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TIER II SAMPLING AND ANALYSIS PLAN DEFENSE HIGHWAY PIPELINE CHAMBER
INVESTIGATION NS NEWPORT RI
4/15/2013
RESOLUTION CONSULTANTS

**TIER II SAMPLING AND ANALYSIS PLAN
Defense Highway Pipeline Chamber Investigation
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 WE29

Prepared by:



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

April 15, 2013

Draft

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January 2, 2013

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EXECUTIVE SUMMARY

This Tier II Sampling and Analysis Plan (SAP) was prepared by Resolution Consultants (Resolution) for the U.S. Department of the Navy (Navy) and the Naval Facilities Engineering Command (NAVFAC). This work is regulated under the RIDEM Remediation Regulations (RIDEM, 2011). Resolution has prepared this document under NAVFAC Atlantic, Comprehensive Long-Term Environmental Action, Navy (CLEAN) Contract No. N62470-11-D-8013, Contract Task Order (CTO) WE29. This SAP pertains to planned field investigations and data evaluations of soil and groundwater impacts in the vicinity of 17 chambers located along the previously pigged and cleaned main fuel supply pipeline located along Defense Highway at NAVSTA Newport, Rhode Island.

Consistent with the August 1, 2012 Statement of Work (SOW) and subsequent discussions with the Navy Remedial Program Manager (RPM) and Rhode Island Department of Environmental Management (RIDEM) Case Manager, this SAP provides details for the investigation and delineation of petroleum and oil (POL) impacted soil immediately surrounding 12 of the 17 chambers (A4, A5, A6, AE6, E6, E11, A16, E22, E16, E17, V3 and S1) and soil at the terminus end of drains leading out of 11 of the 17 chambers (A4, A5, E5, A6, AE6, E6, A7, A8, E9, A10 and E11). Note that chambers A4, A5, A6, AE6, E6 and E11 are included in both investigations. The information obtained as part of these investigations will be used to subsequently develop a proposed remedial strategy to reach regulatory closure for these particular chamber areas. In addition, groundwater samples will be collected in the vicinity of chambers A16, E16 and E22 in order to delineate impacts upgradient of the former location of Building 70. Remediation efforts have been ongoing at the Building 70 study area and there is concern that releases from chambers A16, E16 or E22 may be contributing to impacts downgradient.

The primary objective of the investigations described herein is to refine the extent of petroleum impacts related to 17 chambers along the former Defense Highway pipeline and position the areas for regulatory closure under RIDEM Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases (Remediation Regulations, 2011). The objective will be met by comparing concentrations of Chemicals of Concern (COCs) in soil to the Rhode Island Residential Direct Exposure Criteria (RDEC) for soils and the GA Groundwater Objectives (where established) or United States Environmental Protection Agency (USEPA) Maximum Contaminant Levels (MCLs) for groundwater.

The specific goals of the investigations are listed below and further defined in this SAP:

- Goal 1 – Refine the extent of soil impacts from prior operations surrounding 12 of 17 chambers

- Goal 2 – Locate the ultimate discharge points of chamber drain lines at 11 of 17 chambers and collect a sample to determine if impacted soil is present at the 4 outfalls associated with those drain lines
- Goal 3 – Refine the extent of groundwater impacts in the vicinity of 3 of the 17 chambers located upgradient of the Building 70 study area
- Goal 4 – Compare analytical results to applicable RIDEM Criteria, where established

Matrices to be sampled include subsurface soil (at 12 of 17 chambers) and shallow soil (1.5 feet deep) (at the ultimate discharge points of drain lines exiting 11 of the 17 chambers). In addition, groundwater will be sampled at three chambers located upgradient of the Building 70 study area to aid in delineation of groundwater impacts at that study area. 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
 Pipeline Chambers, NAVSTA Newport, RI**

Analytical Parameter	Matrix
Parameters of Interest	
VOCs, PAHs	SS
TPH	SS, GW
Physical and Geochemical Data	
TOD	SS
Alkalinity	GW

Notes:

- VOCs – Volatile Organic Compounds
- PAHs – Polycyclic Aromatic Hydrocarbons
- TPH – Total Petroleum Hydrocarbons
- SS – Surface or subsurface soil
- GW – Groundwater

CONTENTS

(UFP-QAPP Manual Section 2.1 – Worksheet #1 Title and Approval Page)	1
SAP Worksheet #5: Project Organizational Chart.....	9
SAP Worksheet #6: Communication Pathways	10
SAP Worksheet #9: Project Scoping Session Participants Sheet.....	14
SAP Worksheet #9: Project Scoping Session Participants Sheet.....	16
SAP Worksheet #9: Project Scoping Session Participants Sheet.....	18
SAP Worksheet #10: Conceptual Site Model, Defense Highway Pipeline Chambers.....	20
SAP Worksheet #11: Project Quality Objectives/Systematic Planning Process Statements, Defense Highway Pipeline Chambers	38
SAP Worksheet #12-1: Measurement Performance Criteria – Field QC Samples for Volatile Organic Compounds	49
SAP Worksheet #12-2: Measurement Performance Criteria – Field QC Samples for Gasoline Range Organics	51
SAP Worksheet #12-3: Measurement Performance Criteria – Field QC Samples for Polycyclic Aromatic Hydrocarbons	53
SAP Worksheet #12-4: Measurement Performance Criteria – Field QC Samples for Diesel Range Organics	54
SAP Worksheet #12-5: Measurement Performance Criteria – Field QC Samples for Total Oxidant Demand	55
SAP Worksheet #12-6: Measurement Performance Criteria – Field QC Samples for Gasoline Range Organics	56
SAP Worksheet #12-7: Measurement Performance Criteria – Field QC Samples for Diesel Range Organics	57
SAP Worksheet #12-8: Measurement Performance Criteria – Field QC Samples for Alkalinity	58
SAP Worksheet #12: Notes.....	59
SAP Worksheet #17: Sampling Design and Rationale, Defense Highway Pipeline Chamber Investigation.....	60
SAP Worksheet #14: Summary of Project Tasks, Pipeline Investigation	64
SAP Worksheet #21: Project Sampling SOP References Table.....	69
SAP Worksheet #18, 19, 20 and 30: Field Project Implementation (Field Project Instructions)	70
SAP Worksheet #15: Reference Limits and Evaluation Tables	78
SAP Worksheet #23: Analytical SOP References Table.....	80
SAP Worksheet #23: Analytical SOP References Table.....	82
SAP Worksheet #28-1: Laboratory QC Samples Table	83
SAP Worksheet #28-2: Laboratory QC Samples Table	85
SAP Worksheet #28-3: Laboratory QC Samples Table	86
SAP Worksheet #28-4: Laboratory QC Samples Table	88
SAP Worksheet #28-5: Laboratory QC Samples Table	89
SAP Worksheet #28-6: Laboratory QC Samples Table	90
SAP Worksheet #28-7: Laboratory QC Samples Table	91

SAP Worksheet #28-8: Laboratory QC Samples Table	92
SAP Worksheet #34, 35, 36 Data Verification and Validation (Steps I and IIa/IIb) Process Table ..	93
SAP Worksheet #37: Usability Assessment	97

Figures

Figure 1	Regional Location of Pipeline Chambers to Investigated
Figure 2	Chamber A4
Figure 3	Chamber E5
Figure 4	Chamber A5
Figure 5	Chamber E6
Figure 6	Chamber AE6
Figure 7	Chamber A6
Figure 8	Chamber A7
Figure 9	Chamber A8
Figure 10	Chamber E9
Figure 11	Chamber A10
Figure 12	Chamber E11
Figure 13	Chamber E16
Figure 14	Chamber E22
Figure 15	Chamber A16
Figure 16	Chamber E17
Figure 17	Chamber S1
Figure 18	Chamber V3

Appendices

Appendix A	Resolution Consultants SOPs
Appendix B	Laboratory Certifications

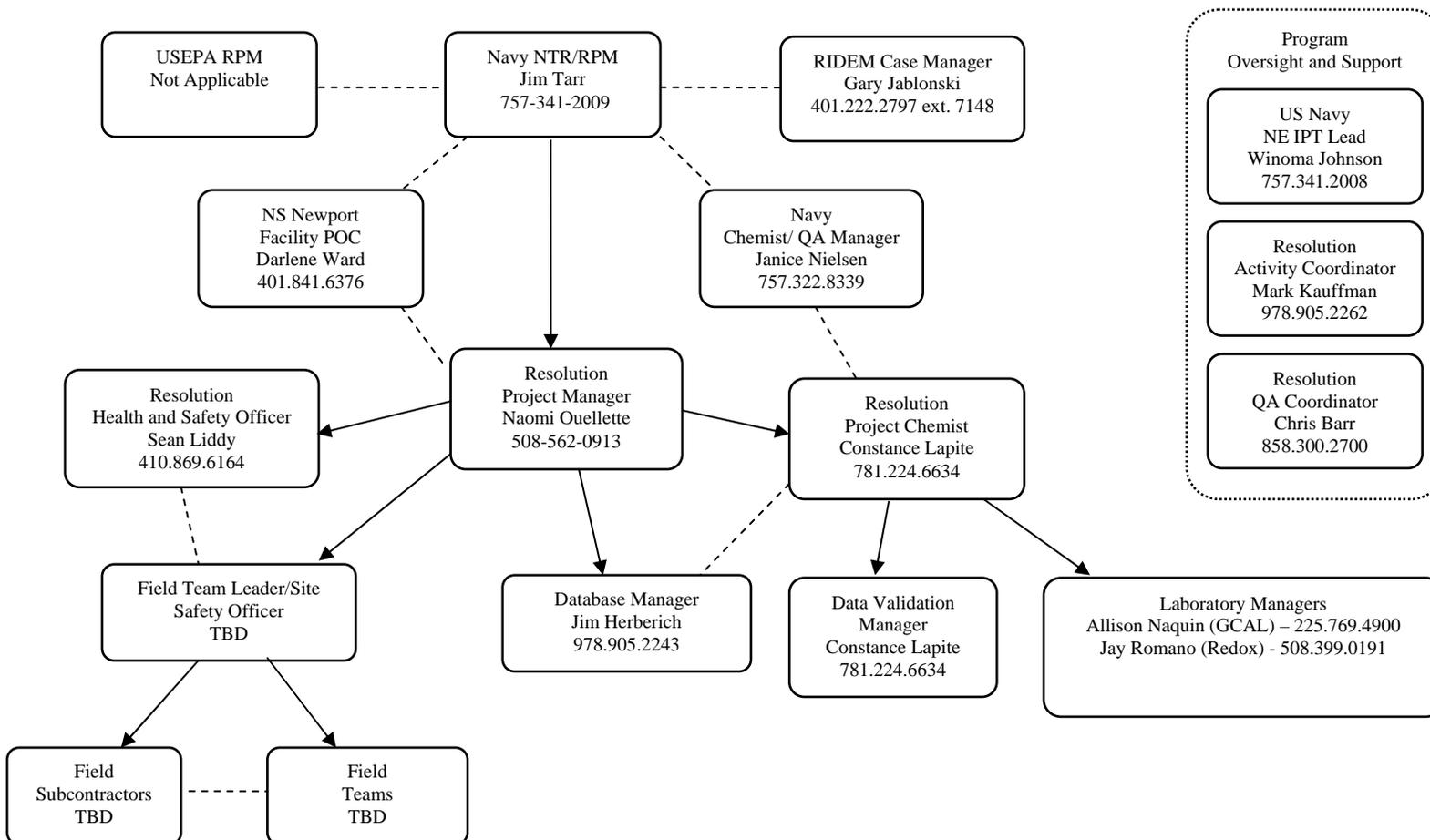
ACRONYMS AND ABBREVIATIONS

°C	Degrees Celsius
BGS	Below Ground Surface
BSG	Below Surface Grade
CAP	Corrective Action Plan
CLEAN	Comprehensive Long-Term Environmental Action, Navy
CoC	Chain-of-Custody
COC	Chemicals of Concern
CSM	Conceptual Site Model
CTO	Contract Task Order
DL	Detection Limit
DO	Dissolved Oxygen
DoD	Department of Defense
DQI	Data Quality Indicator
DRO	Diesel Range Organic
ELAP	Environmental Laboratory Accreditation Program
FTL	Field Team Leader
FTMR	Field Task Modification Request
FWENC	Foster Wheeler Environmental Corporation
GCAL	Gulf Coast Analytical Laboratories
GRO	Gasoline Range Organic
GPS	Global Positioning System
ICDEC	Industrial/Commercial Direct Exposure Criteria
IDW	Investigation-Derived Waste
IR	Installation Restoration
LCS	Laboratory Control Sample
LCSD	LCS Duplicate
LNAPL	Light non-aqueous phase liquid
LOD	Limit of Detection
LOE	Level of effort
LOQ	Limit of Quantitation
LUCs	Land Use Controls
MCLs	Maximum Contaminant Levels
MPIs	Measurement Performance Indicators
MS/MSD	Matrix Spike/Matrix Spike Duplicate
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
ORP	Oxidation-Reduction Potential
OU	Operable Unit
PAHs	Polycyclic Aromatic Hydrocarbons
PAL	Project Action Limit
PCE	Tetrachlorethene

PDF	Portable Document Format
PID	Photoionization Detector
PM	Project Manager
POC	Point of Contact
POL	Petroleum and oil
PPM	Parts-per-million
PQOs	Project Quality Objectives
PVC	Polyvinyl Chloride
QA/QC	Quality Assurance/Quality Control
QSM	Quality Systems Manual
Resolution	Resolution Consultants
RDEC	Residential Direct Exposure Criteria
Redox	Redox Tech NE, LLC
RIDEM	Rhode Island Department of Environmental Management
RPD	Relative Percent Difference
RPM	Remedial Program Manager
SAP	Sampling and Analysis Plan
SDG	Sample Delivery Group
SIR	Site Investigation Report
SOP	Standard Operating Procedure
SOW	Statement of Work
SSO	Site Safety Officer
SVOCs	Semi-Volatile Organic Compounds
TAL	Target Analyte List
TAT	Turnaround Time
TBD	To Be Determined
TCL	Target Compound List
TOD	Total Oxidant Demand
TPH	Total Petroleum Hydrocarbons
UFP-QAPP	Uniform Federal Policy for Quality Assurance Project Plans
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UST	Underground Storage Tank
VOCs	Volatile Organic Compounds
VOVs	Volatile Organic Vapors

SAP Worksheet #5: Project Organizational Chart

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



SAP Worksheet #6: Communication Pathways

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	Navy RPM	Jim Tarr	757-341-2009	Navy Remedial Project Manager (RPM) will interface with Regulatory Agency directly via phone or email as needed.
Field Progress Reports	Resolution FTL\SSO Resolution PM Navy RPM RIDEM Case Manager	FTL\SSO – TBD Naomi Ouellette Jim Tarr Gary Jablonski	TBD 508-562-0913 757-341-2009 401-222-2797 x 7148	<p>The Resolution Field Team Leader (FTL) will email daily field progress reports to the Resolution Project Manager (PM). In addition, there will be phone conversation between the Resolution FTL and the Resolution PM as needed.</p> <p>The Resolution RPM will email the Navy RPM at a minimum weekly or as needed.</p> <p>The Resolution PM will provide RIDEM and the Navy with a one week notice before field activities are initiated and a 48 hour notice prior to the completion of the field activities. Once field activities are initiated, Resolution will provide a weekly construction update. Updates will be provided via electronic mail. At a minimum, these weekly construction updates will provide the following: 1) Summary of the work completed the previous week; 2) Summary of the work planned for current week; 3) Sampling results; 4) Discussions of major construction issues and resolutions; and 5) Proposed amendments to the SAP.</p>
Gaining Site Access	NS Newport Facility POC Resolution PM	Darlene Ward Naomi Ouellette	401.841.6376 508-562-0913	The Resolution PM will coordinate directly with the Navy point of contact (POC) at least 48 hours prior to initiating field work in order to gain access to the site.
Obtaining Utility Clearances for Intrusive Activities	Resolution PM	Naomi Ouellette	508-562-0913	The Resolution PM (or their designee) will contact Digsafe at least 72 hours prior to initiating intrusive field work activities.

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathway To/From, etc.)
Stop Work due to Safety Issues	Resolution FTLSSO Resolution PM Resolution HSO Navy RPM	FTL\SSO – TBD Naomi Ouellette Sean Liddy Jim Tarr	TBD 508-562-0913 410.869.6164 757-341-2009	The Resolution Site Safety Officer (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 (HSO) and Navy RPM to resolve issues.
SAP Changes prior to Field/Laboratory Work	Resolution PM Navy RPM	Naomi Ouellette Jim Tarr	508-562-0913 757-341-2009	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\SSO Resolution PM Navy RPM	FTL\SSO – TBD Naomi Ouellette Jim Tarr	TBD 508-562-0913 757-341-2009	The Resolution FTL 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\SSO Resolution PM Navy RPM	FTL\SSO – TBD Naomi Ouellette Jim Tarr	TBD 508-562-0913 757-341-2009	The need for corrective action for field issues will be determined by the Resolution FTL. The Resolution FTL will notify the Resolution PM.
Sample Receipt Variances and Laboratory Quality Variances	GCAL Redox Resolution FTL\SSO Resolution PM Resolution Project Chemist	Allison Naquin Jay Romano FTL\SSO – TBD Naomi Ouellette Constance Lapite	225-769-4900 580-399-0191 TBD 508-562-0913 781-224-6634	The Laboratory PM will notify (verbally or via e-mail) the Resolution FTL immediately upon receipt of any chain of custody/sample receipt variances for clarification or direction from the Resolution FTL. The Resolution FTL will notify (verbally or via e-mail) the Resolution PM and project chemist within 1 business day, if corrective action is required. The Resolution PM or project chemist will notify (verbally or via e-mail) the Laboratory PM and the Resolution FTL within 1 business day of any required corrective action.

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathway To/From, etc.)
Analytical Corrective Actions	GCAL Redox Resolution Project Chemist	Allison Naquin Jay Romano Constance Lapite	225-769-4900 580-399-0191 781-224-6634	The laboratory will notify the Resolution project chemist of any analytical data anomaly within 1 business day of discovery. After the laboratory receives guidance from Resolution project chemist, the laboratory shall initiate any corrective action to prevent further anomalies.
Analytical Data Quality Issues	GCAL Redox Resolution FTL\SSO Resolution PM Resolution Project Chemist Navy RPM	Allison Naquin Jay Romano FTL\SSO – TBD Naomi Ouellette Constance Lapite Jim Tarr	225-769-4900 580-399-0191 TBD 508-562-0913 781-224-6634 757-341-2009	<p>The laboratory PM will notify (verbally or via e-mail) the Resolution project chemist within 1 business day of when an issue related to laboratory data is discovered. The Resolution project chemist will notify the Resolution PM within 1 business day.</p> <p>The Resolution project chemist will notify the Resolution PM verbally or via e-mail within 48 hours of validation completion that a non-routine and significant laboratory quality deficiency has been detected that could affect this project and/or other projects. The Resolution PM will verbally advise the Navy RPM within 24 hours of notification from the chemist. The Navy RPM will engage the Navy Quality Assurance Officer (QAO) to ensure the issues with this project can be evaluated to determine impact to other DoD projects.</p>
Reporting Data Validation Issues/ Data Validation Corrective Actions	Resolution PM Resolution Project Chemist	Naomi Ouellette Constance Lapite	508-562-0913 781-224-6634	<p>The Resolution project chemist or data validator will perform validation as specified in Worksheets #34, 35, and 36, and will contact the laboratory as soon as possible if issues are found that require corrective action.</p> <p>If the Resolution project chemist or data validator identifies non-usable data during the data validation process that requires corrective action, the Resolution PM will coordinate with the project chemist to take corrective action appropriate for the identified deficiency to ensure the project objectives are met. Corrective action may include resampling and/or reanalyzing the affected samples, as determined by the Resolution PM.</p>

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathway To/From, etc.)
Notification of Non-Usable Data	GCAL Redox Resolution PM Resolution Project Chemist Navy RPM	Allison Naquin Jay Romano Naomi Ouellette Constance Lapite Jim Tarr	225-769-4900 580-399-0191 508-562-0913 781-224-6634 757-341-2009	<p>If the laboratory determines that any data they have generated is non-usable, the Laboratory PM will notify (verbally or via e-mail) the Resolution project chemist within 1 business day of when the issue is discovered.</p> <p>The Resolution project chemist will notify (verbally or via e-mail) Resolution PM within 1 business day of the need for corrective action, if the non-usable data is a significant issue (i.e., critical sample data). Corrective action may include resampling and/or reanalyzing the effected samples.</p> <p>If a Resolution project chemist or data validator identifies non-usable data during the data validation process, the PM will be notified verbally or via e-mail within 48 hours of validation completion that a non-routine and significant laboratory quality deficiency has resulted in non-usable data.</p> <p>The Resolution PM will take corrective action appropriate for the identified deficiency to ensure the project objectives are met. The Resolution PM will notify (verbally or via email) the Navy RPM on any problems with the laboratory or analysis that could significantly affect the usability of the data or project failures that impact the ability to complete the scope of work. The Navy RPM will contact the Navy QAO for assistance in problem resolution. Such notification will be made within 1 business day of when the issue is discovered.</p>

Notes:

- | | |
|--|----------------------------------|
| RPM = Remedial project manager | POC = Point of contact |
| FTL/SSO = Field team leader/ Site safety officer | HSO = Health and safety officer |
| PM = Project manager | SAP = Sampling and analysis plan |
| GCAL = Gulf Coast Analytical Laboratory | Redox = Redox Tech NE, LLC |
| FTMR = Field task modification request | QAO = Quality Assurance Officer |

SAP Worksheet #9: Project Scoping Session Participants Sheet

Project Name:	Pipeline Chamber Investigation	Site Name:	Pipeline Chamber Investigation
Projected Date(s) of Sampling:	Spring 2013	Site Location:	Along Defense Highway, NAVSTA, Newport, RI
Project Manager:	Naomi Ouellette		
Date of Session:	10/17/2012		
Scoping Session Purpose:	Kickoff Meeting		

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Jim Tarr	RPM	NAVFAC MIDLANT	757-341-2009	James.Tarr@navy.mil	Coordinates IR Activities
Mark Kauffman	Resolution Activity Coordination	Resolution	978.905.2262	Mark.Kauffman@aecom.com	Senior Oversight/Review
Naomi Ouellette	Resolution PM	Resolution	508-562-0913	Naomi.Ouellette@aecom.com	Oversight of SAP Production

Comments/Decisions:

- Discussed the scope of the investigation.
 - Prepare informal work plan for soil boring investigation at chambers along pipeline
 - Conduct soil boring investigation
 - Prepare a Corrective Action Plan (CAP)
- Discussed the proposed schedule.
- Discussed Work Plan versus Formal Tier II SAP.
- Discussed action levels for PetroFLAG™ and RIDEM concurrence with approach.
- Navy requested we review and compile all historic data to verify which chambers require additional investigation.
- Discussed RIDEM definition of light non-aqueous phase liquid (LNAPL).

Action Items:

- Need to compile all historic data and compare to current standards, create figures.
- Navy forwarded emails regarding previous discussions about TPH sampling.

Consensus Decisions:

- Internal Draft due to Navy end of November. Aim for field work in early Spring. Draft CAP end of July.
- Initially decided an informal Work Plan would suffice, but following the call, Navy indicated it would need to be a Tier II SAP.
- Action level of 400 parts-per-million (ppm) for PetroFLAG was developed by RIDEM Case Manager Gary Jablonski. Case Manager also concurs with boring survey as opposed to test pits.

SAP Worksheet #9: Project Scoping Session Participants Sheet

Project Name:	Pipeline Chamber Investigation	Site Name:	Pipeline Chamber Investigation
Projected Date(s) of Sampling:	Spring 2013	Site Location:	Along Defense Highway, NAVSTA, Newport, RI
Project Manager:	Naomi Ouellette		
Date of Session:	11/7/2012		
Scoping Session Purpose:	Discuss Changes in Scope		

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Jim Tarr	RPM	NAVFAC MIDLANT	757-341-2009	James.Tarr@navy.mil	Coordinates IR Activities
Naomi Ouellette	Resolution PM	Resolution	508-562-0913	Naomi.Ouellette@aecom.com	Oversight of SAP Production

Comments/Decisions:

- Discussed the change in scope.
 - Change from informal work plan to formal Tier II SAP that would require the formal review process.
 - Added review of all historical data to verify which chambers need further investigation.
 - Added a third sampling interval (groundwater may be as deep as 12 feet)
- Discussed the RIDEM approval of change in scope and how that affects the schedule.

Action Items:

- Submit concurrence letter for changes in scope.
- Navy will contact case manager again about approving scope changes.

Consensus Decisions:

- All changes in scope approved
 - Extra level of effort (LOE) for Tier II SAP and compiling historical data
 - Extra LOE for hand entering data and starting figures from scratch
 - Additional sampling interval (10-15 feet), additional drilling costs, field effort and PetroFLAG costs.
 - Concurrent with Total Oxidant Demand (TOD) soil sampling, soil samples for alkalinity will be collected, groundwater will be collected from borings to mix with TOD soil and YSI parameters collected. (Note that subsequent discussion with chemist determined that alkalinity should be analyzed from groundwater samples instead of soil).
- Due date for first 3 worksheets to Navy Chemist by November 30, 2012.

SAP Worksheet #9: Project Scoping Session Participants Sheet

Project Name:	Pipeline Chamber Investigation	Site Name:	Pipeline Chamber Investigation
Projected Date(s) of Sampling:	Spring 2013	Site Location:	Along Defense Highway, NAVSTA, Newport, RI
Project Manager:	Naomi Ouellette		
Date of Session:	11/8/2012		
Scoping Session Purpose:	Refining Scope		

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Gary Jablonski	Principal Engineer	RIDEM	401-222-2797 x 7148	gary.jablonski@dem.ri.gov	Case Manager
Naomi Ouellette	Resolution PM	Resolution	508-562-0913	Naomi.Ouellette@aecom.com	Oversight of SAP Production

Comments/Decisions:

- Discussed the change in scope.
 - Clarified RIDEM's preference for test pitting at the chambers.
 - Clarified definition of "terminus" (ultimate discharge point) and sampling needs at those locations.
 - Limiting analyte list
 - Final report needs

Action Items:

- Submit 2000 results for A4 for beryllium. (Results are below current standard. Will remove metals from scope).
- Mr. Jablonski forwarding RIDEM's response to Closeout Report for Piping Chamber Remediation (January 29, 2011) which clarifies sampling needs.

Consensus Decisions:

- Test pitting will be conducted on all four sides of each chamber (12 total) to be investigated. Chamber E16 added back to list because sample from 2000 was collected on upgradient side.
- Approved limiting analyte list at chambers to just those analytes that exceeded standards in 2000.
- An attempt will be made to find the ultimate discharge point for drains in 11 chambers by clearing vegetation in drainage ditch located opposite chamber adjacent to Defense Highway (similar scope conducted in 2008). For A10 – the drain line will be traced east to the manhole to determine if piping is sound. (Note that upon review of Navy plans, there is a common drain line for some chambers, with common ultimate discharge points. These are described in further detail in subsequent sections of this SAP).
- Final Report will be a Site Investigation Report (SIR) with recommendations for proposed remedial actions as needed.

SAP Worksheet #10: Conceptual Site Model, Defense Highway Pipeline Chambers

Overview

This SAP pertains to planned field investigations and data evaluations of soil impacts in the vicinity of 17 chambers (A4, A5, E5, A6, AE6, E6, A7, A8, E9, A10, E11, A16, E22, E16, E17, V3 and S1) and groundwater impacts in the vicinity of three chambers (A16, E16 and E22, located upgradient of the Building 70 study area) located along the previously pigged and cleaned main fuel supply pipeline located along Defense Highway at NAVSTA Newport, Rhode Island. Portions of the former fuel line are located in Middletown and portions in Portsmouth, Rhode Island. In 2000, a 6-mile long section of the inactive main fuel line and associated chambers were cleaned. This section of the pipeline extended from the Defense Energy Support Center to the Navy's Pier 1. Specifically, this SAP provides details for the investigation and delineation of POL impacted soil immediately surrounding 12 of the 17 chambers (A4, A5, A6, AE6, E6, E11, A16, E22, E16, E17, V3 and S1) and soil at the terminus end of drains leading out of 11 of the 17 chambers (A4, A5, E5, A6, AE6, E6, A7, A8, E9, A10 and E11). Note that chambers A4, A5, A6, AE6, E6 and E11 are included in both investigations. The information obtained as part of these investigations will be used to subsequently develop a proposed remedial strategy to reach regulatory closure for these particular chamber areas. In addition, groundwater samples will be collected in the vicinity of chambers A16, E16 and E22 in order to delineate impacts upgradient of the Building 70 study area. Remediation efforts have been ongoing at the Building 70 study area and there is concern that releases from chambers A16, E16 or E22 may be contributing to impacts downgradient. Refer to Figure 1 for the regional location.

This work is regulated under the RIDEM Remediation Regulations (RIDEM, 2011). The areas included in this investigation were chosen based on a review of the Final Construction Completion Report for Fuel Line Closure (FWENC, 2001), the Closeout Report for Piping Chamber Remediation (Tetra Tech, 2008), RIDEM's comments to the Closeout Report dated January 28, 2011 and subsequent conversations with RIDEM Case Manager Gary Jablonski.

In addition to the above-referenced documents, the following were also relied upon for the majority of information discussed in this worksheet and best describe the operational history, physical characteristics, and other key elements of the conceptual site model (CSM): the Work Plan for Fuel Line Closure (FWENC, 2000), the Work Plan for Piping Chamber Remediation (FWENC, 2002), and the Final Site Investigation and Removal Action Work Plan (Tetra Tech, 2004).

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

- Figure 1 – Regional Location of Pipeline Chambers to be Investigated
- Figures 2 through 18 – Historical and Proposed Sampling Locations for Chambers

Operational History

The pipeline was the main fuel supply line once used to transfer various fuels, including jet fuel (JP-5 and JP-8), marine diesel, Navy Special, No. 2 fuel oil and No. 6 fuel oil from Tank Farms 1, 2, 3, 4 and 5 to various ship fueling stations at nearby piers. The pipeline is located along Burma Road (Defense Highway) and extends from the Defense Energy Support Center North Booster Pump House (Building No. 58) at the northern end, to each of the Tank Farms, and ultimately to the supply lines for Pier No. 1 and Pier No.2 at the southern end. The pipeline extends from the Melville Marine Basin through the towns of Portsmouth and Middletown, Rhode Island. The majority of the pipeline in this vicinity was enclosed in a concrete culvert trench that extends from the area of the Defense Fuel Support Center to Chamber A-19 located at Tank Farm 5 (TF 5). From TF 5 the pipeline was directly buried and extended to Building 73 located on Pier No. 2 (Tetra Tech, 2008).

There were a total of 50 concrete chambers, including two which were co-located, that were located along the pipeline that were scheduled for demolition during the cleanout process in 2000. The chambers were partially buried. A typical expansion chamber was approximately 10 feet wide by 14 feet long by 8 feet deep. A typical anchor chamber was approximately 6 feet wide by 10 feet long by 8 feet deep. These chambers served to provide access to valves, expansion joints, and reducers associated with the main fuel pipeline. This SAP pertains to soil located in the immediate vicinity of 17 chambers and/or their associated drain lines only. No further action is considered warranted at the remaining 33 chambers that were previously investigated and/or remediated (Tetra Tech, 2008).

Current Site Use

The former main fuel supply pipeline and chambers are currently not in use and have been pigged and cleaned. RIDEM and the Navy are currently evaluating whether additional site impacts remain that require additional investigation prior to closure.

Information about the general location of the 17 chambers included in the investigations herein is included in the following table (Table 10-1). Chambers are listed in order from north to south along the pipeline. The second column indicates whether soil surrounding the chamber itself is being investigated (C) and/or the soil at the terminus end of the chamber drain line is being investigated (T). Also refer to Figure 1 for regional locations of the 17 chambers.

Table 10-1

Approximate Location of Chambers to be Investigated

Chamber	Chamber (C)/ Terminus of Drain Line (T)	Location
A4	C/T	Approximately 2,400 feet south of Chamber C18 and the entrance to Tank Farm 2. In Portsmouth, RI.
E5	T	Approximately 400 feet south of Chamber A4. In Portsmouth, RI.
A5	C/T	Approximately 400 feet south of Chamber E5. In Portsmouth, RI.
E6	C/T	Under Defense Highway, approximately 350 feet south of Chamber A5 and 125 feet north of the outfall for Lawton's Brook to Narragansett Bay. In Portsmouth, RI.
AE6	C/T	Under Defense Highway, approximately 50 feet south of the outfall of Lawton's Brook to Narragansett Bay. In Portsmouth, RI.
A6	C/T	Under Defense Highway, approximately 250 feet south of Chamber A6 and approximately 750 feet north of the entrance to Tank Farm 3. In Portsmouth, RI.
A7	T	Approximately 825 feet south of Chamber A6. In Portsmouth, RI.
A8	T	Approximately 750 feet south of Chamber A7. In Portsmouth, RI.
E9	T	Approximately 400 feet south of Chamber A8. In Portsmouth, RI.
A10	T	Approximately 500 feet south of the roadway entrance to Tank Farm 4. Chamber A10 connects to the pipeline feeding Tank Farm 4. In Portsmouth, RI.
E11	C/T	Under Burma Rd, approximately 900 feet south of the entrance to Tank Farm 4 and approximately 125 feet north of the outfall for Norman's Brook to Narragansett Bay. In Portsmouth, RI.
E16	C	Directly across Defense Highway (east) of Building 70. Approximately 950 feet north of Greene Lane. In Middletown, RI.
E22	C	Diagonally (southeast) across Defense Highway from Building 70 and directly across from the entrance to Midway Pier. Approximately 800 feet north of Greene Lane. In Middletown, RI.
A16	C	Approximately 125 feet south of Chamber E22 and across Defense Highway from Building 71. In Middletown, RI.
E17	C	Approximately 300 feet south of Chamber A16 and approximately 500 feet from where the pipeline crosses under Greene Lane. In Middletown, RI.
S1	C	South of the golf course and approximately 400 feet north of Building 112. In Middletown, RI.
V3	C	Approximately 100 feet south of Building 113 and near Gate 30. In Middletown, RI.

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

To Resolution's knowledge, groundwater at the site is not currently being used for potable use, there are no wells present on site, and the site is served by the municipal water supply. This information will be confirmed as part of the SIR.

The pipeline runs adjacent to with portions running underneath Burma Road (Defense Highway). Portions are also adjacent to a bike path and traverse over drainage areas for Lawton's Brook and Norman's Brook to Narragansett Bay.

Topography and Geology

Specific topography and geology in the vicinity of each chamber was not available in previous reports. However, the topographic profile of the area along the pipeline and most of NAVSTA Newport is generally flat with a mean elevation of approximately 25 feet above sea level. The former pipeline ran along Defense Highway which parallels in close proximity to Narragansett Bay; therefore, in general, the topography along this area is near mean sea level and relatively flat. Groundwater elevation data in the vicinity indicates that groundwater flow is to the west toward the Narragansett Bay.

Located within the Narragansett Basin, are primarily Pennsylvanian aged sedimentary rocks. Soil types 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).

Hydrology and Hydrogeology

Surface water bodies known to be located within the vicinity of select chambers are Lawton's Brook (located approximately 125 feet south of Chamber E6) and Norman's Brook (located approximately 125 south of Chamber E11). In addition, Narragansett Bay is located within as little as 200 feet of some of the chambers, beyond Defense Highway; however, the exact distance to Narragansett Bay or other surface water bodies was not available in previous reports.

Although site specific data regarding groundwater specific to each chamber is not known, groundwater underlying the pipeline is anticipated to be typical of NAVSTA Newport. Groundwater is generally located within aquifers located in the glacial till and bedrock. The average depth to groundwater at the site is anticipated to be between 8 and 12 feet. The groundwater underlying the chambers being investigated herein is classified as Class GA, which is a RIDEM designation for groundwater that is "suitable for drinking water use without treatment." The area planned for investigation is considered one shallow overburden aquifer zone, ranging from approximately 8 to 12 feet in depth, to the top of bedrock (ranging from approximately 17 to 40 feet).

Previous Site Investigation Activities

In 2000, Tetra Tech was contracted to perform in-place cleaning of a 6-mile span of the main fuel pipeline located at NAVSTA Newport. During these investigations, the main fuel line was cleaned, pressure tested, and isolated from the Tank Farms, Piers, and any other distribution lines. The closure process included asbestos abatement of the steam line insulation systems within the chambers to be demolished/removed. RIDEM and the Navy are currently evaluating whether additional site impacts remain that require additional investigation prior to closure.

Upon completion of the cleaning process and asbestos abatement, the soils below and adjacent to main fuel pipeline penetrations were accessed for soil sampling. Prior to sample collection a backhoe was used to excavate and expose the chamber roofs. Once the roof of the chamber was exposed, an excavator was used to demolish the chamber roofs. The backhoe was then used to remove the concrete debris from the interior of the chamber. Once the debris was removed, the excavator was used to hammer a hole through the floor of the chamber. One sample was collected from directly beneath the chamber floor slab where the concrete was broken to allow for future drainage of water. In some cases, the concrete bottom was too thick to penetrate and a sample was collected from outside the chamber walls. Soil samples were analyzed for TPH (Methods 418.1 and 8015), VOCs (Method 8260B), semivolatile organic compounds (SVOCs) (Method 8270D), and Target Analyte List (TAL) Metals (Method 6010) (Tetra Tech, 2008).

The chambers were then demolished and backfilled. The excavator was used to break the chamber walls to one foot below the ground surface. All broken concrete was placed within the chamber and mixed with 2-4 inch stone to minimize void space, and to allow drainage of water to continue. A 6-ounce woven geotextile was placed on top of the stone layer and extended to the top of the demolished wall (approximately one-foot below ground surface). Imported clean dense graded gravel was placed on top of the woven geotextile and brought to within 4 inches of the existing grade. The backfill was compacted with the backhoe bucket during placement. All soils removed were placed in a stockpile adjacent to the work area, and used to backfill the excavations. As a final restoration measure, 4 inches of imported topsoil was placed on the surface, and the area was seeded with grass seed (Tetra Tech, 2008).

Four of the 50 chambers were reportedly demolished during construction of the bike path along Defense Highway and could not be located during the pipeline inspection. Therefore, soil samples could not be collected. These four chambers are included herein for investigation (A6, AE6, E6 and E11).

Analytical results from 32 of the 50 chambers indicated concentrations of all analyzed constituents were below applicable RIDEM criteria or presented limited risk and no further investigations were

warranted. Analytical results from 14 of the 50 of chambers indicated the presence of constituents above the RIDEM RDEC and/or Industrial/Commercial Direct Exposure Criteria (ICDEC) in soil located directly beneath the chamber floors requiring further investigation and remedial action.

Of these 14, seven chambers were subsequently remediated (Tetra Tech, 2007 and Tetra Tech, 2008); however, seven chambers (A4, A5, A16, E22, E17, V3 and S1) were never further investigated, delineated or remediated. In addition, RIDEM subsequently requested that an eighth chamber (E16) be further investigated due to the fact that oil was observed in the chamber and the soil sample previously collected from beneath this chamber was on the upgradient side and only slightly below the RDEC criteria for TPH. These eight chambers in addition to the four not previously investigated (A6, AE6, E6 and E11) are included herein for investigation, for a total of 12 chambers for which soil surrounding the chambers were never fully delineated.

In addition, during the closure in place of the chambers, drain lines were observed leading out of some of the chambers. Several of these drain lines were investigated further by Tetra Tech (Tetra Tech, 2008); however, 11 were not and are included herein as part of this investigation (A4, E5, A5, E6, AE6, A6, A7, A8, E9, A10, and E11). Note that chambers A4, A5, A6, AE6, E6 and E11 are also included in the investigation of soil immediately surrounding the chambers. The following table (Table 10-2) summarizes information regarding the ultimate discharge points for the drain lines leading out of the 11 chambers. Information regarding the ultimate discharge point of the 11 chambers was obtained from the following two sources:

- NAVSTA Newport historical plans of the pipeline ("Details of Fuel Oil System North Side of Pier 2" plans dated July 27, 1979), which illustrates the locations of the chambers and underground drainage connected to the chambers, and
- Table 7-1 Drainage Summary included in the Final Construction Completion Report (FWENC, 2001).

Table 10-2

Terminus of Drain Lines to be Investigated

Chamber	Summary of drainage information
A4	FWENC's dye testing and Navy map indicate a drain line exits chamber A4 to the west, connects to surface water drainage from a catch basin in Defense Highway, and continues to drain westerly to an outfall on west side of Defense Highway.
E5	FWENC's dye testing and Navy map indicate a drain line exits chamber E5 to the west and connects to a drain line flowing to the south under Defense Highway. The common drain line under Defense Highway accepts drain lines from chambers A5 and E6 before ultimately discharging to an outfall on the northern side of Lawton's Brook near Tank Farm 3.
A5	See comment for E5.
E6	See comment for E5.
AE6	FWENC's dye testing and Navy map indicate a drain line exits chamber AE6 to the west and connects to a drain line flowing north under Defense Highway. The common drain line under Defense Highway accepts drain lines from chambers A6 and A7 prior to reaching AE6 and ultimately discharges to an outfall located on the southern side of Lawton's Brook near Tank Farm 3.
A6	See comment for AE6.
A7	See comment for AE6.
A8	FWENC's dye testing and Navy map indicate a drain line exits chamber A8 to the east and connects to a common drain line flowing to the south. The common drain line accepts drain lines from chambers E9, A10 and E11 and ultimately discharges to an outfall at Norman's Brook, south of Tank Farm 4.
E9	See comment for A8.
A10	See comment for A8.
E11	See comment for A8.

Based on the above information, there are four ultimate discharge points common to the 11 chambers in question that require additional investigation – the outfall located west of chamber A4, the outfall located along the northern side of Lawton's Brook (common outfall to chambers E5, A5 and E6), the outfall located along the southern side of Lawton's Brook (common outfall to chambers AE6, A6, and A7), and the outfall located at Norman's Brook (common outfall to chambers A8, E9, A10 and E11).

Results of soil sampling and other investigations conducted on the chambers (video inspections, drainage assessments, etc.) are documented in the Final Construction Completion Report for Fuel Line Closure (FWENC, 2001), the Work Plan for Piping Chamber Remediation (FWENC, 2002), the Final Site Investigation and Removal Action Work Plan (Tetra Tech, 2004) and the Closeout Report for Piping Chamber Remediation (Tetra Tech, 2008).

The following is a brief summary of the soil sampling results. The exceedances in soil are depicted on Figures 2 through 18, respectively and summarized in the following table (Table 10-3):

Table 10-3

Summary of Previous Sampling Conducted at the 17 Chambers Included in this Investigation

Chamber	Previous Evidence of Impacts
A4	One soil sample collected from beneath floor of chamber near drain pipe on western side. At approximately 9 feet BSG. PAHs greater than RDEC in 2000.
E5	One soil sample collected from adjacent to eastern side of chamber at 10.5 feet BSG. All constituents were below standards. Chamber included for investigation of drain line discharge point only.
A5	One soil sample collected from beneath floor of chamber on eastern side. No depth provided. PAHs greater than RDEC in 2000. Chrysene was detected at a concentration equal to the RDEC of 0.4 mg/kg.
E6	Located under Defense Highway. Video inspected only. No soil samples previously collected.
AE6	Located under Defense Highway. Video inspected only. No soil samples previously collected.
A6	Located under Defense Highway. Video inspected only. No soil samples previously collected.
A7	One soil sample collected from beneath the western side of chamber floor. No depth provided. All constituents were below standards. Chamber included for investigation of drain line discharge point only.
A8	One soil sample collected from center of chamber floor at approximately 10 feet BSG. All constituents were below standards. Chamber included for investigation of drain line discharge point only.
E9	One soil sample collected beneath the eastern side of the chamber floor. No depth provided. All constituents were below standards. Chamber included for investigation of drain line discharge point only.
A10	One soil sample collected from adjacent to western side of chamber. No depth provided. All constituents were below standards. Chamber included for investigation of drain line discharge point only.
E11	Located under Defense Highway. Video inspected only. No soil samples previously collected.
E22	One soil sample collected from below the eastern side floor of the chamber. No depth provided. TPH exceeded RDEC and ICDEC.
E16	One soil sample collected from adjacent to eastern side of chamber at the depth of the chamber floor. Actual depth not provided. All constituents were below standards. Chamber included for investigation at the request of RIDEM since oil was observed in the chamber, the sample was collected from the upgradient side, and TPH result was just below the RDEC standards.
A16	Extended 4 feet under Burma Road (bike path). The portion of the chamber below ground was approx. 13.75 feet long by 16 feet wide by 5.5 high (interior). One soil sample collected from below center of chamber (sample A16-01) and one sample was collected from beneath the western half of an adjacent condensate underground storage tank (UST) (sample A16-T01). No depth provided. TPH exceeded RDEC in the sample collected from beneath the chamber.
E17	One soil sample collected at approximately 10 feet deep along western edge of chamber. Chrysene was detected at a concentration greater than the RDEC.
S1	Two soil samples collected. Sample S1-01 from the northern exterior of the chamber (depth not provided) and Sample S1-02 from the southern side of the chamber (depth not provided). Both were collected from beneath the 24" pipeline that accessed the chamber. Chrysene was detected at a concentration equal to the RDEC of 0.4 mg/kg in sample from south side of chamber.
V3	Two soil samples collected. Sample V3-01 from the below the chamber floor on the eastern side. Sample V3-02 from the southern exterior wall of the chamber beneath the pipeline. Sample V3-02 PAHs greater than RDEC and equal to the ICDEC standard in the case of on COC (benzo(a)pyrene).

*Note that arsenic was detected above RDEC in most soil samples submitted in 2000, however, arsenic detections are considered consistent with background at the site and do not necessitate additional investigation.

Historical laboratory analytical results are summarized in detail in Tables 10-4A through 10-4C, which summarize TPH, SVOC, and VOC data, respectively.

Nature and Extent of Contamination

The primary sources of contamination at the former pipeline chambers are various fuels, including jet fuel (JP-5 and JP-8), marine diesel, Navy Special, No. 2 fuel oil and No. 6 fuel oil. Elevated concentrations of petroleum hydrocarbons and PAHs have been detected in soil surrounding the chambers.

Beryllium was detected at a concentration greater than the RIDEM RDEC in one of the chambers included herein for further investigation (A4). However, this concentration is less than the current updated RDEC. Therefore, no further investigations or remediation was recommended for the beryllium impacts at chamber A4. Also note that elevated concentrations of arsenic were detected at most locations. The presence of arsenic at the site has been attributed to background and will not be further investigated (FWENC, 2001). Elevated concentrations of lead were detected at one chamber, but these impacts were remediated previously.

The planned investigation described in this SAP is primarily intended to refine the extent of impacts at 17 chambers from prior operations associated with the former fuel distribution. This investigation has been designed to expand upon the information that currently exists; therefore, petroleum hydrocarbons and PAHs that demonstrated elevated concentrations during previous investigations will be assessed as part of the planned investigations at 8 chambers.

For the four chambers for which no sampling has been conducted previously and for the four ultimate discharge points of the drain lines, petroleum hydrocarbons, PAHs and VOCs will be investigated. VOCs are being included due to the detection of select VOCs at some chambers during the 2000 soil sampling event. VOCs previously detected were all below applicable standards and included typical petroleum constituents (toluene, xylenes, etc.) as well as tetrachlorethene (PCE). For this reason, the VOC analyte list for this investigation will be limited to benzene, toluene, ethylbenzene and xylenes (BTEX), PCE and breakdown products of PCE (refer to Worksheet #15 for specific analyte list).

PCE was detected at low concentrations in soil collected from chambers A4 and A5. The potential source of the PCE was not discussed in historical reports for the pipeline and chamber investigations; however, historical reports reviewed for the Tank Farm 3 study area indicated that chlorinated compounds have previously been detected in surface water at Lawton's Brook and may be attributable to an upgradient source. Therefore, PCE and breakdown products of PCE are being included in the VOC analyte list for the outfalls and the four chambers not previously sampled in

order to determine if these specific VOCs previously detected at low concentrations in soil along the pipeline are present at concentrations exceeding the applicable RIDEM standards at these previously uninvestigated locations.

Target Matrices

The primary sources of contamination have generally been limited to shallow subsurface soil (to the depths of the bottom of the chambers). Because of the relatively shallow depth to groundwater (estimated to be 8-12 feet) at the site and the proximity to Narragansett Bay, subsurface soil will be assessed during the planned investigation. Note that groundwater will be sampled at 3 of the 17 chambers, located directly upgradient of the former Midway Booster Pump House (Building 70). A recurring source of LNAPL and TPH has been detected in the vicinity of Building 70 and groundwater in the vicinity of chambers E16, A16 and E22 will be investigated as a potential source in conjunction with the soil investigations taking place herein.

Conceptual Site Model Summary

In addition to refining the extent of impacts 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. There is little specific information relative to the specific chambers in previous reports. These elements of the CSM will be refined as part of ongoing investigations. An overall CSM summary of is briefly presented below.

Sources and Release Mechanisms

Primary sources of contamination at the pipeline chambers consist of petroleum hydrocarbons and PAHs and, to a lesser extent, select VOCs. Based on this and previous investigations, subsurface soil and groundwater will be analyzed for petroleum hydrocarbons, PAHs, and/or select VOCs. Primary release mechanisms consisted of releases of various fuels from the pipeline and chambers directly to soil. Secondary release mechanisms could have included volatilization of certain petroleum hydrocarbons, PAHs and VOCs, generation of fugitive dust from soil, chemical leaching into groundwater, groundwater discharge into Narragansett Bay, and food-chain uptake.

As previously discussed, the ultimate source of the low PCE concentrations in soil at Chambers A4 and A5 is unknown, but historical reports for Tank Farm 3 mentioned chlorinated impacts at Lawton's Brook may be attributable to an upgradient source.

Receptors and Exposure Pathways

Relative to potential human health risks, current receptors that could be potentially exposed to COCs include on-site workers, construction workers, recreational users, or trespassers. Since the chamber areas are not currently subject to any Land Use Controls (LUCs), future receptors include the same as current receptors, with the addition of hypothetical on-site residents. Relative to potential ecological risks, receptors include terrestrial plants, soil invertebrates, aquatic animals and avian mammals.

Contaminant and exposure pathways include overland flow and transport of particulates to drainage areas that could potentially include Lawton's Brook, Norman's Brook, and the Narragansett Bay and their associated wetland areas. Typical exposure pathways to be considered include ingestion or dermal contact with soil, inhalation of particulates or volatiles in air, ingestion or dermal contact with groundwater, sediment, or surface water, and ingestion of fish tissue.

Table 10-4A
 Historical Soil Analytical Results - Total Petroleum Hydrocarbons
 Defense Highway Pipeline Chamber Investigation
 NAVSTA, Newport, RI

Chemical Name	Chamber Identification		A10	A16	A16	A4	A5	A7
	RIDEM RDEC	RIDEM ICDEC	Sample Date 9/28/2000	11/7/2000	11/6/2000	9/7/2000	9/7/2000	9/12/2000
			Sample ID NAVSTA-CS-NAVSTA-CS-VA10-01	NAVSTA-CS-NAVSTA-CS-VA16-01	NAVSTA-CS-NAVSTA-CS-VA16-T01	NAVSTA-CS-NAVSTA-CS-VA4-01	NAVSTA-CS-NAVSTA-CS-VA5-01	NAVSTA-CS-NAVSTA-CS-VA7-01
TPH	500	2500	28 U	700	29 U	29 U	29 U	28 U
TPH-C24-C36	NSA	NSA	20 U	620	20 U	61	110	20 U
TPH-C6-C9	NSA	NSA	12 U	12 U	12 U	12 U	12 U	12 U
TPH-C9-C24	NSA	NSA	4 U	860	4 U	15	54	4 U
TOTAL TPH 8015(Calculated)	500	2500	0	1480	0	76	164	0

Notes:
 Red and Bold fonts indicates exceeds Residential Criteria
 Blue and Bold fonts indicates exceeds Industrial/Commercial Criteria
 TPH results are reported from lab under 418.1 analytical method
 Total TPH 8015 are calculated results under 8015 analytical method
 representing a total of the 3 compounds from 8015
 Results are in milligrams per kilogram
 U = not detected above report detection limits
 NSA = No Standard Available
 RIDEM RDEC = Rhode Island Department of Environmental Protection
 Residential Direct Exposure Criteria, Remediation Regulations
 (amended Nov 2011)
 RIDEM ICDEC = Rhode Island Department of Environmental Protection
 Industrial Commercial Direct Exposure Criteria, Remediation
 Regulations (amended Nov 2011)

Table 10-4A
 Historical Soil Analytical Results - Total Petroleum Hydrocarbons
 Defense Highway Pipeline Chamber Investigation
 NAVSTA, Newport, RI

Chemical Name	Chamber Identification A8			E16	E17	E22	E5	E9
	RIDEM RDEC	RIDEM ICDEC	Sample Date	Sample Date	Sample Date	Sample Date	Sample Date	Sample Date
			9/11/2000	10/30/2000	10/3/2000	10/30/2000	9/28/2000	9/13/2000
		Sample ID	NAVSTA-CS-NAVSTA-CS-VA8-01	NAVSTA-CS-NAVSTA-CS-VE16-01	NAVSTA-CS-NAVSTA-CS-VE17-01	NAVSTA-CS-NAVSTA-CS-VE22-01	NAVSTA-CS-NAVSTA-CS-VE5-01	NAVSTA-CS-NAVSTA-CS-VE9-01
TPH	500	2500	29 U	190	28 U	3000	29 U	30 U
TPH-C24-C36	NSA	NSA	20 U	330	20 U	140	47	20 U
TPH-C6-C9	NSA	NSA	12 U	12 U	12 U	12 U	12 U	12 U
TPH-C9-C24	NSA	NSA	4 U	150	4 U	1100	40	4 U
TOTAL TPH 8015(Calculated)	500	2500	0	480	0	1240	87	0

Notes:
 Red and Bold fonts indicates exceeds Residential Criteria
 Blue and Bold fonts indicates exceeds Industrial/Commercial Criteria
 TPH results are reported from lab under 418.1 analytical method
 Total TPH 8015 are calculated results under 8015 analytical method
 representing a total of the 3 compounds from 8015
 Results are in milligrams per kilogram
 U = not detected above report detection limits
 NSA = No Standard Available
 RIDEM RDEC = Rhode Island Department of Environmental Protection
 Residential Direct Exposure Criteria, Remediation Regulations
 (amended Nov 2011)
 RIDEM ICDEC = Rhode Island Department of Environmental Protection
 Industrial Commercial Direct Exposure Criteria, Remediation
 Regulations (amended Nov 2011)

Table 10-4A
 Historical Soil Analytical Results - Total Petroleum Hydrocarbons
 Defense Highway Pipeline Chamber Investigation
 NAVSTA, Newport, RI

Chemical Name	Chamber Identification		S1	S1	V3	V3
	RIDEM RDEC	RIDEM ICDEC	Sample Date	Sample Date	Sample Date	Sample Date
			Sample ID	Sample ID	Sample ID	Sample ID
TPH	500	2500	10/30/2000	10/30/2000	11/1/2000	11/1/2000
TPH-C24-C36	NSA	NSA	NAVSTA-CS-NAVSTA-CS-VS1-01	NAVSTA-CS-NAVSTA-CS-VS1-02	NAVSTA-CS-NAVSTA-CS-VV3-01	NAVSTA-CS-NAVSTA-CS-VV3-02
TPH-C6-C9	NSA	NSA	80	120	27 U	150
TPH-C9-C24	NSA	NSA	93	51	20 U	210
TOTAL TPH 8015(Calculated)	500	2500	12 U	12 U	12 U	12 U
			150	50	76	250
			243	101	76	460

Notes:
 Red and Bold fonts indicates exceeds Residential Criteria
 Blue and Bold fonts indicates exceeds Industrial/Commercial Criteria
 TPH results are reported from lab under 418.1 analytical method
 Total TPH 8015 are calculated results under 8015 analytical method
 representing a total of the 3 compounds from 8015
 Results are in milligrams per kilogram
 U = not detected above report detection limits
 NSA = No Standard Available
 RIDEM RDEC = Rhode Island Department of Environmental Protection
 Residential Direct Exposure Criteria, Remediation Regulations
 (amended Nov 2011)
 RIDEM ICDEC = Rhode Island Department of Environmental Protection
 Industrial Commercial Direct Exposure Criteria, Remediation
 Regulations (amended Nov 2011)

Table 10-4B
 Historical Soil Analytical Results - Semivolatile Organic Compounds
 Defense Highway Pipeline Chamber Investigation
 NAVSTA, Newport, RI

Chemical Name	Chamber Identification		A10	A16	A16	A4	A5	A7	A8	E16	E17	E22
	RIDEM	RDEC	Sample Date	Sample ID	Sample ID	Sample ID	Sample ID	Sample ID	Sample ID	Sample ID	Sample ID	Sample ID
			9/28/2000	NAVSTA-CS-NAVSTA-CS-VA10-01	NAVSTA-CS-NAVSTA-CS-VA16-T01	NAVSTA-CS-NAVSTA-CS-VA16-01	NAVSTA-CS-NAVSTA-CS-VA4-01	NAVSTA-CS-NAVSTA-CS-VA5-01	NAVSTA-CS-NAVSTA-CS-VA7-01	NAVSTA-CS-NAVSTA-CS-VA8-01	NAVSTA-CS-NAVSTA-CS-VE16-01	NAVSTA-CS-NAVSTA-CS-VE17-01
1,2,4-TRICHLOROBENZENE	96	10000	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
1,2-DICHLOROBENZENE	510	10000	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
1,2-DIPHENYLHYDRAZINE	NSA	NSA	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
1,3-DICHLOROBENZENE	430	10000	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
1,4-DICHLOROBENZENE	27	240	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
2,4,6-TRICHLOROPHENOL	58	520	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
2,4-DICHLOROPHENOL	30	6100	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
2,4-DIMETHYLPHENOL	1400	10000	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
2,4-DINITROPHENOL	160	4100	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
2,4-DINITROTOLUENE	0.9	8.4	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
2,6-DINITROTOLUENE	0.9	8.4	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
2-CHLORONAPHTHALENE	NSA	NSA	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
2-CHLOROPHENOL	50	10000	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
2-NITROPHENOL	6000	10000	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
3,3-DICHLOROBENZIDINE	1.4	13	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
4,6-DINITRO-2-METHYLPHENOL	160	4100	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
4-BROMOPHENYL-PHENYLETHER	NSA	NSA	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
4-CHLORO-3-METHYLPHENOL	50	10000	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
4-CHLOROPHENYL-PHENYLETHER	NSA	NSA	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
4-NITROPHENOL	6000	10000	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
ACENAPHTHENE	43	10000	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
ACENAPHTHYLENE	23	10000	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
ANTHRACENE	35	10000	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.5	0.4 U
BENZIDINE	NSA	NSA	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
BENZO[A]ANTHRACENE	0.9	7.8	0.4 U	0.4 U	0.4 U	0.7	0.4 U	0.4 U	0.4 U	0.4 U	0.6	0.4 U
BENZO[A]PYRENE	0.4	0.8	0.2 U	0.2 U	0.2 U	0.6	0.3	0.2 U	0.2 U	0.2 U	0.4	0.2 U
BENZO[B]FLUORANTHENE	0.9	7.8	0.4 U	0.4 U	0.4 U	0.6	0.4	0.4 U	0.4 U	0.4 U	0.5	0.4 U
BENZO[G,H,I]PERYLENE	0.8	10000	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
BENZO[K]FLUORANTHENE	0.9	78	0.4 U	0.4 U	0.4 U	1.1	0.7	0.4 U	0.4 U	0.4 U	0.4	0.4 U
BIS(2-CHLOROETHOXY)METHANE	NSA	NSA	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
BIS(2-CHLOROETHYL)ETHER	0.6	5.2	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
BIS(2-CHLOROISOPROPYL)ETHER	NSA	NSA	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
BIS(2-ETHYLHEXYL)PHTHALATE	46	410	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
BUTYLBENZYLPHTHALATE	NSA	NSA	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
CHRYSENE	0.4	780	0.4 U	0.4 U	0.4 U	0.8	0.4	0.4 U	0.4 U	0.4 U	0.7	0.4 U
DIBENZ[A,H]ANTHRACENE	0.4	0.8	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
DIETHYLPHTHALATE	340	10000	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
DIMETHYL PHTHALATE	1900	10000	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
DI-N-OCTYLPHTHALATE	NSA	NSA	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
FLUORANTHENE	20	10000	0.4 U	0.4 U	0.4 U	1.5	0.7	0.4 U	0.4 U	0.4 U	1.8	0.4 U
FLUORENE	28	10000	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
HEXACHLOROBENZENE	0.4	3.6	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
HEXACHLOROBUTADIENE	8.2	73	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
HEXACHLOROCYCLOPENTADIENE	NSA	NSA	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
HEXACHLOROETHANE	46	410	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
INDENO[1,2,3-CD]PYRENE	0.9	7.8	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
ISOPHORONE	NSA	NSA	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
NAPHTHALENE	54	10000	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
NITROBENZENE	NSA	NSA	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
N-NITROSODIMETHYLAMINE	NSA	NSA	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
N-NITROSODIPROPYLAMINE	NSA	NSA	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
N-NITROSODIPHENYLAMINE	NSA	NSA	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
PENTACHLOROPHENOL	5.3	48	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
PHENANTHRENE	40	10000	0.4 U	0.4 U	0.4 U	1	0.4 U	0.4 U	0.4 U	0.4 U	1.3	0.6
PHENOL	6000	10000	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
PYRENE	13	10000	0.4 U	0.4 U	0.4 U	1.2	0.6	0.4 U	0.4 U	0.4 U	1.4	0.4 U

Notes
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 Results are in milligrams per kilogram
 U = not detected above report detection limits
 NSA = No Standard Available
 RIDEM RDEC = Rhode Island Department of Environmental Protection Residential Direct Exposure Criteria, Remediation Regulations (amended Nov 2011)
 RIDEM ICDEC = Rhode Island Department of Environmental Protection Industrial Commercial Direct Exposure Criteria, Remediation Regulations (amended Nov 2011)

Table 10-4B
 Historical Soil Analytical Results - Semivolatile Organic Compounds
 Defense Highway Pipeline Chamber Investigation
 NAVSTA, Newport, RI

Chemical Name	Chamber Identification E5		E9	S1	S1	V3	V3
	RIDEM	RDEC	Sample Date 9/28/2000	10/30/2000	10/30/2000	11/1/2000	11/1/2000
	Sample ID	NAVSTA-CS-NAVSTA-CS-VE5-01	NAVSTA-CS-NAVSTA-CS-VE9-01	NAVSTA-CS-NAVSTA-CS-VS1-01	NAVSTA-CS-NAVSTA-CS-VS1-02	NAVSTA-CS-NAVSTA-CS-VV3-01	NAVSTA-CS-NAVSTA-CS-VV3-02
1,2,4-TRICHLOROBENZENE	96	10000	0.4 U				
1,2-DICHLOROBENZENE	510	10000	0.4 U				
1,2-DIPHENYLHYDRAZINE	NSA	NSA	0.4 U				
1,3-DICHLOROBENZENE	430	10000	0.4 U				
1,4-DICHLOROBENZENE	27	240	0.4 U				
2,4,6-TRICHLOROPHENOL	58	520	0.4 U				
2,4-DICHLOROPHENOL	30	6100	0.4 U				
2,4-DIMETHYLPHENOL	1400	10000	0.4 U				
2,4-DINITROPHENOL	160	4100	0.4 U				
2,4-DINITROTOLUENE	0.9	8.4	0.4 U				
2,6-DINITROTOLUENE	0.9	8.4	0.4 U				
2-CHLORONAPHTHALENE	NSA	NSA	0.4 U				
2-CHLOROPHENOL	50	10000	0.4 U				
2-NITROPHENOL	6000	10000	0.4 U				
3,3-DICHLOROBENZIDINE	1.4	13	0.4 U				
4,6-DINITRO-2-METHYLPHENOL	160	4100	0.4 U				
4-BROMOPHENYL-PHENYLETHER	NSA	NSA	0.4 U				
4-CHLORO-3-METHYLPHENOL	50	10000	0.4 U				
4-CHLOROPHENYL-PHENYLETHER	NSA	NSA	0.4 U				
4-NITROPHENOL	6000	10000	0.4 U				
ACENAPHTHENE	43	10000	0.4 U				
ACENAPHTHYLENE	23	10000	0.4 U				
ANTHRACENE	35	10000	0.4 U	0.4 U	0.4 U	0.4 U	0.6
BENZIDINE	NSA	NSA	0.4 U				
BENZO[A]ANTHRACENE	0.9	7.8	0.4 U	0.4 U	0.4	0.4 U	1.1
BENZO[A]PYRENE	0.4	0.8	0.2 U	0.2 U	0.2	0.2 U	0.8
BENZO[B]FLUORANTHENE	0.9	7.8	0.4 U	0.4 U	0.4 U	0.4 U	0.7
BENZO[G,H,I]PERYLENE	0.8	10000	0.4 U				
BENZO[K]FLUORANTHENE	0.9	78	0.4 U				
BIS(2-CHLOROETHOXY)METHANE	NSA	NSA	0.4 U				
BIS(2-CHLOROETHYL)ETHER	0.6	5.2	0.4 U				
BIS(2-CHLOROISOPROPYL)ETHER	NSA	NSA	0.4 U				
BIS(2-ETHYLHEXYL)PHTHALATE	46	410	0.4 U				
BUTYLBENZYLPHTHALATE	NSA	NSA	0.4 U				
CHRYSENE	0.4	780	0.4 U	0.4 U	0.4	0.4 U	1
DIBENZ[A,H]ANTHRACENE	0.4	0.8	0.4 U				
DIETHYLPHTHALATE	340	10000	0.4 U				
DIMETHYL PHTHALATE	1900	10000	0.4 U				
DI-N-OCTYLPHTHALATE	NSA	NSA	0.4 U				
FLUORANTHENE	20	10000	0.4 U	0.4 U	0.8	0.4 U	2.6
FLUORENE	28	10000	0.4 U				
HEXACHLOROBENZENE	0.4	3.6	0.4 U				
HEXACHLOROBUTADIENE	8.2	73	0.4 U				
HEXACHLOROCYCLOPENTADIENE	NSA	NSA	0.4 U				
HEXACHLOROETHANE	46	410	0.4 U				
INDENO[1,2,3-CD]PYRENE	0.9	7.8	0.4 U				
ISOPHORONE	NSA	NSA	0.4 U				
NAPHTHALENE	54	10000	0.4 U				
NITROBENZENE	NSA	NSA	0.4 U				
N-NITROSODIMETHYLAMINE	NSA	NSA	0.4 U				
N-NITROSODIPROPYLAMINE	NSA	NSA	0.4 U				
N-NITROSODIPHENYLAMINE	NSA	NSA	0.4 U				
PENTACHLOROPHENOL	5.3	48	0.4 U				
PHENANTHRENE	40	10000	0.4 U	0.4 U	0.6	0.4 U	2.2
PHENOL	6000	10000	0.4 U				
PYRENE	13	10000	0.4 U	0.4 U	0.5	0.4 U	1.9

Notes
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 Results are in milligrams per kilogram
 U = not detected above report detection limits
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 RIDEM RDEC = Rhode Island Department of Environmental Protection Residential Direct Exposure Criteria, Remediation Regulations (amended Nov 2011)
 RIDEM ICDEC = Rhode Island Department of Environmental Protection Industrial Commercial Direct Exposure Criteria, Remediation Regulations (amended Nov 2011)

Table 10-4C
 Historical Soil Analytical Results - Volatile Organic Compounds
 Defense Highway Pipeline Chamber Investigation
 NAVSTA, Newport, RI

Chemical Name	Chamber Identification A10			A16	A16	A4	A5	A7	A8	E16	E17	E22
	Sample Date	9/28/2000		11/6/2000	11/7/2000	9/7/2000	9/7/2000	9/12/2000	9/11/2000	10/30/2000	10/2/2000	10/30/2000
	Sample ID	NAVSTA-CS-NAVSTA-CS-VA10-01		NAVSTA-CS-NAVSTA-CS-VA16-T01	NAVSTA-CS-NAVSTA-CS-VA16-01	NAVSTA-CS-NAVSTA-CS-VA4-01	NAVSTA-CS-NAVSTA-CS-VA5-01	NAVSTA-CS-NAVSTA-CS-VA7-01	NAVSTA-CS-NAVSTA-CS-VA8-01	NAVSTA-CS-NAVSTA-CS-VE16-01	NAVSTA-CS-NAVSTA-CS-VE17-01	NAVSTA-CS-NAVSTA-CS-VE22-01
	RIDEM	RIDEM	ICDEC									
1,1,1,2-TETRACHLOROETHANE	2.2	220	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
1,1,1-TRICHLOROETHANE	540	10000	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
1,1,2,2-TETRACHLOROETHANE	1.3	29	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
1,1,2-TRICHLOROETHANE	3.6	100	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
1,1-DICHLOROETHANE	920	10000	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
1,1-DICHLOROETHENE	0.2	9.5	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
1,1-DICHLOROPROPENE	NSA	NSA	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
1,2,3-TRICHLOROBENZENE	96	10000	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
1,2,3-TRICHLOROPROPANE	NSA	NSA	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
1,2,4-TRICHLOROBENZENE	96	10000	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
1,2,4-TRIMETHYLBENZENE	NSA	NSA	0.004 U	0.004 U	0.01	0.004 U	0.004 U	0.004 U				
1,2-DIBROMO-3-CHLOROPROPANE	0.5	4.1	0.008 U	0.008 U	0.008 U	0.008 U	0.008 U	0.008 U	0.008 U	0.008 U	0.008 U	0.008 U
1,2-DIBROMOETHANE	0.01	0.07	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
1,2-DICHLOROBENZENE	510	10000	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
1,2-DICHLOROETHANE	0.9	63	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
1,2-DICHLOROPROPANE	1.9	84	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
1,3,5-TRIMETHYLBENZENE	NSA	NSA	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
1,3-DICHLOROBENZENE	430	10000	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
1,3-DICHLOROPROPANE	1.9	84	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
1,4-DICHLOROBENZENE	27	240	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
2,2-DICHLOROPROPANE	1.9	84	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
2-CHLOROTOLUENE	210	10000	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
4-CHLOROTOLUENE	210	10000	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
4-ISOPROPYLTOLUENE	27	10000	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
BENZENE	2.5	200	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
BROMOBENZENE	NSA	NSA	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
BROMOCHLOROMETHANE	NSA	NSA	0.008 U	0.008 U	0.008 U	0.008 U	0.008 U	0.008 U	0.008 U	0.008 U	0.008 U	0.008 U
BROMODICHLOROMETHANE	10	92	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
BROMOFORM	81	720	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
BROMOMETHANE	0.8	2900	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
CARBON TETRACHLORIDE	1.5	44	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
CHLOROBENZENE	210	10000	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
CHLOROETHANE	NSA	NSA	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
CHLOROFORM	1.2	940	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
CHLOROMETHANE	NSA	NSA	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
CIS-1,2-DICHLOROETHENE	630	10000	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
DIBROMOCHLOROMETHANE	7.6	68	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
DIBROMOMETHANE	NSA	NSA	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
DICHLORODIFLUOROMETHANE	NSA	NSA	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
ETHYLBENZENE	71	10000	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
HEXACHLOROBUTADIENE	8.2	73	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
ISOPROPYLBENZENE	27	10000	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
M- AND P-XYLENE	NSA	NSA	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
METHYL TERT-BUTYL ETHER	390	10000	0.008 U	0.008 U	0.008 U	0.008 U	0.008 U	0.008 U	0.008 U	0.008 U	0.008 U	0.008 U
METHYLENE CHLORIDE	45	760	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
NAPHTHALENE	54	10000	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
N-BUTYLBENZENE	NSA	NSA	0.004 U	0.004 U	0.005	0.004 U	0.004 U	0.004 U				
O-XYLENE	NSA	NSA	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
PROPYLBENZENE	NSA	NSA	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.023
SEC-BUTYLBENZENE	NSA	NSA	0.004 U	0.004 U	0.022	0.004 U	0.004 U	0.117				
STYRENE	13	190	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
TERT-BUTYLBENZENE	NSA	NSA	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
TETRACHLOROETHENE	12	110	0.004 U	0.004 U	0.004 U	0.01	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
TOLUENE	190	10000	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
TRANS-1,2-DICHLOROETHENE	1100	10000	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
TRICHLOROETHENE	13	520	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
TRICHLOROFLUOROMETHANE	NSA	NSA	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
VINYL CHLORIDE	0.02	3	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
XYLENES, TOTAL	110	10000	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U

Notes
 Results are in milligrams per kilogram
 U = not detected above report detection limits
 NSA = No Standard Available
 RIDEM RDEC = Rhode Island Department of Environmental Protection
 Residential Direct Exposure Criteria, Remediation Regulations
 (amended Nov 2011)
 RIDEM ICDEC = Rhode Island Department of Environmental
 Protection Industrial Commercial Direct Exposure Criteria, Remediation
 Regulations (amended Nov 2011)

Table 10-4C
 Historical Soil Analytical Results - Volatile Organic Compounds
 Defense Highway Pipeline Chamber Investigation
 NAVSTA, Newport, RI

Chemical Name	Chamber Identification E3		E4	E5	E9	S1	S1	V3	V3
	Sample Date	9/19/2000	9/28/2000	9/28/2000	9/13/2000	10/30/2000	10/30/2000	11/1/2000	11/1/2000
	Sample ID	NAVSTA-CS-NAVSTA-CS-VE3-01	NAVSTA-CS-NAVSTA-CS-VE4-01	NAVSTA-CS-NAVSTA-CS-VE5-01	NAVSTA-CS-NAVSTA-CS-VE9-01	NAVSTA-CS-NAVSTA-CS-VS1-01	NAVSTA-CS-NAVSTA-CS-VS1-02	NAVSTA-CS-NAVSTA-CS-VV3-01	NAVSTA-CS-NAVSTA-CS-VV3-02
	RIDEM	ICDEC							
1,1,1,2-TETRACHLOROETHANE	2.2	220	0.004 U						
1,1,1-TRICHLOROETHANE	540	10000	0.004 U						
1,1,2,2-TETRACHLOROETHANE	1.3	29	0.004 U						
1,1,2-TRICHLOROETHANE	3.6	100	0.004 U						
1,1-DICHLOROETHANE	920	10000	0.004 U						
1,1-DICHLOROETHENE	0.2	9.5	0.004 U						
1,1-DICHLOROPROPENE	NSA	NSA	0.004 U						
1,2,3-TRICHLOROBENZENE	96	10000	0.004 U						
1,2,3-TRICHLOROPROPANE	NSA	NSA	0.004 U						
1,2,4-TRICHLOROBENZENE	96	10000	0.004 U						
1,2,4-TRIMETHYLBENZENE	NSA	NSA	0.004 U						
1,2-DIBROMO-3-CHLOROPROPANE	0.5	4.1	0.008 U						
1,2-DIBROMOETHANE	0.01	0.07	0.004 U						
1,2-DICHLOROBENZENE	510	10000	0.004 U						
1,2-DICHLOROETHANE	0.9	63	0.004 U						
1,2-DICHLOROPROPANE	1.9	84	0.004 U						
1,3,5-TRIMETHYLBENZENE	NSA	NSA	0.004 U						
1,3-DICHLOROBENZENE	430	10000	0.004 U						
1,3-DICHLOROPROPANE	1.9	84	0.004 U						
1,4-DICHLOROBENZENE	27	240	0.004 U						
2,2-DICHLOROPROPANE	1.9	84	0.004 U						
2-CHLOROTOLUENE	210	10000	0.004 U						
4-CHLOROTOLUENE	210	10000	0.004 U						
4-ISOPROPYLTOLUENE	27	10000	0.004 U						
BENZENE	2.5	200	0.004 U						
BROMOBENZENE	NSA	NSA	0.004 U						
BROMOCHLOROMETHANE	NSA	NSA	0.008 U						
BROMODICHLOROMETHANE	10	92	0.004 U						
BROMOFORM	81	720	0.004 U						
BROMOMETHANE	0.8	2900	0.02 U						
CARBON TETRACHLORIDE	1.5	44	0.004 U						
CHLOROBENZENE	210	10000	0.004 U						
CHLOROETHANE	NSA	NSA	0.01 U						
CHLOROFORM	1.2	940	0.004 U						
CHLOROMETHANE	NSA	NSA	0.01 U						
CIS-1,2-DICHLOROETHENE	630	10000	0.004 U						
DIBROMOCHLOROMETHANE	7.6	68	0.004 U						
DIBROMOMETHANE	NSA	NSA	0.004 U						
DICHLORODIFLUOROMETHANE	NSA	NSA	0.01 U						
ETHYLBENZENE	71	10000	0.004 U						
HEXACHLOROBUTADIENE	8.2	73	0.004 U						
ISOPROPYLBENZENE	27	10000	0.004 U						
M- AND P-XYLENE	NSA	NSA	0.004 U						
METHYL TERT-BUTYL ETHER	390	10000	0.008 U						
METHYLENE CHLORIDE	45	760	0.01 U						
NAPHTHALENE	54	10000	0.004 U						
N-BUTYLBENZENE	NSA	NSA	0.004 U						
O-XYLENE	NSA	NSA	0.004 U						
PROPYLBENZENE	NSA	NSA	0.004 U						
SEC-BUTYLBENZENE	NSA	NSA	0.004 U						
STYRENE	13	190	0.004 U						
TERT-BUTYLBENZENE	NSA	NSA	0.004 U						
TETRACHLOROETHENE	12	110	0.004 U						
TOLUENE	190	10000	0.004 U						
TRANS-1,2-DICHLOROETHENE	1100	10000	0.004 U						
TRICHLOROETHENE	13	520	0.004 U						
TRICHLOROFLUOROMETHANE	NSA	NSA	0.004 U						
VINYL CHLORIDE	0.02	3	0.004 U						
XYLENES, TOTAL	110	10000	0.004 U						

Notes
 Results are in milligrams per kilogram
 U = not detected above report detection limits
 NSA = No Standard Available
 RIDEM RDEC = Rhode Island Department of Environmental Protection
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SAP Worksheet #11: Project Quality Objectives/Systematic Planning Process Statements, Defense Highway Pipeline Chambers

The planned investigation at the former main fuel supply pipeline chambers is intended to define the vertical and horizontal extent of petroleum related impacts to soil in the vicinity of 17 chambers located along a former pipeline adjacent to Defense Highway. Specifically, soil will be investigated in the immediate vicinity of 12 of the 17 chambers (A4, A5, A6, AE6, E6, E11, A16, E22, E16, E17, V3 and S1) and soil will be investigated at the terminus end (outfalls) of drains connected to 11 of the 17 chambers (A4, A5, E5, A6, AE6, E6, A7, A8, E9, A10 and E11). In addition, groundwater samples will be collected in the vicinity of chambers A16, E16 and E22 in order to delineate impacts upgradient of former location of Building 70. Remediation efforts have been ongoing at the Building 70 study area and there is concern that releases from chambers A16, E16 or E22 may be contributing to impacts downgradient.

The information collected from this investigation will be used to evaluate remedial alternatives and prepare a SIR under RIDEM's Remediation Regulations program. Although the primary project quality objectives (PQOs) entail refining the extent of impacts from prior operations, there are multiple PQOs to be achieved through the planned investigation, as described in this worksheet. The PQOs developed for this investigation are 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

During fuel line closure activities that took place in 2000, soil samples collected around some of the 50 chambers indicated concentrations of TPH or PAHs above applicable RIDEM RDECs. Twelve of those chambers have not yet been adequately remediated under RIDEM's Remediation Regulations guidance. Therefore, contaminants are still present that may pose potential risk/hazard above target levels to human health and the environment. These contaminants include TPH, PAHs and (to a lesser extent) VOCs in soil.

In addition, the ultimate discharge point of drain lines observed during closeout activities in the eleven chambers noted above have not been identified or sampled.

Based on current data, the extent of impacts 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 impacts is necessary to refine the extent of impacts 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 pipeline chamber investigation is to evaluate the extent of soil and groundwater impacts resulting from the release of petroleum related constituents in the vicinity of the 17 chambers. The specific study goals of the planned investigation are listed below, and are intended to refine the CSM and select appropriate remedial actions pursuant to RIDEMs Remediation Regulations.

- Goal 1 – Refine the extent of soil impacts from prior operations surrounding 12 of 17 chambers
- Goal 2 – Locate the ultimate discharge points of chamber drain lines at 11 of 17 chambers and collect a sample to determine if impacted soil is present at the 4 outfalls associated with those drain lines
- Goal 3 – Refine the extent of groundwater impacts in the vicinity of 3 of the 17 chambers located upgradient of the Building 70 study area
- Goal 4 – Compare analytical results to applicable RIDEM Criteria

To achieve these goals and ensure that appropriate data quality is obtained, Project Action Limits (PALs) were identified. As an initial threshold value for choosing between alternative actions, chemical data will first be compared to PALs, as specified in Worksheet #15 and appropriate background data. The PALs must be met in order to be of sufficient quality for use in the SIR and selection of remedial alternatives in order to meet the RIDEM RDEC.

To conduct comparisons of site data to screening levels, the selected laboratory must be able to achieve limits of quantitation (LOQs) that are low enough to measure constituent concentrations less than the PALs. Refer to Worksheet #15 for the specific PALs and associated sources.

Step 3 – Information Inputs

Information inputs needed to resolve the problem statement identified in Step 1 will consist of field observations and measurement and chemical data from the 17 chambers, as presented in this SAP. The prior sampling exceedances in site media and the planned sampling locations are depicted in Figures 2 through 18. The following data will be collected to characterize the location and extent of site impacts:

- Available site specific historical data from 2000
- Field screening - pH, dissolved oxygen (DO), and oxidation-reduction potential (ORP) in groundwater, photoionization detector (PID) and PetroFLAG in soil
- Subsurface soil sampling – TPH, PAHs, select VOCs, and TOD
- Groundwater sampling – TPH, alkalinity, and TOD (to be mixed with the soil TOD sample)

- Background data – Representative background concentrations for relevant environmental media for comparison to site-specific data. For the purpose of this investigation, Resolution will rely on analytical results from other chambers exhibiting non-detect results for COCs.

Step 4 – Study Boundaries

The former main fuel supply pipeline is approximately 6 miles long and runs along Defense Highway, near Narragansett Bay. Refer to Figure 1 and Table 10-1 for the regional location and approximate location of each of the 17 chambers to be investigated. Spatial and temporal boundaries are described below.

Spatial Boundaries

A key element for this investigation is to refine the horizontal and vertical extent of impacts that may warrant study area remediation and or restrictions. Prior investigations at the chambers have identified TPH, PAHs and (to a lesser extent) VOCs in soil. However, the specific boundaries of impacts have not been fully delineated. Historical sampling locations are shown on Figures 2 through 18 and results are summarized in Table 10-3. The planned investigation is designed to collect data at each chamber to better define the extent of impacts. Proposed sampling locations and target sampling depths have been identified based on prior investigations at the chambers (refer to Figures 2 through 18 and Table 11-1); however, it is anticipated that modifications may be made in the field based on actual field conditions (i.e., depth to groundwater, field screening, visual observations, etc.) to best refine the extent of potential impacts.

At 12 of the 17 chambers the planned investigation will include assessment of soil to an estimated depth of 8 to 12 feet to confirm that the vertical extent of impacts is defined and any potential “smear zone” created by fluctuations in groundwater is captured.

At 11 of the 17 chambers, the investigation will include assessment of shallow soil located from surface grade to 1.5 feet deep only at the ultimate discharge points of the chamber drain lines, if they can be located. Refer to Table 10-2 for a description of the outfall locations based on dye testing conducted in 2000. A total of four outfalls common to the 11 chambers will be sampled once located.

Groundwater is relatively shallow therefore the planned investigation area is limited to the shallow overburden aquifer zone. The shallow overburden aquifer zone ranges from approximately 5 to 12 feet to the top of bedrock, which is unknown at each chamber location specifically but, at nearby sites, ranges from approximate depths of 17 to 39 feet below surface grade (BSG).

Temporal Boundaries

The temporal boundaries for this study will be the period of the actual field investigation, anticipated to occur in Spring 2013. 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 Soil Impacts from Prior Operations Surrounding 12 of 17 Chambers

- Test pits will be advanced on all 4 sides of each chamber (A4, A5, A6, AE6, E6, E11, A16, E22, E16, E17, V3 and S1) until the bottom of the chamber is reached.
- According to historical reports, chambers A6, AE6, E6 and E11 may be located in close proximity to a paved road/bike path. **If** this is the case, determined during pre-construction meetings, **then** an alternative sampling program will be developed for these four chambers (likely geoprobe soil borings on all four sides of the chambers) in order to not undermine the road or any paved surfaces.
- Approximately three grab soil samples will be collected at regular intervals in each test pit and screened in the field using an in the field PID at chambers A6, AE6, E6 and E11 only. **If** volatile organic vapors (VOVs) are detected greater than 100 ppm calibrated with isobutylene, **then** one soil sample will be collected for confirmatory laboratory analysis of VOCs from each test pit. The sample exhibiting the highest PID reading will be submitted from each test pit so that a maximum of 16 VOC samples will be submitted. **If** PID readings are all less than 100 ppm for a particular chamber, **then** one sample from the downgradient test pit or the sample exhibiting the highest PID reading from that chamber study area will be submitted so that each of the 4 chambers has at least one soil sample submitted for analysis of VOCs (for a minimum of 4 and a maximum of 16 soil samples collected from around the 4 chambers for VOC analysis).
- Approximately three grab soil samples will be collected at regular intervals in each of the 48 test pits around chambers A4, A5, A6, AE6, E6, E11, A16, E22, E16, E17, V3 and S1 and screened in the field using the field PetroFLAG screening kit. **If** TPH is detected at greater than 400 ppm, **then** a soil sample will be collected for confirmatory laboratory analysis of TPH. The sample exhibiting the highest PetroFLAG reading will be submitted from each test pit so that a maximum of 48 soil samples will be submitted. **If** PetroFLAG readings are all less than 400 ppm for a particular chamber, **then** one sample from the downgradient test pit or the sample exhibiting the highest PetroFLAG reading from that chamber study area will be submitted so

that each of the 12 chambers has at least one soil sample submitted for analysis of TPH (for a minimum of 12 and a maximum of 48 soil samples collected from around the 12 chambers for TPH analysis).

- **If** PetroFLAG readings are greater than 400 ppm in soil samples from test pits surrounding chambers A4, A5, E17, V3, S1, A6, AE6, E6 and E11, **then** a sample will also be submitted for analysis of PAHs. **If** samples are all less than 400 ppm for a particular chamber, **then** one sample from the downgradient test pit or the sample exhibiting the highest PetroFLAG reading from that chamber study area will be submitted so that each of the 9 chambers has at least one soil sample submitted for analysis of PAHs (for a minimum of 9 and a maximum of 36 soil samples collected from around the 9 chambers for PAH analysis).
- One soil sample will be collected for analysis of TOD from each chamber study area in support of the remedial analysis. **If** subsurface soil characteristics are similar at some chambers, **then** TOD samples will only be submitted from chambers exhibiting distinctly different soil characteristics to avoid duplicating analyses.

Goal 2 – Locate the Ultimate Discharge Points of Chamber Drain Lines at 11 of 17 Chambers and Collect a Soil Sample to Determine if Impacted Soil is Present at the Outfall

- For chambers A4, A5, E5, A6, AE6, E6, A7, A8, E9, A10 and E11, the ultimate discharge point of observed drain lines will be located by clearing vegetation from the four outfall locations common to the 11 chamber drain lines, as summarized in Table 10-2.
- **If** the drainage point is successfully located through these methods, **then** soil will be screened and submitted for analysis. Three soil samples will be collected in a radius approximately 2 to 3 feet from the end of the outfall pipe and approximately 1 ½ feet deep. Each grab sample will be screened with a PID (calibrated with isobutylene) and a PetroFLAG screening kit. The sample exhibiting the highest reading from each discharge point will be submitted for analysis of TPH, PAHs, and VOCs.

Goal 3 – Refine the extent of groundwater impacts in the vicinity of 3 of the 17 chambers located upgradient of the Building 70 study area

- A temporary monitoring well will be installed in the test pit located on the downgradient side of chambers A16, E22, and E16. A groundwater sample will be collected from the temporary well for analysis of TPH. Refer to Worksheet #17 for a description of the well installation.
- **If** LNAPL is observed in the test pits, **then** a sample of the LNAPL may be obtained as well.

Goal 4 – Compare Analytical Results for both soil and groundwater to RIDEM Criteria and Evaluate the Data

- **If** COCs are detected in site-specific environmental media, **then** they will be further evaluated relative to the appropriate background dataset.
- **If** COCs are detected in site-specific environmental media and are greater than the background dataset, **then** they will be compared to applicable RIDEM RDEC (for soil) or RIDEM GA Groundwater Objectives, where established, or USEPA MCLs (for groundwater).

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
- Determine how decision errors will be managed during the project

Sampling Strategy

The soil and groundwater sampling design was developed to further characterize contaminant concentrations historically detected in soil and groundwater at the chambers. A biased sampling design based on previously identified impacts, with regulatory agency input during the planned pre-investigation study area visit, will be used to advance 4 test pits around each of the 12 chambers to be investigated (one on each side of the chamber [north, east, south and west]) for a total of up to 48 soil sampling locations. A groundwater sample will be collected from test pits advanced on the downgradient side of three of the chambers (A16, E16 and E22). In addition, one soil sample will be submitted from the ultimate discharge point of drain lines exiting 11 of the 17 chambers. This sampling approach was determined to be the most appropriate because of the availability of historical analytical data.

Potential Sources of Error

Potential sources of error in the investigations 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 study area. 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 study area.

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 study area-related compounds, sampling locations, and study area 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) for sample analysis by a competent analytical laboratory certified by the Department of Defense (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.

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, and #21).

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) 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 the pipeline investigations was developed to optimize resources and generate data to satisfy the PQOs. The critical objective is to obtain a quality dataset for the SIR and for the evaluation of whether or remediation will be required.

Field Screening

Field measurements will be recorded in a field logbook and/or onto field data collection sheets. Soil samples will be screened in the field using a PID calibrated with isobutylene (at locations where VOC sampling is proposed) and PetroFLAG screening kits (at all locations). Groundwater will be measured in the field for pH, DO, and ORP. Field data will be compiled and stored in project folders, for subsequent use in evaluating analytical data and completing the SIR report.

Soil Sampling

There are up to 48 discrete soil sampling locations from test pits and 4 grab soil sample locations from outfall discharge points as part of this SAP. Soil samples will be screened at regular intervals from approximately 1 to 12 feet BSG in the test pits and at a depth of 1 ½ feet at the outfall points. Each soil sample will be screened in the field using a PetroFLAG screening kit and a PID. If a soil sample exhibits a reading of 400 ppm or greater with the PetroFLAG or 100 ppm or greater with the PID calibrated with isobutylene, that sample will be retained for potential submittal for laboratory confirmatory analysis. No samples will be composited. Between 12 and 48 subsurface soil samples will be collected for laboratory analysis during the test pit investigation. If all PetroFLAG results are below 400 ppm, a minimum of one soil sample will be collected from each of the 12 chamber study areas. If all soil samples exhibit PetroFLAG readings greater than 400 ppm, a maximum of 48 soil samples will be collected. One soil sample will be submitted from each outfall (a total of 4). Therefore, a maximum total of 52 sampling points is estimated. The extent of subsurface soil depths is based on the observed depths of the chamber bottoms. Further details on the subsurface soil sampling are provided in Worksheet #17.

Groundwater Sampling

Grab groundwater samples will be collected from temporary monitoring wells installed in the test pit advanced on the downgradient (presumed west) side of three chambers (A16, E16 and E22). These chambers indicated the highest TPH impacts during previous investigations. Groundwater will be collected via peristaltic pump from the monitoring wells. The groundwater sampling locations were selected to assess potential contaminants in the shallow aquifer underlying the site due to historical operations. Further details on the groundwater sampling are provided in Worksheet #17.

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 combined Worksheet #18, 19, 20, and 30 of this SAP.

Resolution will provide data validation services and verify and evaluate the usability of the data. All definitive data generated by the fixed laboratory will undergo limited data validation. Limited validation will consist of review for completeness and the subset of measurement performance indicators (MPIs) specific to the analytical batch and individual samples (i.e. instrument calibration and similar MPIs are not included in limited validation). Recalculation of results from raw data will not be performed. Validation will be performed using criteria for the methods listed in Worksheet #'s 12, 15, and 28, the DoD Quality Systems Manual (QSM), laboratory work order, and laboratory SOPs. If not addressed in the worksheets or DoD QSM, the logic outlined in the Region I, USEPA-New England Data Validation Functional Guidelines For Evaluating Environmental Analyses (December 1996), and USEPA National Functional Guidelines for Superfund Organic Methods Data Review (June 2008) will be used to apply qualifiers to data.

Portable Document Format (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. All other data generated in the field and reports generated for the project will be stored as computer readable data files by Resolution.

Chamber ID	Proposed Sample	Media	Target Depth(1)	Target Parameter (2)					Rationale (7)
				TPH(3)	VOC(4)	PAHs	TOD	Alkalinity	
A16	TPA16-1	Subsurface Soil	8-12'	X			X		Delineate extent of TPH exceedances detected during in-place abandonment. TOD is in support of remedial analysis.
A16	TPA16	Groundwater(5)	8-12'(6)	X			X	X	To assess potential impacts to groundwater upgradient of Building 70 (Area 9). GW will be collected to mix with TOD soil sample. Alkalinity is in support of remedial analysis.
E22	TPE22	Groundwater	8-12'	X			X	X	To assess potential impacts to groundwater upgradient of Building 70 (Area 9). GW will be collected to mix with TOD soil sample. Alkalinity is in support of remedial analysis.
E16	TPE16	Groundwater	8-12'	X			X	X	To assess potential impacts to groundwater upgradient of Building 70 (Area 9). GW will be collected to mix with TOD soil sample. Alkalinity is in support of remedial analysis.
A4	TPA4	Groundwater	8-12'				X	X	GW will be collected to mix with TOD soil sample. Alkalinity is in support of remedial analysis.
A5	TPA5	Groundwater	8-12'				X	X	GW will be collected to mix with TOD soil sample. Alkalinity is in support of remedial analysis.
E17	TPE17	Groundwater	8-12'				X	X	GW will be collected to mix with TOD soil sample. Alkalinity is in support of remedial analysis.
V3	TPV3	Groundwater	8-12'				X	X	GW will be collected to mix with TOD soil sample. Alkalinity is in support of remedial analysis.
S1	TPS1	Groundwater	8-12'				X	X	GW will be collected to mix with TOD soil sample. Alkalinity is in support of remedial analysis.
A6	TPA6	Groundwater	8-12'				X	X	GW will be collected to mix with TOD soil sample. Alkalinity is in support of remedial analysis.
AE6	TPAE6	Groundwater	8-12'				X	X	GW will be collected to mix with TOD soil sample. Alkalinity is in support of remedial analysis.
E6	TPE6	Groundwater	8-12'				X	X	GW will be collected to mix with TOD soil sample. Alkalinity is in support of remedial analysis.
E11	TPE11	Groundwater	8-12'				X	X	GW will be collected to mix with TOD soil sample. Alkalinity is in support of remedial analysis.
A4	OFA4-1	Surface Soil	1.5'	X	X	X			To assess potential impact from the discharge point of the drain line at chamber A4. Outfall located west of Defense Highway.
E5, A5, E6	OFE5-1	Surface Soil	1.5'	X	X	X			To assess potential impact from the discharge point of the drain lines from chambers E5, A5 and E6. Outfall located at Lawton's Brook.
AE6, A6, A7	OFAE6-1	Surface Soil	1.5'	X	X	X			To assess potential impact from the discharge point of the drain lines from chambers AE6, A6 and A7. Outfall located at Lawton's Brook.
A8, E9, A10, E11	OFA8-1	Surface Soil	1.5'	X	X	X			To assess potential impact from the discharge point of the drain lines from chambers A8, E9, A10, and E11. Outfall located at Norman's Brook.

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).

(2) - Physical/geochemical analysis consists of TOD and alkalinity. Physical/geochemical analysis will be conducted on a subset of samples. Locations of samples will be determined in the field based on actual field conditions (i.e, sample depth, strata type, field screening, etc.). A maximum of one sample will be collected from the test pit advanced on the downgradient side of each chamber or the most heavily impacted area from each chamber. Samples may be excluded if soil characteristics are similar in more than one chamber. GW will be collected from the test pit advanced on the downgradient side of each chamber to be mixed with the soil TOD sample.

(3) - TPH samples will be submitted for analysis if PetroFLAG readings exceed 400 ppm.

(4) - VOC samples will be submitted for analysis if PID readings exceed 100 ppm.

(5) - Groundwater will be collected from the test pit on the downgradient side of the chamber using a peristaltic pump or similar equipment. Groundwater will be sampled directly from the pump and also be screened for insitu parameters (pH, DO, ORP).

(6) - Groundwater depth will vary depending on field conditions.

(7) - Historical exceedances are based Foster Wheelers 2001 Final Construction Completion Report for Fuel Line Closure.

SAP Worksheet #12-1: Measurement Performance Criteria – Field QC Samples for Volatile Organic Compounds

Matrix: Surface and Subsurface Soil

Analytical Group: Volatile Organic Compounds

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Trip Blank	Volatile Organic Compounds	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 (°C).
Field Duplicate		One per ten samples per matrix	Precision	Relative Percent Difference (RPD) ≤ 50% if both results are ≥ 2 x LOQ

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Matrix Spike/Matrix Spike Duplicate		Submitted: One per twenty samples per matrix. Analyzed: More frequent of one per twenty samples or sample delivery group (SDG) per matrix.	Accuracy/Bias/Precision	Refer to Worksheet 28-1

SAP Worksheet #12-2: Measurement Performance Criteria – Field QC Samples for Gasoline Range Organics

Matrix: Surface and Subsurface Soil

Analytical Group: Gasoline Range Organics (GRO) (C6-C12)

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Trip Blank		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	Gasoline Range Organics (C6-C12)	One per day of sampling per type of equipment used	Accuracy/Bias	No analytes detected > 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).
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

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
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 for Polycyclic Aromatic Hydrocarbons

Matrix: Surface and Subsurface Soil

Analytical Group: Polycyclic Aromatic Hydrocarbons (Full Scan and SIM)

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Equipment Rinsate Blank	Polycyclic Aromatic Hydrocarbons (Full Scan and SIM)	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 LOQ, 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 28-3

SAP Worksheet #12-4: Measurement Performance Criteria – Field QC Samples for Diesel Range Organics

Matrix: Surface and Subsurface Soil

Analytical Group: Diesel Range Organics (DRO) (C10-C36)

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Equipment Rinsate Blank	Diesel Range Organics (C10-C36)	One per day of sampling per type of equipment used	Accuracy/Bias	No analytes detected > 1/2 LOQ 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 > 5 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 28-4

SAP Worksheet #12-5: Measurement Performance Criteria – Field QC Samples for Total Oxidant Demand

Matrix: Subsurface Soil

Analytical Group: Total Oxidant Demand

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Cooler Temperature Indicator	Total Oxidant Demand	One per cooler	Accuracy/Representativeness	Temperature ≤ 6 degrees Celsius.

SAP Worksheet #12-6: Measurement Performance Criteria – Field QC Samples for Gasoline Range Organics

Matrix: Groundwater

Analytical Group: Gasoline Range Organics (C6-C12)

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Trip Blank	Gasoline Range Organics (C6-C12)	One per cooler containing GRO 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 analytes detected > 1/2 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).
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
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 28-6

SAP Worksheet #12-7: Measurement Performance Criteria – Field QC Samples for Diesel Range Organics

Matrix: Groundwater

Analytical Group: Diesel Range Organics (C10-C36)

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Equipment Rinsate Blank	Diesel Range Organics (C10-C36)	One per day of sampling per type of equipment used	Accuracy/Bias	No analytes detected > 1/2 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).
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
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 28-7

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

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 ≤ 50% if both results are > 5 x LOQ

SAP Worksheet #12: Notes

DoD QSM – Department of Defense Quality Systems Manual
DQI – Data Quality Indicator
LOQ – Limit of Quantitation
PAL – Project Action Limit
QC- Quality Control
RPD – Relative Percent Difference
SDG – Sample Delivery Group
SIM – Selective Ion Monitoring
VOC – Volatile Organic Compound

SAP Worksheet #17: Sampling Design and Rationale, Defense Highway Pipeline Chamber Investigation

Overview

This section describes the sampling rationale and sampling design for the collection of subsurface soil samples in the immediate vicinity of 12 of the 17 chambers (A4, A5, A6, AE6, E6, E11, A16, E22, E16, E17, V3 and S1), shallow subsurface soil at the four ultimate discharge points of drain lines observed exiting 11 of the 17 chambers (A4, A5, E5, A6, AE6, E6, A7, A8, E9, A10 and E11) and groundwater in the vicinity of 3 of the 17 chambers (A16, E22 and E16) located along the former main fuel pipeline at NAVSTA Newport. The general approach for the planned investigation is to collect groundwater samples directly from three test pits and to field screen, characterize and collect soil samples from around the target chambers and discharge points in order to delineate the extent of previously detected petroleum-related impacts; in order to refine the CSM; and to support the selection of remedial alternatives as part of an SIR. A key element for this investigation is to refine the horizontal and vertical extent of petroleum impacts at each chamber that may warrant remediation and/or restrictions.

Prior investigations for the pipeline chambers have identified VOCs, PAHs, petroleum hydrocarbons, and metals in soil. Groundwater has not previously been sampled from around the chambers and is not generally being investigated as part of this scope at all 17 chambers; however, groundwater sampling is proposed for three chambers (A16, E22, and E16) located directly upgradient of the former location of Building 70 where on-going soil remediation has taken place. It is believed that impacts related to the three chambers may be migrating to the downgradient Building 70 study area; therefore, groundwater sampling is being conducted in conjunction with the chamber investigation at those three chambers only to gather data to support the Building 70 study area investigation.

The specific boundaries of soil impacts at each chamber have not been fully delineated. The planned investigation is designed to collect data to better define the extent of impacts in the vicinity of each chamber and/or its drain line discharge point. Further details regarding the specific DQOs for the planned investigation are presented in Worksheet #11, and PALs are quantified in Worksheet #15.

Field Parameters

Organic vapor measurements will be recorded at each chamber via a PID calibrated with isobutylene, or similar device, for the purpose of anticipating the relative levels of VOCs. Measurements will be obtained in the breathing zone of field staff during sampling activities to

assess potential health risks. Measurements will also be obtained at each sampling depth interval during the collection of soil samples using a PID and a PetroFLAG screening kit. The field parameter data will be reviewed by the project team to best estimate the optimal locations for the collection of soil samples.

Other field parameter collection will consist of measurements associated with groundwater sampling. Measurements of pH, DO, and ORP will be recorded in relevant field logs. The specific methodology and procedures to be implemented for field parameter collection are included within the SOPs provided with this SAP.

Soil Sampling

An estimated 52 discrete soil samples from 52 locations (48 test pits and 4 discharge points) are planned for collection during the investigation program at the various chambers. Approximate locations of the test pits and outfall sampling locations are shown on Figures 2 through 18 for each chamber and outfall location. These locations will be field-adjusted as necessary to accomplish the PQOs for this program.

The investigation has been planned to refine the extent of impacts at each chamber, 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 impacts at each chamber.

To support Goal 1, one discrete soil sample will be collected from each test pit (48 total). Target depths/rationale are shown on Table 11-1; however, the precise depths may be modified based on actual field conditions (i.e., field parameters, visual evidence of impacts, depth to groundwater, depth to bottom of the chamber, etc.). Soil samples will be collected as discrete samples and no compositing is proposed. To support Goal 2, shallow soil samples (1 ½ feet BSG) will be collected from the ultimate discharge point of the 11 chambers exhibiting drain lines. As previously stated, based on the drainage assessment conducted in 2000 and Navy plans for the pipeline and drainage system, there are 4 ultimate discharge points associated with these 11 chambers.

- A4: The drain line from chamber A4 flows west, combines with a surface water catch basin drain line in Defense Highway, and continues west to an outfall located west of Defense Highway.
- E5, A5 and E6: The drain lines from chambers E5, A5 and E6 reportedly flow west into a common drain line located under Defense Highway. The common drain line flows to the south with an ultimate discharge point at Lawton's Brook near Tank Farm 3.

- AE6, A6 and A7: The drain lines from chambers AE6, A6 and A7 reportedly flow west into a common drain line located under Defense Highway. The common drain line flows to the north with an ultimate discharge point at Lawton's Brook near Tank Farm 3.
- A8, E9, A10 and E11: The drain lines from chambers A8, E9, A10 and E11 reportedly flow east into a common drain line located under undeveloped land. The common drain line flows to the south with an ultimate discharge point at Norman's Brook south of Tank Farm 4.

Soil samples will be collected and handled in accordance with SOP 3-21 and analyzed for petroleum hydrocarbons, PAHs, and/or select VOCs in order to refine the extent of impacts from those constituents at each chamber study area. Analysis will be determined based on historic sampling results (see Table 11-1). In the case of VOCs, the analyte list will be limited to BTEX petroleum related constituents and PCE and its breakdown constituents. PCE and breakdown constituents are included due to low levels of PCE being detected in select soil samples collected during the 2000 soil investigation and to ensure that PCE and its breakdown constituents are not present at concentrations exceeding applicable standards at these previously uninvestigated locations. In addition to the primary samples, QA/QC samples will be collected in accordance with this SAP.

To support Goal 4, a subset of the soil samples will be analyzed for TOD. A maximum of 12 soil samples will be submitted from the test pits (one from each chamber). This subset of parameters has been included on the rationale table (Table 11-1), however, the exact samples to be submitted will be determined in the field based on actual field conditions (i.e., sample depth, strata type, field parameters, etc.).

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.

Groundwater Sampling

To support Goal 4 and the remedial alternatives evaluation, groundwater will be purged directly from one test pit at each of the 12 chambers and tested in-situ for DO, ORP and pH. In addition, a subset of groundwater samples will be collected for laboratory analysis of alkalinity. Groundwater will also be collected for mixing with the soil TOD samples from each of the 12 chamber study areas. Groundwater will be collected from the same test pits as the soil TOD samples and placed in 500-ml amber glass jars and placed on ice. The jars will be provided to the selected laboratory for mixing with the soil samples. There is no holding time for the TOD analysis, therefore, all samples will be held until the field program is complete and a decision will be made as to which samples will ultimately be submitted (based on observed impacts, observed soil characteristics, etc.).

To support Goal 3, a temporary well will be installed during the backfilling of the test pit advanced on the downgradient side of chambers A16, E16 and E22. To the extent practicable, each test pit will be advanced at least 5 feet into the groundwater table in the area of the proposed well. A 2-inch diameter PVC well with an appropriate length of screen will be placed into the test pit at depth. The test pit will be backfilled with excavated material; however, the area immediately surrounding the well materials will be surrounded with peastone and/or an appropriately graded sand in order aid in well development and to prevent fine sediments from entering the well screen. In addition, as previously stated, some chambers may be partly located under Defense Highway and may be inaccessible for test pitting. Geoprobe soil borings may be required to investigate these chambers. In the event that a Geoprobe will be accessing the site, Resolution reserves the right to consider installing these temporary wells using a Geoprobe.

After appropriate development and purging, groundwater samples will be collected from the temporary wells for analysis of GRO and DRO in order to refine impacts to groundwater in the vicinity of the Building 70 study area, at which investigations and remediation activities are ongoing. The specific methodology and procedures to be implemented for groundwater collection and sampling are included within the SOPs provided with this SAP.

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.

SAP Worksheet #14: Summary of Project Tasks, Pipeline Investigation

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 test pits at chambers A4, A5, A6, AE6, E6, E11, A16, E22, E16, E17, V3 and S1. The mark out of the locations will be utilized for utility clearance (described below).

Resolution will also attempt to locate the four outfalls associated with the ultimate discharge points of the drain lines for chambers A4, A5, A7, A8, E5, E9, A6, AE6, E6, A10 and E11.

In addition, Resolution will identify any locations which will require clearing of vegetation in order to advance the test pits or locate the four outfalls. 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.

Test Pits and Soil Sample Collection

Forty eight test pits will be dug to help delineate the extent of site impacts surrounding chambers A4, A5, A6, AE6, E6, E11, A16, E22, E16, E17, V3 and S1 (total of 12). Test pitting will be conducted using an excavator to at least the depth of the bottoms of the chambers (assumed to be approximately 8-10 feet BSG) on all four sides of each chamber. Approximately three discrete grab soil samples will be collected at regular intervals in each of the test pits for field screening purposes (evenly spaced throughout the total depth of each test pit or at areas of observed visual impacts). Field screening will be conducted with a PID calibrated with isobutylene (at chambers A6, AE6, E6, E11) and PetroFLAG screening kits (at all locations). Soil will also be inspected for visual description of soil composition. Final depths of the test pits will be determined, based on field conditions, at the time of test pitting activities and will be advanced, to the extent practicable, until impacted soil has been delineated vertically.

A minimum of 12 soil samples (one from each chamber study area) and a maximum 48 soil samples (one from each test pit) will be submitted for laboratory analysis based on field screening values observed during test pitting activities. Refer to Worksheet #11, Goal 1 for details regarding field screening values and the determination of which samples should be submitted.

Table 11-1 identifies target depths for the subsurface samples; however, it is possible these will be modified in the field based on actual field conditions. The soil samples will be analyzed for TCL

VOCs via USEPA Method 8260B, PAHs via USEPA Method 8270D, and/or GRO and DRO via USEPA Method 8100 (also referred to as EPA Method 8015 for DRO, which will include the full carbon spectrum to range C36) (refer to Table 11-1 for the list of proposed analytes for each test pit/chamber study area).

A subset of these samples will also be analyzed for TOD. Up to 12 samples (one from each chamber study area) will be submitted. The sample chosen will represent the most highly impacted area of each chamber study area. If subsurface conditions are similar across multiple test pits, a field decision will be made to only submit samples from differing geologic units.

The proposed test pit locations are shown on Figures 2 through 18.

Four chambers (A6, AE6, E6 and E11) could not be located during closure in place activities in 2000 and were reportedly demolished during the construction of a paved bike path along Burma Road (Defense Highway). In the event that these chambers are located under pavement, test pitting activities may not be possible without undermining the integrity of the road. Therefore, Geoprobe or Hollow-Stem Auger drilling may be required at these locations. This will be decided during the pre-construction meeting held with Resolution, Navy and RIDEM prior to start of work.

All soil generated as part of test pitting activities will be returned to the test pit at the approximate depth from which it was removed. In the event that laboratory analytical results indicate concentrations of COCs are above applicable RIDEM RDECs, impacts will be addressed under future remedial activities, as needed.

Groundwater Quality Monitoring and Sample Collection

Following test pitting activities, a peristaltic pump or similar equipment will be used to collect groundwater from the downgradient side of each chamber. Groundwater will be pumped and analyzed in-situ using a YSI or similar equipment for pH, DO and ORP. A sample will then be collected from each of the 12 chambers for mixing with the soil TOD sample at the laboratory and for alkalinity analysis.

Finally, during test pit backfilling at chamber study areas A16, E16 and E22 only, a temporary well will be installed in the test pit on the downgradient side of these three chambers. Following development and purging, a sample will be collected from the well for laboratory analysis of DRO and GRO via USEPA Method 8100 (also referred to as Method 8015 for DRO). Groundwater will be sampled in accordance with modified SOP 3-14 and USEPA Region 1 Low-Flow Sampling Guidance.

Groundwater generated as part of these activities will be discharged directly to the ground at all locations other than chambers A16, E16 and E22. Groundwater generated from these three

chambers will be managed as investigation derived waste (IDW) pending laboratory results. As no TPH standard exists in the RIDEM Remediation Regulations, if DRO or GRO concentrations exceed USEPA Maximum Concentration Limits (MCLs), groundwater will be disposed of off-site. If DRO and GRO concentrations are below the MCLs, water generated as part of these activities will be returned to the ground.

Drain Line Outfall Location, Surficial Soil Sample Collection

As previously stated, an attempt will be made to locate the four outfalls for drain lines observed in 11 chambers (A4, A5, A7, A8, E5, E9, A6, AE6, E6, A10 and E11). The outfalls were located previously during FWENC's 2000 drainage assessment and confirmed based on Navy's plans for the pipeline and associated drainage. However, the four outfalls will need to be located again. Once located, a radius of approximately 2 to 3 feet from the outfall pipe will be hand dug to approximately 1 ½ feet deep and three soil samples will be collected and screened with a PID and PetroFLAG screening kit. One sample from each outfall exhibiting the highest field screening readings will be submitted for analysis of TCL VOCs via USEPA Method 8260B, PAHs via USEPA Method 8270D, and/or GRO and DRO via USEPA Method 8100 (also referred to as Method 8015 for DRO).

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 and groundwater.
- **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., stainless spoons, stainless bowls, submersible pumps, and water quality meters 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, as necessary.

Investigation-Derived Waste Management

In accordance with RIDEM's *Policy Memo 95-01 Guidelines for the Management of Investigation Derived Wastes*, IDW, consisting of purge water, water generated during decontamination processes and PPE, generated during the test pitting activities, groundwater sampling and decontamination activities will be collected in properly labeled 55-gallon drums and temporarily stored on the site for subsequent off-site disposal as necessary. Soil not used for sampling purposes will be returned to the test pits whenever possible, pending future remedial actions. Subsequently, the containers will be characterized with laboratory analyses and properly disposed at a Navy approved disposal facility. Note that, if laboratory analytical results indicate purge and decontamination water are below applicable standards, the water will be returned to the ground surface.

Land Surveying

A survey of the soil boring 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 and/or NAVD where available. 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 21 days 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 results and will add data

validation qualifiers to both versions. 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.

Report Preparation

Following data collection, analysis and validation, a Site Investigation Report that fulfills the requirements set forth in Section 7 of RIDEM's Remediation Regulations will be prepared for the chamber investigation. The SIR report elements will include the objectives of the study area investigations, a brief site history and a summary of historical investigations and results, a summary of field efforts conducted as part of this SAP, deviations from the SAP (if any), data tables and figures, comprehensive discussion of the extent of study area impacts, characterization of study area hydrogeology and topography, fate and transport models, potential for volatilization or entrainment by wind or erosion actions of study area contaminants, and all other standard RIDEM and Navy requirements for SIR or similar reports. In addition, the SIR Report will include a recommendation for chosen remedial alternative(s) to address any residual contamination observed at each chamber.

SAP Worksheet #21: Project Sampling SOP References Table

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		N	
3-13	Monitoring Well Development	Resolution		N	
3-14	Monitoring Well Sampling	Resolution	YSI, Turbidity Meter, Peristaltic Pump, Oil Water Interface Probe	Y	SOP was modified to include collecting groundwater directly from a test pit.
3-16	Soil and Rock Classification	Resolution		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	Excavator, Backhoe, hand tools	N	
3-24	Water Quality Parameter Testing	Resolution	YSI, Turbidity Meter, Peristaltic Pump	N	
3-34	PetroFLAG Soil Screening	Resolution	PetroFLAG Testing Kit	N	

SAP Worksheet #18, 19, 20 and 30: Field Project Implementation (Field Project Instructions)

Sample Details Table

	Analysis Group	Volatile Organic Compounds	Gasoline Range Organics	Polycyclic Aromatic Hydrocarbons	Diesel Range Organics	Total Oxidant Demand
CTO WE29 Defense Highway Pipeline Chamber Investigation Spring 2013	Preparation and Analytical Method	SW-846 5035, 8260B	SW-846 5035, 8015C	SW846 3550C, 8270D Full Scan and SIM	SW-846 3550C, 8015C	Haselow et al., 2003. Estimating the Total Oxidant Demand for In Situ Chemical Oxidation Design, Remediation, Autumn, 2003.
	Analytical Laboratory/ Analytical SOP Reference³	GCAL / SOP GCMSV-003	GCAL / SOP GC-006	GCAL / SOPs EXT-001 and GCMSSV-004	GCAL / SOP EXT-027 and GC-004	Redox Tech LLC/SPS Total Oxidant Demand Procedure
	Data Package Turnaround Time (TAT)	21 Calendar day	21 Calendar day	21 Calendar day	21 Calendar day	21 Calendar day
Gulf Coast Analytical Laboratories, Inc. (Brenda Martinez) (225-769-4900) and Redox Tech NE, LLC Jay Romano (508) 399-0191	Container Type/ Volume required (if different than container volume)³	Two 40-milliliter (ml) VOA vials	One 40-ml VOA vial	One 4-oz amber glass wide-mouth jar		One 8-oz. glass amber ⁴ wide-mouth jar
		One 40-ml VOA vial				
		One 2-ounce(2-oz) wide-mouth jar for percent moisture				
	Preservative³	5 ml reagent water; Cool to ≤ 6 °C; then Freeze to ≤ -7 °C; store in the dark	5ml methanol; Cool to ≤ 6 °C; store in the dark	Cool to ≤ 6 °C; store in the dark	Cool to ≤ 6 °C; store in the dark	Cool to ≤ 6 °C; store in the dark ⁴
5 ml methanol; Cool to ≤ 6 °C; store in the dark						
Cool to ≤ 6 °C; store in the dark						
Holding Time (Preparation/ Analysis)³	48 hours to freezing at --7°C, 14 days to analysis	28 days to analysis	14 days to extraction, 40 days to analysis	14 days to extraction; 40 days to analysis	None ⁴	
14 days to analysis						
NA						

Site	Matrix	Station ID	Sample ID	Coordinates (optional)		Depth/ Sampling Interval					
				X	Y						
A16	Subsurface Soil	TPA16-1	TPA16-1-BD-ED			8-12' bgs		X		X	X
		TPA16-2	TPA16-2-BD-ED				X		X		
		TPA16-3	TPA16-3-BD-ED				X		X		
		TPA16-4	TPA16-4-BD-ED				X		X		
E22		TPE22-1	TPE22-1-BD-ED				X		X	X	
		TPE22-2	TPE22-2-BD-ED				X		X		
		TPE22-3	TPE22-3-BD-ED				X		X		
		TPE22-4	TPE22-4-BD-ED				X		X		
E16		TPE16-1	TPE16-1-BD-ED				X		X	X	
		TPE16-2	TPE16-2-BD-ED				X		X		
		TPE16-3	TPE16-3-BD-ED				X		X		
		TPE16-4	TPE16-4-BD-ED				X		X		
A4		TPA4-1	TPA4-1-BD-ED				X	X	X	X	
		TPA4-2	TPA4-2-BD-ED				X	X	X		
		TPA4-3	TPA4-3-BD-ED				X	X	X		
		TPA4-4	TPA4-4-BD-ED				X	X	X		
A5		TPA5-1	TPA5-1-BD-ED				X	X	X	X	
		TPA5-2	TPA5-2-BD-ED				X	X	X		
		TPA5-3	TPA5-3-BD-ED				X	X	X		
		TPA5-4	TPA5-4-BD-ED				X	X	X		
E17		TPE17-1	TPE17-1-BD-ED				X	X	X	X	
		TPE17-2	TPE17-2-BD-ED				X	X	X		
		TPE17-3	TPE17-3-BD-ED				X	X	X		
		TPE17-4	TPE17-4-BD-ED				X	X	X		
V3		TPV3-1	TPV3-1-BD-ED				X	X	X	X	
		TPV3-2	TPV3-2-BD-ED				X	X	X		
		TPV3-3	TPV3-3-BD-ED				X	X	X		
		TPV3-4	TPV3-4-BD-ED				X	X	X		

Site	Matrix	Station ID	Sample ID	Coordinates (optional)		Depth/ Sampling Interval						
				X	Y							
S1		TPS1-1	TPS1-1-BD-ED					X	X	X	X	
		TPS1-2	TPS1-2-BD-ED					X	X	X		
		TPS1-3	TPS1-3-BD-ED					X	X	X		
		TPS1-4	TPS1-4-BD-ED					X	X	X		
A6		TPA6-1	TPA6-1-BD-ED				X	X	X	X	X	
		TPA6-2	TPA6-2-BD-ED				X	X	X	X		
		TPA6-3	TPA6-3-BD-ED				X	X	X	X		
		TPA6-4	TPA6-4-BD-ED				X	X	X	X		
AE6		TPAE6-1	TPAE6-1-BD-ED				X	X	X	X	X	
		TPAE6-2	TPAE6-2-BD-ED				X	X	X	X		
		TPAE6-3	TPAE6-3-BD-ED				X	X	X	X		
		TPAE6-4	TPAE6-4-BD-ED				X	X	X	X		
E6		TPE6-1	TPE6-1-BD-ED				X	X	X	X	X	
		TPE6-2	TPE6-2-BD-ED				X	X	X	X		
		TPE6-3	TPE6-3-BD-ED				X	X	X	X		
		TPE6-4	TPE6-4-BD-ED				X	X	X	X		
E11		TPE11-1	TPE11-1-BD-ED				X	X	X	X	X	
		TPE11-2	TPE11-2-BD-ED				X	X	X	X		
		TPE11-3	TPE11-3-BD-ED				X	X	X	X		
		TPE11-4	TPE11-4-BD-ED				X	X	X	X		
Field QC Samples ¹												
TBD	Field Duplicate	TBD	FDSB01-MMDDYY	Same as parent sample	Same as parent sample	X	X	X	X			
TBD		TBD	FDSB02-MMDDYY							X		
TBD		TBD	FDSB03-MMDDYY							X	X	
TBD		TBD	FDSB04-MMDDYY							X	X	
TBD		TBD	FDSB05-MMDDYY					X	X	X	X	
TBD	MS/MSD or MS/MD	TBD	Same as parent sample	Same as parent sample	Same as parent sample	X	X	X	X			
TBD		TBD								X		
TBD		TBD								X	X	X
	Equipment Blank ³		EBSB01-MMDDYY			X	X	X	X			
			EBSB02-MMDDYY				X	X	X			
			EBSB3-MMDDYY				X	X	X			

Site	Matrix	Station ID	Sample ID	Coordinates (optional)		Depth/ Sampling Interval					
				X	Y						
			EBSB04-MMDDYY				X	X	X		
			EBSB05-MMDDYY			X	X	X	X		
			EBSB06-MMDDYY				X	X	X		
			EBSB07-MMDDYY				X	X	X		
			EBSB08-MMDDYY			X	X	X	X		
			EBSB09-MMDDYY				X	X	X		
	Trip Blank ²		TB01-MMDDYY			X					
			TB02-MMDDYY			X					
			TB03-MMDDYY			X					
						Total No. of Samples to the Laboratory	16 samples 2 FDs 2 MS/MSD 3 EBs 3 TBs	48 samples 5 FDs 3 MS/MSDs 9 EBs	36 samples 4 FDs 2 MS/MSDs 9 EBs	48 samples 5 FDs 3 MS/MSDs 9 EBs	12 samples

1. Frequency of QA/QC sample collection:

Field Duplicate- One per 10 field samples

MS/MD/MSD- One pair per 20 field samples (including field duplicate samples)

Trip Blank- One per cooler to the laboratory containing volatiles (numbers presented assume 3 sampling days for VOCs, 1 cooler per day)

Equipment Blank- One per day of sampling or 20 field samples, whichever is more frequent (numbers presented assume 9 sampling days)

2. The sample trip blank may apply to both surface soil and subsurface soil samples.

3. The container, preservation, and holding time information for the aqueous equipment blanks is as follows:

Volatile Organic Compounds: Three 40-ml VOA vials; HCl to pH < 2, Cool to ≤ 6 °C, store in the dark; 14 days to analysis.

Gasoline Range Organics: Two 40-ml VOA vial; HCl to pH < 2, Cool to ≤ 6 °C, store in the dark; 14 days to analysis

Polycyclic Aromatic Hydrocarbons: Two 1-L wide-mouth amber glass bottles; Cool to ≤ 6°C, store in the dark; 7 days to extraction, 40 days to analysis

Diesel Range Organics: Two 1-L wide-mouth amber glass bottles; 5 ml of 1:1 HCl, Cool to ≤ 6°C, store in the dark; 14 days to extraction, 40 days to analysis

4. Groundwater will be submitted to Redox for mixing with the soil for TOD analysis. For each soil sample, one 500-ml amber glass jar of groundwater will be submitted.

The groundwater will be cooled to ≤ 6 °C. There is no holding time for the TOD analysis.

Site	Matrix	Station ID	Sample ID	Coordinates (optional)		Depth/ Sampling Interval				
				X	Y					
A4	Surface Soil	OFA4-1	OFA4-1-BD-ED			0-1.5' bgs	X	X	X	X
E5, A5, E6		OFE5-1	OFE5-1-BD-ED				X	X	X	X
AE6, A6, A7		OFAE6-1	OFAE6-1-BD-ED				X	X	X	X
A8, E9, A10, E11		OFA8-1	OFA8-1-BD-ED				X	X	X	X
Field QC Samples ¹										
TBD	Field Duplicate	TBD	FDSS01-MMDDYY	Same as parent sample		Same as parent sample	X			
TBD	MS/MSD or MS/MD	TBD	Same as parent sample	Same as parent sample		Same as parent sample	X	X	X	X
	Equipment Blank	EBSS01-MMDDYY				NA	X	X	X	X
	Trip Blank ²	TB04-MMDDYY				NA	X			
						Total Number of Samples to the Laboratory	4 Samples 1 FD 1 MS/MSD 1EB 1TB	4 Samples 1 FD 1 MS/MSD 1 EB	4 Samples 1 FD 1 MS/MSD 1 EB	4 Samples 1 FD 1 MS/MSD 1 EB

1. Frequency of QA/QC sample collection:

Field Duplicate- One per 10 field samples

MS/MD/MSD- One pair per 20 field samples (including field duplicate samples)

Trip Blank- One per cooler to the laboratory containing volatiles (numbers presented assume 1 sampling day for VOCs, 1 cooler per day)

Equipment Blank- One per day of sampling or 20 field samples, whichever is more frequent (numbers presented assume 1 sampling day)

2. The sample trip blank may apply to both surface soil and subsurface soil samples.

3. The container, preservation, and holding time information for the aqueous equipment blanks is as follows:

Volatile Organic Compounds: Three 40-ml VOA vials; HCl to pH < 2, Cool to ≤ 6 °C, store in the dark; 14 days to analysis.

Gasoline Range Organics: Two 40-ml VOA vial; HCl to pH < 2, Cool to ≤ 6 °C, store in the dark; 14 days to analysis

Polycyclic Aromatic Hydrocarbons: Two 1-L wide-mouth amber glass bottles; Cool to ≤ 6 °C, store in the dark; 7 days to extraction, 40 days to analysis

Diesel Range Organics: Two 1-L wide-mouth amber glass bottles; 5 ml of 1:1 HCl, Cool to ≤ 6 °C, store in the dark; 14 days to extraction, 40 days to analysis

Field Project Implementation (Field Project Instructions), continued

Sample Details-Groundwater

CTO WE29 Defense Highway Pipeline Chamber Investigation Spring 2013 Gulf Coast Analytical Laboratories, Inc. (Brenda Martinez) (225-769-4900)					Analysis Group	Gasoline Range Organics	Diesel Range Organics	Alkalinity
					Preparation and Analytical Method	SW846 5030B, 8015C	SW-846 3510C 8015C	SM 2320B
					Analytical Laboratory/ Analytical SOP Reference ³	GCAL / SOP GC-006	GCAL / SOP EXT00 29 and GC-004	GCAL SOP WL-063
					Data Package Turnaround Time ³	21 Calendar day	21 Calendar day	21 Calendar days
					Container Type/ Volume required (if different than container volume)	Two 40-ml VOA vial	Two 1-L wide-mouth amber glass bottles	One 250mL plastic or glass bottle
					Preservative	HCl to pH < 2; Cool to ≤ 6 °C; store in the dark	5 ml of 1:1 HCl; Cool to ≤ 6 °C; store in the dark	Cool ≤ 6 °C
					Holding Time (Preparation/ Analysis) ³	14 days to analysis	14 days to extraction, 40 days to analysis	14 days to analysis
Site	Matrix	Station ID	Sample ID	Coordinates (optional) X Y	Depth/ Sampling Interval			
A16	Groundwater	TPA16	TPA16-BD-ED		8-12' bgs	X	X	X
E22		TPE22	TPE22-BD-ED			X	X	X
E16		TPE16	TPE16-BD-ED			X	X	X
A4		TPA4	TPA4-BD-ED					X
A5		TPA5	TPA5-BD-ED					X
E17		TPE17	TPE17-BD-ED					X
V3		TPV3	TPV3-BD-ED					X
S1		TPS1	TPS1-BD-ED					X
A6		TPA6	TPA6-BD-ED					X
AE6		TPAE6	TPAE6-BD-ED					X
E6		TPE6	TPE6-BD-ED					X
E11		TPE11	TPE11-BD-ED					X

Field QC Samples ¹								
TBD	Field Duplicate	Same as parent sample	FDGW01-MMDDYY	Same as parent sample	Same as parent sample	X	X	X
TBD	MS/MSD or MS/MD	Same as parent sample	X	X				
	Equipment Blank		EBGW01-MMDDYY			X	X	
					Total Number of Samples to the Laboratory	12 Samples 1 FD 1 MS/MSD 1 EB	12 Samples 1 FD 1 MS/MSD 1 EB	12 Samples 1 FD

1. Frequency of QA/QC sample collection:

Field Duplicate- One per 10 field samples

MS/MD/MSD- One pair per 20 field samples (including field duplicate samples)

Equipment Blank- One per day of sampling or 20 field samples, whichever is more frequent (numbers presented assume 1 sampling day)

SAP Worksheet #15: Reference Limits and Evaluation Tables

Defense Highway Pipeline Chamber Investigation
 Naval Station Newport, Rhode Island

Matrix	Method	Analyte	CAS RN	Units	RIDEM Standard		LOQ Goal	Laboratory Limits		
					Project Action Limit	Source		LOQ	LOD	MDL
SO	8015	TPH-GASOLINE RANGE C6-C12 ¹	-3544	mg/kg	500	RIDEM1_SO_RES	167	5.0	2.0	0.49
SO	8015	TPH-C10-C36 BUNKER FUEL ¹	-235	mg/kg	500	RIDEM1_SO_RES	167	4.0	2.0	1.31
SO	8260B	BENZENE	71-43-2	mg/kg	0.200	RIDEM1_SO_LC_GA	0.0667	0.005	0.0005	0.00005
SO	8260B	1,1-DICHLOROETHENE	75-35-4	mg/kg	0.200	RIDEM1_SO_RES	0.0667	0.005	0.0005	0.00023
SO	8260B	CIS-1,2-DICHLOROETHENE	156-59-2	mg/kg	1.70	RIDEM1_SO_LC_GA	0.567	0.005	0.0005	0.00011
SO	8260B	TRANS-1,2-DICHLOROETHENE	156-60-5	mg/kg	3.30	RIDEM1_SO_LC_GA	1.10	0.005	0.0005	0.00012
SO	8260B	ETHYLBENZENE	100-41-4	mg/kg	27.0	RIDEM1_SO_LC_GA	9.00	0.005	0.0005	0.00018
SO	8260B	TETRACHLOROETHENE	127-18-4	mg/kg	0.100	RIDEM1_SO_LC_GA	0.0333	0.005	0.0005	0.00030
SO	8260B	TOLUENE	108-88-3	mg/kg	32.0	RIDEM1_SO_LC_GA	10.7	0.005	0.0005	0.00011
SO	8260B	TRICHLOROETHENE	79-01-6	mg/kg	0.200	RIDEM1_SO_LC_GA	0.0667	0.005	0.0005	0.00013
SO	8260B	VINYL CHLORIDE	75-01-4	mg/kg	0.0200	RIDEM1_SO_RES	0.00667	0.005	0.0005	0.00019
SO	8260B	XYLENES, TOTAL	1330-20-7	mg/kg	110	RIDEM1_SO_RES	36.7	0.015	0.0015	0.00040
SO	8270D	ACENAPHTHENE	83-32-9	mg/kg	43.0	RIDEM1_SO_RES	14.3	0.33	0.0333	0.00866
SO	8270D	ACENAPHTHYLENE	208-96-8	mg/kg	23.0	RIDEM1_SO_RES	7.67	0.33	0.0333	0.01006
SO	8270D	ANTHRACENE	120-12-7	mg/kg	35.0	RIDEM1_SO_RES	11.7	0.33	0.0333	0.00824
SO	8270D	BENZO[A]ANTHRACENE	56-55-3	mg/kg	0.900	RIDEM1_SO_RES	0.300	0.33	0.0333	0.02918
SO	8270D	BENZO[A]PYRENE	50-32-8	mg/kg	0.400	RIDEM1_SO_RES	0.133	0.33	0.0333	0.00885
SO	8270D	BENZO[B]FLUORANTHENE	205-99-2	mg/kg	0.900	RIDEM1_SO_RES	0.300	0.33	0.0333	0.05066
SO	8270D	BENZO[G,H,I]PERYLENE	191-24-2	mg/kg	0.800	RIDEM1_SO_RES	0.267	0.33	0.0167	0.01118
SO	8270D	BENZO[K]FLUORANTHENE	207-08-9	mg/kg	0.900	RIDEM1_SO_RES	0.300	0.33	0.0333	0.00763
SO	8270D	CHRYSENE	218-01-9	mg/kg	0.400	RIDEM1_SO_RES	0.133	0.33	0.0333	0.00921
SO	8270D	DIBENZ[A,H]ANTHRACENE	53-70-3	mg/kg	0.400	RIDEM1_SO_RES	0.133	0.33	0.0167	0.00965
SO	8270D	FLUORANTHENE	206-44-0	mg/kg	20.0	RIDEM1_SO_RES	6.67	0.33	0.0167	0.00644
SO	8270D	FLUORENE	86-73-7	mg/kg	28.0	RIDEM1_SO_RES	9.33	0.33	0.0333	0.01063
SO	8270D	INDENO[1,2,3-CD]PYRENE	193-39-5	mg/kg	0.900	RIDEM1_SO_RES	0.300	0.33	0.0333	0.02032
SO	8270D	2-METHYLNAPHTHALENE	91-57-6	mg/kg	0.800	RIDEM1_SO_LC_GA	0.267	0.33	0.0333	0.01043
SO	8270D	NAPHTHALENE	91-20-3	mg/kg	0.800	RIDEM1_SO_LC_GA	0.267	0.33	0.0333	0.01025
SO	8270D	PHENANTHRENE	85-01-8	mg/kg	40.0	RIDEM1_SO_RES	13.3	0.33	0.0333	0.00875
SO	8270D	PYRENE	129-00-0	mg/kg	13.0	RIDEM1_SO_RES	4.33	0.33	0.0333	0.00759
SO	8270DSIM	ACENAPHTHENE	83-32-9	mg/kg	43.0	RIDEM1_SO_RES	14.3	0.003	0.0017	0.00083

Matrix	Method	Analyte	CAS RN	Units	RIDEM Standard		LOQ Goal	Laboratory Limits		
					Project Action Limit	Source		LOQ	LOD	MDL
SO	8270DSIM	ACENAPHTHYLENE	208-96-8	mg/kg	23.0	RIDEM1_SO_RES	7.67	0.003	0.0017	0.00053
SO	8270DSIM	ANTHRACENE	120-12-7	mg/kg	35.0	RIDEM1_SO_RES	11.7	0.003	0.0017	0.00023
SO	8270DSIM	BENZO[A]ANTHRACENE	56-55-3	mg/kg	0.900	RIDEM1_SO_RES	0.300	0.003	0.0017	0.00067
SO	8270DSIM	BENZO[A]PYRENE	50-32-8	mg/kg	0.400	RIDEM1_SO_RES	0.133	0.003	0.0017	0.00040
SO	8270DSIM	BENZO[B]FLUORANTHENE	205-99-2	mg/kg	0.900	RIDEM1_SO_RES	0.300	0.003	0.0017	0.00089
SO	8270DSIM	BENZO[G,H,I]PERYLENE	191-24-2	mg/kg	0.800	RIDEM1_SO_RES	0.267	0.003	0.0025	0.00072
SO	8270DSIM	BENZO[K]FLUORANTHENE	207-08-9	mg/kg	0.900	RIDEM1_SO_RES	0.300	0.003	0.0017	0.00031
SO	8270DSIM	CHRYSENE	218-01-9	mg/kg	0.400	RIDEM1_SO_RES	0.133	0.003	0.0025	0.00035
SO	8270DSIM	DIBENZ[A,H]ANTHRACENE	53-70-3	mg/kg	0.400	RIDEM1_SO_RES	0.133	0.003	0.0025	0.00041
SO	8270DSIM	FLUORANTHENE	206-44-0	mg/kg	20.0	RIDEM1_SO_RES	6.67	0.003	0.0017	0.00061
SO	8270DSIM	FLUORENE	86-73-7	mg/kg	28.0	RIDEM1_SO_RES	9.33	0.003	0.0017	0.00031
SO	8270DSIM	INDENO[1,2,3-CD]PYRENE	193-39-5	mg/kg	0.900	RIDEM1_SO_RES	0.300	0.003	0.0025	0.00059
SO	8270DSIM	2-METHYLNAPHTHALENE	91-57-6	mg/kg	0.800	RIDEM1_SO_LC_GA	0.267	0.003	0.0025	0.00104
SO	8270DSIM	NAPHTHALENE	91-20-3	mg/kg	0.800	RIDEM1_SO_LC_GA	0.267	0.003	0.0025	0.00054
SO	8270DSIM	PHENANTHRENE	85-01-8	mg/kg	40.0	RIDEM1_SO_RES	13.3	0.003	0.0017	0.00057
SO	8270DSIM	PYRENE	129-00-0	mg/kg	13.0	RIDEM1_SO_RES	4.3	0.003	0.0017	0.00052
WG	8015C	TPH-GASOLINE RANGE C6-C12 ¹	-3544	mg/L				0.1	0.040	0.006
WG	8015C	TPH-C10-C36 BUNKER FUEL ¹	-235	mg/L				0.125	0.080	0.049

Notes:

1 The values presented for Project Action Limit and LOQ Goal apply to Total TPH as determined by summing the GRO and DRO results through C36.

Shading The limit presented is not below the LOQ Goal.

Abbreviations

DL - Detection Limit

LOD - Limit of Detection

LOQ - Limit of Quantitation

mg/kg - milligram per kilogram

mg/L - milligram per liter

Min - minimum

SO - Soil

WG - Groundwater

RIDEM1_SO_LC_GA - State of Rhode Island and Providence Plantations Department of Environmental Management

Method 1 Soil Objective GA Leachability Criteria (RIDEM, 2011)

RIDEM1_SO_RES - State of Rhode Island and Providence Plantations Department of Environmental Management

Method 1 Soil Objective (Residential) (RIDEM, 2011)

SIM- Selected Ion Monitoring

TPH - Total Petroleum Hydrocarbons

SAP Worksheet #23: Analytical SOP References Table

Laboratory Name and Address: Gulf Coast Analytical Laboratories, Inc.¹

Point of Contact Name: Brenda Martinez

Phone Number: 225.769.4900

Lab SOP Number ²	Title, Revision Date, and Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Variance to QSM	Modified for Project Work? (Y/N)
EXT-001	SOP for the Preparation of BNA Solids, Revision 18, 11/18/11	Definitive	Solid, PAHs (full scan and SIM)	NA	No	N
EXT-003	SOP for the Preparation of BNA by 3510C, Revision 22, 11/28/12	Definitive	Water, PAHs (full scan and SIM)	NA	No	N
GCMSSV-004	SOP for Analysis of BNAs by 8270D, Revision 7, 2/13/12	Definitive	Extracts, PAHs (full scan and SIM)	Agilent GC/MS 7890/5975 or 6890/5973	No	N
EXT-027	SOP for the Preparation of DRO in Solids, Revision 14, 12/2/11	Definitive	Solid, DRO	NA	No	N
EXT-029	SOP for the Preparation of DRO in Aqueous Samples	Definitive	Water, DRO	NA	No	N
GCV-004	SOP for the Analysis of DRO by 8015C, Revision 18, 12/14/11	Definitive	Extracts, DRO	Agilent GC/FID, 6890	No	Y ²
GCV-006	SOP for the Analysis of GRO by 8015C, Revision 16, 9/13/10	Definitive	Solid and Water, GRO	Agilent GC/FID 6890	No	N

Lab SOP Number ²	Title, Revision Date, and Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Variance to QSM	Modified for Project Work? (Y/N)
GCMSV-003	SOP for the Analysis of Volatile Organics by 8260B, Revision 23, 9/14/11	Definitive	Solid and Water, Volatile Organic Compounds	Agilent GC/MS 6890/5973	No	N
WL-063	SOP for the Analysis of Alkalinity, Revision 7, 3/14/11	Screening	Water, Alkalinity	Mettler Toledo DL53	No	N

Notes:

1. Laboratories will hold current DoD ELAP accreditation for all definitive analyses (all analyses except alkalinity and TOD) from the time of sample submittal through the time of sample analysis. Certificates of current DoD ELAP certification for Gulf Coast Analytical Laboratories, Inc. are presented in Appendix B.
2. DRO Modifications are as follows:
 - extend calibration and analysis range to C36
 - perform analysis of a single-point standard for Navy Special, and a single-point standard for Fuel Oil #6 for the purposes of hydrocarbon “fingerprint” assessment

SAP Worksheet #23: Analytical SOP References Table

Laboratory Name and Address: Redox Tech NE, LLC

Point of Contact Name: Jay Romano

Phone Number: 508.399.0191

Lab SOP Number ²	Title, Revision Date, and Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Variance to QSM	Modified for Project Work? (Y/N)
None	SPS Total Oxidant Demand Procedure.doc	Screening	Soil (with groundwater), Total Oxidant Demand	Not applicable	Not applicable	N

Notes:

1. DoD ELAP accreditation will not be required for alkalinity and TOD since they are considered screening-level data.

SAP Worksheet #28-1: Laboratory QC Samples Table

Matrix: Surface and Subsurface Soil

Analytical Group: Volatile Organic Compounds

Analytical Method/ SOP Reference: SW846 8260B / GCAL SOP GCMSV-003

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.
Surrogate	Four per sample: Dibromofluoromethane 1,2-Dichloroethane-d4 Toluene-d8 4-Bromofluorobenzene	%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 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.

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. 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 Sample Delivery Group 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.
Internal Standard	Three per sample: Chlorobenzene-d5 1,4-dichlorobenzene-d4 Fluorobenzene	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	Apply "J" qualifier to results between DL and LOQ.	Not applicable	Analyst, Laboratory Department Manager, and Data Validator	Accuracy	Same as QC Acceptance Limits.

SAP Worksheet #28-2: Laboratory QC Samples Table

Matrix: Surface and Subsurface Soil

Analytical Group: Gasoline Range Organics (C6-C12)

Analytical Method/ SOP Reference: SW-846 8015C / GCAL SOP GC-006

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 > 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).	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 and >10X the blank. Otherwise, reprepare a blank and the remaining samples.	Analyst, Supervisor, QA Manager	Accuracy/Bias, Contamination	Same as Method/SOP QC Acceptance Limits.
Surrogates	Bromochlorobenzene	70-130% recovery	Reanalyze; present both sets of data.	Analyst, Supervisor, QA Manager	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
LCS	One per preparation batch of twenty or fewer samples of similar matrix.	70-130% recovery.	Evaluate the samples and associated QC: i.e. If an LCS/LCSD was performed and only one of the set was unacceptable, narrate. If the LCS recovery is high but the sample results are < LOQ, narrate. Otherwise, reprepare a blank and the remaining samples.	Analyst, Supervisor, QA Manager	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
MS/MSD	One per SDG or every 20 samples.	70-130% recovery. RPD ≤ 50%	Evaluate the samples and associated QC: i.e. If the LCS results are acceptable, narrate. If both the LCS and MS/MSD are unacceptable, reprepare the samples and QC.	Analyst, Supervisor, QA Manager	Precision/Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.

SAP Worksheet #28-3: Laboratory QC Samples Table

Matrix: Surface and Subsurface Soil

Analytical Group: Polycyclic Aromatic Hydrocarbons (Full Scan and SIM)

Analytical Method/ SOP Reference: SW846 8270D / GCAL SOP GCMSSV-004

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 LOQ, 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. 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.
Breakdown check Dichlorodiphenyltrichloroethane (DDT)	At the beginning of each 12-hour period, prior to analysis of samples.	Degradation ≤ 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 checks.	Analyst, Laboratory Supervisor	Accuracy / Bias	Degradation ≤ 20% for DDT. Benzidine and pentachlorophenol should be present at their normal responses, and should not exceed a tailing factor of 2.
Surrogate	- 6 per sample: 2-Fluorophenol Phenol-d6 Nitrobenzene-d5 2-Fluorobiphenyl 2,4,6-Tribromophenol Terphenyl-d14 For PAHs, only Base/Neutral Surrogates are evaluated	%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.

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 (refer to Worksheet 28-3a). 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 ± 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 #28-4: Laboratory QC Samples Table

Matrix: Surface and Subsurface Soil

Analytical Group: Diesel Range Organics (C10-C36)

Analytical Method/ SOP Reference: SW-846 8015C / GCAL SOP GC-004

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 > 1/2 LOQ 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).	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 and >10X the blank. Otherwise, reprepare a blank and the remaining samples.	Analyst, Supervisor, QA Manager	Accuracy/Bias, Contamination	Same as Method/SOP QC Acceptance Limits
Surrogates	ortho-Terphenyl,	Water and soil: 40-140% recovery	Reanalyze; present both sets of data.	Analyst, Supervisor, QA Manager	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
LCS	One per preparation batch of twenty or fewer samples of similar matrix.	40-140% recovery	Evaluate the samples and associated QC: i.e. If an LCS/LCSD was performed and only one of the set was unacceptable, narrate. If the LCS recovery is high but the sample results are < LOQ, narrate. Otherwise, reprepare a blank and the remaining samples.	Analyst, Supervisor, QA Manager	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
MS/MSD	One per SDG or every 20 samples.	40-140% recovery; RPD ≤ 50%	Evaluate the samples and associated QC: i.e. If the LCS is acceptable, narrate. If both the LCS and MS/MSD are unacceptable, reprepare the samples and QC.	Analyst, Supervisor, QA Manager	Precision/Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.

SAP Worksheet #28-5: Laboratory QC Samples Table

Matrix: Subsurface Soil

Analytical Group: Total Oxidant Demand

Analytical Method/ SOP Reference: SPS Total Oxidant Demand Procedure.doc

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

SAP Worksheet #28-6: Laboratory QC Samples Table

Matrix: Groundwater

Analytical Group: Gasoline Range Organics (C6-C12)

Analytical Method/ SOP Reference: SW-846 8015C / GCAL SOP GC-006

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 > 1/2 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. Evaluate the samples and associated QC: i.e., if the blank results are above the LOQ, report samples results which are < LOQ and >10X the blank. Otherwise, reprepare a blank and the remaining samples.	Analyst, Supervisor, QA Manager	Accuracy/Bias, Contamination	Same as Method/SOP QC Acceptance Limits.
Surrogates	Bromochlorobenzene	70-130% recovery	Reanalyze; present both sets of data.	Analyst, Supervisor, QA Manager	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
LCS	One per preparation batch of twenty or fewer samples of similar matrix.	70-130% recovery.	Evaluate the samples and associated QC: i.e. If an LCS/LCSD was performed and only one of the set was unacceptable, narrate. If the LCS recovery is high but the sample results are < LOQ, narrate. Otherwise, reprepare a blank and the remaining samples.	Analyst, Supervisor, QA Manager	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
MS/MSD	One per SDG or every 20 samples.	70-130% recovery. RPD ≤ 50%	Evaluate the samples and associated QC: i.e. If the LCS results are acceptable, narrate. If both the LCS and MS/MSD are unacceptable, reprepare the samples and QC.	Analyst, Supervisor, QA Manager	Precision/Accuracy/Bias	Same as Method/SOP QC Acceptance Limits..

SAP Worksheet #28-7: Laboratory QC Samples Table

Matrix: Groundwater

Analytical Group: Diesel Range Organics (C10-C36)

Analytical Method/ SOP Reference: SW-846 8015C / GCAL SOP GC-004

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 > 1/2 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. Evaluate the samples and associated QC: i.e., if the blank results are above the LOQ, report samples results which are < LOQ and >10X the blank. Otherwise, reprepare a blank and the remaining samples.	Analyst, Supervisor, QA Manager	Accuracy/Bias, Contamination	Same as Method/SOP QC Acceptance Limits.
Surrogates	ortho-Terphenyl,	40-140% recovery	Reanalyze; present both sets of data.	Analyst, Supervisor, QA Manager	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
LCS	One per preparation batch of twenty or fewer samples of similar matrix.	40-140% recovery	Evaluate the samples and associated QC: i.e. If an LCS/LCSD was performed and only one of the set was unacceptable, narrate. If the LCS recovery is high but the sample results are < LOQ, narrate. Otherwise, reprepare a blank and the remaining samples.	Analyst, Supervisor, QA Manager	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
MS/MSD	One per SDG or every 20 samples.	40-140% recovery; RPD ≤ 50%	Evaluate the samples and associated QC: i.e. If the LCS is acceptable, narrate. If both the LCS and MS/MSD are unacceptable, reprepare the samples and QC.	Analyst, Supervisor, QA Manager	Precision/Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.

SAP Worksheet #28-8: Laboratory QC Samples Table

Matrix: Groundwater

Analytical Group: Alkalinity

Analytical Method/ SOP Reference: GCAL SOP WL-063

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
LCS	One per batch of 20 or fewer samples	Recovery 90-110%	Evaluate the samples and QC, if LCS is above control limits and there are no detections in associated samples, the samples may be reported with a case narrative. Else perform corrective action and reanalyze QC and all affected samples.	Analyst, supervisor	Accuracy/Bias	Same as method/SOP QC acceptance limits
Duplicate	One per batch of 20 or fewer samples	RPD ≤ 10%	Evaluate samples to ensure that precision failure is not the result of a laboratory error. Re-analyze all samples in the batch	Analyst, supervisor	Precision	Same as method/SOP QC acceptance limits

**SAP Worksheet #34, 35, 36 Data Verification and Validation (Steps I and IIa/IIb)
 Process Table**

Data Review Input	Description	Responsible for Verification (name, organization)	Step I / IIa / IIb¹	Internal/ External
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 Subcontract Data Validator.	Field Team Leader and Field Crew, Resolution	I	External
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	Internal
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	External
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	External
Field Screening Data (Field Analyses)	PID results and PetroFlag results will be reviewed for completeness and to confirm that analyses were performed in accordance with the applicable SOPs. Data will be reviewed to determine whether calibration and quality control requirements specified in the applicable SOPs were met. Results for which these criteria were not met will be noted in the report when the results are presented.	CTO Manager, Field Team Leader, or designee, Resolution	IIa	External
Sample Tables	Proposed samples verified to have been collected.	Field Team Leader and Field Crew, Resolution	IIa	External
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	External
Field QC Samples	Verify that field QC samples listed in Worksheet #12 were collected as required.	Field Team Leader or designee, Resolution	IIa	External
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	External

Data Review Input	Description	Responsible for Verification (name, organization)	Step I / IIa / IIb ¹	Internal/ External
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
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 fixed-laboratory data for all analyses except TOD and alkalinity, limited data validation (similar to an EPA Level II validation) will be performed using criteria for the methods listed in Worksheet #'s 12, 15, and 28, the DoD QSM v 4.2, 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. Note that the <i>USEPA Contract Laboratory Program National Functional Guidelines For Organic Data Review</i> (February 1994) will be applied to the VOC and PAH data for measurement performance indicators, such as surrogates, that are not addressed by the most recent USEPA validation guidelines.	Data Validator, Resolution	IIb	External

Data Review Input	Description	Responsible for Verification (name, organization)	Step I / IIa / IIb ¹	Internal/ External
Analytical Data Packages (in addition to Level III Validation)	<p>Data Results: Verify that the summary form results are consistent with those presented on the EDD.</p> <p>Project Quantitation Limits for Sensitivity: Verify that the LOQs and LODs listed in Worksheet # 15 were achieved.</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
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.	Resolution Project Chemist	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	I1a/I1b	External
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Notes:

- I1a Compliance with methods, procedures, and contracts [see Table 10, page 117, UFP-QAPP manual, V.1, March 2005.]
- I1b Comparison with measurement performance criteria in the SAP [see Table 11, page 118, UFP-QAPP manual, V.1, March 2005]

SAP Worksheet #37: Usability Assessment

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

Resolution will validate the fixed-laboratory data for all definitive analyses conducted (alkalinity and TOD are considered screening-level data). Validation will be conducted in accordance with the protocols described in Worksheets #34-36. These procedures are consistent with USEPA National 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 investigation. 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, 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 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 coordinated by the Resolution Project Chemist and will be conducted by the Resolution data validation staff. Data usability will be assessed by the Resolution CTO Manager with the assistance of the Resolution 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 memorandum that describes the information reviewed, the results of this review, and a recommendation on data usability and limitations of specific data points. The memorandum provides 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, review of associated QC analyses including blanks, LCSs, MSs, and field and/or laboratory duplicates. 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.

Figures



Legend

- Former Fuel Supply Pipeline Abandoned in Place 2000
- A5** Former Chamber

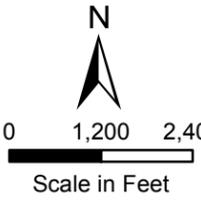


Drawn: JB 11/08/2012
 Approved: MK 11/08/2012
 Project #: 60268619

Map Location

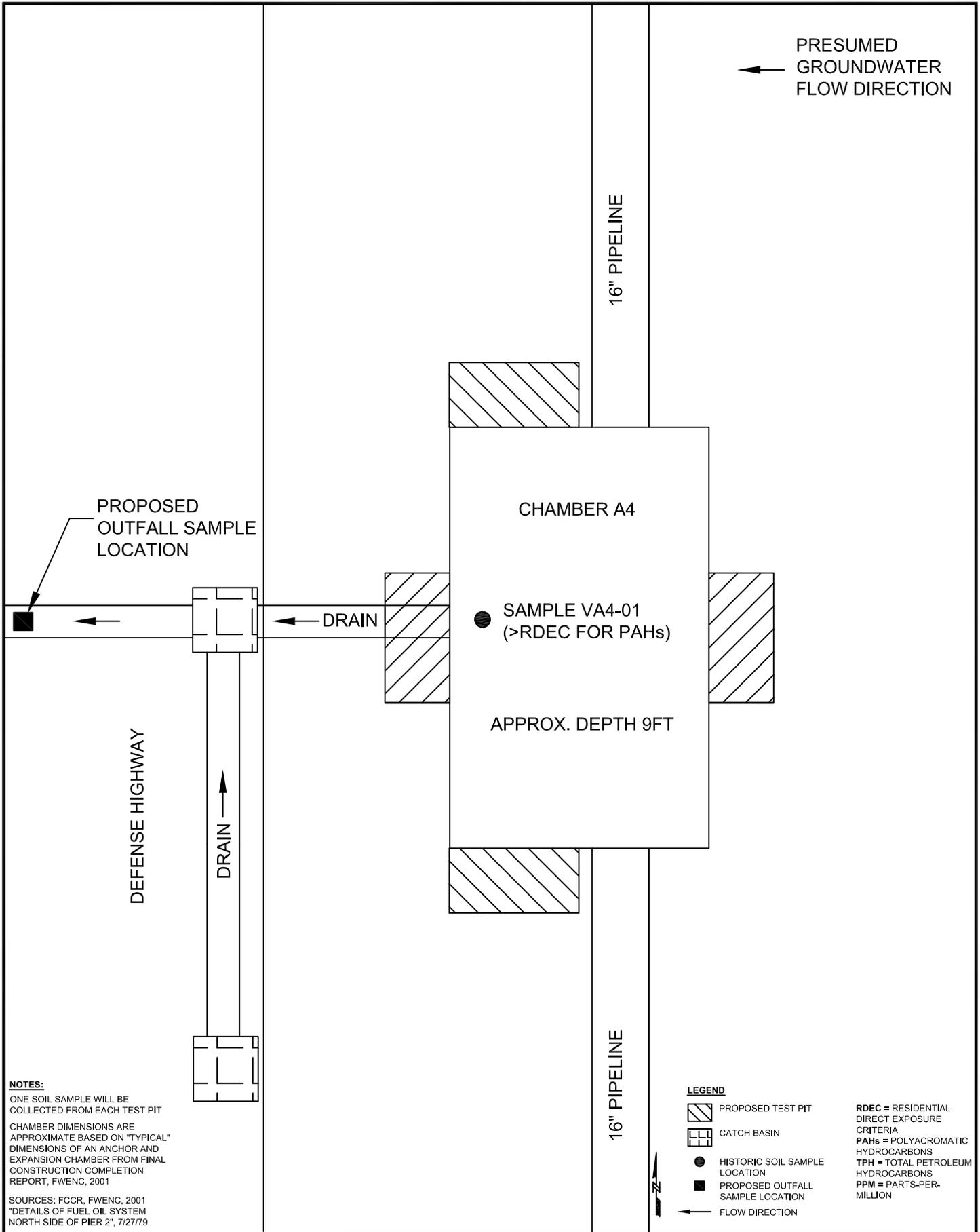


N



0 1,200 2,400
Scale in Feet

FIGURE 1
 REGIONAL LOCATION OF
 PIPELINE CHAMBERS TO BE INVESTIGATED
 NAVSTA NEWPORT, RHODE ISLAND

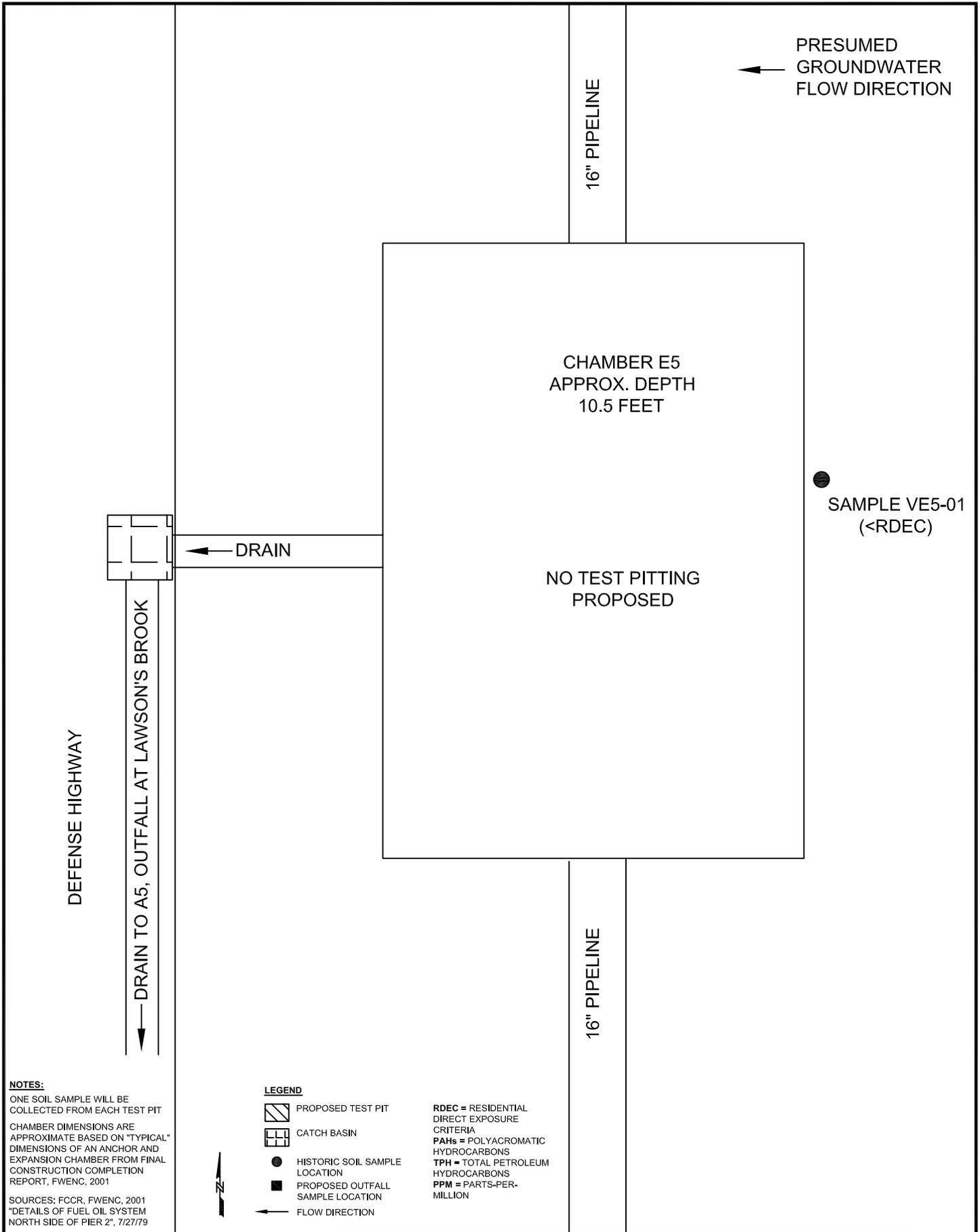


**NAVSTA
NEWPORT, RHODE ISLAND**

DATE: 11/16/12 DRWN: AES

CHAMBER A4

1"=3' (APPROX.) FIGURE 2



NOTES:
 ONE SOIL SAMPLE WILL BE COLLECTED FROM EACH TEST PIT
 CHAMBER DIMENSIONS ARE APPROXIMATE BASED ON "TYPICAL" DIMENSIONS OF AN ANCHOR AND EXPANSION CHAMBER FROM FINAL CONSTRUCTION COMPLETION REPORT, FWENC, 2001
 SOURCES: FCCR, FWENC, 2001
 *DETAILS OF FUEL OIL SYSTEM NORTH SIDE OF PIER 2", 7/27/79

- LEGEND**
-  PROPOSED TEST PIT
 -  CATCH BASIN
 -  HISTORIC SOIL SAMPLE LOCATION
 -  PROPOSED OUTFALL SAMPLE LOCATION
 -  FLOW DIRECTION
- RDEC = RESIDENTIAL DIRECT EXPOSURE CRITERIA**
PAHs = POLYACROMATIC HYDROCARBONS
TPH = TOTAL PETROLEUM HYDROCARBONS
PPM = PARTS-PER-MILLION



**NAVSTA
NEWPORT, RHODE ISLAND**

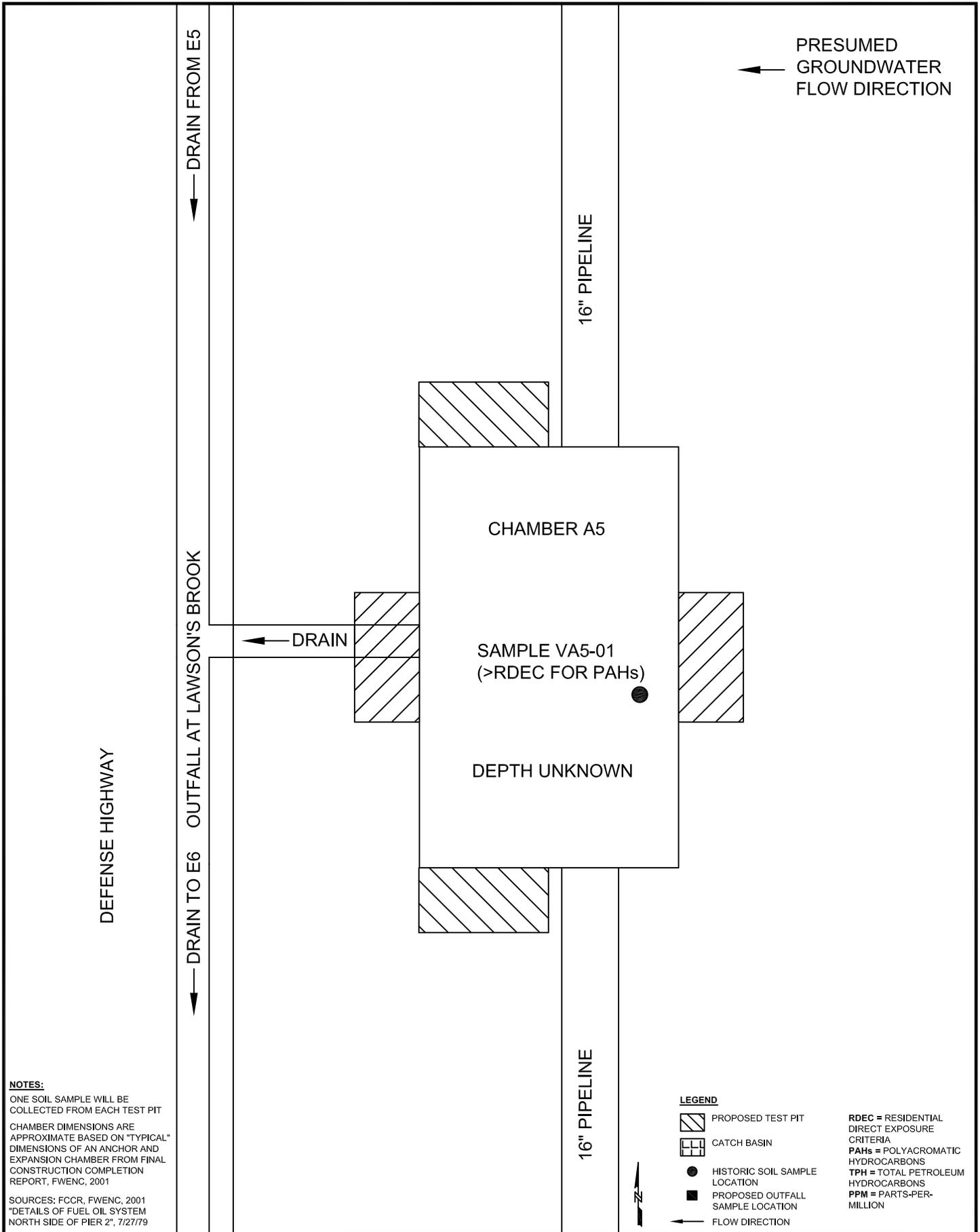
CHAMBER E5

DATE: 11/16/12

DRWN: AES

1"=3' (APPROX.)

FIGURE 3



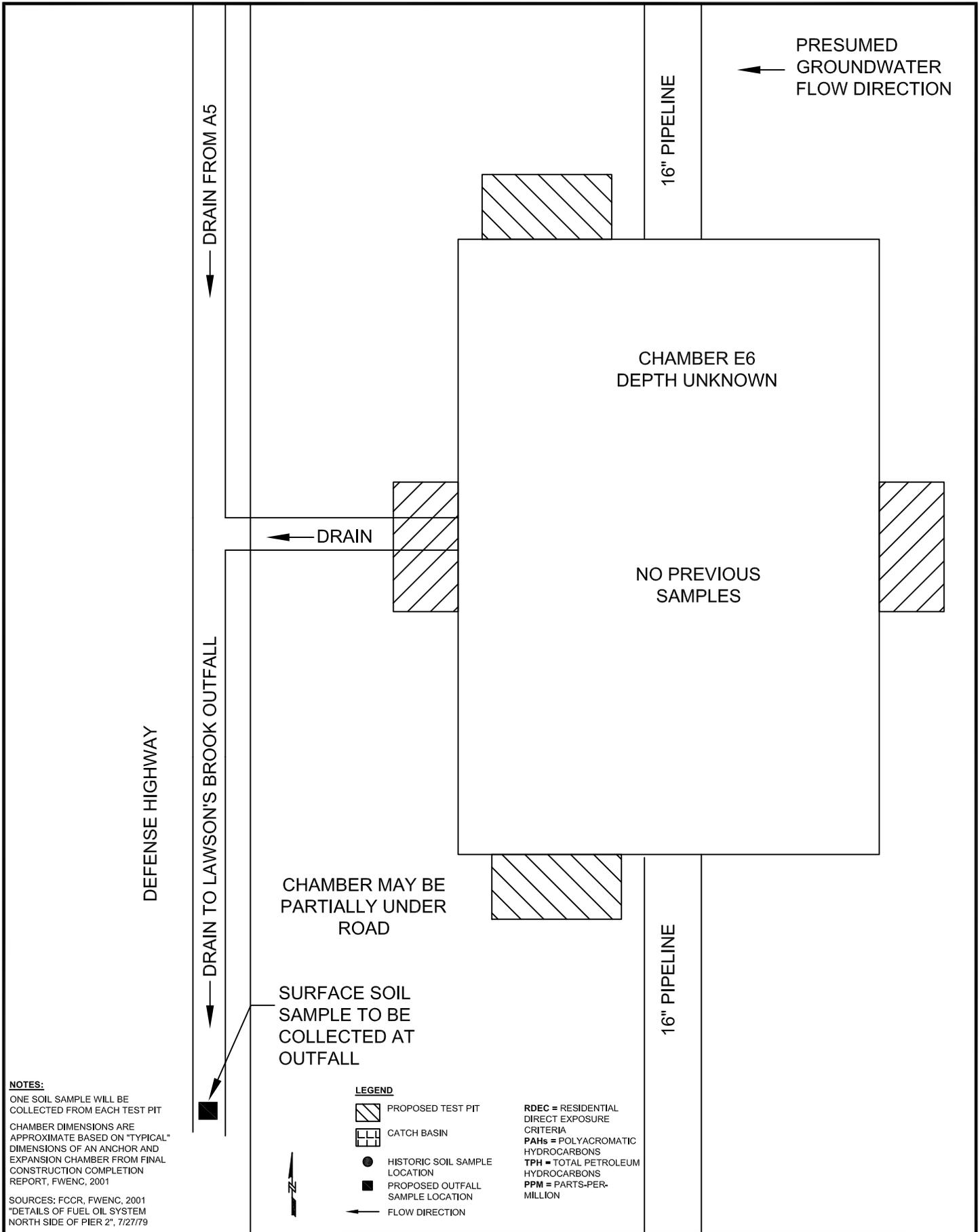
NOTES:
 ONE SOIL SAMPLE WILL BE COLLECTED FROM EACH TEST PIT
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LEGEND
 PROPOSED TEST PIT
 CATCH BASIN
 HISTORIC SOIL SAMPLE LOCATION
 PROPOSED OUTFALL SAMPLE LOCATION
 FLOW DIRECTION
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PAHs = POLYACROMATIC HYDROCARBONS
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PPM = PARTS-PER-MILLION



**NAVSTA
 NEWPORT, RHODE ISLAND**
 DATE: 11/16/12 DRWN: AES

CHAMBER A5
 1"=3' (APPROX.) FIGURE 4

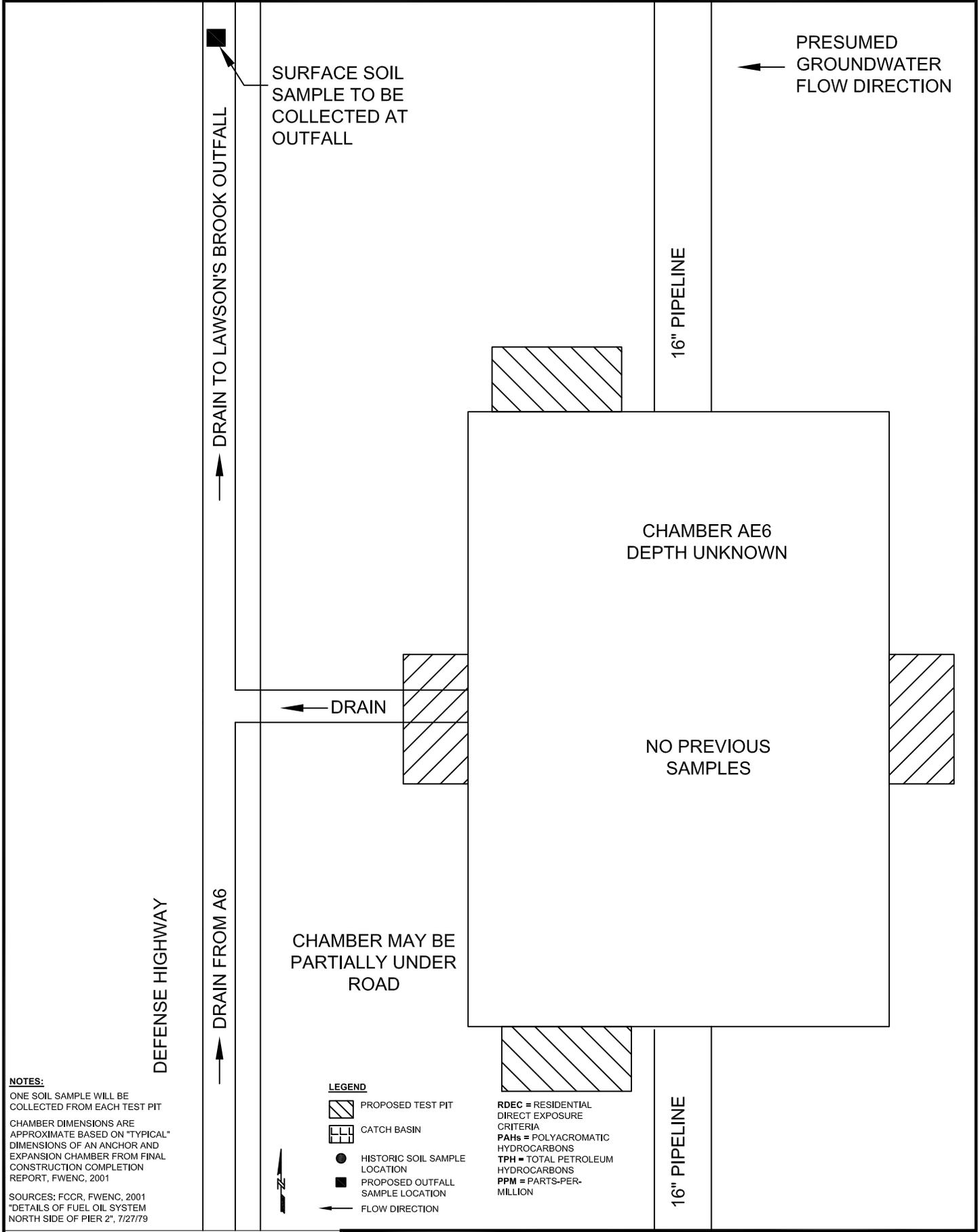


**NAVSTA
NEWPORT, RHODE ISLAND**

DATE: 11/16/12 DRWN: AES

CHAMBER E6

1"=3' (APPROX.) FIGURE 5



NOTES:
 ONE SOIL SAMPLE WILL BE COLLECTED FROM EACH TEST PIT
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LEGEND

- PROPOSED TEST PIT
- CATCH BASIN
- HISTORIC SOIL SAMPLE LOCATION
- PROPOSED OUTFALL SAMPLE LOCATION
- FLOW DIRECTION

RDEC = RESIDENTIAL DIRECT EXPOSURE CRITERIA
PAHs = POLYACROMATIC HYDROCARBONS
TPH = TOTAL PETROLEUM HYDROCARBONS
PPM = PARTS-PER-MILLION

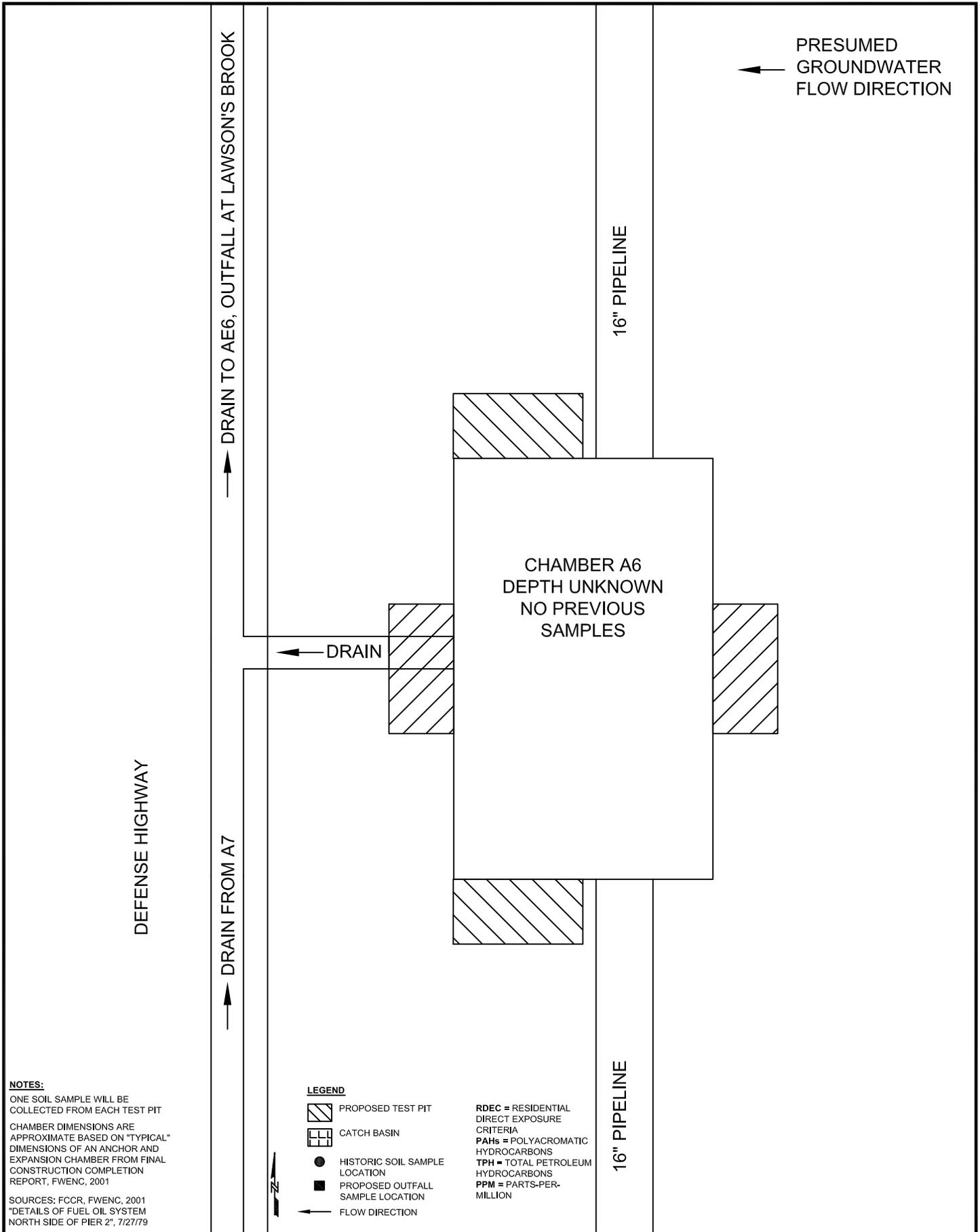


**NAVSTA
 NEWPORT, RHODE ISLAND**

DATE: 11/16/12 DRWN: AES

CHAMBER AE6

1"=3' (APPROX.) FIGURE 6



NOTES:
 ONE SOIL SAMPLE WILL BE COLLECTED FROM EACH TEST PIT
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 SOURCES: FCCR, FWENC, 2001 "DETAILS OF FUEL OIL SYSTEM NORTH SIDE OF PIER 2", 7/27/79

- LEGEND**
-  PROPOSED TEST PIT
 -  CATCH BASIN
 -  HISTORIC SOIL SAMPLE LOCATION
 -  PROPOSED OUTFALL SAMPLE LOCATION
 -  FLOW DIRECTION
- RDEC = RESIDENTIAL DIRECT EXPOSURE CRITERIA**
PAHs = POLYACROMATIC HYDROCARBONS
TPH = TOTAL PETROLEUM HYDROCARBONS
PPM = PARTS-PER-MILLION



**NAVSTA
NEWPORT, RHODE ISLAND**

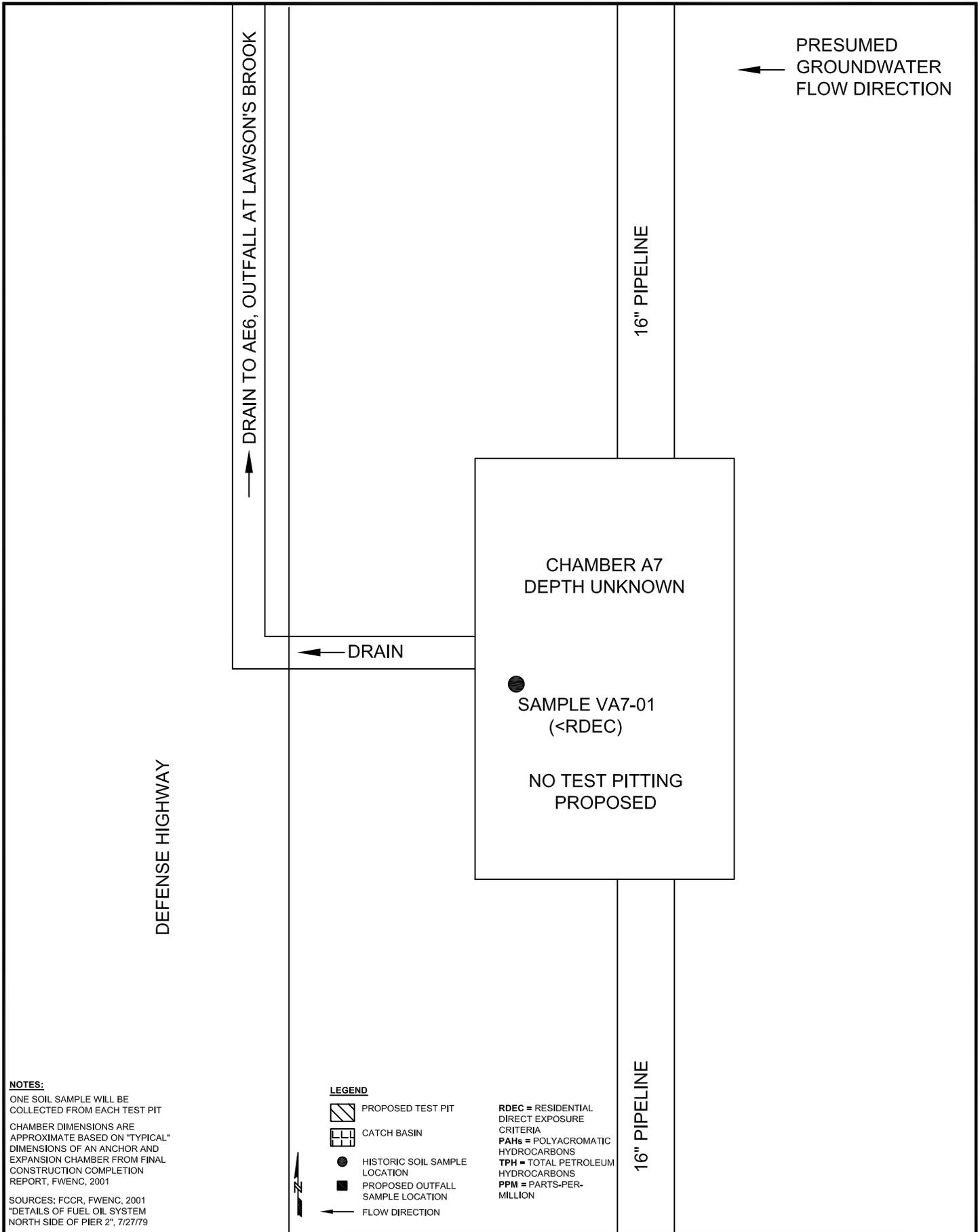
CHAMBER A6

DATE: 11/16/12

DRWN: AES

1"=3' (APPROX.)

FIGURE 7



NOTES:
 ONE SOIL SAMPLE WILL BE COLLECTED FROM EACH TEST PIT
 CHAMBER DIMENSIONS ARE APPROXIMATE BASED ON "TYPICAL" DIMENSIONS OF AN ANCHOR AND EXPANSION CHAMBER FROM FINAL CONSTRUCTION COMPLETION REPORT, FWENC, 2001
 SOURCES: FCCR, FWENC, 2001
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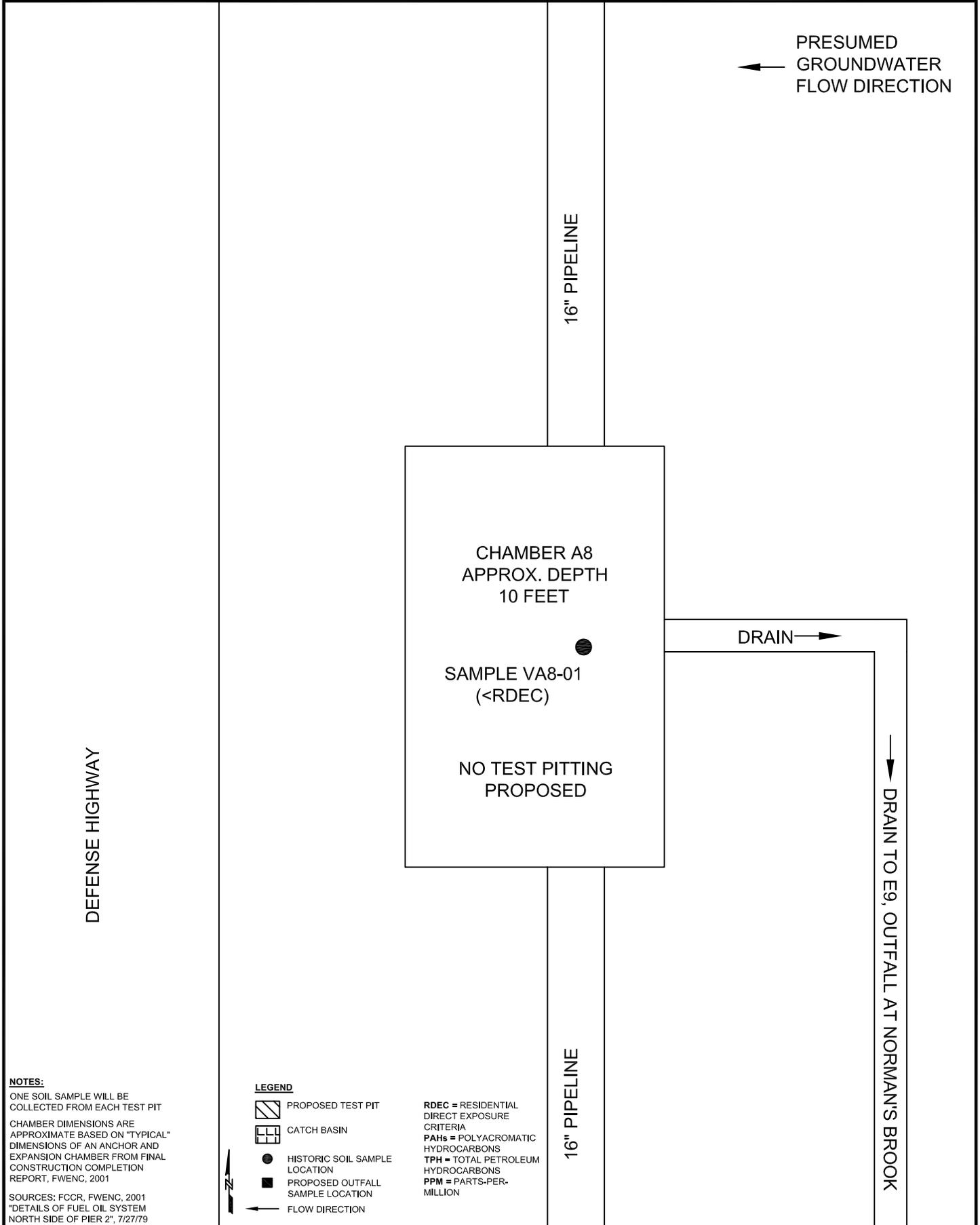


**NAVSTA
NEWPORT, RHODE ISLAND**

DATE: 11/16/12 DRWN: AES

CHAMBER A7

1"=3' (APPROX.) FIGURE 8



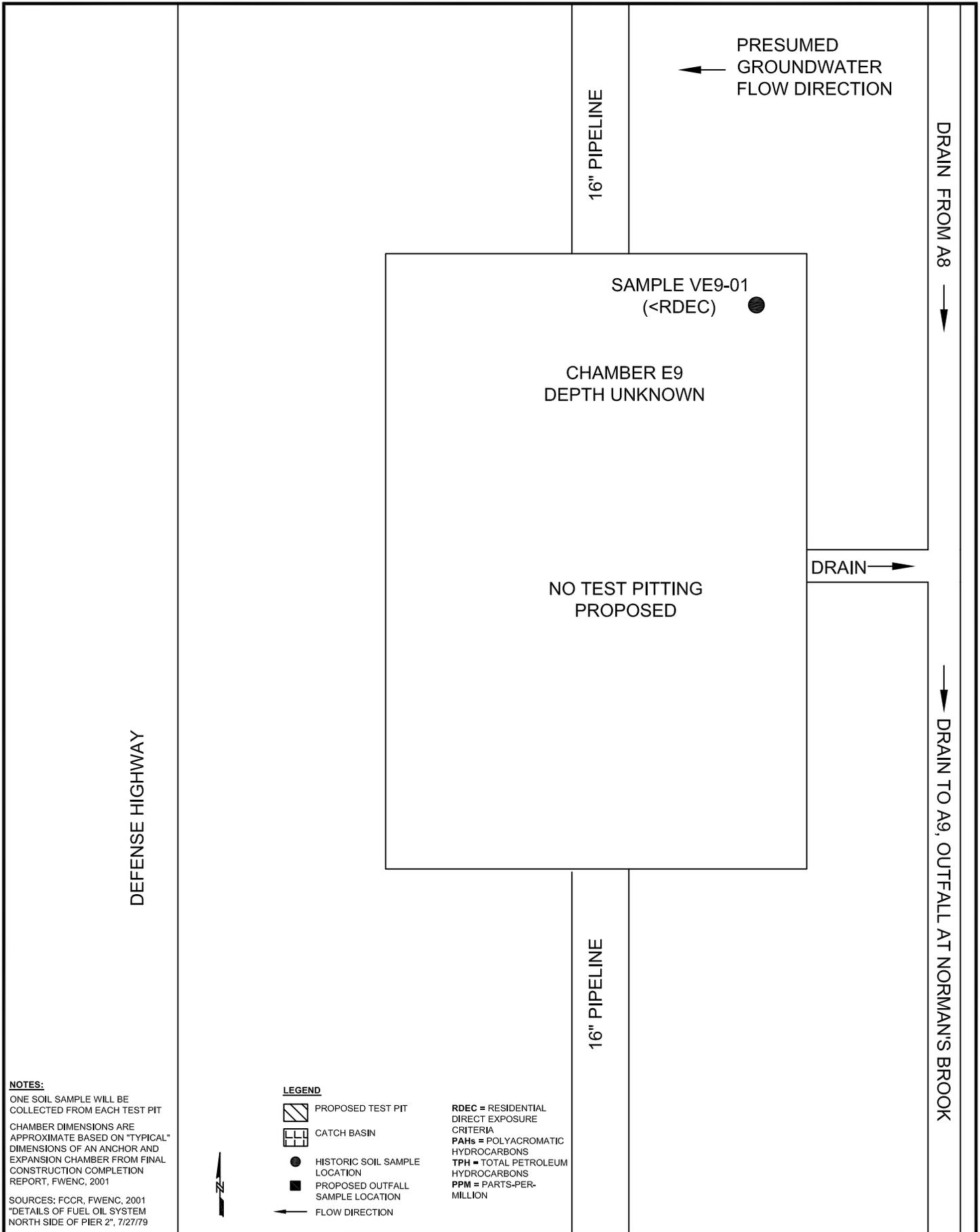
NOTES:
 ONE SOIL SAMPLE WILL BE COLLECTED FROM EACH TEST PIT
 CHAMBER DIMENSIONS ARE APPROXIMATE BASED ON "TYPICAL" DIMENSIONS OF AN ANCHOR AND EXPANSION CHAMBER FROM FINAL CONSTRUCTION COMPLETION REPORT, FWENC, 2001
 SOURCES: FCCR, FWENC, 2001
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- LEGEND**
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 - CATCH BASIN
 - HISTORIC SOIL SAMPLE LOCATION
 - PROPOSED OUTFALL SAMPLE LOCATION
 - FLOW DIRECTION
- RDEC = RESIDENTIAL DIRECT EXPOSURE CRITERIA**
PAHs = POLYACROMATIC HYDROCARBONS
TPH = TOTAL PETROLEUM HYDROCARBONS
PPM = PARTS-PER-MILLION



**NAVSTA
NEWPORT, RHODE ISLAND**

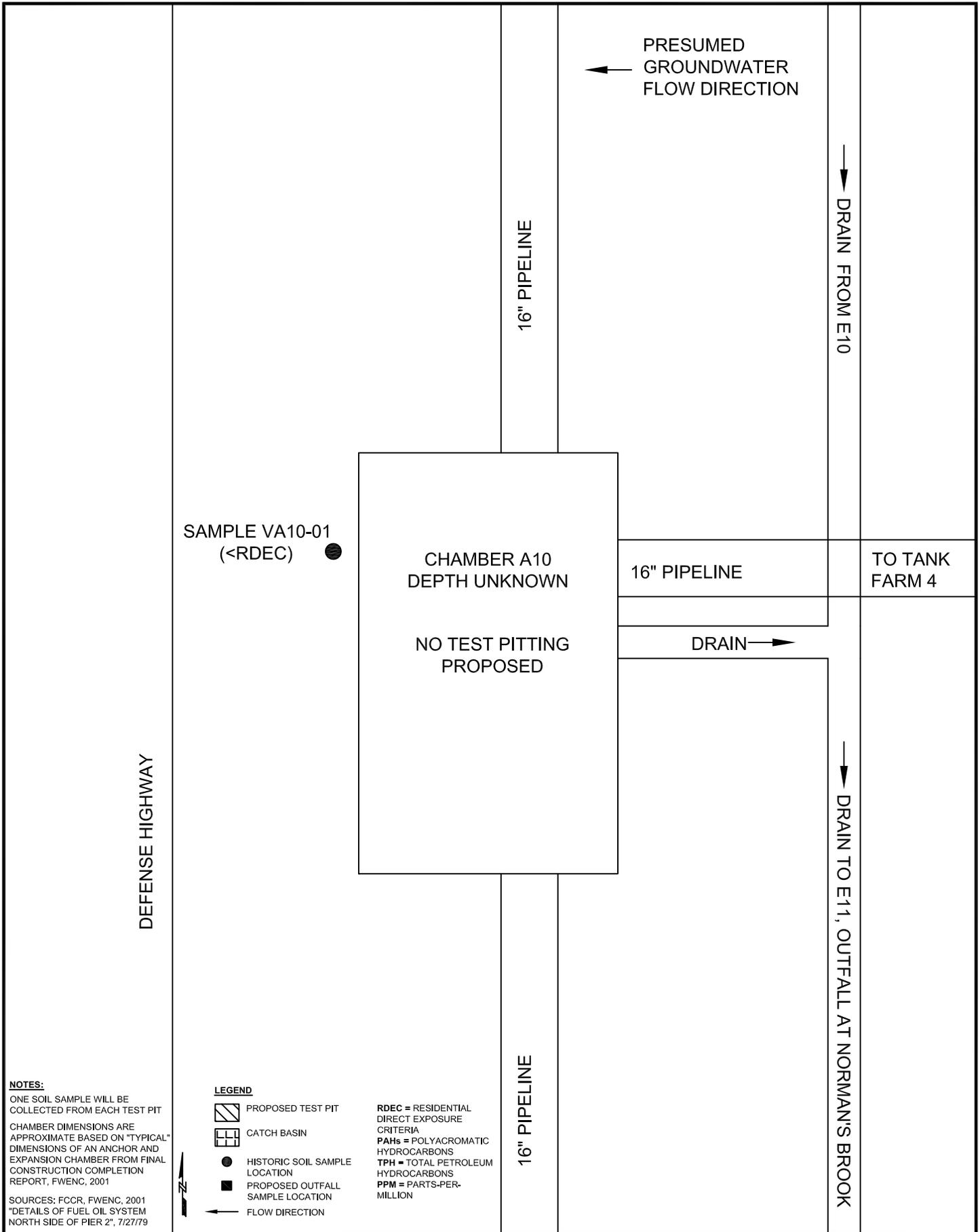
CHAMBER A8



NOTES:
 ONE SOIL SAMPLE WILL BE COLLECTED FROM EACH TEST PIT
 CHAMBER DIMENSIONS ARE APPROXIMATE BASED ON "TYPICAL" DIMENSIONS OF AN ANCHOR AND EXPANSION CHAMBER FROM FINAL CONSTRUCTION COMPLETION REPORT, FWENC, 2001
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PPM = PARTS-PER-MILLION





NOTES:
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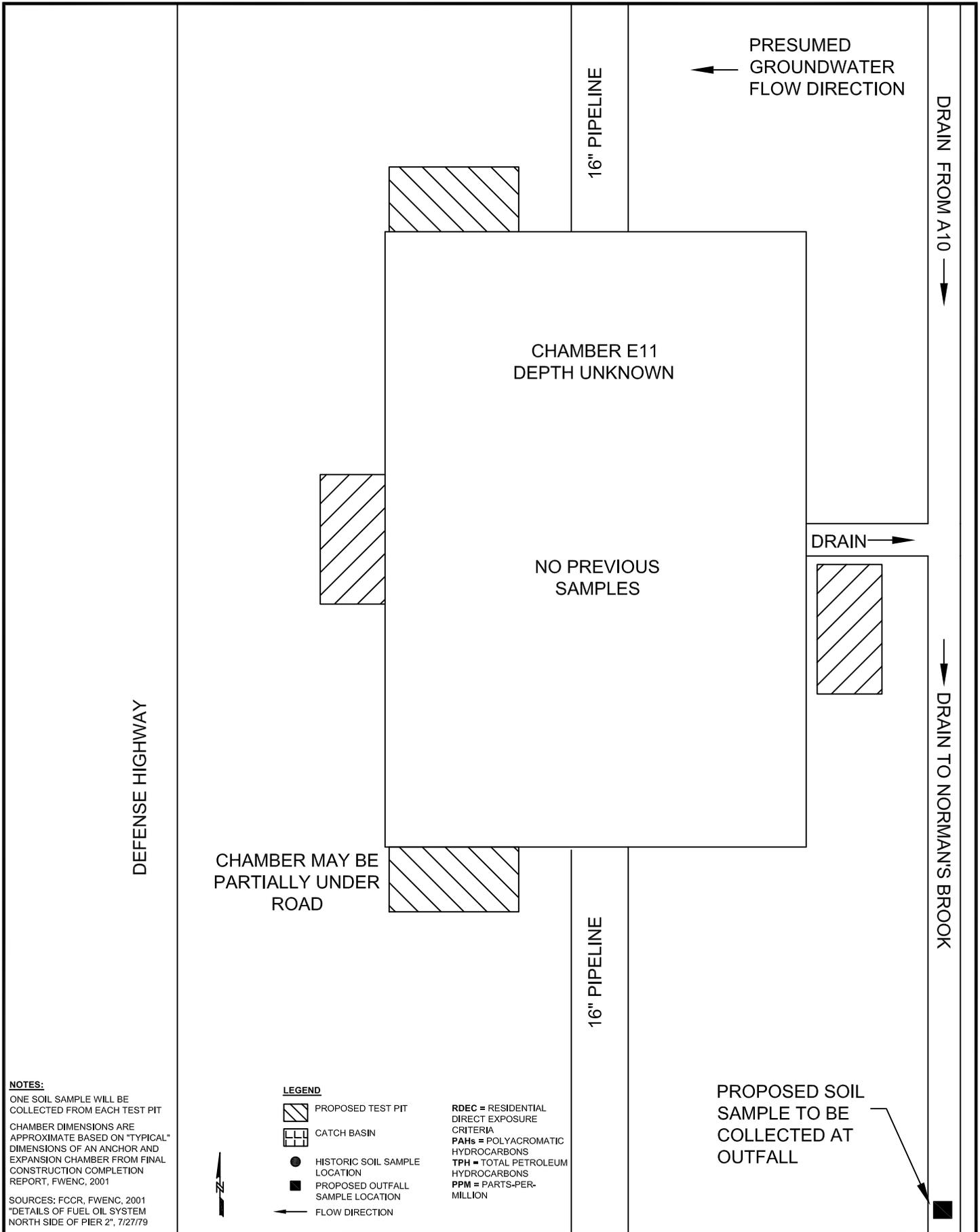
LEGEND
 PROPOSED TEST PIT
 CATCH BASIN
 HISTORIC SOIL SAMPLE LOCATION
 PROPOSED OUTFALL SAMPLE LOCATION
 FLOW DIRECTION

RDEC = RESIDENTIAL DIRECT EXPOSURE CRITERIA
PAHs = POLYACROMATIC HYDROCARBONS
TPH = TOTAL PETROLEUM HYDROCARBONS
PPM = PARTS-PER-MILLION



**NAVSTA
 NEWPORT, RHODE ISLAND**

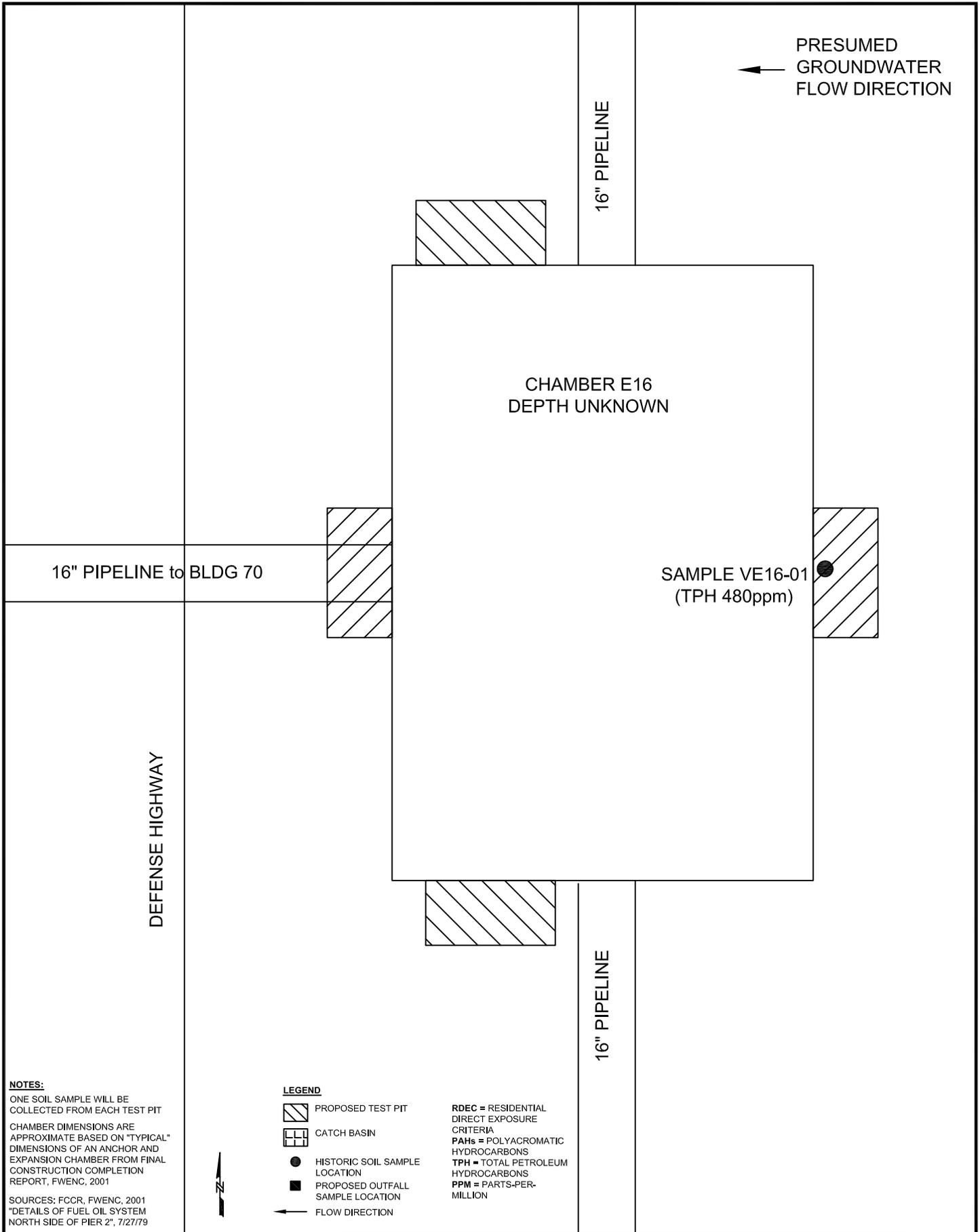
CHAMBER A10



NOTES:
 ONE SOIL SAMPLE WILL BE COLLECTED FROM EACH TEST PIT
 CHAMBER DIMENSIONS ARE APPROXIMATE BASED ON "TYPICAL" DIMENSIONS OF AN ANCHOR AND EXPANSION CHAMBER FROM FINAL CONSTRUCTION COMPLETION REPORT, FWENC, 2001
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PAHs = POLYACROMATIC HYDROCARBONS
TPH = TOTAL PETROLEUM HYDROCARBONS
PPM = PARTS-PER-MILLION

PROPOSED SOIL SAMPLE TO BE COLLECTED AT OUTFALL



NOTES:
 ONE SOIL SAMPLE WILL BE COLLECTED FROM EACH TEST PIT
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TPH = TOTAL PETROLEUM HYDROCARBONS
PPM = PARTS-PER-MILLION



**NAVSTA
 NEWPORT, RHODE ISLAND**

CHAMBER E16

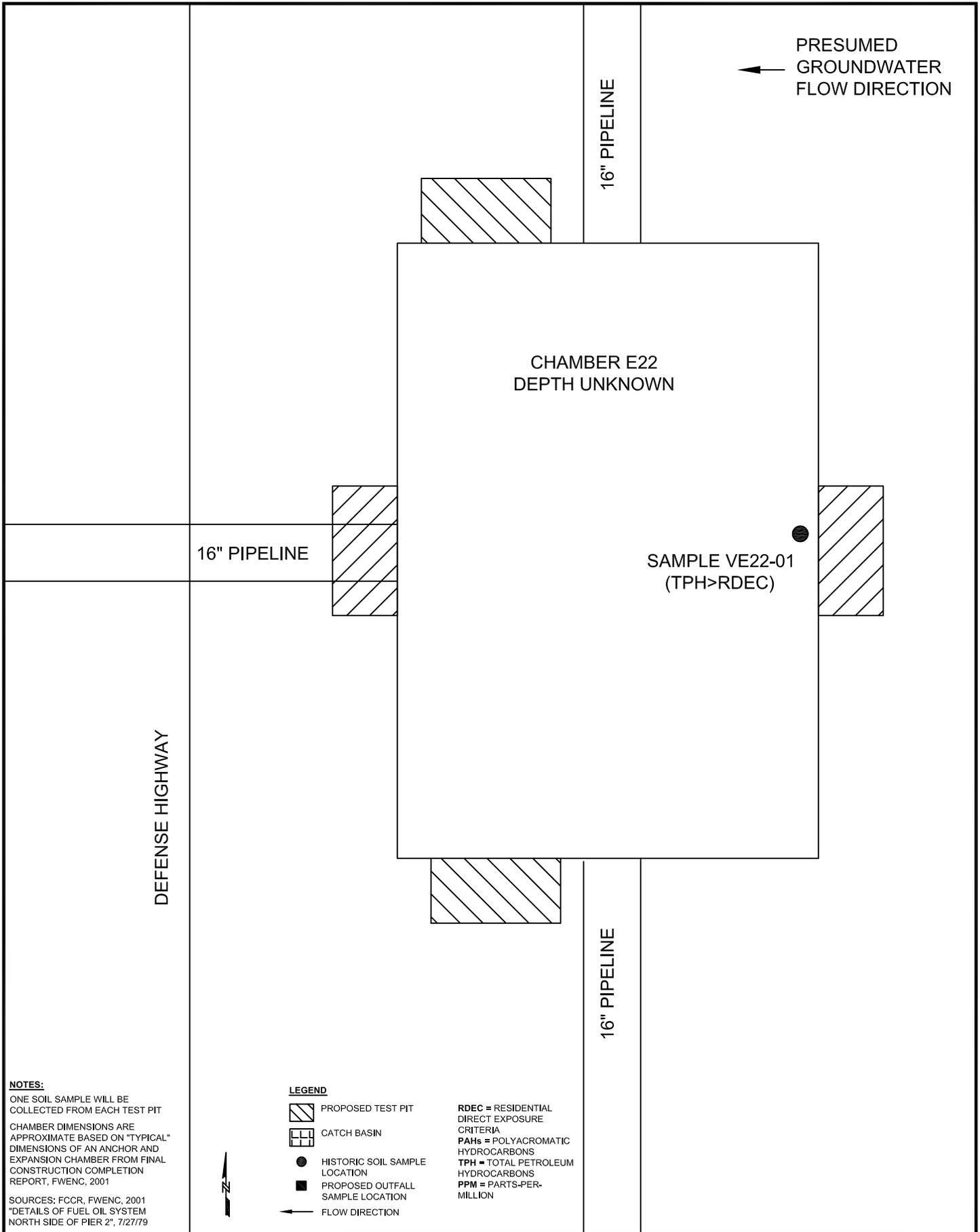
DATE: 11/16/12

DRWN: AES

1"=3' (APPROX.)

FIGURE 13

File: W:\Govt\Projects\Navy CLEAN AECOM-EnSafe JV\Newport\CAD\Chambers_Figures\CHAMBER DETAILS.dwg Layout: FIGURE 14-CHAMBER E22 User: sanchez1 Plotted: Nov 26, 2012 - 1:04pm Xref's:



**NAVSTA
NEWPORT, RHODE ISLAND**

CHAMBER E22

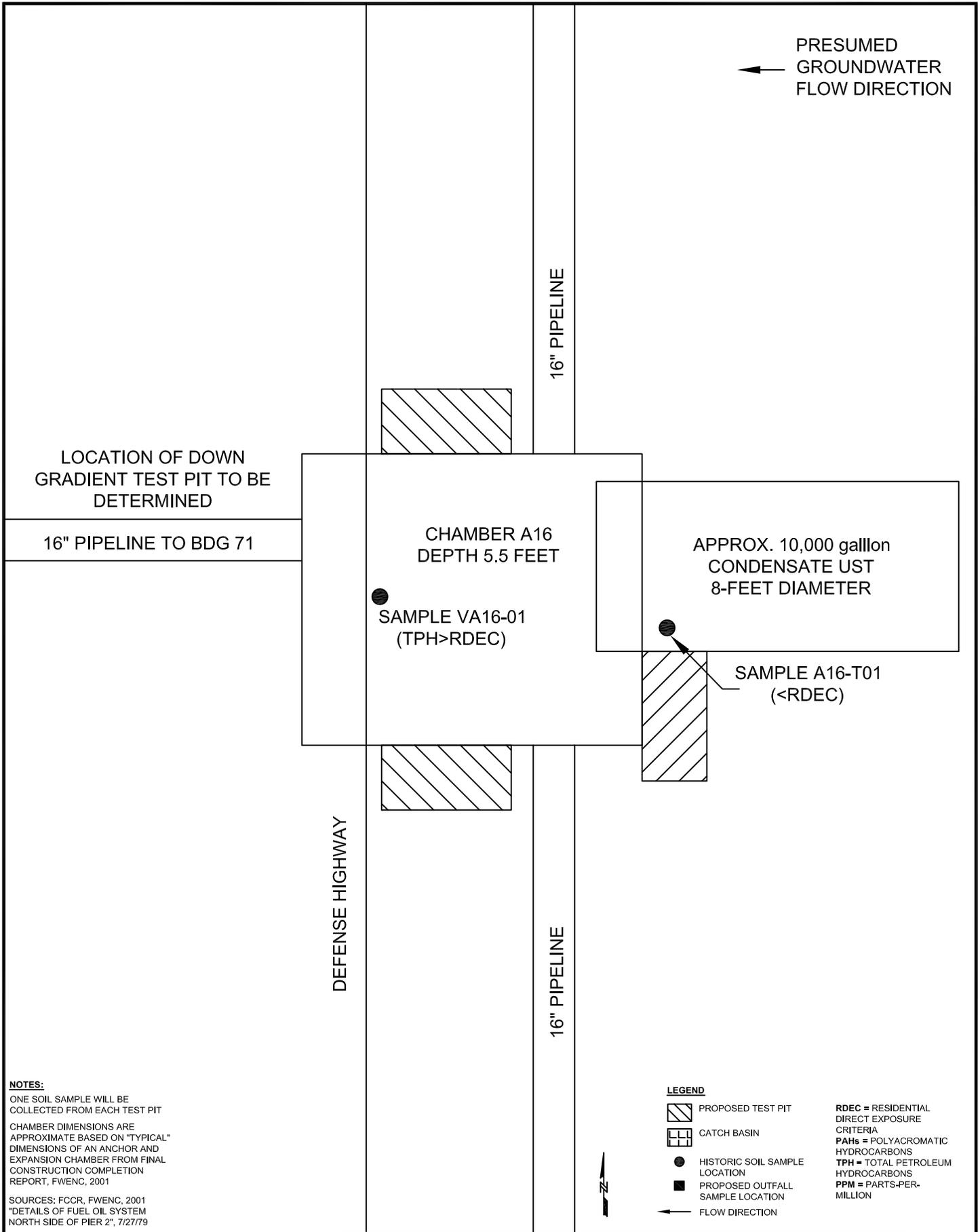
DATE: 11/16/12

DRWN: AES

1"=3' (APPROX.)

FIGURE 14

File: W:\Govt\Projects\Navy CLEAN AECOM-EnSafe JV\Newport\CAD\Chambers_Figures\CHAMBER DETAILS.dwg Layout: FIGURE 15-A16 User: sancheza1 Plotted: Nov 26, 2012 - 1:04pm Xref's:



NOTES:
 ONE SOIL SAMPLE WILL BE COLLECTED FROM EACH TEST PIT
 CHAMBER DIMENSIONS ARE APPROXIMATE BASED ON "TYPICAL" DIMENSIONS OF AN ANCHOR AND EXPANSION CHAMBER FROM FINAL CONSTRUCTION COMPLETION REPORT, FWENC, 2001
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LEGEND
 PROPOSED TEST PIT
 CATCH BASIN
 HISTORIC SOIL SAMPLE LOCATION
 PROPOSED OUTFALL SAMPLE LOCATION
 FLOW DIRECTION
RDEC = RESIDENTIAL DIRECT EXPOSURE CRITERIA
PAHs = POLYACROMATIC HYDROCARBONS
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PPM = PARTS-PER-MILLION



**NAVSTA
 NEWPORT, RHODE ISLAND**
 DATE: 11/16/12 DRWN: AES

CHAMBER A16
 1"=6' (APPROX.) FIGURE 15

DEFENSE HIGHWAY

← PRESUMED
GROUNDWATER
FLOW DIRECTION

16" PIPELINE

CHAMBER E17
APPROX. DEPTH
10 FEET

SAMPLE VE17-01
(>RDEC FOR PAHs)

16" PIPELINE

NOTES:

ONE SOIL SAMPLE WILL BE COLLECTED FROM EACH TEST PIT

CHAMBER DIMENSIONS ARE APPROXIMATE BASED ON "TYPICAL" DIMENSIONS OF AN ANCHOR AND EXPANSION CHAMBER FROM FINAL CONSTRUCTION COMPLETION REPORT, FWENC, 2001

SOURCES: FCCR, FWENC, 2001
"DETAILS OF FUEL OIL SYSTEM NORTH SIDE OF PIER 2", 7/27/79

LEGEND

 PROPOSED TEST PIT

 CATCH BASIN

 HISTORIC SOIL SAMPLE LOCATION

 PROPOSED OUTFALL SAMPLE LOCATION

 FLOW DIRECTION

RDEC = RESIDENTIAL DIRECT EXPOSURE CRITERIA

PAHs = POLYACROMATIC HYDROCARBONS

TPH = TOTAL PETROLEUM HYDROCARBONS

PPM = PARTS-PER-MILLION



NAVSTA
NEWPORT, RHODE ISLAND

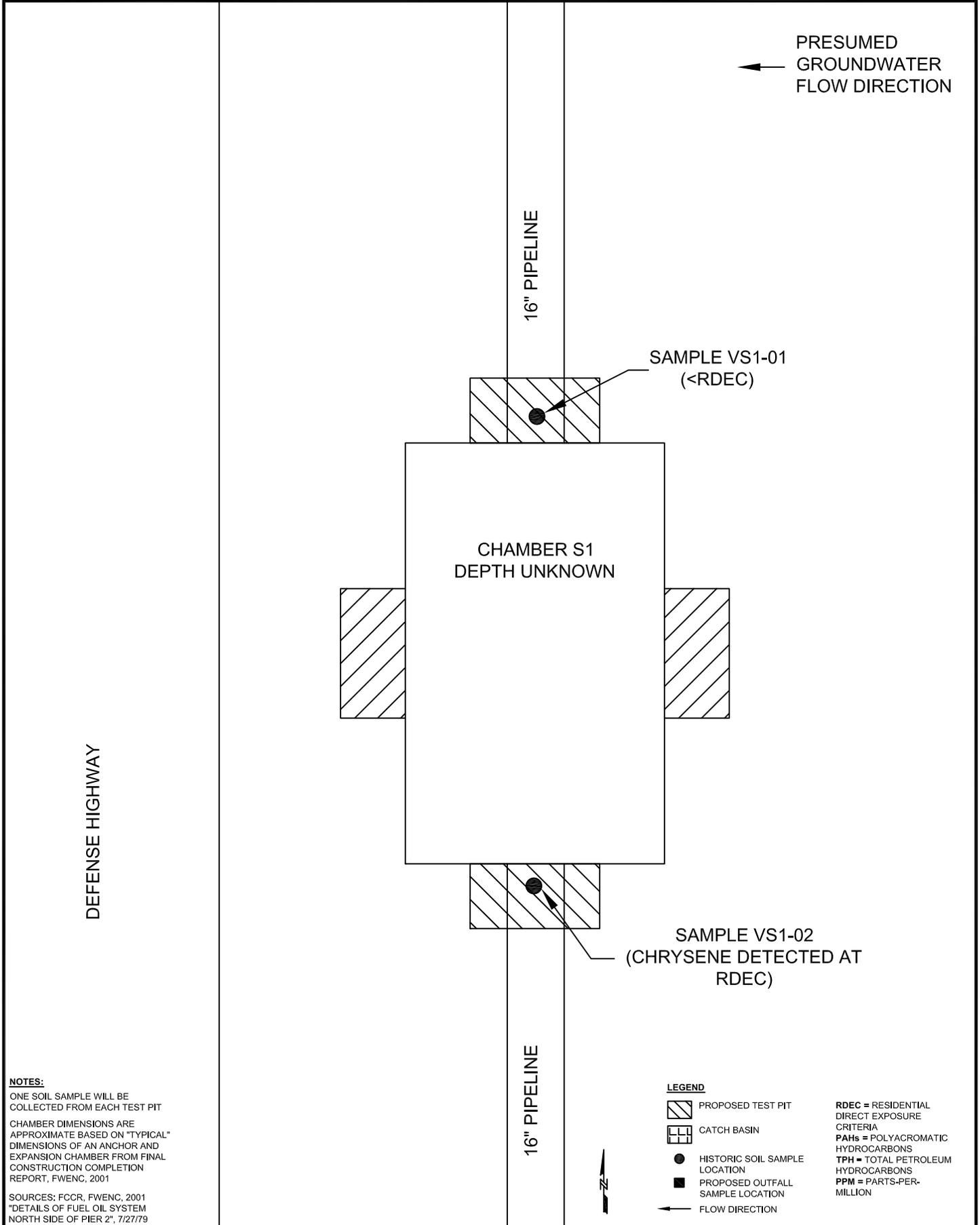
CHAMBER E17

DATE: 11/16/12

DRWN: AES

1"=3' (APPROX.)

FIGURE 16



NOTES:
 ONE SOIL SAMPLE WILL BE COLLECTED FROM EACH TEST PIT
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LEGEND
 PROPOSED TEST PIT
 CATCH BASIN
 HISTORIC SOIL SAMPLE LOCATION
 PROPOSED OUTFALL SAMPLE LOCATION
 FLOW DIRECTION
RDEC = RESIDENTIAL DIRECT EXPOSURE CRITERIA
PAHs = POLYCYCLIC AROMATIC HYDROCARBONS
TPH = TOTAL PETROLEUM HYDROCARBONS
PPM = PARTS-PER-MILLION

RESOLUTION CONSULTANTS

**NAVSTA
 NEWPORT, RHODE ISLAND**

DATE: 11/16/12 DRWN: AES

CHAMBER S1

1"=3' (APPROX.) FIGURE 17

DEFENSE HIGHWAY

← PRESUMED
GROUNDWATER
FLOW DIRECTION

16" PIPELINE

CHAMBER V3
DEPTH UNKNOWN

● SAMPLE VV3-01
(<RDEC)

● SAMPLE VV3-02
(>RDEC FOR PAHs)

16" PIPELINE

NOTES:
ONE SOIL SAMPLE WILL BE COLLECTED FROM EACH TEST PIT
CHAMBER DIMENSIONS ARE APPROXIMATE BASED ON "TYPICAL" DIMENSIONS OF AN ANCHOR AND EXPANSION CHAMBER FROM FINAL CONSTRUCTION COMPLETION REPORT, FWENC, 2001
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PPM = PARTS-PER-MILLION



NAVSTA
NEWPORT, RHODE ISLAND

CHAMBER V3

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.

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.

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.

Author	Reviewer	Revisions (Technical or Editorial)
Mark Kromis Program Chemist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue

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.

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.

-
- 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.
-

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

M001575

CHAIN OF CUSTODY RECORD												Page ____ of ____
Client/Project Name:				Project Location:				Analysis Requested				
Project Number:				Field Logbook No.:								
Sample#: (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	Filter	Filled	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

OUT OF CONTROL FORM	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:	

3. Results of Corrective Action	
<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 (HNO₃), sulfuric acid (H₂SO₄), 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

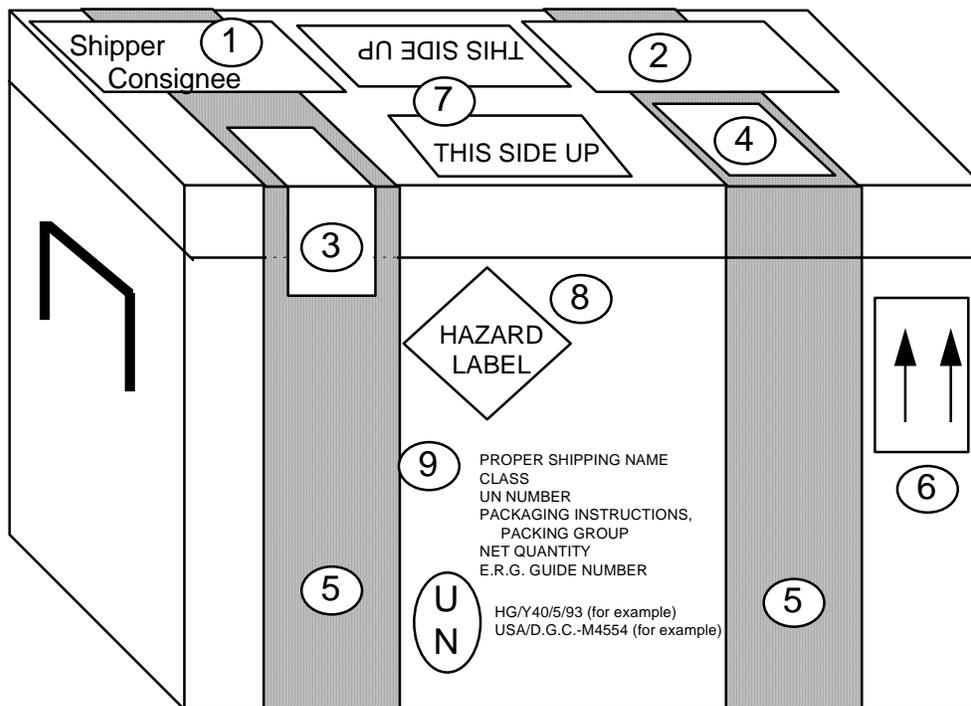
- 7.1 Maintain records as required by implementing these procedures.
- 7.2 Deviations from this procedure or the project-specific sampling and analysis plan shall be documented in field records. Significant changes shall be approved by the **Program Quality Manager**.

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 ^(Note A) -----					
2.1: Flammable Gas	----- Forbidden ^(Note B) -----					
2.2: Non-Flammable, non-toxic gas	----- See Notes A and B -----					
2.3: Toxic gas	----- Forbidden ^(Note A) -----					
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 ^(Note C)	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 ^(Note A) -----					
7: Radioactive material ^(Note D)	----- Forbidden ^(Note A) -----					
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 ^(Note A) -----					
9: Other miscellaneous materials ^(Note E)	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 3 Dangerous Goods in Excepted Quantities

DANGEROUS GOODS IN EXCEPTED QUANTITIES							
This package contains dangerous goods in excepted small quantities and is in all respects in compliance with the applicable international and national government regulations and the IATA Dangerous Goods Regulations.							

Signature of Shipper							
_____				_____			
Title				Date			

Name and address of Shipper							
This package contains substance(s) in Class(es) (check applicable box(es))							
Class:	2	3	4	5	6	8	9
	<input type="checkbox"/>						
and the applicable UN Numbers are:							

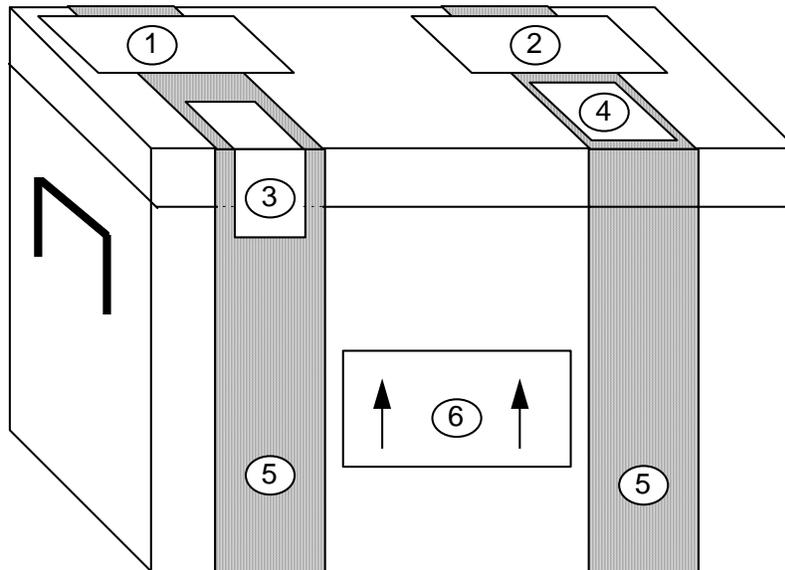
Attachment 4

SW-846 Preservative Exception

Measurement	Vol. Req. (mL)	Container ²	Preservative ^{3,4}	Holding Time ⁵
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 (HNO₃) in water solutions at concentrations of 0.15% by weight or less (pH about 1.62 or greater); Sulfuric acid (H₂SO₄) 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 <hotel name> <hotel address></i>				CONSIGNEE <i>Sample Receipt <Lab Name> <Lab Address></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>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 <hotel name> <hotel address></i>				CONSIGNEE <i>Sample Receipt <Lab Name> <Lab Address></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		
	<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

Soil Permit

Columbia Analytical Services
(Lee Wolf)
1317 S. 13th Avenue
Kelso, Washington 98626
TELEPHONE: (360) 577-7222

Permit Number: S-52239

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:

Plant Protection and Quarantine

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.

Expiration Date: JUNE 30, 2006

Deborah M. Knott
Approving Official DEBORAH M. KNOTT

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

<hr/> <p>U.S. DEPARTMENT OF AGRICULTURE ANIMAL AND PLANT HEALTH INSPECTION SERVICE PLANT PROTECTION AND QUARANTINE HYATTSVILLE, MARYLAND 20782</p> <p>SOIL SAMPLES RESTRICTED ENTRY</p> <hr/> <p>The material contained in this package is imported under authority of the Federal Plant Pest Act of May 23, 1957.</p> <hr/> <p>For release without treatment if addressee is currently listed as approved by Plant Protection and Quarantine.</p> <hr/> <p>PPQ FORM 550 <i>Edition of 12/77 may be used</i> (JAN 83)</p>

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.

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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.
- 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*.

Author	Reviewer	Revisions (Technical or Editorial)
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.

<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.

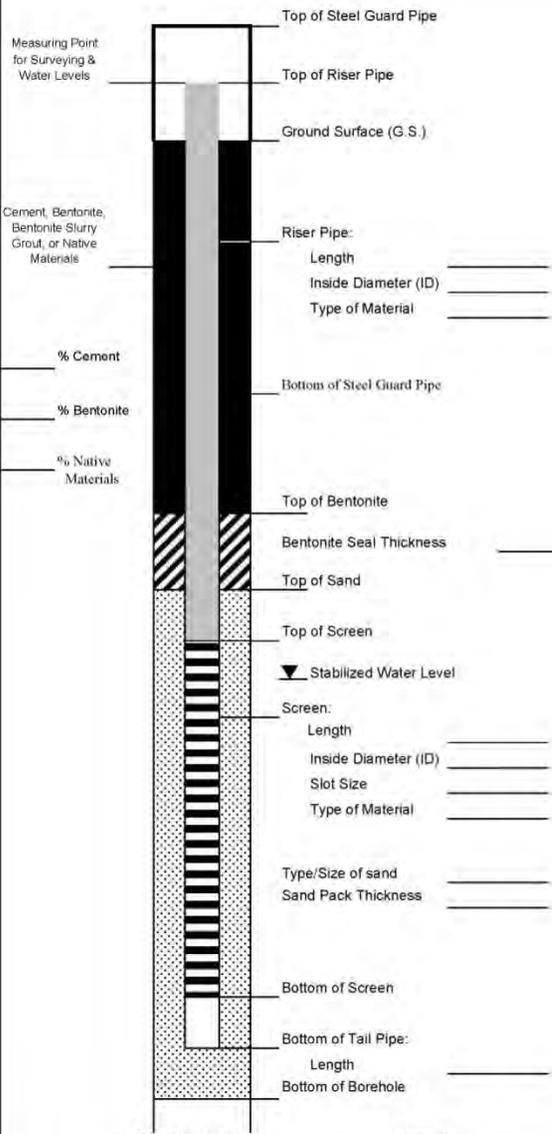
10.0 Attachments or References

- 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.
- 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)

Attachment 1 Monitoring Well Construction Form

	Client: _____		WELL ID: _____
	Project Number: _____		
	Site Location: _____		
	Well Location: _____	Coords: _____	
	Method: _____		
MONITORING WELL CONSTRUCTION DETAIL			
		Depth from G.S. (feet)	Elevation(feet) Datum _____
	Top of Steel Guard Pipe	_____	_____
	Top of Riser Pipe	_____	_____
	Ground Surface (G.S.)	0.0	_____
	Riser Pipe:		
	Length _____		
	Inside Diameter (ID) _____		
	Type of Material _____		
	Bottom of Steel Guard Pipe	_____	_____
	Top of Bentonite	_____	_____
	Bentonite Seal Thickness _____		
	Top of Sand	_____	_____
	Top of Screen	_____	_____
	▼ Stabilized Water Level	_____	_____
	Screen:		
	Length _____		
Inside Diameter (ID) _____			
Slot Size _____			
Type of Material _____			
Type/Size of sand _____			
Sand Pack Thickness _____			
Bottom of Screen	_____	_____	
Bottom of Tail Pipe:			
Length _____			
Bottom of Borehole	_____	_____	
Borehole Diameter _____			
Approved: _____			
Describe Measuring Point: _____	Signature _____	Date _____	

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[®] 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[®] 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 ± 0.2 units
 - Specific conductivity – within $\pm 3\%$
 - ORP – within ± 10 mV
 - Temperature – within ± 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 as well as groundwater sampling directly from a test pit and establishes the method for sampling groundwater 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 groundwater. 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 or test pit sampling tasks. Conduct preliminary area monitoring of sampling wells or test pits 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 groundwater 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 Groundwater 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.

- Use caution when working around test pits and refer to the HASP regarding precautionary measure when working around excavations.

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 groundwater sampling activities comply with this procedure. The **CTO Manager** is responsible for ensuring that all field sampling personnel involved in groundwater 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 volatile organic compound (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 groundwater sampling. Review historic groundwater analytical data including, but not limited to, well or test pit 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 groundwater 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 groundwater 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 or an evaluation of the test pit to be sampled;
- 2) Decontamination of equipment;
- 3) Measurement of well depth to groundwater or depth to groundwater in the test pit;
- 4) Assessment of the presence or absence of an immiscible phase;
- 5) Assessment of purge parameter stabilization (for monitoring well sampling only);
- 6) Purging of static water within the well and well bore (for monitoring well sampling only); 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 or Test Pit Security and Condition

At each monitoring well or test pit location, observe the conditions of the well or test pit 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 or test pit.

8.2.2 Decontamination of Equipment

Where possible, dedicated supplies should be used at each well or test pit 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 or test pit 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 or test pit 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 or test pit. 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 or test pit. Do not place clean sampling equipment directly on the ground or other contaminated surfaces prior to insertion into the well or test pit. Dedicated sampling equipment that has been certified by the manufacturer as being decontaminated can be placed in the well or test pit 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.

When sampling directly from a test pit, measure the depth to standing water from the ground surface. Record depth to groundwater as well as from which side of the test pit the depth was measured.

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 or test pit 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.

If LNAPL is visible on the surface of groundwater in the test pit, record these observations.

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. Although purging will not be required if collecting a groundwater sample directly from a test pit, water quality information should be recorded prior to collecting a groundwater

sample. In either case, readings should be stabilized enough to accomplish the goals of the sampling plan.

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 and test pits 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 or test pit. 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 or back into the test pit. Place the pump in the middle of the saturated screened interval within the well and maintain it in that position during purging.

If sampling from a test pit, the test pit should be deep enough to allow sufficient standing water to allow for the pump to be submerged into the standing water and maintained at a depth to keep it off of the bottom of the test pit.

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 or sample a test pit 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. If sampling from a test pit, tubing should be lowered into the standing water table and maintained at a depth higher than the bottom of the test pit to avoid clogging the tubing with sediment.

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.

Bailers may be used to sample groundwater from a test pit if the depth of the water is sufficient enough to allow the bailer to collect an adequate sample.

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/test pit and always remove them from the well/test pit 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 or test pit, 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 or test pit, 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 or test pit
- Well or test pit 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
- Purging 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.

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)
Naomi Ouellette CTO Manager	Melissa Cannon Senior Reviewer	Rev 1 – SAP Specific Modification (December 2012)

Attachment 1 Groundwater Sample Collection Record



Well ID: _____

Groundwater Sample Collection Record

Client: _____ Date: _____ Time: Start _____ am/pm
 Project No: _____ Finish _____ am/pm
 Site Location: _____
 Weather Conds: _____ Collector(s): _____

1. WATER LEVEL DATA: (measured from Top of Casing)

- a. Total Well Length _____ c. Length of Water Column _____ (a-b) Casing Diameter/Material _____
 b. Water Table Depth _____ d. Calculated Well Volume (see back) _____

2. WELL PURGEABLE DATA

- a. Purge Method: _____
 b. Acceptance Criteria defined (see SAP or Work Plan)
 - Minimum Required Purge Volume (@ _____ well volumes) _____
 - Maximum Allowable Turbidity _____ NTUs
 - Stabilization of parameters _____ %
 c. Field Testing Equipment used: Make Model Serial Number

Time (min)	Removed Volume (gal)	Temp. (°C)	pH s.u.	Spec. Cond. (µS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Flow Rate (ml/min)	Drawdown (m)	Color/Odor/etc.

- d. Acceptance criteria pass/fail Yes No N/A (continued on back)
 Has required volume been removed
 Has required turbidity been reached
 Have parameters stabilized
 If no or N/A - Explain below.

3. SAMPLE COLLECTION: Method: _____

Sample ID	Container Type	No. of Containers	Preservation	Analysis Req.	Time

Comments _____

Signature _____ Date _____

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:

GW¹ Well graded (poorly sorted) gravel (>50 percent gravel, <5percent fines)

GP¹ Poorly graded (well sorted) gravel (>50percent gravel, <5percent fines)

GM¹ Silty gravel (>50 percent gravel, >15 percent silt)

GC¹ Clayey gravel (>50 percent gravel, >15 percent clay)

SW¹ Well graded (poorly sorted) sand (>50 percent sand, <5 percent fines)

SP¹ Poorly graded (well sorted) sand (>50 percent sand, <5 percent fines)

¹ 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 ¹	Silty sand (>50 percent sand, >15 percent silt)
SC ¹	Clayey sand (>50 percent sand, >15 percent clay)
ML ²	Inorganic, low plasticity silt (slow to rapid dilatancy, low toughness, and plasticity)
CL ²	Inorganic, low plasticity (lean) clay (no or slow dilatancy, medium toughness and plasticity)
MH ²	Inorganic elastic silt (no to slow dilatancy, low to medium toughness and plasticity)
CH ²	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:

² 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			
COARSE GRAINED SOILS More Than Half of Material is Larger Than No. 200 Sieve Size	GRAVELS More Than Half of Coarse Fraction is Smaller Than No. 4 Sieve	CLEAN GRAVELS (Less than 6% Fines)		GW	Well graded gravels, gravel-sand mixtures, little or no fines		
		GRAVELS With Fines		GP	Poorly graded gravels, gravel-sand mixtures, little or no fines		
				GM	Silty gravels, gravel-sand-silt mixtures, non-plastic fines		
		SANDS More Than Half of Coarse Fraction is Smaller Than No. 4 Sieve	CLEAN SANDS (Less than 6% Fines)		SW	Well graded sands, gravelly sands, little or no fines	
				SP	Poorly graded sands, gravelly sands, little or no fines		
	SANDS With Fines			SM	Silty sands, sand-silt mixtures, non-plastic fines		
				SC	Clayey sands, sand-clay mixtures, plastic fines		
	FINE GRAINED SOILS More Than Half of Material is Smaller Than No. 200 Sieve Size	SILTS AND CLAYS Liquid Limit is Less Than 50%		ML	Inorganic silts, rock flour, fine sandy silts or clays, and clayey silts with non- or slightly-plastic fines		
			CL	Inorganic clays of low to medium plasticity, gravelly clays, silty clays, sandy clays, lean clays			
			OL	Organic silts and organic silty clays of low plasticity			
SILTS AND CLAYS Liquid Limit is Greater Than 50%			MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts, clayey silt			
			CH	inorganic clays of high plasticity, fat clays			
			OH	Organic clays of medium to high plasticity, organic silts			
HIGHLY ORGANIC SOILS			PT	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)

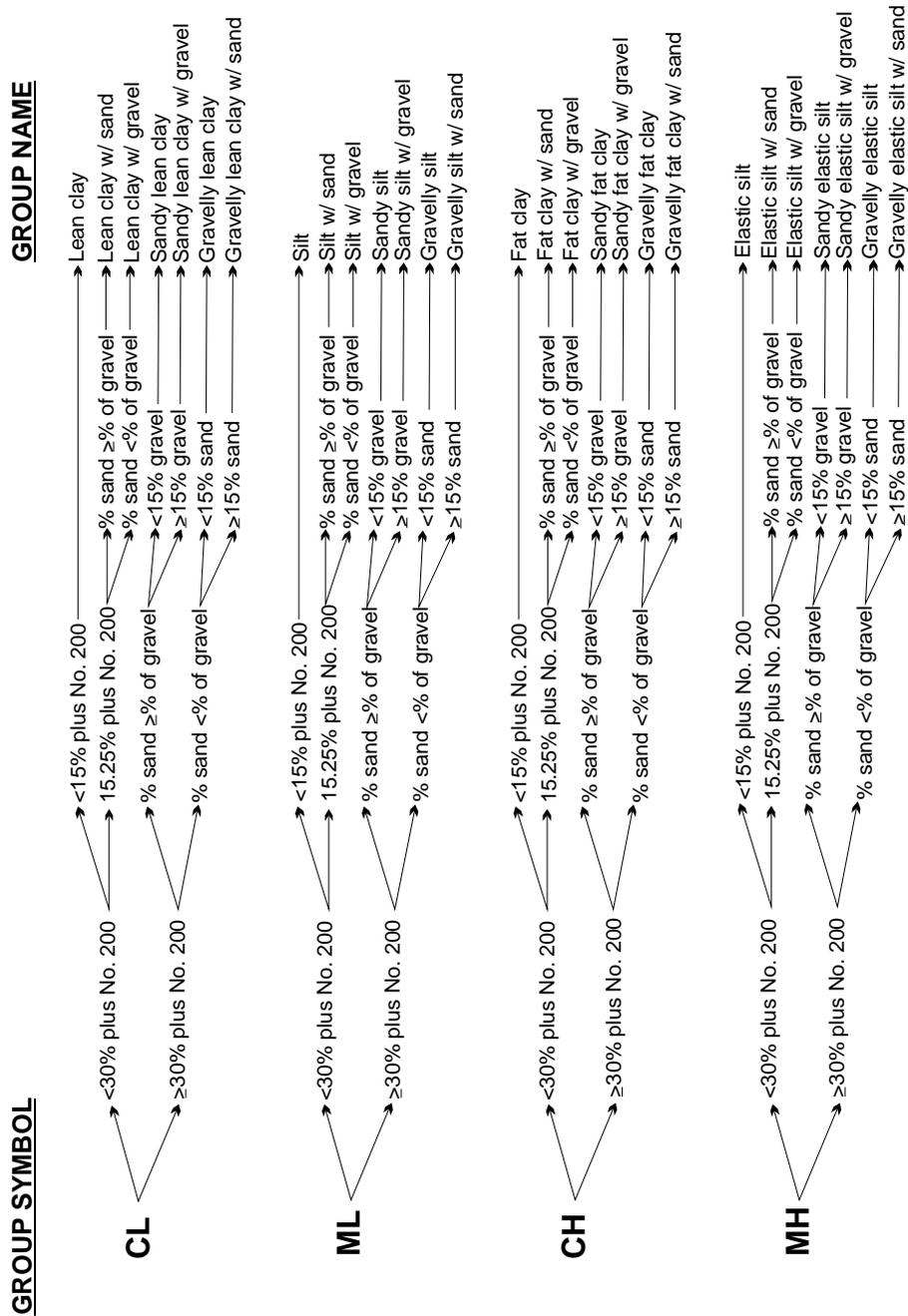


Figure 8-2: Flow Chart for Fine Grain Soil Classification

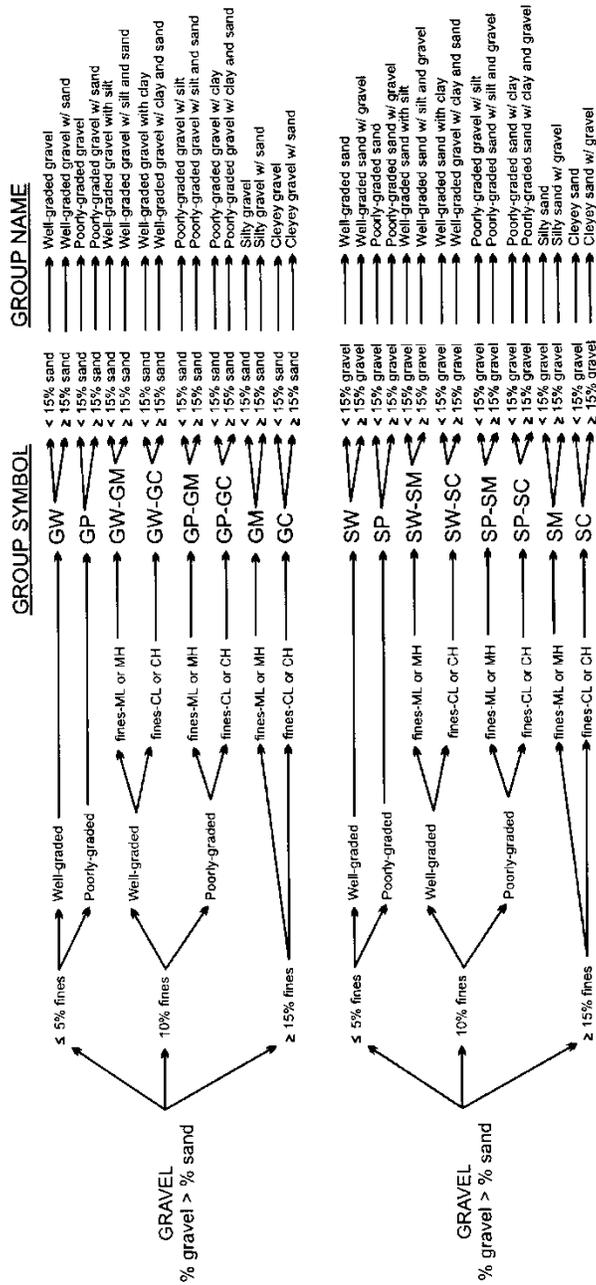


Figure 8-3: Flow Chart for Soil with Gravel

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

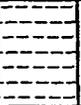
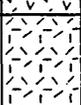
DEFINITION OF TERMS					
PRIMARY DIVISIONS		SYMBOLS		SECONDARY DIVISIONS	
SEDIMENTARY ROCKS	Clastic Sediments	CONGLOMERATE		CG	Coarse-grained Clastic Sedimentary Rock types including: Conglomerates and Breccias
		SANDSTONE		SS	Clastic Sedimentary Rock types including: Sandstone, Arkose and Greywacke
		SHALE		SH	Fine-grained Clastic Sedimentary Rock types including: Shale, Siltstone, Mudstone and Claystone
	Chemical Precipitates	CARBONATES		LS	Chemical Precipitates including: Limestone, Crystalline Limestone, Fossiliferous Limestone Micrite and Dolomite
		EVAPORITES		EV	Evaporites including: Anhydrite, Gypsum, Halite, Travertine and Caliche
IGNEOUS ROCKS	EXTRUSIVE (Volcanic)		IE	Volcanic Rock types including: Basalt, Andesite, Rhyolite, Volcanic Tuff, and Volcanic Breccia	
	INTRUSIVE (Plutonic)		II	Plutonic Rock types including: Granite, Diorite and Gabbro	
METAMORPHIC ROCKS	FOLIATED		MF	Foliated Rock types including: Slate, Phyllite, Schist and Gneiss	
	NON-FOLIATED		MN	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

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, SEDS, 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)

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**

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

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 ± 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) Standard: ± 0.2 standard units				DO (mg/L) Standard: ± 0.3 mg/L of theoretical*			
Initial Calibration		Initial Calibration Verification		IC (Temp:)		ICV (Temp:)	
Hach SL	Reading	Pine SL	Reading	Saturation (%)	Reading (%)	Theoretical (mg/L)	Reading (mg/L)
pH7				100			
pH4							
Continuing Calibration Verification				CCV (Temp:)			
Hach SL	Reading	Deviation	Acceptable Variance (Y/N)	Saturation (%)	Reading (%)	Deviation	Acceptable Variance (Y/N)
pH7				100			
pH4				Theoretical (mg/L)	Reading (mg/L)	Deviation	Acceptable Variance (Y/N)
ORP (mV) Standard: NA				Turbidity (ntu) Standard: ±10% of Standard			
IC (Zobell SL:)		ICV (Pine SL:)		Initial Calibration			
TCS (Std/Temp)	Reading	TCS (Std/Temp)	Reading	Standard	Reading		
CCV (Zobell SL:)				Continuing Calibration Verification			
TCS (Std/Temp)	Reading	Deviation	Acceptable Variance (Y/N)	Standard	Reading	Deviation	Acceptable Variance (Y/N)
Conductivity (ms ^c /cm) Standard: ± 5% of standard value				Comments:			
IC (YSI SL:)		ICV (Pine SL:)					
Standard	Reading	Standard	Reading				
CCV (YSI SL:)							
Standard	Reading	Deviation	Acceptable Variance (Y/N)				

Notes:

SL	solution lot	su	standard units	ntu	Nephelometric Turbidity Units
TCS	temperature corrected standard	mV	millivolts	°C	degrees Celsius
Std	standard	%	percent	ms ^c /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

Solubility of Oxygen in Water at Atmospheric Pressure			
Temperature	Oxygen Solubility	Temperature	Oxygen Solubility
°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

			<input type="checkbox"/> Bailer	<input type="checkbox"/> Pump	Description:
Sample ID	Date (m/d/y)	Time (hh:mm)	Bottles (total to lab)	Filtered (0.45 µm)	Remarks

Purging/Sampling Device Decon Process:

COMMENTS:

Operation and Calibration of a PetroFLAG Screening Kit

Procedure 3-34

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 PetroFLAG Hydrocarbon Screening Kit (PetroFLAG). The PetroFLAG hydrocarbon analysis system is a broad spectrum field analytical tool suitable for any type of hydrocarbon contamination regardless of the source or state of degradation. The PetroFLAG unit allows the user to select, in the field, the response factor that is appropriate for the suspected contaminant. Using the selected response factor, the analyzer compensates for the relative response of each analyte and displays the correct concentration in parts-per-million (ppm or $\mu\text{g/g}$).
- 1.1.2 Personnel responsible for using the PetroFLAG kit should first read and thoroughly familiarize themselves with the instrument manual.

1.2 Principle of Operation

- 1.2.1 PetroFLAG relies on a unique system of extraction solvents, analytical reagents and a hand-held, battery-powered analyzer to read contamination levels directly in ppm.
- 1.2.2 The test is performed using three steps: extraction, filtration and analysis. In the first step a proprietary solvent system that does not contain chlorofluorocarbons effectively extracts hydrocarbons from a variety of soils ranging from coarse sand to marine sediment and clay. Moisture content has no effect on extraction efficiency. The second step filters out all suspended materials from the extract so that they do not interfere with the test results. Finally, a developing solution is added and the soil extract starts to react and develops a response in proportion to the amount of hydrocarbon contained in the soil sample. Within ten minutes the developing solution equilibrates and a reading can be obtained using the analyzer.
- 1.2.3 If the type of hydrocarbon is known, then the specific response factor can be selected from the on-board menu to calibrate for the analyte. If the contaminant is unknown a general hydrocarbon screen can be performed by selecting a conservative response factor and using the "screen" mode. This will provide a conservative, general screening result that lets the user know if contamination is present and if so, at what relative concentration. If a mix of hydrocarbon contaminants is suspected, the most conservative response factor should be selected.

1.3 Specifications

- 1.3.1 Refer to the manufacturer's instructions for the technical specifications of the instrument being used.

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) site-specific workplan or Sampling and Analysis Plan (SAP) (hereafter referred to as the project plan) and/or direction from the **Site Safety Officer (SSO)**.
- 2.1.1 When opening the break-top ampules DO NOT remove the plastic sleeve from the top. It is there for your protection. Removing it may result in personal injury.

- 2.1.2 The Extraction Solvent and Calibration Standards contain methanol and are Flammable and Poisonous. Read the Material Safety Data Sheet before performing test.
- 2.1.3 Wear rubber gloves and safety glasses while performing tests.
- 2.1.4 Dispose of all used reagents and soil properly.

3.0 Terms and Definitions

None.

4.0 Interferences

- 4.1 Since the PetroFLAG system responds to the full range of hydrocarbons it will also detect some naturally occurring hydrocarbon-like compounds. Therefore, in situations where high organic content is suspected, background levels outside the spill site should be determined. Any organic matter should be removed from soil samples prior to screening and care should be taken to not collect samples in the vicinity of tree roots or beneath plants that produce natural oils.
- 4.2 The PetroFLAG unit should be calibrated for temperature prior to use; however, in the event that ambient temperature fluctuates greater than 10 degrees Celcius ($^{\circ}$ C) over the course of the day, an error may occur. Refer to the PetroFLAG instrument manual for instructions on how to properly calibrate the unit by storing two temperature calibration equations.
- 4.3 Accurate results can be difficult to obtain when 10 gram soil samples with high contaminant concentrations are used since they may cause a over-range condition on the PetroFLAG analyzer. To quantify these high contaminant samples, extract fresh soil samples of 1 gram size and reanalyze. Then multiply the result by 10 to obtain the concentration in the sample.
- 4.4 The presence of water in a soil sample being screened may result in a "dilution effect" on the resulting reading. A smaller sample size can be used to lessen this effect or refer to the manufacturers' instructions for conversion factors when water is present in a soil sample.
- 4.5 The PetroFLAG development chemistry will fade over time and are only good for a single use. Readings should be collected for a prepared sample immediately after the 10 minute preparation time is up and samples should not be re-screened.

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

- PetroFLAG Screening Kit (includes digital analyser, portable electronic balance, digital countdown timer, 2 calibration standards, reagents for 10 tests, and carrying case)
- Additional Soil Reagent Test Kits (each kit contains ten sample tests, one calibration standard and one blank);
- Extra 9V battery;
- PPE;
- Manufacturer's instructions; and
- Field data sheets or logbook/pen.

7.0 Procedure

7.1 Preliminary Steps

7.1.1 Preliminary steps (battery check, calibration, maintenance) should be conducted in a controlled or non-hazardous environment.

7.2 Calibration

7.2.1 The PetroFLAG meter should be recalibrated with each batch of 10 samples or, at least, daily. Each ten-pack of reagents is equipped with an extraction solvent ampule as a blank and the calibration standard.

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, and the date and the time in the field records.

7.2.3 If the calibration cannot be achieved refer to the instrument manual for trouble shooting tips.

7.3 Operation

7.3.1 Label soil extraction tubes and developer vials with soil sample ID.

7.3.2 Weigh 10 grams of soil per sample into each of the labelled soil extraction sample tubes. Up to 10 soil samples can be processed with each test.

7.3.3 Add one ampule of extraction solvent to the first soil extraction sample tube and replace cap. Start 5 minute timer and shake tube for 15 seconds. Repeat for each sample tube, intermittently shaking all tubes for the first 4 minutes. Allow all tubes to stand for remaining 1 minute.

7.3.4 Check that the filter disk is tightly screwed onto the dedicated syringe for each sample. Decant liquid from the first soil extraction sample tube into the syringe. Transfer liquid, drop-wise, from the syringe into the developer solution in the correspondingly labelled developer vial. Replace cap and shake liquid for 10 seconds and start 10 minute timer. Repeat with remaining soil extraction sample tubes.

7.3.5 Read the samples as close to the 10 minute time period as possible. Do not re-read samples. Do not let samples stand for longer than 20 minutes before reading.

7.3.6 Read samples by wiping vials clean, placing into meter and turning meter on. Record result. Read vials in the same order as they were prepared.

7.4 Routine Maintenance

7.4.1 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 Check ambient temperature before preparing each batch of soil. If temperature has changed greater than 10 ° C, recalibrate ambient temperature to avoid error message.
- 7.5.2 Do not store the PetroFLAG unit in direct sunlight when not in use.
- 7.5.3 Avoid sampling organic matter and avoid collecting soil samples from near tree roots and oil emitting plants.
- 7.5.4 Total time to analyze 10-15 samples is approximately 20-25 minutes.

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 the project plan.
- 8.2 Calibration of the PetroFLAG unit will be conducted with every batch of 10 samples, or at least daily and documented in the field records.
- 8.3 A preset number of confirmatory samples (both high and low contamination) should be sent to a qualified lab for verification as to the type of hydrocarbon contamination present and to check the response factor being used. When PetroFLAG meter results are determined to be either high or low when correlated to laboratory data, then a new response factor should be calculated and used. If the PetroFLAG results are not well correlated with the lab, then the field techniques should be examined to determine possible sources of error. A lack of correlation may be the result of inhomogeneous samples or may be due to splitting technique, etc.

9.0 Records, Data Analysis, Calculations

Screening with the PetroFLAG unit 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 check at beginning and end of day (meter readings before adjustment) and periodically thereafter;
- Response Factor setting;
- Meter readings (monitoring data obtained);
- Instances of erratic or questionable meter readings and corrective actions taken; and
- Instrument checks and response verifications as described in the instrument manual.

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.

Dexsil PetroFLAG Instrument Manual

Author	Reviewer	Revisions (Technical or Editorial)
Naomi Ouellette CTO Manager	Melissa J. Cannon Senior Reviewer	Rev 0 – Initial Issue (December 2012)

Appendix B
Laboratory Certifications



CERTIFICATE OF ACCREDITATION

ANSI-ASQ National Accreditation Board/AClass
500 Montgomery Street, Suite 625, Alexandria, VA 22314, 877-344-3044

This is to certify that

Gulf Coast Analytical Laboratories, Inc.
7979 GSRI Avenue
Baton Rouge, LA 70820

has been assessed by AClass
and meets the requirements of

ISO/IEC 17025:2005 and DoD-ELAP

while demonstrating technical competence in the field(s) of

TESTING

Refer to the accompanying Scope(s) of Accreditation for information regarding the types of tests to which this accreditation applies.

ADE-1482

Certificate Number

AClass Approval



Certificate Valid: 08/15/2012-09/09/2014
Version No. 003 Issued: 08/29/2012



This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated January 2009).



ANSI-ASQ National Accreditation Board

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005 & DoD-ELAP

Gulf Coast Analytical Laboratories, Inc.

7979 GSRI Avenue, Baton Rouge, LA 70820
 Karen S. Varnado Phone: 225-769-4900

TESTING

Valid to: September 9, 2014

Certificate Number: ADE- 1482

I. Environmental

MATRIX	SPECIFIC TEST or GROUP OF ANALYTES**	SPECIFICATION OR STANDARD METHOD (all EPA unless specified)	* KEY EQUIPMENT OR TECHNOLOGY USED
Water	Flashpoint / Ignitability	1010A	Automated FP Analyzer
Water	Alkalinity	SM 2320B / 310.1	Autotitrator
Water	Acidity	SM 2310B	Autotitrator
Water / Solid	Ammonia	SM 4500 NH3 B & E, 18th ed. SM 4500 NH3 B & C, 20 th ed.	Autotitrator
Water	Mercury	7470A	CVAA
Solid	Mercury	7471B	CVAA
Water	Mercury	245.1 / 245.2	CVAA
Water / Solid	Cyanide	9012B	FIA
Water / Solid	Total Phenols	420.4 / 9066	FIA
Solid	Chloride	9251	FIA
Water / Solid	Chloride	9251 / 325.2 / SM 4500 Cl E	FIA
Water / Solid	Nitrate/Nitrite/N+N	353.2	FIA
Water / Solid	Total Phosphorous	365.1	FIA
Water / Solid	Reactive Cyanide	SW846 Sec 7.3	FIA
Water / Solid	Pesticides	8081A	GC-ECD
Water / Solid	PCB's	8082A	GC-ECD
Water / Solid	Herbicides	8151A	GC-ECD



MATRIX	SPECIFIC TEST or GROUP OF ANALYTES**	SPECIFICATION OR STANDARD METHOD (all EPA unless specified)	* KEY EQUIPMENT OR TECHNOLOGY USED
Water	EDB / DBCP	8011	GC-ECD
Water / Solid	DRO / ORO	8015B	GC-FID
Water / Solid	GRO	8015B	GC-FID
Water / Solid	TPH	TX 1005 / TX 1006	GC-FID
Water / Solid	TPH	Florida PRO	GC-FID
Water / Solid	Aromatic Volatile Organics	8021B	GC-FID/PID
Water	Dissolved Gases	RSK-175	GC-FID/TCD
Water / Solid	VOCs	8260B	GC-MS
Water / Solid	SVOCs	8270C / 8270D / SIM	GC-MS
Water	VOCs	624	GC-MS
Water	SVOCs	625	GC-MS
Water / Solid	OP Pesticides	8141A	GC-NPD
Water	TSS	SM 2540D / 160.2	Gravimetric
Water	TDS	SM 2540C / 160.1	Gravimetric
Water	TS	SM 2540B / 160.3	Gravimetric
Solid	TS	SM 2540B	Gravimetric
Water / Solid	Explosives	8330A	HPLC
Water / Solid	PAH's	8310	HPLC
Water	Anions	300.0	IC
Water / Solid	Anions	9056A	IC
Water	Perchlorate	314.0	IC
Water / Solid	ICP Metals	6010B / 6010C	ICP
Water	ICP Metals	200.7	ICP
Water	Volatile Fatty Acids	GCAL SOP WL-070	Ion Chromatography
Water / Solid	Ammonia	SM 4500 NH3 B & F 18 th ed	Ion Selective Electrode



MATRIX	SPECIFIC TEST or GROUP OF ANALYTES	SPECIFICATION OR STANDARD METHOD (all EPA unless specified)	* KEY EQUIPMENT OR TECHNOLOGY USED
Water	Solid Phase Extraction	3535A	N/A
Water	Separatory Funnel Extraction	3510C	N/A
Water	Metals Digestion ICP	3010A	N/A
Solid	Ultrasonic Extraction for SVOA Analysis	3550C	N/A
Solid	Soxhlet Extraction for SVOA Analysis	3540C	N/A
Solid	Metals Digestion ICP	3050B	N/A
Water / Solid	TCLP	1311	N/A
Solid	Paint Filter Test	9095B	N/A
Water	pH	SM 4500 H+B / 9040C	pH Meter
Solid	pH	9045D	pH Meter
Water	VOC's	5030B	Purge and Trap
Solid	VOC's	5035	Purge and Trap
Water	Oil & Grease	1664A	SPE/Gravimetric
Water	Hexavalent Chromium	7196A	Spectrophotometer
Water	Sulfide	SM 4500 S2 D / 376.2	Spectrophotometer
Water	COD	HACH 8000	Spectrophotometer
Water / Solid	Sulfate	9038 / 375.4	Spectrophotometer
Water	Ortho Phosphate	SM 4500 P E	Spectrophotometer
Water	Silica	SM 4500 Si D	Spectrophotometer
Water/Solid	TKN	SM4500 Norg C SM4500 NH3 B SM4500NH3 E	Spectrophotometer
Water	Sulfide	SM 4500 S2 E / 376.1	Titration
Water / Solid	Reactive Sulfide	SW846 Sec 7.3	Titration
Solid	TOC	Lloyd Kahn 9060A	TOC Analyzer
Water	TOC	SM 5310B / 415.1 / 9060A	TOC Analyzer



MATRIX	SPECIFIC TEST or GROUP OF ANALYTES	SPECIFICATION OR STANDARD METHOD (all EPA unless specified)	* KEY EQUIPMENT OR TECHNOLOGY USED
Water	TOX	9020B	TOX Analyzer
Water	Turbidity	SM2130B	Turbidimeter
Solid	Ignitability	1030	N/A
Water	Massachusetts EPH	Massachusetts EPH	GC-FID
Solid	Massachusetts EPH	Massachusetts EPH	GC-FID
Water	Massachusetts VPH	Massachusetts VPH	GC-FID/PID
Solid	Massachusetts VPH	Massachusetts VPH	GC-FID/PID
Water/Solid	ICP-MS Metals	6020A/200.8	ICP-MS
Water	ICP-MS Metals	200.8	ICP-MS

Notes:

1. * = As Applicable
2. **=Refer to accredited analyte listing for exact analyte(s) in which the lab is accredited.
3. This scope is part of and must be included with the Certificate of Accreditation No. ADE- 1482



Vice President



Gulf Coast Analytical Certifications
DoD ELAP Certification

Accredited Analytes/Methods (by matrix)

Gulf Coast Analytical Laboratories, Inc.

Baton Rouge, LA

NELAC Code	Analyte	Matrix											
		Aqueous						Solid					
		6010B	6010C	6020A	200.7	200.8		6010B	6010C	6020A			
1000	Aluminum	6010B	6010C	6020A	200.7	200.8							
1005	Antimony	6010B	6010C	6020A	200.7	200.8	3010 A	1311	6010B	6010C	6020A	1311	6010C
1010	Arsenic	6010B	6010C	6020A	200.7	200.8	3010 A	1311	6010B	6010C	6020A	1311	6010C
1015	Barium	6010B	6010C	6020A	200.7	200.8	3010 A	1311	6010B	6010C	6020A	1311	6010C
1020	Beryllium	6010B	6010C	6020A	200.7	200.8	3010 A	1311	6010B	6010C	6020A	1311	6010C
1025	Boron	6010B	6010C		200.7				6010B	6010C			
1030	Cadmium	6010B	6010C	6020A	200.7	200.8	3010 A	1311	6010B	6010C	6020A	1311	6010C
1035	Calcium	6010B	6010C	6020A	200.7	200.8			6010B	6010C	6020A		
1040	Chromium	6010B	6010C	6020A	200.7	200.8	3010 A	1311	6010B	6010C	6020A	1311	6010C
1045	Chromium VI	7196A											
1050	Cobalt	6010B	6010C	6020A	200.7	200.8			6010B	6010C	6020A		
1055	Copper	6010B	6010C	6020A	200.7	200.8			6010B	6010C	6020A		
1070	Iron	6010B	6010C	6020A	200.7	200.8			6010B	6010C	6020A		
1075	Lead	6010B	6010C	6020A	200.7	200.8	3010 A	1311	6010B	6010C	6020A	1311	6010C
1085	Magnesium	6010B	6010C	6020A	200.7	200.8			6010B	6010C	6020A		
1090	Manganese	6010B	6010C	6020A	200.7	200.8			6010B	6010C	6020A		
1095	Mercury	7470A	245.2	245.1			3010 A	1311	7471B			1311	6010C
1100	Molybdenum	6010B	6010C	6020A	200.7	200.8			6010B	6010C	6020A		
1105	Nickel	6010B	6010C	6020A	200.7	200.8			6010B	6010C	6020A		
1125	Potassium	6010B	6010C	6020A	200.7	200.8			6010B	6010C	6020A		
1140	Selenium	6010B	6010C	6020A	200.7	200.8	3010 A	1311	6010B	6010C	6020A	1311	6010C
1150	Silver	6010B	6010C	6020A	200.7	200.8	3010 A	1311	6010B	6010C	6020A	1311	6010C
1155	Sodium	6010B	6010C	6020A	200.7	200.8			6010B	6010C	6020A		
1160	Strontium	6010B	6010C	6020A	200.7	200.8			6010B	6010C	6020A		
1165	Thallium	6010B	6010C	6020A	200.7	200.8	3010 A	1311	6010B	6010C	6020A	1311	6010C
1175	Tin	6010B	6010C	6020A	200.7	200.8			6010B	6010C	6020A		
1180	Titanium	6010B	6010C	6020A	200.7	200.8			6010B	6010C	6020A		
1185	Vanadium	6010B	6010C	6020A	200.7	200.8			6010B	6010C	6020A		
1190	Zinc	6010B	6010C	6020A	200.7	200.8	3010 A	1311	6010B	6010C	6020A	1311	6010C
1192	Zirconium			6020A		200.8					6020A		
1500	Acidity(as CaCO3)	SM 2310B											
1505	Total Alkalinity(as CaCO3)	SM 2320B	EPA 310.1										
1515	Ammonia as N	SM4500 NH3 B & E	SM4500 NH3 B & F	SM4500 NH3 B & C					SM 4500 NH3 BE	SM 4500 NH3 BF	SM4500 NH3 B & C		
1540	Bromide	9056A	EPA 300.0						9056A				
1565	COD	HACH 8000											
1575	Chloride	9056A	EPA 300.0	9251	EPA 325.2			SM 4500 Cl E	9056A	9251			
1625	Corrosivity (pH)	9040C	SM 4500 H+B						9045D				
1645	Total Cyanide	9012B							9012B				
1730	Fluoride	9056A	EPA 300.0						9056A				
1755	Total Hardness (as CaCO3)	6020A	200.8										
1780	Ignitability	1010A							1010A				
1810	Nitrate as N	9056A	EPA 300.0	EPA 353.2					9056A	EPA 353.2			
1820	Nitrate and Nitrite as N	9056A	EPA 300.0	EPA 353.2					9056A	EPA 353.2			
1840	Nitrite as N	9056A	EPA 300.0	EPA 353.2					9056A	EPA 353.2			
1860	Oil & Grease	EPA 1664A											
1870	Orthophosphate as P	SM 4500 PE											
1895	Perchlorate	EPA 314.0							EPA 314.0				
1900	pH	9040C	SM 4500 H+B						9040C				
1905	Total Phenolics (4AAP)	9066	EPA 420.4						9066	EPA 420.4			
1910	Total Phosphorous	EPA 365.1							EPA 365.1				
1925	Reactive sulfide	SW846 Sec 7.3							SW846 Sec 7.3				
-	Reactive Cyanide	SW846 Sec 7.3							SW846 Sec 7.3				
-	Percent Moisture								SM 2540G				
1950	Total Solids	SM 2540B	EPA 160.3						SM2540 G				
1955	Total Dissolved Solids at 180° (TFR)	SM 2540C	EPA 160.1										
1960	Non-Filterable Residue (TSS)	SM 2540D	EPA 160.2										
2000	Sulfate	9056A	EPA 300.0	9038	EPA 375.4				9056A	9038	9038	EPA 375.4	

Accredited Analytes/Methods (by matrix)

Gulf Coast Analytical Laboratories, Inc.

Baton Rouge, LA

NELAC Code	Analyte	Matrix																
		Aqueous						Solid										
		SM 4500 S2 D	EPA 376.2	SM 4500 S2 E	EPA 376.1													
2005	Sulfide	SM 4500 S2 D	EPA 376.2	SM 4500 S2 E	EPA 376.1													
2040	TOC	SM 5310B	EPA 415.1	9060A								EPA 9060A						
2045	Total Organic Halides	9020B										9020B						
2055	Turbidity	SM 2130 B																
4315	Acetone	8260B	624									8260B						
4320	Acetonitrile	8260B	624									8260B						
4325	Acrolein	8260B	624									8260B						
4340	Acrylonitrile	8260B	624									8260B						
4375	Benzene	8260B	624	1311								8260B	1311					
4385	Bromobenzene	8260 B										8260 B						
4390	Bromochloromethane	8260B	624									8260B						
4395	Bromodichloromethane	8260B	624									8260B						
4400	Bromoform	8260B	624									8260B						
4410	2-Butanone (MEK)	8260B	624	1311								8260B	1311					
4435	n-Butylbenzene	8260B	624									8260B						
4440	sec-Butylbenzene	8260B	624									8260B						
4445	tert-Butylbenzene	8260B	624									8260B						
4450	Carbon disulfide	8260B	624									8260B						
4455	Carbon tetrachloride	8260B	624	1311								8260B	1311					
4475	Chlorobenzene	8260B	624	1311								8260B	1311					
4485	Chloroethane	8260B	624									8260B						
4500	2-Chloroethylvinylether	8260B	624									8260B						
4505	Chloroform	8260B	624	1311								8260B	1311					
4535	2-Chlorotoluene	8260B	624									8260B						
4540	4-Chlorotoluene	8260B	624									8260B						
4570	1,2-Dibromo-3-chloropropane (DBCP)	8260B	624	8011								8260B						
4575	Dibromochloromethane	8260B	624									8260B						
4585	1,2-Dibromoethane (EDB)	8260B	624	8011								8260B						
4595	Dibromomethane	8260B	624									8260B						
4610	1,2 Dichlorobenzene	8260B	624			8270C	8270D	625				8260B		8270C	8270D			
4615	1,3 Dichlorobenzene	8260B	624			8270C	8270D	625				8260B		8270C	8270D			
4620	1,4 Dichlorobenzene	8260B	624	1311		8270C	8270D	625				8260B	1311	8270C	8270D			
4625	Dichlorodifluoromethane	8260B	624									8260B						
4630	1,1-Dichloroethane	8260B	624									8260B						
4635	1,2 Dichloroethane	8260B	624	1311								8260B	1311					
4640	1,1-Dichloroethene	8260B	624	1311								8260B	1311					
4645	cis-1,2-Dichloroethene	8260B	624									8260B						
4655	1,2-Dichloropropane	8260B	624									8260B						
4660	1,3-Dichloropropane	8260B	624									8260B						
4665	2,2-Dichloropropane	8260B	624									8260B						
4670	1,1-Dichloropropene	8260B	624									8260B						
4680	cis-1,3-Dichloropropylene	8260B	624									8260B						
4685	trans-1,3-Dichloropropene	8260B	624									8260B						
4700	trans-1,2-Dichloroethene	8260B	624									8260B						
4740	p-Dioxane					8270C	8270D	625										
4765	Ethylbenzene	8260B	624									8260B						
4835	Hexachlorobutadiene	8260B	624	1311		8270C	8270D	625				8260B	1311	8270C	8270D			
4840	Hexachloroethane			1311		8270C	8270D	625					1311	8270C	8270D			
4860	2-Hexanone	8260B	624									8260B						
4900	Isopropylbenzene	8260B	624									8260B						
4910	p-Isopropyltoluene	8260B	624									8260B						
4950	Bromomethane	8260B	624									8260B						
4960	Chloromethane	8260B	624									8260B						
	Methyl Acetate	8260B										8260B						
4975	Methylene Chloride	8260B	624									8260B						
	Methylcyclohexane	8260B										8260B						
4995	4-Methyl-2-pentanone (MIBK)	8260B	624									8260B						

Accredited Analytes/Methods (by matrix)

Gulf Coast Analytical Laboratories, Inc.

Baton Rouge, LA

NELAC Code	Analyte	Matrix											
		Aqueous						Solid					
		8260B	624	8310	8270 C	8270D	625	8260B	1311	8270C	8270D	8330A	
5000	Methyl tert-butyl ether (MTBE)	8260B	624					8260B					
5005	Naphthalene	8260B	624	8310	8270 C	8270D	625	8260B		8270C	8270D		8310
5015	Nitrobenzene	8330 A		1311	8270C	8270D	625		1311	8270C	8270D		8330A
5090	n-Propylbenzene	8260B	624					8260B					
5095	Pyridine			1311	8270C	8270D	625		1311	8270C	8270D		
5100	Styrene	8260B	624					8260B					
5105	1,1,1,2-Tetrachloroethane	8260B	624					8260B					
5110	1,1,2,2-Tetrachloroethane	8260B	624					8260B					
	1,2,4,5-Tetrachlorobenzene	8260B						8260B					
5115	Tetrachloroethene	8260B	624	1311				8260B	1311				
5140	Toluene	8260B	624					8260B					
5145	o-Toluidine				8270C	8270D	625						
	1,1,2-trichloro-1,2,2-trifluoroethane	8260B						8260B					
5150	1,2,3-Trichlorobenzene	8260B	624					8260B					
5155	1,2,4-Trichlorobenzene	8260B	624		8270C	8270D	625	8260B	8270 C	8270 D			
5160	1,1,1-Trichloroethane	8260B	624					8260B					
5165	1,1,2-Trichloroethane	8260B	624					8260B					
5170	Trichloroethene	8260B	624	1311				8260B	1311				
5175	Trichlorofluoromethane	8260B	624					8260B					
5180	1,2,3-Trichloropropane	8260B	624					8260B					
5210	1,2,4-Trimethylbenzene	8260B	624					8260B					
5215	1,3,5-Trimethylbenzene	8260B	624					8260B					
5225	Vinyl acetate	8260B	624					8260B					
5235	Vinyl chloride	8260B	624	1311				8260B	1311				
5240	m+p-Xylene	8260B	624					8260B					
5250	o-Xylene	8260B	624					8260B					
5260	Xylenes, total	8260B	624					8260B					
5500	Acenaphthene	8310			8270C	8270D	625			8270C	8270D		8310
5505	Acenaphthylene	8310			8270C	8270D	625			8270C	8270D		8310
	Acetophenone				8270C					8270C			
5545	Aniline				8270C	8270D	625			8270C	8270D		
5555	Anthracene	8310			8270C	8270D	625			8270C	8270D		8310
	Benzaldehyde				8270C					8270C			
5575	Benzo(a)anthracene	8310			8270C	8270D	625			8270C	8270D		8310
5580	Benzo(a)pyrene	8310			8270C	8270D	625			8270C	8270D		8310
5585	Benzo(b)fluoranthene	8310			8270C	8270D	625			8270C	8270D		8310
5590	Benzo(g,h,i)perylene	8310			8270C	8270D	625			8270C	8270D		8310
5595	Benzidine				8270C	8270D	625			8270C	8270D		
5600	Benzo(k)fluoranthene	8310			8270C	8270D	625			8270C	8270D		8310
5610	Benzoic acid				8270C	8270D	625			8270C	8270D		
5630	Benzyl alcohol				8270C	8270D	625			8270C	8270D		
	Biphenyl				8270C					8270C			
5660	4-Bromophenyl-phenylether				8270C	8270D	625			8270C	8270D		
5670	Butyl benzyl phthalate				8270C	8270D	625			8270C	8270D		
5680	Carbazole				8270C	8270D	625			8270C	8270D		
5700	4-Chloro-3-methylphenol				8270C	8270D	625			8270C	8270D		
5745	4-Chloroaniline				8270C	8270D	625			8270C	8270D		
5760	bis(2-Chloroethoxy)methane				8270C	8270D	625			8270C	8270D		
5765	bis(2-Chloroethyl)ether				8270C	8270D	625			8270C	8270D		
5780	bis(2-Chloroisopropyl) ether				8270C	8270D	625			8270C	8270D		
5795	2-Chloronaphthalene				8270C	8270D	625			8270C	8270D		
5800	2-Chlorophenol				8270C	8270D	625			8270C	8270D		
5825	4-Chlorophenyl-phenylether				8270C	8270D	625			8270C	8270D		
5855	Chrysene	8310			8270C	8270D	625			8270C	8270D		8310
5895	Dibenzo(a,h)anthracene	8310			8270C	8270D	625			8270C	8270D		8310
5905	Dibenzofuran				8270C	8270D	625			8270C	8270D		
5925	Di-n-butylphthalate				8270C	8270D	625			8270C	8270D		

Accredited Analytes/Methods (by matrix)

Gulf Coast Analytical Laboratories, Inc.

Baton Rouge, LA

NELAC Code	Analyte	Matrix																	
		Aqueous						Solid											
5945	3,3'-Dichlorobenzidine					8270C	8270D			625				8270C	8270D				
6000	2,4-Dichlorophenol					8270C	8270D			625				8270C	8270D				
6005	2,6-Dichlorophenol					8270C	8270D			625				8270C	8270D				
6070	Diethyl phthalate					8270C	8270D			625				8270C	8270D				
6130	2,4-Dimethylphenol					8270C	8270D			625				8270C	8270D				
6135	Dimethyl phthalate					8270C	8270D			625				8270C	8270D				
6160	1,3-Dinitrobenzene	8330 A											8330A						
6175	2,4-Dinitrophenol					8270C	8270D			625				8270C	8270D				
6185	2,4-Dinitrotoluene	8330 A	1311			8270C	8270D			625			1311	8270C	8270D			8330A	
6190	2,6-Dinitrotoluene	8330 A				8270C	8270D			625				8270C	8270D			8330A	
6200	Di-n-octylphthalate					8270C	8270D			625				8270C	8270D				
6255	bis(2-ethylhexyl) phthalate					8270C	8270D			625				8270C	8270D				
6265	Fluoranthene	8310				8270C	8270D			625				8270C	8270D				8310
6270	Fluorene	8310				8270C	8270D			625				8270C	8270D				8310
6275	Hexachlorobenzene		1311			8270C	8270D			625			1311	8270C	8270D				
6285	Hexachlorocyclopentadiene					8270C	8270D			625				8270C	8270D				
6315	Indeno(1,2,3, cd)pyrene	8310				8270C	8270D			625				8270C	8270D				8310
6320	Isophorone					8270C	8270D			625				8270C	8270D				
6360	2-Methyl-4,6-Dinitrophenol					8270C	8270D			625				8270C	8270D				
6380	1-Methylnaphthalene					8270C	8270D			625									
6385	2-Methylnaphthalene	8310				8270C	8270D			625				8270C	8270D				8310
6400	2-Methylphenol		1311			8270C	8270D			625			1311	8270C	8270D				
6410	4-Methylphenol (and/or 3-Methylphenol)		1311			8270C	8270D			625			1311	8270C	8270D				
6415	Tetryl (Methyl-2,4,6-trinitrophenylnitramine)	8330 A											8330 A						
6460	2-Nitroaniline					8270C	8270D			625				8270C	8270D				
6465	3-Nitroaniline					8270C	8270D			625				8270C	8270D				
6470	4-Nitroaniline					8270C	8270D			625				8270C	8270D				
6490	2-Nitrophenol					8270C	8270D			625				8270C	8270D				
6500	4-Nitrophenol	8151 A				8270C	8270D			625			8151 A	8270C	8270D				
6525	N-Nitrosodiethylamine					8270C	8270D			625				8270C	8270D				
6530	N-Nitrosodimethylamine					8270C	8270D			625				8270C	8270D				
6535	N-Nitrosodiphenylamine					8270C	8270D			625				8270C	8270D				
6545	N-Nitroso-di-n-propylamine					8270C	8270D			625				8270C	8270D				
6590	Pentachlorobenzene					8270C	8270D			625				8270C	8270D				
6605	Pentachlorophenol	8151 A	1311			8270C	8270D			625			8151 A	1311	8270C	8270D			
6615	Phenanthrene	8310				8270C	8270D			625				8270C	8270D				8310
6625	Phenol					8270C	8270D			625				8270C	8270D				
6665	Pyrene	8310				8270C	8270D			625				8270C	8270D				8310
6715	1,2,4,5-Tetrachlorobenzene					8270C	8270D			625				8270C	8270D				
6735	2,3,4,6-Tetrachlorophenol					8270C	8270D			625				8270C	8270D				
6835	2,4,5-Trichlorophenol		1311			8270C	8270D			625			1311	8270C	8270D				
6840	2,4,6-Trichlorophenol		1311			8270C	8270D			625			1311	8270C	8270D				
6885	1,3,5-Trinitrobenzene	8330 A																	8330A
7025	Aldrin	8081B																8081B	
7075	Azinphos-methyl (Guthion)	8141B											8141B						
7105	delta-BHC	8081B																8081B	
7110	alpha-BHC	8081B																8081B	
7115	beta-BHC	8081B																8081B	
7120	gamma-BHC (Lindane)	8081B	1311										1311					8081B	
7240	alpha-Chlordane	8081B																8081B	
7245	gamma-Chlordane	8081B																8081B	
7250	Chlordane (total)	8081B																8081B	
7355	DDD (4,4)	8081B																8081B	
7360	DDE (4,4)	8081B																8081B	
7365	DDT (4,4)	8081B																8081B	
7410	Diazinon	8141B											8141B						
7470	Dieldrin	8081B																8081B	

Accredited Analytes/Methods (by matrix)

Gulf Coast Analytical Laboratories, Inc.

Baton Rouge, LA

NELAC Code	Analyte	Matrix											
		Aqueous						Solid					
7510	Endosulfan I	8081B										8081B	
7515	Endosulfan II	8081B										8081B	
7520	Endosulfan sulfate	8081B										8081B	
7530	Endrin aldehyde	8081B										8081B	
7535	Endrin ketone	8081B										8081B	
7540	Endrin	8081B	1311						1311			8081B	
7685	Heptachlor	8081B	1311						1311			8081B	
7690	Heptachlor Epoxide (beta)	8081B	1311						1311			8081B	
7770	Malathion	8141B							8141B				
7775	MCPA	8151A							8151A				
7780	MCPP	8151 A							8151 A				
7810	Methoxychlor	8081B	1311						1311			8081B	
7825	Parathion, methyl	8141B							8141B				
7955	Parathion, ethyl	8141B							8141B				
7985	Phorate	8141B							8141B				
8110	Ronnel	8141B							8141B				
8200	Stirophos	8141B							8141B				
8250	Toxaphene (total)	8081B										8081B	
8505	Acifluorfen	8151 A							8151 A				
8530	Bentazon	8151 A							8151 A				
8540	Chloramben	8151 A							8151 A				
8545	2,4-D	8151 A	1311						8151A	1311			
8550	Dacthal (DCPA)	8151 A							8151 A				
8555	Dalapon	8151 A							8151 A				
8560	2,4-DB	8151 A							8151A				
8595	Dicamba	8151 A							8151A				
8600	3,5-Dichlorobenzoic acid	8151 A							8151 A				
8605	2,4-DP (Dichlorprop)	8151 A							8151 A				
8620	Dinoseb (2-sec-butyl-4,6-dinitrophenol, DNBP)	8151 A							8151A				
8625	Disulfoton	8141B							8141B				
8645	Picloram	8151 A							8151 A				
8650	2,4,5-TP (Silvex)	8151 A	1311							1311		8151A	
8655	2,4,5-T	8151 A							8151A				
8880	Aroclor 1016	8082A							8082A				
8885	Aroclor 1221	8082A							8082A				
8890	Aroclor 1232	8082A							8082A				
8895	Aroclor 1242	8082A							8082A				
8900	Aroclor 1248	8082A							8082A				
8905	Aroclor 1254	8082A							8082A				
8910	Aroclor 1260	8082A							8082A				
9303	2-Amino-4,6-dinitrotoluene	8330 A											8330A
9306	4-Amino-2,6-dinitrotoluene	8330 A											8330A
9369	Diesel range organics (DRO)	8015C							8015C				
9432	RDX (Hexahydro-1,3,5-trinitro-1,3,5-triazine)	8330 A											8330A
9507	2-Nitrotoluene	8330 A											8330A
9510	3-Nitrotoluene	8330 A											8330A
9513	4-Nitrotoluene	8330 A											8330A
9522	HMX (Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine)	8330 A											8330A
9651	2,4,6-Trinitrotoluene	8330 A											8330A
	Methane	RSK-175											
	Ethane	RSK-175											
	Ethene	RSK-175											
	Carbon Dioxide	RSK-175											
	Lactic Acid	GCAL SOP WL-070											
	Formic Acid	GCAL SOP WL-070											
	Acetic Acid	GCAL SOP WL-070											
	Propionic Acid	GCAL SOP WL-070											

Accredited Analytes/Methods (by matrix)

Gulf Coast Analytical Laboratories, Inc.

Baton Rouge, LA

NELAC Code	Analyte	Matrix											
		Aqueous						Solid					
	Butyric Acid	GCAL SOP WL-070											
	1-Chlorohexane	8260B											
	1-Chlorohexane							8260B					
	1,2-Diphenylhydrazine	8270C	8270D										
	1,2-Diphenylhydrazine							8270C	8270D				
	Chlordane	8082B	1311					1311	8082B				
	Toxaphene	8082 A	1311					1311	8082 A				
	Paint Filter Test	9095B						9095B					
	Oil Range Organics	8015C						8015C					
	Petroleum Hydrocarbons	Florida PRO						Florida PRO					
	Ignitability							1030					
9408	Gasoline	8015C						8015C					
4375	Benzene	8021B						8021B					
4765	Ethyl Benzene	8021B						8021B					
5140	Toluene	8021B						8021B					
5260	Xylene	8021B						8021B					
9375	DIPE	8260B						8260B					
4770	ETBE	8260B						8260B					
5000	MTBE	8260B						8260B					
4370	TAME	8260B						8260B					
4420	tert-Butyl alcohol	8260B						8260B					
9369	Diesel	8015C						8015C					
2050	Total Petroleum Hydrocarbon	TNRCC 1005						TNRCC 1005					
	Total Petroleum Hydrocarbon	TNRCC 1006						TNRCC 1006					
	GRO-Total	TNRCC 1006						TNRCC 1006					
	DRO-Total	TNRCC 1006						TNRCC 1006					
	ORO-Total	TNRCC 1006						TNRCC 1006					
	GRO-aliphatic	TNRCC 1006						TNRCC 1006					
	DRO-aliphatic	TNRCC 1006						TNRCC 1006					
	ORO-aliphatic	TNRCC 1006						TNRCC 1006					
	GRO-aromatic	TNRCC 1006						TNRCC 1006					
	DRO-aromatic	TNRCC 1006						TNRCC 1006					
	ORO-aromatic	TNRCC 1006						TNRCC 1006					
-	C5-C8 Alliphatic Hydrocarbons	MADEP VPH						MADEP VPH					
-	C9-C12 Alliphatic Hydrocarbons	MADEP VPH						MADEP VPH					
-	C9-C10 Aromatic Hydrocarbons	MADEP VPH						MADEP VPH					
-	C9-C18 Alliphatic Hydrocarbons	MADEP EPH						MADEP EPH					
-	C19-C36 Alliphatic Hydrocarbons	MADEP EPH						MADEP EPH					
-	C11-C22 Aromatic Hydrocarbons	MADEP EPH						MADEP EPH					