPA R5 (shrew/vole)
1,2,3-Trichloropropane	NV		NV		3.4	USEPA R5 (shrew/vole)
1,2,4-Trichlorobenzene	20	ORNL (inverts)	0.05	(n) USEPA R4 (unspecified)	11.1	USEPA R5 (shrew/vole)
1,2,4-Trimethylbenzene	0.05	(n) USEPA R4 (unspecified)	0.05	(n) USEPA R4 (unspecified)	0.26	(n) USEPA R5 (shrew/vole)
1,2-Dibromo-3-chloropropane	NV		NV		0.035	USEPA R5 (shrew/vole)
1,2-Dibromoethane	NV		NV		1.2	USEPA R5 (shrew/vole)
1,2-Dichlorobenzene	20	(k) ORNL (inverts)	0.05	(n) USEPA R4 (unspecified)	3.0	USEPA R5 (shrew/vole)
1,2-Dichloroethane	0.4	USEPA R4 (unspecified)	0.4	USEPA R4 (unspecified)	21.2	USEPA R5 (shrew/vole)
1,2-Dichloropropane	700	ORNL (inverts)	700	USEPA R4 (unspecified)	32.7	USEPA R5 (shrew/vole)
1,3,5-Trimethylbenzene	0.05	(n) USEPA R4 (unspecified)	0.05	(n) USEPA R4 (unspecified)	0.26	(n) USEPA R5 (shrew/vole)
1,3-Dichlorobenzene	20	(k) ORNL (inverts)	0.05	(n) USEPA R4 (unspecified)	37.7	USEPA R5 (shrew/vole)
1,3-Dichloropropane	700	(h) ORNL (inverts)	NV		32.7	(h) USEPA R5 (shrew/vole)
1,4-Dichlorobenzene	20	ORNL (inverts)	0.05	(n) USEPA R4 (unspecified)	0.55	USEPA R5 (shrew/vole)
2,2-Dichloropropane	700	(h) ORNL (inverts)	NV		32.7	(h) USEPA R5 (shrew/vole)
2-Butanone	NV		NV		89.6	USEPA R5 (shrew/vole)
2-Chlorotoluene	0.05	(q) USEPA R4 (unspecified)	200	(q) ORNL (plants)	5.5	(q) USEPA R5 (shrew/vole)
2-Hexanone	NV		NV		12.6	USEPA R5 (shrew/vole)
4-Chlorotoluene	0.05	(q) USEPA R4 (unspecified)	200	(q) ORNL (plants)	5.5	(q) USEPA R5 (shrew/vole)
4-Methyl-2-pentanone	NV		NV		443	USEPA R5 (shrew/vole)
Acetone	NV		NV		2.5	USEPA R5 (shrew/vole)
Benzene	0.05	USEPA R4 (unspecified)	0.05	USEPA R4 (unspecified)	0.26	USEPA R5 (shrew/vole)
Bromobenzene	0.05	(n) USEPA R4 (unspecified)	0.05	(n) USEPA R4 (unspecified)	0.26	(n) USEPA R5 (shrew/vole)
Bromochloromethane	NV		NV		NV	
Bromodichloromethane	NV		NV		0.54	USEPA R5 (shrew/vole)
Bromoform	NV		NV		15.9	USEPA R5 (shrew/vole)
Bromomethane	NV		NV		0.24	USEPA R5 (shrew/vole)
Carbon Disulfide	NV		NV		0.094	USEPA R5 (shrew/vole)
Carbon tetrachloride	1000	USEPA R4 (unspecified)	1000	USEPA R4 (unspecified)	3.0	USEPA R5 (shrew/vole)
Chlorobenzene	40	ORNL (inverts)	0.05	(n) USEPA R4 (unspecified)	13.1	USEPA R5 (shrew/vole)
Chlorodibromomethane	NV		NV		2.1	USEPA R5 (shrew/vole)
Chloroethane	NV		NV		NV	
Chloroform	0.001	USEPA R4 (unspecified)	0.001	USEPA R4 (unspecified)	1.2	USEPA R5 (shrew/vole)
Chloromethane	NV		NV		10.4	USEPA R5 (shrew/vole)
cis-1,2-Dichloroethene	NV		NV		0.78	(v) USEPA R5 (shrew/vole)
cis-1,3-Dichloropropene	NV		NV		0.40	USEPA R5 (shrew/vole)
Dibromomethane	NV		NV		65	USEPA R5 (shrew/vole)
Dichlorodifluoromethane	NV		NV		39.5	USEPA R5 (shrew/vole)
Ethylbenzene	0.05	USEPA R4 (unspecified)	0.05	USEPA R4 (unspecified)	5.2	USEPA R5 (shrew/vole)
Hexachlorobutadiene	NV		NV		0.040	USEPA R5 (shrew/vole)
Isopropylbenzene	0.05	(n) USEPA R4 (unspecified)	0.05	(n) USEPA R4 (unspecified)	0.26	(n) USEPA R5 (shrew/vole)
Methylcyclohexane	NV		NV		NV	
Methyl tert-butyl ether	NV		NV		NV	
Methylene chloride	2	USEPA R4 (unspecified)	2	USEPA R4 (unspecified)	4.1	USEPA R5 (shrew/vole)
n-Butylbenzene	0.05	(n) USEPA R4 (unspecified)	0.05	(n) USEPA R4 (unspecified)	0.26	(n) USEPA R5 (shrew/vole)
n-Propylbenzene	0.05	(n) USEPA R4 (unspecified)	0.05	(n) USEPA R4 (unspecified)	0.26	(n) USEPA R5 (shrew/vole)
p-Isopropyltoluene	0.05	(q) USEPA R4 (unspecified)	200	(q) ORNL (plants)	5.5	(q) USEPA R5 (shrew/vole)
sec-Butylbenzene	0.05	(n) USEPA R4 (unspecified)	0.05	(n) USEPA R4 (unspecified)	0.26	(n) USEPA R5 (shrew/vole)
Styrene	NV		300	ORNL (plants)	4.7	USEPA R5 (shrew/vole)
tert-Butyl-Alcohol	NV		NV		NV	
tert-Butylbenzene	0.05	(n) USEPA R4 (unspecified)	0.05	(n) USEPA R4 (unspecified)	0.26	(n) USEPA R5 (shrew/vole)
Tetrachloroethene	0.5	CCME (commercial)	0.6	CCME (industrial)	9.9	USEPA R5 (shrew/vole)
Toluene	0.05	USEPA R4 (unspecified)	200	ORNL (plants)	5.5	USEPA R5 (shrew/vole)
Total-1,2-Dichloroethene	NV		NV		0.78	(v) USEPA R5 (shrew/vole)
trans-1,2-Dichloroethene	NV		NV		0.78	USEPA R5 (shrew/vole)
trans-1,3-Dichloropropene	NV		NV		0.40	USEPA R5 (shrew/vole)
Trichloroethene	0.001	USEPA R4 (unspecified)	0.001	USEPA R4 (unspecified)	12.4	USEPA R5 (shrew/vole)
Trichlorofluoromethane	NV		NV		16.4	USEPA R5 (shrew/vole)
Vinyl chloride	0.01	USEPA R4 (unspecified)	0.01	USEPA R4 (unspecified)	0.65	USEPA R5 (shrew/vole)
Xylenes (total)	0.05	USEPA R4 (unspecified)	10	USEPA R5 (plants)	0.1	TV (unspecified)

TABLE 5  
 ECOLOGICAL SCREENING VALUES - SOIL  
 ECOLOGICAL RISK ASSESSMENT  
 NEWPORT, RHODE ISLAND

Chemical	ECOLOGICAL SCREENING LEVELS FOR SOIL							
	Invertebrates		Plants		Wildlife			
<b>PESTICIDES</b>								
4,4'-DDD	12	(t)	CCME (commercial)	12	(t)	CCME (industrial)	0.021	Eco-SSL (mammals)
4,4'-DDE	12	(t)	CCME (commercial)	12	(t)	CCME (industrial)	0.021	Eco-SSL (mammals)
4,4'-DDT	12	(t)	CCME (commercial)	12	(t)	CCME (industrial)	0.021	Eco-SSL (mammals)
Aldrin	0.0025		USEPA R4 (unspecified)	0.00332		USEPA R5 (plants)	0.00006	TV (unspecified)
alpha-BHC	0.0025		USEPA R4 (unspecified)	0.0025		USEPA R4 (unspecified)	0.099	USEPA R5 (shrew/vole)
alpha-Chlordane	0.00003	(a)	TV (unspecified)	0.224	(a)	USEPA R5 (plants)	0.00003	(a) TV (unspecified)
beta-BHC	0.001		USEPA R4 (unspecified)	0.00398		USEPA R5 (plants)	0.009	TV (unspecified)
delta-BHC	NV			NV			9.9	USEPA R5 (shrew/vole)
Dieldrin	0.0005		USEPA R4 (unspecified)	0.0005		USEPA R4 (unspecified)	0.0049	Eco-SSL (mammals)
Endosulfan I	0.00001	(u)	TV (unspecified)	0.00001	(u)	TV (unspecified)	0.12	USEPA R5 (shrew/vole)
Endosulfan II	0.00001	(u)	TV (unspecified)	0.00001	(u)	TV (unspecified)	0.12	USEPA R5 (shrew/vole)
Endosulfan sulfate	0.00001	(u)	TV (unspecified)	0.00001	(u)	TV (unspecified)	0.036	USEPA R5 (shrew/vole)
Endrin	0.001		USEPA R4 (unspecified)	0.001		USEPA R4 (unspecified)	0.010	USEPA R5 (shrew/vole)
Endrin aldehyde	0.001	(m)	USEPA R4 (unspecified)	0.001	(m)	USEPA R4 (unspecified)	0.011	USEPA R5 (shrew/vole)
Endrin ketone	0.001	(m)	USEPA R4 (unspecified)	0.001	(m)	USEPA R4 (unspecified)	0.010	(m) USEPA R5 (shrew/vole)
gamma-BHC	0.00005		USEPA R4 (unspecified)	0.005		USEPA R5 (plants)	0.00005	TV (unspecified)
gamma-Chlordane	0.00003	(a)	TV (unspecified)	0.224	(a)	USEPA R5 (plants)	0.00003	(a) TV (unspecified)
Heptachlor	NV			NV			0.0060	USEPA R5 (shrew/vole)
Heptachlor epoxide	NV			NV			0.15	USEPA R5 (shrew/vole)
Methoxychlor	NV			NV			0.020	USEPA R5 (shrew/vole)
Toxaphene	NV			NV			0.12	USEPA R5 (shrew/vole)
<b>POLYCHLORINATED BIPHENYLS</b>								
Aroclor-1016	33	(p)	CCME (commercial)	40	(p)	ORNL (plants)	1.3	(p) CCME (residential/parkland)
Aroclor-1221	33	(p)	CCME (commercial)	40	(p)	ORNL (plants)	1.3	(p) CCME (residential/parkland)
Aroclor-1232	33	(p)	CCME (commercial)	40	(p)	ORNL (plants)	1.3	(p) CCME (residential/parkland)
Aroclor-1242	33	(p)	CCME (commercial)	40	(p)	ORNL (plants)	1.3	(p) CCME (residential/parkland)
Aroclor-1248	33	(p)	CCME (commercial)	40	(p)	ORNL (plants)	1.3	(p) CCME (residential/parkland)
Aroclor-1254	33	(p)	CCME (commercial)	40	(p)	ORNL (plants)	1.3	(p) CCME (residential/parkland)
Aroclor-1260	33	(p)	CCME (commercial)	40	(p)	ORNL (plants)	1.3	(p) CCME (residential/parkland)
Aroclor-1262	33	(p)	CCME (commercial)	40	(p)	ORNL (plants)	1.3	(p) CCME (residential/parkland)
Aroclor-1268	33	(p)	CCME (commercial)	40	(p)	ORNL (plants)	1.3	(p) CCME (residential/parkland)
Total PCBs	33		CCME (commercial)	40		ORNL (plants)	1.3	CCME (residential/parkland)

Notes:  
 All screening values reported in milligram per kilogram (mg/kg).  
 CCME - Canadian Council of Ministers of the Environment (2002). Commercial value based on direct contact. Residential/parkland value based on soil and food ingestion.  
 Eco-SSL - Ecological Soil Screening Level. Derived by USEPA according to USEPA guidance (2005c).  
 HMW - High Molecular Weight.  
 LMW - Low Molecular Weight.  
 NV - No value identified.  
 ORNL - Oak Ridge National Laboratory (Efroymson, et al., 1997a and b).  
 PAH - Polycyclic Aromatic Hydrocarbon.  
 PCB - Polychlorinated Biphenyl.  
 SVOC - Semivolatile Organic Compound.  
 TV - Target Value (Dutch standards presented in Buchman, 2008).  
 USEPA - United States Environmental Protection Agency.  
 USEPA R4 - USEPA Region 4 recommended ecological screening values for soil (USEPA, 2001c).  
 USEPA R5 - USEPA Region 5 ecological screening levels for soil (USEPA, 2003c).  
 VOC - Volatile Organic Compound.

- (a) Value for chlordane used due to structural similarities.
- (b) Value for diethyl phthalate used due to structural similarities.
- (c) Value for di-n-butyl phthalate used due to structural similarities.
- (d) Value for 2,4,5-trichlorophenol used due to structural similarities.
- (e) Value for 3-chloroaniline used as a surrogate due to structural similarities.
- (f) Value for 3-chlorophenol used as a surrogate due to structural similarities.
- (g) Value for 3,4-dichlorophenol used as a surrogate due to structural similarities.
- (h) Value for 1,2-dichloropropane used as a surrogate due to structural similarities.
- (i) Value for dimethyl phthalate used as a surrogate due to structural similarities.
- (j) Value for 4-nitrophenol used as a surrogate due to structural similarities.
- (k) Value for 1,4-dichlorobenzene used as a surrogate due to structural similarities.
- (l) Value for acenaphthene used as a surrogate for individual PAHs without values.
- (m) Value for endrin used due to structural similarities.
- (n) Value for benzene used due to structural similarities.
- (o) Generic value for phthalates (total) used as a surrogate.
- (p) Value for Total PCBs used for individual Aroclors without screening values.
- (q) Value for toluene used due to structural similarities.
- (r) Value for Total HMW PAHs used for individual HMW PAHs without screening values.
- (s) Value for Total LMW PAHs used for individual LMW PAHs without screening values.
- (t) Value for DDT (Total) used.
- (u) Value for endosulfan used due to structural similarities.
- (v) Value for trans-1,2-dichloroethene used as a surrogate due to structural similarities.
- (w) Value for 1,2,4 trichlorobenzene used as a surrogate due to structural similarities.
- (x) Value provided is for methylmercury.

TABLE 6  
 ECOLOGICAL SCREENING VALUES - MARINE SEDIMENT  
 ECOLOGICAL RISK ASSESSMENT  
 NEWPORT, RHODE ISLAND

Chemical	ECOLOGICAL SCREENING LEVELS FOR SEDIMENT			
	Value for Use in SRA		Value for Use in BERA	
<b>INORGANICS</b>				
Aluminum	18000	NOAA SQuiRT (Marine; AET)	25500	NOAA SQuiRT (Freshwater; ARCS)
Antimony	2	NOAA ERL (Freshwater)	25	NOAA ERM (Freshwater)
Arsenic	8.2	NOAA ERL (Marine)	70	NOAA ERM (Marine)
Barium	48	NOAA SQuiRT (Marine; AET)	130.1	NOAA SQuiRT (Marine; TEL)
Beryllium	NV		NV	
Cadmium	1.2	NOAA ERL (Marine)	9.6	NOAA ERM (Marine)
Calcium	NV		NV	
Chromium	81	NOAA ERL (Marine)	370	NOAA ERM (Marine)
Cobalt	10	NOAA SQuiRT (Marine; AET)	50	NOAA SQuiRT (Freshwater; LEL)
Copper	34	NOAA ERL (Marine)	270	NOAA ERM (Marine)
Iron	220000	NOAA SQuiRT (Marine; AET)	NV	
Lead	46.7	NOAA ERL (Marine)	218	NOAA ERM (Marine)
Magnesium	NV		NV	
Manganese	260	NOAA SQuiRT (Marine; AET)	1100	NOAA SQuiRT (Freshwater; UET)
Mercury	0.15	NOAA ERL (Marine)	0.71	NOAA ERM (Marine)
Nickel	20.9	NOAA ERL (Marine)	51.6	NOAA ERM (Marine)
Potassium	NV		NV	
Selenium	1	NOAA SQuiRT (Marine; AET)	NV	
Silver	1	NOAA ERL (Marine)	3.7	NOAA ERM (Marine)
Sodium	NV		NV	
Thallium	NV		NV	
Vanadium	57	NOAA SQuiRT (Marine; AET)	NV	
Zinc	150	NOAA ERL (Marine)	410	NOAA ERM (Marine)
<b>SEMI VOLATILE ORGANIC COMPOUNDS</b>				
1,2-Dichlorobenzene	0.013	NOAA SQuiRT (Marine; AET)	0.34	NOAA SQuiRT (EcoTox EqP @ 1% TOC)
1,2-Diphenylhydrazine	NV		NV	
1,3-Dichlorobenzene	0.013	(j) NOAA SQuiRT (Marine; AET)	1.7	NOAA SQuiRT (EcoTox EqP @ 1% TOC)
1,4-Dichlorobenzene	0.11	NOAA SQuiRT (Marine; AET)	0.35	NOAA SQuiRT (EcoTox EqP @ 1% TOC)
2,4,5-Trichlorophenol	0.003	NOAA SQuiRT (Marine; AET)	NV	
2,4,6-Trichlorophenol	0.006	NOAA SQuiRT (Marine; AET)	NV	
2,4-Dichlorophenol	0.0002083	NOAA SQuiRT (Marine; AET)	NV	
2,4-Dimethylphenol	0.018	NOAA SQuiRT (Marine; AET)	NV	
2,4-Dinitrophenol	NV		NV	
2,4-Dinitrotoluene	0.0416	(h) USEPA R3 (Marine)	NV	
2,6-Dichlorophenol	0.0002083	(k) NOAA SQuiRT (Marine; AET)	NV	
2,6-Dinitrotoluene	0.0416	(h,o) USEPA R3 (Marine)	NV	
2-Chloronaphthalene	NV		NV	
2-Chlorophenol	0.000333	NOAA SQuiRT (Marine; AET)	NV	
2-Methylnaphthalene	0.07	NOAA ERL (Marine)	0.67	NOAA ERM (Marine)
2-Methylphenol	0.008	NOAA SQuiRT (Marine; AET)	NV	
2-Nitroaniline	NV		NV	
2-Nitrophenol	NV		NV	
3,3'-Dichlorobenzidine	2.06	(a) USEPA R3 (Marine)	NV	
3-Methylphenol & 4-Methylphenol	0.1	(p) NOAA SQuiRT (Marine; AET)	NV	
3-Nitroaniline	NV		NV	
4,6-Dinitro-2-methylphenol	NV		NV	
4-Bromophenyl phenyl ether	1.23	(h) USEPA R3 (Marine)	NV	
4-Chloro-3-methylphenol	NV		NV	
4-Chloroaniline	NV		NV	
4-Chlorophenyl phenyl ether	NV		NV	
4-Nitroaniline	NV		NV	
4-Nitrophenol	NV		NV	
Benidine	NV		NV	
Benzoic acid	0.065	NOAA SQuiRT (Marine; AET)	NV	
Benzyl alcohol	0.052	NOAA SQuiRT (Marine; AET)	NV	
Bis(2-chlorethoxy)methane	NV		NV	
Bis(2-chloroethyl) ether	NV		NV	
Bis(2-chloroisopropyl) ether	NV		NV	
Bis(2-Ethylhexyl)phthalate	0.182	NOAA SQuiRT (Marine; TEL)	2.647	NOAA SQuiRT (Marine; PEL)
Butyl benzyl phthalate	0.063	NOAA SQuiRT (Marine; AET)	1.1	NOAA SQuiRT (EcoTox EqP @ 1% TOC)
Caprolactam	NV		NV	
Carbazole	NV		NV	
Dibenzofuran	0.11	NOAA SQuiRT (Marine; AET)	2	NOAA SQuiRT (EcoTox EqP @ 1% TOC)
Diethyl phthalate	0.006	NOAA SQuiRT (Marine; AET)	0.63	NOAA SQuiRT (EcoTox EqP @ 1% TOC)
Dimethyl phthalate	0.006	NOAA SQuiRT (Marine; AET)	0.63	(q) NOAA SQuiRT (EcoTox EqP @ 1% TOC)
Di-n-butyl phthalate	0.058	NOAA SQuiRT (Marine; AET)	11	NOAA SQuiRT (EcoTox EqP @ 1% TOC)
Di-n-octyl phthalate	0.061	NOAA SQuiRT (Marine; AET)	11	(r) NOAA SQuiRT (EcoTox EqP @ 1% TOC)
Hexachlorobenzene	0.006	NOAA SQuiRT (Marine; AET)	NV	
Hexachlorobutadiene	0.0013	NOAA SQuiRT (Marine; AET)	NV	
Hexachloroethane	0.073	NOAA SQuiRT (Marine; AET)	1	NOAA SQuiRT (EcoTox EqP @ 1% TOC)
Isophorone	NV		NV	
Nitrobenzene	0.021	NOAA SQuiRT (Marine; AET)	NV	
N-Nitrosodimethylamine	NV		NV	
N-Nitrosodi-n-propylamine	NV		NV	
N-Nitrosodiphenylamine	0.028	NOAA SQuiRT (Marine; AET)	NV	
N-Nitrosopyrrolidine	NV		NV	
Pentachlorophenol	0.017	NOAA SQuiRT (Marine; AET)	NV	
Phenol	0.13	NOAA SQuiRT (Marine; AET)	NV	

TABLE 6  
 ECOLOGICAL SCREENING VALUES - MARINE SEDIMENT  
 ECOLOGICAL RISK ASSESSMENT  
 NEWPORT, RHODE ISLAND

Chemical	ECOLOGICAL SCREENING LEVELS FOR SEDIMENT				
	Value for Use in SRA		Value for Use in BERA		
Acenaphthene	0.016		NOAA ERL (Marine)	0.5	NOAA ERM (Marine)
Acenaphthylene	0.044		NOAA ERL (Marine)	0.64	NOAA ERM (Marine)
Anthracene	0.0853		NOAA ERL (Marine)	1.1	NOAA ERM (Marine)
Benzo(a)anthracene	0.261		NOAA ERL (Marine)	1.6	NOAA ERM (Marine)
Benzo(a)pyrene	0.43		NOAA ERL (Marine)	1.6	NOAA ERM (Marine)
Benzo(b)fluoranthene	0.6	(d)	NOAA ERL (Marine)	5.1	(d) NOAA ERM (Marine)
Benzo(g,h,i)perylene	0.0634	(e)	NOAA ERL (Marine)	0.26	(e) NOAA ERM (Marine)
Benzo(k)fluoranthene	0.6	(d)	NOAA ERL (Marine)	5.1	(d) NOAA ERM (Marine)
Chrysene	0.384		NOAA ERL (Marine)	2.8	NOAA ERM (Marine)
Dibenzo(a,h)anthracene	0.0634		NOAA ERL (Marine)	0.26	NOAA ERM (Marine)
Fluoranthene	0.6		NOAA ERL (Marine)	5.1	NOAA ERM (Marine)
Fluorene	0.019		NOAA ERL (Marine)	0.54	NOAA ERM (Marine)
Indeno(1,2,3-cd)pyrene	0.0634	(e)	NOAA ERL (Marine)	0.26	(e) NOAA ERM (Marine)
Naphthalene	0.16		NOAA ERL (Marine)	2.1	NOAA ERM (Marine)
Phenanthrene	0.24		NOAA ERL (Marine)	1.5	NOAA ERM (Marine)
Pyrene	0.665		NOAA ERL (Marine)	2.6	NOAA ERM (Marine)
Total PAHs	4.022		NOAA ERL (Marine)	44.792	NOAA ERM (Marine)
Total LMW PAHs	0.552		NOAA ERL (Marine)	3.16	NOAA ERM (Marine)
Total HMW PAHs	1.7		NOAA ERL (Marine)	9.6	NOAA ERM (Marine)
<b>VOLATILE ORGANIC COMPOUNDS</b>					
1,1,1,2-Tetrachloroethane	NV			NV	
1,1,1-Trichloroethane	0.856	(a)	USEPA R3 (Marine)	NV	
1,1,2,2-Tetrachloroethane	0.202	(a)	USEPA R3 (Marine)	NV	
1,1,2-Trichloroethane	0.57	(a)	USEPA R3 (Marine)	NV	
1,1-Biphenyl	NV			NV	
1,1-Dichloroethane	NV			NV	
1,1-Dichloroethene	2.78	(a)	USEPA R3 (Marine)	NV	
1,1-Dichloropropene	NV			NV	
1,2,3-Trichlorobenzene	0.0048	(l)	NOAA SQuiRT (Marine; AET)	9.2	(l) NOAA SQuiRT (EcoTox EqP @ 1% TOC)
1,2,3-Trichloropropane	NV			NV	
1,2,4-Trichlorobenzene	0.0048		NOAA SQuiRT (Marine; AET)	9.2	NOAA SQuiRT (EcoTox EqP @ 1% TOC)
1,2,4-Trimethylbenzene	0.137	(a,m)	USEPA R3 (Marine)	0.057	(m) NOAA SQuiRT (EcoTox EqP @ 1% TOC)
1,2-Dibromo-3-chloropropane	NV			NV	
1,2-Dibromoethane	NV			NV	
1,2-Dichlorobenzene	0.013		NOAA SQuiRT (Marine; AET)	0.34	NOAA SQuiRT (EcoTox EqP @ 1% TOC)
1,2-Dichloroethane	NV			NV	
1,2-Dichloropropane	NV			NV	
1,3,5-Trimethylbenzene	0.137	(a,m)	USEPA R3 (Marine)	0.057	(m) NOAA SQuiRT (EcoTox EqP @ 1% TOC)
1,3-Dichlorobenzene	0.013	(j)	NOAA SQuiRT (Marine; AET)	1.7	NOAA SQuiRT (EcoTox EqP @ 1% TOC)
1,3-Dichloropropane	NV			NV	
1,4-Dichlorobenzene	0.11		NOAA SQuiRT (Marine; AET)	0.35	NOAA SQuiRT (EcoTox EqP @ 1% TOC)
2,2-Dichloropropane	NV			NV	
2-Butanone	NV			NV	
2-Chlorotoluene	1.09	(a,n)	USEPA R3 (Marine)	0.67	(n) NOAA SQuiRT (EcoTox EqP @ 1% TOC)
2-Hexanone	NV			NV	
4-Chlorotoluene	1.09	(a,n)	USEPA R3 (Marine)	0.67	(n) NOAA SQuiRT (EcoTox EqP @ 1% TOC)
4-Methyl-2-pentanone	NV			NV	
Acetone	NV			NV	
Benzene	0.137	(a)	USEPA R3 (Marine)	0.057	NOAA SQuiRT (EcoTox EqP @ 1% TOC)
Bromobenzene	0.137	(a,m)	USEPA R3 (Marine)	0.057	(m) NOAA SQuiRT (EcoTox EqP @ 1% TOC)
Bromochloromethane	NV			NV	
Bromodichloromethane	NV			NV	
Bromoform	1.31	(a)	USEPA R3 (Marine)	0.65	NOAA SQuiRT (EcoTox EqP @ 1% TOC)
Bromomethane	NV			NV	
Carbon Disulfide	0.000851	(h)	USEPA R3 (Marine)	NV	
Carbon tetrachloride	7.24	(a)	USEPA R3 (Marine)	1.2	NOAA SQuiRT (EcoTox EqP @ 1% TOC)
Chlorobenzene	0.162	(a)	USEPA R3 (Marine)	0.82	NOAA SQuiRT (EcoTox EqP @ 1% TOC)
Chlorodibromomethane	NV			NV	
Chloroethane	NV			NV	
Chloroform	NV			NV	
Chloromethane	NV			NV	
cis-1,2-Dichloroethene	NV			NV	
cis-1,3-Dichloropropene	NV			NV	
Dibromomethane	NV			NV	
Dichlorodifluoromethane	NV			NV	
Ethylbenzene	0.004		NOAA SQuiRT (Marine; AET)	3.6	NOAA SQuiRT (EcoTox EqP @ 1% TOC)
Hexachlorobutadiene	0.0013		NOAA SQuiRT (Marine; AET)	NV	
Isopropylbenzene	0.086	(h)	USEPA R3 (Marine)	0.057	(m) NOAA SQuiRT (EcoTox EqP @ 1% TOC)
Methylcyclohexane	NV			NV	
Methyl tert-butyl ether	NV			NV	
Methylene chloride	NV			NV	
n-Butylbenzene	0.137	(a,m)	USEPA R3 (Marine)	0.057	(m) NOAA SQuiRT (EcoTox EqP @ 1% TOC)
n-Propylbenzene	0.137	(a,m)	USEPA R3 (Marine)	0.057	(m) NOAA SQuiRT (EcoTox EqP @ 1% TOC)
p-Isopropyltoluene	1.09	(a,n)	USEPA R3 (Marine)	0.67	(n) NOAA SQuiRT (EcoTox EqP @ 1% TOC)
sec-Butylbenzene	0.137	(a,m)	USEPA R3 (Marine)	0.057	(m) NOAA SQuiRT (EcoTox EqP @ 1% TOC)
Styrene	7.07	(a)	USEPA R3 (Marine)	NV	
tert-Butyl-Alcohol	NV			NV	
tert-Butylbenzene	0.137	(a,m)	USEPA R3 (Marine)	0.057	(m) NOAA SQuiRT (EcoTox EqP @ 1% TOC)
Tetrachloroethene	0.057		NOAA SQuiRT (Marine; AET)	0.53	NOAA SQuiRT (EcoTox EqP @ 1% TOC)
Toluene	1.09	(a)	USEPA R3 (Marine)	0.67	NOAA SQuiRT (EcoTox EqP @ 1% TOC)
Total-1,2-Dichloroethene	NV			NV	
trans-1,2-Dichloroethene	1.05	(h)	USEPA R3 (Marine)	NV	
trans-1,3-Dichloropropene	NV			NV	
Trichloroethene	0.041		NOAA SQuiRT (Marine; AET)	1.6	NOAA SQuiRT (EcoTox EqP @ 1% TOC)
Trichlorofluoromethane	NV			NV	
Vinyl chloride	NV			NV	
Xylenes (total)	0.004		NOAA SQuiRT (Marine; AET)	0.025	(s) NOAA SQuiRT (EcoTox EqP @ 1% TOC)

TABLE 6  
 ECOLOGICAL SCREENING VALUES - MARINE SEDIMENT  
 ECOLOGICAL RISK ASSESSMENT  
 NEWPORT, RHODE ISLAND

Chemical	ECOLOGICAL SCREENING LEVELS FOR SEDIMENT				
	Value for Use in SRA		Value for Use in BERA		
<b>PESTICIDES</b>					
4,4'-DDD	0.002		NOAA SQuiRT (Marine; ERL)	0.02	NOAA SQuiRT (Marine; ERM)
4,4'-DDE	0.0022		NOAA ERL (Marine)	0.027	NOAA ERM (Marine)
4,4'-DDT	0.00158	(c)	NOAA ERL (Marine)	0.0461	(c) NOAA ERM (Marine)
Aldrin	0.0095		NOAA SQuiRT (Marine; AET)	0.08	NOAA SQuiRT (Freshwater; SEL)
alpha-BHC	0.00032	(i)	NOAA SQuiRT (Marine; TEL)	0.0048	(i) NOAA SQuiRT (Marine; AET)
alpha-Chlordane	0.0005	(b)	NOAA SQuiRT (Marine; ERL)	0.006	(b) NOAA SQuiRT (Marine; ERM)
beta-BHC	0.00032	(i)	NOAA SQuiRT (Marine; TEL)	0.0048	(i) NOAA SQuiRT (Marine; AET)
delta-BHC	0.00032	(i)	NOAA SQuiRT (Marine; TEL)	0.0048	(i) NOAA SQuiRT (Marine; AET)
Dieldrin	0.0002		NOAA SQuiRT (Marine; ERL)	0.008	NOAA SQuiRT (Marine; ERM)
Endosulfan I	0.0029	(h)	USEPA R3 (Marine)	NV	
Endosulfan II	0.014	(h)	USEPA R3 (Marine)	NV	
Endosulfan sulfate	0.000357	(a)	USEPA R3 (Marine)	NV	
Endrin	0.00267		USEPA R3 (Marine)	NV	
Endrin aldehyde	0.00267	(g)	USEPA R3 (Marine)	NV	
Endrin ketone	0.00267	(g)	USEPA R3 (Marine)	NV	
gamma-BHC	0.00032		NOAA SQuiRT (Marine; TEL)	0.0048	NOAA SQuiRT (Marine; AET)
gamma-Chlordane	0.0005	(b)	NOAA SQuiRT (Marine; ERL)	0.006	(b) NOAA SQuiRT (Marine; ERM)
Heptachlor	0.0003		NOAA SQuiRT (Marine; AET)	NV	
Heptachlor epoxide	0.0006		NOAA SQuiRT (Marine; T20)	NV	
Methoxychlor	0.0296	(a)	USEPA R3 (Marine)	NV	
Toxaphene	0.0001		NOAA SQuiRT (Marine; TEL)	0.028	NOAA SQuiRT (EcoTox EqP @ 1% TOC)
<b>POLYCHLORINATED BIPHENYLS</b>					
Aroclor-1016	0.0227	(f)	NOAA ERL (Marine)	0.18	(f) NOAA ERM (Marine)
Aroclor-1221	0.0227	(f)	NOAA ERL (Marine)	0.18	(f) NOAA ERM (Marine)
Aroclor-1232	0.0227	(f)	NOAA ERL (Marine)	0.18	(f) NOAA ERM (Marine)
Aroclor-1242	0.0227	(f)	NOAA ERL (Marine)	0.18	(f) NOAA ERM (Marine)
Aroclor-1248	0.0227	(f)	NOAA ERL (Marine)	0.18	(f) NOAA ERM (Marine)
Aroclor-1254	0.0227	(f)	NOAA ERL (Marine)	0.18	(f) NOAA ERM (Marine)
Aroclor-1260	0.0227	(f)	NOAA ERL (Marine)	0.18	(f) NOAA ERM (Marine)
Aroclor-1262	0.0227	(f)	NOAA ERL (Marine)	0.18	(f) NOAA ERM (Marine)
Aroclor-1268	0.0227	(f)	NOAA ERL (Marine)	0.18	(f) NOAA ERM (Marine)
Total PCBs	0.0227		NOAA ERL (Marine)	0.18	NOAA ERM (Marine)

Notes:

- All screening values reported in milligram per kilogram (mg/kg).
- AET - Apparent Effect Threshold.
- ARCS - Assessment and Remediation of Contaminated Sediments TEL for *Hyalella azteca* as presented in Buchman (2008).
- BERA - Baseline Ecological Risk Assessment.
- EcoTox EqP @ 1% TOC - EcoUpdate EcoTox Thresholds derived using equilibrium partitioning and assumption of 1% total organic carbon.
- ERL - Effects Range Low (Marine - Long, et al., 1995; Freshwater - Long and Morgan, 1991).
- ERM - Effects Range Median (Marine - Long, et al., 1995; Freshwater - Long and Morgan, 1991).
- HMW - High Molecular Weight.
- LMW - Low Molecular Weight.
- NOAA - National Oceanic and Atmospheric Administration.
- NV - No value identified.
- PAH - Polycyclic Aromatic Hydrocarbon.
- PCB - Polychlorinated Biphenyl.
- SQuiRT - Screening Quick Reference Tables (Buchman, 2008).
- SRA - Screening Risk Assessment.
- SVOC - Semivolatile organic compound
- T20 - 20% Effect Level.
- TEL - Threshold Effect Level.
- USEPA - United States Environmental Protection Agency.
- USEPA R3 - USEPA Region 3 marine sediment screening values (USEPA, 2006a,b).
- VOC - Volatile Organic Compound.

- (a) Value derived from the equilibrium partitioning (EqP) method with Region 3 surface water screening values and logK<sub>ow</sub> values. Only logK<sub>ow</sub> values between 2 and 6 were used.
- (b) Value for chlordane.
- (c) Value for Total DDT used.
- (d) Value for fluoranthene used as a surrogate due to structural similarities.
- (e) Value for dibenzo(a,h)anthracene used as a surrogate due to structural similarities.
- (f) Value for Total PCBs used for individual Aroclors without screening values.
- (g) Value for endrin used due to structural similarities.
- (h) Region 3 freshwater value used when Region 3 marine value is not derived.
- (i) Value for gamma-BHC used due to structural similarities.
- (j) Value for 1,2-dichlorobenzene used due to structural similarities.
- (k) Value for 2,4-dichlorophenol used due to structural similarities.
- (l) Value for 1,2,4 trichlorobenzene used due to structural similarities.
- (m) Value for benzene used due to structural similarities.
- (n) Value for toluene used due to structural similarities.
- (o) Value for 2,4-dinitrotoluene used due to structural similarities.
- (p) Value for 4-methylphenol used due to structural similarities.
- (q) Value for diethyl phthalate used due to structural similarities.
- (r) Value for di-n-butyl phthalate used due to structural similarities.
- (s) Value for m-xylene used due to structural similarities.

TABLE 7  
 TOXICITY REFERENCE VALUES FOR FOOD CHAIN MODELS  
 ECOLOGICAL RISK ASSESSMENT  
 NEWPORT, RHODE ISLAND

Chemical	Mammalian TRV (mg/kg bw/day)		Avian TRV (mg/kg bw/day)	
	NOAEL	LOAEL	NOAEL	LOAEL
<b>INORGANICS</b>				
Aluminum	1.93	19.3	109.7	1097
Antimony	0.059	2.76	NV	NV
Arsenic	1.04	4.55	2.24	4.51
Barium	51.8	82.7	NV	NV
Beryllium	0.532	0.673	NV	NV
Cadmium	0.77	6.9	1.47	6.35
Chromium	2.4	58.17	2.66	15.63
Cobalt	7.33	18.9	7.61	18.34
Copper	5.6	82.7	4.05	34.87
Iron	50	500	100	1000
Lead	4.7	186.4	1.63	44.63
Manganese	51.5	146	179	377
Mercury	0.032	0.16	0.0064	0.064
Nickel	1.7	14.77	6.71	18.57
Selenium	0.143	0.66	0.29	0.82
Silver	6.02	118.6	2.02	60.47
Thallium	0.0074	0.074	NV	NV
Vanadium	4.16	9.44	0.34	1.7
Zinc	75.4	298	66.1	171
<b>SEMI VOLATILE ORGANIC COMPOUNDS</b>				
Acenaphthene	65.6	356	2	20
Acenaphthylene	65.6	356	2	20
Anthracene	65.6	356	2	20
Benzo(a)anthracene	0.615	38.4	2	20
Benzo(a)pyrene	0.615	38.4	2	20
Benzo(b)fluoranthene	0.615	38.4	2	20
Benzo(g,h,i)perylene	0.615	38.4	2	20
Benzo(k)fluoranthene	0.615	38.4	2	20
Chrysene	0.615	38.4	2	20
Dibenzo(a,h)anthracene	0.615	38.4	2	20
Fluoranthene	65.6	356	2	20
Fluorene	65.6	356	2	20
Indeno(1,2,3-cd)pyrene	0.615	38.4	2	20
Naphthalene	65.6	356	2	20
Phenanthrene	65.6	356	2	20
Pyrene	0.615	38.4	2	20
<b>PESTICIDES</b>				
4,4'-DDD	0.147	5.56	0.227	2.7
4,4'-DDE	0.147	5.56	0.227	2.7
4,4'-DDT	0.147	5.56	0.227	2.7
Aldrin	0.2	1	NV	NV
alpha-BHC	0.014	0.14	NV	NV
alpha-Chlordane	4.58	9.16	NV	NV
beta-BHC	0.014	0.14	NV	NV
delta-BHC	0.014	0.14	NV	NV
Dieldrin	0.015	1.27	NV	NV
Endosulfan I	0.15	1.5	NV	NV
Endosulfan II	0.15	1.5	NV	NV
Endosulfan Sulfate	0.15	1.5	NV	NV
Endrin	0.092	0.92	NV	NV
Endrin Aldehyde	0.92	0.92	NV	NV
Endrin Ketone	0.92	0.92	NV	NV
gamma-BHC	8	80	NV	NV
gamma-Chlordane	4.58	9.16	NV	NV
Heptachlor	0.1	1	NV	NV
Heptachlor epoxide	0.1	1	NV	NV
Methoxychlor	4	8	NV	NV
Toxaphene	8	10	NV	NV

TABLE 7  
 TOXICITY REFERENCE VALUES FOR FOOD CHAIN MODELS  
 ECOLOGICAL RISK ASSESSMENT  
 NEWPORT, RHODE ISLAND

Chemical	Mammalian TRV (mg/kg bw/day)		Avian TRV (mg/kg bw/day)	
	NOAEL	LOAEL	NOAEL	LOAEL
<b>POLYCHLORINATED BIPHENYLS</b>			NV	NV
Aroclor 1016	1.37	3.43	NV	NV
Aroclor 1221	NV	NV	NV	NV
Aroclor 1232	NV	NV	NV	NV
Aroclor 1242	0.069	0.69	0.41	4.1
Aroclor 1248	0.01	1	NV	NV
Aroclor 1254	0.068	0.68	0.18	1.8
Aroclor 1260	0.068	0.68	0.18	1.8
Total PCBs	0.068	0.68	0.18	1.8

Notes:

NV - No value identified.

NOAEL - No Observed Adverse Effects Level.

LOAEL - Lowest Observed Adverse Effects Level.

TRV - Toxicity Reference Value.

The sources of these NOAELs and LOAELs are presented in Table 8.

The NOAELs and LOAELs in Table 9 were divided by 10 if a subchronic study was the basis for the value. If only a NOAEL was available, the value was multiplied by 10 to estimate the LOAEL. If only a LOAEL was available, the value was divided by 10 to estimate the NOAEL.

TABLE 8  
 SOURCES AND ENPOINTS FOR DERIVATION OF WILDLIFE TOXICITY REFERENCE VALUES  
 ECOLOGICAL RISK ASSESSMENT  
 NEWPORT, RHODE ISLAND

Chemical	Concentration (mg/kg bw/day)	Endpoint	Effect	Chronic/ Subchronic	Species	Primary Reference	Source of Reference
<b>INORGANICS</b>							
Aluminum	109.7	NOAEL	reproductive	chronic	ringed dove	Carriere et al., 1986	Sample et al., 1996
Aluminum	19.3	LOAEL	reproductive	chronic	mouse	Ondreicka et al., 1966	Sample et al., 1996
Antimony	0.059	NOAEL	reproduction & growth	chronic	mammals	USEPA, 2005a	
Antimony	2.76	LOAEL	reproduction & growth	chronic	mammals	USEPA, 2005a	
Arsenic	2.24	NOAEL	reproduction & growth	chronic	birds	USEPA, 2005b	
Arsenic	4.51	LOAEL	reproduction & growth	chronic	birds	USEPA, 2005b	
Arsenic	1.04	NOAEL	reproduction & growth	chronic	mammals	USEPA, 2005b	
Arsenic	4.55	LOAEL	reproduction & growth	chronic	mammals	USEPA, 2005b	
Barium	51.8	NOAEL	reproduction & growth	chronic	mammals	USEPA, 2005c	
Barium	82.7	LOAEL	reproduction & growth	chronic	mammals	USEPA, 2005c	
Beryllium	0.532	NOAEL	reproduction & growth	chronic	rat	USEPA, 2005d	
Beryllium	0.673	LOAEL	reproduction & growth	chronic	mammals	USEPA, 2005d	
Cadmium	1.47	NOAEL	reproduction & growth	chronic	birds	USEPA, 2005e	
Cadmium	6.35	LOAEL	reproduction & growth	chronic	birds	USEPA, 2005e	
Cadmium	0.77	NOAEL	reproduction & growth	chronic	mammals	USEPA, 2005e	
Cadmium	6.9	LOAEL	reproduction & growth	chronic	mammals	USEPA, 2005e	
Chromium(III)	2.66	NOAEL	reproduction & growth	chronic	birds	USEPA, 2008	
Chromium(III)	15.63	LOAEL	reproduction & growth	chronic	birds	USEPA, 2008	
Chromium(III)	2.4	NOAEL	reproduction & growth	chronic	mammals	USEPA, 2008	
Chromium(III)	58.17	LOAEL	reproduction & growth	chronic	mammals	USEPA, 2008	
Cobalt	7.61	NOAEL	reproduction & growth	chronic	birds	USEPA, 2005f	
Cobalt	18.34	LOAEL	reproduction & growth	chronic	birds	USEPA, 2005f	
Cobalt	7.33	NOAEL	reproduction & growth	chronic	mammals	USEPA, 2005f	
Cobalt	18.9	LOAEL	reproduction & growth	chronic	mammals	USEPA, 2005f	
Copper	4.05	NOAEL	reproduction & growth	chronic	birds	USEPA, 2007a	
Copper	34.87	LOAEL	reproduction & growth	chronic	birds	USEPA, 2007a	
Copper	5.6	NOAEL	reproduction & growth	chronic	mammals	USEPA, 2007a	
Copper	82.7	LOAEL	reproduction & growth	chronic	mammals	USEPA, 2007a	
Iron	500	LOAEL	unknown	chronic	rabbit	NAS, 1980	
Iron	1000	LOAEL	unknown	chronic	poultry	NAS, 1980	
Lead	1.63	NOAEL	reproduction & growth	chronic	birds	USEPA, 2005g	
Lead	44.6	LOAEL	reproduction & growth	chronic	birds	USEPA, 2005g	
Lead	4.7	NOAEL	reproduction & growth	chronic	mammals	USEPA, 2005g	
Lead	186.4	LOAEL	reproduction & growth	chronic	mammals	USEPA, 2005g	
Manganese	179	NOAEL	reproduction & growth	chronic	birds	USEPA, 2007b	
Manganese	376.6	LOAEL	reproduction & growth	chronic	birds	USEPA, 2007b	
Manganese	51.5	NOAEL	reproduction & growth	chronic	mammals	USEPA, 2007b	
Manganese	145.67	LOAEL	reproduction & growth	chronic	mammals	USEPA, 2007b	
Mercury	0.064	LOAEL	reproductive	chronic	mallard duck	Heinz, 1979	Sample et al., 1996
Mercury	0.032	NOAEL	reproductive	chronic	rat	Verschuuren et al., 1976	Sample et al., 1996
Mercury	0.16	LOAEL	reproductive	chronic	rat	Verschuuren et al., 1976	Sample et al., 1996
Nickel	6.71	NOAEL	reproduction & growth	chronic	birds	USEPA, 2007c	
Nickel	18.57	LOAEL	reproduction & growth	chronic	birds	USEPA, 2007c	
Nickel	1.7	NOAEL	reproduction & growth	chronic	mammals	USEPA, 2007c	
Nickel	14.77	LOAEL	reproduction & growth	chronic	mammals	USEPA, 2007c	
Selenium	0.29	NOAEL	reproduction & growth	chronic	birds	USEPA, 2007d	
Selenium	0.819	LOAEL	reproduction & growth	chronic	birds	USEPA, 2007d	
Selenium	0.143	NOAEL	reproduction & growth	chronic	mammals	USEPA, 2007d	
Selenium	0.661	LOAEL	reproduction & growth	chronic	mammals	USEPA, 2007d	
Silver	2.02	NOAEL	reproduction & growth	chronic	birds	USEPA, 2006	
Silver	60.47	LOAEL	reproduction & growth	chronic	birds	USEPA, 2006	
Silver	6.02	NOAEL	reproduction & growth	chronic	mammals	USEPA, 2006	
Silver	118.62	LOAEL	reproduction & growth	chronic	mammals	USEPA, 2006	

TABLE 8  
 SOURCES AND ENPOINTS FOR DERIVATION OF WILDLIFE TOXICITY REFERENCE VALUES  
 ECOLOGICAL RISK ASSESSMENT  
 NEWPORT, RHODE ISLAND

Chemical	Concentration (mg/kg bw/day)	Endpoint	Effect	Chronic/ Subchronic	Species	Primary Reference	Source of Reference
Thallium	0.0074	NOAEL	reproduction	subchronic	rat	Formigli, et al., 1986	Sample et al., 1996
Thallium	0.074	LOAEL	reproduction	subchronic	rat	Formigli, et al., 1986	Sample et al., 1996
Vanadium	0.344	NOAEL	reproduction & growth	chronic	birds	USEPA, 2005h	
Vanadium	1.686	LOAEL	reproduction & growth	chronic	birds	USEPA, 2005h	
Vanadium	4.16	NOAEL	reproduction & growth	chronic	mammals	USEPA, 2005h	
Vanadium	9.436	LOAEL	reproduction & growth	chronic	mammals	USEPA, 2005h	
Zinc	75.4	NOAEL	reproduction & growth	chronic	mammals	USEPA, 2007e	
Zinc	297.58	LOAEL	reproduction & growth	chronic	mammals	USEPA, 2007e	
Zinc	66.1	NOAEL	reproduction & growth	chronic	birds	USEPA, 2007e	
Zinc	171.44	LOAEL	reproduction & growth	chronic	birds	USEPA, 2007e	
<b>SEMI VOLATILE ORGANIC COMPOUNDS</b>							
Acenaphthene	65.6	NOAEL	reproduction & growth	chronic	mammals	USEPA, 2007f	
Acenaphthene	356	LOAEL	reproduction & growth	chronic	mammals	USEPA, 2007f	
Acenaphthylene	65.6	NOAEL	reproduction & growth	chronic	mammals	USEPA, 2007f	
Acenaphthylene	356	LOAEL	reproduction & growth	chronic	mammals	USEPA, 2007f	
Anthracene	65.6	NOAEL	reproduction & growth	chronic	mammals	USEPA, 2007f	
Anthracene	356	LOAEL	reproduction & growth	chronic	mammals	USEPA, 2007f	
Benzo(a)anthracene	0.615	NOAEL	growth	chronic	mammals	USEPA, 2007f	
Benzo(a)anthracene	38.4	LOAEL	growth	chronic	mammals	USEPA, 2007f	
Benzo(a)pyrene	0.615	NOAEL	growth	chronic	mammals	USEPA, 2007f	
Benzo(a)pyrene	38.4	LOAEL	growth	chronic	mammals	USEPA, 2007f	
Benzo(b)fluoranthene	0.615	NOAEL	reproduction & growth	chronic	mammals	USEPA, 2007f	
Benzo(b)fluoranthene	38.4	LOAEL	reproduction & growth	chronic	mammals	USEPA, 2007f	
Benzo(g,h,i)perylene	0.615	NOAEL	reproduction & growth	chronic	mammals	USEPA, 2007f	
Benzo(g,h,i)perylene	38.4	LOAEL	reproduction & growth	chronic	mammals	USEPA, 2007f	
Benzo(k)fluoranthene	0.615	NOAEL	reproduction & growth	chronic	mammals	USEPA, 2007f	
Benzo(k)fluoranthene	38.4	LOAEL	reproduction & growth	chronic	mammals	USEPA, 2007f	
Chrysene	0.615	NOAEL	reproduction & growth	chronic	mammals	USEPA, 2007f	
Chrysene	38.4	LOAEL	reproduction & growth	chronic	mammals	USEPA, 2007f	
Dibenzo(a,h)anthracene	0.615	NOAEL	reproduction & growth	chronic	mammals	USEPA, 2007f	
Dibenzo(a,h)anthracene	38.4	LOAEL	reproduction & growth	chronic	mammals	USEPA, 2007f	
Fluoranthene	65.6	NOAEL	reproduction & growth	chronic	mammals	USEPA, 2007f	
Fluoranthene	356	LOAEL	reproduction & growth	chronic	mammals	USEPA, 2007f	
Fluorene	65.6	NOAEL	reproduction & growth	chronic	mammals	USEPA, 2007f	
Fluorene	356	LOAEL	reproduction & growth	chronic	mammals	USEPA, 2007f	
Indeno(1,2,3-cd)pyrene	0.615	NOAEL	reproduction & growth	chronic	mammals	USEPA, 2007f	
Indeno(1,2,3-cd)pyrene	38.4	LOAEL	reproduction & growth	chronic	mammals	USEPA, 2007f	
Naphthalene	65.6	NOAEL	reproduction & growth	chronic	mammals	USEPA, 2007f	
Naphthalene	356	LOAEL	reproduction & growth	chronic	mammals	USEPA, 2007f	
Phenanthrene	65.5	NOAEL	reproduction & growth	chronic	mammals	USEPA, 2007f	
Phenanthrene	356	LOAEL	reproduction & growth	chronic	mammals	USEPA, 2007f	
Pyrene	0.615	NOAEL	reproduction & growth	chronic	mammals	USEPA, 2007f	
Pyrene	38.4	LOAEL	reproduction & growth	chronic	mammals	USEPA, 2007f	
Low Molecular Weight PAHs	65.6	NOAEL	reproduction & growth	chronic	mammals	USEPA, 2007f	
Low Molecular Weight PAHs	356	LOAEL	reproduction & growth	chronic	mammals	USEPA, 2007f	
High Molecular Weight PAHs	0.615	NOAEL	reproduction & growth	chronic	mammals	USEPA, 2007f	
High Molecular Weight PAHs	38.4	LOAEL	reproduction & growth	chronic	mammals	USEPA, 2007f	
7,12-Dimethylbenz(a)anthracene	2	NOAEL	systemic	chronic	nestling/starlings	Trust et al., 1994	
7,12-Dimethylbenz(a)anthracene	20	LOAEL	systemic	chronic	nestling/starlings	Trust et al., 1994	

TABLE 8  
 SOURCES AND ENPOINTS FOR DERIVATION OF WILDLIFE TOXICITY REFERENCE VALUES  
 ECOLOGICAL RISK ASSESSMENT  
 NEWPORT, RHODE ISLAND

Chemical	Concentration (mg/kg bw/day)	Endpoint	Effect	Chronic/ Subchronic	Species	Primary Reference	Source of Reference
<b>PESTICIDES</b>							
Aldrin	0.2	NOAEL	reproductive	chronic	rat	Treon and Cleveland, 1955	Sample et al., 1996
Aldrin	1	LOAEL	reproductive	chronic	rat	Treon and Cleveland, 1955	Sample et al., 1996
BHC (mixed isomers)	0.137	LOAEL	reproductive	chronic	mink	Bleavins et al., 1984	Sample et al., 1996
BHC (mixed isomers)	0.563	NOAEL	reproductive	chronic	Japanese quail	Vos et al., 1971	Sample et al., 1996
BHC (mixed isomers)	2.25	LOAEL	reproductive	chronic	Japanese quail	Vos et al., 1971	Sample et al., 1996
gamma-BHC (lindane)	8	NOAEL	reproductive	chronic	rat	Palmer et al., 1978	Sample et al., 1996
gamma-BHC (lindane)	20	LOAEL	reproductive	chronic	mallard duck	Chakravarty and Lahiri, 1986	Sample et al., 1996
Chlordane	2.14	NOAEL	mortality	chronic	red-winged blackbird	Stickel et al., 1983	Sample et al., 1996
Chlordane	10.7	LOAEL	mortality	chronic	red-winged blackbird	Stickel et al., 1983	Sample et al., 1996
Chlordane	4.58	NOAEL	reproduction	chronic	mouse	WHO, 1984	Sample et al., 1996
Chlordane	9.16	LOAEL	reproduction	chronic	mouse	WHO, 1984	Sample et al., 1996
4,4'-DDT	0.147	NOAEL	reproduction & growth	chronic	mammals	USEPA, 2007g	
4,4'-DDT	5.56	LOAEL	reproduction & growth	chronic	mammals	USEPA, 2007g	
4,4'-DDT	0.227	NOAEL	reproduction & growth	chronic	birds	USEPA, 2007g	
4,4'-DDT	2.7	LOAEL	reproduction & growth	chronic	birds	USEPA, 2007g	
Dieldrin	0.0709	NOAEL	reproduction & growth	chronic	birds	USEPA, 2007h	
Dieldrin	0.87	LOAEL	reproduction & growth	chronic	birds	USEPA, 2007h	
Dieldrin	0.015	NOAEL	reproduction & growth	chronic	mammals	USEPA, 2007h	
Dieldrin	1.27	LOAEL	reproduction & growth	chronic	mammals	USEPA, 2007h	
Endosulfan	1.5	NOAEL	reproduction	subchronic	rat	Dikshith et al., 1984	ATSDR, 2000
Endosulfan	10	NOAEL	reproduction	chronic	gray partridge	Abiola, 1992	Sample et al., 1996
Endrin	0.92	LOAEL	reproduction	chronic	mouse	Good and Ware, 1969	Sample et al., 1996
Endrin	0.1035	LOAEL	reproduction	chronic	screech owl	Fleming et al., 1982	Sample et al., 1996
Heptachlor	1	LOAEL	reproduction	chronic	mink	Crum et al., 1993	Sample et al., 1996
Methoxychlor	4	NOAEL	reproduction	chronic	rat	Gray et al., 1988	Sample et al., 1996
Methoxychlor	8	LOAEL	reproduction	chronic	rat	Gray et al., 1988	Sample et al., 1996
Toxaphene	8	NOAEL	reproduction	chronic	rat	Kennedy et al., 1973	Sample et al., 1996
<b>POLYCHLORINATED BIPHENYLS</b>							
Aroclor 1016	1.37	NOAEL	reproduction	chronic	mink	Aulerich and Ringer, 1980	Sample et al., 1996
Aroclor 1016	3.43	LOAEL	reproduction	chronic	mink	Aulerich and Ringer, 1980	Sample et al., 1996
Aroclor 1242	0.069	NOAEL	reproduction	chronic	mink	Bleavins et al., 1984	Sample et al., 1996
Aroclor 1242	0.69	LOAEL	reproduction	chronic	mink	Bleavins et al., 1984	Sample et al., 1996
Aroclor 1242	0.41	NOAEL	reproduction	chronic	screech owl	McLane and Hughes, 1980	Sample et al., 1996
Aroclor 1248	0.01	NOAEL	reproduction	chronic	rhesus monkey	Barsotti, et al., 1976	Sample et al., 1996
Aroclor 1248	1	LOAEL	reproduction	chronic	rhesus monkey	Barsotti, et al., 1976	Sample et al., 1996
Aroclor 1254	1.8	LOAEL	reproduction	chronic	pheasant	Dahlgren et al., 1972	Sample et al., 1996
Aroclor 1254	0.68	LOAEL	reproduction	chronic	mouse	McCoy et al., 1995	Sample et al., 1996

Notes:

NOAEL - No Observed Adverse Effects Level.

LOAEL - Lowest Observed Adverse Effects Level.

The mammalian NOAELs and LOAELs for the following PAHs are based on the Low Molecular Weight PAH values: acenaphthylene, acenaphthene, anthracene, fluoranthene, fluorene phenanthrene, 2-methylnaphthalene, and naphthalene

The mammalian NOAELs and LOAELs for the following PAHs are based on the High Molecular Weight PAH values: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene benzo(k)fluoranthene, benzo(g,h,i)perylene, carbazole, chrysene, dibenzo(a,h)anthracene, dibenzofuran, indeno(1,2,3-c,d)pyrene, and pyrene

The avian NOAELs and LOAELs for the PAHs are based on 7,12-dimethylbenz(a)anthracene

The LOAELs used for several metals were calculated as the geometric mean of growth and reproduction data from the USEPA Ecological Soil Screening Level documents

The LOAELs for Aroclor-1254 were used as surrogates for Aroclor-1260 and Total PCBs

The LOAELs for heptachlor were used as surrogates for heptachlor epoxide

TABLE 9  
 UPTAKE FACTORS FOR PLANTS, EARTHWORMS, AND SMALL MAMMALS  
 ECOLOGICAL RISK ASSESSMENT  
 NEWPORT, RHODE ISLAND

Chemical	Soil-to-Plant BAF		Soil-to-Earthworm BAF		Soil-to-Small Mammal	
	Value for Use in SRA	Value for Use in BERA	Value for Use in SRA	Value for Use in BERA	Value for Use in SRA	Value for Use in BERA
<b>INORGANICS</b>						
Aluminum	5.00E-03 (b)	2.87E-03 (b)	1.18E-01 (c)	4.30E-02 (c)	1.00E+00 (f)	1.00E+00 (f)
Antimony	Eco-SSL regression (a)	Eco-SSL regression (a)	1.00E+00 (a)	1.00E+00 (a)	5.00E-02 (a,o)	5.00E-02 (a,o)
Arsenic	3.75E-02 (a)	3.75E-02 (a)	Eco-SSL regression (a)	Eco-SSL regression (a)	Eco-SSL regression (a)	Eco-SSL regression (a)
Barium	1.56E-01 (a)	1.56E-01 (a)	9.10E-02 (a)	9.10E-02 (a)	7.50E-03 (a,o)	7.50E-03 (a,o)
Beryllium	Eco-SSL regression (a)	Eco-SSL regression (a)	4.50E-02 (a)	4.50E-02 (a)	5.00E-02 (a,o)	5.00E-02 (a,o)
Cadmium	Eco-SSL regression (a)	Eco-SSL regression (a)				
Chromium	4.10E-02 (a)	4.10E-02 (a)	3.06E-01 (a)	3.06E-01 (a)	Eco-SSL regression (a)	Eco-SSL regression (a)
Cobalt	7.50E-03 (a)	7.50E-03 (a)	1.22E-01 (a)	1.22E-01 (a)	Eco-SSL regression (a)	Eco-SSL regression (a)
Copper	Eco-SSL regression (a)	Eco-SSL regression (a)	5.15E-01 (a)	5.15E-01 (a)	Eco-SSL regression (a)	Eco-SSL regression (a)
Iron	1.00E-02 (b)	4.25E-03 (b)	7.80E-02 (c)	3.60E-02 (c)	1.71E-02 (n)	1.24E-02 (n)
Lead	Eco-SSL regression (a)	Eco-SSL regression (a)				
Manganese	7.90E-02 (a)	7.90E-02 (a)	Eco-SSL regression (a)	Eco-SSL regression (a)	2.05E-02 (a)	2.05E-02 (a)
Mercury	5.00E+00 (b)	6.52E-01 (b)	Regression (c)	Regression (c)	1.92E-01 (n)	5.43E-02 (n)
Nickel	Eco-SSL regression (a)	Eco-SSL regression (a)	4.73E+00 (c)	1.06E+00 (c)	Eco-SSL regression (a)	Eco-SSL regression (a)
Selenium	Eco-SSL regression (a)	Eco-SSL regression (a)				
Silver	1.40E-02 (a)	1.40E-02 (a)	2.05E+00 (a)	2.05E+00 (a)	4.00E-03 (a)	4.00E-03 (a)
Thallium	1.00E+00 (f)	1.00E+00 (f)	1.00E+00 (f)	1.00E+00 (f)	1.23E-01 (n)	1.12E-01 (n)
Vanadium	4.85E-03 (a)	4.85E-03 (a)	4.20E-02 (a)	4.20E-02 (a)	1.23E-02 (a)	1.23E-02 (a)
Zinc	Eco-SSL regression (a)	Eco-SSL regression (a)				
<b>POLYCYCLIC AROMATIC HYDROCARBONS</b>						
Acenaphthene	Eco-SSL regression (a)	Eco-SSL regression (a)	1.47E+00 (a)	1.47E+00 (a)	0.00E+00 (a,m)	0.00E+00 (a,m)
Acenaphthylene	Eco-SSL regression (a)	Eco-SSL regression (a)	2.29E+01 (a)	2.29E+01 (a)	0.00E+00 (a,m)	0.00E+00 (a,m)
Anthracene	Eco-SSL regression (a)	Eco-SSL regression (a)	2.42E+00 (a)	2.42E+00 (a)	0.00E+00 (a,m)	0.00E+00 (a,m)
Benzo(a)anthracene	Eco-SSL regression (a)	Eco-SSL regression (a)	1.59E+00 (a)	1.59E+00 (a)	0.00E+00 (a,m)	0.00E+00 (a,m)
Benzo(a)pyrene	Eco-SSL regression (a)	Eco-SSL regression (a)	1.33E+00 (a)	1.33E+00 (a)	0.00E+00 (a,m)	0.00E+00 (a,m)
Benzo(b)fluoranthene	3.10E-01 (a)	3.10E-01 (a)	2.60E+00 (a)	2.60E+00 (a)	0.00E+00 (a,m)	0.00E+00 (a,m)
Benzo(g,h,i)perylene	Eco-SSL regression (a)	Eco-SSL regression (a)	2.94E+00 (a)	2.94E+00 (a)	0.00E+00 (a,m)	0.00E+00 (a,m)
Benzo(k)fluoranthene	Eco-SSL regression (a)	Eco-SSL regression (a)	2.60E+00 (a)	2.60E+00 (a)	0.00E+00 (a,m)	0.00E+00 (a,m)
Chrysene	Eco-SSL regression (a)	Eco-SSL regression (a)	2.29E+00 (a)	2.29E+00 (a)	0.00E+00 (a,m)	0.00E+00 (a,m)
Dibenzo(a,h)anthracene	1.30E-01 (a)	1.30E-01 (a)	2.31E+00 (a)	2.31E+00 (a)	0.00E+00 (a,m)	0.00E+00 (a,m)
Fluoranthene	5.00E-01 (a)	5.00E-01 (a)	3.04E+00 (a)	3.04E+00 (a)	0.00E+00 (a,m)	0.00E+00 (a,m)
Fluorene	Eco-SSL regression (a)	Eco-SSL regression (a)	9.57E+00 (a)	9.57E+00 (a)	0.00E+00 (a,m)	0.00E+00 (a,m)
Indeno(1,2,3-cd)pyrene	1.10E-01 (a)	1.10E-01 (a)	2.86E+00 (a)	2.86E+00 (a)	0.00E+00 (a,m)	0.00E+00 (a,m)
Naphthalene	1.22E+01 (a)	1.22E+01 (a)	4.40E+00 (a)	4.40E+00 (a)	0.00E+00 (a,m)	0.00E+00 (a,m)
Phenanthrene	Eco-SSL regression (a)	Eco-SSL regression (a)	1.72E+00 (a)	1.72E+00 (a)	0.00E+00 (a,m)	0.00E+00 (a,m)
Pyrene	7.20E-01 (a)	7.20E-01 (a)	1.75E+00 (a)	1.75E+00 (a)	0.00E+00 (a,m)	0.00E+00 (a,m)
Total HMW PAHs	Eco-SSL regression (a)	Eco-SSL regression (a)	2.60E+00 (a)	2.60E+00 (a)	0.00E+00 (a,m)	0.00E+00 (a,m)
Total LMW PAHs	Eco-SSL regression (a)	Eco-SSL regression (a)	3.04E+00 (a)	3.04E+00 (a)	0.00E+00 (a,m)	0.00E+00 (a,m)
<b>PESTICIDES</b>						
4,4'-DDD	1.24E-02 (d)	1.24E-02 (d)	Eco-SSL regression (a)	Eco-SSL regression (a)	Eco-SSL regression (a,p)	Eco-SSL regression (a,p)
4,4'-DDE	6.45E-03 (d)	6.45E-03 (d)	Eco-SSL regression (a)	Eco-SSL regression (a)	Eco-SSL regression (a)	Eco-SSL regression (a)
4,4'-DDT	3.78E-03 (d)	3.78E-03 (d)	Eco-SSL regression (a)	Eco-SSL regression (a)	Eco-SSL regression (a)	Eco-SSL regression (a)
Total DDT	Eco-SSL regression (a)	Eco-SSL regression (a)	1.12E+01 (a)	1.12E+01 (a)	4.83E+00 (a)	4.83E+00 (a)
Aldrin	6.54E-03 (d)	6.54E-03 (d)	1.00E+00 (f)	1.00E+00 (f)	1.00E+00 (f)	1.00E+00 (f)
alpha-BHC	2.41E-01 (d)	2.41E-01 (d)	5.00E+00 (e,i)	5.00E+00 (e,i)	1.00E+00 (f)	1.00E+00 (f)
alpha-Chlordane	9.50E-03 (d,i)	9.50E-03 (d,i)	5.00E+00 (e)	5.00E+00 (e)	1.00E+00 (f)	1.00E+00 (f)
beta-BHC	2.47E-01 (d)	2.47E-01 (d)	5.00E+00 (e,i)	5.00E+00 (e,i)	1.00E+00 (f)	1.00E+00 (f)
delta-BHC	1.53E-01 (d)	1.53E-01 (d)	5.00E+00 (e,i)	5.00E+00 (e,i)	1.00E+00 (f)	1.00E+00 (f)
Dieldrin	4.10E-01 (a)	4.10E-01 (a)	1.47E+01 (a)	1.47E+01 (a)	1.20E+00 (a,o)	1.20E+00 (a,o)
Endosulfan I	2.31E-01 (d,g)	2.31E-01 (d,g)	1.00E+00 (f)	1.00E+00 (f)	1.00E+00 (f)	1.00E+00 (f)
Endosulfan II	2.31E-01 (d,g)	2.31E-01 (d,g)	1.00E+00 (f)	1.00E+00 (f)	1.00E+00 (f)	1.00E+00 (f)
Endosulfan sulfate	2.31E-01 (d,g)	2.31E-01 (d,g)	1.00E+00 (f)	1.00E+00 (f)	1.00E+00 (f)	1.00E+00 (f)

TABLE 9  
 UPTAKE FACTORS FOR PLANTS, EARTHWORMS, AND SMALL MAMMALS  
 ECOLOGICAL RISK ASSESSMENT  
 NEWPORT, RHODE ISLAND

Chemical	Soil-to-Plant BAF		Soil-to-Earthworm BAF		Soil-to-Small Mammal	
	Value for Use in SRA	Value for Use in BERA	Value for Use in SRA	Value for Use in BERA	Value for Use in SRA	Value for Use in BERA
Endrin	3.71E-02 (d)	3.71E-02 (d)	3.60E+00 (e)	3.60E+00 (e)	1.00E+00 (f)	1.00E+00 (f)
Endrin aldehyde	3.71E-02 (d,h)	3.71E-02 (d,h)	3.60E+00 (e)	3.60E+00 (e)	1.00E+00 (f)	1.00E+00 (f)
Endrin ketone	3.71E-02 (d,h)	3.71E-02 (d,h)	3.60E+00 (e)	3.60E+00 (e)	1.00E+00 (f)	1.00E+00 (f)
gamma-BHC	2.68E-01 (d)	2.68E-01 (d)	5.00E+00 (e)	5.00E+00 (e)	1.00E+00 (f)	1.00E+00 (f)
gamma-Chlordane	9.50E-03 (d,i)	9.50E-03 (d,i)	5.00E+00 (e)	5.00E+00 (e)	1.00E+00 (f)	1.00E+00 (f)
Heptachlor	1.12E-02 (d)	1.12E-02 (d)	3.00E+00 (e,k)	3.00E+00 (e,k)	1.00E+00 (f)	1.00E+00 (f)
Heptachlor epoxide	4.98E-02 (d)	4.98E-02 (d)	3.00E+00 (e)	3.00E+00 (e)	1.00E+00 (f)	1.00E+00 (f)
Methoxychlor	4.36E-02 (d)	4.36E-02 (d)	1.00E+00 (f)	1.00E+00 (f)	1.00E+00 (f)	1.00E+00 (f)
Toxaphene	1.71E-02 (d)	1.71E-02 (d)	1.00E+00 (f)	1.00E+00 (f)	1.00E+00 (f)	1.00E+00 (f)
<b>POLYCHLORINATED BIPHENYLS</b>						
Aroclor 1016	2.12E-02 (d)	2.12E-02 (d)	1.59E+01 (c,l)	1.59E+01 (c,l)	1.00E+00 (f)	1.00E+00 (f)
Aroclor 1221	9.08E-02 (d)	9.08E-02 (d)	1.59E+01 (c,l)	1.59E+01 (c,l)	1.00E+00 (f)	1.00E+00 (f)
Aroclor 1232	9.08E-02 (d)	9.08E-02 (d)	1.59E+01 (c,l)	1.59E+01 (c,l)	1.00E+00 (f)	1.00E+00 (f)
Aroclor 1242	8.65E-03 (d)	8.65E-03 (d)	1.59E+01 (c,l)	1.59E+01 (c,l)	1.00E+00 (f)	1.00E+00 (f)
Aroclor 1248	8.10E-03 (d)	8.10E-03 (d)	1.59E+01 (c,l)	1.59E+01 (c,l)	1.00E+00 (f)	1.00E+00 (f)
Aroclor 1254	4.44E-03 (d)	4.44E-03 (d)	1.59E+01 (c,l)	1.59E+01 (c,l)	1.00E+00 (f)	1.00E+00 (f)
Aroclor 1260	6.15E-04 (d)	6.15E-04 (d)	1.59E+01 (c,l)	1.59E+01 (c,l)	1.00E+00 (f)	1.00E+00 (f)
Aroclor 1262	8.65E-03 (d,l)	8.65E-03 (d,l)	1.59E+01 (c,l)	6.67E+00 (c,l)	1.00E+00 (f)	1.00E+00 (f)
Aroclor 1268	8.65E-03 (d,l)	8.65E-03 (d,l)	1.59E+01 (c,l)	6.67E+00 (c,l)	1.00E+00 (f)	1.00E+00 (f)
Total PCBs	8.65E-03 (d)	8.65E-03 (d)	1.59E+01 (c)	6.67E+00 (c)	1.00E+00 (f)	1.00E+00 (f)

Notes:

- Values expressed on a dry weight basis
- BAF - Bioaccumulation Factor.
- BERA - Baseline Ecological Risk Assessment.
- Eco-SSL regression - Regression models recommended by USEPA (Attachment 4-1; USEPA, 2007). Table 4a for inorganics and 4b for organics
- SRA - Screening Risk Assessment.
- USEPA - United States Environmental Protection Agency

Sources:

- (a) Uptake factors and regression equations recommended by USEPA in development of Ecological Soil Screening Levels
- (b) Soil-to-plant uptake factors from Bechtel Jacobs (1998a; values from Table D-1; mercury values from Table 6). Value for SRA is 90th percentile; value for BERA is median uptake factor
- (c) Soil-to-earthworm uptake factors from Sample, et al (1998a) - aluminum and iron from Table C.1, mercury from Table 4, nickel and PCBs from Table 11. Value for SRA is 90th percentile; value for BERA is median uptake factor.
- (d) Values identified using the Risk Assessment Information System ([http://rais.onrl.gov/cgi-bin/tools/TOX\\_search?select=chem\\_spef](http://rais.onrl.gov/cgi-bin/tools/TOX_search?select=chem_spef); accessed September 22, 2012)
- (e) Soil-to-earthworm BAFs derived in *Site Investigation for MRP Site 1 - Carr Point* (Appendix F Table 6; TetraTech, 2010).
- (f) Default value of 1 assigned to parameters without uptake factors
- (g) Value for endosulfan used as a surrogate due to structural similarity.
- (h) Value for endrin used as a surrogate due to structural similarity.
- (i) Value for chlordane used as a surrogate due to structural similarity.
- (j) Value for gamma BHC used as a surrogate due to structural similarity.
- (k) Value for heptachlor epoxide used as a surrogate due to structural similarity.
- (l) Value for Total PCBs used as a for individual Aroclors without uptake factors.
- (m) Assumes negligible uptake.
- (n) Soil-to-mammal uptake factor from Sample, et al (1998b) - values for general mammals from Table 7. Value for SRA is 90th Percentile; value for BERA is median uptake factor
- (o) Uptake factor is multiplied by concentration in the small mammal diet (assumed to be 100% earthworms)
- (p) Regression equation for DDE used as a surrogate due to structural similarity

TABLE 10  
 UPTAKE FACTORS FOR FISH AND BENTHIC INVERTEBRATES  
 ECOLOGICAL RISK ASSESSMENT  
 NEWPORT, RHODE ISLAND

Chemical	Fish BSAF (a)		Benthic Invertebrate BSAF (b)	
	Value for Use in SRA	Value for Use in BERA	Value for Use in SRA	Value for Use in BERA
<b>INORGANICS</b>				
Aluminum	1.00E+00 (f)	1.00E+00 (f)	1.00E+00 (f)	1.00E+00 (f)
Antimony	1.00E+00 (f)	1.00E+00 (f)	1.00E+00 (f)	1.00E+00 (f)
Arsenic	1.00E+00 (f)	1.00E+00 (f)	6.90E-01	1.43E-01
Barium	1.00E+00 (f)	1.00E+00 (f)	1.00E+00 (f)	1.00E+00 (f)
Beryllium	1.00E+00 (f)	1.00E+00 (f)	1.00E+00 (f)	1.00E+00 (f)
Cadmium	1.00E+00 (f)	1.00E+00 (f)	7.99E+00	6.00E-01
Chromium	1.00E+00 (f)	1.00E+00 (f)	4.68E-01	1.00E-01
Cobalt	1.00E+00 (f)	1.00E+00 (f)	1.00E+00 (f)	1.00E+00 (f)
Copper	1.00E+00 (f)	1.00E+00 (f)	5.25E+00	1.56E+00
Iron	1.00E+00 (f)	1.00E+00 (f)	1.00E+00 (f)	1.00E+00 (f)
Lead	1.00E+00 (f)	1.00E+00 (f)	6.07E-01	7.10E-02
Manganese	1.00E+00 (f)	1.00E+00 (f)	1.00E+00 (f)	1.00E+00 (f)
Mercury	1.00E+00 (f)	1.00E+00 (f)	2.87E+00	1.14E+00
Nickel	1.00E+00 (f)	1.00E+00 (f)	2.32E+00	4.86E-01
Selenium	1.00E+00 (f)	1.00E+00 (f)	1.00E+00 (f)	1.00E+00 (f)
Silver	1.00E+00 (f)	1.00E+00 (f)	1.00E+00 (f)	1.00E+00 (f)
Thallium	1.00E+00 (f)	1.00E+00 (f)	1.00E+00 (f)	1.00E+00 (f)
Vanadium	1.00E+00 (f)	1.00E+00 (f)	1.00E+00 (f)	1.00E+00 (f)
Zinc	1.00E+00 (f)	1.00E+00 (f)	7.53E+00	1.94E+00
<b>POLYCYCLIC AROMATIC HYDROCARBONS</b>				
Acenaphthene	2.90E-01	2.90E-01	1.00E+00 (f)	1.00E+00 (f)
Acenaphthylene	2.90E-01	2.90E-01	1.00E+00 (f)	1.00E+00 (f)
Anthracene	2.90E-01	2.90E-01	1.00E+00 (f)	1.00E+00 (f)
Benzo(a)anthracene	2.90E-01	2.90E-01	1.00E+00 (f)	1.00E+00 (f)
Benzo(a)pyrene	2.90E-01	2.90E-01	1.00E+00 (f)	1.00E+00 (f)
Benzo(b)fluoranthene	2.90E-01	2.90E-01	1.00E+00 (f)	1.00E+00 (f)
Benzo(g,h,i)perylene	2.90E-01	2.90E-01	1.00E+00 (f)	1.00E+00 (f)
Benzo(k)fluoranthene	2.90E-01	2.90E-01	1.00E+00 (f)	1.00E+00 (f)
Chrysene	2.90E-01	2.90E-01	1.00E+00 (f)	1.00E+00 (f)
Dibenzo(a,h)anthracene	2.90E-01	2.90E-01	1.00E+00 (f)	1.00E+00 (f)
Fluoranthene	2.90E-01	2.90E-01	1.00E+00 (f)	1.00E+00 (f)
Fluorene	2.90E-01	2.90E-01	1.00E+00 (f)	1.00E+00 (f)
Indeno(1,2,3-cd)pyrene	2.90E-01	2.90E-01	1.00E+00 (f)	1.00E+00 (f)
Naphthalene	2.90E-01	2.90E-01	1.00E+00 (f)	1.00E+00 (f)
Phenanthrene	2.90E-01	2.90E-01	1.00E+00 (f)	1.00E+00 (f)
Pyrene	2.90E-01	2.90E-01	1.00E+00 (f)	1.00E+00 (f)
Total HMW PAHs	1.29E+00	1.29E+00	1.00E+00 (f)	1.00E+00 (f)
Total LMW PAHs	2.29E+00	2.29E+00	1.00E+00 (f)	1.00E+00 (f)
<b>PESTICIDES</b>				
4,4'-DDD	2.80E-01	2.80E-01	1.00E+00 (f)	1.00E+00 (f)
4,4'-DDE	7.70E+00	7.70E+00	1.00E+00 (f)	1.00E+00 (f)
4,4'-DDT	1.67E+00	1.67E+00	1.00E+00 (f)	1.00E+00 (f)
Total DDT	7.70E+00	7.70E+00	1.00E+00 (f)	1.00E+00 (f)
Aldrin	1.80E+00	1.80E+00	1.00E+00 (f)	1.00E+00 (f)
alpha-BHC	1.00E+00 (f)	1.00E+00 (f)	1.00E+00 (f)	1.00E+00 (f)
alpha-Chlordane	4.77E+00	4.77E+00	1.00E+00 (f)	1.00E+00 (f)
beta-BHC	1.00E+00 (f)	1.00E+00 (f)	1.00E+00 (f)	1.00E+00 (f)
delta-BHC	1.00E+00 (f)	1.00E+00 (f)	1.00E+00 (f)	1.00E+00 (f)
Dieldrin	1.80E+00	1.80E+00	1.00E+00 (f)	1.00E+00 (f)
Endosulfan I	1.80E+00	1.80E+00	1.00E+00 (f)	1.00E+00 (f)
Endosulfan II	1.80E+00	1.80E+00	1.00E+00 (f)	1.00E+00 (f)
Endosulfan sulfate	1.80E+00 (c)	1.80E+00 (c)	1.00E+00 (f)	1.00E+00 (f)
Endrin	1.80E+00	1.80E+00	1.00E+00 (f)	1.00E+00 (f)
Endrin aldehyde	1.80E+00 (d)	1.80E+00 (d)	1.00E+00 (f)	1.00E+00 (f)
Endrin ketone	2.80E+00 (d)	2.80E+00 (d)	1.00E+00 (f)	1.00E+00 (f)
gamma-BHC	1.00E+00 (f)	1.00E+00 (f)	1.00E+00 (f)	1.00E+00 (f)
gamma-Chlordane	2.22E+00	2.22E+00	1.00E+00 (f)	1.00E+00 (f)
Heptachlor	1.80E+00	1.80E+00	1.00E+00 (f)	1.00E+00 (f)
Heptachlor epoxide	1.80E+00	1.80E+00	1.00E+00 (f)	1.00E+00 (f)
Methoxychlor	1.00E+00 (f)	1.00E+00 (f)	1.00E+00 (f)	1.00E+00 (f)
Toxaphene	1.80E+00	1.80E+00	1.00E+00 (f)	1.00E+00 (f)

TABLE 10  
 UPTAKE FACTORS FOR FISH AND BENTHIC INVERTEBRATES  
 ECOLOGICAL RISK ASSESSMENT  
 NEWPORT, RHODE ISLAND

Chemical	Fish BSAF (a)		Benthic Invertebrate BSAF (b)	
	Value for Use in SRA	Value for Use in BERA	Value for Use in SRA	Value for Use in BERA
<b>POLYCHLORINATED BIPHENYLS</b>				
Aroclor 1016	1.85E+00 (e)	1.85E+00 (e)	2.19E+01 (e)	4.67E+00 (e)
Aroclor 1221	1.85E+00 (e)	1.85E+00 (e)	2.19E+01 (e)	4.67E+00 (e)
Aroclor 1232	1.85E+00 (e)	1.85E+00 (e)	2.19E+01 (e)	4.67E+00 (e)
Aroclor 1242	1.85E+00 (e)	1.85E+00 (e)	2.19E+01 (e)	4.67E+00 (e)
Aroclor 1248	1.85E+00 (e)	1.85E+00 (e)	2.19E+01 (e)	4.67E+00 (e)
Aroclor 1254	1.85E+00 (e)	1.85E+00 (e)	2.19E+01 (e)	4.67E+00 (e)
Aroclor 1260	1.85E+00 (e)	1.85E+00 (e)	2.19E+01 (e)	4.67E+00 (e)
Aroclor 1262	1.85E+00 (e)	1.85E+00 (e)	2.19E+01 (e)	4.67E+00 (e)
Aroclor 1268	1.85E+00 (e)	1.85E+00 (e)	2.19E+01 (e)	4.67E+00 (e)
Total PCBs	1.85E+00	1.85E+00	2.19E+01	4.67E+00

Notes:

Values expressed on a dry weight basis  
 BERA - Baseline Ecological Risk Assessment.  
 BSAF - Biota Sediment Accumulation Factor.  
 SRA - Screening Risk Assessment.  
 USEPA - United States Environmental Protection Agency

Sources:

- (a) Fish BSAFs obtained from Appendix C-1 of *The Incidence and Severity of Sediment Contamination in Surface Waters of the United States, National Sediment Quality Survey: Second Edition*. (USEPA, 2004d). Values for organic chemicals are the same for wet weight and dry weight
- (b) Benthic invertebrate BSAFs obtained from Bechtel Jacobs (1998b; Table 2; all data). Value for SRA is 90th percentile; value for BERA is median uptake factor
- (c) Value for endosulfan used as a surrogate due to structural similarity.
- (d) Value for endrin used as a surrogate due to structural similarity.
- (e) Value for Total PCBs used as a for individual Aroclors without uptake factors.
- (f) Default value of 1 assigned to parameters without uptake factors

TABLE 11  
EXPOSURE PARAMETERS FOR ECOLOGICAL RECEPTORS  
ECOLOGICAL RISK ASSESSMENT  
NEWPORT, RHODE ISLAND

Receptor Species	Value for Use in SRA Minimum Body Weight (kg)	Value for Use in SRA [b] Maximum Body Weight (kg)	Value for Use in BERA Average Body Weight (kg)	Value for Use in SRA Food Ingestion Rate (kg <sub>dw</sub> /day)	Value for Use in BERA Food Ingestion Rate (kg <sub>dw</sub> /day)	Value for Use in SRA Incidental Soil/Sediment Ingestion (%)	Value for Use in BERA Incidental Soil/Sediment Ingestion (%)	Value for Use in BERA Average Home Range (acres)	Dietary Assumptions for Use in SRA	Dietary Assumptions for Use in BERA
<b>BIRDS</b>										
Bobwhite quail ( <i>Colinus virginianus</i> )	0.154 [a]	0.194 [a]	0.170 [a]	0.0096 [c]	0.0085 [d]	13.9% [e]	6.1% [f]	24.7 [g]	100% vegetation [h]	86% vegetation 14% soil invertebrates [i]
American robin ( <i>Turdus migratorius</i> )	0.0773 [a]	0.0862 [a]	0.081 [a]	0.0125 [c]	0.0120 [d]	3.0% [e]	0.9% [f]	0.6095 [g]	100% soil invertebrates [h]	63% vegetation 37% soil invertebrates [i]
Herring gull ( <i>Larus argentatus</i> )	0.951 [a]	1.232 [a]	1.092 [a]	0.1243 [c]	0.1132 [d]	8.2% [e]	8.2% [f]	10 km [g] radius	100% fish or benthic invertebrates [h] [more contaminated item selected]	68% benthic invertebrates 32% fish [i]
<b>MAMMALS</b>										
Meadow vole ( <i>Microtus pennsylvanicus</i> )	0.0170 [a]	0.0524 [a]	0.033 [a]	0.0103 [c]	0.0077 [d]	3.2% [e]	1.2% [f]	0.0659 [g]	100% vegetation [h]	99% vegetation 1% soil invertebrates [i]
Short-tailed shrew ( <i>Blarina brevicauda</i> )	0.0150 [a]	0.0192 [a]	0.0168 [a]	0.0023 [c]	0.0022 [d]	3.0% [e]	0.9% [f]	0.9637 [g]	100% soil invertebrates [h]	5% vegetation 87% soil invertebrates 8% small mammals [i]
Raccoon ( <i>Procyon lotor</i> )	3.67 [a]	7.60 [a]	5.78 [a]	0.1848 [c]	0.1535 [d]	9.4% [e]	9.4% [f]	1558 [g]	100% fish or benthic invertebrates [h] [more contaminated item selected]	59% vegetation 15% soil invertebrates 17% small mammals 7% fish 2% benthic invertebrates [i]

General Notes:

BERA - Baseline Ecological Risk Assessment

BW - Body Weight

DW - Dry Weight

FIR - Food Ingestion Rate

g - grams

kg - kilograms

L - liters

SRA - Screening Risk Assessment

WIR - Water Ingestion Rate

Notes for Bobwhite quail

[a] Range and average of adult body weights listed by USEPA (1993b).

[b] Maximum body weight is only used to determine conservative ingestion rates for the SRA.

[c] Food ingestion rate calculated using algorithm for quail developed by Nagy, 2001 [FIR (g<sub>dw</sub>/day) = 0.088\*BW<sup>0.891</sup>] using maximum body weight.

[d] Food ingestion rate calculated using algorithm for quail developed by Nagy, 2001 [FIR (g<sub>dw</sub>/day) = 0.088\*BW<sup>0.891</sup>] using average body weight.

[e] In the absence of data for quail, the incidental soil ingestion rate is based on 90<sup>th</sup> percentile value for mourning dove (USEPA, 2007).

[f] In the absence of data for quail, the incidental soil ingestion rate is based on 50<sup>th</sup> percentile value for mourning dove (USEPA, 2007).

[g] Home range listed by USEPA (1993b) ranges from 8.9 to 41.3 acres with an average of 24.7 acres.

[h] An exclusive diet was selected for the SRA.

[i] Average diet over the course of a year for adult quail in the southeastern United States (USEPA, 1993b).

TABLE 11  
EXPOSURE PARAMETERS FOR ECOLOGICAL RECEPTORS  
ECOLOGICAL RISK ASSESSMENT  
NEWPORT, RHODE ISLAND

Notes for American robin

- [a] Range and average of adult body weights listed by USEPA (1993b).
- [b] Maximum body weight is only used to determine conservative ingestion rates for the SRA.
- [c] Food ingestion rate calculated using algorithm for insectivorous birds developed by Nagy, 2001 [FIR (g<sub>dw</sub>/day) = 0.540\*BW<sup>0.705</sup>] using maximum body weight.
- [d] Food ingestion rate calculated using algorithm for insectivorous birds developed by Nagy, 2001 [FIR (g<sub>dw</sub>/day) = 0.540\*BW<sup>0.705</sup>] using average body weight.
- [e] In the absence of data for the robin, the incidental soil ingestion rate is based on 90<sup>th</sup> percentile value for shrew (consuming 100% earthworms; USEPA, 2007).
- [f] In the absence of data for the robin, the incidental soil ingestion rate is based on 50<sup>th</sup> percentile value for shrew (consuming 100% earthworms; USEPA, 2007).
- [g] Home range listed by USEPA (1993b) ranges from 0.27 to 1.04 acres with an average of 0.6095 acres.
- [h] An exclusive diet was selected for the SRA.
- [i] Average diet over the course of a year for adult robin in the eastern United States (USEPA, 1993b).

Notes for Herring gull

- [a] Range and average of adult body weights listed by USEPA (1993b).
- [b] Maximum body weight is only used to determine conservative ingestion rates for the SRA.
- [c] Food ingestion rate calculated using algorithm for gulls developed by Nagy, 2001 [FIR (g<sub>dw</sub>/day) = 0.522\*BW<sup>0.769</sup>] using maximum body weight.
- [d] Food ingestion rate calculated using algorithm for gulls developed by Nagy, 2001 [FIR (g<sub>dw</sub>/day) = 0.522\*BW<sup>0.769</sup>] using average body weight.
- [e] The incidental sediment ingestion rate is based on the value identified by Beyer (1994) for the Canada goose.
- [f] The incidental sediment ingestion rate is based on the value identified by Beyer (1994) for the Canada goose.
- [g] Foraging range listed by USEPA (1993b) ranges from 3 to 50 km with an average of 10 km.
- [h] An exclusive diet was selected for the SRA.
- [i] Dietary composition for adult herring gulls in coastal regions of the United States (USEPA, 1993b). The percent allotted to 'small mammals' and 'garbage' were assigned to fish.

Notes for Meadow vole

- [a] Range and average of adult body weights listed by USEPA (1993b).
- [b] Maximum body weight is only used to determine conservative ingestion rates for the SRA.
- [c] Food ingestion rate calculated using algorithm for herbivorous mammals developed by Nagy, 2001 [FIR (g<sub>dw</sub>/day) = 0.859\*BW<sup>0.628</sup>] using maximum body weight.
- [d] Food ingestion rate calculated using algorithm for herbivorous mammals developed by Nagy, 2001 [FIR (g<sub>dw</sub>/day) = 0.859\*BW<sup>0.628</sup>] using average body weight.
- [e] The incidental soil ingestion rate is based on 90<sup>th</sup> percentile value for vole (USEPA, 2007).
- [f] The incidental soil ingestion rate is based on 50<sup>th</sup> percentile value for vole (USEPA, 2007).
- [g] Home range listed by USEPA (1993b) ranges from 0.000494 to 0.2051 acres with an average of 0.0659 acres.
- [h] An exclusive diet was selected for the SRA.
- [i] Average diet over the course of a year for meadow vole based on bluegrass habitat in Illinois (USEPA, 1993b).

Notes for Short-tailed shrew

- [a] Range and average of adult body weights listed by USEPA (1993b).
- [b] Maximum body weight is only used to determine conservative ingestion rates for the SRA.
- [c] Food ingestion rate calculated using algorithm for insectivorous mammals developed by Nagy, 2001 [FIR (g<sub>dw</sub>/day) = 0.373\*BW<sup>0.622</sup>] using maximum body weight.
- [d] Food ingestion rate calculated using algorithm for insectivorous mammals developed by Nagy, 2001 [FIR (g<sub>dw</sub>/day) = 0.373\*BW<sup>0.622</sup>] using average body weight.
- [e] The incidental soil ingestion rate is based on 90<sup>th</sup> percentile value for shrew (USEPA, 2007).
- [f] The incidental soil ingestion rate is based on 50<sup>th</sup> percentile value for shrew (USEPA, 2007).
- [g] Single home range value was listed by USEPA (1993b).
- [h] An exclusive diet was selected for the SRA.
- [i] Dietary composition for shrew in New York (June to October; USEPA, 1993b). The percent allotted to 'other' was assigned to soil invertebrates.

Notes for Raccoon

- [a] Range and average of adult body weights listed by USEPA (1993b).
- [b] Maximum body weight is only used to determine conservative ingestion rates for the SRA.
- [c] Food ingestion rate calculated using algorithm for omnivorous mammals developed by Nagy, 2001 [FIR (g<sub>dw</sub>/day) = 0.432\*BW<sup>0.678</sup>] using maximum body weight.
- [d] Food ingestion rate calculated using algorithm for omnivorous mammals developed by Nagy, 2001 [FIR (g<sub>dw</sub>/day) = 0.432\*BW<sup>0.678</sup>] using average body weight.
- [e] The incidental soil ingestion rate is based on the value identified by Beyer (1994) for raccoons.
- [f] The incidental soil ingestion rate is based on the value identified by Beyer (1994) for raccoons.
- [g] Home range listed by USEPA (1993b) ranges from 96 to 6325 acres with an average of 1558 acres.
- [h] An exclusive diet was selected for the SRA.
- [i] Dietary composition for raccoon in New York (June to October; USEPA, 1993b). The percent allotted to small mammals includes birds and carrion. The percent allotted to fish includes amphibians and reptiles.