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FINAL SAMPLING AND ANALYSIS PLAN SITE 32 SEWAGE TREATMENT PLANT NUMBER 2
SLUDGE DRYING BED SITE INVESTIGATION NWS YORKTOWN VA
1/1/2012
CH2M HILL

Final
Sampling and Analysis Plan
(Field Sampling Plan and
Quality Assurance Project Plan)
Site 32, Sewage Treatment Plant #2
Sludge Drying Bed Site Investigation

Naval Weapons Station Yorktown
Yorktown, Virginia



Prepared for

Department of the Navy
Naval Facilities Engineering Command
Mid-Atlantic

Contract No.
N62470-08-D-1000
CTO-WE29

January 2012

Prepared by

CH2MHILL

SAP Worksheet #1—Title and Approval Page

Final

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(Field Sampling Plan and
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Contract Task Order WE29

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**Department of the Navy
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Under the

**NAVFAC CLEAN 1000 Program
Contract N62470-08-D-1000**

Prepared by:



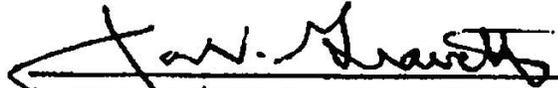
Virginia Beach, Virginia

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Approval Signatures

The following person(s) hereby state that they have reviewed and approved this document.

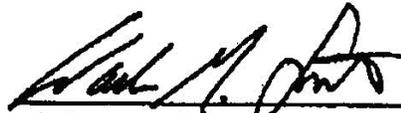
Approval Signatures:

 1/4/12

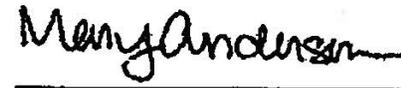
Jim Gravelle/ U.S. Navy Remedial Project Manager/ Date

 1/5/12

Moshood Oduwole/ USEPA Remedial Project Manager/
Date

 1/4/12

Wade Smith/ VDEQ Remedial Project Manager/ Date

 01/04/2012

Mary Anderson/ CH2M HILL Project Manager/ Date

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Executive Summary

This Sampling and Analysis Plan (SAP) is being submitted to provide a systematic data collection and analysis structure for the Site Investigation (SI) at Site 32 (formerly Site Screening Area [SSA] 25) at Naval Weapons Station (WPNSTA) Yorktown, Yorktown, Virginia. In accordance with the Guidance for Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP, March 2005), this United States Navy (Navy)-specific SAP includes 37 worksheets that detail various aspects of the environmental investigation process and serves as guidelines for the field work and data quality. The site-specific field standard operating procedures (SOPs) are located in [Appendix A](#) of this SAP (on compact disc [CD]).

The Naval Facilities Engineering Command (NAVFAC) Mid-Atlantic, is conducting this sampling under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). CERCLA work is being conducted with the United States Environmental Protection Agency (USEPA) Region 3 as the lead regulatory agency. The Virginia Department of Environmental Quality (VDEQ) is the State regulatory agency. Together, these three agencies form the stakeholder agencies for this project.

This document will help ensure that environmental data collected or compiled are scientifically sound, of known and documented quality, and suitable for intended uses. The laboratory information cited in this SAP is for the analytical laboratory that is currently contracted to provide analytical services for this investigation. The analytical services for this investigation will be provided by Environmental Conservation Laboratories (ENCO Labs) as the primary laboratory.

According to Site 32 history, a discharge pipe running from the sewage treatment plant (STP) at the site (STP #2) to the downgradient wetland area resulted in the release of mercury and other contaminants directly into surface water and sediment. Sediment and surface water at Site 32 have been sufficiently investigated and remediated as part of previous investigations and actions. Soil and groundwater were not investigated because the release posing concerns was believed to be directly discharged into the wetland. However, based on a review of additional site information, mercury-contaminated soil was removed at the site at one time, and no confirmation samples were collected. The purpose of the additional sampling included in this plan is to determine whether site-related contamination remains at the site in soil and/or groundwater in the vicinity of former STP #2 and, if present, whether it poses a potentially unacceptable risk. Based on the historical use of Site 32 and previous investigation results, soil will be investigated primarily for mercury, cadmium, and silver. Additionally, composite soil samples collected within the former sludge drying bed at the site will be analyzed for a broader suite of contaminants as described below. Results of the soil sampling will be reviewed to determine the analytical parameters for groundwater and will determine if CERCLA action is needed for soil and groundwater at WPNSTA Yorktown Site 32. The following is a summary of the activities that will be conducted in order to fill gaps in the current dataset and determine if additional CERCLA action is warranted:

- Co-located surface (0-6 inches below ground surface [bgs]) and subsurface (6 -24 inches bgs) soil samples will be collected in seven locations: one upgradient of the site to serve as site-specific background, one within the former footprint of the Imhoff Tank, one within the former footprint of the trickling filter, and four downgradient locations. In the location of the trickling filter samples, an additional sample will also be collected just above the water table to ensure that native material is evaluated (because this area was formerly backfilled). These samples will be analyzed for mercury, cadmium, and silver only.
- One composite surface (0-6 inches bgs) and one composite subsurface (6-24 inches bgs) soil sample will be collected from five points within the sludge drying bed. These two samples will be analyzed for target analyte list (TAL) metals, target compound list (TCL) volatile organic compounds (VOCs), TCL semivolatiles organic compounds (SVOCs), TCL pesticides, and polychlorinated biphenyls (PCBs).

- Groundwater monitoring wells will be installed at five of the soil locations in the vicinity of the former STP #2. One monitoring well will be installed in the upgradient soil sampling location, and the remaining four will be installed in the four downgradient soil sampling locations.
- Monitoring wells will be sampled and analyzed for parameters to be determined on the basis of multiple lines of evidence from the results of the soil sampling. These lines of evidence will include comparisons to human health and ecological screening criteria, site-specific and basewide background concentrations, and soil leaching criteria. However, it is noted that there is no correlation between human health (that is, Regional Screening Levels [RSLs]) or ecological screening criteria and chemical concentrations of concern in groundwater. Once data are reviewed and screened, the team will agree to analytical parameters for groundwater.
- A water level survey will be completed to better evaluate groundwater flow direction at the site.
- Validated soil and groundwater data will be compared to human health and ecological risk-based screening levels. Soil samples collected from a depth greater than 2 feet (ft) bgs (if applicable) will not be screened against ecological screening values due to the lack of a complete exposure pathway below this depth, but these data will be used for human health screening purposes. Soil samples collected from a depth greater than 12 ft bgs (if applicable) will not be screened against either human health or ecological screening values for the same reason. These data will be compared to site-specific and basewide background values and soil leaching criteria. Constituents that exceed screening values will be considered contaminants of potential concern (COPCs) for further analysis.
- Based on the nature of the screening value exceedances, a Human Health Risk Screening (HHRS) and/or Screening Ecological Risk Assessment (SERA) may be performed for COPCs in order to determine if a release posing potentially unacceptable risk to human health or the environment has occurred.
- Concentrations found to pose potentially unacceptable risks will be compared to site-specific and basewide background values. Constituents that exceed background concentrations will be considered to be potentially site-related.

Data, results, and recommendations regarding the path forward for Site 32 will be documented in an SI Report. If no unacceptable, site-related human health and ecological risks exist, no additional action will be necessary at Site 32. If unacceptable risks are identified and the nature and extent of contamination has been sufficiently defined by the proposed sample locations, a Non-Time Critical Removal Action (NTCRA) will be considered. If contamination posing potentially unacceptable risks is identified, but additional evaluation of the nature and extent is needed, a Remedial Investigation (RI) may be considered.

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Appendixes

- A Field Standard Operating Procedures
- B Navy CLEAN Data Management Plan
- C Laboratory DoD ELAP Certificate

Figures

- 1 Site 32 Location Map
- 2 Site 32 Layout Map
- 3 Site 32 Proposed Sample Locations

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Abbreviations and Acronyms

°C	degree Celsius
µg/kg	microgram per kilogram
µg/L	microgram per liter
AM	Activity Manager
amsl	above mean sea level
amu	atomic mass unit
AQM	Activity Quality Manager
ASTM	American Society for Testing and Materials
BD	bottom depth
BERA	Baseline Ecological Risk Assessment
bgs	below ground surface
BHC	benzene hexachloride
BTAG	Biological Technical Assistance Group
CA	corrective action
CAS	Chemical Abstract Analytical Services
CCC	calibration check compound
CCV	continuing calibration verification
CD	compact disc
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLEAN	Comprehensive Long-term Environmental Action—Navy
COC	constituent of concern
COD	coefficient of determination
COPC	contaminant of potential concern
CTO	Contract Task Order
CVAA	cold vapor atomic absorption
DL	detection limit
DO	dissolved oxygen
DoD	Department of Defense
DQI	data quality indicator
DV	Data Validator
ECD	electron capture detector
EICP	enclosed inductively coupled plasma
ELAP	Environmental Laboratory Accreditation Program
ENCO Labs	Environmental Conservation Laboratories
ERP	Environmental Restoration Program
ft	foot
FTL	Field Team Leader
g	gram
GC	gas chromatography
H&S	health and safety
HHRS	Human Health Risk Screening
HS&E	health, safety, and environment

HSO	Health and Safety Officer
HSP	Health and Safety Plan
ICAL	initial calibration
ICP	inductively coupled plasma
ICS	interference check standard
ICV	initial calibration verification
ID	identification
IDW	investigation-derived waste
ISTD	internal standard
LCS	Laboratory Control Sample
LCL	Lower Control Limit
LIMS	Laboratory Information Management Systems
LOD	limit of detection
LOQ	Limit of Quantitation
MCL	Maximum Contaminant Level
MDL	method detection limit
mg/kg	milligram per kilogram
ml	milliliter
MPC	Measurement Performance Criteria
MS	matrix spike, mass spectrometry
MSD	matrix spike duplicate
MTBE	Methyl-tert-butyl ether
N/A	not applicable
NAVFAC	Naval Facilities Engineering Command
Navy	United States Navy
NC	no criteria
NIRIS	Navy Installation Restoration Information System
NTCRA	Non-time Critical Removal Action
ORP	oxidation-reduction potential
oz	ounce
PAL	Project Action Limit
PC	Project Chemist
PCB	polychlorinated biphenyl
PDM	Project Data Manager
PM	Project Manager
POC	point of contact
PPE	personal protective equipment
PQL	Project Quantitation Limit
PQO	Project Quality Objective
PVC	polyvinyl chloride
QA	quality assurance
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plans
QC	quality control
QSM	Quality Systems Manual
RF	response factor
RI	Remedial Investigation

RL	Reporting Limit
RPD	relative percent difference
RPM	Remedial Project Manager
RRT	relative retention time
RSD	relative standard deviation
RSL	Regional Screening Level
SAP	Sampling and Analysis Plan
SCV	Second Source Calibration Verification
SERA	Screening-Level Ecological Risk Assessment
SI	Site Investigation
SOP	standard operating procedure
SPCC	system performance check compound
SSA	Site Screening Area
SSL	Soil Screening Level
STC	Senior Technical Consultant
STP	Sewage Treatment Plant
SVOC	semivolatile organic compound
TAL	target analyte list
TBD	to be determined
TCL	target compound list
TD	top depth
TNT	trinitrotoluene
UCL	upper control limit
UFP	Uniform Federal Policy
USEPA	United States Environmental Protection Agency
UTL	Upper Tolerance Limit
VDEQ	Virginia Department of Environmental Quality
VOC	volatile organic compound
WPNSTA	Naval Weapons Station

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SAP Worksheet #2—SAP Identifying Information

Site Name/Number: Site 32 (Formerly Site Screening Area [SSA] 25)
Former Operable Unit(s): Not Applicable (N/A)
Contractor Name: CH2M HILL
Contract Number: N62470-08-D-1000, Contract Task Order (CTO)-WE29
Contract Title: Comprehensive Long-term Environmental Action—Navy (CLEAN) 1000

1. This Sampling and Analysis (SAP) was prepared in accordance with the requirements of:

- *Navy Uniform Federal Policy-Sampling and Analysis Plan (UFP-SAP) Template* (Navy, 2008)
- *Guidance on Systematic Planning Using the Data Quality Objectives Process* (USEPA, 2006)
- *Uniform Federal Policy for Quality Assurance Project Plans* (USEPA, 2005)
- *Guidance for Quality Assurance Project Plans, United States Environmental Protection Agency (USEPA) QA/G-5, QAMS* (USEPA, 2002)

2. Regulatory program:

- Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

3. This SAP is project-specific.

4. Scoping Sessions:

Scoping Session	Date
Joint scoping session with stakeholders	6/23/10
Internal scoping session for selection of proposed sampling locations	9/15/10
Joint scoping session with stakeholders	10/13/10
Joint scoping session with stakeholders	9/8/11

5. List dates and titles of any SAP documents written for previous site work that are relevant to the current investigation.

Document*	Date	AR Number
<i>Final Background Study Work Plan, Naval Weapons Station Yorktown, Yorktown, Virginia and Cheatham Annex, Williamsburg, Virginia.</i>	July, 2009	N00109_000008

*Copies of these listed reports may be obtained through the administrative record:
<http://public.lantops-ir.org/sites/public/yorktown/Site%20Files/AdminRecords.aspx>

SAP Worksheet #2—SAP Identifying Information (continued)

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

- **Lead Organization**: Naval Facilities Engineering Command (NAVFAC) Mid-Atlantic Division
- **Land Owner**: Department of Defense (DoD)
- **Lead Regulatory Agency**: USEPA Region 3
- **State Regulatory Agency**: Virginia Department of Environmental Quality (VDEQ)

7. If any required SAP elements or required information are N/A to the project or are provided elsewhere, then note the omitted SAP elements and provide an explanation for their exclusion below:

- All SAP elements required for this project are described herein on the 37 UFP-SAP Worksheets. Therefore, the crosswalk table is not necessary for this project.

SAP Worksheet #3—Distribution List

Name of SAP Recipients	Title/Role	Organization	Telephone Number	E-mail Address or Mailing Address	Document Control Number
Jim Gravette	Remedial Project Manager (RPM)	NAVFAC Mid-Atlantic	(757) 341-0477	james.gravette@navy.mil	An Administrative Record number will be assigned when the final document is being prepared.
Moshood Oduwole	RPM	USEPA Region 3	(215) 814-3362	Oduwole.Moshood@epamail.epa.gov	
Wade Smith	RPM	VDEQ	(804) 698-4125	wade.smith@deq.virginia.gov	
Bonnie Capito	Librarian	NAVFAC Atlantic	(757) 322-4785	bonnie.capito@navy.mil	
John McCloskey	Biological Technical Assistance Group (BTAG)	Fish and Wildlife Service	(804) 693-6694 x108	john_mccloskey@fws.gov	
Bill Friedmann	Activity Manager (AM)	CH2M HILL	(757) 671-6223	william.friedmann@ch2m.com	
Mary Anderson	Project Manager (PM)	CH2M HILL	(518) 982-0572	mary.anderson@ch2m.com	
Herb Kelly or his designee	Contractor Data Validator (DV)	CH2M HILL	(352) 384-7100	herb.kelly@ch2m.com	
Ronald Wambles	Laboratory Subcontractor PM	Environmental Conservation Laboratories (ENCO Labs)	(407) 826-5314	rwambles@encolabs.com	

SAP Worksheet #3—Distribution List (continued)

The following people may receive copies of the SAP, subsequent SAP revisions, addenda, and amendments provided by people/organizations listed above.

Name of SAP Recipients	Title/Role	Organization	Telephone Number	E-mail Address or Mailing Address	Document Control Number
Roni Warren	Navy CLEAN Human Health Risk Assessor	CH2M HILL	(814) 364-2454	roni.warren@ch2m.com	An Administrative Record number will be assigned when the final document is being prepared.
William Kappleman	Navy CLEAN Ecological Risk Assessor	CH2M HILL	(703) 376-5152	william.kappleman@ch2m.com	
Megan Morrison	Project Chemist (PC)	CH2M HILL	(703) 376-5053	megan.morrison@ch2m.com	
David Barclift	Ecological Technical Support	NAVFAC LANT	(610) 595-0567	david.barclift@navy.mil	
Kyle Newman	Ecological Technical Support	VDEQ	(804) 698-4452	kyle.newman@deq.virginia.gov	
Doug Bitterman	Activity Quality Manager (AQM)	CH2M HILL	(757) 671-6209	doug.bitterman@ch2m.com	
Hillary Ott	Project Data Manager (PDM)	CH2M HILL	(703) 376-5165	hillary.ott@ch2m.com hillary.ott@ch2m.com	
Kimberley Coke	Field Team Leader (FTL)	CH2M HILL	(757) 671-6290	kimberley.coke@ch2m.com	
To be determined (TBD)	Field Team Members	CH2M HILL	TBD	TBD	

SAP Worksheet #4—Project Personnel Sign-Off Sheet

The following is a list of people who are responsible for ensuring overall implementation of the SAP:

Name	Organization/ Title/Role	Telephone Number	Signature/E-mail Receipt	SAP Section Reviewed	Date SAP Read
Jim Gravette	NAVFAC Mid-Atlantic RPM	(757) 341-0477			
Moshood Oduwole	USEPA RPM	(215) 814-3362			
Wade Smith	VDEQ RPM	(804) 698-4125			
Bill Friedmann	CH2M HILL AM	(757) 671-6223			
Anita Dodson	CH2M HILL Navy CLEAN Program Chemist	(757) 671-6218			
Laura Cook	CH2M HILL Senior Technical Consultant (STC)	(757) 671-6214			
Brett Doerr	CH2M HILL SAP Quality Reviewer	(757) 671-6219			
Doug Bitterman	CH2M HILL AQM	(757) 671-6209			

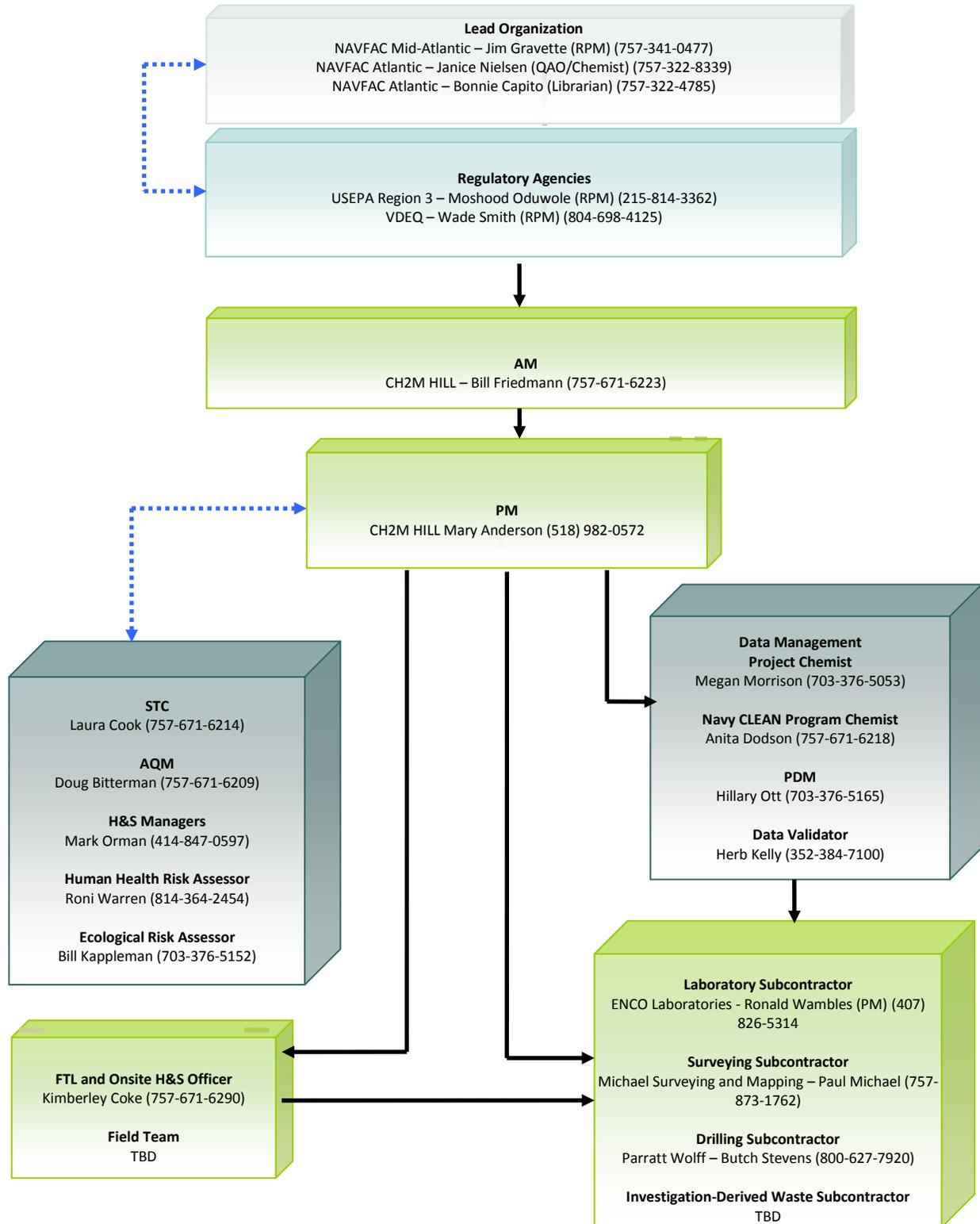
The following is a list of people who may provide input and therefore review portions or all of the SAP:

Name	Organization/Title/Role	Telephone Number	Signature/ E-mail Receipt	SAP Section Reviewed	Date SAP Read
Mary Anderson	CH2M HILL PM	(518) 982-0572			
Bonnie Capito	NAVFAC Atlantic Librarian	(757) 322-4785			
Megan Morrison	CH2M HILL PC	(703) 376-5053			
Roni Warren	CH2M HILL Human Health Risk Assessor	(814) 364-2454			
William Kappleman	CH2M HILL Ecological Risk Assessor	(703) 376-5152			
Hillary Ott	CH2M HILL PDM	(703) 376-5165			
Kimberley Coke	CH2M HILL FTL	(757) 671-6290			
Herb Kelly	CH2M HILL DV	(352) 384-7100			
TBD	CH2M HILL Field Team Members	TBD			
Ronald Wambles	Analytical Laboratory PM	(407) 826-5314			

Once this worksheet has been completed and signed, it will be maintained in the project files by the PM.

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SAP Worksheet #5—Project Organizational Chart



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SAP Worksheet #6—Communication Pathways

Communication Drivers	Responsible Affiliation	Name	Phone Number and/or E-mail	Procedure
Point of contact (POC) with USEPA Region 3 and VDEQ PMs	RPM, NAVFAC Mid-Atlantic	Jim Gravette	(757) 341-0477	All Materials and information pertaining to the project will be forwarded to Wade Smith and Rob Thomson within 2 business days by the RPM following review.
Oversight on all projects at Naval Weapon Station (WPNSTA) Yorktown; AM	CH2M HILL AM	Bill Friedmann	(757) 671-6223	Issues are to be reported to the United States Navy (Navy) RPM immediately and followed up in writing within 2 business days.
Implement SAP and manage all phases of this project	CH2M HILL PM	Mary Anderson	(518) 982-0572	Communicate directly (verbal and/or in writing) with the AM and NAVFAC as necessary.
SAP changes in the field	CH2M HILL FTL	Kimberley Coke	(757) 671-6290	Communicate directly (verbal and/or in writing) with CH2M HILL AM or PM with daily meetings. Documentation of deviations from the UFP-SAP made in field logbooks; deviations made only with approval of PM, who will communicate with the AM, Navy and regulators. The FTL will ensure SAP requirements are met by field staff.
Data tracking from collection through upload to database	CH2M HILL PDM	Hillary Ott	(703) 376-5165	The PDM tracks the data and informs the PM and PC of potential problems or issues. The PM and AM are informed within 24 hours to pass on communications to Navy and regulators as appropriate.
Reporting Data Validation Issues	CH2M HILL DV	Herb Kelly or his designee	(352) 384-7100	All completeness and data issues will be addressed with the laboratory. The DV should copy the CH2M HILL PDM on all communications to the laboratory. The validated data package will be due within 14 calendar days of data receipt by the validator.
Reporting Analytical Lab Data Quality Issues	ENCO Laboratories PM	Ronald Wambles	(407) 826-5314	All quality assurance (QA)/quality control (QC) issues with project field samples will be reported by the subcontracted lab, who will relay them to the PDM, PM, and Contractor Quality Assurance Officer (QAO) immediately upon discovery.
Field and Analytical Corrective Actions (CAs)	CH2M HILL Program Chemist PC FTL	Anita Dodson Megan Morrison Kimberley Coke	(757) 671-6218 (703) 376-5053 (757) 671-6290	The need for CA for field and analytical issues will be determined by the FTL, PC, senior support staff, and/or Contractor QAO as necessary. The Senior support will ensure Quality Assurance Project Plans (QAPP) requirements are met by field staff. The PC will ensure QAPP requirements are met by the laboratory. The FTL will notify the PM of any needed field CAs. The PM will have 24 hours to respond to the request for field CA. CA with laboratories will be coordinated by PC. The PC will notify the Program Chemist, who will in turn notify the Navy Chemist of any lab issues that render DQOs unattainable or cause delivery issues such that project schedule cannot be met.

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SAP Worksheet #7—Personnel Responsibilities and Qualifications Table

Name	Organization/Title	Responsibilities	Qualifications	
			Education	Years of Applicable Experience
Jim Gravette	NAVFAC Mid-Atlantic RPM	Coordinates all environmental activities at WPNSTA Yorktown.	1992 BS Geological Sciences 1997 MS Geology	16
Moshood Oduwole	USEPA Region 3 RPM	Manages all aspects of project to confirm Federal regulations and requirements are met.	2002 BS Geology 2009 MS Environmental Geology	5
Wade Smith	VDEQ RPM	Manages all aspects of project to confirm State regulations and requirements are met.	1995 BS Earth Science 1998 MS Environmental Engineering	12
Bonnie Capito	NAVFAC Mid-Atlantic Librarian	Responsible for document tracking and filing.	MSLS Library and Information Science	30
Bill Friedmann, P.G.	CH2M HILL AM	Responsible for support to Navy to implement CERCLA Environmental Restoration Program (ERP) at WPNSTA Yorktown	1989 BS Geology	21
Mary Anderson	CH2M HILL PM	Day-to-day project management to implement SAP. Directs and oversees staff; health, safety, and environment (HS&E). Contractor POC for decision-making. Conducts data usability assessment.	1992 BS Biology 1994 MS Biology	18
Laura Cook, P.G.	CH2M HILL STC	Provides program level review and senior technical oversight.	1998 BS Geological and Environmental Sciences	12
Doug Bitterman, P.G.	CH2M HILL AQM	Provides senior technical oversight	1985 BS Geology 1989 MS Civil Engineering	22
William Kappleman	CH2M HILL Senior Ecological Risk Assessor	Conducts Ecological Risk Assessment to determine any impacts to ecological receptors	1983 BS Wildlife Biology 1991 MS Wildlife Biology	23

SAP Worksheet #7—Personnel Responsibilities and Qualifications Table (continued)

Name	Organization/Title	Responsibilities	Qualifications	
			Education	Years of Applicable Experience
Roni Warren, P.E.	CH2M HILL Human Health Risk Assessor	Responsible for performing Human Health Risk Assessment	1988 BS Computer Science 1990 MS Environmental Engineering	20
Anita Dodson	CH2M HILL Program Chemist	Provides program level review of the UFP-SAP	1994 BS Chemistry	16
Megan Morrison	CH2M HILL PC	Performs oversight of laboratory and DVs, and evaluates usability of data	2005 BS Chemistry 2005 BS Environmental Science	5
Kimberley Coke	CH2M HILL FTL	Supervises field sampling and coordinates all field activities	2002 BS Geology	5
Herb Kelly	CH2M HILL DV	Responsible for the analytical data review and validation	1982 BS Chemistry	29
Hillary Ott	CH2M HILL PDM	Manages sample tracking, coordinates with laboratory and DV, data management	2009 BS Environmental Geosciences	2
Mark Orman, CSP, CHMM, ARM	CH2M HILL Health and Safety Officer (HSO)	Oversees health and safety (H&S) for CLEAN Program	1992 BS Environmental Science	18
Ronald Wambles	ENCO Laboratories PM	Provide analytical services	2000 BS Chemistry	11
Butch Stevens	Parratt Wolff PM	Provide drilling services	TBD	TBD

SAP Worksheet #8—Special Personnel Training Requirements Table

Note: Special personnel training requirements are not needed for completion of project work.

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SAP Worksheet #9a—Project Scoping Session Participants Sheet

Project Name: Yorktown Site 32 Site investigation (SI) for Soil and Groundwater Projected Date(s) of Sampling: Spring 2011 PM: Mary Anderson				Site Name: Site 32 Site Location: WPNSTA Yorktown, Virginia	
Date of Session: June 23, 2010 Scoping Session Purpose: To review previous investigation data and present the proposed sampling approach to the Partnering Team for Site 32 soil and groundwater.					
Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Bill Friedmann	AM	CH2M HILL	(757) 671-6223	william.friedmann@ch2m.com	Overseeing project delivery, technical support
Adam Forshey	PM	CH2M HILL	(757) 671-6267	adam.forshey@ch2m.com	UFP-SAP production, project management
Rob Thomson	RPM	USEPA	(215) 814-3357	Thomson.Bob@epamail.epa.gov	Lead representative of USEPA, responsible for review of documents and ensure that appropriate regulations are applied
Wade Smith	RPM	VDEQ	(804) 698-4125	wade.smith@deq.virginia.gov	Lead representative of VDEQ, responsible for review of documents and ensure that appropriate regulations are applied
Tom Kowalski	RPM	NAVFAC Mid-Atlantic	(757) 341-0479	tom.kowalski@navy.mil	Representative of lead agency responsible for overseeing execution of projects

Comments/Decisions:

Following the completion of remedial actions of Site 32 sediment, the USEPA had previously requested available information on the demolition and removal of the Sewage Treatment Plant (STP) #2 to determine if there existed a potential concern related to metals in soil and groundwater. The presentation and discussion during this meeting was the initial planning step for the investigation of soil and groundwater at this site.

During the discussion, historical site information and a proposed sampling plan were presented for Site 32 soils and groundwater. The Partnering Team discussed that during the 2000 removal action, approximately 12 drums of mercury-contaminated soils were removed. However, no documentation of post removal sampling could be located. Additionally, cadmium and silver were identified as site-related contaminants during the sediment and surface water investigations and action, but these chemicals were also never evaluated in soil or groundwater. Therefore, the purpose of the additional proposed sampling is to determine if cadmium, mercury or silver are present in soil or groundwater at the site, and if so, whether concentrations of these metals pose a potentially unacceptable risk to human health or the environment. The team agreed to analyze the soil and groundwater for cadmium, mercury, and silver only (based on the constituents of concern [COCs] remediated as part of the sediment removal action). If it is determined that there is no release or contamination associated with a release does not pose an unacceptable risk, then the SI will serve as the decision document for Site 32 soil and groundwater. A Proposed Plan is already being drafted for Site 32 surface water and sediment.

SAP Worksheet #9a—Project Scoping Session Participants Sheet (continued)

The proposed sampling included four surface soil/subsurface soil and four groundwater samples. The USEPA suggested a review of historical photos to identify the location of the STP for placement of the soil samples **[Action Item #1]**. It was noted that multiple soil sample depths may be considered during development of the SAP to ensure collection of samples in native soils and not just from within fill from previous demolition activities.

Action Items:

- CH2M HILL will review historical photos of Site 32 to determine the location of the STP to facilitate selection of sample locations.

Resolution: Historical photos of the STP could not be identified. However, a previous drawing with the location of the STP was identified and compared with existing imaging to determine the location of the former STP and assist in the placement of soil samples.

Consensus Decisions:

The team agreed that additional sampling would be conducted for soil and groundwater at the former STP #2 and agreed with the conceptual sample locations (pending completion of the action item) and that the only constituents that need to be sampled for are cadmium, mercury, and silver.

SAP Worksheet #9b—Project Scoping Session Participants Sheet

Project Name: Yorktown Site 32 SI for Soil and Groundwater Projected Date(s) of Sampling: Spring 2011 PM: Mary Anderson				Site Name: Site 32 Site Location: WPNSTA Yorktown, Virginia	
Date of Session: September, 2010 Scoping Session Purpose: To review previous investigation data and identify specific sampling locations for soil and groundwater.					
Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Bill Friedmann	AM	CH2M HILL	(757) 671-6223	william.friedmann@ch2m.com	Overseeing project delivery, technical support
Adam Forshey	PM	CH2M HILL	(757) 671-6267	adam.forshey@ch2m.com	UFP-SAP production, project management
Laura Cook	AQM and STC	CH2M HILL	(757) 671-6214	laura.cook@ch2.com	Overseeing project delivery, technical support
Jason Mills	Staff Engineer	CH2M HILL	(757) 671-6270	jason.mills@ch2m.com	UFP-SAP production

Comments/Decisions:

Following a review of historical information, including aerial photographs, location, and function of individual structures, and inferred groundwater flow direction, proposed adjustments to the conceptual sampling locations were made by CH2M HILL.

Adam began the meeting by reviewing the proposed sampling approach for Site 32 (formerly SSA 25). This investigation will be for soil and groundwater only. Sediments and surface water have been addressed separately by previous investigations and documents. During this SI, soil and groundwater samples will be collected from four (4) locations in the vicinity of the former STP location. Based upon the discussion with the Partnering Team in June 2010, samples will be analyzed for mercury, silver, and cadmium, as these were the only COCs identified for the sediments.

Samples will be collected from a total of four locations at Site 32. One soil sample will be proposed from the approximate location of the former trickling filter of the STP, where beaded elemental mercury was previously identified and removed. The other three soil samples will be proposed along the perimeter fence, downgradient of the STP. One sample will be proposed near the former chlorination unit (in the approximate location of the discharge pipe), one will be proposed near the former sludge drying bed, and one will be proposed further east (downgradient of the STP). Groundwater monitoring wells will be co-located with the soil sample locations. Two soil samples will be proposed from each sample location. During the discussion, it was determined that surface soil samples will be proposed from 0-6 inches below ground surface (bgs) from each of the sample locations. Additionally, co-located second samples will be proposed from 6-24 inches in the samples located downgradient of the former STP. At the location of the former trickling filter, a second sample will be proposed from 0-18 inches below the field-determined fill material (i.e. the 18 inches of native soil immediately below the tricking filter). Discussion in the draft UFP-SAP worksheets will be updated to reflect these sample depths.

SAP Worksheet #9b—Project Scoping Session Participants Sheet (continued)

Action Items:

- Check the Groundwater Management Plan for language on Hydrology for Site 32

Consensus Decisions:

The CH2M HILL team agreed on the sampling approach and analytical parameters to be proposed in the SAP.

SAP Worksheet #9c—Project Scoping Session Participants Sheet

Project Name: Yorktown Site 32 SI for Soil and Groundwater Projected Date(s) of Sampling: Spring 2011 PM: Mary Anderson				Site Name: Site 32 Site Location: WPNSTA Yorktown, Virginia	
Date of Session: October 13, 2010 Scoping Session Purpose: To review previous investigation data and identify specific sampling locations for soil and groundwater.					
Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Bill Friedmann	AM	CH2M HILL	(757) 671-6223	william.friedmann@ch2m.com	Overseeing project delivery, technical support
Adam Forshey	PM	CH2M HILL	(757) 671-6267	adam.forshey@ch2m.com	UFP-SAP production, project management
Rob Thomson	RPM	USEPA	(215) 814-3357	Thomson.Bob@epamail.epa.gov	Lead representative of USEPA, responsible for review of documents and ensure that appropriate regulations are applied
Wade Smith	RPM	VDEQ	(804) 698-4125	wade.smith@deg.virginia.gov	Lead representative of VDEQ, responsible for review of documents and ensure that appropriate regulations are applied
Tom Kowalski	RPM	NAVFAC Mid-Atlantic	(757) 341-0479	Tom.Kowalski@navy.mil	Representative of lead agency responsible for overseeing execution of projects

Comments/Decisions:

Based on the discussion with the Tier I Partnering Team in June 2010 and following a review of historical information, the adjusted sampling locations for soil and groundwater were presented to the Partnering Team for discussion and consensus.

The Partnering Team discussed and agreed to the sampling approach proposed during the CH2M HILL internal scoping session, which consisted of four co-located surface soil, subsurface soil and monitoring well groundwater samples. One sample is to be collected in the former footprint of the trickling filter. The subsurface sample in that location is to be collected in the first 18 inches of native soil because the area was backfilled when the filter was removed. The remaining samples will be collected slightly downgradient of the chlorination unit, trickling filter and sludge drying bed at the site. All of the downgradient subsurface samples would be collected from 6-24 inches bgs. Surface soil samples in all four locations will be collected from 0-6 inches bgs. Monitoring wells will be screened in the top 10 feet (ft) of the aquifer because the contaminants of interest are metals which are more likely to be encountered at shallow depth intervals.

Action Items:

- None

Consensus Decisions:

The team agreed to the sampling approach and analytical parameters.

SAP Worksheet #9d—Project Scoping Session Participants Sheet

Project Name: Yorktown Site 32 SI for Soil and Groundwater Projected Date(s) of Sampling: Winter 2012 PM: Mary Anderson				Site Name: Site 32 Site Location: WPNSTA Yorktown, Virginia	
Date of Session: 9/8/2011 Scoping Session Purpose: To address comments on the draft SAP.					
Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Bill Friedmann	AM	CH2M HILL	(757) 671-6223	william.friedmann@ch2m.com	Overseeing project delivery, technical support
Adam Forshey	PM	CH2M HILL	(757) 671-6267	adam.forshey@ch2m.com	UFP-SAP production, project management
Moshood Oduwole	RPM	USEPA	(215) 814-3357	Oduwole.Moshood@epamail.epa.gov	Lead representative of USEPA, responsible for review of documents and ensure that appropriate regulations are applied
Wade Smith	RPM	VDEQ	(804) 698-4125	wade.smith@deq.virginia.gov	Lead representative of VDEQ, responsible for review of documents and ensure that appropriate regulations are applied
Jim Gravette	RPM	NAVFAC Mid-Atlantic	(757) 341-0477	james.gravette@navy.mil	Representative of lead agency responsible for overseeing execution of projects

Comments/Decisions:

The team discussed comments submitted by USEPA and VDEQ on the original draft version of this SAP. USEPA provided comments indicating that the proposed SAP was insufficient to address concerns related to potential spatial and analytical data gaps at the site. The previous partnering discussions/previous investigations that led to the plan presented in the original draft document were discussed. USEPA indicated there was more of a concern with the sludge drying bed rather than the trickling filter with respect to the limited number of analytes proposed (cadmium, mercury and silver). The team agreed to a full suite, 5-point composite within the sludge drying bed and also agreed to analyze the remaining areas for only the sediment COCs (mercury, cadmium, and silver). The team also agreed to add some additional samples, including an upgradient, site-specific background sample. The total number of soil sample locations was increased to eight and the total number of monitoring wells was increased to five. The team agreed to install groundwater wells during the soil sampling, but wait to sample them based on the soil sample results. The Navy requested that an exit strategy for groundwater be included in the sampling plan (i.e. no detection after two quarters of sampling).

Action Items:

Moshood requested that the changes to the SAP are clear and are highlighted or redlined for a quick review.

Consensus Decisions:

The team agreed to the revised sampling strategy.

SAP Worksheet #10—Problem Definition

The purpose of this SI is to determine if contamination is present at levels posing potentially unacceptable risk in soil and groundwater at WPNSTA Yorktown Site 32 (formerly SSA 25), STP #2 Sludge Drying Bed. Previous investigation activities at Site 32 have focused exclusively on surface water and sediment in the downgradient wetlands area. To date, no soil or groundwater analytical samples have been collected to characterize these media. This investigation will provide information within the footprint and downgradient of the former STP (i.e., where contamination from past releases is most likely to be found, if present).

The data collected will be used to determine if contamination is present at Site 32, and if so, to evaluate any potential risks to human health and the environment present at the site. Based on discussions with the USEPA and VDEQ, the focus of this investigation will be on those constituents identified as COCs in the downgradient wetland area sediment: mercury, cadmium, and silver. However, sampling for additional parameters within the former footprint of the sludge drying bed will be completed to confirm that a release has not occurred in the area.

WPNSTA Yorktown History and Location

WPNSTA Yorktown is a 10,624-acre installation located on the Virginia Peninsula in York and James City Counties Virginia ([Figure 1](#)). WPNSTA Yorktown is bounded to the northwest by Cheatham Annex to the northeast by the York River and the Colonial National Historic Parkway, to the southwest by Route 143 and Interstate 64, and to the southeast by Route 238 and the town of Lackey.

Originally named the United States Mine Depot, WPNSTA Yorktown was established in 1918 to support the laying of mines in the North Sea during World War I. For 20 years after World War I, the depot continued to receive, reclaim, store, and issue mines, depth charges, and related materials. During World War II, the facility was expanded to include three trinitrotoluene (TNT) loading plants and new torpedo overhaul facilities. A research and development laboratory for experimentation with high explosives was established in 1944. In 1947, a quality evaluation laboratory was developed to monitor special tasks assigned to the facility which included the design and development of depth charges and advanced underwater weapons. On August 7, 1959, the depot was renamed the U.S. Naval Weapons Station. Today, the primary mission of WPNSTA Yorktown is to provide ordnance, technical support, and related services to sustain the war-fighting capability of the armed forces in support of national military strategy.

Site-Specific Location and History

The Site 32 study area is located in the eastern-most portion of WPNSTA Yorktown, bordered by dense tree cover to the north, Ballard Creek to the south, and the York River further to the east ([Figure 1](#)). The terrestrial portion of the study area is approximately 1.4 acres in size and consists of the footprint of the former STP #2. Currently, the study area is cleared and slopes moderately from the north to south at elevations ranging from 30- 20 ft above mean sea level (amsl). Beyond the WPNSTA Yorktown perimeter fence line, the site slopes steeply towards the downgradient wetlands, leveling off at an elevation of 10 ft amsl ([Figure 2](#)). After its installation in 1952, the STP reportedly received and managed only sanitary waste from the base. The STP consisted of a clarifier (Imhoff) tank, trickling filter, chlorination unit, and sludge drying bed. Wastewater first entered the plant through the Imhoff tank, which operated as a primary settling basin for the waste. The wastewater was then passed through the trickling filter for biological treatment and pumped back to the Imhoff tank for secondary settling. The wastewater was then chlorinated in the chlorination unit and discharged directly to Ballard Creek through a regulated outfall. Sludge that had settled in the Imhoff tank was periodically removed and placed in the sludge drying bed. It is believed that treatment plant operations ceased before the early 1970s, prior to the promulgation of the Clean Water Act. The use of mercury seals on trickling filters, like that used at STP #2, have been prohibited in Virginia since 1971 (9 Virginia Administrative Code 25-790).

SAP Worksheet #10—Problem Definition (continued)

No historical releases have been reported or documented during the operation of the STP, but beaded, elemental mercury was discovered around the base of the trickling filter during excavation of the structure in 2000. The source of this mercury was likely the mercury-containing bearings located in the distributor arms of the trickling filter tank. Based on anecdotal evidence, a total of twelve drums of mercury-contaminated soils were excavated and disposed of during the removal of the trickling filter and the site was backfilled and regraded. However, no documentation of the removal activities, confirmation samples, or the depth of fill exists. Contamination to downgradient sediment and surface water has been addressed as part of previous investigations and a subsequent removal action in 2009. Therefore, these media will not be addressed as part of this SI.

Hydrogeological Setting

WPNSTA Yorktown is located in the Coastal Plain Physiographic Province, which is characterized by unconsolidated sedimentary deposits that begin at the Fall Line and gradually thicken and gently slope to the southeast. The deposits generally consist of interbedded sand, silt, clay, gravel, and shell material that together form a system of aquifers and confining units and are overlain by modern alluvial, colluvial, and marsh deposits according to *Geohydrology of the Shallow Aquifer System* (Brockman et al., 1997).

The Coastal Plain is generally divided into a series of terraces of differing elevations that were deposited during variations in sea level throughout recent geologic history. These terraces are truncated by scarps which were cut by ancient shorelines. Most of WPNSTA Yorktown, including Site 32, lies within the Lackey Plain terrace. The Lackey Plain is bounded on the northeast by the Camp Peary Scarp, which trends roughly parallel to the York River (Brockman et al., 1997) and lies just south of the lower Croaker Flat terrace.

No drilling has been completed at Site 32, so the lithologic sequence in this area has not been confirmed. However, because of the location of Site 32 within the Lackey Plain Terrace, it is anticipated that the hydrogeologic sequence will be consistent with nearby sites on the terrace. The typical hydrogeologic sequence in the area consists of an unsaturated unit lithologically consistent with the Columbia aquifer at the surface. This unit is underlain by the orange-brown clay of the Cornwallis Cave confining unit which overlies the orange-brown sand and shell hash of the Cornwallis Cave aquifer at the site. The Cornwallis Cave aquifer overlies the fat gray clay of the Yorktown confining unit and the gray sand of the Yorktown-Eastover aquifer. Cornwallis Cave aquifer groundwater is expected to be the first encountered groundwater at the site and is expected to flow radially toward the wetland area.

Previous Investigations

Soil and groundwater were not previously considered media of concern because a removal action of the former STP #2 structures had been conducted in 2000 and because the Partnering Team believed that the environmental concern with the site was the direct discharge to the wetlands adjacent to Ballard Creek and Beaver Pond. Therefore, no investigation of the soils and groundwater has been conducted to date at the site.

Sediment and surface water was first investigated in August 2003 as part of a field investigation to delineate total mercury concentrations in sediment in the vicinity of the WPNSTA Yorktown Site 12 Long Term Monitoring sediment sampling locations. Site 12 is upstream of Site 32 along Ballard Creek and mercury had been detected at levels of concern in the downstream sediment samples and did not appear to be related to Site 12. Based on the results of this investigation, the Yorktown Partnering Team signed a consensus statement (5-18-04-37) agreeing to proceed with additional investigations of sediment and surface water at Site 32. Subsequent investigations at Site 32, culminating in a Step 7 Baseline Ecological Risk Assessment (BERA), focused solely on surface water and sediment in the wetlands downgradient of STP #2 and identified cadmium, mercury, and silver as COCs in these media (CH2M HILL, 2008).

SAP Worksheet #10—Problem Definition (continued)

Problem Definition

During the demolition of the former STP #2 in 2000, a total of 12 drums of elemental mercury-contaminated soils were excavated and removed; however, the absence of documentation surrounding the removal action resulted in a data gap regarding the completeness of the removal of contaminated soil and potential leaching to groundwater. Analytical samples for soil and groundwater are necessary to complete characterization of the site and to determine if any contamination remains at Site 32 from the former STP and, if so, whether the residual contaminant levels pose potentially unacceptable human health and/or ecological risks.

Based on the above information, the purpose of this SI is to determine if historical operations at STP #2 resulted in a CERCLA-regulated release to site soil and/or groundwater and, if so, whether unacceptable risks remain at the site resulting from the release. Based on the COCs identified in downgradient surface water and sediment, and, with concurrence from the USEPA and VDEQ, the focus of this investigation will be potential cadmium, mercury, and silver in soil and groundwater at the site, with a limited investigation of other potential constituents to confirm that a release has not occurred in the area of the former drying bed.

Environmental Questions answered by this Project

Has there been a release of contaminants to soils due to historical activities associated with STP #2?

The following investigation activities will be conducted to identify if cadmium, mercury, and/or silver contamination are present in soils associated with STP #2 and whether these and/or other contaminants are present within soils in the sludge drying bed at the site:

- Co-located surface (0-6 inches bgs) and subsurface (6-24 inches bgs) soil samples will be collected in seven locations (**Figure 3**): one upgradient of the site (to serve as site-specific background), one within the former footprint of the Imhoff Tank, one within the former footprint of the trickling filter, and four downgradient locations. In the location of the trickling filter samples, an additional sample will be collected just above the water table to ensure that native material is evaluated (because this area was formerly backfilled). These samples will be analyzed for mercury, cadmium and silver only.
- One composite surface (0-6 inches bgs) and one composite subsurface (6-24 inches bgs) soil sample (**Figure 3**) will be collected from five points within the sludge drying bed. These samples will be analyzed for target analyte list (TAL) metals, target compound list (TCL) volatile organic compounds (VOCs), TCL semivolatile organic compounds (SVOCs), TCL pesticides, and polychlorinated biphenyls (PCBs).

Has there been a release of contaminants to groundwater due to leaching from soil at the site?

- Groundwater monitoring wells will be installed at four locations downgradient of the former STP #2 and one location upgradient of the site (to serve as site-specific background). Samples will be analyzed for parameters to be determined on the basis of the soil sample results, including comparisons to soil leaching criteria and site-specific and basewide background concentrations. Wells will be surveyed by a licensed surveyor.

Do site-related soil and groundwater contaminant concentrations (if present) pose a potentially unacceptable human health or ecological risk?

All grab soil samples will be collected and analyzed for cadmium, mercury, and silver. Composite samples from the sludge drying bed (surface and subsurface) will be analyzed for TAL metals, TCL VOCs, TCL SVOCs, TCL pesticides, and PCBs. All analytical soil data collected within 2 ft of the surface will be screened against the human health and ecological risk-based screening values and site-specific and basewide background data. Results from the soil sample collected just above the water table in the area of the former trickling filter will be

SAP Worksheet #10—Problem Definition (continued)

compared to site-specific and basewide background values only if the depth of the sample is greater than 12 ft bgs.

Groundwater samples will be sampled and analyzed for parameters to be determined on the basis of multiple lines of evidence from the results of the soil sampling. These lines of evidence will include comparisons to human health and ecological screening criteria, site-specific and basewide background concentrations, and soil leaching criteria. However, it is noted that there is no correlation between human health (i.e. Regional Screening Levels [RSLs]) or ecological screening criteria and chemical concentrations of concern in groundwater. The team will reach consensus on parameters to be analyzed in groundwater before sampling occurs. Once groundwater results are received, the data will be screened against human health and ecological risk-based screening values.

What are the likely contaminant transport pathways at the site?

Because previous investigations have focused on the wetland area, limited information regarding the hydrogeologic conditions is available, and therefore, the ability to determine likely transport pathways is limited. The following activities will be completed to answer this environmental question:

- During monitoring well installation, continuous macro core soil samples will be collected and logged for soil descriptions (i.e. grain size, color, moisture content, consistency, soil structure, mineralogy, and other relevant information concerning contamination).
- Following monitoring well installation, a water-level survey will be completed to better determine groundwater flow direction at the site.

Is further investigation (i.e., further data collection and evaluation) warranted at the site based on the results of this study?

If a site-related release posing potentially unacceptable risks to human health or the environment is identified, the team will discuss the need for additional data collection (if the extent of contamination is not well defined) or completion of a Non-time Critical Removal Action (NTCRA). If no site-related release is identified or if no unacceptable risks are found associated with an identified release, no additional investigation or action will be necessary. The final determination for the path forward will be made via discussion and concurrence among the Navy, USEPA, and VDEQ upon evaluation of the data and recommendations presented in the SI Report.

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

Who will use the data?

The data will be used by the Navy, its contractors, and the other stakeholder agencies (e.g. USEPA, VDEQ) to ensure that a potential release(s) of contaminants to site soil and groundwater has been adequately characterized and to assess potential risks to human health and the environment. If appropriate, the information will be used to evaluate actions to be taken to provide adequate protection of human health and the environment. Engineers and scientists will evaluate the data for decision making and a chemist will evaluate laboratory data quality. Once published in the Administrative Record, the data will be available to the public.

What types of data are needed?

Analytical data for site soil and groundwater are required for this project. All analytical samples will be submitted to an offsite subcontracted laboratory for analysis. The following list presents a summary of the samples required. [Worksheets #17](#) and [#18](#) provide sample locations, numbers, rationale, and methodology.

- Surface/Subsurface Soil (all locations except sludge drying bed)
 - Select TAL metals (cadmium, mercury, and silver) will be analyzed at an off-site laboratory.
 - Geologic data will be collected during sample collection and concurrent installation of the permanent monitoring wells to characterize site lithology and identify the depth of the shallow aquifer. The water table will not be determined at locations where wells will not be installed.
- Surface/Subsurface Soil (composite sludge drying bed samples)
 - TAL metals, TCL VOCs, TCL SVOCs, TCL pesticides and PCBs will be analyzed at an off-site laboratory.
 - Geologic data will be collected during sample collection and concurrent installation of the permanent monitoring wells to characterize site lithology and identify the depth of the shallow aquifer. The water table will not be tagged at locations where wells will not be installed
- Groundwater
 - Samples from each new well will be analyzed at an off-site laboratory for analyses to be determined by the Partnering Team based on the results of soil sampling. Both total and dissolved metals data will be collected when metals data is required.
 - Water quality parameters (i.e., dissolved oxygen [DO], pH, turbidity, conductivity, oxidation-reduction potential [ORP], salinity, and temperature) will be field-analyzed with a Horiba U-22 or YSI water quality meter.
 - A water level survey will be completed.

What are the Project Action Limits?

Project Action Limits (PALs) are media specific standards and criteria chosen for evaluation to help provide a conservative assessment of site conditions and determine if action is needed to address concentrations of chemicals present on-site. The following list presents a summary of the PALs for each medium.

[Worksheets #15-A1](#) through [15-B5](#) provide a list of the PALs for each constituent in each medium.

SAP Worksheet #11—Project Quality Objectives/Systematic Planning Process Statements (continued)

- Surface/ Subsurface Soil
 - WPNSTA Yorktown Background Dataset (CH2M HILL, 2011)
 - USEPA Residential Soil RSLs (Updated December 2010), RSLs based on non-carcinogenic endpoints will be adjusted by dividing by 10, RSLs based on carcinogenic endpoints will be used as presented in the RSL Table
 - USEPA ecological soil screening values for plants and soil invertebrates
 - USEPA Soil Screening Levels (SSLs) to determine leaching potential
- Groundwater
 - Maximum WPNSTA Yorktown Base-Wide Background Upper Tolerance Limits (UTLs) (CH2M HILL, 2010)
 - Federal Maximum Contaminant Levels (MCLs)
 - USEPA Tap Water RSLs (Updated December 2010), RSLs based on non-carcinogenic endpoints will be adjusted by dividing by 10, RSLs based on carcinogenic endpoints will be used as presented in the RSL Table
 - USEPA Ambient Water Quality Criteria for the Protection of Aquatic Life

For what will the data be used?

The data will be used to determine whether there has been a site-related release of contaminants to soil and/or groundwater and, if so, whether the contaminant levels pose an unacceptable human health and/or ecological risk. This information will, in turn, be used to determine if the site warrants further investigation or action. See [Worksheets #15-1](#) through [15-4](#) for a detailed list of the PALs for each constituent.

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

The analytical data will be of the quantity and quality necessary to provide technically sound and defensible assessments of the presence of a site-related release and, if so, potential risks to human and ecological receptors posed by the contaminants identified. QC sample requirements are detailed in [Worksheet #20](#). QA/QC samples will be collected according to standard operating procedures (SOPs) for the data validation and the generation of a Human Health Risk Screening (HHRS) and Screening-Level Ecological Risk Assessment (SERA). For risk assessment and further action decisions, the laboratory will follow the Measurement Performance Criteria (MPC) in [Worksheet #12-1](#) and [12-2](#) for field QC samples and [Worksheet #28](#) for laboratory QC samples. These MPC are consistent with the DoD Quality Systems Manual (QSM) as applicable and laboratory in-house limits where the QSM does not apply.

In the instance that the laboratory limit of detection (LOD) for a specific constituent is greater than the corresponding PAL, any detection of this constituent above background will be considered potentially site-related. In those cases where this specific constituent is non-detect, the analyte will be considered not present. In efforts to reach lower limits, the laboratory will report concentrations between the Limit of Quantitation (LOQ) and detection limit (DL) as estimated. These results will have a “J” qualifier applied to them.

All data will be validated by CH2M HILL using the procedures listed in [Worksheet #36](#). A full level IV equivalent data package and QC sampling are required for these data. A Level IV equivalent data packages includes a case narrative, all field sample results, QC forms, and raw data.

SAP Worksheet #11—Project Quality Objectives/Systematic Planning Process Statements (continued)

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

Proposed sample locations for all media are shown on [Figure 3](#). Five groundwater, eight surface soil, eight subsurface soil and associated QA/QC samples will be collected.

Where, when, and how should the data be collected/generated?

The data will be collected and generated in accordance with the SOPs contained in this SAP. Surface soil and subsurface soil samples from the drying bed will be composited in the field. Soil samples for VOCs from the drying bed will be composited from the 5 points but will not be homogenized prior to placement in the jar. Fieldwork is tentatively scheduled to begin in Winter of 2012. Data will be validated by CH2M HILL and available approximately nine weeks after the lab receives the samples.

Who will collect and generate the data?

CH2M HILL staff will collect the field samples with the aid of the drilling subcontractor Parratt Wolff, and submit them for analysis to ENCO Laboratories, an off-site DoD Environmental Laboratory Accreditation Program (ELAP)-approved analytical laboratory. CH2M HILL will oversee the subcontractor process.

How will the data be reported?

CH2M HILL will receive the data and will upload it into a centralized database used for

Navy projects by the project team. Data will be presented in tabular format and evaluated against prescribed screening values as previously outlined. The results of the investigations will be documented in a SI Report.

How will the data be archived?

Data will be archived according to procedures dictated via the Navy CLEAN program and contract; all data will be archived in accordance with federal law and will be uploaded into the Navy Installation Restoration Information System (NIRIS). At the end of the project, archived data will be returned to the Navy.

List the Project Quality Objectives (PQOs) in the form of if/then qualitative and quantitative statements.

If concentrations of any contaminants in the sludge drying bed composite samples exceed RSLs, ecological screening criteria, or SSLs and additionally exceed both site-specific and basewide background, the team will meet to evaluate the data and decide on the contaminants to be analyzed in groundwater (other than cadmium, mercury or silver, which will be evaluated in groundwater regardless of soil results).

If concentrations of any contaminants are present in surface soil, subsurface soil, or total groundwater at levels posing potentially unacceptable risk to human or ecological receptors based on a risk screening, concentrations will be compared to base-wide and site-specific upgradient background levels.

If concentrations of any contaminants are present in total groundwater at levels exceeding MCLs, concentrations will be compared to base-wide and site-specific upgradient background levels.

If review of the groundwater data indicates that the dissolved and total recoverable metals data are dissimilar, then the dissolved data will be considered in accordance with the 1992 USEPA Region III *Guidance on the Selection of Metal Results from Monitoring Well Samples for Use in the Quantitative Assessment of Risk*.

If concentrations of contaminants above background in total groundwater are present at levels above MCLs or potentially posing unacceptable risk, the team will review the total and dissolved data to determine if there is a significant difference between the two datasets. If the elevated concentrations could be a result of

SAP Worksheet #11—Project Quality Objectives/Systematic Planning Process Statements (continued)

suspended sediment based on the two data sets, the team will discuss possible use of the dissolved data for decision-making.

If concentrations of contaminants potentially posing unacceptable risk are present at concentrations greater than background, the risk will be considered site-related.

If a potentially unacceptable site-related risk is identified in soil and the team agrees that the nature and extent of contamination has been sufficiently defined to support a removal, a NTCRA will be considered.

If potentially unacceptable site-related risk is identified in either soil or groundwater (or if groundwater concentrations are greater than background and MCLs) and the team agrees that additional investigation is necessary to define the nature and extent of contamination, a Remedial Investigation (RI) will be completed.

If no unacceptable risks or MCL exceedances are identified for groundwater or soil that are attributable to the site, no further investigation or action will be warranted and monitoring wells will be abandoned upon finalization of the SI report.

If unacceptable site-related risks are identified for soil, but not for groundwater, wells will be abandoned following a second round of groundwater sampling for which the same conclusion is drawn. If unacceptable risk is identified for groundwater, but not for soils, and/or if concentrations greater than background and MCLs are found in groundwater in the absence of unacceptable risk, an evaluation of groundwater monitoring alternatives will be considered.

SAP Worksheet #12-A1—Measurement Performance Criteria Table- Field QC Samples

Matrix: Surface Soil and Subsurface Soil

Analytical Group: VOCs

Concentration Level: Medium

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	MPC	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
Equipment Rinsate Blank	VOCs	One per day of sampling per type of equipment	Contamination, Bias	No analyte detected >1/2 LOQ	S&A
Trip Blank		One per cooler to the laboratory	Contamination, Bias		S&A
Cooler Temperature Blank		One per cooler to the laboratory	Contamination, Bias	<6 degrees Celsius (°C)	S
Field Duplicate		One per 10 samples per matrix	Accuracy / Precision	Relative percent difference (RPD) ≤ 35%	S&A

SAP Worksheet #12-A2—Measurement Performance Criteria Table- Field QC Samples

Matrix: Surface Soil and Subsurface Soil

Analytical Group: SVOCs, Pesticides, PCBs¹

Concentration Level: Medium and Low

QC Sample	Analytical Group	Frequency	DQIs	MPC	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
Equipment Rinsate Blank	SVOCs, Pesticides, PCBs	One per day of sampling per type of equipment	Contamination, Bias	no analyte detected >1/2 LOQ	S&A
Cooler Temperature Blank		One per cooler to the laboratory	Contamination, Bias	<6 °C	S
Field Duplicate		One per 10 samples per matrix	Accuracy / Precision	RPD ≤ 35%	S&A

¹ Field QA/QC samples will be collected for each analytical group.

SAP Worksheet #12-A3—Measurement Performance Criteria Table- Field QC Samples

Matrix: Surface Soil and Subsurface Soil

Analytical Group: Metals

Concentration Level: Low

QC Sample	Analytical Group	Frequency	DQIs	MPC	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
Equipment Rinsate Blank	Metals	One per day of sampling per type of equipment	Contamination, Bias	no analyte detected >1/2 LOQ	S&A
Cooler Temperature Blank		One per cooler to the laboratory	Contamination, Bias	<6 °C	S
Field Duplicate		One per 10 samples per matrix	Accuracy / Precision	RPD ≤ 35%	S&A

SAP Worksheet #12-B1—Measurement Performance Criteria Table- Field QC Samples

Matrix: Groundwater

Analytical Group: VOCs

Concentration Level: Medium

QC Sample	Analytical Group	Frequency	DQIs	MPC	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
Equipment Rinsate Blank	VOCs	One per day of sampling per type of equipment	Contamination, Bias	no analyte detected >1/2 LOQ	S&A
Trip Blank		One per cooler to the laboratory	Contamination, Bias		S&A
Cooler Temperature Blank		One per cooler to the laboratory	Contamination, Bias	<6 °C	S
Field Duplicate		One per 10 samples per matrix	Accuracy / Precision	RPD ≤ 25%	S&A

SAP Worksheet #12-B2—Measurement Performance Criteria Table- Field QC Samples

Matrix: Groundwater

Analytical Group: SVOCs, Pesticides, PCBs¹

Concentration Level: Medium and Low

QC Sample	Analytical Group	Frequency	DQIs	MPC	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
Equipment Rinsate Blank	SVOCs, Pesticides, PCBs	One per day of sampling per type of equipment	Contamination, Bias	no analyte detected >1/2 LOQ	S&A
Cooler Temperature Blank		One per cooler to the laboratory	Contamination, Bias	<6 °C	S
Field Duplicate		One per 10 samples per matrix	Accuracy / Precision	RPD ≤ 25%	S&A

¹ Field QA/QC samples will be collected for each analytical group.

SAP Worksheet #12-B3—Measurement Performance Criteria Table- Field QC Samples

Matrix: Groundwater (Unfiltered and Filtered)

Analytical Group: Metals and/or Dissolved Metals

Concentration Level: Low

QC Sample	Analytical Group	Frequency	DQIs	MPC	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
Equipment Rinsate Blank	Metals and/or Dissolved Metals	One per day of sampling per type of equipment	Contamination, Bias	no analyte detected >1/2 LOQ	S&A
Cooler Temperature Blank		One per cooler to the laboratory	Contamination, Bias	<6 °C	S
Field Duplicate		One per 10 samples per matrix	Accuracy / Precision	RPD ≤ 25%	S&A

SAP Worksheet #13—Secondary Data Criteria and Limitations Table

Secondary Data	Data Source	Data Generator(s)	How Data Will Be Used	Limitations on Data Use
Yorktown Background Dataset	Calculation of UTL Background Values at WPNSTA Yorktown and Cheatham Annex	CH2M HILL, 2010	UTLs will be used to screen chemicals identified as posing potential risk to determine if those chemicals are site related	If background DLs are greater than concentrations of contaminants posing potential risk, usefulness may be limited

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SAP Worksheet #14—Summary of Project Tasks

Project Logistics

In general, work will be performed in Level D personal protective equipment (PPE), which includes hardhat, safety glasses, safety toed boots, and hearing protection. Optional PPE includes the use of Tyvek® coveralls as necessary. Upgrades to higher levels of PPE are discussed in the Health and Safety Plan (HSP), which will be provided as a separate document from this UFP-SAP.

Well installation, development, and sampling will take place during normal working hours.

Following the investigational activities, the site will be restored to its original condition to the satisfaction of the property owner.

Project Tasks

Applicable SOPs for project tasks outlined in this section are listed on [Worksheet #21](#) and provided in [Appendix A](#).

Utility Clearance

Utilities will be cleared before beginning intrusive activities. CH2M HILL will coordinate utility clearance with Miss Utility of Virginia and the base's approving authority. Additionally, a separate utilities subcontractor (Accumark) will ensure the accuracy of the utility markings. Any proposed monitoring well locations interfering with utility locations will be relocated to avoid impact to utilities while continuing to meet the intent of the sampling rationale.

Investigational Activities

- **Monitoring Well Installation** - Five permanent monitoring wells will be installed (one upgradient and four downgradient of site features comprising the former trickling filter, Imhoff Tank, sludge drying bed and chlorination unit). Proposed monitoring well locations are shown on [Figure 3](#). New monitoring well screen depths will be installed 10 ft into the top of the shallow aquifer. Each new monitoring well will be constructed with 2-inch inside-diameter Schedule 40 polyvinyl chloride (PVC) screen and riser. The monitoring well screen will be machine slotted (0.010-inch slot width) and be 10 ft long. A silica filter pack will be placed around the annular space of the well screen from the bottom of the boring extending to 2 ft above the top of the screen. A 2-ft-thick bentonite layer will be placed above the sand pack. After the bentonite has been hydrated, a cement-bentonite grout will be placed in the remaining annular space. The monitoring wells will be completed with stickup casing with a watertight steel cover. A locking, watertight cap will be placed on the PVC pipe and the wells clearly marked. Wells will be surrounded with bollards and locked.
- **Monitoring Well Development**--Each new monitoring well will be developed using a submersible pump. At least three well volumes of water will be removed, in addition to the amount of water added during the installation process. Development will continue until water quality parameters have stabilized and turbidity has been reduced to the extent practicable. Development information, including turbidity, pH, specific conductivity, temperature, and gallons removed, will be recorded in the field logbook.
- **Water-Level Survey**--A complete round of water levels will be recorded from the monitoring wells sampled. Depth to water and time measured will be recorded in the field logbook.
- **Groundwater Sampling**--All site monitoring wells will be sampled using a peristaltic pump and disposable tubing following low-flow sampling protocol. Groundwater quality parameters (pH, specific conductance, turbidity, DO, temperature, salinity, and ORP) will be recorded and stabilized before a sample is collected.

SAP Worksheet #14—Summary of Project Tasks (continued)

- **Discrete Soil Sampling** – Surface and subsurface soil samples will be collected with acetate sleeves or hand auger. Surface soil will be collected from 0- 6 inches bgs and subsurface soil will be collected from 6-24 inches bgs. Additionally, in the location of the former trickling filter, an additional soil sample will be collected directly above the water table to ensure that mercury identified below the structure during its demolition has been completely removed.
- **Composite Soil Sampling** – Five-point composite surface and subsurface soil samples will be collected with hand augers from within the footprint of the former sludge drying bed. Surface soil will be collected from 0- 6 inches bgs and subsurface soil will be collected from 6- 24 inches bgs. Soil samples for all analyses except VOCs will be homogenized and composited in the field. Composite soil samples for VOCs will not be homogenized prior to placement in the sample container.

Equipment Decontamination

- All non-disposable sampling equipment will be decontaminated before use and immediately after each use in accordance with applicable SOPs ([Appendix A](#)). The water-level indicator will be rinsed with deionized water between each measurement. Heavy equipment such as drill rig (augers, rods or split spoons) will be steam-cleaned before use at each new monitoring well location. Monitoring well risers and screens will also be steam-cleaned using the same procedure, unless they are certified by the manufacturer as clean and the plastic seals intact. A decontamination pad will be set up to prevent runoff of the decontamination water and to allow easy collection of decontamination fluids.

Investigation-derived Waste Handling

- Investigation-derived waste (IDW) generated during investigational activities at Site 32 will include drill cuttings from monitoring well installation, well development and purge water, and solutions used to decontaminate drilling equipment. Solid and aqueous IDW will be containerized in approved 55-gallon drums.
- IDW will be characterized for appropriate offsite disposal and will be removed from the site within 90 days of generation. Soil and aqueous IDW generated during monitoring well installation and sampling will be contained in 55-gallon drums, sampled, and characterized for appropriate offsite disposal.

Quality Control

- Implement SOPs for field ([Appendix A](#)) and laboratory activities being performed.
- Summary of daily field activities will be documented in a field log book; this log book will also detail sampling activities and information regarding boring logs, well construction, and well development.
- QC samples to be collected are outlined on [Worksheet #20](#).

Surveying

- Newly installed monitoring wells will be horizontally (± 0.1 ft) and vertically (± 0.01 ft) located by a Virginia-licensed surveyor.

Analytical Tasks

- The laboratory will maintain, test, inspect, and calibrate analytical instruments ([Worksheets #24](#) and [#25](#)).
- The laboratory will process and prepare samples for analysis.

SAP Worksheet #14—Summary of Project Tasks (continued)

Data Management

- See [Appendix B](#), Navy CLEAN Data Management Plan for all data management procedures.
- Procedures for data tracking, storage, archiving, retrieval and security for both electronic and hardcopy data:
 - See the Navy CLEAN Data Management Plan for detailed information ([Appendix B](#))
 - The Project PDM, Hillary Ott, is responsible for data tracking and storage
 - Stacy Davenport of CH2M HILL will coordinate archiving and retrieval of data

Project Assessment/Audit

- [Worksheets #31](#) and [#32](#)

Data Review

- Data Validation ([Worksheets #35](#) and [#36](#))

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SAP Worksheet #15-A1—Reference Limits and Evaluation Table

Matrix: Surface Soil, Subsurface Soil

Analytical Group: VOCs

Analyte	Chemical Abstract Services (CAS) Number	Residential Soil RSL (adjusted) ¹	Ecological Screening Value ¹	Project Quantitation Limit (PQL) Goal ²	Units	Laboratory-specific			Laboratory Control Sample (LCS) and Matrix Spike (MS)/Matrix Spike Duplicate (MSD) Recovery Limits		
						LOQ	LO D	DL	Lower Control Limit (LCL) %	Upper Control Limit (UCL) %	RPD %
Dichlorodifluoromethane (Freon-12)	75-71-8	9400	No Criteria (NC)	4700	micrograms per kilogram (µg/kg)	1	1	0.6	35	135	30
Chloromethane	74-87-3	12000	5000	2500		1	1	0.6	50	130	30
Vinyl chloride	75-01-4	60	412	30		1	1	0.4	60	125	30
Bromomethane	74-83-9	730	NC	365		1	1	0.8	30	160	30
Chloroethane	75-00-3	1500000	5000	2500		1	1	0.5	40	155	30
Trichlorofluoromethane(Freon-11)	75-69-4	79000	NC	39500		1	1	0.5	25	185	30
1,1-Dichloroethene	75-35-4	24000	173	86.5		1	1	0.6	65	135	30
1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113)	76-13-1	910000	NC	455000		1	1	0.6	70	130	30
Acetone	67-64-1	6100000	NC	3050000		25	12	0.8	20	160	30
Carbon disulfide	75-15-0	82000	NC	41000		5	5	1.4	45	160	30
Methyl acetate	79-20-9	7800000	NC	3900000		10	5	1.6	70	130	30
Methylene chloride	75-09-2	11000	1250	625		10	5	0.6	55	140	30
trans-1,2-Dichloroethene	156-60-5	15000	447	223.5		1	1	0.7	65	135	30
Methyl-tert-butyl ether (MTBE)	1634-04-4	43000	NC	21500		1	1	0.3	58	123	30
1,1-Dichloroethane	75-34-3	3300	548	274		1	1	0.6	75	125	30
cis-1,2-Dichloroethene	156-59-2	16000	447	223.5		1	1	0.5	65	125	30
2-Butanone	78-93-3	2800000	NC	1400000	5	2.5	1.4	30	160	30	

SAP Worksheet #15-A1—Reference Limits and Evaluation Table (continued)

Matrix: Surface Soil, Subsurface Soil

Analytical Group: VOCs

Analyte	CAS Number	Residential Soil RSL (adjusted) ¹	Ecological Screening Value ¹	PQL Goal ²	Units	Laboratory-specific			LCS and MS/MSD Recovery Limits		
						LOQ	LOD	DL	LCL %	Upper Control Limit (UCL) %	RPD %
Chloroform	67-66-3	290	1844	145	µg/kg	1	1	0.4	70	125	30
1,1,1-Trichloroethane	71-55-6	640000	5000	2500		1	1	0.4	70	135	30
Cyclohexane	110-82-7	120000	6000	3000		1	1	0.5	70	130	30
Carbon tetrachloride	56-23-5	610	3400	305		1	1	0.6	65	135	30
Benzene	71-43-2	1100	1140	550		1	1	0.4	75	125	30
1,2-Dichloroethane	107-06-2	430	2190	215		1	1	0.3	70	135	30
Trichloroethene	79-01-6	2500	500	250		1	1	0.5	75	125	30
Methylcyclohexane	108-87-2	NC	NC	1		2	1	0.3	70	130	30
1,2-Dichloropropane	78-87-5	940	38800	470		1	1	0.6	70	120	30
Bromodichloromethane	75-27-4	270	NC	135		1	1	0.4	70	130	30
cis-1,3-Dichloropropene	10061-01-5	1700	5000	850		1	1	0.3	70	125	30
4-Methyl-2-pentanone	108-10-1	530000	NC	265000		5	2.5	1.4	45	145	30
Toluene	108-88-3	500000	40000	20000		1	1	0.5	70	125	30
trans-1,3-Dichloropropene	10061-02-6	1700	5000	850		1	1	0.3	65	125	30
1,1,2-Trichloroethane	79-00-5	160	2000	80		1	1	0.6	60	125	30
Tetrachloroethene	127-18-4	550	179	89.5		1	1	0.3	65	140	30
2-Hexanone	591-78-6	21000	NC	10500		5	2.5	0.9	45	145	30

SAP Worksheet #15-A1—Reference Limits and Evaluation Table (continued)

Matrix: Surface Soil, Subsurface Soil

Analytical Group: VOCs

Analyte	CAS Number	Residential Soil RSL (adjusted) ¹	Ecological Screening Value ¹	PQL Goal ²	Units	Laboratory-specific			LCS and MS/MSD Recovery Limits		
						LOQ	LOD	DL	LCL %	Upper Control Limit (UCL) %	RPD %
Dibromochloromethane	124-48-1	680	NC	340	µg/kg	1	1	0.2	65	130	30
1,2-Dibromoethane	106-93-4	34	300	17		1	1	0.3	70	125	30
Chlorobenzene	108-90-7	29000	2400	1200		1	1	0.5	75	125	30
Ethylbenzene	100-41-4	5400	1815	907.5		1	1	0.6	75	125	30
Xylene, total	1330-20-7	63000	NC	31500		3	3	1.4			
Styrene	100-42-5	630000	64000	32000		1	1	0.4	75	125	30
Bromoform	75-25-2	62000	300	150		1	1	0.3	55	135	30
Isopropylbenzene	98-82-8	210000	NC	105000		1	1	0.5	75	130	30
1,1,2,2-Tetrachloroethane	79-34-5	560	5000	280		1	1	0.3	55	130	30
1,3-Dichlorobenzene	541-73-1	NC	NC	1		1	1	0.4	70	125	30
1,4-Dichlorobenzene	106-46-7	2400	1280	640		1	1	0.4	70	125	30
1,2-Dichlorobenzene	95-50-1	190000	1000	500		1	1	0.4	75	120	30
1,2-Dibromo-3-chloropropane	96-12-8	5.4	NC	2.7		1	1	0.3	40	135	30
1,2,4-Trichlorobenzene	120-82-1	NC	NC	1		1	1	0.6	65	130	30

¹ PALs were developed to be protective of human health and the environment. Refer to [Worksheets #10](#) and [#11](#) for a detailed discussion on the development of PALs. There are no background values for VOCs; therefore they are omitted from this table.

² PQL Goals are equal to half of the minimum of the applicable criteria (PALs). If no PALs are available, the PQL goal is equivalent to the laboratory LOD.

SAP Worksheet #15-A2—Reference Limits and Evaluation Table

Matrix: Surface Soil, Subsurface Soil

Analytical Group: SVOCs

Analyte	CAS Number	Residential Soil RSL (adjusted) ¹	Ecological Screening Value ¹	Project Quantitation Limit Goal ²	Units	Laboratory-specific			LCS and MS/MSD Recovery Limits		
						LOQ	LOD	DL	LCL (%)	UCL (%)	RPD %
Benzaldehyde	100-52-7	780000	NC	390000	µg/kg	330	100	48	60	83	30
Phenol	108-95-2	1800000	1880	940		330	100	64	40	100	30
bis(2-Chloroethyl)ether	111-44-4	210	NC	105		330	100	43	40	105	30
2-Chlorophenol	95-57-8	39000	500	250		330	100	74	45	105	30
2-Methylphenol	95-48-7	310000	1000	500		330	100	33	40	105	30
2,2'-Oxybis(1-chloropropane)	108-60-1	4600	NC	2300		330	100	45	20	115	30
Acetophenone	98-86-2	780000	NC	390000		330	100	84	52	86	30
3&4-Methylphenol	106-44-5	31000	1000	500		330	100	79	40	105	30
n-Nitroso-di-n-propylamine	621-64-7	69	NC	34.5		330	100	44	40	115	30
Hexachloroethane	67-72-1	6100	NC	3050		330	100	45	35	110	30
Nitrobenzene	98-95-3	4800	NC	2400		330	100	45	40	115	30
Isophorone	78-59-1	510000	NC	255000		330	100	42	45	110	30
2-Nitrophenol	88-75-5	39000	1000	500		330	100	71	40	110	30
2,4-Dimethylphenol	105-67-9	120000	1000	500		330	100	49	30	105	30
bis(2-Chloroethoxy)methane	111-91-1	18000	NC	9000		330	100	40	45	110	30
2,4-Dichlorophenol	120-83-2	18000	500	250		330	100	73	45	110	30
Naphthalene	91-20-3	3600	3625	1800		33	25	23	40	105	30
4-Chloroaniline	106-47-8	2400	500	250		330	100	29	10	100	30
Hexachlorobutadiene	87-68-3	6100	NC	3050		330	100	44	40	115	30
Caprolactam	105-60-2	3100000	NC	1550000		330	200	41	14	125	30
4-Chloro-3-methylphenol	59-50-7	610000	500	250		330	100	80	45	115	30
2-Methylnaphthalene	91-57-6	31000	3625	1812.5		33	25	21	45	105	30
Hexachlorocyclopentadiene	77-47-4	37000	2000	1000		330	100	45	24	120	30
2,4,6-Trichlorophenol	88-06-2	6100	580	290		330	100	62	45	110	30
2,4,5-Trichlorophenol	95-95-4	610000	1350	675		330	100	37	50	110	30

SAP Worksheet #15-A2—Reference Limits and Evaluation Table (continued)

Matrix: Surface Soil, Subsurface Soil

Analytical Group: SVOCs

Analyte	CAS Number	Residential Soil RSL (adjusted) ¹	Ecological Screening Value ¹	Project Quantitation Limit Goal ²	Units	Laboratory-specific			LCS and MS/MSD Recovery Limits		
						LOQ	LOD	DL	LCL (%)	UCL (%)	RPD %
1,1-Biphenyl	92-52-4	5100	13600	2550	µg/kg	330	100	56	64	87	30
2-Chloronaphthalene	91-58-7	180000	NC	90000		330	100	43	45	105	30
2-Nitroaniline	88-74-4	NC	NC	100		330	100	55	45	120	30
Dimethyl phthalate	131-11-3	NC	NC	100		330	100	52	50	110	30
2,6-Dinitrotoluene	606-20-2	6100	NC	3050		330	100	56	50	110	30
Acenaphthylene	208-96-8	340000	3625	1812.5		33	25	19	45	105	30
3-Nitroaniline	99-09-2	NC	NC	100		330	100	56	25	110	30
Acenaphthene	83-32-9	340000	3625	1812.5		33	25	22	45	110	30
2,4-Dinitrophenol	51-28-5	12000	20000	6000		330	300	36	15	130	30
4-Nitrophenol	100-02-7	4800	380	190		330	100	76	15	140	30
Dibenzofuran	132-64-9	7800	NC	3900		330	100	55	50	105	30
2,4-Dinitrotoluene	121-14-2	1600	NC	800		330	100	56	50	115	30
Diethylphthalate	84-66-2	4900000	26800	13400		330	100	66	50	115	30
Fluorene	86-73-7	230000	3625	1812.5		33	25	21	40	110	30
4-Chlorophenyl-phenylether	7005-72-3	31000	NC	15500		330	100	56	45	110	30
4-Nitroaniline	100-01-6	24000	NC	12000		330	100	49	35	115	30
4,6-Dinitro-2-methylphenol	534-52-1	490	1000	245		330	300	76	30	135	30
n-Nitrosodiphenylamine	86-30-6	99000	1090	545		330	200	110	50	115	30
4-Bromophenyl-phenylether	101-55-3	NC	NC	100		330	100	47	45	115	30
Hexachlorobenzene	118-74-1	300	1000	150		330	100	38	45	120	30
Atrazine	1912-24-9	2100	11.9	5.95		330	100	77	45	120	30
Pentachlorophenol	87-86-5	890	5000	445		330	300	89	25	120	30
Phenanthrene	85-01-8	1700000	3625	1812.5		33	25	18	50	110	30
Anthracene	120-12-7	1700000	3625	1812.5		33	25	14	55	105	30
Carbazole	86-74-8	NC	NC	100		330	100	47	45	115	30
Di-n-butylphthalate	84-74-2	610000	40000	20000		330	100	73	55	110	30

SAP Worksheet #15-A2—Reference Limits and Evaluation Table (continued)

Matrix: Surface Soil, Subsurface Soil

Analytical Group: SVOCs

Analyte	CAS Number	Residential Soil RSL (adjusted) ¹	Ecological Screening Value ¹	Project Quantitation Limit Goal ²	Units	Laboratory-specific			LCS and MS/MSD Recovery Limits		
						LOQ	LOD	DL	LCL (%)	UCL (%)	RPD %
Fluoranthene	206-44-0	230000	3625	1812.5		33	25	13	55	115	30
Pyrene	129-00-0	170000	2000	1000		33	25	12	45	125	30
Butylbenzylphthalate	85-68-7	260000	30000	15000		330	100	85	50	125	30
3,3'-Dichlorobenzidine	91-94-1	1100	NC	550		330	100	63	10	130	30
Benzo(a)anthracene	56-55-3	150	2000	75		33	25	9.3	50	110	30
Chrysene	218-01-9	15000	2000	1000		33	25	11	55	110	30
bis(2-Ethylhexyl)phthalate	117-81-7	35000	30000	15000		330	100	78	45	125	30
Di-n-octylphthalate	117-84-0	NC	NC	100		330	100	75	40	130	30
Benzo(b)fluoranthene	205-99-2	150	2000	75		33	25	12	45	115	30
Benzo(k)fluoranthene	207-08-9	1500	2000	750		33	25	12	45	125	30
Benzo(a)pyrene	50-32-8	15	2000	7.5		33	25	6.7	50	110	30
Indeno(1,2,3-cd)pyrene	193-39-5	150	2000	75		33	25	12	40	120	30
Dibenz(a,h)anthracene	53-70-3	15	2000	7.5		33	25	11	40	125	30
Benzo(g,h,i)perylene	191-24-2	170000	2000	1000		33	25	12	40	125	30

¹ PALs were developed to be protective of human health and the environment. Refer to [Worksheets #10](#) and [#11](#) for a detailed discussion on the development of PALs. There are no background values for SVOCs; therefore they are omitted from this table.

² PQL Goals are equal to half of the minimum of the applicable criteria (PALs). If no PALs are available, the PQL goal is equivalent to the laboratory LOD.

Shading represents cases where the PAL is lower than the laboratory LOD. Refer to [Worksheet #11](#), "How 'good' must the data be..." for a discussion of how data will be used in this instance.

SAP Worksheet #15-A3—Reference Limits and Evaluation Table

Matrix: Surface Soil, Subsurface Soil

Analytical Group: Pesticides

Analyte	CAS Number	Residential Soil RSL (adjusted) ¹	Ecological Screening Value ¹	PQL Goal ²	Units	Laboratory-specific			LCS and MS/MSD Recovery Limits		
						LOQ	LOD	DL	LCL (%)	UCL (%)	RPD %
alpha- benzene hexachloride (BHC)	319-84-6	77	226	38.5	µg/kg	1.7	1	0.49	60	125	30
beta-BHC	319-85-7	270	342	135		1.7	1	1	60	125	30
delta-BHC	319-86-8	270	226	113		1.7	1	0.48	55	130	30
gamma-BHC (Lindane)	58-89-9	520	7.75	3.875		1.7	1	0.45	60	125	30
Heptachlor	76-44-8	110	52.9	26.45		1.7	1	0.53	50	140	30
Aldrin	309-00-2	29	3.63	1.815		1.7	1	0.49	45	140	30
Heptachlor epoxide	1024-57-3	53	52.9	26.45		1.7	1	0.48	65	130	30
Endosulfan I	959-98-8	37000	6.32	3.16		1.7	1	0.39	15	135	30
Dieldrin	60-57-1	30	10.5	5.25		1.7	1	0.45	65	125	30
4,4'-DDE	72-55-9	1400	114	57		1.7	1	0.52	70	125	30
Endrin	72-20-8	1800	1.95	0.975		1.7	1	0.74	60	135	30
Endosulfan II	33213-65-9	37000	6.32	3.16		1.7	1	0.48	35	140	30
4,4'-DDD	72-54-8	2000	583	291.5		1.7	1	0.48	30	135	30
Endosulfan sulfate	1031-07-8	37000	6.32	3.16		1.7	1	0.49	60	135	30
4,4'-DDT	50-29-3	1700	100	50		1.7	1	0.66	45	140	30
Methoxychlor	72-43-5	31000	500	250		1.7	1	0.86	55	145	30
Endrin ketone	53494-70-5	1800	1.95	0.975		1.7	1	0.45	65	135	30
Endrin aldehyde	7421-93-4	1800	1.95	0.975		1.7	1	0.5	35	145	30
alpha-Chlordane	5103-71-9	1600	11	5.5		1.7	1	0.45	65	120	30
gamma-Chlordane	5103-74-2	1600	11	5.5		1.7	1	0.45	65	125	30
Toxaphene	8001-35-2	440	500	220	33	20	10	60	140	40	

¹ PALs were developed to be protective of human health and the environment. Refer to [Worksheets #10](#) and [#11](#) for a detailed discussion on the development of PALs. There are no background values for pesticides; therefore they are omitted from this table.

² PQL Goals are equal to half of the minimum of the applicable criteria (PALs).

SAP Worksheet #15-A4—Reference Limits and Evaluation Table

Matrix: Surface Soil, Subsurface Soil

Analytical Group: PCBs

Analyte	CAS Number	Residential Soil RSL (adjusted) ¹	Ecological Screening Value ¹	PQL Goal ²	Units	Laboratory-specific			LCS and MS/MSD Recovery Limits		
						LOQ	LOD	DL	LCL (%)	UCL (%)	RPD %
Aroclor-1016	12674-11-2	390	8000	195	µg/kg	40	20	6.9	25	145	20
Aroclor-1221	11104-28-2	140	8000	70		40	20	12	11	162	23
Aroclor-1232	11141-16-5	140	8000	70		40	20	13	11	162	23
Aroclor-1242	53469-21-9	220	8000	110		40	20	10	11	162	23
Aroclor-1248	12672-29-6	220	8000	110		40	20	5.5	11	162	23
Aroclor-1254	11097-69-1	110	8000	55		40	20	12	11	162	23
Aroclor-1260	11096-82-5	220	8000	110		40	20	3	30	145	19

¹ PALs were developed to be protective of human health and the environment. Refer to [Worksheets #10](#) and [#11](#) for a detailed discussion on the development of PALs. There are no background values for PCBs; therefore they are omitted from this table.

² PQL Goals are equal to half of the minimum of the applicable criteria (PALs).

SAP Worksheet #15-A5—Reference Limits and Evaluation Table

Matrix: Surface Soil, Subsurface Soil

Analytical Group: Metals

Analyte	CAS Number	WPNSTA Yorktown Background Dataset ¹	Residential Soil RSL (adjusted) ¹	Ecological Screening Value ¹	PQL Goal ²	Units	Laboratory-specific			LCS and MS/MSD Recovery Limits		
							LOQ	LOD	DL	LCL (%)	UCL (%)	RPD %
Aluminum	7429-90-5	12200	7700	NC	3850	milligrams per kilogram (mg/kg)	40	20	5.2	80	120	20
Antimony	7440-36-0	11	3.1	78	1.55		0.5	0.3	0.2	80	120	20
Arsenic	7440-38-2	6.36	0.39	18	0.195		20	10	0.51	80	120	20
Barium	7440-39-3	52.9	1500	330	26.45		10	3.5	1.1	80	120	20
Beryllium	7440-41-7	0.587	16	40	0.2935		2	0.3	0.1	80	120	20
Cadmium	7440-43-9	1.5	7	32	0.75		8	4	0.13	80	120	20
Calcium	7440-70-2	2290	NC	NC	1145		600	300	18	80	120	20
Chromium	7440-47-3	18.2	0.29	64	0.145		10	5	0.55	80	120	20
Cobalt	7440-48-4	9.93	2.3	13	1.15		1	0.6	0.14	80	120	20
Copper	7440-50-8	4.25	310	70	2.125		2	1	0.22	80	120	20
Iron	7439-89-6	19900	5500	NC	2750		14	7	1.7	80	120	20
Lead	7439-92-1	17.4	400	120	8.7		5	1	0.24	80	120	20
Magnesium	7439-95-4	1070	NC	NC	535		220	110	28	80	120	20
Manganese	7439-96-5	324	180	220	90		2.4	1.2	0.28	80	120	20
Mercury	7439-97-6	0.111	2.3	0.1	0.05		0.0162	0.0057	0.0019	80	120	20
Nickel	7440-02-0	9.52	150	38	4.76		1.2	0.6	0.25	80	120	20
Potassium	7440-09-7	708	NC	NC	354		1000	500	29	80	120	20
Selenium	7782-49-2	0.51	39	0.52	0.255		7	3.5	0.91	80	120	20
Silver	7440-22-4	2.1	39	560	1.05		0.5	0.08	0.033	80	120	20
Sodium	7440-23-5	521	NC	NC	260.5		400	200	47	80	120	20
Thallium	7440-28-0	NC	0.078	1	0.039	1	0.15	0.037	80	120	20	
Vanadium	7440-62-2	27.9	39	130	13.95	2	1	0.22	80	120	20	
Zinc	7440-66-6	26.5	2300	120	13.25	10	5	1.3	80	120	20	

¹ PALs were developed to be protective of human health and the environment. Refer to [Worksheets #10](#) and [#11](#) for a detailed discussion on the development of PALs.

² PQL Goals are equal to half of the minimum of the applicable criteria (PALs).

Shading represents cases where the PAL is lower than the laboratory LOD. Refer to [Worksheet #11](#), "How 'good' must the data be...." for a discussion of how data will be used in this instance.

SAP Worksheet #15-B1—Reference Limits and Evaluation Table

Matrix: Groundwater
 Analytical Group: VOCs

Analyte	CAS Number	Tapwater RSL (adjusted) ¹	MCL ¹	Freshwater Eco PAL ¹	PQL Goal ²	Units	Laboratory-specific			LCS and MS/MSD Recovery Limits		
							LOQ	LOD	DL	LCL (%)	UCL (%)	RPD %
Dichlorodifluoromethane (Freon-12)	75-71-8	20	NC	NC	10	micrograms per liter (µg/L)	1	1	0.74	30	155	30
Chloromethane	74-87-3	19	NC	5500	9.5		1	1	0.82	40	125	30
Vinyl chloride	75-01-4	0.016	2	930	0.008		1	1	0.71	50	145	30
Bromomethane	74-83-9	0.87	NC	110	0.435		1	1	0.95	30	145	30
Chloroethane	75-00-3	2100	NC	NC	1050		1	1	0.98	60	135	30
Trichlorofluoromethane (Freon-11)	75-69-4	130	NC	NC	65		1	1	0.68	60	145	30
1,1-Dichloroethene	75-35-4	34	7	25	3.5		1	1	0.94	70	130	30
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon-113)	76-13-1	5900	NC	NC	2950		1	1	0.73	47	173	30
Acetone	67-64-1	2200	NC	1500	750		12	12	1.8	40	140	30
Carbon disulfide	75-15-0	100	NC	0.92	0.46		5	5	1.9	35	160	30
Methyl acetate	79-20-9	3700	NC	NC	1850		2	1	0.95	24	129	30
Methylene chloride	75-09-2	4.8	5	2200	2.4		5	5	0.69	55	140	30
trans-1,2-Dichloroethene	156-60-5	11	100	590	5.5		1	1	0.72	60	140	30
MTBE	1634-04-4	12	NC	11070	6		1	1	0.6	65	125	30
1,1-Dichloroethane	75-34-3	2.4	NC	47	1.2		1	1	0.57	70	135	30
cis-1,2-Dichloroethene	156-59-2	7.3	70	590	3.65		1	1	0.49	70	125	30
2-Butanone	78-93-3	710	NC	14000	355		12	12	4.5	30	150	30
Chloroform	67-66-3	0.19	80	28	0.095		1	1	0.54	65	135	30
1,1,1-Trichloroethane	71-55-6	910	200	11	5.5		1	1	0.59	65	130	30
Cyclohexane	110-82-7	1300	NC	NC	650		2	1	0.93	45	147	30
Carbon tetrachloride	56-23-5	0.44	5	240	0.22	1	1	0.65	65	140	30	

SAP Worksheet #15-B1—Reference Limits and Evaluation Table (continued)

Matrix: Groundwater
 Analytical Group: VOCs

Analyte	CAS Number	Tapwater RSL (adjusted) ¹	MCL ¹	Freshwater Eco PAL ¹	PQL Goal ²	Units	Laboratory-specific			LCS and MS/MSD Recovery Limits		
							LOQ	LOD	DL	LCL (%)	UCL (%)	RPD %
Benzene	71-43-2	0.41	5	130	0.205	µg/L	1	1	0.58	80	120	30
1,2-Dichloroethane	107-06-2	0.15	5	910	0.075		1	1	0.5	70	130	30
Trichloroethene	79-01-6	2	5	47	1		1	1	0.55	70	125	30
Methylcyclohexane	108-87-2	NC	NC	NC	0		2	1	0.59	55	121	30
1,2-Dichloropropane	78-87-5	0.39	5	525	0.195		1	1	0.8	75	125	30
Bromodichloromethane	75-27-4	0.12	80	NC	0.06		1	1	0.49	75	120	30
cis-1,3-Dichloropropene	10061-01-5	0.43	NC	24.4	0.215		1	1	0.59	70	130	30
4-Methyl-2-pentanone	108-10-1	200	NC	170	85		12	12	2.8	60	135	30
Toluene	108-88-3	230	1000	9.8	4.9		1	1	0.58	75	120	30
trans-1,3-Dichloropropene	10061-02-6	0.43	NC	24.4	0.215		1	1	0.64	55	140	30
1,1,2-Trichloroethane	79-00-5	0.042	5	1200	0.021		1	1	0.63	75	125	30
Tetrachloroethene	127-18-4	0.11	5	98	0.055		1	1	0.76	45	150	30
2-Hexanone	591-78-6	4.7	NC	99	2.35		5	2.5	1.4	55	130	30
Dibromochloromethane	124-48-1	0.15	80	NC	0.075		1	1	0.44	60	135	30
1,2-Dibromoethane	106-93-4	0.0065	0.05	NC	0.00325		1	1	0.78	80	120	30
Chlorobenzene	108-90-7	9.1	100	64	4.55		1	1	0.51	80	120	30
Ethylbenzene	100-41-4	1.5	700	290	0.75		1	1	0.69	75	125	30
Xylene, total	1330-20-7	20	10000	13	6.5		3	3	1.8	na	na	na
Styrene	100-42-5	160	100	72	36		1	1	0.49	65	135	30
Bromoform	75-25-2	8.5	80	320	4.25		1	1	0.75	70	130	30
Isopropylbenzene	98-82-8	68	NC	2.6	1.3	1	1	0.67	75	125	30	

SAP Worksheet #15-B1—Reference Limits and Evaluation Table (continued)

Matrix: Groundwater

Analytical Group: VOCs

Analyte	CAS Number	Tapwater RSL (adjusted) ¹	MCL ¹	Freshwater Eco PAL ¹	PQL Goal ²	Units	Laboratory-specific			LCS and MS/MSD Recovery Limits		
							LOQ	LOD	DL	LCL (%)	UCL (%)	RPD %
1,1,2,2-Tetrachloroethane	79-34-5	0.067	NC	610	0.0335		1	1	0.54	65	130	30
1,3-Dichlorobenzene	541-73-1	NC	NC	71	35.5		1	1	0.53	75	125	30
1,4-Dichlorobenzene	106-46-7	0.43	75	15	0.215		1	1	0.46	75	125	30
1,2-Dichlorobenzene	95-50-1	37	600	14	7		1	1	0.57	70	120	30
1,2-Dibromo-3-chloropropane	96-12-8	0.00032	0.2	NC	0.00016		1	1	0.96	50	130	30
1,2,4-Trichlorobenzene	120-82-1	0.41	70	110	0.205		1	1	0.7	65	135	30

¹ PALs were developed to be protective of human health and the environment. Refer to [Worksheets #10](#) and [#11](#) for a detailed discussion on the development of PALs. There are no background values for VOCs; therefore they are omitted from this table.

² PQL Goals are equal to half of the minimum of the applicable criteria (PALs). If no PALs are available, the PQL goal is equivalent to the laboratory LOD.

Shading represents cases where the PAL is lower than the laboratory LOD. Refer to [Worksheet #11](#), “How ‘good’ must the data be....” for a discussion of how data will be used in this instance.

SAP Worksheet #15-B2—Reference Limits and Evaluation Table

Matrix: Groundwater

Analytical Group: SVOCs

Analyte	CAS Number	Tapwater RSL (adjusted) ¹	MCL ¹	Freshwater Eco PAL ¹	PQL Goal ²	Units	Laboratory-specific			LCS and MS/MSD Recovery Limits		
							LOQ	LOD	DL	LCL (%)	UCL (%)	RPD %
Benzaldehyde	100-52-7	370	NC	NC	185	µg/L	10	5	2.6	43	87	30
Phenol	108-95-2	1100	NC	110	55		10	6	1.7	0	115	30
bis(2-Chloroethyl)ether	111-44-4	0.012	NC	1900	0.006		10	6	2.4	35	110	30
2-Chlorophenol	95-57-8	18	NC	24	9		10	6	3.6	35	105	30
2-Methylphenol	95-48-7	180	NC	13	6.5		10	6	1.6	40	110	30
2,2'-Oxybis(1-chloropropane)	108-60-1	0.32	NC	NC	0.16		10	6	2.4	25	130	30
Acetophenone	98-86-2	370	NC	NC	185		10	6	4.8	41	92	30
3&4-Methylphenol	106-44-5	18	NC	543	9		10	6	3.5	30	110	30
n-Nitroso-di-n-propylamine	621-64-7	0.0096	NC	NC	0.0048		10	6	2.6	35	130	30
Hexachloroethane	67-72-1	3.7	NC	12	1.85		10	6	1.6	30	100	30
Nitrobenzene	98-95-3	0.12	NC	270	0.06		10	6	2.6	45	110	30
Isophorone	78-59-1	71	NC	1170	35.5		10	6	2.7	50	110	30
2-Nitrophenol	88-75-5	18	NC	1920	9		10	6	4.2	40	115	30
2,4-Dimethylphenol	105-67-9	73	NC	100	36.5		10	6	3	30	110	30
bis(2-Chloroethoxy)methane	111-91-1	11	NC	NC	5.5		10	6	2.4	45	105	30
2,4-Dichlorophenol	120-83-2	11	NC	11	5.5		10	6	4	50	105	30
Naphthalene	91-20-3	0.14	NC	12	0.07		0.1	0.08	0.04 5	40	100	30
4-Chloroaniline	106-47-8	0.34	NC	232	0.17		10	6	2.4	15	110	30
Hexachlorobutadiene	87-68-3	0.86	NC	1.3	0.43		10	3	1.4	25	105	30
Caprolactam	105-60-2	1800	NC	NC	900		10	4	0.92	14	31	30
4-Chloro-3-methylphenol	59-50-7	370	NC	0.3	0.15		10	6	3.1	45	110	30
2-Methylnaphthalene	91-57-6	15	NC	330	7.5		0.1	0.08	0.04 6	45	105	30
Hexachlorocyclopentadiene	77-47-4	22	50	1.04	0.52		10	3	1.1	13	120	30
2,4,6-Trichlorophenol	88-06-2	3.7	NC	4.9	1.85		10	6	3.3	50	115	30
2,4,5-Trichlorophenol	95-95-4	370	NC	63	31.5		10	3	1.5	50	110	30
1,1-Biphenyl	92-52-4	0.083	NC	14	0.0415		10	5	2.5	46	83	30
2-Chloronaphthalene	91-58-7	290	NC	0.4	0.2		10	3	1.9	50	105	30

SAP Worksheet #15-B2—Reference Limits and Evaluation Table (continued)

Matrix: Groundwater

Analytical Group: SVOCs

Analyte	CAS Number	Tapwater RSL (adjusted) ¹	MCL ¹	Freshwater Eco PAL ¹	PQL Goal ²	Units	Laboratory-specific			LCS and MS/MSD Recovery Limits		
							LOQ	LOD	DL	LCL (%)	UCL (%)	RPD %
2-Nitroaniline	88-74-4	NC	NC	NC	0	µg/L	10	6	2.5	50	115	30
Dimethyl phthalate	131-11-3	NC	NC	330	165		10	3	2	25	125	30
2,6-Dinitrotoluene	606-20-2	3.7	NC	81	1.85		10	3	2.4	50	115	30
Acenaphthylene	208-96-8	220	NC	4840	110		0.1	0.08	0.052	50	105	30
3-Nitroaniline	99-09-2	NC	NC	NC	0		10	3	2.1	20	125	30
Acenaphthene	83-32-9	220	NC	23	11.5		0.1	0.08	0.049	45	110	30
2,4-Dinitrophenol	51-28-5	7.3	NC	19	3.65		10	6	3.3	15	140	30
4-Nitrophenol	100-02-7	0.12	NC	300	0.06		10	3	1.8	0	125	30
Dibenzofuran	132-64-9	3.7	NC	3.7	1.85		10	3	2.3	55	105	30
2,4-Dinitrotoluene	121-14-2	0.22	NC	44	0.11		10	3	2.1	50	120	30
Diethylphthalate	84-66-2	2900	NC	270	135		10	3	2.1	40	120	30
Fluorene	86-73-7	150	NC	3.9	1.95		0.1	0.08	0.049	50	110	30
4-Chlorophenyl-phenylether	7005-72-3	18	NC	NC	9		10	3	1.9	50	110	30
4-Nitroaniline	100-01-6	3.4	NC	NC	1.7		10	3	2.2	35	120	30
4,6-Dinitro-2-methylphenol	534-52-1	0.29	NC	2.3	0.145		10	6	4.3	40	130	30
n-Nitrosodiphenylamine	86-30-6	14	NC	210	7		10	6	3.8	50	110	30
4-Bromophenyl-phenylether	101-55-3	NC	NC	1.5	0.75		10	3	1.4	50	115	30
Hexachlorobenzene	118-74-1	0.042	1	3.68	0.021		10	3	1.2	50	110	30
Atrazine	1912-24-9	0.29	3	1.8	0.145		10	5	2.6	57	88	30
Pentachlorophenol	87-86-5	0.17	1	15	0.085		10	6	3.5	40	115	30
Phenanthrene	85-01-8	1100	NC	6.3	3.15		0.1	0.08	0.044	50	115	30
Anthracene	120-12-7	1100	NC	0.73	0.365		0.1	0.08	0.044	55	110	30
Carbazole	86-74-8	NC	NC	NC	0		10	3	1.9	50	115	30
Di-n-butylphthalate	84-74-2	370	NC	35	17.5		10	3	2.5	55	115	30
Fluoranthene	206-44-0	150	NC	8.1	4.05		0.1	0.08	0.054	55	115	30
Pyrene	129-00-0	110	NC	0.025	0.0125		0.1	0.08	0.053	50	130	30
Butylbenzylphthalate	85-68-7	35	NC	19	9.5		10	6	3.4	45	115	30
3,3'-Dichlorobenzidine	91-94-1	0.15	NC	4.5	0.075		10	3	2.3	20	110	30

SAP Worksheet #15-B2—Reference Limits and Evaluation Table (continued)

Matrix: Groundwater

Analytical Group: SVOCs

Analyte	CAS Number	Tapwater RSL (adjusted) ¹	MCL ¹	Freshwater Eco PAL ¹	PQL Goal ²	Units	Laboratory-specific			LCS and MS/MSD Recovery Limits		
							LOQ	LOD	DL	LCL (%)	UCL (%)	RPD %
Benzo(a)anthracene	56-55-3	0.029	NC	0.027	0.0135		0.1	0.08	0.049	55	110	30
Chrysene	218-01-9	2.9	NC	NC	1.45		0.1	0.08	0.049	55	110	30
bis(2-Ethylhexyl)phthalate	117-81-7	4.8	6	32	2.4		5	3	2.7	40	125	30
Di-n-octylphthalate	117-84-0	NC	NC	22	11		10	3	2.3	35	135	30
Benzo(b)fluoranthene	205-99-2	0.029	NC	9.07	0.0145		0.1	0.08	0.051	45	120	30
Benzo(k)fluoranthene	207-08-9	0.29	NC	9.07	0.145		0.1	0.08	0.054	45	125	30
Benzo(a)pyrene	50-32-8	0.0029	0.2	0.014	0.00145		0.1	0.08	0.058	55	110	30
Indeno(1,2,3-cd)pyrene	193-39-5	0.029	NC	4.31	0.0145		0.1	0.08	0.067	45	125	30
Dibenz(a,h)anthracene	53-70-3	0.0029	NC	NC	0.00145		0.1	0.08	0.069	40	125	30
Benzo(g,h,i)perylene	191-24-2	110	NC	7.64	3.82		0.1	0.08	0.063	40	125	30

¹ PALs were developed to be protective of human health and the environment. Refer to [Worksheets #10 and #11](#) for a detailed discussion on the development of PALs. There are no background values for SVOCs; therefore they are omitted from this table.

² PQL Goals are equal to half of the minimum of the applicable criteria (PALs). If no PALs are available, the PQL goal is equivalent to the laboratory LOD.

Shading represents cases where the PAL is lower than the laboratory LOD. Refer to [Worksheet #11](#), "How 'good' must the data be...." for a discussion of how data will be used in this instance.

SAP Worksheet #15-B3—Reference Limits and Evaluation Table

Matrix: Groundwater

Analytical Group: Pesticides

Analyte	CAS Number	Tapwater RSL (adjusted) ¹	MCL ¹	Freshwater Eco PAL ¹	PQL Goal ²	Units	Laboratory-specific			LCS and MS/MSD Recovery Limits		
							LOQ	LOD	DL	LCL (%)	UCL (%)	RPD %
alpha-BHC	319-84-6	0.011	NC	2.2	0.0055	µg/L	0.1	0.05	0.032	60	130	30
beta-BHC	319-85-7	0.037	NC	2.2	0.0185		0.1	0.05	0.028	65	125	30
delta-BHC	319-86-8	0.037	NC	2.2	0.0185		0.1	0.05	0.043	45	135	30
gamma-BHC (Lindane)	58-89-9	0.061	0.2	0.08	0.0305		0.1	0.05	0.03	25	135	30
Heptachlor	76-44-8	0.015	0.4	0.0069	0.00345		0.1	0.05	0.038	40	130	30
Aldrin	309-00-2	0.004	NC	0.3	0.002		0.1	0.05	0.033	25	140	30
Heptachlor epoxide	1024-57-3	0.0074	0.2	0.0069	0.00345		0.1	0.05	0.027	60	130	30
Endosulfan I	959-98-8	22	NC	0.056	0.028		0.1	0.05	0.025	50	110	30
Dieldrin	60-57-1	0.0042	NC	0.056	0.0021		0.1	0.05	0.031	60	130	30
4,4'-DDE	72-55-9	0.2	NC	0.013	0.0065		0.1	0.05	0.023	35	140	30
Endrin	72-20-8	1.1	2	0.036	0.018		0.1	0.05	0.019	55	135	30
Endosulfan II	33213-65-9	22	NC	0.056	0.028		0.1	0.05	0.023	30	130	30
4,4'-DDD	72-54-8	0.28	NC	0.011	0.0055		0.1	0.05	0.023	25	150	30
Endosulfan sulfate	1031-07-8	22	NC	0.056	0.028		0.1	0.05	0.02	55	135	30
4,4'-DDT	50-29-3	0.2	NC	0.013	0.0065		0.1	0.05	0.015	45	140	30
Methoxychlor	72-43-5	18	40	0.03	0.015		0.1	0.05	0.014	55	150	30
Endrin ketone	53494-70-5	1.1	2	0.15	0.075		0.1	0.05	0.012	75	125	30
Endrin aldehyde	7421-93-4	1.1	2	0.15	0.075		0.1	0.05	0.024	55	135	30
alpha-Chlordane	5103-71-9	0.19	NC	0.17	0.085		0.1	0.05	0.027	65	125	30
gamma-Chlordane	5103-74-2	0.19	NC	0.17	0.085		0.1	0.05	0.038	60	125	30
Toxaphene	8001-35-2	0.061	3	0.011	0.0055	0.64	0.64	0.32	60	140	40	

¹ PALs were developed to be protective of human health and the environment. Refer to [Worksheets #10 and #11](#) for a detailed discussion on the development of PALs. There are no background values for pesticides; therefore they are omitted from this table.

² PQL Goals are equal to half of the minimum of the applicable criteria (PALs).

Shading represents cases where the PAL is lower than the laboratory LOD. Refer to [Worksheet #11](#), "How 'good' must the data be...." for a discussion of how data will be used in this instance.

SAP Worksheet #15-B4—Reference Limits and Evaluation Table

Matrix: Groundwater

Analytical Group: PCBs

Analyte	CAS Number	Tapwater RSL (adjusted) ¹	MCL ¹	Freshwater Eco PAL ¹	PQL Goal ²	Units	Laboratory-specific			LCS and MS/MSD Recovery Limits		
							LOQ	LOD	DL	LCL (%)	UCL (%)	RPD %
Aroclor-1016	12674-11-2	0.26	0.5	0.14	0.07	µg/L	0.68	0.34	0.32	40	140	16
Aroclor-1221	11104-28-2	0.0068	0.5	0.28	0.0034		1.0	0.50	0.46	29	185	21
Aroclor-1232	11141-16-5	0.0068	0.5	0.58	0.0034		1.0	0.50	0.45	29	185	21
Aroclor-1242	53469-21-9	0.034	0.5	0.053	0.017		1.0	0.50	0.49	29	185	21
Aroclor-1248	12672-29-6	0.034	0.5	0.081	0.017		1.0	0.50	0.24	29	185	21
Aroclor-1254	11097-69-1	0.034	0.5	0.033	0.0165		1.0	0.50	0.46	29	185	21
Aroclor-1260	11096-82-5	0.034	0.5	0.14	0.017		1.0	0.50	0.48	60	130	12

¹ PALs were developed to be protective of human health and the environment. Refer to [Worksheets #10 and #11](#) for a detailed discussion on the development of PALs. There are no background values for PCBs; therefore they are omitted from this table.

² PQL Goals are equal to half of the minimum of the applicable criteria (PALs).

Shading represents cases where the PAL is lower than the laboratory LOD. Refer to [Worksheet #11](#), "How 'good' must the data be...." for a discussion of how data will be used in this instance.

SAP Worksheet #15-B5—Reference Limits and Evaluation Table

Matrix: Groundwater

Analytical Group: Metals (Total and Dissolved)

Analyte	CAS Number	WPNSTA Yorktown Background Dataset (Total Metals) ¹	WPNSTA Yorktown Background Dataset (Dissolved Metals) ¹	Tapwater RSL (adjusted) ¹	MCL ¹	Freshwater ECO PAL (Total Metals) ¹	Freshwater ECO PAL (Dissolved Metals) ¹	PQL Goal ²	Units	Laboratory-specific			LCS and MS/MSD Recovery Limits		
										LOQ	LOD	DL	LCL (%)	UCL (%)	RPD %
Aluminum	7429-90-5	2230	100	3700	NC	87	87	43.5	µg/L	100	25	6.8	80	120	20
Antimony	7440-36-0	18.8	9.7	1.5	6	30	30	0.75		2	0.42	0.095	80	120	20
Arsenic	7440-38-2	2.28	1.37	0.045	10	150	150	0.0225		20	10	0.41	80	120	20
Barium	7440-39-3	118	127	730	2000	4	4	2		100	6	1.7	80	120	20
Beryllium	7440-41-7	2.45	NC	7.3	4	0.66	0.66	0.33		1	0.37	0.094	80	120	20
Cadmium	7440-43-9	0.605	0.177	1.8	5	0.27	0.25	0.0885		8	4	0.11	80	120	20
Calcium	7440-70-2	158000	148000	NC	NC	NC	NC	74000		600	300	30	80	120	20
Chromium	7440-47-3	15.1	6.04	0.043	100	11.4	11	0.0215		6	3	0.45	80	120	20
Cobalt	7440-48-4	20.6	0.7	1.1	NC	23	23	0.35		10	0.84	0.21	80	120	20
Copper	7440-50-8	12.2	3	150	1300	9.33	8.96	1.5		10	0.88	0.22	80	120	20
Iron	7439-89-6	3590	631	2600	NC	1000	1000	315.5		50	15	3.8	80	120	20
Lead	7439-92-1	21.3	1.7	15	15	3.18	2.52	0.85		5	0.6	0.16	80	120	20
Magnesium	7439-95-4	3600	3880	NC	NC	NC	NC	1800		1000	120	30	80	120	20
Manganese	7439-96-5	57.9	49.5	88	NC	120	120	24.75		10	0.8	0.2	80	120	20
Mercury	7439-97-6	0.081	0.1	1.1	2	0.91	0.77	0.0405		0.2	0.069	0.023	80	120	20
Nickel	7440-02-0	11.4	12.2	73	NC	52.2	52	5.7		10	0.9	0.23	80	120	20
Potassium	7440-09-7	3490	1710	NC	NC	NC	NC	855		1000	500	31	80	120	20

SAP Worksheet #15-B5—Reference Limits and Evaluation Table (continued)

Matrix: Groundwater

Analytical Group: Metals (Total and Dissolved)

Analyte	CAS Number	WPNSTA Yorktown Background Dataset (Total Metals) ¹	WPNSTA Yorktown Background Dataset (Dissolved Metals) ¹	Tapwater RSL (adjusted) ¹	MCL ¹	Freshwater ECO PAL (Total Metals) ¹	Freshwater ECO PAL (Dissolved Metals) ¹	PQL Goal ²	Units	Laboratory-specific			LCS and MS/MSD Recovery Limits		
										LOQ	LOD	DL	LCL (%)	UCL (%)	RPD %
Selenium	7782-49-2	NC	9.1	18	50	5	4.61	2.305		10	2	0.53	80	120	20
Silver	7440-22-4	NC	NC	18	NC	0.36	0.36	0.18		1	0.12	0.029	80	120	20
Sodium	7440-23-5	9920	1000	NC	NC	NC	NC	500		1000	120	32	80	120	20
Thallium	7440-28-0	NC	NC	0.037	2	12	12	0.0185		1	0.16	0.041	80	120	20
Vanadium	7440-62-2	26.2	4.3	18	NC	20	20	2.15		10	0.68	0.17	80	120	20
Zinc	7440-66-6	4.52	NC	1100	NC	120	118	2.26		50	6	1.6	80	120	20

¹ PALs were developed to be protective of human health and the environment. Refer to [Worksheets #10 and #11](#) for a detailed discussion on the development of PALs.

² PQL Goals are equal to half of the minimum of the applicable criteria (PALs).

Shading represents cases where the PAL is lower than the laboratory LOD. Refer to [Worksheet #11](#), “How ‘good’ must the data be....” for a discussion of how data will be used in this instance.

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SAP Worksheet #16—Project Schedule / Timeline Table

ID	Task Name	Duration	Start	Finish	Predecessors	2011												2012												
						Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	
1	Project Award	1 day	Wed 7/7/10	Wed 7/7/10		◆ 7/7																								
2	Project Kickoff	1 day	Fri 8/6/10	Fri 8/6/10		◆ 8/6																								
3	Site 32 SAP and HASP Preparation	532 days	Sat 8/7/10	Fri 1/20/12																										
4	Laboratory Procurement	145 days	Sat 8/14/10	Wed 1/5/11																										
5	Preliminary SAP and HASP - Site 32	199 days	Sat 8/7/10	Mon 2/21/11																										
6	Client Review of Preliminary SAP - Site 32	37 days	Tue 2/22/11	Wed 3/30/11	5																									
7	Draft SAP to Regulators - Site 32	8 days	Thu 3/24/11	Thu 3/31/11	6																									
8	Regulatory Review of Draft SAP - Site 32	161 days	Fri 4/1/11	Thu 9/8/11	7																									
9	Draft Final SAP to Regulators - Site 32	40 days	Sat 11/12/11	Wed 12/21/11	8																									
10	Final SAP - Site 32	30 days	Thu 12/22/11	Fri 1/20/12	9																									
11	Site 32 Investigation Activities	116 days	Mon 1/2/12	Thu 4/26/12																										
12	Subcontractor Procurement	30 days	Mon 1/2/12	Tue 1/31/12																										
13	Utility Locating	1 day	Sat 2/25/12	Sat 2/25/12	10FS+35 days																									
14	Monitoring Well Installation	4 days	Sun 2/26/12	Wed 2/29/12	13																									
15	Field Sampling	5 days	Sun 2/26/12	Thu 3/1/12	13																									
16	Land Surveying	1 day	Fri 3/2/12	Fri 3/2/12	15																									
17	Sampling Laboratory Analysis	30 days	Thu 3/1/12	Fri 3/30/12	14																									
18	Data Validation	14 days	Sat 3/31/12	Fri 4/13/12	17																									
19	IDW Removal	1 day	Thu 4/26/12	Thu 4/26/12	14SS+60 days																									

Project: CTO WE 29 - Site 7 and 32 UF Date: Thu 1/12/12	Task		Milestone		External Tasks	
	Split		Summary		External Milestone	
	Progress		Project Summary		Deadline	

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SAP Worksheet #17—Sampling Design and Rationale

Matrix	Depths to Sample	Analysis	Method	Number of Samples	Rationale	* Sampling Strategy
Site 32						
Grab Subsurface Soil (all locations except sludge drying bed)	6-24 inches bgs	mercury, cadmium and silver	SW846 6020A/ 7470A/7471A	7	Sample locations are intended to determine if site-related contaminants are present in subsurface soils at levels posing unacceptable risk. Locations were selected to evaluate soils in the footprints of the former trickling filter and Imhoff tank, downgradient of the former STP and upgradient of the site (for the purpose of site-specific background reference). Analytical parameters are consistent with COCs for sediment previously investigated and remediated at the site.	See Figure 3 for proposed sampling locations.
Grab Subsurface Soil (trickling filter only)	6-inch interval directly above water table	Mercury, cadmium and silver	SW846 6020A/ 7470A/7471A	1	This sample location is intended to determine if site-related contaminants are present in subsurface soil at levels indicating a release and/or posing unacceptable risk (if the depth represents and exposure point for human or ecological receptors) in the native material beneath the clean fill in the former trickling filter location. Analytical parameters are consistent with COCs for sediment previously investigated and remediated at the site.	See Figure 3 for proposed sampling locations.
Grab Surface Soil (all locations except sludge drying bed)	0- 6 inches bgs	Mercury, cadmium and silver	SW846 6020A/ 7470A/7471A	7	Sample locations are intended to determine if site-related contaminants are present in subsurface soils at levels posing unacceptable risk. Locations were selected to evaluate soils in the footprints of the former trickling filter and Imhoff tank, downgradient of the former STP and upgradient of the site (for the purpose of site-specific background reference). Analytical parameters are consistent with COCs for sediment previously investigated and remediated at the site.	See Figure 3 for proposed sampling locations.

SAP Worksheet #17—Sampling Design and Rationale (continued)

Matrix	Depths to Sample	Analysis	Method	Number of Samples	Rationale	* Sampling Strategy
Site 32						
Composite Surface soil (sludge drying bed)	0- 6 inches bgs	TAL Metals, TCL VOCs, TCL SVOCs, TCL pesticides and PCBs	SW846 6020A/7471A/8260B/8270D/8081B/8082A	1	The surface composite sample is intended to provide spatial coverage in the sludge drying bed area given the level of disturbance. One composite sample will be collected from five locations within the sludge drying beds to evaluate potential surface contamination resulting from the former sludge drying activities	See Figure 3 for proposed sampling locations.
Composite Subsurface soil (sludge drying bed)	6-24 inches bgs	TAL Metals, TCL VOCs, TCL SVOCs, TCL pesticides and PCBs	SW846 6020A/7471A/8260B/8270D/8081B/8082A	1	The subsurface composite sample is intended to provide spatial coverage in the sludge drying bed area given the level of disturbance. One composite sample will be collected from five locations within the sludge drying beds to evaluate potential surface contamination resulting from the former sludge drying activities	See Figure 3 for proposed sampling locations.
Groundwater	Well screened across the top of the surficial aquifer.	TBD on the basis of soil results (possibly TAL metals, TCL VOCs, TCL SVOCs, TCL pesticides and PCBs)	SW846 6020A/7470A/8260B/8270D/8081B/8082A	5	Sample locations are intended to determine if site-related contaminants are present in groundwater at levels potentially posing unacceptable risk. Locations were selected to evaluate impacts from the former trickling filter, Imhoff tank, sludge drying bed chlorination unit and to provide site-specific background (upgradient) conditions. Analytical parameters will be determined based on the results of soil sampling. Sample depths were selected to be close to the top of the aquifer where metals are most likely to be found because these are the most likely site-related contaminants.	See Figure 3 for proposed sampling locations. Groundwater samples will be collected from an independent, second mobilization following Team review of the soil sampling results.

SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table

Sampling Location / Identification (ID) Number	Matrix	Depth (units)	Analytical Group	Number of Samples (identify field duplicates)	Sampling SOP Reference ⁴
YS32-GW01 / YS32-SB01-TD-BD-MMY ¹ YS32-GW02 / YS32-SB02-TD-BD -MMYY YS32-GW03/YS32-SB03--TD-BD MMY YS32-GW03 / YS32-SB03-TD-BD -MMYY-MS YS32-GW03 / YS32-SB03-TD-BD -MMYY-SD YS32-GW04/YS32-SB04-TD-BD -MMYY YS32-GW04/YS32-SB04P-TD-BD -MMYY YS32-GW05/YS32-SB05--TD-BD MMY YS32-SO06/YS32-SB06--TD-BD MMY YS32-SO07/YS32-SB07--TD-BD MMY YS32-SO07/YS32-SB07--TD-BD MMY ¹	Subsurface Soil (all locations except sludge drying bed)	6- 24 inches bgs, with the exception of the samples at SO07 where one sample will be collected from 6- 24 inches bgs and the second sample will be collected from the 6-inches above the water table	Metals	8 Field Samples	006_SBLog 009_BlankPrep 010_COC 011_Decon 012_DeconRig 015_LogBook 017_DPTSoil
YS32-GW01 / YS32-SS01-MMY ¹ YS32-GW02 / YS32-SS02-MMY YS32-GW03/YS32-SS03-MMY YS32-GW03 / YS32-SS03-MMY-MS YS32-GW03 / YS32-SS03-MMY-SD YS32-GW04/YS32-SS04-MMY YS32-GW04/YS32-SS04P-MMY YS32-GW05/YS32-SS05-MMY YS32-SO06/YS32-SS06-MMY YS32-SO07/YS32-SS07-MMY	Surface Soil (all locations except sludge drying bed)	0-6 inches bgs	Metals	7 Field Samples	006_SBLog 009_BlankPrep 010_COC 011_Decon 012_DeconRig 015_LogBook 017_DPTSoil
YS32-SO08/YS32-SO08-TD-BD-MMY	Subsurface Soil (sludge drying bed)	6-24 inches bgs	Metals, VOCs, SVOCs, pesticides and PCBs	1 Field Sample 1 Duplicate 1 MS/MSD	006_SBLog 009_BlankPrep 010_COC 011_Decon 012_DeconRig 015_LogBook 017_DPTSoil

SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table (continued)

Sampling Location / ID Number	Matrix	Depth (units)	Analytical Group	Number of Samples (identify field duplicates)	Sampling SOP Reference ⁴
YS32-SO08/YS32-SO08-TD-BD-MMY	Surface Soil (sludge drying bed)	0- 6 inches bgs	Metals, VOCs, SVOCs, pesticides and PCBs	1 Field Sample 1 Duplicate	006_SBLog 009_BlankPrep 010_COC 011_Decon 012_DeconRig 015_LogBook 017_DPTSoil
YS32-GW01 / YS32-GW01-MMY ¹ YS32-GW02 / YS32-GW02-MMY YS32-GW03/YS32-GW03-MMY YS32-GW03 / YS32-GW03-MMY-MS YS32-GW03 / YS32-GW03-MMY-SD YS32-GW04/YS32-GW04-MMY YS32-GW04/YS32-GW04P-MMY YS32-GW05/YS32-GW05-MMY	Groundwater	Middle of screen	TBD based on the results of soil sampling	5 Field Samples Field Duplicate – MW04 MS/MSD – MW03	001_Filter 002_HoribaU22 003_LowFlow 007_Preserve 008_WaterLevels

¹ Sample will be differentiated by the top depth (TD) and bottom depth (BD) values.

TD – Top Depth

BD – Bottom Depth

SAP Worksheet #19—Analytical SOP Requirements Table

Matrix	Analytical Group	Analytical and Preparation Method / SOP Reference ¹	Containers (Number, Size, and Type)	Minimum Sample Amount	Preservation Requirements (Chemical, Temperature, Light Protected)	Maximum Holding Time (Preparation/ Analysis) ²
Surface Soil, Subsurface Soil	VOCs	SW-846 8260B/5035 / VGCMS-05	3, 40 milliliter (ml) glass + stirbar (tared)	3 of 5 grams (g) plug	Freeze to - 10°C	48 hours to freeze(-10°C) / 14 days to analysis
	SVOCs	SW-846 8270D and 8270D-SIM/3550C / SVGCMS-03/EXSV-16	1, 4 ounces (oz), glass	40 g	Cool to <6°C	14 days/40 days
	Pest/PCB	SW-846 8081B and SW-846 8082A/3550C / SVGC-04 and SVGC-07/ EXSV-16	1, 4 oz, glass	40 g	Cool to <6°C	14 days/40 days
	Metals	SW-846 6020A / EXMT-09, MET-15	4 oz jar	100 g	Cool to <6°C	180 days
SW-846 7471A / MET-03		100 g		Cool to <6°C	28 days	
Groundwater	VOCs	SW-846 8260B/5030B / VGCMS-05	3, 40 ml Vials, Glass	3 X 40 ml (no headspace)	HCl to pH<2, Cool to <6°C	14 days
	SVOCs	SW-846 8270D and 8270D-SIM/3510C / SVGCMS-03/EXSV-27	2, 1 Liter, Amber Glass	1000 ml	Cool to <6°C	7 days/40 days
	Pest/PCB	SW-846 8081B and SW-846 8082A/3510C / SVGC-04 and SVGC-07/EXSV-27	2, 1 Liter, Amber Glass	1000 ml	Cool to <6°C	7 days/40 days
	Total Metals	SW-846 6020A / EXMT-12, MET-15	1 bottle, 250 ml plastic	50 ml	HNO3 to pH < 2, Cool to <6 °C	180 days
		SW-846 7470A / MET-16		50 ml	HNO3 to pH < 2, Cool to <6 °C	28days
	Dissolved Metals	SW-846 6020A / EXMT-12, MET-15	1 bottle, 250 ml plastic	50 ml	HNO3 to pH < 2, Cool to <6 °C	180 days
SW-846 7470A / MET-16		50 ml		HNO3 to pH < 2, Cool to <6 °C	28 days	

¹ Refer to [Worksheet #23](#) for a complete reference to relevant analytical SOPs.

² Maximum holding time is calculated from the time the sample is collected to the time the sample is prepared/extracted.

³ For SVOCs, 500 ml is required for SW-846 8270D and another 500 ml is required for SW-846 8270D-SIM

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SAP Worksheet #20—Field Quality Control Sample Summary Table

Matrix	Analytical Group	No. of Sampling Locations ²	No. of Field Duplicates	No. of MS/MSDs ¹	No. of Field Blanks	No. of Equip. Blanks ³	Total No. of Samples to Lab
First Event							
Surface Soil	VOCs	7	1	1	0	1	11
	SVOCs	7	1	1	0	1	11
	Pesticides	7	1	1	0	1	11
	PCBs	7	1	1	0	1	11
	Metals	7	1	1	0	1	11
Subsurface Soil	VOCs	7	1	1	0	1	11
	SVOCs	7	1	1	0	1	11
	Pesticides	7	1	1	0	1	11
	PCBs	7	1	1	0	1	11
	Metals	7	1	1	0	1	11
Composite Surface Soil	VOCs	1	1	1	0	0	4
	SVOCs	1	1	1	0	0	4
	Pesticides	1	1	1	0	0	4
	PCBs	1	1	1	0	0	4
	Metals	1	1	1	0	0	4

SAP Worksheet #20—Field Quality Control Sample Summary Table (continued)

Matrix	Analytical Group	No. of Sampling Locations ²	No. of Field Duplicates	No. of MS/MSDs ¹	No. of Field Blanks	No. of Equip. Blanks ³	Total No. of Samples to Lab
Composite Subsurface Soil	VOCs	1	1	1	0	0	4
	SVOCs	1	1	1	0	0	4
	Pesticides	1	1	1	0	0	4
	PCBs	1	1	1	0	0	4
	Metals	1	1	1	0	0	4
Second Event⁴							
Groundwater	VOCs ⁴	5	1	1	0	1	9
	SVOCs ⁴	5	1	1	0	1	9
	Pesticides ⁴	5	1	1	0	1	9
	PCBs ⁴	5	1	1	0	1	9
	Total Metals ⁴	5	1	1	0	1	9
	Dissolved Metals ⁴	5	1	1	0	1	9

¹ Although the MS/MSD is not typically considered a field QC, it is included here because location determination is often established in the field.

² If samples will be collected at different depths at the same location, count each discrete sampling depth as a separate sampling location or station.

³ The number of equipment blanks is based on a fundamental assumption of the number of sampling days each site will require.

⁴ Groundwater will be sampled for some or all of these analytical groups, depending on the results of the soil sampling.

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
001_Filter	Field Filtering, 6/2011	CH2M HILL	Filter, pump, gloves, bottles, preservatives	N	
002_HoribaU22	Field Measurement of pH, Specific Conductance, Turbidity, DO, ORP, and Temperature using the Horiba U-22 with Flow-through cell, 10/2011	CH2M HILL	Horiba U-22 water quality checker with flow-through cell, distilled water, Horiba U-22 auto-calibration standard solution	N	
003_LowFlow	Low-Flow Groundwater Sampling from Monitoring Wells, 5/2011	CH2M HILL	Flow through cell, Horiba U-22, water level indicator, filter (if necessary), adjustable rate pump, polyethylene tubing, plastic sheets, well construction info, measuring cup, bucket, sample containers	N	
004_MWInstal	General Guidance for Monitoring Well Installation, 5/2011	CH2M HILL	Drill rig with mud rotary or hollow stem auger capability, bentonite, cement-bentonite grout, Schedule 40 PVC, factory slotted well screen, PVC cap, silica sand, well casing (flushmount or stickup), surge block, pump, 55-gal drum, Horiba U-22, water level	N	
005_MWShall	Installation of Shallow Monitoring Wells, 5/2011	CH2M HILL	Drill rig with hollow stem auger capability, bentonite, cement-bentonite grout, Schedule 40 PVC, factory slotted well screen, PVC cap, silica sand, well casing (flushmount or stickup), surge block, pump, 55-gal drum, Horiba U-22, water level	N	
006_SBLog	Logging of Soil Borings, 5/2011	CH2M HILL	Indelible pen, ruler, spatula, rock or soil chart (Munsell), grain size chart, hand lens, squirt bottle, soil chart	N	
007_ShallowSo	Shallow soil sampling, 5/2011	CH2M HILL	Sample jars, gloves, trowel	N	
008_WaterLevels	Water-Level Measurements, 5/2011	CH2M HILL	Electronic water-level meter with interface probe	N	

SAP Worksheet #21—Project Sampling SOP References Table (continued)

Reference Number	Title, Revision Date and / or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Y/N)	Comments
009_BlankPrep	Equipment Blank and Field Blank Preparation, 5/2011	CH2M HILL	Blank liquid (use American Society for Testing and Materials [ASTM] Type II grade water), De-ionized water, sample bottles, gloves, preservatives	N	
010_COC	Chain-of-Custody, 5/2011	CH2M HILL	Paper chain of custody form (provided by laboratory)	N	
011_Decon	Decontamination of Personnel and Equipment, 5/2011	CH2M HILL	De-ionized water, distilled water, potable water, 2.5 percent liquinox and water solution, methanol, plastic pails, 55-gallon drum for waste, gloves, decon pad, steam cleaner	N	
012_DeconRig	Decontamination of Drilling Rigs and Equipment, 5/2011	CH2M HILL	Steam cleaner, potable water, liquinox, buckets, brushes, distilled water, methanol, deionized water, aluminum foil	N	
013_Dispose	Disposal of Waste Fluids and Solids, 5/2011	CH2M HILL	Fluids-55 gal drum, tools to secure drum, funnel, labels, marking pen, seals for drum Solids-55 gal drum, tools to secure drum, plastic sheets, labels, marking pen	N	
014_DrumSample	Sampling Contents of Tanks and Drums, 5/2011	CH2M HILL	Drum/tank, sampling instrument, gloves, plastic sheets, labels, monitoring instrument	N	
015_LogBooks	Preparing Field Log Books, 5/2011	CH2M HILL	Log book, Indelible pen	N	
017_Ship	Packaging and Shipping Procedures, 6/2011	CH2M HILL	Coolers, duct tape, ice, strapping tape, packaging material, Ziploc® bags, custody seals, chain of custody	N	
018_Utility Location	Locating and Clearing Underground Utilities, 5/2011	CH2M HILL	Subsurface locating instruments, spray paint (provided by utility locating contractor), historical documents, facility as built diagrams	N	
019_DPSoil	Direct-Push Soil Sample Collection, 5/2011	CH2M HILL	Drill rig, hydraulic percussion hammer, sampling rods, acetate liners, sample containers, gloves	N	

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

Field Equipment	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	CA	Responsible Person	SOP Reference ¹
Horiba U-22		Check mechanical and electronic parts, verify system continuity, check battery, and clean probes. Calibration check.	Visual inspection		Daily before use, at the end of the day, and when unstable readings occur.	Stable readings after 3 minutes. pH reads 4.0 ±3 percent conductivity reads 4.49 ± 3 percent turbidity reads 0 ± 3%	Clean probe with deionized water and calibrate again. Do not use instrument if not able to calibrate properly.	FTL	HoribaU22
Groundwater sampling pumps and tubing				Inspect pumps, tubing and air/sample line quick connects	Regularly	Maintained in good working order per manufacturer's recommendations	Replace items		F103, F105, F107, F201

¹Reference from [Worksheet #2](#)

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SAP Worksheet #23—Analytical SOP References Table

Lab SOP Number	Title, Revision Date and/or Number	Date Reviewed ¹	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work (Y/N)
EXMT-09	ACID DIGESTION OF SOIL AND WASTE SAMPLES FOR ANALYSIS BY Inductively Coupled Plasma (ICP) AND ICP-mass spectrometry (MS) (Revision 6, Effective 08/31/2011).	8/31/2011	Definitive	Soil Metals	N/A	ENCO - Orlando	N
EXMT-12	ACID DIGESTION OF AQUEOUS SAMPLES FOR ANALYSIS BY ICP AND ICP-MS (Revision 4, Effective 12/30/2009).	In review	Definitive	Aqueous Metals	N/A	ENCO - Orlando	N
MET-15	METALS ANALYSIS USING ICP-MS (Revision 5, Effective 02/14/2011)	2/14/2011	Definitive	Aqueous and Soil Metals	ICP-MS	ENCO - Orlando	N
MET-03	MERCURY IN WATERS BY DIGESTION/ cold vapor atomic absorption (CVAA) (Revision 4, Effective 1/4/2010)	1/11/2011	Definitive	Aqueous Mercury	CVAA	ENCO - Orlando	N
MET-16	MERCURY IN SOIL BY DIGESTION/CVAA (Revision 4, Effective 3/1/2010)	4/14/2011	Definitive	Soil Mercury	CVAA	ENCO - Orlando	N
LOGINS-03	RECEIVING SAMPLES (Revision 10, Effective 1/23/2010).	4/20/2011	N/A	N/A	N/A	ENCO - Orlando	N
ADMIN-14	WASTE DISPOSAL AND CHARACTERIZATION (Revision 5, Effective 1/1/2010)	1/4/2011	N/A	N/A	N/A	ENCO - Orlando	N
EXSV-27	Extraction of Samples Using Separatory Funnel Techniques (Rev. 5, 09/15/2011)	09/15/2011	N/A	Aqueous SVOC Prep	N/A	ENCO - Orlando	N
EXSV-16	Extraction of Soil/Solid Samples Using Sonication, (Rev. 6, 3/23/2010)	04/14/2011	N/A	Soils SVOC Prep	N/A	ENCO - Orlando	N

SAP Worksheet #23—Analytical SOP References Table (continued)

Lab SOP Number	Title, Revision Date and/or Number	Date Reviewed ¹	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work (Y/N)
SVGCMS-03	Analysis of SVOCs by gas chromatography (GC) MS (Rev. 16, Effective 11/29/2010)	In review	Definitive	Soil, Aqueous SVOC	GCMS	ENCO - Orlando	N
VGCMS-05	Analysis of VOCs by GC/MS (Rev.16, Effective 11/5/2010)	In review	Definitive	Soil, Aqueous VOC	GC/MS	ENCO - Orlando	N
SVG-04	Organochlorine Pesticides by GC/ electron capture detector (ECD) (Rev. 9, Effective Date 12/9/2009)	01/07/2011	Definitive	Soil, Aqueous Pesticides	GC	ENCO - Orlando	N
SVG-07	PCBs by GC/ECD (Rev. 4, 1/4/2010)	1/7/2011	Definitive	Soil, Aqueous PCBs	GC	ENCO - Orlando	N

¹ SOPs that have "in review" in this column are currently being reviewed by the laboratory.

SAP Worksheet #24—Analytical Instrument Calibration Table

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference
GC-MS (VOCs)	Tuning	Prior to initial calibration (ICAL) and at the beginning of each 12-hour period.	Refer to method for specific ion criteria.	Retune instrument and verify. Rerun affected samples.	Analyst	VGCMS-05
	Minimum five-point ICAL for all analytes	ICAL prior to sample analysis.	1. Average response factor (RF) for system performance check compounds (SPCCs): VOCs ≥ 0.30 for chlorobenzene and 1,1,2,2-tetrachloroethane; VOCs ≥ 0.1 for chloromethane, bromoform, and 1,1-dichloroethane. 2. Relative standard deviation (RSD) for RFs for calibration check compounds (CCCs): VOCs $\leq 30\%$ and one option below: <u>Option 1</u> : RSD for each analyte $\leq 15\%$; <u>Option 2</u> : linear least squares regression $R \geq 0.995$; <u>Option 3</u> : non-linear regression coefficient of determination (COD) $R^2 \geq 0.990$ (6 points shall be used for second order, 7 points shall be used for third order).	Correct problem then repeat ICAL.		
	Second source initial calibration verification (ICV)	Once after each ICAL.	All project analytes within $\pm 20\%$ of true value.	Correct problem and verify second source standard. Rerun second source verification. If that fails, correct problem and repeat ICAL.		
	Retention time window position establishment for each analyte and surrogate.	Once per ICAL.	Position shall be set using the midpoint standard of the ICAL curve when ICAL is performed. On days when ICAL is not performed, the initial continuing calibration verification (CCV) is used.	N/A.		
	Evaluation of relative retention times (RRTs)	With each sample.	RRT of each target analyte within ± 0.06 RRT units.	Correct problem, then rerun ICAL.		
	CCV	Daily before sample analysis and every 12 hours of analysis time.	1. Average RF for SPCCs: VOCs ≥ 0.30 for chlorobenzene and 1,1,2,2-tetrachloroethane; ≥ 0.1 for chloromethane, bromoform, and 1,1-dichloroethane. 2. %Difference/Drift for all target compounds and surrogates: VOCs $\leq 20\%D$ (Note: D = difference when using RFs or drift when using least squares regression or non-linear calibration).	DoD project-level (PC) approval must be obtained for each of the failed analytes or CA must be taken. Correct problem, then rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since last acceptable CCV.		

SAP Worksheet #24—Analytical Instrument Calibration Table (continued)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference
GC-MS (SVOCs)	Tuning	Prior to ICAL and at the beginning of each 12-hour period.	Refer to method for specific ion criteria.	Retune instrument and verify. Rerun affected samples.	Analyst	SVGCMS-03
	Breakdown Check (DDT, Method 8270 only)	At the beginning of each 12 hour sequence, prior to analysis of samples.	Degradation $\leq 20\%$ for DDT.	Correct problem then repeat breakdown check.		
	Minimum five-point ICAL for all analytes	ICAL prior to sample analysis.	1. Average RF for SPCCs: SVOCs ≥ 0.050 . 2. RSD for RFs for CCCs: SVOCs $\leq 30\%$ and one option below: <u>Option 1</u> : RSD for each analyte $\leq 20\%$; <u>Option 2</u> : linear least squares regression $r \geq 0.995$; <u>Option 3</u> : non-linear regression COD $r^2 \geq 0.990$ (6 points shall be used for second order, 7 points shall be used for third order).	Correct problem then repeat ICAL.		
	Second source ICV	Once after each ICAL.	All project analytes within $\pm 20\%$ of true value.	Correct problem and verify second source standard. Rerun second source verification. If that fails, correct problem and repeat ICAL.		
	Retention time window position establishment for each analyte and surrogate.	Once per ICAL.	Position shall be set using the midpoint standard of the ICAL curve when ICAL is performed. On days when ICAL is not performed, the initial CCV is used.	N/A.		
	Evaluation of RRT	With each sample.	RRT of each target analyte within ± 0.06 RRT units.	Correct problem, then rerun ICAL.		

SAP Worksheet #24—Analytical Instrument Calibration Table (continued)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference
GC-MS (SVOCs) (continued)	CCV	Daily before sample analysis and every 12 hours of analysis time.	1. Average RF for SPCCs: SVOCs ≥ 0.050 . 2. %Difference/Drift for all target compounds and surrogates: SVOCs $\leq 20\%D$ (Note: D = difference when using RFs or drift when using least squares regression or non-linear calibration).	DoD project-level approval must be obtained for each of the failed analytes or CA must be taken. Correct problem, then rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since last acceptable CCV.		
GC/ECD (Pesticides)	Breakdown Check (Endrin/DDT Method 8081 only)	At the beginning of each 12 hour sequence, prior to analysis of samples.	Degradation $\leq 15\%$ for both DDT and Endrin.	Correct the problem, repeat breakdown check.	Analyst/Supervisor	SVGC-04
	Minimum five-point ICAL for all analytes	ICAL prior to sample analysis.	One of the following options: <u>Option 1:</u> RSD for each analyte $\leq 20\%$ <u>Option 2:</u> Linear regression fit, $r \geq 0.995$.	Correct the problem, repeat ICAL.		
	Retention time window position establishment	Once per ICAL and at the beginning of the analytical shift.	Position shall be set using the midpoint standard of the ICAL curve when ICAL is performed. On days when ICAL is not performed, the initial CCV is used.	N/A.		
	Second Source Calibration Verification (SCV)	Immediately following the ICAL.	Within 80-120% of true value.	Correct the problem: rerun SCV. If that fails, repeat ICAL.		
	CCV	At the beginning of every 12-hour sequence, after the pesticide breakdown check.	Within 80-120% of true value.	Correct the problem, then rerun CCV. If that fails, repeat ICAL. Re-analyze all samples since the last successful calibration verification.		

SAP Worksheet #24—Analytical Instrument Calibration Table (continued)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference
GC/ECD (PCBs)	Minimum five-point ICAL for all analytes	ICAL prior to sample analysis.	One of the following options: <u>Option 1:</u> RSD for each analyte $\leq 20\%$ <u>Option 2:</u> Linear regression fit, $r \geq 0.990$.	Correct the problem, repeat ICAL.	Analyst	SVGC-07
	Retention time window position establishment	Once per ICAL and at the beginning of the analytical shift.	Position shall be set using the midpoint standard of the ICAL curve when ICAL is performed. On days when ICAL is not performed, the initial CCV is used.	N/A.		
	SCV	Immediately following the ICAL.	Within 80-120% of true value.	Correct the problem, rerun SCV. If that fails, repeat ICAL.		
	CCV	Prior to any samples in sequences that do not include ICAL, after every 10th sample, and at the end of the sequence.	Within 80-120% of true value.	Correct the problem, then rerun CCV. If that fails, repeat ICAL. Re-analyze all samples since the last successful calibration verification.		
ICP-MS	Tuning	Daily, prior to calibration	Mass calibration ≤ 0.07 atomic mass unit (amu) from the true value; Resolution < 0.05 amu full width at 10% peak height; For stability, RSD $\leq 5\%$ for at least four replicate analyses.	Retune instrument then re-analyze tuning solution.	Analyst	MET-15
	ICAL (with a minimum of three standards and a calibration blank)	ICAL daily prior to sample analysis.	Correlation coefficient > 0.995	Correct problem, then repeat ICAL.	Analyst	
	ICV, prepared at the calibration midpoint	Once per ICAL.	Within $\pm 10\%$ of the true value for all target analytes.	Correct problem, then repeat. If still fails, repeat ICAL.	Analyst	

SAP Worksheet #24—Analytical Instrument Calibration Table (continued)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference
ICP-MS (continued)	CCV, same source as ICV	Following ICV, after every 10 samples and the end of the sequence.	Within $\pm 10\%$ of the true value for all target analytes.	Correct problem, then repeat. If still fails, repeat ICAL. Re-analyze all samples since the last successful calibration verification.	Analyst	
	Low-level calibration check standard	Daily, after one-point ICAL.	Within $\pm 20\%$ of the true value.	Correct problem, then reanalyze.	Analyst	
	Calibration blank	Daily after ICAL and every ten samples.	If greater than LOD.	Re-analyze the blank and affected samples.	Analyst	
	Interference check standard (ICS) (ICS-A and ICS-B)	At the beginning of every analytical run and every 12 hours.	ICS-A: Absolute value of concentration for all non-spiked analytes < LOD (unless they are a verified trace impurity from one of the spiked analytes); ICS-AB: Within $\pm 20\%$	Terminate analysis, locate and correct problem, reanalyze ICS, reanalyze all samples.	Analyst	
CVAA	ICAL per manufacturer's instructions, with a minimum of five standards and a calibration blank.	ICAL daily prior to sample analysis.	Correlation coefficient > 0.995; accepted if the ICV passes.	Correct problem, then repeat ICAL.	Analyst	MET-03 and MET -16
	Second-source ICV, prepared at the calibration midpoint	Once per ICAL.	$\pm 10\%$ difference from ICV for all target analytes.	Correct problem, then repeat. If still fails, repeat ICAL.	Analyst	
	CCV, same source as ICV.	Following ICV, after every 10 samples and the end of the sequence.	$\pm 10\%$ difference from ICV for all target analytes	Correct problem, then repeat. If still fails, repeat ICAL. Re-analyze all samples since the last successful calibration verification.	Analyst	
	Calibration blank	Daily after ICAL and every ten samples.	No analytes > LOD	Re-analyze the samples affected samples	Analyst	

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

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	CA	Responsible Person	SOP Reference
GC/MS (VOCs & SVOCs)	Clean sources, maintain vacuum pumps.	Tuning	Instrument performance and sensitivity.	Service vacuum pumps twice per year, other maintenance as needed.	Tune and CCV pass criteria.	Recalibrate instrument.	Analyst	GC/MS (VOCs & SVOCs)
	Change septum, clean injection port, change or clip column, install new liner, change trap.	Sensitivity check	Instrument performance and sensitivity.	Daily or as needed.	Tune and CCV pass criteria.	Re-inspect injector port, cut additional column, re-analyze CCV, and re-calibrate instrument.		
GC/ECD (Pesticides)	Injection port maintenance	Degradation check run every 12 hrs	DDT and Endrin breakdown <15%.	Beginning of each 12 hour 8081 sequence.	DDT and Endrin breakdown <15%.	Clip the guard column, replace the injection port liner, replace the gold seal, clean the injection port and repeat degradation check.	Analyst	GC/ECD (Pesticides)
GC/ECD (PCBs)	Injection port maintenance	N/A	Evaluate baseline and peak shapes.	As needed.	analyst judgment of excessive tailing or baseline fluctuation	Clip the guard column, replace the injection port liner, replace the gold seal, and clean the injection port.		GC/ECD (PCBs)
ICP-MS	Replace pump windings	Monitor internal standard (ISTD) counts for variation	Instrument performance and sensitivity	As needed	Monitor ISTD counts for variation	Replace windings, recalibrate and re-analyze	Analyst	MET-15

SAP Worksheet #25—Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table (continued)

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	CA	Responsible Person	SOP Reference
CVAA	Replace disposables, flush lines	Sensitivity check	Instrument performance and sensitivity	Daily or as needed	CCV pass criteria	Recalibrate	Analyst	MET-03 and MET- 16

SAP Worksheet #26—Sample Handling System

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): Field Team Members/ CH2M HILL
Sample Packaging (Personnel/Organization): Field Team Members/ CH2M HILL
Coordination of Shipment (Personnel/Organization): FTL/ CH2M HILL
Type of Shipment/Carrier: FedEx Overnight
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): Kim Casey/ENCO
Sample Custody and Storage (Personnel/Organization): Kim Casey/ENCO
Sample Preparation (Personnel/Organization): Ivy Rosado/ENCO
Sample Determinative Analysis (Personnel/Organization): Jerry Yestrebksy/ENCO - Jesus Ayuso/ENCO
SAMPLE ARCHIVING
Field Sample Storage (No. of days from sample collection): 90 days from receipt
Sample Extract/Digestate Storage (No. of days from extraction/digestion): Kurt Bentzen/30 days
Biological Sample Storage (No. of days from sample collection): n/a
SAMPLE DISPOSAL
Personnel/Organization: Kurt Bentzen/ENCO,
Number of Days from Analysis: 45

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SAP Worksheet #27—Sample Custody Requirements Table

Field Sample Custody Procedures (sample collection, packaging, shipment, and delivery to laboratory):
<p>Samples will be collected by field team members under the supervision of the FTL. As samples are collected, they will be placed into containers and labeled. Labels will be taped to the jar to ensure they do not separate. Samples will be cushioned with packaging material and placed into coolers containing enough ice to keep the samples 4±2 °C until they are received by the laboratory.</p> <p>The chain of custody will be placed into the cooler in a resealable plastic bag. Coolers will be taped up and shipped to the laboratories via FedEx overnight, with the air bill number indicated on the chain-of-custody (to relinquish custody). Upon delivery, the laboratory will log in each cooler and report the status of the samples to CH2M HILL.</p> <p>See Worksheet #21 for SOPs containing sample custody guidance.</p> <p>The CH2M HILL field team will ship all environmental samples to ENCO Laboratories.</p>
Laboratory Sample Custody Procedures (receipt of samples, archiving, disposal):
<p>Laboratory custody procedures can be found in the following SOP, which is referenced in Worksheet #23 and will be provided for review upon request:</p> <p>LOGINS-03</p>
Sample ID Procedures:
<p>Sample labels will include, at a minimum, client name, site, sample ID, date/time collected, analysis group or method, preservation, and sampler’s initials. The field logbook will identify the sample ID with the location and time collected and the parameters requested. The laboratory will assign each field sample a laboratory sample ID based on information in the chain of custody. The laboratory will send sample log-in forms to the PDM to check that sample IDs and parameters are correct.</p>
Chain-of-custody Procedures:
<p>Chain-of-custodies will include, at minimum, laboratory contact information, client contact information, sample information, and relinquished by/received by information. Sample information will include sample ID. Date/time collected, number and type of containers, preservative information, analysis method, and comments. The chain of custody will link location of the sample from the field logbook to the laboratory receipt of the sample. The laboratory will use the sample information to populate the Laboratory Information Management Systems (LIMS) database for each sample.</p>

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SAP Worksheet #28-A1—Laboratory Quality Control Samples Table

Matrix: Surface Soil, Subsurface Soil

Analytical Group: VOCs

Analytical Method/SOP Reference: SW-846 8260B / VGCMS-05

QC Sample:	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method blank	One per preparatory batch	No analytes detected > ½ Reporting Limit (RL) 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.	Correct problem. If required, re-prep and re-analyze method blank and all samples processed with the contaminated blank.	Analyst	Bias/contamination	Same as Method/SOP QC Acceptance Limits.
LCS		Refer to Worksheet #15 .	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes. If reanalysis cannot be performed, data must be qualified and explained in a case narrative.		Precision and Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
MS		Same as LCS.	In the absence of client specific requirements, flag the data.		Precision and Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
MSD		Same as LCS and see Worksheet #15	In the absence of client specific requirements, flag the data.		Precision and Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
ISTD	Spiked in Every Sample	Retention time within 30 seconds from retention time of the midpoint standard in the ICAL; enclosed inductively coupled plasma (EICP) areas within -50% to +100% of ICAL midpoint standard.	Inspect mass spectrometer and gas chromatograph for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning.		Precision and Accuracy	Same as Method/SOP QC Acceptance Limits.

SAP Worksheet #28-A1—Laboratory Quality Control Samples Table (continued)

Matrix: Surface Soil, Subsurface Soil

Analytical Group: VOCs

Analytical Method/SOP Reference: SW-846 8260B / VGCMS-05

QC Sample:	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Surrogates		Dibromofluoromethane 74-133%, Toluene-d8 85-115%, 1,2-Dichloroethane-d4 59-133%, 4-Bromofluorobenzene 85-120%	Re-prep and re-analyze sample unless objective evidence of suspected or confirmed sample matrix effects are available. If insufficient sample exists for reanalysis, client will be contacted for instructions. In the absence of client instruction, data will be qualified.		Precision and Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.

SAP Worksheet #28-A2—Laboratory Quality Control Samples Table

Matrix: Surface Soil, Subsurface Soil

Analytical Group: SVOCs

Analytical Method/SOP Reference: SW-846 8270D and 8270D-SIM / SVGCMS-03

QC Sample:	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per preparatory batch	No analytes detected > ½ RL 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.	Correct problem. If required, re-prep and re-analyze method blank and all samples processed with the contaminated blank.	Analyst	Bias/Contamination	Same as Method/SOP QC Acceptance Limits.
LCS		See Worksheet #15 .	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes. If reanalysis cannot be performed, data must be qualified and explained in a case narrative.		Precision and Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
MS		Same as LCS.	In absence of client specific requirements, flag the data.		Precision and Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
MSD		Same as LCS and see Worksheet #15	In absence of client specific requirements, flag the data.		Precision and Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.

SAP Worksheet #28-A2—Laboratory Quality Control Samples Table (continued)

Matrix: Surface Soil, Subsurface Soil

Analytical Group: SVOCs

Analytical Method/SOP Reference: SW-846 8270D and 8270D-SIM / SVGCMS-03

QC Sample:	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Surrogate Spike	Spiked in every sample	2-Fluorobiphenyl 45-105%, Terphenyl-d ₁₄ 30-125%, Nitrobenzene-d ₅ , 35-100%, 2-Fluorophenol 35-105%, Phenol-d ₅ 40-100%, 2,4,6-Tribromophenol 35-125%	Re-prepare and re-analyze sample unless objective evidence of suspected or confirmed sample matrix effects are available. If insufficient sample exists for reanalysis, client will be contacted for instructions. In absence of client instruction, data will be qualified.		Precision and Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
ISTDs		Retention time within 30 seconds from retention time of the midpoint standard in the ICAL; EICP areas within -50% to +100% of ICAL midpoint standard.	Inspect mass spectrometer and gas chromatograph for malfunctions; mandatory re-analysis of samples analyzed while system was malfunctioning.		Precision and Accuracy	Same as Method/SOP QC Acceptance Limits.

AP Worksheet #28-A3—Laboratory Quality Control Samples Table

Matrix: Surface Soil, Subsurface Soil

Analytical Group: Pesticides

Analytical Method/SOP Reference: SW-846 8081B / SVGC-04

QC Sample:	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC	
Method Blank	One per preparatory batch	No analytes detected > ½ RL 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.	Correct problem. If required, re-prep and re-analyze method blank and all samples processed with the contaminated blank.	Analyst	Bias/Contamination	Same as Method/SOP QC Acceptance Limits.	
LCS		See Worksheet #15 . See ENCO exceptions regarding Toxaphene and Chlordane.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes. If reanalysis cannot be performed, data must be qualified and explained in a case narrative.		Precision and Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.	
MS		Same as LCS.	In absence of client specific requirements, flag the data.		Precision and Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.	
MSD		Same as LCS and see Worksheet #15	In absence of client specific requirements, flag the data.		Precision and Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.	
Surrogates		Spiked in every sample	Decachlorobiphenyl 55-130%, 2,4,5,6-TCX 70-125%.		For QC and field samples, correct problem then re-prep and re-analyze all failed samples for failed surrogates in the associated preparatory batch.	Precision and Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
Confirmation of Positive Results (second column or second detector)		All positive results	Calibration and QC criteria the same as for initial or primary column analysis. Results between primary and secondary column RPD ≤ 40%.		N/A	Confirmation	N/A

SAP Worksheet #28-A4—Laboratory Quality Control Samples Table

Matrix: Surface Soil

Analytical Group: PCBs

Analytical Method/SOP Reference: SW-846 8082A / SVGC-07

QC Sample:	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per preparatory batch.	No analytes detected > ½ RL 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.	Correct problem. If required, re-prep and re-analyze method blank and all samples processed with the contaminated blank.	Analyst	Bias/Contamination	Same as Method/SOP QC Acceptance Limits.
LCS		See Worksheet #15 .	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes. If reanalysis cannot be performed, data must be qualified and explained in a case narrative.		Precision and Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
MS		Same as LCS	In absence of client specific requirements, flag the data.		Precision and Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
MSD		Same as LCS and see Worksheet #15	In absence of client specific requirements, flag the data.		Precision and Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
Surrogates		Spiked in every sample.	Decachlorobiphenyl 60 - 125%, 2,4,5,6-TCX 20-137%		For QC and field samples, correct problem then re-prep and re-analyze all failed samples for failed surrogates in the associated preparatory batch.	Precision and Accuracy/Bias
Confirmation of Positive Results (second column or second detector)	All positive results	Calibration and QC criteria the same as for initial or primary column analysis. Results between primary and secondary column RPD ≤ 40%.	N/A		Confirmation	N/A

SAP Worksheet #28-A5—Laboratory Quality Control Samples Table

Matrix: Surface Soil, Subsurface Soil

Analytical Group: Total Metals (ICP/MS)

Analytical Method/SOP Reference: SW-846 6020A / MET-16

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	5%	No target analytes \geq LOQ	Correct problem, then repeat. If still fails, repeat ICAL.	Analyst	Accuracy/Bias Contamination	No target analytes \geq LOQ
LCS	5%	See Worksheet #15 .	LCS is re-analyzed; if still fails samples along with QC are re-prepped and re-analyzed.	Analyst	Precision and Accuracy/Bias	80-120% of true value
MS/MSD	5%	Same as LCS and see Worksheet#15	See LCS requirements.	Analyst	Precision and Accuracy/Bias	80-120% of true value; RPD \pm 20%
Dilution test	5%	\pm 10% of true value	Re-prep and re-analyze samples. Perform Post-digestion spike addition.	Analyst	Precision and Accuracy/Bias	\pm 10% of true value
Post-digestion spike addition	When dilution test fails or analyte concentration for all samples < 50x LOD	75-125% of true value	Run all associated samples in the batch by the method of standard additions	Analyst	Precision and Accuracy/Bias	75-125% of true value
ISTDs	Every Sample	ISTD intensity within 30-120% of intensity of ISTD in ICAL	Re-analyze sample at 5X dilution with the addition of appropriate amounts of ISTD.	Analyst	Accuracy/Bias Contamination	ISTD intensity within 30-120% of intensity of ISTD in ICAL

SAP Worksheet #28-A6—Laboratory Quality Control Samples Table

Matrix: Surface Soil, Subsurface Soil

Analytical Group: Total Mercury (CVAA)

Analytical Method/SOP Reference: SW-846 7471A / MET-03

QC Sample:	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	5%	No analytes detected > LOQ.	Correct problem, then repeat. If still fails, repeat ICAL.	Analyst	Accuracy/Bias Contamination	No analytes detected > LOQ.
LCS	5%	See Worksheet #15 .	LCS is re-analyzed; if still fails samples along with QC are re-prepped and re-analyzed.	Analyst	Precision and Accuracy/Bias	80-120% of true value
MS/MSD	5%	Same as LCS and see Worksheet #15	See LCS requirements.	Analyst	Precision and Accuracy/Bias	80-120% of true value; RPD ≤ 20%

SAP Worksheet #28-B1—Laboratory Quality Control Samples Table

Matrix: Groundwater

Analytical Group: VOCs

Analytical Method/SOP Reference: SW-846 8260B / VGCMS-05

QC Sample:	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method blank	One per preparatory batch	No analytes detected > ½ RL 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.	Correct problem. If required, re-prep and re-analyze method blank and all samples processed with the contaminated blank.	Analyst	Bias/Contamination	Same as Method/SOP QC Acceptance Limits.
LCS		Refer to Worksheet #15 .	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes. If reanalysis cannot be performed, data must be qualified and explained in a case narrative.		Precision and Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
MS		Same as LCS.	In the absence of client specific requirements, flag the data.		Precision and Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
MSD		Same as LCS and see Worksheet #15 .	In the absence of client specific requirements, flag the data.		Precision and Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.

SAP Worksheet #28-B1—Laboratory Quality Control Samples Table (continued)

Matrix: Groundwater

Analytical Group: VOCs

Analytical Method/SOP Reference: SW-846 8260B / VGCMS-05

QC Sample:	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
ISTD	Spiked in Every Sample	Retention time within 30 seconds from retention time of the midpoint standard in the ICAL; areas within -50% to +100% of ICAL midpoint standard.	Inspect mass spectrometer and gas chromatograph for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning.		Precision and Accuracy	Same as Method/SOP QC Acceptance Limits.
Surrogates		Dibromofluoromethane 85-115%, Toluene-d ₈ 85-120%, 1,2-Dichloroethane-d ₄ 70-120%, 4-Bromofluorobenzene 75-120%	Re-prep and re-analyze sample unless objective evidence of suspected or confirmed sample matrix effects are available. If insufficient sample exists for reanalysis, client will be contacted for instructions. In the absence of client instruction, data will be qualified.		Precision and Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.

SAP Worksheet #28-B2—Laboratory Quality Control Samples Table

Matrix: Groundwater

Analytical Group: SVOCs

Analytical Method/SOP Reference: SW-846 8270D and 8270D-SIM / SVGCMS-03

QC Sample:	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per preparatory batch.	No analytes detected > ½ RL 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.	Correct problem. If required, re-prep and re-analyze method blank and all samples processed with the contaminated blank.	Analyst	Bias/Contamination	Same as Method/SOP QC Acceptance Limits.
LCS		See Worksheet #15 .	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes. If reanalysis cannot be performed, data must be qualified and explained in a case narrative.		Precision and Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
MS		Same as LCS.	In the absence of client specific requirements, flag the data.		Precision and Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
MSD		Same as LCS and see Worksheet #15 .	In the absence of client specific requirements, flag the data.		Precision and Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.

SAP Worksheet #28-B2—Laboratory Quality Control Samples Table (continued)

Matrix: Groundwater

Analytical Group: SVOCs

Analytical Method/SOP Reference: SW-846 8270D and 8270D-SIM / SVGCMS-03

QC Sample:	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Surrogate Spike	Spiked in every sample.	2-Fluorobiphenyl 50-110%, Terphenyl-d ₁₄ 50-135%, Nitrobenzene-d ₅ , 40-110%, 2-Fluorophenol 20-110%, Phenol-d ₅ 10-115%, 2,4,6-Tribromophenol 40-125%	Re-prep and re-analyze sample unless objective evidence of suspected or confirmed matrix effects are available. If insufficient sample exists for reanalysis, client will be contacted for instructions. In the absence of client instruction, data will be qualified.		Precision and Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
ISTDs	Spiked in every sample.	Retention time within 30 seconds from retention time of the midpoint standard in the ICAL; areas within -50% to +100% of ICAL midpoint standard.	Inspect mass spectrometer and gas chromatograph for malfunctions; mandatory re-analysis of samples analyzed while system was malfunctioning.		Precision and Accuracy	Same as Method/SOP QC Acceptance Limits.

SAP Worksheet #28-B3—Laboratory Quality Control Samples Table

Matrix: Groundwater

Analytical Group: Pesticides

Analytical Method/SOP Reference: SW-846 8081B / SVGC-04

QC Sample:	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per preparatory batch	No analytes detected > ½ RL 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.	Correct problem. If required, re-prepare and re-analyze method blank and all samples processed with the contaminated blank.	Analyst	Bias/Contamination	Same as Method/SOP QC Acceptance Limits.
LCS		See Worksheet #15 . See ENCO exceptions regarding Toxaphene and Chlordane.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes. If reanalysis cannot be performed, data must be qualified and explained in a case narrative.		Precision and Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
MS		Same as LCS.	In the absence of client specific requirements, flag the data.		Precision and Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
MSD		Same as LCS and see Worksheet #15 .	In the absence of client specific requirements, flag the data.		Precision and Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.

SAP Worksheet #28-B3—Laboratory Quality Control Samples Table (continued)

Matrix: Groundwater

Analytical Group: Pesticides

Analytical Method/SOP Reference: SW-846 8081B / SVGC-04

QC Sample:	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Surrogates	Spiked in every sample.	Decachlorobiphenyl 30-135%, 2,4,5,6-TCX 25-140%.	For QC and field samples, correct problem then re-prepare and re-analyze all failed samples for failed surrogates in the associated preparatory batch.		Precision and Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
Confirmation of Positive Results (second column or second detector)	All positive results	Calibration and QC criteria the same as for initial or primary column analysis. Results between primary and secondary column RPD ≤ 40%.	N/A		Confirmation	N/A

SAP Worksheet #28-B4—Laboratory Quality Control Samples Table

Matrix: Groundwater

Analytical Group: PCBs

Analytical Method/SOP Reference: SW-846 8082A / SVGC-07

QC Sample:	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per preparatory batch	No analytes detected > ½ RL 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.	Correct problem. If required, re-prepare and re-analyze method blank and all samples processed with the contaminated blank.	Analyst	Bias/Contamination	Same as Method/SOP QC Acceptance Limits.
LCS		See Worksheet #15 .	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes. If reanalysis cannot be performed, data must be qualified and explained in a case narrative.		Precision and Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
MS		Same as LCS	In absence of client specific requirements, flag the data.		Precision and Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
MSD		Same as LCS and see Worksheet #15 .	In absence of client specific requirements, flag the data.		Precision and Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.

SAP Worksheet #28-B4—Laboratory Quality Control Samples Table (continued)

Matrix: Groundwater

Analytical Group: PCBs

Analytical Method/SOP Reference: SW-846 8082A / SVGC-07

QC Sample:	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Surrogates	Spiked in every sample.	Decachlorobiphenyl 40-135%, 2,4,5,6-TCX 38-142%.	For QC and field samples, correct problem then re-prep and re-analyze all failed samples for failed surrogates in the associated preparatory batch.		Precision and Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
Confirmation of Positive Results (second column or second detector)	All positive results	Calibration and QC criteria the same as for initial or primary column analysis. Results between primary and secondary column RPD ≤ 40%.	N/A		Confirmation	N/A

SAP Worksheet #28-B5—Laboratory Quality Control Samples Table

Matrix: Groundwater

Analytical Group: Metals

Analytical Method/SOP Reference: SW-846 6020A / MET-15

QC Sample:	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC	
Method Blank	One per preparatory batch	No analytes detected > ½ RL 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.	Correct problem, then repeat. If still fails, repeat ICAL.	Analyst	Accuracy/Bias Contamination	Same as Method/SOP QC Acceptance Limits.	
LCS		See Worksheet #15 .	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes. If reanalysis cannot be performed, data must be qualified and explained in a case narrative.		Precision and Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.	
MS/MSD		Same as LCS and see Worksheet #15	See LCS requirements.		Precision and Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.	
Dilution test		± 10% of true value	Re-prep and re-analyze samples. Perform Post-digestion spike addition.		Precision and Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.	
Post-digestion spike addition		When dilution test fails or analyte concentration for all samples < 50x LOD	75-125% of true value		If dilution test recovers outside of QC acceptance limits but post spike meets QC acceptance criteria, matrix effects are not confirmed, reprep and reanalyze sample.	Precision and Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
ISTDs		Every Sample	ISTD intensity within 30-120% of intensity of ISTD in ICAL		Re-analyze sample at 5X dilution with the addition of appropriate amounts of ISTD.	Accuracy/Bias Contamination	Same as Method/SOP QC Acceptance Limits.

SAP Worksheet #28-B6—Laboratory Quality Control Samples Table

Matrix: Groundwater

Analytical Group: Mercury

Analytical Method/SOP Reference: SW-846 7470A/ MET-16

QC Sample:	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per preparatory batch	No analytes detected > 1/2 LOQ. Blank result must not otherwise affect sample results.	Correct problem; then repeat. If the method blank still fails; re-prepare and re-analyze all samples processed with contaminated blank.	Analyst	Bias/Contamination	Same as Method/SOP QC Acceptance Limits.
LCS		See Worksheet #15 .	Correct problem, then reprepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes. If reanalysis cannot be performed, data must be qualified and explained in a case narrative.		Precision and Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
MS		Same as LCS.	Examine the project specific DQOs. In absence of project specific instruction, flag the data.		Precision and Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
MSD		Same as LCS and see Worksheet #15 .	Examine the project-specific DQOs, Contact the client as to additional measures to be taken.		Precision and Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.

SAP Worksheet #29—Project Documents and Records Table

Sample Collection Documents and Records	Onsite Analysis Documents and Records	Offsite Analysis Documents and Records ¹	Data Assessment Documents and Records	Other
<ul style="list-style-type: none"> • Field Notebooks • Chain-of-Custody Records • Air Bills • Custody Seals • CA Forms • Electronic Data Deliverables • ID of QC Samples • Meteorological Data from Field (Logging daily weather) • Sampling Instrument Calibration Logs • Sampling Locations and Sampling Plan • Sampling Notes and Drilling Logs 	<ul style="list-style-type: none"> • No onsite analysis will take place other than collecting water quality parameters. These readings will be recorded in field logbooks as they are collected 	<ul style="list-style-type: none"> • Sample Receipt, Chain-of-Custody, and Tracking Records • Standard Traceability Logs • Equipment Calibration Logs • Sample Prep Logs • Run Logs • Equipment Maintenance, Testing, and Inspection Logs • CA Forms • Reported Field Sample Results • Reported Result for Standards, QC Checks, and QC Samples • Instrument printouts (raw data) for Field Samples, Standards, QC Checks, and QC Samples • Data Package Completeness Checklists • Sample disposal records • Extraction/Clean-up Records • Raw Data (stored on disk) 	<ul style="list-style-type: none"> • Fixed Laboratory Audit Checklists • Data Validation Reports • CA Forms • Laboratory QA Plan • Method Detection Limit (MDL) Study Information 	

¹ Offsite documents are archived with Iron Mountain Inc. which is headquartered at 745 Atlantic Avenue, Boston, MA 02111.

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SAP Worksheet #30—Analytical Services Table

Matrix	Analytical Group	Sample Locations/ID Number	Analytical Method	Data Package Turnaround Time	Laboratory / Organization	Backup Laboratory / Organization ¹
Surface Soil (discreet and composite)	VOCs	See Worksheet #18	SW-846 8260B	28 calendar days	ENCO Laboratories	TBD
	SVOCs		SW-846 8270D / 8270D-SIM			
	Pesticides		SW-846 8081B			
	PCBs		SW-846 8082A			
	Metals		SW-846 6020 and 7471			
Subsurface Soil (discreet and composite)	VOCs		SW-846 8260B			
	SVOCs		SW-846 8270D / 8270D-SIM			
	Pesticides		SW-846 8081B			
	PCBs		SW-846 8082A			
	Metals		SW-846 6020 and 7471			
Groundwater	VOCs		SW-846 8260B			
	SVOCs		SW-846 8270D / 8270D-SIM			
	Pesticides		SW-846 8081B			
	PCBs		SW-846 8082A			
	Total Metals		SW-846 6020 and 7471			
	Dissolved Metals					

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SAP Worksheet #31-1—Planned Project Assessments Table

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person Responsible for Performing Assessment	Person Responsible for Responding to Assessment Findings	Person Responsible for Identifying and Implementing CA	Person Responsible for Monitoring Effectiveness of CA
Field QA and H&S Audit	Once	Internal	CH2M HILL	Stephen Brand	Kimberley Coke, FTL and Field Staff	Stephen Brand	Brett Doerr Mark Orman
Onsite Laboratory Technical Systems Audit	Laboratory must have a current accreditation from the DoD ELAP, which will identify the period of performance and scope of analytical methods. The laboratory must be re-evaluated prior to expiration of period of performance. Appendix C contains the ELAP certificate.	External	Third Party Accrediting Body	Third Party Accrediting Body (TBD)	Dorian Pearson-Shaver, ENCO Laboratories QA Officer	Dorian Pearson-Shaver, Laboratories QA Officer	Anita Dodson, Program Chemist, CH2M HILL

SAP Worksheet #31-2—Corrective Action Form

Person initiating corrective action _____ Date _____

Description of problem and when identified: _____

Cause of problem, if known or suspected: _____

Sequence of Corrective Action: (including date implemented, action planned and personnel/data affected)

CA implemented by: _____ Date: _____

CA initially approved by: _____ Date: _____

Follow-up date: _____

Final CA approved by: _____ Date: _____

Information copies to:

Anita Dodson, CH2M HILL Program Chemist

SAP Worksheet #32—Assessment Findings and Corrective Action Responses

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings	Timeframe of Notification	Nature of CA Response Documentation	Individual(s) Receiving CA Response	Timeframe for Response
Field QA and H&S Audit	Checklist and Written Audit Report	Mary Anderson/ CH2M HILL, PM	Within 1 week of audit	Memorandum	Kimberley Coke FTL CH2M HILL Laura Cook AQM CH2M HILL	Within 1 week of receipt of CA Form
Onsite Laboratory Technical Systems Audit	Written audit report from DoD Laboratory Accrediting Body	Dorian Pearson-Shaver ENCO Labs QA Officer	Within 2 months of audit	Memorandum	DoD Laboratory Accrediting Body (TBD)	Within 2 months of receipt of initial notification

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SAP Worksheet #33—Quality Assurance Management Reports Table

Type of Report	Frequency (daily, weekly monthly, quarterly, annually, etc.)	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation (title and organizational affiliation)	Report Recipient(s) (title and organizational affiliation)
SI Report	Post-Field Event	TBD	Mary Anderson, PM, CH2M HILL	Stakeholders, see Worksheet #4

The SI Report will address the following:

- Summary of project QA/QC requirements/procedures
- Conformance of project to UFP-SAP requirements/procedures
- Status of project schedule
- Deviations from the UFP-SAP and approved amendments that were made
- Results of data review activities (how much usable data was generated)
- CAs if needed and their effectiveness
- Data usability with regards to: limitations on data use, precision, accuracy, representativeness, completeness, comparability, and sensitivity

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SAP Worksheet #34—Verification (Step I) Process Table

Verification Input	Description	Internal / External	Responsible for Verification (name, organization)
Planning Documents	Evidence of approval and completeness of UFP-SAP.	Internal	PM: Mary Anderson/CH2M HILL
Chain of Custody and shipping forms	Chain-of-custody forms and shipping documentation will be reviewed internally upon their completion and verified against the packed sample coolers they represent. The shipper's signature on the chain-of-custody will be initialed by the reviewer, a copy of the chain-of-custody retained in the site file, and the original and remaining copies taped inside the cooler for shipment. See Chain-of-Custody SOP for further details.	Internal	FTL: Kimberley Coke/CH2M HILL PDM: Hillary Ott/CH2M HILL
Field Log Notebooks	Field notes will be reviewed to ensure completeness of field data parameters, shipping information, sample collection times, etc. The logbook will also be used to document, explain, and justify all deviations from the approved work plan and UFP-SAP.	Internal	PM: Mary Anderson/CH2M HILL
Sample Login/ Receipt	Upon their arrival at the laboratory, the samples will be cross-referenced against the chain-of-custody records. All sample labels will be checked against the chain-of-custody, and any mislabeling will be identified, investigated, and corrected. The samples will be logged in at every storage area and work station required by the designated analyses. Individual analysts will verify the completeness and accuracy of the data recorded on the forms.	Internal	Sample Receipt Personnel Respective Laboratory Personnel
QC Summary Report	A summary of all QC sample results will be verified for completeness once the data is received from the laboratory.	External	PDM: Hillary Ott/CH2M HILL

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

Step IIa / IIb ¹	Validation Input	Description	Responsible for Validation (name, organization)
IIa	SOPs	Review field logbooks, laboratory case narratives, data deliverables for compliance to methods and signatures.	FTL: Kimberley Coke/CH2M HILL PM: Mary Anderson/CH2M HILL
IIa	QC Results	Establish that all field and lab QC samples were run and compliant with method-required limits as specified in Worksheets #12 and #28 .	Herb Kelly/CH2M HILL
IIb	QC Results	Verify that QC samples were run and compliant with limits established in the UFP-SAP.	PC: Megan Morrison/CH2M HILL
IIb	PQLs	Ensure all sample results met the project quantification and action limits specified in Worksheet #15 .	PC: Megan Morrison/CH2M HILL
IIb	Raw data	10 percent review of raw data to confirm laboratory calculations.	Herb Kelly/CH2M HILL

¹ IIa=compliance with methods, procedures, and contracts [see Table 10, page 117, UFP-QAPP manual, V.1, March 2005.]
 IIb=comparison with MPC in the SAP [see Table 11, page 118, UFP-QAPP manual, V.1, March 2005]

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SAP Worksheet #36—Analytical Data Validation (Steps IIa and IIb) Summary Table

Step IIa / IIb	Matrix	Analytical Group	Validation Criteria	DV
IIa	Surface Soil, Subsurface Soil, Composite Surface Soil, Composite Subsurface Soil, Groundwater (unfiltered), and Groundwater (filtered)	VOCs, SVOCs, Pesticides, PCBs, Metals (Total and Dissolved)	Analytical methods and laboratory SOPs as presented in this SAP will be used to evaluate compliance against QA/QC criteria. Should adherence to QA/QC criteria yield deficiencies, data may be qualified. The data qualifiers used are those presented in <i>Region III Modifications to the National Functional Guidelines for Inorganic Analyses, (April 1993)</i> and <i>Region III Modifications to the National Functional Guidelines for Organic Data Review, (September, 1994)</i> . National Functional Guidelines will not be used for data validation; however, the specific qualifiers listed therein may be applied to data should non-conformances against the QA/QC criteria as presented in this SAP be identified.	Herb Kelly/ CH2M HILL
IIb		VOCs, SVOCs, Pesticides, PCBs, Metals (Total and Dissolved)	See PALs in Worksheet #15 ; See Method calibration and QC criteria in Worksheets #24 and #28 .	Mary Anderson, Megan Morrison/ CH2M HILL

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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:

- Non-detected site contaminants will be evaluated to ensure that project required quantitation limits in [Worksheet #15](#) were achieved. If PQLs were achieved and the verification and validation steps yielded acceptable data, then the data is considered usable. If PQLs were not achieved, then the reason will be investigated and documented, and the impact on data usability will be discussed.
- During verification and validation steps, data may be qualified as estimated with the following qualifiers: J, UJ, K, L, or UL. These qualifiers represent minor QC deficiencies which will not affect the usability of the data. When major QC deficiencies are encountered, data will be qualified with an R and in most cases are not considered usable for project decisions.
 - J - Analyte present. Reported value is estimated and may or may not be accurate or precise
 - UJ - Analyte not detected. Quantitation limit may be inaccurate or imprecise
 - K - Analyte present. Reported value is estimated and may be biased high. Actual value is expected to be lower
 - L - Analyte present. Reported value is estimated and may be biased low. Actual value is expected to be higher
 - UL - Analyte not detected. Quantitation limit is probably higher.
 - R - Rejected result. Result is not usable.
- Additional qualifiers that may be given by the validator include B, E, N, NJ, and U:
 - B - Not detected more than 5 times than that in an associated blank (10 times for common laboratory contaminants in VOCs)
 - N - Tentative ID. Consider Present. Special methods may be needed to confirm its presence or absence in future sampling efforts
 - NJ - Qualitative ID questionable due to poor resolution. Presumptively present at approximate quantity
 - U - Not Detected
- For statistical comparison, non-detect values will be represented by a concentration equal to one-half the sample RL. For duplicate sample results, the greater of values will be used for project decisions.
- Analytical data will be checked to ensure the values and any qualifiers are appropriately transferred to the electronic database. These checks include comparison of hardcopy data and qualifiers to the electronic data deliverable. Once the data have been uploaded into the electronic database, another check will be performed to ensure all results were loaded accurately.
- Field and laboratory precision will be assessed as RPD between the two results.

SAP Worksheet #37—Usability Assessment (continued)

Deviations from the SAP will be reviewed to assess whether CA is warranted and to assess impacts to achievement of project objectives.

Identify the personnel responsible for performing the usability assessment.

- The PM, PC, and other team members will be responsible for compiling the data. The data will then be presented to the Partnering Team who, as a whole, will evaluate the data usability according to project objectives.

References

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- CH2M HILL. 2008. *Final Steps 6 and 7 of the Aquatic Baseline Ecological Risk Assessment. Site Screening Area 25 – Wetlands Downgradient of Beaver Pond. Naval Weapons Stations Yorktown, Yorktown, Virginia*. November.
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- United States Environmental Protection Agency (USEPA). 2002. *Guidance for Quality Assurance Project Plans, USEPA QA/G-5, QAMS*.
- USEPA. 2005. *Uniform Federal Policy for Quality Assurance Project Plans*.
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- United States Navy (Navy). 2008. *Navy Uniform Federal Policy-Sampling and Analysis Plan (UFP-SAP) Template*.

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Figures



- Legend**
- Site 32
 - Naval Weapons Station Yorktown Boundary

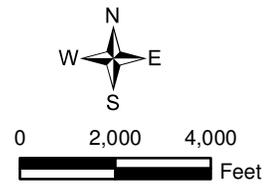
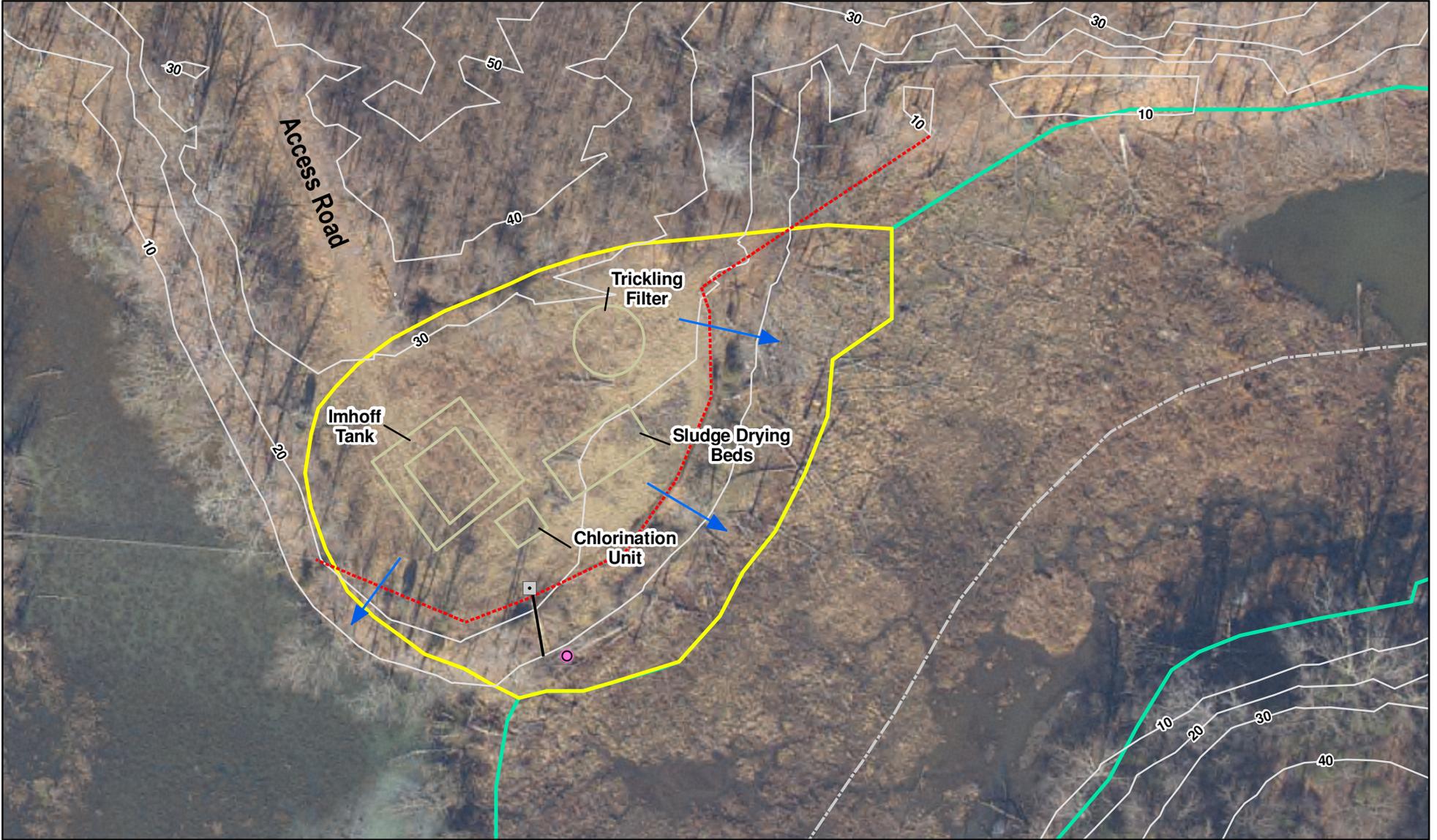


Figure 1
Site 32 Location Map
Naval Weapons Station Yorktown
Yorktown, Virginia



Legend

- Terrestrial Study Area
- Aquatic Study Area
- Former Structures
- Approximate Property Boundary Line
- Fence
- Stairs
- Gate 24
- Outfall
- Elevation Contour (10 ft interval)
- Expected Groundwater Flow Direction

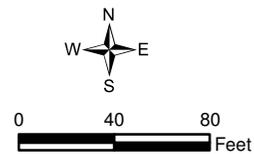
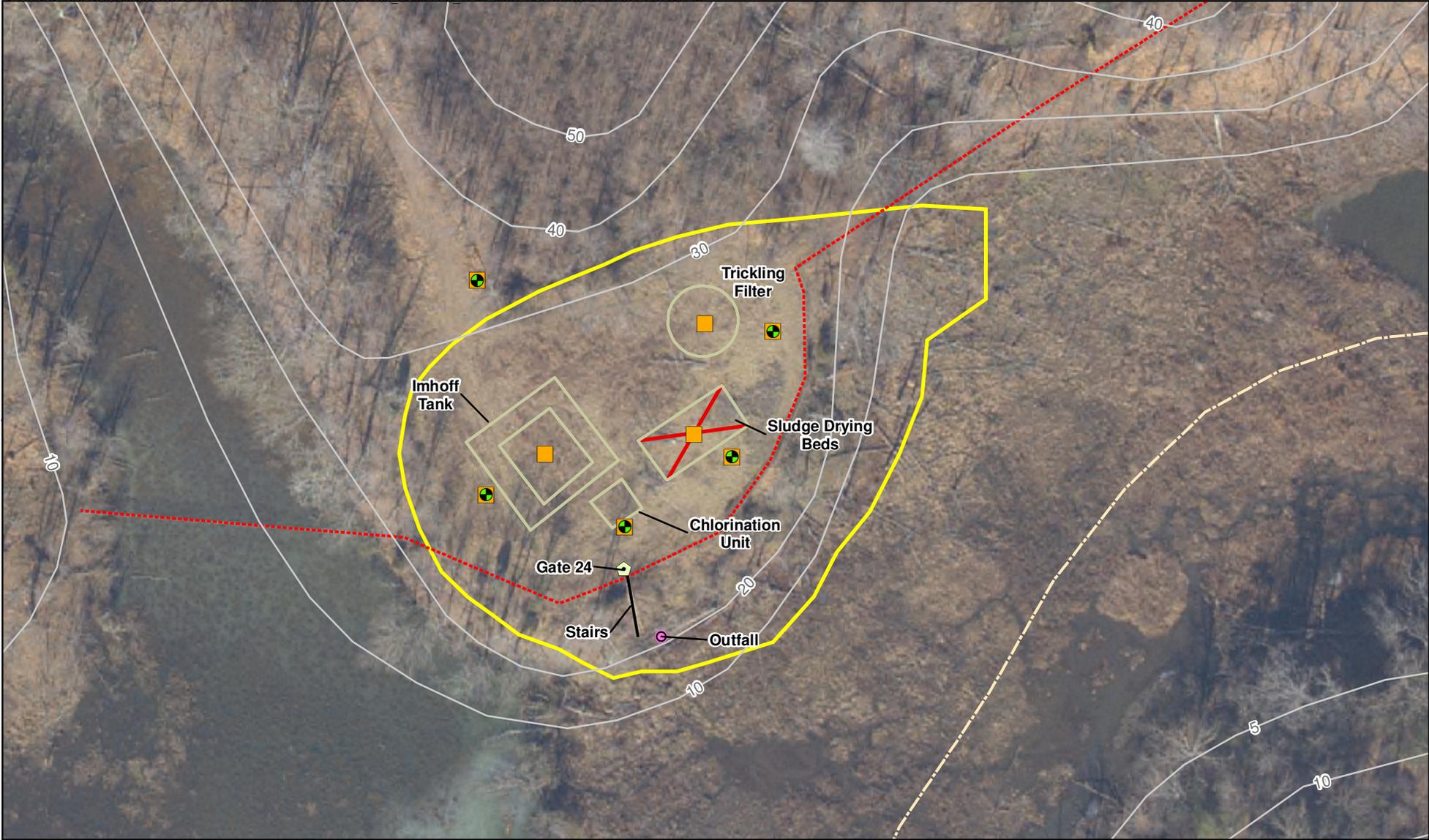


Figure 2
Site 32 Layout Map
Naval Weapons Station Yorktown
Yorktown, Virginia



Legend

-  Proposed Monitoring Well Location
-  Proposed Soil Sample Location
-  Fence
-  Elevation contour (10ft)
-  Approximate Property Boundary Line
-  Proposed 5 point composite soil sample location
-  Former Structures
-  Terrestrial Study Area

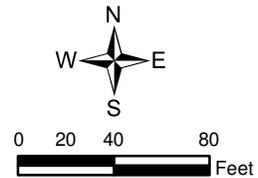


Figure 3
 Site 32 Proposed Sample Locations
 Naval Weapons Station Yorktown
 Yorktown, Virginia

Appendix A
Field Standard Operating Procedures

Field Filtering

I. Purpose

To provide a general guideline for the field filtering of water samples for dissolved metals analysis.

II. Scope

This is a general discussion of the standard method of field filtering techniques. Operating manuals should be consulted regarding specific procedures.

III. Equipment and Materials

- Peristaltic pump
- C-Flex[®] tubing or equivalent
- Teflon tubing or equivalent
- 0.45 µm in-line filter cartridge
- Pre-preserved sample container with HNO₃

IV. Procedures and Guidelines

- A. Decontaminate reusable equipment before filtration.
- B. Prepare the peristaltic pump and the disposable Teflon tubing. The flexible C-Flex tubing goes through the pump head of the pump, and the Teflon tubing (if needed) extends into or from the borehole.
- C. Attach the 0.45 µm in-line filter cartridge to the discharge end of the Teflon tubing.
- D. Attach the intake end of the Teflon tubing to the groundwater source. This can be:
 - Directly from the borehole if pumping with the peristaltic pump through tubing.
 - From an unused and pre-cleaned sample container that is used as a temporary reservoir for the sample filtration.
 - Directly from the bailer by cutting a small hole in the bailer for the tubing or by attaching the flexible tubing to the end of the bailer.
- E. Turn on the peristaltic pump and discard a small amount of the initial sample that flows out of the filter.

- F. Direct the discharge end of the C-Flex tubing into the pre-cleaned bottle that will be submitted to the laboratory and pump the remainder of the filtered sample into it.
- G. Discard disposable tubing and filter.
- H. Repeat for each sample.

V. Attachments

None.

VI. Key Checks and Items

- Use precleaned containers.

Field Measurement of pH, Specific Conductance, Turbidity, Dissolved Oxygen, ORP, and Temperature Using a Horiba or YSI Water Quality Parameter Meter with Flow-through Cell

I. Purpose and Scope

The purpose of this procedure is to provide a general guideline for using a water quality parameter meter (e.g., Horiba® or YSI) for field measurements of pH, specific conductance, turbidity, dissolved oxygen, oxidation-reduction potential (ORP), and temperature of aqueous samples. The YSI instrument does not measure turbidity. A separate turbidity meter (i.e., Hanna Turbidity Meter) will need to be used in conjunction with the YSI meter. The operator's manual should be consulted for detailed operating procedures.

II. Equipment and Materials

- Water Quality Parameter Meter such as a Horiba® Water Quality Monitoring System or YSI with flow-through cell
- Auto-Calibration Standard Solution (provided by rental company)
- Distilled water in squirt bottle

III. Procedures and Guidelines

A. Parameters and Specifications:

<u>Parameter</u>	<u>Range of measurement</u>	<u>Accuracy</u>
pH	0 to 14 pH units	+/- 0.1 pH units
Specific conductance	0 to 9.99 S/m	+/- 3 % full scale
Turbidity	0 to 800 NTU	+/- 5 % full scale
Dissolved oxygen	0 to 19.99 mg/l	+/- 0.2 mg/l
Temperature	0 to 55 °C	+/- 1.0 °C
ORP	-999 to +999 mV	+/- 15 mV
Salinity	0 to 4 %	+/- 0.3 %

B. Calibration:

Prior to each day's use, clean the probe and flow-through cell using deionized water and calibrate using the Standard Solution.

Horiba Calibration procedure:

1. Fill a calibration beaker with standard solution to the recommended fill line.
2. Insert the probe into the beaker. All the parameter sensors will now be immersed in the standard solution except the D.O. sensor; the D.O. calibration is done using atmospheric air.
3. Turn power on and allow some time for the machine to warm-up prior to starting the calibration. When the initial readings appear to stabilize the instrument is ready to calibrate.
4. Press CAL key to put the unit in the calibration mode.
5. Press the ENT key to start automatic calibration. Wait a moment, and the upper cursor will gradually move across the four auto-calibration parameters one by one: pH, COND, TURB, and DO. When the calibration is complete, the readout will briefly show END. The instrument is now calibrated.
6. If the unit is calibrated properly the instrument readings, while immersed in the standard solution, will match the standard solution values provided on the solution container. The typical standard solution values are: pH = 4.0 +/- 3%, conductivity 4.49 mS/cm +/- 3%, and turbidity = 0 NTU +/- 3%.
7. Record the calibration data (e.g. time, instrument ID, solution lot number and expiration date, final calibrated readings, and solution temperature in the field logbook.

YSI Calibration procedure:

1. Press the **On/off** key to display the run screen
2. Press the **Escape** key to display the main menu screen
3. Use the arrow keys to highlight the **Calibrate**
4. Press the **Enter** key. The Calibrate screen is displayed
5. Choose the parameter to calibrate

A. *Conductivity Calibration:*

This procedure calibrates specific conductance (recommended), conductivity and salinity. Calibrating any one option automatically calibrates the other two.

- 1) Use the arrow keys to highlight the **Conductivity** selection
- 2) Press **Enter**. The Conductivity Calibration Selection Screen is displayed.
- 3) Use the arrow keys to highlight the Specific Conductance selection.
- 4) Press **Enter**. The Conductivity Calibration Entry Screen is displayed.
- 5) Place the correct amount of conductivity standard (see Instrument Manual) into a clean, dry or pre-rinsed transport/calibration cup.
- 6) Carefully immerse the sensor end of the probe module into the solution.

- 7) Gently rotate and/or move the probe module up and down to remove any bubbles from the conductivity cell.
NOTE: The sensor must be completely immersed past its vent hole. Using the recommended volumes from the Instrument Manual Calibration Volumes should ensure that the vent hole is covered.
- 8) Screw the transport/calibration cup on the threaded end of the probe module and securely tighten.
NOTE: Do not over tighten as this could cause damage to the threaded portions.
- 9) Use the keypad to enter the calibration value of the standard you are using.
NOTE: Be sure to enter the value in **mS/cm at 25°C**.
- 10) Press **Enter**. The Conductivity Calibration Screen is displayed.
- 11) Allow at least one minute for temperature equilibration before proceeding. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize.
- 12) Observe the reading under Specific Conductance. When the reading shows no significant change for approximately 30 seconds, press **Enter**. The screen will indicate that the calibration has been accepted and prompt you to press **Enter** again to Continue.
- 13) Press **Enter**. This returns you to the Conductivity Calibrate Selection Screen
- 14) Press **Escape** to return to the calibrate menu.
- 15) Rinse the probe module and sensors in tap or purified water and dry.

B. Dissolved Oxygen Calibration:

This procedure calibrates dissolved oxygen. Calibrating any one option (% or mg/L) automatically calibrates the other.

- 1) Go to the calibrate screen as described in Section
NOTE: The instrument must be on for at least 20 minutes to polarize the DO sensor before calibrating.
- 2) Use the arrow keys to highlight the **Dissolved Oxygen** selection.
- 3) Press **Enter**. The dissolved oxygen calibration screen is displayed.
- 4) DO calibration in mg/L is carried out in a water sample which has a known concentration of dissolved oxygen (usually determined by a Winkler titration).
- 5) Use the arrow keys to highlight the **DO mg/L** selection.
- 6) Press **Enter**. The DO mg/L Entry Screen is displayed.
- 7) Place the probe module in water with a known DO concentration.
NOTE: Be sure to completely immerse all the sensors.
- 8) Use the keypad to enter the known DO concentration of the water.
- 9) Press **Enter**. The Dissolved Oxygen mg/L Calibration Screen is displayed.
- 10) Stir the water with a stir bar, or by rapidly moving the probe module, to provide fresh sample to the DO sensor.
- 11) Allow at least one minute for temperature equilibration before proceeding. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize.
- 12) Observe the DO mg/L reading, when the reading is stable (shows no significant change for approximately 30 seconds), press **Enter**. The screen will indicate that the calibration has been accepted and prompt you to press **Enter** again to Continue.
- 13) Press **Enter**. This returns you to the DO calibration screen.
- 14) Press **Escape** to return to the calibrate menu.

15) Rinse the probe module and sensors in tap or purified water and dry.

C. *pH Calibration:*

- 1) Go to the calibrate screen.
- 2) Use the arrow keys to highlight the **pH** selection.
- 3) Press **Enter**. The pH calibration screen is displayed.
 - Select the **1-point** option only if you are adjusting a previous calibration. If a 2-point or 3-point calibration has been performed previously, you can adjust the calibration by carrying out a one point calibration. The procedure for this calibration is the same as for a 2-point calibration, but the software will prompt you to select only one pH buffer.
 - Select the **2-point** option to calibrate the pH sensor using only two calibration standards. Use this option if the media being monitored is known to be either basic or acidic. For example, if the pH of a pond is known to vary between 5.5 and 7, a two-point calibration with pH 7 and pH 4 buffers is sufficient. A three point calibration with an additional pH 10 buffer will not increase the accuracy of this measurement since the pH is not within this higher range.
 - Select the **3-point** option to calibrate the pH sensor using three calibration solutions. In this procedure, the pH sensor is calibrated with a pH 7 buffer and two additional buffers. The 3-point calibration method assures maximum accuracy when the pH of the media to be monitored cannot be anticipated. The procedure for this calibration is the same as for a 2-point calibration, but the software will prompt you to select a third pH buffer.
- 4) Use the arrow keys to highlight the **2-point** selection.
- 5) Press **Enter**. The pH Entry Screen is displayed.
- 6) Place the correct amount of pH buffer into a clean, dry or pre-rinsed transport/calibration cup.
 - NOTE:** For maximum accuracy, the pH buffers you choose should be within the same pH range as the water you are preparing to sample.
 - NOTE:** Before proceeding, ensure that the sensor is as dry as possible. Ideally, rinse the pH sensor with a small amount of buffer that can be discarded. Be certain that you avoid cross-contamination of buffers with other solutions.
- 7) Carefully immerse the sensor end of the probe module into the solution.
- 8) Gently rotate and/or move the probe module up and down to remove any bubbles from the pH sensor.
 - NOTE:** The sensor must be completely immersed. Using the recommended volumes from Table 6.1 Calibration Volumes, should ensure that the sensor is covered.
- 9) Screw the transport/calibration cup on the threaded end of the probe module and securely tighten.
 - NOTE:** Do not over tighten as this could cause damage to the threaded portions.
- 10) Use the keypad to enter the calibration value of the buffer you are using **at the current temperature**.
 - NOTE:** pH vs. temperature values are printed on the labels of all YSI pH buffers.
- 11) Press **Enter**. The pH calibration screen is displayed.

- 12) Allow at least one minute for temperature equilibration before proceeding. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize.
- 13) Observe the reading under pH, when the reading shows no significant change for approximately 30 seconds, press **Enter**. The screen will indicate that the calibration has been accepted and prompt you to press **Enter** again to Continue.
- 14) Press **Enter**. This returns you to the Specified pH Calibration Screen.
- 15) Rinse the probe module, transport/calibration cup and sensors in tap or purified water and dry.
- 16) Repeat steps 6 through 13 above using a second pH buffer.
- 17) Press **Enter**. This returns you to the pH Calibration Screen.
- 18) Press **Escape** to return to the calibrate menu.
- 19) Rinse the probe module and sensors in tap or purified water and dry.

D. ORP Calibration:

- 1) Go to the calibrate screen.
- 2) Use the arrow keys to highlight the **ORP** selection.
- 3) Press **Enter**. The ORP calibration screen is displayed.
- 4) Place the correct amount of a known ORP solution into a clean, dry or pre-rinsed transport/calibration cup.

NOTE: Before proceeding, ensure that the sensor is as dry as possible. Ideally, rinse the ORP sensor with a small amount of solution that can be discarded. Be certain that you avoid cross-contamination with other solutions.
- 5) Carefully immerse the sensor end of the probe module into the solution.
- 6) Gently rotate and/or move the probe module up and down to remove any bubbles from the ORP sensor.

NOTE: The sensor must be completely immersed.
- 7) Screw the transport/calibration cup on the threaded end of the probe module and securely tighten.
- 8) Use the keypad to enter the correct value of the calibration solution you are using at the current temperature.
- 9) Press **Enter**. The ORP calibration screen is displayed.
- 10) Allow at least one minute for temperature equilibration before proceeding. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize.
- 11) Observe the reading under ORP, when the reading shows no significant change for approximately 30 seconds, press **Enter**. The screen will indicate that the calibration has been accepted and prompt you to press **Enter** again to Continue.
- 12) Press **Enter**. This returns you to the Calibrate Screen.
- 13) Rinse the probe module and sensors in tap or purified water and dry. Record the calibration data (e.g. time, instrument ID, solution lot number and expiration date, final calibrated readings, and solution temperature in the field logbook.

C. Sample Measurement:

Horiba measurement procedure:

As water passes through the flow-through the flow cell, press MEAS to obtain reading;

record data in a field notebook.

YSI measurement procedure:

As water passes through the flow-through the flow cell, the readings are displayed for each parameter. Record the water quality parameter data in a field notebook. In addition, the data is recorded in the YSI and can be downloaded to a computer following completion of the sampling event.

IV. Key Checks and Preventive Maintenance

- Calibrate meter
- Clean probe with deionized water when done
- Refer to operations manual for recommended maintenance and troubleshooting
- Check batteries, and have a replacement set on hand
- Due to the importance of obtaining these parameters, the field team should have a spare unit readily available in case of an equipment malfunction.

V. References

YSI 556 Multi Probe System Operator Manual

Low-Flow Groundwater Sampling from Monitoring Wells

I. Purpose and Scope

This SOP presents general guidelines for the collection of groundwater samples from monitoring wells using low-flow purging and sampling procedures. Operations manuals should be consulted for specific calibration and operating procedures.

II. Equipment and Materials

- Adjustable-rate positive-displacement pump, submersible pump, or peristaltic pump
- Horiba® U-22 or equivalent water quality meters to monitor pH, specific conductance, turbidity, dissolved oxygen, oxidation-reduction potential (ORP), and temperature
- Flow-through cell with inlet/outlet ports for purged groundwater and watertight ports for each probe
- Generator or alternate power source depending on pump type
- Water-level indicator
- Disposable Teflon, Teflon-lined polyethylene tubing or polyethylene tubing for metals and other inorganics
- Plastic sheeting
- Well-construction information
- Calibrated container and stopwatch to determine flow rate
- Sample containers
- In-line disposable 0.45µm filters (QED® FF8100 or equivalent)
- Shipping supplies (labels, coolers, and ice)
- Field book

III. Procedures and Guidelines

A. Setup and Purging

1. Obtain information on well location, diameter(s), depth, and screen interval(s), and the method for disposal of purged water.
2. Calibrate instruments according to manufacturer's instructions.
3. The well number, site, date, and condition are recorded in the field logbook.

4. Plastic sheeting is placed on the ground, and the well is unlocked and opened. All decontaminated equipment to be used in sampling will be placed only on the plastic sheeting until after the sampling has been completed. To avoid cross-contamination, do not let any downhole equipment touch the ground.
5. All sampling equipment and any other equipment to be placed in the well is cleaned and decontaminated before sampling in accordance with SOP *Decontamination of Personnel and Equipment*.
6. Water level measurements are collected in accordance with the *Water Level Measurements* SOP. **Do not measure the depth to the bottom of the well at this time**; this reduces the possibility that any accumulated sediment in the well will be disturbed. Obtain depth to bottom information from well construction log.
7. Attach and secure the tubing to the low-flow pump. Lower the pump slowly into the well and set it at approximately the middle of the screen. Place the pump intake in the middle of the saturated screen length and should be at least two feet above the bottom of the well to avoid mobilization of any sediment present in the bottom.
8. Insert the measurement probes into the flow-through cell. The purged groundwater is directed through the cell, allowing measurements to be collected before the water contacts the atmosphere.
9. If using a generator, locate it 30 feet downwind from the well to avoid exhaust fumes contaminating the samples.
10. Start purging the well at 0.2 to 0.5 liters per minute. Avoid surging. Purging rates for more transmissive formations could be started at 0.5-liter to 1 liter per minute. The initial field parameters of pH, specific conductance, dissolved oxygen, ORP, turbidity, and temperature of water are measured and recorded in the field logbook.
11. The water level should be monitored during purging, and, ideally, the purge rate should equal the well recharge rate so that there is little or no drawdown in the well (i.e., less than 0.3-foot). The water level should stabilize for the specific purge rate. There should be at least 1 foot of water over the pump intake so there is no risk of the pump suction being broken, or entrainment of air in the sample. Record adjustments in the purge rate and changes in depth to water in the logbook. Purge rates should, if needed, be decreased to the minimum capabilities of the pump (0.1- to 0.2-liter per minute) to avoid affecting well drawdown.
12. During purging, the field parameters are measured frequently (every 5 minutes) until the parameters have stabilized. Field parameters are considered stable when measurements meet the following criteria:
 - pH: within 0.1 pH units

- Specific conductance: within 3 percent
- Dissolved oxygen: within 10 percent
- Turbidity: within 10 percent for values greater than 5 NTU; if 3 turbidity values are less than 5 NTU, consider the values as stabilized
- ORP: within 10 mV
- Temperature: within 3 percent

B. Sample Collection

Once purging is complete the well is ready to sample. The elapsed time between completion of purging and collection of the groundwater sample should be minimized. Typically, the sample is collected immediately after the well has been purged, but this is also dependent on well recovery.

Samples will be placed in sample containers that have been cleaned to laboratory standards and are preserved in accordance with the analytical method. The containers are typically pre-preserved, if required.

VOC samples are normally collected first and directly into pre-preserved sample containers.

During purging and sampling, the centrifugal/peristaltic pump tubing must remain filled with water to avoid aeration of the groundwater. It is recommended that ¼ or 3/8 inch inside diameter tubing be used to help insure that the sample tubing remains water filled. If the pump tubing is not completely filled to the sampling point, collect non-VOC dissolved gasses samples first, then increase flow rate slightly until water completely fills the tubing and collect the VOC/dissolved gases samples. Record new flow rate and drawdown depth.

The steps to be followed for sample collection are as follows:

1. The cap is removed from the sample bottle, and the bottle is tilted slightly.
2. The sample is slowly poured from the bailer or discharged from the pump so that it runs down the inside of the sample bottle with a minimum of splashing. The pumping rate should be reduced to approximately 100 ml per minute when sampling VOCs.
3. Inorganics, including metals, may be collected and preserved in the filtered form as well as the unfiltered form. Disposable in-line filters (0.45 micron filter), connected to the end of the sample tubing,, are typically used for field filtration. Samples are field filtered as the water is being placed into the sample container. If a bailer is used, filtration may be driven by a peristaltic pump.

4. Adequate space is left in the bottle to allow for expansion, except for VOC vials, which are filled to the top with a positive meniscus.
5. The bottle is capped and clearly labeled.
6. Samples are placed in appropriate containers and, if necessary, packed with ice in coolers as soon as practical.
7. Nondedicated equipment is cleaned and decontaminated in accordance with the *Decontamination of Personnel and Equipment* SOP.

The following information, at a minimum, will be recorded in the log book:

1. Sample identification (site name, location, and project number; sample name/number and location; sample type and matrix; time and date; sampler's identity)
2. Sample source and source description
3. Field observations and measurements (appearance, volatile screening, field chemistry, sampling method), volume of water purged prior to sampling, number of well volumes purged, and field parameter measurements
4. Sample disposition (preservative; laboratory name, date and time sent; laboratory sample number, chain-of-custody number, sample bottle lot number)
5. Additional remarks

C. Additional remarks

1. If the well goes dry during purging, wait until it recovers sufficiently to remove the required volumes to sample all parameters. It may be necessary to return periodically to the well but a particular sample (e.g., large amber bottles for semivolatile analysis) should be filled at one time rather than over the course of two or more visits to the well.
2. Disposable tubing is disposed of with PPE and other site trash.

IV. Attachments

White paper on reasons and rationale for low-flow sampling.

V. Key Checks and Preventative Maintenance

- The drawdown in the well should be minimized as much as possible (preferably no more than 0.5-foot to 1 foot) so that natural groundwater-flow conditions are maintained as closely as possible.
- The highest purging rate should not exceed 1 liter per minute. This is to keep the drawdown minimized.

- Stirring up of sediment in the well should be avoided so that turbidity containing adsorbed chemicals is not suspended in the well and taken in by the pump.
- Overheating of the pump should be avoided to minimize the potential for losing VOCs through volatilization.
- Keep the working space clean with plastic sheeting and good housekeeping.
- Maintain field equipment in accordance with the manufacturer's recommendations. This will include, but is not limited to:
 - Inspect sampling pump regularly and replace as warranted
 - Inspect quick-connects regularly and replace as warranted
 - Verify battery charge, calibration, and proper working order of field measurement equipment prior to initial mobilization and daily during field efforts

Attachment to the SOP on Low-Flow Sampling Groundwater Sampling from Monitoring Wells

White Paper on Low-Flow Sampling

EPA recommends low-flow sampling as a means of collecting groundwater samples in a way that minimizes the disturbance to the natural groundwater flow system and minimizes the introduction of contamination into the samples from extraneous sources. The following are details about these issues.

When a pump removes groundwater from the well at the same rate that groundwater enters the well through the screen, the natural groundwater-flow system around the well experiences a minimum of disturbance. Some disturbance is bound to occur because you are causing groundwater to flow to the well in a radial fashion that otherwise would have flowed past it. However, the resulting low-flow sample provides the most-representative indication we can get of groundwater quality in the immediate vicinity of the well.

Normally, when a well is pumped at an excessive rate that drops the water level in the well below the water level in the aquifer, the water cascades down the inside of the well screen when it enters the well. The turbulence from this cascading causes gases such as oxygen and carbon dioxide to mix with the water in concentrations that are not representative of the native groundwater and are higher than expected. This causes geochemical changes in the nature of the water that can change the concentrations of some analytes, particularly metals, in the groundwater sample, not mention it's effect on the dissolved oxygen levels that then will be measured in the flow-through cell. Such turbulence also may cause lower-than-expected concentrations of volatile organic compounds due to volatilization.

For wells in which the water level is above the top of the screen, the water up in the riser is out of the natural circulation of the groundwater and, therefore, can become stagnant. This stagnant water is no longer representative of natural groundwater quality because its pH, dissolved-oxygen content, and other geochemical characteristics change as it contacts the air in the riser. If we minimize the drawdown in the well when we pump, then we minimize the amount of this stagnant water that is brought down into the well screen and potentially into the pump. As a result, a more-representative sample is obtained.

Typically, wells contain some sediment in the bottom of the well, either as a residue from development that has settled out of the water column or that has sifted through the sand pack and screen since the well was installed. This sediment commonly has adsorbed on it such analytes as metals, SVOCs, and dioxins that normally would not be dissolved in the groundwater. If these sediments are picked up in the groundwater when the well is disturbed by excessive pumping, they can:

- Make filtering the samples for metals analysis more difficult
- Add unreasonably to the measured concentration of SVOCs and other organic compounds

The SOP for low-flow sampling has been modified recently and should be consulted for additional information about low-flow sampling and ways of dealing with wells in which the water level cannot be maintained at a constant level.

General Guidance for Monitoring Well Installation

I. Purpose

To provide site personnel with a review of the well installation procedures that will be performed. These procedures are to be considered general guidelines only and are in no way intended to supplement or replace the contractual specifications in the driller's subcontract.

II. Scope

Monitoring well installations are planned for shallow and/or deep unconsolidated aquifers and/or for bedrock aquifers. The SOPs *Installation of Shallow Monitoring Wells*, *Installation of Surface-Cased Monitoring Wells*, *Installation of Bedrock Monitoring Wells*, and *Installation of Monitoring Wells Using Sonic Drilling* provide more specifics.

III. Equipment and Materials

1. Drilling rig (hollow stem auger, sonic, air hammer, air rotary, or mud rotary)
2. Well-construction materials (i.e., surface casing, screens, riser, casing, caps, bottom plugs, centering guides, sand, bentonite, grout, and surface-finish materials)
3. Development equipment

IV. Procedures and Guidelines

1. Wells will be installed in accordance with standard EPA procedures. Note that USEPA Region III requires any well penetrating a confining layer to be double-cased.
2. The threaded connections will be water-tight.
3. Well screens generally will be constructed of 10-slot or 20-slot Schedule 40 PVC and will be 5 to 10 feet in length depending on saturated thickness of unconsolidated sediments. The exact slot size and length will be determined by the field team supervisor. Stainless steel may be required under certain contaminant conditions.
4. Stick-up wells will be surrounded by four concrete-filled guard posts at least 2 inches in diameter.

5. A record of the finished well construction will be compiled.
6. All soils and liquids generated during well installations will be drummed for proper disposal.

Monitoring Well Installation

- 2" monitoring wells in unconsolidated materials will be installed in at least 6-inch-diameter boreholes to accommodate well completion materials in designated locations.
- All monitoring wells penetrating a confining layer will be surface-cased from the ground surface to approximately 5 feet into the confining layer. Exceptions to this may be allowed under certain circumstances (e.g., evidence of significant natural gaps in the confining layer).
- Monitoring wells in unconsolidated materials will be constructed of 2-inch-diameter, factory manufactured, flush-jointed, Schedule 40 PVC (or stainless steel) screen with threaded bottom plug and riser.
- Screens will be filter packed with a properly sized and graded, thoroughly washed, sound, durable, well-rounded basalt or siliceous sand. When using hollow-stem augers, the filter pack will be installed by slowly pouring the sand into the annular space while simultaneously raising the augers and using a weighted tape to sound for the sand surface. For rotary-drilled wells, the height of the sand pack also will be sounded with a weighted tape.
- The primary filter sand pack (typically Morie #00 or DSI #1 for a 10-slot screen) will extend from 1 to 2 feet below the base to 2 feet above the top of the screen; filter pack will be allowed to settle before final measurement is taken. For wells deeper than 30 feet, the filter pack will be placed using a tremie pipe and flowing water.
- A secondary filter sand pack (typically a fine sand seal) 1-foot thick may be placed above the primary sand pack.
- Annular well seals will consist of 2 feet of pelletized, chip, or granular bentonite clay placed above the filter pack. If necessary the pellets will be hydrated using potable water. For wells installed using hollow-stem augers, the bentonite will be poured into the annular space while slowly raising the augers and sounding for the top of the bentonite with a weighted tape. A high-solids bentonite slurry using powdered bentonite introduced with a side-discharging tremie pipe will be used for the bentonite seals in wells greater than 30 feet deep. For rotary-drilled wells, the height of the well seal also will be sounded with a weighted tape. High-solids slurries will have solids content of at least 20 percent.
- The top of the annular seal will be measured after the bentonite seal has been allowed to hydrate and before the grout is applied. The seal will be allowed to hydrate for at least 30 minutes before work in the well continues.

- The annular space above the bentonite seal will be filled to grade with a bentonite-cement slurry grout mixture.
- The grout mixture consists of 6 to 8 gallons of water per 94-pound bag of Portland cement; 3 to 6 pounds of bentonite added per bag of cement to reduce shrinkage.
- The grout mix will be carefully applied to avoid disturbing the bentonite seal; the method of grout placement must force grout from the top of the bentonite seal to ground surface.
- After allowing the grout to settle and set up overnight, additional grout will be added to maintain grade.
- A protective steel casing equipped with keyed alike locking caps will be grouted in place for each new well; the casing will extend at least 2 feet above grade and 3 feet below grade, and will be painted a bright color.

Well Development

- New monitoring wells will be developed after the well has been completely installed and the grout has hardened (at least 24 hours)
- The well will be developed by surging and pumping.
- Equipment placed in the well will be decontaminated before use.
- If information is available, begin developing in the least-contaminated well first.
- Development will include surging the well by either abruptly stopping flow and allowing water in the well column to fall back into the well or through the use of a surge block that is slightly smaller in diameter than the well casing inner diameter.
- Pipes and pumps must not be fitted with foot valves or other devices that might inhibit the return flow of water to the well.
- Surging should continue throughout the development process.
- The air-lift method may be used to pump materials out of the well. The air compressor will be fitted with filters to remove all oil and the air lift hose used will be made of inert materials.
- Well development will continue until the water produced is free of turbidity, sand, and silt. A Horiba-U22 meter, YSI meter with separate Hanna turbidity meter, or equivalent should be used to determine when the turbidity is low and parameters have stabilized.
- Development water will be considered hazardous and placed in sealed 55-gallon U.S. DOT approved steel drums. CH2M HILL will label and date the drums as pending analysis, and transport the drums to a designated site for storage.

V. Attachments

None.

VI. Key Check and Items

- Ensure that all equipment is properly decontaminated as needed.
- Only new, sealed materials (e.g., screens, risers, and sand) will be used in constructing the well.
- Care shall be taken when making downhole measurements to ensure that proper heights of sand, seal, and grout are achieved.

Installation of Shallow Monitoring Wells

I. Purpose and Scope

The purpose of this guideline is to describe methods for drilling and installation of shallow monitoring wells and piezometers in unconsolidated or poorly consolidated materials using hollow stem augers, air rotary, or mud rotary. Installing monitoring wells in unconsolidated materials using sonic drilling is discussed in SOP *Installation of Monitoring Wells Using Sonic Drilling*. Methods for drilling and installing bedrock monitoring wells and deep, surface-cased wells in unconsolidated materials are presented in SOPs *Installation of Bedrock Monitoring Wells* and *Installation of Surface-Cased Monitoring Wells*, respectively.

II. Equipment and Materials

Drilling

- Drilling rig (hollow stem auger, air rotary or mud rotary) and associated tools and equipment

Well Riser/Screen and Associated Materials

- Polyvinyl chloride (PVC), Schedule 40, minimum 2-inch ID, flush-threaded riser; alternatively, stainless-steel riser
- PVC, Schedule 40, minimum 2-inch ID, flush-threaded, factory slotted screen; alternatively, stainless-steel screen
- PVC bottom cap, threaded to match the well screen; alternatively, stainless steel
- PVC or stainless-steel centering guides (if used)
- Above-grade well completion: PVC well cap, threaded or push-on type, vented
- Flush-mount well completion: PVC well cap, locking, leak-proof seal
- Stainless steel to be used as appropriate

Sand

- Clean silica sand, provided in factory-sealed bags, well-rounded, containing no organic material, anhydrite, gypsum, mica, or calcareous material; primary (coarse – e.g., Morie #1) filter pack, and secondary (fine sand seal) filter pack. Grain size determined based on sediments observed during drilling.

Bentonite

- Pure, additive-free bentonite pellets or chips
- Pure, additive-free powdered bentonite
- Coated bentonite pellets; coating must biodegrade within 7 days
- Cement-Bentonite Grout: proportion of 6 to 8 gallons of water per 94-pound bag of Portland cement; 3 to 6 pounds of bentonite added per bag of cement to reduce shrinkage.

Protective Casing

- Above-grade well completion: 6-inch minimum ID black iron steel pipe with locking cover, diameter at least 2 inches greater than the well casing, painted with epoxy paint for rust protection; heavy duty lock; protective posts if appropriate
- Flush-mount well completion: Morrison 9-inch or 12-inch 519 manhole cover, or equivalent; rubber seal to prevent leakage; locking cover inside of road box

Well Development

- Surge block
- Well-development pump and associated equipment
- Calibrated meters to ensure pH, temperature, specific conductance, ORP, and dissolved oxygen of development water
- Containers (e.g., DOT-approved 55-gallon drums) for water produced from well.

III. Procedures and Guidelines

A. Drilling Method

Typically, continuous-flight hollow-stem augers with a minimum 4.25-inch inside diameter (ID) will be used to drill shallow monitoring well boreholes for 2-inch diameter monitoring wells. Alternatively, air or mud rotary may be used.

The bit of the auger is placed at the ground surface and then turned with the drilling rig. To collect split spoon samples, the auger is advanced to the top of the sampling depth, and the split-spoon sample is collected from below the auger head. The split spoon is advanced through repeated blows from a 140- or 300-pound hammer dropped from a height of 30 inches. Thin-walled tube samplers are advanced by pressing down on the rods with the weight of the drilling rig. Split-spoon samples may be collected at selected intervals for chemical analysis and/or lithologic classification. Soil sampling procedures are detailed in SOPs *Soil Boring Sampling – Split Spoons* and *Soil Sampling*.

The use of water to assist in hollow-stem auger drilling for monitoring well installation will be avoided, unless required for such conditions as running sands.

Hollow-stem augers, drilling bits, rods, split-spoon samplers, and other downhole drilling tools will be properly decontaminated prior to the initiation of drilling activities and between each borehole location. Split-spoon samplers and other downhole soil sampling equipment will also be properly decontaminated before and after each use. *SOP Decontamination of Drill Rigs and Equipment* details proper decontamination procedures.

Drill cuttings and decontamination fluids generated during well drilling activities will be contained according to the procedures detailed in the *SOP Disposal of Waste Fluids and Solids* and the Investigation Derived Waste Management Plan (IDWMP).

Air or mud rotary drilling may be used instead of hollow-stem augers. The use of added mud should be kept to a minimum.

B. Monitoring-Well Installation

Shallow monitoring wells will be constructed inside the hollow-stem augers, once the borehole has been advanced to the desired depth, or in the mudded borehole once the drilling rods have been withdrawn. If the borehole has been drilled to a depth greater than that at which the well is to be set, the borehole will be backfilled with bentonite pellets or chips or a bentonite-cement slurry to a depth approximately 1 foot below the intended well depth. Approximately 1 foot of clean sand will be placed on top of the bentonite to return the borehole to the proper depth for well installation.

The appropriate lengths of well screen, nominally 10 feet (with bottom cap), and casing will be joined watertight and lowered inside the augers to the bottom of the borehole. Centering guides, if used, will be placed at the bottom of the screen and above the interval in which the bentonite seal is placed.

Selection of the filter pack and well screen intervals for the shallow monitoring wells shall be made in the field.

A primary sand pack consisting of clean Morie No. 00 (or DSI No.1) silica sand for 10-slot screen and Morie No. 01 (or DSI No.2) for 20-slot screen silica sand will be placed around the well screen. The sand will be placed into the borehole at a uniform rate, in a manner that will allow even placement of the sand pack. The augers will be raised gradually during sand pack installation to avoid caving of the borehole wall; at no time will the augers be raised higher than the top of the sand pack during installation. During placement of the sand, the position of the top of the sand will be continuously sounded.

The primary sand pack will be extended from the bottom of the borehole to a minimum height of 2 feet above the top of the well screen. A secondary, finer-grained (fine sand seal), sand pack will be installed for a minimum of 1 foot above the coarse sand pack. Heights of the coarse and fine sand packs

and bentonite seal may be modified in the field to account for a shallow water table and a small saturated thickness of the surficial aquifer.

A bentonite seal at least 2 feet thick will be placed above the sand pack. The seal will be placed into the borehole in a manner that will prevent bridging. The position of the top of the bentonite seal will be verified using a weighted tape measure. If all or a portion of the bentonite seal is above the water table, clean water will be added to hydrate the bentonite. A hydration period of at least 30 minutes will be required following installation of the bentonite seal.

Above the bentonite seal, an annular seal of cement-bentonite grout will be placed. The cement-bentonite grout will be installed continuously in one operation from the bottom of the space to be grouted to the ground surface through a tremie pipe. The tremie pipe must be plugged at the bottom and have small openings along the sides of the bottom 1-foot length of pipe. This will allow the grout to diffuse laterally into the borehole and not disturb the bentonite pellet seal.

C. Well Completion

For monitoring wells that will be completed above-grade, a locking steel protective casing set in a concrete pad will be installed. The steel protective casing will extend at least 3 feet into the ground and 2 feet above ground but should not penetrate the bentonite seal. The concrete pad will be square, approximately 2 feet per side (unless otherwise specified in the project plans), and poured into wooden forms. The concrete will be sloped away from the protective casing.

Guard posts may be installed in high-traffic areas for additional protection. Four steel guard posts will be installed around the protective casing. Guard posts would be concrete-filled, at least 2 inches in diameter, and would extend at least 2 feet into the ground and 3 feet above the ground. The protective casing and guard posts will be painted with an epoxy paint to prevent rust.

For monitoring wells with flush-mount completions, Morrison 9-inch or 12-inch 519 manhole cover or equivalent, with a rubber-sealed cover and drain will be installed. The top of the manhole cover will be positioned approximately 1 inch above grade. A square concrete pad, approximately 2 feet per side (unless otherwise specified in the project plans), will be installed as a concrete collar surrounding the road box cover, and will slope uniformly downward to the adjacent grade. The road box and installation thereof will be of sufficient strength to withstand normal vehicular traffic.

Concrete pads installed at all wells will be a minimum of 6 inches below grade. The concrete pad will be 12 inches thick at the center and taper to 6-inch thick at the edge. The surface of the pad should slope away from the protective casing to prevent water from pooling around the casing. Protective casing, guard posts, and flush mounts will be installed into this concrete.

Each well will be properly labeled on the exterior of the locking cap or protective casing with a metal stamp indicating the permanent well number.

D. Well Development

Well development will be accomplished using a combination of surging throughout the well screen and pumping, until the physical and chemical parameters of the discharge water that are measured in the field have stabilized and the turbidity of the discharge water is substantially reduced. Fine-grained materials in the surficial aquifer at the site may not allow low turbidity results to be achieved.

The surging apparatus will include a surge block. Well development will begin by surging the well screen, starting at the bottom of the screen and proceeding upwards, throughout the screened zone. Following surging, the well will be pumped to remove the fine materials that have been drawn into the well. During pumping, measurements of pH, temperature, and specific conductance will be recorded.

Development will continue by alternately surging and pumping until the discharge water is free from sand and silt, the turbidity is substantially reduced, and the pH, temperature, and specific conductance have stabilized at regional background levels, based on historical data. Development will continue for a minimum of 30 minutes and until the water removed from the well is as clear of turbidity as practicable.

Well development equipment will be decontaminated prior to initial use and after the development of each well. Decontamination procedures are detailed in SOP *Decontamination of Personnel and Equipment*. Water generated during well development will be contained and managed as detailed in the SOP *Disposal of Waste Fluids and Solids* and the Investigation Derived Waste Management Plan.

IV. Attachments

Schematic diagram of shallow monitoring-well construction (MWSingleDiag.xls)

Logging of Soil Borings

I. Purpose and Scope

This SOP provides guidance to obtain accurate and consistent descriptions of soil characteristics during soil-sampling operations. The characterization is based on visual examination and manual tests, not on laboratory determinations.

II. Equipment and Materials

- Indelible pens
- Tape measure or ruler
- Field logbook
- Spatula
- HCl, 10 percent solution
- Squirt bottle with water
- Rock- or soil-color chart (e.g., Munsell)
- Grain-size chart
- Hand lens
- Unified Soil Classification System (USCS) index charts and tables to help with soil classification (attached)

III. Procedures and Guidelines

This section covers several aspects of soil characterization: instructions for completing the CH2M HILL soil boring log Form D1586 (attached), field classification of soil, and standard penetration test procedures.

A. Instructions for Completing Soil Boring Logs

Soil boring logs will be completed in the field log books or on separate soil boring log sheets. Information collected will be consistent with that required for Form D1586 (attached), a standard CH2M HILL form (attached), or an equivalent form that supplies the same information.

The information collected in the field to perform the soil characterization is described below.

Field personnel should review completed logs for accuracy, clarity, and thoroughness of detail. Samples also should be checked to see that information is correctly recorded on both jar lids and labels and on the log sheets.

B. Heading Information

Boring/Well Number. Enter the boring/well number. A numbering system should be chosen that does not conflict with information recorded for previous exploratory work done at the site. Number the sheets consecutively for each boring.

Location. If station, coordinates, mileposts, or similar project layout information is available, indicate the position of the boring to that system using modifiers such as "approximate" or "estimated" as appropriate.

Elevation. Elevation will be determined at the conclusion of field activities through a survey.

Drilling Contractor. Enter the name of the drilling company and the city and state where the company is based.

Drilling Method and Equipment. Identify the bit size and type, drilling fluid (if used), and method of drilling (e.g., rotary, hollow-stem auger). Information on the drilling equipment (e.g., CME 55, Mobile B61) also is noted.

Water Level and Date. Enter the depth below ground surface to the apparent water level in the borehole. The information should be recorded as a comment. If free water is not encountered during drilling or cannot be detected because of the drilling method, this information should be noted. Record date and time of day (for tides, river stage) of each water level measurement.

Date of Start and Finish. Enter the dates the boring was begun and completed. Time of day should be added if several borings are performed on the same day.

Logger. Enter the first and last name.

C. Technical Data

Depth Below Surface. Use a depth scale that is appropriate for the sample spacing and for the complexity of subsurface conditions.

Sample Interval. Note the depth at the top and bottom of the sample interval.

Sample Type and Number. Enter the sample type and number. SS-1 = split spoon, first sample. Number samples consecutively regardless of type. Enter a sample number even if no material was recovered in the sampler.

Sample Recovery. Enter the length to the nearest 0.1-foot of soil sample recovered from the sampler. Often, there will be some wash or caved material above the sample; do not include the wash material in the measurement. Record soil recovery in feet.

Standard Penetration Test Results. In this column, enter the number of blows required for each 6 inches of sampler penetration and the "N" value, which is the sum of the blows in the middle two 6-inch penetration intervals. A typical standard penetration test involving successive blow counts of 2, 3, 4, and 5 is recorded as 2-3-4-5 and (7). The standard penetration test is terminated if the sampler encounters refusal. Refusal is a penetration of less than 6 inches with a blow count of 50. A

partial penetration of 50 blows for 4 inches is recorded as 50/4 inches. Penetration by the weight of the slide hammer only is recorded as "WOH."

Samples should be collected using a 140-pound hammer and 2-inch diameter split spoons. Samples may be collected using direct push sampling equipment. However, blow counts will not be available. A pocket penetrometer may be used instead to determine relative soil density of fine grained materials (silts and clays).

Sample also may be collected using a 300-pound hammer or 3-inch-diameter split-spoon samples at the site. However, use of either of these sample collection devices invalidates standard penetration test results and should be noted in the comments section of the log. The 300-pound hammer should only be used for collection of 3-inch-diameter split-spoon samples. Blow counts should be recorded for collection of samples using either a 3-inch split-spoon, or a 300-pound hammer. An "N" value need not be calculated.

Soil Description. The soil classification should follow the format described in the "Field Classification of Soil" subsection below.

Comments. Include all pertinent observations (changes in drilling fluid color, rod drops, drilling chatter, rod bounce as in driving on a cobble, damaged Shelby tubes, and equipment malfunctions). In addition, note if casing was used, the sizes and depths installed, and if drilling fluid was added or changed. You should instruct the driller to alert you to any significant changes in drilling (changes in material, occurrence of boulders, and loss of drilling fluid). Such information should be attributed to the driller and recorded in this column.

Specific information might include the following:

- The date and the time drilling began and ended each day
- The depth and size of casing and the method of installation
- The date, time, and depth of water level measurements
- Depth of rod chatter
- Depth and percentage of drilling fluid loss
- Depth of hole caving or heaving
- Depth of change in material
- Health and safety monitoring data
- Drilling interval through a boulder

D. Field Classification of Soil

This section presents the format for the field classification of soil. In general, the approach and format for classifying soils should conform to ASTM D 2488, Visual-Manual Procedure for Description and Identification of Soils (attached).

The Unified Soil Classification System is based on numerical values of certain soil properties that are measured by laboratory tests. It is possible, however, to estimate these values in the field with reasonable accuracy using visual-manual procedures (ASTM D 2488). In addition, some elements of a complete soil

description, such as the presence of cobbles or boulders, changes in strata, and the relative proportions of soil types in a bedded deposit, can be obtained only in the field.

Soil descriptions should be precise and comprehensive without being verbose. The correct overall impression of the soil should not be distorted by excessive emphasis on insignificant details. In general, similarities rather than differences between consecutive samples should be stressed.

Soil descriptions must be recorded for every soil sample collected. The format and order for soil descriptions should be as follows:

1. Soil name (synonymous with ASTM D 2488 Group Name) with appropriate modifiers. Soil name should be in all capitals in the log, for example "POORLY-GRADED SAND."
2. Group symbol, in parentheses, for example, "(SP)."
3. Color, using Munsell color designation
4. Moisture content
5. Relative density or consistency
6. Soil structure, mineralogy, or other descriptors

This order follows, in general, the format described in ASTM D 2488.

E. Soil Name

The basic name of a soil should be the ASTM D 2488 Group Name on the basis of visual estimates of gradation and plasticity. The soil name should be capitalized.

Examples of acceptable soil names are illustrated by the following descriptions:

- A soil sample is visually estimated to contain 15 percent gravel, 55 percent sand, and 30 percent fines (passing No. 200 sieve). The fines are estimated as either low or highly plastic silt. This visual classification is SILTY SAND WITH GRAVEL, with a Group Symbol of (SM).
- Another soil sample has the following visual estimate: 10 percent gravel, 30 percent sand, and 60 percent fines (passing the No. 200 sieve). The fines are estimated as low plastic silt. This visual classification is SANDY SILT. The gravel portion is not included in the soil name because the gravel portion was estimated as less than 15 percent. The Group Symbol is (ML).

The gradation of coarse-grained soil (more than 50 percent retained on No. 200 sieve) is included in the specific soil name in accordance with ASTM D 2488. There is no need to further document the gradation. However, the maximum size and angularity or roundness of gravel and sand-sized particles should be recorded. For fine-grained soil (50 percent or more passing the No. 200 sieve), the name is modified by the appropriate plasticity/elasticity term in accordance with ASTM D 2488.

Interlayered soil should each be described starting with the predominant type. An introductory name, such as “Interlayered Sand and Silt,” should be used. In addition, the relative proportion of each soil type should be indicated (see Table 1 for example).

Where helpful, the evaluation of plasticity/elasticity can be justified by describing results from any of the visual-manual procedures for identifying fine-grained soils, such as reaction to shaking, toughness of a soil thread, or dry strength as described in ASTM D 2488.

F. Group Symbol

The appropriate group symbol from ASTM D 2488 must be given after each soil name. The group symbol should be placed in parentheses to indicate that the classification has been estimated.

In accordance with ASTM D 2488, dual symbols (e.g., GP-GM or SW-SC) can be used to indicate that a soil is estimated to have about 10 percent fines. Borderline symbols (e.g., GM/SM or SW/SP) can be used to indicate that a soil sample has been identified as having properties that do not distinctly place the soil into a specific group. Generally, the group name assigned to a soil with a borderline symbol should be the group name for the first symbol. The use of a borderline symbol should not be used indiscriminately. Every effort should be made to first place the soil into a single group.

G. Color

The color of a soil must be given. The color description should be based on the Munsell system. The color name and the hue, value, and chroma should be given.

H. Moisture Content

The degree of moisture present in a soil sample should be defined as dry, moist, or wet. Moisture content can be estimated from the criteria listed on Table 2.

I. Relative Density or Consistency

Relative density of a coarse-grained (cohesionless) soil is based on N-values (ASTM D 1586 [attached]). If the presence of large gravel, disturbance of the sample, or non-standard sample collection makes determination of the in situ relative density or consistency difficult, then this item should be left out of the description and explained in the Comments column of the soil boring log.

Consistency of fine-grained (cohesive) soil is properly based on results of pocket penetrometer or torvane results. In the absence of this information, consistency can be estimated from N-values. Relationships for determining relative density or consistency of soil samples are given in Tables 3 and 4.

J. Soil Structure, Mineralogy, and Other Descriptors

Discontinuities and inclusions are important and should be described. Such features include joints or fissures, slickensides, bedding or laminations, veins, root holes, and wood debris.

Significant mineralogical information such as cementation, abundant mica, or unusual mineralogy should be described.

Other descriptors may include particle size range or percentages, particle angularity or shape, maximum particle size, hardness of large particles, plasticity of fines, dry strength, dilatancy, toughness, reaction to HCl, and staining, as well as other information such as organic debris, odor, or presence of free product.

K. Equipment and Calibration

Before starting the testing, the equipment should be inspected for compliance with the requirements of ASTM D 1586. The split-barrel sampler should measure 2-inch or 3-inch O.D., and should have a split tube at least 18 inches long. The minimum size sampler rod allowed is "A" rod (1-5/8-inch O.D.). A stiffer rod, such as an "N" rod (2-5/8-inch O.D.), is required for depths greater than 50 feet. The drive weight assembly should consist of a 140-pound or 300-pound hammer weight, a drive head, and a hammer guide that permits a free fall of 30 inches.

IV. Attachments

Soil Boring Log (Sample Soil Boring Log.xls)

CH2M HILL Form D1586 and a completed example (Soil_Log_Examp.pdf)

ASTM D 2488 *Standard Practice for Description and Identification of Soils (Visual-Manual Procedures)* (ASTM D2488.pdf)

ASTM 1586 *Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils* (ASTM D1586.pdf)

Tables 1 through 4 (Tables 1-4.pdf)

V. Key Checks and Preventive Maintenance

- Check entries to the soil-boring log and field logbook in the field; because the samples will be disposed of at the end of fieldwork, confirmation and corrections cannot be made later.
- Check that sample numbers and intervals are properly specified.
- Check that drilling and sampling equipment is decontaminated using the procedures defined in SOP *Decontamination of Drilling Rigs and Equipment*.

Shallow Soil Sampling

I. Purpose

To provide general guidelines for the collection and handling of surface soil samples during field operations.

II. Scope

The method described for surface soil sampling is applicable for loosely packed earth and is used to collect disturbed-soil samples.

III. Equipment and Materials

- Sample jars.
- A hand auger or other device that can be used to remove the soil from the ground. Only stainless steel, Teflon, or glass materials should be used. The only exception is split spoons, which are most commonly available in carbon steel; these are acceptable for use only if they are not rusty.
- A stainless steel spatula or disposable plastic scoop should be used to remove material from the sampling device.
- Unpainted wooden stakes or pin flags
- Fiberglass measuring tape (at least 200 feet in length)
- GPS Unit (if available)

IV. Procedures and Guidelines

- A. Wear protective gear, as specified in the Health and Safety Plan.
- B. To locate samples, identify the correct location using the pin flags or stakes. Proceed to collect a sample from the undisturbed soil adjacent to the marker following steps C and D. If markers are not present, the following procedures will be used.
 1. For samples on a grid:
 - a. Use measuring tape to locate each sampling point on the first grid line as prescribed in the sampling plan. As each point is located, drive a numbered stake in the ground and record its location on the site map and in the logbook.

- b. Proceed to sample the points on the grid line.
 - c. Measure to location where next grid line is to start and stake first sample. For subsequent samples on the line take two orthogonal measurements: one to the previous grid line, and one to the previous sample on the same grid line.
 - d. Proceed to sample the points on the grid line as described in Section C below.
 - e. Repeat 1c and 1d above until all samples are collected from the area.
 - f. Or, a GPS unit can be used to identify each location based on map coordinated, if available.
2. For non-grid samples:
- a. Use steel measuring tape to position sampling point at location described in the sampling plan by taking two measurements from fixed landmarks (e.g., corner of house and fence post).
 - b. Note measurements, landmarks, and sampling point on a sketch in the field notebook, and on a site location map.
 - c. Proceed to sample as described in Section C below.
 - d. Repeat 2a through 2c above until all samples are collected from the area.
 - e. Or, a GPS unit can be used to identify each location based on map coordinated, if available.
- C. To the extent possible, differentiate between fill and natural soil. If both are encountered at a boring location, sample both as prescribed in the field sampling plan. Do not locate samples in debris, tree roots, or standing water. In residential areas, do not sample in areas where residents' activities may impact the sample (e.g., barbecue areas, beneath eaves of roofs, driveways, garbage areas). If an obstacle prevents sampling at a measured grid point, move as close as possible, but up to a distance of one half the grid spacing in any direction to locate an appropriate sample. If an appropriate location cannot be found, consult with the Field Team Leader (FTL). If the FTL concurs, the sampling point will be deleted from the program. The FTL will contact the CH2M HILL project manager (PM) immediately. The PM and Navy Technical Representative (NTR) will discuss whether the point should be deleted from the program. If it is deleted, the PM will follow-up with the NTR in writing.
- D. To collect samples:
- 1. Use a decontaminated stainless steel scoop/trowel or disposable plastic scoopto scrape away surficial organic material (grass, leaves, etc.) adjacent to

the stake. New disposable scoops or trowels may also be used to reduce the need for equipment blanks.

2. If sampling:
 - a. Surface soil: Obtain soil sample by scooping soil using the augering scoop/trowel, starting from the surface and digging down to a depth of about 6 inches, or the depth specified in the workplan.
 - b. Subsurface soil: Obtain the subsurface soil sample using an auger down to the depths prescribed in the field sampling plan.
3. Take a photoionization detector (PID) reading of the sampled soil if organics are anticipated to be present and record the response in the field notebook. Also record lithologic description and any pertinent observations (such as discoloration) in the logbook.
4. Empty the contents of the scoop/trowel into a decontaminated stainless steel pan or dedicated sealable bag.
5. Repeat this procedure until sufficient soil is collected to meet volume requirements.
6. For TCL VOC and field GC aliquots, fill sample jars directly with the trowel/scoop or specialized sampling equipment (i.e. Encore® or Terra Core® sampler) and cap immediately upon filling. DO NOT HOMOGENIZE.
7. For TCL pesticides/PCBs and SVOCs, TAL metals, and field XRF aliquots, homogenize cuttings in the pan using a decontaminated stainless steel utensil in accordance with SOP *Decontamination of Drilling Rigs and Equipment*.
8. Transfer sample for analysis into appropriate containers with a decontaminated utensil.
9. Backfill the hole with soil removed from the borehole. To the extent possible, replace topsoil and grass and attempt to return appearance of sampling area to its pre-sampled condition. For samples in non-residential, unmowed areas, mark the sample number on the stake and leave stake in place. In mowed areas, remove stake.

V. Attachments

None.

VI. Key Checks and Items

- Use phthalate-free latex or surgical gloves and other personal protective equipment.
- Transfer volatiles first, avoid mixing.
- Decontaminate utensils before reuse, or use dedicated, disposable utensils.

Water-Level Measurements

I. Purpose and Scope

The purpose of this procedure is to provide a guideline for the measurement of the depth to groundwater in piezometers and monitoring wells, even where a second phase of floating liquid (e.g., gasoline) is encountered, and on staff gages in surface-water bodies. This SOP includes guidelines for discrete measurements of static water levels and does not cover the use of continuously recording loggers (see SOP *Use of Data Loggers and Pressure Transducers*).

II. Equipment and Materials

- Electronic water-level meter (Solinst® or equivalent) with a minimum 100-foot tape; the tape should have graduations in increments of 0.01 feet or less
- Interface probe (Solinst® Model 122 Interface Meter or equivalent)

III. Procedures and Guidelines

Verify that the unit is turned on and functioning properly. Slowly lower the probe on its cable into the piezometer or well until the probe just contacts the water surface; the unit will respond with a tone or light signal. Note the depth from a reference point indicated on the piezometer or well riser. Typically this is the top of the PVC casing. If no reference is clearly visible, measure the depth to water from the northern edge of the PVC casing. If access to the top of the PVC casing is difficult, sight across the top of the locking casing adjacent to the measuring point, recording the position of the cable when the probe is at the water surface.

Measure the distance from this point to the closest interval marker on the tape, and record the water level reading in the logbook. Water levels will be measured to the nearest 0.01-foot. Also when specified in the project plans, measure and record the depth of the piezometer or well. The depth of the piezometer or well may be measured using the water-level probe with the instrument turned off.

Free product light or dense nonaqueous phase liquid may be present in the piezometer or well. If the presence of free product is suspected, the thickness of the product should be determined using appropriate equipment (e.g., Solinst® Model 122 Interface Meter). The depth to water also is determined with this equipment and the water-level meter should not be used in the piezometer or well as long as product is present. Typically, a constant sound is emitted from the device when free product is encountered and an alternating on/off beep sound is emitted when water is encountered.

The apparent elevation of the water level in the well or piezometer is determined by measuring both the apparent depth to water and the thickness of free product. The corrected water-level elevation is calculated by the following equation:

$$WL_c = WL_a + (\text{Free-product thickness} \times 0.80)$$

Where WL_c = Corrected water-level elevation

WL_a = Apparent water-level elevation

0.80 = Typical value for the density of petroleum hydrocarbon products.

If free product is detected on the surface of the water in the piezometer or well, the value of sampling should be reconsidered because of the potential for contaminating the sampling equipment.

Staff gages may be installed in some surface-water bodies. These facilities typically are constructed by attaching a calibrated, marked staff gage to a wood or metal post, driving the post into the bottom of the surface-water body, and surveying the elevation of the top of the post to a resolution or 0.01-foot. The elevation of the water in the surface-water body then can be determined by reading off the distance the water level is from the top of the post. A shield or other protection may be needed to calm the fluctuations in water level if the gage is installed at a location exposed to wind or wave.

IV. Attachments

None.

V. Key Checks

- Before each use, verify that the battery is charged by pressing the test button on the water-level meter.
- Verify that the unit is operating correctly by testing the probe in distilled or de-ionized water. Leave the unit turned off when not in use.

Equipment Blank and Field Blank Preparation

I. Purpose

To prepare blanks to determine whether decontamination procedures are adequate and whether any cross-contamination is occurring during sampling due to contaminated air and dust.

II. Scope

The general protocols for preparing the blanks are outlined. The actual equipment to be rinsed will depend on the requirements of the specific sampling procedure.

III. Equipment and Materials

- Blank liquid (use ASTM Type II or lab grade water)
- Millipore™ deionized water
- Sample bottles as appropriate
- Gloves
- Preservatives as appropriate

IV. Procedures and Guidelines

- A. Decontaminate all sampling equipment that has come in contact with sample according to SOP *Decontamination of Personnel and Equipment*.
- B. To collect an equipment blank for volatile analysis from the surfaces of sampling equipment other than pumps, pour blank water over one piece of equipment and into two 40-ml vials until there is a positive meniscus, then seal the vials. Note the sample number and associated piece of equipment in the field notebook as well as the type and lot number of the water used.

For non-volatiles analyses, one aliquot is to be used for equipment. For example, if a pan and trowel are used, place trowel in pan and pour blank fluid in pan such that pan and trowel surfaces which contacted the sample are contacted by the blank fluid. Pour blank fluid from pan into appropriate sample bottles.

Do not let the blank fluid come in contact with any equipment that has not been decontaminated.

- C. When collecting an equipment blank from a pump, run an extra gallon of deionized water through the pump while collecting the pump outflow into appropriate containers. Make sure the flow rate is low when sampling VOCs. If a Grundfos Redi-Flo2 pump with disposable tubing is used, remove the disposable tubing after sampling but before decon. When decon is complete, put a 3- to 5-foot segment of new tubing onto the pump to collect the equipment blank.
- D. To collect a field blank, slowly pour ASTM Type II or lab grade water directly into sample containers.
- E. Document and ship samples in accordance with the procedures for other samples.
- F. Collect next field sample.

V. Attachments

None.

VI. Key Checks and Items

- Wear gloves.
- Do not use any non-decontaminated equipment to prepare blank.
- Use ASTM-Type II or lab grade water.

Chain-of-Custody

I Purpose

The purpose of this SOP is to provide information on chain-of-custody procedures to be used under the CLEAN Program.

II Scope

This procedure describes the steps necessary for transferring samples through the use of Chain-of-Custody Records. A Chain-of-Custody Record is required, without exception, for the tracking and recording of samples collected for on-site or off-site analysis (chemical or geotechnical) during program activities (except wellhead samples taken for measurement of field parameters). Use of the Chain-of-Custody Record Form creates an accurate written record that can be used to trace the possession and handling of the sample from the moment of its collection through analysis. This procedure identifies the necessary custody records and describes their completion. This procedure does not take precedence over region specific or site-specific requirements for chain-of-custody.

III Definitions

Chain-of-Custody Record Form - A Chain-of-Custody Record Form is a printed two-part form that accompanies a sample or group of samples as custody of the sample(s) is transferred from one custodian to another custodian. One copy of the form must be retained in the project file.

Custodian - The person responsible for the custody of samples at a particular time, until custody is transferred to another person (and so documented), who then becomes custodian. A sample is under one's custody if:

- It is in one's actual possession.
- It is in one's view, after being in one's physical possession.
- It was in one's physical possession and then he/she locked it up to prevent tampering.
- It is in a designated and identified secure area.

Sample - A sample is physical evidence collected from a facility or the environment, which is representative of conditions at the point and time that it was collected.

IV Responsibilities

Project Manager - The Project Manager is responsible for ensuring that project-specific plans are in accordance with these procedures, where applicable, or that other, approved procedures are developed. The Project Manager is responsible for development of documentation of procedures which deviate from those presented herein. The Project Manager is responsible for ensuring that chain-of-custody procedures are implemented. The Project Manager also is responsible for determining that custody procedures have been met by the analytical laboratory.

Field Team Leader - The Field Team Leader is responsible for determining that chain-of-custody procedures are implemented up to and including release to the shipper or laboratory. It is the responsibility of the Field Team Leader to ensure that these procedures are implemented in the field and to ensure that personnel performing sampling activities have been briefed and trained to execute these procedures.

Sample Personnel - It is the responsibility of the field sampling personnel to initiate chain-of-custody procedures, and maintain custody of samples until they are relinquished to another custodian, the sample shipper, or to a common carrier.

V Procedures

The term “chain-of-custody” refers to procedures which ensure that evidence presented in a court of law is valid. The chain-of-custody procedures track the evidence from the time and place it is first obtained to the courtroom, as well as providing security for the evidence as it is moved and/or passed from the custody of one individual to another.

Chain-of-custody procedures, recordkeeping, and documentation are an important part of the management control of samples. Regulatory agencies must be able to provide the chain-of-possession and custody of any samples that are offered for evidence, or that form the basis of analytical test results introduced as evidence. Written procedures must be available and followed whenever evidence samples are collected, transferred, stored, analyzed, or destroyed.

V.1 Sample Identification

The method of identification of a sample depends on the type of measurement or analysis performed. When *in situ* measurements are made, the data are recorded directly in bound logbooks or other field data records with identifying information.

Information which shall be recorded in the field logbook, when in-situ measurements or samples for laboratory analysis are collected, includes:

- Field Sampler(s),
- Contract Task Order (CTO) Number,
- Project Sample Number,
- Sample location or sampling station number,
- Date and time of sample collection and/or measurement,

- Field observations,
- Equipment used to collect samples and measurements, and
- Calibration data for equipment used

Measurements and observations shall be recorded using waterproof ink.

V.1.1 Sample Label

Samples, other than for *in situ* measurements, are removed and transported from the sample location to a laboratory or other location for analysis. Before removal, however, a sample is often divided into portions, depending upon the analyses to be performed. Each portion is preserved in accordance with the Sampling and Analysis Plan. Each sample container is identified by a sample label (see Attachment A). Sample labels are provided, along with sample containers, by the analytical laboratory. The information recorded on the sample label includes:

- Project - CTO Number.
- Station Location - The unique sample number identifying this sample.
- Date - A six-digit number indicating the day, month, and year of sample collection (e.g., 01/21/08).
- Time - A four-digit number indicating the 24-hour time of collection (for example: 0954 is 9:54 a.m., and 1629 is 4:29 p.m.).
- Medium - Water, soil, sediment, sludge, waste, etc.
- Sample Type - Grab or composite.
- Preservation - Type and quantity of preservation added.
- Analysis - VOA, BNAs, PCBs, pesticides, metals, cyanide, other.
- Sampled By - Printed name of the sampler.
- Remarks - Any pertinent additional information.

Using only the work assignment number of the sample label maintains the anonymity of sites. This may be necessary, even to the extent of preventing the laboratory performing the analysis from knowing the identity of the site (e.g., if the laboratory is part of an organization that has performed previous work on the site). The field team should always follow the sample ID system prepared by the project EIS and reviewed by the Project Manager.

V.2 Chain-of-Custody Procedures

After collection, separation, identification, and preservation, the sample is maintained under chain-of-custody procedures until it is in the custody of the analytical laboratory and has been stored or disposed of.

V.2.1 Field Custody Procedures

- Samples are collected as described in the site Sampling and Analysis Plan. Care must be taken to record precisely the sample location and to ensure that the sample number on the label matches the Chain-of-Custody Record exactly.
- A Chain-of-Custody Record will be prepared for each individual cooler shipped and will include *only* the samples contained within that particular cooler. The Chain-of-Custody Record for that cooler will then be sealed in a zip-log bag and placed in the cooler prior to sealing. This ensures that the laboratory properly attributes trip blanks with the correct cooler and allows for easier tracking should a cooler become lost during transit.
- The person undertaking the actual sampling in the field is responsible for the care and custody of the samples collected until they are properly transferred or dispatched.
- When photographs are taken of the sampling as part of the documentation procedure, the name of the photographer, date, time, site location, and site description are entered sequentially in the site logbook as photos are taken. Once downloaded to the server or developed, the electronic files or photographic prints shall be serially numbered, corresponding to the logbook descriptions; photographic prints will be stored in the project files. To identify sample locations in photographs, an easily read sign with the appropriate sample/location number should be included.
- Sample labels shall be completed for each sample, using waterproof ink unless prohibited by weather conditions (e.g., a logbook notation would explain that a pencil was used to fill out the sample label if the pen would not function in freezing weather.)

V.2.2 Transfer of Custody and Shipment

Samples are accompanied by a Chain-of-Custody Record Form. **A Chain-of-Custody Record Form must be completed for each cooler and should include only the samples contained within that cooler.** A Chain-of-Custody Record Form example is shown in Attachment B. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the Record. This Record documents sample custody transfer from the sampler, often through another person, to the analyst in the laboratory. The Chain-of-Custody Record is filled out as given below:

- Enter header information (CTO number, samplers, and project name).
- Enter sample specific information (sample number, media, sample analysis required and analytical method grab or composite, number and type of sample containers, and date/time sample was collected).
- Sign, date, and enter the time under “Relinquished by” entry.

- Have the person receiving the sample sign the “Received by” entry. If shipping samples by a common carrier, print the carrier to be used in this space (i.e., Federal Express).
- If a carrier is used, enter the airbill number under “Remarks,” in the bottom right corner;
- Place the original (top, signed copy) of the Chain-of-Custody Record Form in a plastic zipper-type bag or other appropriate sample-shipping package. Retain the copy with field records.
- Sign and date the custody seal, a 1-inch by 3-inch white paper label with black lettering and an adhesive backing. Attachment C is an example of a custody seal. The custody seal is part of the chain-of-custody process and is used to prevent tampering with samples after they have been collected in the field. Custody seals shall be provided by the analytical laboratory.
- Place the seal across the shipping container opening (front and back) so that it would be broken if the container were to be opened.
- Complete other carrier-required shipping papers.

The custody record is completed using waterproof ink. Any corrections are made by drawing a line through and initialing and dating the change, then entering the correct information. Erasures are not permitted.

Common carriers will usually not accept responsibility for handling Chain-of-Custody Record Forms; this necessitates packing the record in the shipping container (enclosed with other documentation in a plastic zipper-type bag). As long as custody forms are sealed inside the shipping container and the custody seals are intact, commercial carriers are not required to sign the custody form.

The laboratory representative who accepts the incoming sample shipment signs and dates the Chain-of-Custody Record, completing the sample transfer process. It is then the laboratory’s responsibility to maintain internal logbooks and custody records throughout sample preparation and analysis.

VI Quality Assurance Records

Once samples have been packaged and shipped, the Chain-of-Custody copy and airbill receipt become part of the quality assurance record.

VII Attachments

- A. Sample Label
- B. Chain of Custody Form
- C. Custody Seal

VIII References

USEPA. *User's Guide to the Contract Laboratory Program*. Office of Emergency and Remedial Response, Washington, D.C. (EPA/540/P-91/002), January 1991.

Decontamination of Personnel and Equipment

I. Purpose

To provide general guidelines for the decontamination of personnel, sampling equipment, and monitoring equipment used in potentially contaminated environments.

II. Scope

This is a general description of decontamination procedures.

III. Equipment and Materials

- Demonstrated analyte-free, deionized (“DI”) water (specifically, ASTM Type II water or lab-grade DI water)
- Potable water; must be from a municipal water supplier, otherwise an analysis must be run for appropriate volatile and semivolatile organic compounds and inorganic chemicals (e.g., Target Compound List and Target Analyte List chemicals)
- 2.5% (W/W) Liquinox[®] (or Alconox[®]) and water solution
- Concentrated (V/V) pesticide grade methanol (DO NOT USE ACETONE)
- Large plastic pails or tubs for Liquinox[®] and water, scrub brushes, squirt bottles for Liquinox[®] solution, methanol and water, plastic bags and sheets
- DOT approved 55-gallon drum for disposal of waste
- Personal Protective Equipment as specified by the Health and Safety Plan
- Decontamination pad and steam cleaner/high pressure cleaner for large equipment

IV. Procedures and Guidelines

A. PERSONNEL DECONTAMINATION

To be performed after completion of tasks whenever potential for contamination exists, and upon leaving the exclusion zone.

1. Wash boots in Liquinox[®] solution, then rinse with water. If disposable latex booties are worn over boots in the work area, rinse with Liquinox[®] solution, remove, and discard into DOT-approved 55-gallon drum.
2. Wash outer gloves in Liquinox[®] solution, rinse, remove, and discard into DOT-approved 55-gallon drum.
3. Remove disposable coveralls (“Tyveks”) and discard into DOT-approved 55-gallon drum.
4. Remove respirator (if worn).
5. Remove inner gloves and discard.
6. At the end of the work day, shower entire body, including hair, either at the work site or at home.
7. Sanitize respirator if worn.

B. SAMPLING EQUIPMENT DECONTAMINATION – GROUNDWATER SAMPLING PUMPS

Sampling pumps are decontaminated after each use as follows.

1. Don phthalate-free gloves.
2. Spread plastic on the ground to keep equipment from touching the ground
3. Turn off pump after sampling. Remove pump from well and remove and dispose of tubing. Place pump in decontamination tube.
4. Turn pump back on and pump 1 gallon of Liquinox[®] solution through the sampling pump.
5. Rinse with 1 gallon of 10% methanol solution pumped through the pump. (DO NOT USE ACETONE).
6. Rinse with 1 gallon of tap water.
7. Rinse with 1 gallon of deionized water.
8. Keep decontaminated pump in decontamination tube or remove and wrap in aluminum foil or clean plastic sheeting.
9. Collect all rinsate and dispose of in a DOT-approved 55-gallon drum.
10. Decontamination materials (e.g., plastic sheeting, tubing, etc.) that have come in contact with used decontamination fluids or sampling equipment will be disposed of in either DOT-approved 55-gallon drums or with solid waste in garbage bags, dependent on Facility/project requirements.

C. SAMPLING EQUIPMENT DECONTAMINATION – OTHER EQUIPMENT

Reusable sampling equipment is decontaminated after each use as follows.

1. Don phthalate-free gloves.
2. Before entering the potentially contaminated zone, wrap soil contact points in aluminum foil (shiny side out).
3. Rinse and scrub with potable water.
4. Wash all equipment surfaces that contacted the potentially contaminated soil/water with Liquinox[®] solution.
5. Rinse with potable water.
6. Rinse with distilled or potable water and methanol solution (DO NOT USE ACETONE).
7. Air dry.
8. Rinse with deionized water.
9. Completely air dry and wrap exposed areas with aluminum foil (shiny side out) for transport and handling if equipment will not be used immediately.
10. Collect all rinsate and dispose of in a DOT-approved 55-gallon drum.
11. Decontamination materials (e.g., plastic sheeting, tubing, etc.) that have come in contact with used decontamination fluids or sampling equipment will be disposed of in DOT-approved 55-gallon drums or with solid waste in garbage bags, dependent on Facility/project requirements.

D. HEALTH AND SAFETY MONITORING EQUIPMENT DECONTAMINATION

1. Before use, wrap soil contact points in plastic to reduce need for subsequent cleaning.
2. Wipe all surfaces that had possible contact with contaminated materials with a paper towel wet with Liquinox[®] solution, then a towel wet with methanol solution, and finally three times with a towel wet with distilled water. Dispose of all used paper towels in a DOT-approved 55-gallon drum or with solid waste in garbage bags, dependent on Facility/project requirements.

E. SAMPLE CONTAINER DECONTAMINATION

The outsides of sample bottles or containers filled in the field may need to be decontaminated before being packed for shipment or handled by personnel without hand protection. The procedure is:

1. Wipe container with a paper towel dampened with Liquinox[®] solution or immerse in the solution AFTER THE CONTAINERS HAVE BEEN SEALED. Repeat the above steps using potable water.
2. Dispose of all used paper towels in a DOT-approved 55-gallon drum or with solid waste in garbage bags, dependent on Facility/project requirements.

F. HEAVY EQUIPMENT AND TOOLS

Heavy equipment such as drilling rigs, drilling rods/tools, and the backhoe will be decontaminated upon arrival at the site and between locations as follows:

1. Set up a decontamination pad in area designated by the Facility
2. Steam clean heavy equipment until no visible signs of dirt are observed. This may require wire or stiff brushes to dislodge dirt from some areas.

V. Attachments

None.

VI. Key Checks and Items

- Clean with solutions of Liquinox[®], methanol, and distilled water.
- Do not use acetone for decontamination.
- Drum all contaminated rinsate and materials.
- Decontaminate filled sample bottles before relinquishing them to anyone.

Decontamination of Drilling Rigs and Equipment

I. Purpose and Scope

The purpose of this guideline is to provide methods for the decontamination of drilling rigs, downhole drilling tools, and water-level measurement equipment. Personnel decontamination procedures are not addressed in this SOP; refer to the site safety plan and SOP *Decontamination of Personnel and Equipment*. Sample bottles will not be field decontaminated; instead they will be purchased with certification of laboratory sterilization.

II. Equipment and Materials

- Portable steam cleaner and related equipment
- Potable water
- Phosphate-free detergent such as Liquinox[®]
- Buckets
- Brushes
- Methanol, pesticide grade
- Personal Protective Equipment as specified by the Health and Safety Plan
- ASTM-Type II grade water or Lab Grade DI Water
- Aluminum foil

III. Procedures and Guidelines

A. Drilling Rigs and Monitoring Well Materials

Before the onset of drilling, after each borehole, before drilling through permanent isolation casing, and before leaving the site, heavy equipment and machinery will be decontaminated by steam cleaning at a designated area. The steam-cleaning area will be designed to contain decontamination wastes and waste waters and can be an HDPE-lined, bermed pad. A pumping system will be used to convey decontaminated water from the pad to drums.

Surface casings may be steam cleaned in the field if they are exposed to contamination at the site prior to use.

B. Downhole Drilling Tools

Downhole tools will be steam cleaned before the onset of drilling, prior to drilling through permanent isolation casing, between boreholes, and prior to leaving the site. This will include, but is not limited to, rods, split spoons or similar samplers, coring equipment, augers, and casing.

Before the use of a sampling device such as a split-spoon sampler for the collection of a soil sample for physical characterization, the sampler shall be cleaned by scrubbing with a detergent solution followed by a potable water rinse.

Before the use of a sampling device such as a split-spoon sampler for the collection of a soil sample for chemical analysis, the sampler shall be decontaminated following the procedures outlined in the following subsection.

C. Field Analytical Equipment

1. Water Level Indicators

Water level indicators that consist of a probe that comes into contact with the groundwater must be decontaminated using the following steps:

- a. Rinse with tap water
- b. Rinse with de-ionized water
- c. Solvent rinse with methanol
- d. Rinse with de-ionized water

2. Probes

Probes, for example, pH or specific ion electrodes, geophysical probes, or thermometers that would come in direct contact with the sample, will be decontaminated using the procedures specified above unless manufacturer's instructions indicate otherwise. For probes that make no direct contact, for example, OVM equipment, the probe will be wiped with clean paper-towels or cloth wetted with methanol.

IV. Attachments

None.

V. Key Checks and Preventative Maintenance

- The effectiveness of field cleaning procedures may be monitored by rinsing decontaminated equipment with organic-free water and submitting the rinse water in standard sample containers for analysis.

Disposal of Waste Fluids and Solids

I. Purpose and Scope

This SOP describes the procedures used to dispose of hazardous fluid and solid materials generated as a result of the site operations. This SOP does not provide guidance on the details of Department of Transportation regulations pertaining to the transport of hazardous wastes; the appropriate Code of Federal Regulations (49 CFR 171 through 177) should be referenced. Also, the site investigation-derived waste management plan should be consulted for additional information and should take precedence over this SOP.

II. Equipment and Materials

A. Fluids

- DOT-approved 55-gallon steel drums or Baker® Tanks
- Tools for securing drum lids
- Funnel for transferring liquid into drum
- Labels
- Paint Pens
- Marking pen for appropriate labels
- Seals for 55-gallon steel drums

B. Solids

- DOT-approved 55-gallon steel drums or rolloffs
- Tools for securing drum lids
- Paint Pens
- Plastic sheets
- Labels
- Marking pen for appropriate labels

III. Procedures and Guidelines

A. Methodology

Clean, empty drums or rolloffs or Baker® Tanks will be brought to the site by the drilling subcontractor for soil and groundwater collection and storage. The empty drums will be located at the field staging area and moved to drilling locations as required. The drums will be filled with the drilling and well installation wastes, capped, sealed, and moved to the onsite drum storage area by the drilling subcontractor. The full drums will separate types of wastes by media. The drums will

be labeled as they are filled in the field and labels indicating that the contents are pending analysis affixed.

The drum contents will be sampled to determine the disposal requirements of the drilling wastes. The drum sampling will be accomplished through the collection and submittal of composite samples, one sample per 10 drums containing the same media. Similar compositing will be performed in each rolloff to obtain a representative sample. The compositing of the sample will be accomplished by collecting a specific volume of the material in each drum into a large sample container. When samples from each of the drums being sampled in a single compositing are collected, the sample will be submitted for TCLP, ignitability, corrosivity, and reactivity analysis. The analysis will be used to determine if drilling wastes are covered by land disposal restrictions.

If rollofs are used, compositing and sampling of soil will comply with applicable state and federal regulations.

B. Labels

Drums and other containers used for storing wastes from drilling operations will be labeled when accumulation in the container begins. Labels will include the following minimum information:

- Container number
- Container contents
- Origin (source area including individuals wells, piezometers, and soil borings)
- Date that accumulation began
- Date that accumulation ended
- Generator Contact Information
- When laboratory results are received, drum labels will be completed or revised to indicate the hazardous waste constituents in compliance with Title 40 of the Code of Federal Regulations, Part 262, Subpart C if the results indicate hazardous waste or labeled as non-hazardous if applicable.

C. Fluids

Drilling fluids generated during soil boring and groundwater discharged during development and purging of the monitoring wells will be collected in 55-gallon, closed-top drums. When a drum is filled, the bung will be secured tightly. Fluids may also be transferred to Baker® Tanks after being temporarily contained in drums to minimize the amount of drums used.

When development and purging is completed, the water will be tested for appropriate hazardous waste constituents. Compositing and sampling of fluids will comply with applicable state and federal regulations.

D. Solids

The soil cuttings from well and boring drilling will constitute a large portion of the solids to be disposed of.

The solid waste stream also will include plastic sheeting used for decontamination pads, Tyveks, disposable sampling materials, and any other disposable material used during the field operations that appears to be contaminated. These materials will be placed in designated drums.

E. Storage and Disposal

The wastes generated at the site at individual locations will be transported to the drum storage area by the drilling services subcontractor. Drums should be stored on pallets on plastic sheeting with a short berm wall (hay bales or 2 x 4 planks or equivalent) to capture small spills.

Waste solid materials that contain hazardous constituents will be disposed of at an offsite location in a manner consistent with applicable solid waste, hazardous waste, and water quality regulations. Transport and disposal will be performed by a commercial firm under subcontract.

The liquid wastes meeting acceptable levels of discharge contamination may be disposed of through the sanitary sewer system at the site. However, prior to disposal to the sanitary sewer system, approval and contract arrangements will be made with the appropriate authorities. Wastes exceeding acceptable levels for disposal through the sanitary sewer system will be disposed of through contract with a commercial transport and disposal firm.

IV. Attachments

None.

V. Key Checks and Preventative Maintenance

- Check that representative samples of the containerized materials are obtained.
- Be sure that all state and federal regulations are considered when classifying waste for disposal.

Sampling Contents of Tanks and Drums

I. Scope and Application

This procedure provides an overview approach and guidelines for the routine sampling of drums and tanks. Its purpose is to describe standard procedures and precautions which are applied in sampling drums and tanks. Procedures for opening drums with the individual instruments are included in Attachment D.

The samples obtained may be used to obtain physical chemical or radiological data. The resulting data may be qualitative or quantitative in nature, and are appropriate for use in preliminary surveys as well as confirmatory sampling.

II. References

- A. *A Compendium of Superfund Field Operations Methods*, EPA/540/P-87/001, U.S. Environmental Protection Agency, Washington, D.C., 1987.
- B. *Data Quality Objectives for Remedial Activities - Development Process*, EPA/540/G-87/003, U.S. Environmental Protection Agency, Washington, D.C., 1987.
- C. *Annual Book of ASTM Standards, Standard Recommended Practices for Sampling Industrial Chemicals*, ASTM-E-300, 1986.
- D. *Test Method for Evaluating Solid Waste, SW-846, Volume II, Field Methods*, Second Edition, U.S. Environmental Protection Agency, Washington, D.C., 1982.
- E. U.S. Environmental Protection Agency, *Characterization of Hazardous Waste Sites – A Method Manual: Volume II, Available Sampling Methods*, USEPA Environmental Monitoring Systems Laboratory, Las Vegas, EPA-600/4-84-076, December, 1984.
- F. *Environmental Surveillance Procedures, Quality Control Program*, Martin Marietta Energy Systems, ESH/Sub/87-21706/1, Oak Ridge, TN, September 1988.

III. Summary of Methods

Drums are generally sampled by means of sampling tubes such as glass sample tubes or COLIWASA samplers. In either case, the sampling tube is manually inserted into the waste material. A sample of the drum contents is withdrawn by the sampling device. Should a drum contain bottom sludge, a glass tube will be used to retrieve a sample of this as well.

Storage tank and tank trailers, because of their greater depths, require sampling devices that can be lowered from the top, filled at a particular depth, then withdrawn. Such devices are a COLIWASA, a Kemmerer depth sampler, or a Bacon Bomb. Where samples of bottom sludge are desired, a gravity corer can be utilized. This heavy tube with a tapered nose piece will penetrate the sludge as it free falls through the tank.

IV. Comments

The sampling of tanks, containers, and drums present unique problems not associated with environmental samples. Containers of this sort are generally closed except for small access ports, manways, or hatches on the larger vessels, or taps and bungs on smaller drums. The physical size, shape, construction material, and location of access limit the types of equipment and methods of collection that can be used.

When liquids are contained in sealed vessels, gas vapor pressure can build up, sludges can settle out, and density layerings (stratification) can develop. Bulging drums may be under pressure and extreme caution should be exercised. The potential exists for explosive reactions or the release of noxious gases when containers are opened. All vessels should be opened with extreme caution. Check the HSP for the level of personnel protection to be worn. A preliminary sampling of any headspace gases is warranted. As a minimum, a preliminary check with an explosimeter and an organic vapor analyzer may be of aid in selecting a sampling method.

In most cases it is impossible to observe the contents of these sealed or partially sealed vessels. Since some layering or stratification is likely in any solution left undisturbed over time, a sample must be taken that represents the entire depth of the vessel.

V. Required Equipment and Apparatus

- A. **Health and safety equipment/materials:** As listed in the site safety plan.
- B. **Sampling equipment:** COLIWASA, glass sample tubes, Kemmerer depth sampler, Bacon Bomb, gravity corer.
- C. **Tools:** Rubber mallet, bung wrench, speed wrench with socket, etc., (all non-sparking), paint marker.
- D. **Heavy equipment:** Backhoe equipped with explosion shield, drum grapppler, and 3-foot copper-beryllium (non-sparking) spike with 6-inch collar (to puncture top of drums for sampling, if necessary).
- E. **Sample Containers:** As specified in the field sampling plan.

VI. Procedures

A. Drums

NOTE: DO NOT open more than one drum at a time. Each drum must be handled and sampled as a separate entity to reduce vapors in the sampling area.

1. Drums will be sampled on an area-by-area basis. Drums will be sampled after they have been placed in overpack drums but before they are transferred from the excavation to the onsite storage area.
2. Record, in logbook, all pertinent information from visual inspection of drum (e.g., physical condition, leaks, bulges, and labels). Label each drum with a unique identifying number.
3. If possible, stage drums for easy access.
4. If necessary, attach ground strap to drums and grounding point.
5. Remove any standing material (water, etc.) from container top.
6. Using non-sparking tools, carefully remove the bung or lid while monitoring air quality with appropriate instruments. If necessary (and as a last resort), the non-sparking spike affixed to the backhoe can also be used to puncture the drum for sampling. See Attachment D for method of drum opening. Record air-quality monitoring results.
7. When sampling a previously sealed vessel, a check should be made for the presence of bottom sludge. This is accomplished by measuring the depth to apparent bottom, then comparing it to the known interior depth.
8. Agitation to disrupt the layers and rehomogenize the sample is physically difficult and almost always undesirable. If the vessel is greater than 3 feet in depth (say, a 55-gallon drum), the appropriate sampling method is to slowly lower the sampling device (i.e., suction line of peristaltic pump, glass tube) in known increments of length. Discrete samples can be collected from various depths, then combined or analyzed separately. If the depth of the vessel is greater than the lift capacity of the pump, an at-depth water sampler, such as the Kemmerer or Bacon Bomb type, may be required.
9. Extract a representative sample from the drum using a glass rod, COLIWASA, Bacon Bomb, Kemmerer bottle, or gravity corer (See Attachments). Ensure that the entire depth of material is penetrated. Depending on the size of the opening of the drum, three to four takes should be collected from random locations across the drum surface, to ensure a representative sample. Any observed stratification must be recorded in logbook, including number and thickness of the layers and a conceptualized sketch.

10. Record a visual description of the sample (e.g., liquid, solid, color, viscosity, and percent layers).
11. When possible, sampling equipment (like glass tubes) should be expendable and be left inside the drum for disposal with drum contents, once sampling is completed.
12. Place lid, bung, cap, etc., back in place on drum. Tighten hand tight. If necessary, the sampling port can be sealed using a cork.
13. Wipe up spilled material with lab wipes. Wipe off sample containers.
14. Mark the drum with a unique sample identification number and date using a paint marker.
15. Samples will be handled as high hazard samples. Samples will be placed in containers defined according to the analytical needs, wiped clean, and then packed in paint cans for shipping. Packaging, labeling, and preparation for shipment procedures will follow procedures as specified in the field sampling plan.

B. Underground Storage Tanks

1. A sampling team of at least two people is required for sampling – one will collect samples, the other will relay required equipment and implements.
2. Sampling team will locate a sampling port on the tank. Personnel should be wearing appropriate protective clothing at this time and carrying sampling gear.
3. Do not attempt to climb down into tank. Sampling **MUST BE** accomplished from the top.
4. Collect a sample from the upper, middle, and lower section of the tank contents with one of the recommended sampling devices.
5. If compositing is necessary, ship samples to laboratory in separate containers for laboratory compositing.
6. Samples will be handled as hazardous. Samples will be placed in appropriate containers and packed with ice in a cooler. Packaging, labeling, and preparation for shipment will follow procedures specified in the field sampling plan.

C. Tank Trailers or Above-Ground Storage Tanks

1. A sampling team of two is required. One will collect samples, the other will relay required equipment and implements.
2. Samples will be collected through the manhole (hatch) on top of the tanker or the fill port. Do not open valves at the bottom. Before opening the hatch, check for a pressure gauge or release valve. Open the release valve slowly to bring the tank to atmospheric pressure.

3. If tank pressure is too great, or venting releases large amounts of toxic gas, discontinue venting and sampling immediately. Measure vented gas with organic vapor analyzer and explosimeter.
4. If no release valve exists, slowly loosen hatch cover bolts to relieve pressure in the tank. (Again, stop if pressure is too great.)
5. Once pressure in tank has been relieved, open the hatch and withdraw sample using one of the recommended sampling devices.
6. Sample each trailer compartment.
7. If compositing is necessary, ship samples to laboratory in separate containers for laboratory compositing.
8. Samples will be handled as hazardous. Samples will be placed in appropriate containers and packed with ice in a cooler. Packaging, labeling, and preparation for shipment will follow procedures specified in the field sampling plan.

D. Refer to Attachment B for procedures for sampling with appropriate devices as follows:

Drum

Glass tube	–	Procedure 1
COLIWASA	–	Procedure 2

Storage Tank and Tank Trailer

COLIWASA	–	Procedure 2
Bacon Bomb	–	Procedure 3
Gravity Corer (for bottom sludge)	–	Procedure 4

VII. Contamination Control

Sampling tools, instruments, and equipment will be protected from sources of contamination prior to use and decontaminated after use as specified in SOP *Decontamination of Personnel and Equipment*. Liquids and materials from decontamination operations will be handled in accordance with the waste management plan. Sample containers will be protected from sources of contamination. Sampling personnel shall wear chemical resistant gloves when handling any samples. Gloves will be decontaminated or disposed of between samples.

VIII. Attachments

- A. Collection of Liquid-Containerized Wastes Using Glass Tubes
- B. Sampling Containerized Wastes Using the Composite Liquid Waste Sample (COLIWASA)
- C. Sampling Containerized Wastes Using the Bacon Bomb Sampler
- D. Gravity Corer for sampling Sludges in Large Containers
- E. Construction of a Typical COLIWASA
- F. Drum Opening Techniques and Equipment

IX. Field Checklist

- | | |
|---|---|
| <input type="checkbox"/> Sampling Instruments | <input type="checkbox"/> Labels |
| <input type="checkbox"/> Tools | <input type="checkbox"/> Sampling and Analysis Plan |
| <input type="checkbox"/> Rubber Mallet | <input type="checkbox"/> Health and Safety Plan |
| <input type="checkbox"/> Logbook | <input type="checkbox"/> Decontamination Equipment |
| <input type="checkbox"/> Safety Glasses or Monogoggles | <input type="checkbox"/> Lab Wipes |
| <input type="checkbox"/> Safety Shoes | <input type="checkbox"/> Lab Spatulas or Stainless Steel Spoons |
| <input type="checkbox"/> Ice/Cooler, as required | <input type="checkbox"/> Chemical Preservatives, as required |
| <input type="checkbox"/> Custody Seals, as required | <input type="checkbox"/> Appropriate Containers for Waste and Equipment |
| <input type="checkbox"/> Chain-of-Custody Forms | <input type="checkbox"/> Duct Tape |
| <input type="checkbox"/> Drum Labels, as required | <input type="checkbox"/> Plastic Sheeting |
| <input type="checkbox"/> Paint Marker, if drum sampling | |
| <input type="checkbox"/> Black Indelible Pen | |
| <input type="checkbox"/> Monitoring Instruments | |

Attachment A Collection of Liquid-Containerized Wastes Using Glass Tubes

Discussion

Liquid samples from opened containers (i.e., 55-gallon drums) are collected using lengths of glass tubing. The glass tubes are normally 122 centimeters long and 6 to 16 millimeters inside diameter. Larger diameter tubes may be used for more viscous fluids if sampling with the small diameter tube is not adequate. The tubing is broken and discarded in the container after the sample has been collected, eliminating difficult cleanup and disposal problems. This method should not be attempted with less than a two-person sampling team.

Uses

This method provides for a quick, relatively inexpensive means of collecting concentrated containerized wastes. The major disadvantage is from potential sample loss that is especially prevalent when sampling low-viscosity fluids. Splashing can also be a problem and proper protective clothing should always be worn.

Note: A flexible tube with an aspirator attached is an alternative method to the glass tube, and allows various levels to be sampled discretely.

Procedures for Use

1. Remove cover from sample container.
2. Insert glass tubing almost to the bottom of the container. Tubing should be of sufficient length so that at least 30 centimeters extend above the top of the container.
3. Allow the waste in the drum to reach its natural level in the tube.
4. Cap the top of the tube with a safety-gloved thumb or a stopper.
5. Carefully remove the capped tube from the drum. If the tube has passed through more than one layer, the boundary should be apparent in the glass tube.
6. Insert the bottom, uncapped end into the sample container.
7. Partially release the thumb or stopper on the top of the tube and allow the sample to slowly flow into the sample container. If separation of phases is desired, cap off tube before the bottom phase has completely emptied. It may be advisable to have an extra container for "waste," so that the fluid on either side of the phase boundary can be directed into a separate container, allowing collection of pure phase liquids in the sample containers. The liquid remaining after the boundary fluid is removed is collected in yet a third container. NOTE: It is not necessary to put phases in separate containers if analysis of separate phases is not desired.
8. Repeat steps 2 through 6 if more volume is needed to fill the sample container.

9. Remove the tube from the sample container and replace the tube in the drum, breaking it, if necessary, in order to dispose of it in the drum.

Optional Method (if sample of bottom sludge is desired)

1. Remove the cover from the container opening.
2. Insert glass tubing slowly almost to the bottom of the container. Tubing should be of sufficient length so that at least 30 cm extends above the top of the container.
3. Allow the waste in the drum to reach its natural level in the tube.
4. Gently push the tube towards the bottom of the drum into the sludge layer. Do not force it.
5. Cap the top of the tube with a safety-gloved thumb or stopper.
6. Carefully remove the capped tube from the drum and insert the uncapped end into the sample container.
7. Release the thumb or stopper on the top of the tube and allow the sample container to fill to approximately 90 percent of its capacity. If necessary, the sludge plug in the bottom of the tube can be dislodged with the aid of the stainless steel laboratory spatula.
8. Repeat if more volume is needed to fill sample container and recap the tube.

Note:

1. If a reaction is observed when the glass tube is inserted (violent agitation, smoke, light, etc.), the investigators should leave the area immediately.
2. If the glass tube becomes cloudy or smoky after insertion into the drum, the presence of hydrofluoric acid maybe indicated, and a comparable length of rigid plastic tubing should be used to collect the sample.
3. When a solid is encountered in a drum (either layer or bottom sludge) the optional method described above may be used to collect a core of the material, or the material may be collected with a disposable scoop attached to a length of wooden or plastic rod.

Attachment B: Sampling Containerized Wastes using the Composite Liquid Waste Sampler (COLIWASA)

Discussion

The COLIWASA is a much-cited sampler designed to permit representative sampling of multiphase wastes from drums and other containerized wastes. The sampler is commercially available or can be easily fabricated from a variety of materials, including PVC, glass, or Teflon. In its usual configuration it consists of a 152 cm by 4 cm (inside diameter) section of tubing with a neoprene stopper at one end attached by a rod running the length of the tube to a locking mechanism at the other end. Manipulation of the locking mechanism opens and closes the sampler by raising and lowering the neoprene stopper. See Attachment E: Construction of a COLIWASA.

Uses

The COLIWASA is primarily used to sample containerized liquids. The PVC COLIWASA is reported to be able to sample most containerized liquid wastes except for those containing ketones, nitrobenzene, dimethylformamide, mesityloxide, and tetrahydrofuran. A glass COLIWASA is able to handle all wastes unable to be sampled with the plastic unit except strong alkali and hydrofluoric acid solutions. Due to the unknown nature of many containerized wastes, it would therefore be advisable to eliminate the use of PVC materials and use samplers composed of glass or Teflon.

The major drawback associated with using a COLIWASA is concern for decontamination and costs. The sampler is difficult, if not impossible, to decontaminate in the field, and its high cost in relation to alternative procedures (glass tubes) makes it an impractical throwaway item. It still has applications, however, especially in instances where a true representation of a multiphase waste is absolutely necessary.

Procedures for Use

1. Check to make sure the sampler is functioning properly. Adjust the locking mechanism, if present, to make sure the neoprene rubber stopper provides a tight closure.
2. Put the sampler in the open position by placing the stopper rod handle in the T-position and pushing the rod down until the handle sits against the sampler's locking block.
3. Slowly lower the sampler into the liquid waste. Lower the sampler at a rate that permits the levels of the liquid inside and outside the sampler tube to be about the same. If the level of the liquid in the sample tube is lower than that outside the sampler, the sampling rate is too fast and will result in a non-representative sample.
4. When the sampler stopper hits the bottom of the waste container, push the sampler tube downward against the stopper to close the sampler. Lock the sampler in the closed position by turning the T-handle until it is upright and one end rests tightly on the locking block.

5. Slowly withdraw the sampler from the waste container with one hand while wiping the sampler tube with a laboratory wipe with the other hand. A phase boundary, if present, can be observed through the tube.
6. Carefully discharge the sample into a suitable sample container by slowly pulling the lower end of the T-handle away from the locking block while the lower end of the sampler is positioned in a sample container.
7. Unscrew the T-handle of the sampler and disengage the locking block.

Attachment C: Sampling Containerized Wastes using the Bacon Bomb Sampler

Discussion

The Bacon Bomb is designed for the withdrawal of samples from various levels within a storage tank. It consists of a cylindrical body with an internal tapered plunger that acts as a valve to admit the sample. A line attached to the top of the plunger is used to open and close the valve. A removable cover provides a point of attachment for the sample line and has a locking mechanism to keep the plunger closed after sampling. The Bacon Bomb is usually constructed of chrome-plated brass and bronze with a rubber O-ring acting as the plunger-sealing surface. Stainless steel versions are also available. The volumetric capacity is 8, 16, or 32 oz (237, 473, or 946 ml).

Uses

The Bacon Bomb is a heavy sampler suited best for viscous materials held in large storage tanks or in lagoons. If a more non-reactive sampler is needed, the stainless steel version would be used, or any of the samplers could be coated with Teflon.

Procedures for Use

1. Attach the sample line and the plunger line to the sampler.
2. Measure and then mark the sampling line at the desired depth.
3. Gradually lower the sampler by the sample line until the desired level is reached.
4. When the desired level is reached, pull up on the plunger line and allow the sampler to fill for a sufficient length of time before releasing the plunger line to seal off the sampler.
5. Retrieve the sampler by the sample line, being careful not to pull up on the plunger line, thereby accidentally opening the bottom valve.
6. Wipe off the exterior of the sampler body.
7. Position the sampler over the sample container and release its contents by pulling up on the plunger line.

Attachment D: Gravity Corer for Sampling Sludges in Large Containers

Discussion

A gravity corer is a metal tube with a replaceable tapered nosepiece on the bottom and a ball or other type of check valve on the top. The check valve allows water to pass through the corer on descent but prevents a washout during recovery. The tapered nosepiece facilitates cutting and reduces core disturbance during penetration. Most corers are constructed of brass or steel and many can accept plastic liners and additional weights.

Uses

Corers are capable of collecting samples of most sludges and sediments. They collect essentially undisturbed samples that represent the strata profile that may develop in sediments and sludges during variations in the deposition process. Depending on the density of the substrate and the weight of the corer, penetration to depths of 75 cm (30 in.) can be attained. Exercise care when using gravity corers in vessels or lagoons that have liners because penetration depths could exceed those of the substrate; this could result in damage to the liner material.

Procedures for Use

1. Attach a precleaned corer to the required length of sample line. Solid braided 5-mm (3/16-in.) nylon line is sufficient; however, 20-mm (3/4-in.) nylon is easier to grasp during hand hoisting. An additional weight can be attached to the outside of the corer if necessary.
2. Secure the free end of the line to a fixed support to prevent accidental loss of the corer.
3. Allow corer to free fall through the liquid to the bottom.
4. Retrieve corer with a smooth, continuous, up-lifting motion. Do not bump corer because this may result in some sample loss.
5. Remove nosepiece from corer and slide sample out of corer into stainless steel or Teflon pan (preferred).
6. Transfer sample into appropriate sample bottle with a stainless steel lab spoon or laboratory spatula.

Attachment E: Construction of a Typical COLIWASA

The sampling tube consists of a 1.52-m (5-ft) by 4.13-cm (1-5/8 in) I.D. translucent plastic pipe, usually polyvinyl chloride (PVC) or borosilicate glass plumbing tube. The closure-locking mechanism consists of a short-length, channeled aluminum bar attached to the sampler's stopper rod by an adjustable swivel. The aluminum bar serves both as a T-handle and lock for the samplers' closure system. When the sampler is in the open position, the handle is placed in the T-position and pushed down against the locking block. This manipulation pushes out the neoprene stopper and opens at the sampling tube. In the closed position, the handle is rotated until one leg of the T is squarely perpendicular against the locking block. This tightly seats the neoprene stopper against the bottom opening of the sampling tube and positively locks the sampler in the closed position. The closure tension can be adjusted by shortening or lengthening the stopper rod by screwing it in or out of the T-handle swivel. The closure system of the sampler consists of a sharply tapered neoprene stopper attached to a 0.95-cm (3/8-in) O.D. rod, usually PVC. The upper end of the stopper rod is connected to the swivel of the aluminum T-handle. The sharply tapered neoprene stopper can be fabricated according to specifications by plastic-products manufacturers at an extremely high price, or it can be made in-house by grinding down the inexpensive stopper with a shop grinder.

COLIWASA samplers are typically made out of plastic or glass. The plastic type consists of translucent plastic (usually PVC) sampling tube. The glass COLIWASA uses borosilicate glass plumbing pipe as the sampling tube and a Teflon plastic stopper rod. For purpose of multiphase sampling, clear plastic or glass is desirable in order to observe the profile of the multiphase liquid.

The sampler is assembled as follows:

- a. Attach the swivel to the T-handle with the 3.18-cm (1-1/4 in) long bolt and secure with the 0.48-cm (3/16-in) National Coarse (NC) washer and lock nut.
- b. Attach the PTFE stopper to one end of the stopper rod and secure with the 0.95-cm (3/8-in) washer and lock nut.
- c. Install the stopper and stopper rod assembly in the sampling tube.
- d. Secure the locking block sleeve on the block with glue or screw. This block can also be fashioned by shaping a solid plastic rod on a lathe to the required dimension.
- e. Position the locking block on top of the sampling tube such that the sleeveless portion of the block fits inside the tube, the sleeve sits against the top end of the tube, and the upper end of the stopper rod slips through the center hole of the block.
- f. Attach the upper end of the stopper rod to the swivel of the T-handle.
- g. Place the sampler in the close position and adjust the tension on the stopper by screwing the T-handle in or out.

Attachment F: Drum Opening Techniques and Equipment ¹

I. Introduction

The opening of closed drums prior to sampling entails considerable risk if not done with the proper techniques, tools, and safety equipment. The potential for vapor exposure, skin exposure due to splash or spraying, or even explosion resulting from sparks produced by friction of the tools against the drum, necessitate caution when opening any closed container. Both manual drum opening and remote drum opening will be discussed in the following paragraphs. When drums are opened manually risks are greater than when opened remotely; for this reason, the remote opening of drums is advised whenever possible.

Prior to sampling, the drums should be staged to allow easy access. Also, any standing water or other material should be removed from the container top so that the representative nature of the sample is not compromised when the container is opened. There is also the possibility of encountering a water-reactive substance.

II. Manual Drum Opening

A. Bung Wrench

A common method for opening drums manually is using a universal bung wrench. These wrenches have fittings made to remove nearly all commonly encountered bungs. They are usually constructed of cast iron, brass, or a bronze-beryllium (a non-sparking alloy formulated to reduce the likelihood of sparks). The use of bung wrenches marked "NON SPARKING" is encouraged. However, the use of a "NON SPARKING" wrench does not completely eliminate the possibility of spark being produced. Such a wrench only prevents a spark caused by wrench-to-bung friction, but it cannot prevent sparking between the threads on the drum and the bung.

A simple tool to use, the fitting on the bung wrench matching the bung to be removed is inserted into the bung and the tool is turned counterclockwise to remove the bung. Since the contents of some drums may be under pressure (especially, when the ambient temperature is high), the bung should be turned very slowly. If any hissing is heard, the person opening the drum should back off and wait for the hissing to stop. Since drums under pressure can spray out liquids when opened, the wearing of appropriate eye and skin protection in addition to respiratory protection is critical.

B. Drum Deheader

One means by which a drum can be opened manually when a bung is not removable with a bung wrench is by using a drum deheader. This tool is

¹ Taken from EPA Training Course: "Sampling for Hazardous Materials," U.S. Environmental Protection Agency, Office of Emergency and Remedial Response Support Division, March 24, 1987.

constructed of forged steel with an alloy steel blade and is designed to cut the lid of a drum off or part way off by means of a scissors-like cutting action. A limitation of this device is that it can be attached only to closed head drums (i.e., DOT Specification 17E and 17F drums); drums with removable heads must be opened by other means.

Drums are opened with a drum deheader by first positioning the cutting edge just inside the top chime and then tightening the adjustment screw so that the deheader is held against the side of the drum. Moving the handle of the deheader up and down while sliding the deheader along the chime will enable the entire top to be rapidly cut off if so desired. If the top chime of a drum has been damaged or badly dented it may not be possible to cut the entire top off. Since there is always the possibility that a drum may be under pressure, the initial cut should be made very slowly to allow for the gradual release of any built-up pressure. A safer technique would be to employ a remote pressure release method prior to using the deheader.

C. Hand Pick or Spike

When a drum must be opened and neither a bung wrench nor a drum deheader is suitable, then it can be opened for sampling by using a hand pick, pickaxe, or spike. These tools are usually constructed of brass or a non-sparking alloy with a sharpened point that can penetrate the drum lid or head when the tool is swung. The hand picks or pickaxes that are most commonly used are commercially available, whereas the spikes are generally uniquely fabricated 4-foot long poles with a pointed end. Often the drum lid or head must be hit with a great deal of force in order to penetrate it. Because of this, the potential for splash or spraying is greater than with other opening methods and therefore this method of drum opening is not recommended, particularly when opening drums containing liquids. Some spikes used for drum opening have been modified by the addition of a circular splash plate near the penetrating end. This plate acts as a shield and reduces the amount of splash in the direction of the person using the spike. Even with this shield, good splash gear is essential.

Since drums, some of which may be under pressure, cannot be opened slowly with these tools, "sprayers" may result and appropriate safety measures must be taken. The pick or spike should be decontaminated after each drum is opened to avoid cross contamination and/or adverse chemical reaction from incompatible materials.

III. Remote Opening

A. Backhoe Spike

The most common means used to open drums remotely for sampling is the use of a metal spike attached or welded to a backhoe bucket. In addition to being very efficient, this method can greatly reduce the likelihood of personnel exposure.

Drums should be "staged," or placed in rows with adequate aisle space to allow ease in backhoe maneuvering. Once staged, the drums can be quickly opened by punching a hole in the drum head or lid with the spike.

The spike should be decontaminated after each drum is opened to prevent cross contamination. Even though some splash or spray may occur when this method is used, the operator of the backhoe can be protected by mounting a large shatter-resistant shield in front of the operator's cage. This, combined with the normal sampling safety gear, should be sufficient to protect the operator. Additional respiratory protection can be afforded by providing the operator with an on-board airline system. The hole in the drum can be sealed with a cork.

B. Hydraulic Devices

Recently, remotely operated hydraulic devices have been fabricated to open drums remotely. One such device is discussed here. This device uses hydraulic pressure to pierce through the wall of a drum. It consists of a manually operated pump that pressurizes oil through a length of hydraulic line. A piercing device with a metal point is attached to the end of this line and is pushed into the drum by the hydraulic pressure. The piercing device can be attached so that a hole for sampling can be made in either the side or the head/lid of the drum. Some of the metal piercers are hollow or tube-like so that they can be left in place, if desired, and serve as a permanent tap or sampling port. The piercer is designed to establish a tight seal after penetrating the container.

C. Pneumatic Devices

Pneumatically-operated devices utilizing compressed air have been designed to remove drum bungs remotely. A pneumatic bung remover consists of a compressed air supply (usually SCBA cylinders) that is controlled by a heavy-duty, 2-stage regulator. A high pressure air line of desired length delivers compressed air to a pneumatic drill that is adapted to turn a bung fitting (preferably, a bronze-beryllium alloy) selected to fit the bung to be removed. An adjustable bracketing system has been designed to position and align the pneumatic drill over the bung. This bracketing system must be attached to the drum before the drill can be operated. Once the bung has been loosened, the bracketing system must be removed before the drum can be sampled. This attachment and removal procedure is time-consuming and is the major drawback of this device. This remote bung opener does not permit the slow venting of the container, and therefore appropriate precautions must be taken. It also requires the container to be upright and relatively level. Bungs that are rusted shut cannot be removed with this device.

IV. Summary

The opening of closed containers is one of the most hazardous site activities. Maximum efforts would be made to ensure the safety of the sampling team. Proper protective equipment and a general wariness of the possible dangers will minimize the risk inherent to sampling operations. Employing proper drum opening techniques and equipment will also safeguard personnel. The use of remote sampling equipment whenever feasible is highly recommended.

Preparing Field Log Books

I. Purpose

This SOP provides general guidelines for entering field data into log books during site investigation and remediation activities.

II. Scope

This is a general description of data requirements and format for field log books. Log books are needed to properly document all field activities in support of data evaluation and possible legal activities.

III. Equipment and Materials

- Log book
- Indelible pen

IV. Procedures and Guidelines

Properly completed field log books are a requirement for much of the work we perform under the Navy CLEAN contract. Log books are legal documents and, as such, must be prepared following specific procedures and must contain required information to ensure their integrity and legitimacy. This SOP describes the basic requirements for field log book entries.

A. PROCEDURES FOR COMPLETING FIELD LOG BOOKS

1. Field notes commonly are kept in bound, hard-cover logbooks used by surveyors and produced, for example, by Peninsular Publishing Company and SESCO, Inc. Pages should be water-resistant and notes should be taken only with water-proof, non-erasable permanent ink, such as that provided in Sanford Sharpie® permanent markers.
2. On the inside cover of the log book the following information should be included:
 - Company name and address
 - Log-holders name if log book was assigned specifically to that person
 - Activity or location

- Project name
 - Project manager's name
 - Phone numbers of the company, supervisors, emergency response, etc.
3. All lines of all pages should be used to prevent later additions of text, which could later be questioned. Any line not used should be marked through with a line and initialed and dated. Any pages not used should be marked through with a line, the author's initials, the date, and the note "Intentionally Left Blank."
 4. If errors are made in the log book, cross a single line through the error and enter the correct information. All corrections shall be initialed and dated by the personnel performing the correction. If possible, all corrections should be made by the individual who made the error.
 5. Daily entries will be made chronologically.
 6. Information will be recorded directly in the field log book during the work activity. Information will not be written on a separate sheet and then later transcribed into the log book.
 7. Each page of the log book will have the date of the work and the note takers initials.
 8. The final page of each day's notes will include the note-takers signature as well as the date.
 9. Only information relevant to the subject project will be added to the log book.
 10. The field notes will be copied and the copies sent to the Project Manager or designee in a timely manner (at least by the end of each week of work being performed).

B. INFORMATION TO BE INCLUDED IN FIELD LOG BOOKS

1. Entries into the log book should be as detailed and descriptive as possible so that a particular situation can be recalled without reliance on the collector's memory. Entries must be legible and complete.
2. General project information will be recorded at the beginning of each field project. This will include the project title, the project number, and project staff.
3. Scope: Describe the general scope of work to be performed each day.
4. Weather: Record the weather conditions and any significant changes in the weather during the day.
5. Tail Gate Safety Meetings: Record time and location of meeting, who was present, topics discussed, issues/problems/concerns identified,

and corrective actions or adjustments made to address concerns/problems, and other pertinent information.

6. Standard Health and Safety Procedures: Record level of personal protection being used (e.g., level D PPE), record air monitoring data on a regular basis and note where data were recording (e.g., reading in borehole, reading in breathing zone, etc). Also record other required health and safety procedures as specified in the project specific health and safety plan.
7. Instrument Calibration; Record calibration information for each piece of health and safety and field equipment.
8. Personnel: Record names of all personnel present during field activities and list their roles and their affiliation. Record when personnel and visitors enter and leave a project site and their level of personal protection.
9. Communications: Record communications with project manager, subcontractors, regulators, facility personnel, and others that impact performance of the project.
10. Time: Keep a running time log explaining field activities as they occur chronologically throughout the day.
11. Deviations from the Work Plan: Record any deviations from the work plan and document why these were required and any communications authorizing these deviations.
12. Health and Safety Incidents: Record any health and safety incidents and immediately report any incidents to the Project Manager.
13. Subcontractor Information: Record name of company, record names and roles of subcontractor personnel, list type of equipment being used and general scope of work. List times of starting and stopping work and quantities of consumable equipment used if it is to be billed to the project.
14. Problems and Corrective Actions: Clearly describe any problems encountered during the field work and the corrective actions taken to address these problems.
15. Technical and Project Information: Describe the details of the work being performed. The technical information recorded will vary significantly between projects. The project work plan will describe the specific activities to be performed and may also list requirements for note taking. Discuss note-taking expectations with the Project Manager prior to beginning the field work.
16. Any conditions that might adversely affect the work or any data obtained (e.g., nearby construction that might have introduced excessive amounts of dust into the air).

17. Sampling Information; Specific information that will be relevant to most sampling jobs includes the following:
- Description of the general sampling area – site name, buildings and streets in the area, etc.
 - Station/Location identifier
 - Description of the sample location – estimate location in comparison to two fixed points – draw a diagram in the field log book indicating sample location relative to these fixed points – include distances in feet.
 - Sample matrix and type
 - Sample date and time
 - Sample identifier
 - Draw a box around the sample ID so that it stands out in the field notes
 - Information on how the sample was collected – distinguish between “grab,” “composite,” and “discrete” samples
 - Number and type of sample containers collected
 - Record of any field measurements taken (i.e. pH, turbidity, dissolved oxygen, and temperature, and conductivity)
 - Parameters to be analyzed for, if appropriate
 - Descriptions of soil samples and drilling cuttings can be entered in depth sequence, along with PID readings and other observations. Include any unusual appearances of the samples.

C. SUGGESTED FORMAT FOR RECORDING FIELD DATA

1. Use the left side border to record times and the remainder of the page to record information (see attached example).
2. Use tables to record sampling information and field data from multiple samples.
3. Sketch sampling locations and other pertinent information.
4. Sketch well construction diagrams.

V. Attachments

Example field notes.

Packaging and Shipping Procedures

I. Purpose

The purpose of this SOP is to delineate protocols for the packing and shipping of samples to the laboratory for analysis.

II. Scope

This SOP is applicable for all samples collected and prepared for analysis at an offsite laboratory. Packaging and shipping must be performed daily, when required, at the end of a sampling activity. Packaging should be done carefully to ensure the integrity of the samples and the physical conditions of sample containers. Shipping should be performed based on the requirements of the samples obtained (temperature, life time, etc.).

III. Equipment and Materials

- Coolers
- Labels
- Tape
- Garbage bags
- Zip-loc® bags
- Ice
- Absorbent packing material (bubble wrap, vermiculite, etc.)
- Sample containers
- Chain of custody
- Custody seal

IV. Procedures and Guidelines

- A. Prepare coolers for shipment.
 - Tape drains shut.
 - Place mailing label with laboratory address on top of coolers.
 - Fill bottom of coolers with packing material.
- B. Arrange decontaminated sample containers in groups by sample number. Consolidate VOC samples into one cooler to minimize the need for trip blanks.
- C. Affix appropriate adhesive sample labels to each container. Protect with clear label protection tape.

- D. Seal each sample bottle within a separate Zip-loc® plastic bag or bubble wrap, if available. Tape the bag around bottle. Sample label should be visible through the bag.
- E. Line cooler with garbage bag.
- F. Arrange sample bottles in garbage bag so that they do not touch.
- G. If ice is required to preserve the samples, cubes should be repackaged in Zip-loc® bags and placed on and around the containers.
- H. Fill remaining spaces with packing material.
- I. Complete and sign chain-of-custody form (or obtain signature) and indicate the time and date it was relinquished to Federal Express or the courier.
- J. Separate copies of forms. Seal proper copies (traffic reports, packing lists) along with a return address label within a large Zip-loc® bag and tape to inside lid of cooler.
- K. Close lid and latch.
- L. Carefully peel custody seals from backings and place intact over lid openings (right front and left back). Cover seals with clear protection tape.
- M. Tape cooler shut on both ends, making several complete revolutions with strapping tape. Do not cover custody seals.
- N. Relinquish to Federal Express or to a courier arranged with the laboratory.
- O. Contact the analytical laboratory the day following shipment to verify that the samples arrived.

Locating and Clearing Underground Utilities

I. Purpose

The purpose of this SOP is to provide general guidelines and specific procedures that must be followed on Navy CLEAN projects for locating underground utilities and clearing dig locations in order to maximize our ability to avoid hitting underground utilities and to minimize liabilities to CH2M HILL and its subcontractors and health and safety risks to our project staff.

This SOP shall be used by Activity Managers and Project Managers to, in-turn, develop Activity-specific and project-specific utility location procedures. The activity and project-specific procedures will become part of work plans and project instructions and will be used to prepare scopes of work (SOWs) for the procurement of utility location subcontractors to meet the needs of individual projects.

This SOP also identifies the types of utility locating services that are available from subcontractors and the various tools that are used to locate utilities, and discusses when each type of service and tool may or may not be applicable.

II. Scope

Depending on the Navy/Marine Activity we typically find ourselves in one of two scenarios:

Scenario 1

The Activity provides utility locating (or dig clearance) services through the public works department or similar organization, or has a contract with an outside utility clearance service. Some of these services are provided in the form of dig permits which are required before you can dig or drill. In other cases no official permit is required and the process is somewhat vague.

Scenario 2

The Activity does not get involved in any utility locating processes aside from possibly providing the most recent utility maps, and relies on CH2M HILL to clear the dig locations.

Table 1 provides an up to date summary of which scenarios apply to the various primary Activities served under the Navy CLEAN program.

Scenario 1 is preferred because under this scenario the Navy tends to assume the responsibility if the location is improperly cleared, a utility is struck, and property damage results. However, our experience has been that the clearance services provided

by the Navy do not meet the standards that we consider to be adequate, in that they often simply rely on available base maps to mark utilities and do not verify locations using field geophysics. And if they do use locating tools, they do not provide adequate documentation or marking to confirm that a location has been cleared. So while the Navy's process may protect us from liability for property damage, it does not adequately protect our staff and subcontractors from health risks nor does it compensate us for down time, should a utility be hit.

Therefore, regardless of what services the Navy provides, in most cases we still need to supplement this effort with clearance services from our own third party utility location subcontractor following the procedures and guideline outlined in Section IV of this SOP. The cost implications of providing this service will range from \$500 to several \$1,000 depending on the size of the project.

The scope of services that we ask our subcontractors to provide can involve utility marking/mapping or the clearing of individual dig locations. In the former we ask our subs to mark all utilities within a "site" and often ask them to prepare a map based on their work. In the later, we ask them to clear (identify if there are any utilities within) a certain radius of a proposed dig/drill location.

The appropriate requested scope of services for a project will depend on the project. Clearing individual boreholes is often less expensive and allows the sub to concentrate their efforts on a limited area. However if the scope of the investigation is fluid (all borehole locations are not predetermined) it may be best to mark and map an entire site or keep the subcontractor on call.

Clearance of individual dig locations should be done to a minimum 20 foot radius around the location.

An example SOW for a utility subcontractor procurement is provided in Attachment A.

III. Services and Equipment

This section provides a general description of the services available to help us locate subsurface utilities and describes the types of equipment that these services may (or may not) use to perform their work. It identifies the capabilities of each type of equipment to help the PM specify what they should require from our utility location subs.

Services

The services that are available to us for identifying and marking underground utilities are:

- The local public/private utility-run service such as Miss Utility
- Utility location subcontractors (hired by us)

Attachment B provides a detailed description of each type of organization. It also provides contact numbers and web sites for the various Miss-Utility-type organizations in the areas where we do work for the Navy and contacts and services provided by several subcontractors that we have used or spoken to in the past.

Equipment

Attachment C provides a summary of the various types of equipment used for subsurface utility location. It describes the capabilities and limitations of each in order to help the PM determine if the equipment being used by a subcontractor is adequate.

It is important to make the potential subcontractors aware of the possible types of utilities (and utility materials) that are at the site, and to have them explain in their bid what types of equipment they will use to locate utilities /clear dig locations, and what the limitations of these equipment are.

A list of in-house experts that can be used to help you evaluate bids or answer questions you may have is provided in Appendix C.

IV. Procedures and Guidelines

This section presents specific procedures to be followed for the utility location work to be conducted by CH2M HILL and our subcontractors. In addition, a PM will have to follow the procedures required by the Activity to obtain their approvals, clearances and dig permits where necessary. These “dig permit” requirements vary by Activity and must be added to the project-specific SOP, or project instructions. It is preferable that the Activity perform their clearance processes before we follow up with our clearance work.

Activity Notification and Dig Permit Procedures

Identify Activity-specific permit and/or procedural requirements for excavation and drilling activities. Contact the Base Civil Engineer and obtain the appropriate form to begin the clearance process.

Activity Specific: To be provided by Activity or Project Manager

CH2M HILL Utility Clearance Procedures

Do not begin subsurface construction activities (e.g., trenching, excavation, drilling, etc.) until a check for underground utilities and similar obstructions has been conducted by CH2M HILL as a follow-up to the services provided by the Navy. The use of as-built drawings and utility company searches must be supplemented with a geophysical or other survey by a qualified, independent survey contractor (subcontracted to CH2M HILL) to identify additional and undiscovered buried utilities.

Examples of the type of geophysical technologies include (these are further described in Attachment C):

- **Ground Penetrating Radar (GPR)**, which can detect pipes, including gas pipes, tanks, conduits, cables etc, both metallic and non-metallic at depths up to 30 feet depending on equipment. Sensitivity for both minimum object size and maximum depth detectable depends on equipment selected, soil conditions, etc.
- **Radio Frequency (RF)**, involves inducing an RF signal in the pipe or cable and using a receiver to trace it. Some electric and telephone lines emit RF naturally and can be

detected without an induced signal. This method requires knowing where the conductive utility can be accessed to induce RF field if necessary.

- **Dual RF**, a modified version of RF detection using multiple frequencies to enhance sensitivity but with similar limitations to RF
- **Ferromagnetic Detectors**, are metal detectors that will detect ferrous and non-ferrous utilities. Sensitivity is limited, e.g. a 100 mm iron disk to a depth of about one meter or a 25 mm steel paper clip to a depth of about 20 cm.
- **Electronic markers**, are emerging technologies that impart a unique electronic signature to materials such as polyethylene pipe to facilitate location and tracing after installation. Promising for future installations but not of help for most existing utilities already in place.

The following procedures shall be used to identify and mark underground utilities during subsurface construction activities on the project:

- Contact utility companies or the state/regional utility protection service (such as Miss Utility) at least two (2) working days prior to intrusive activities to advise of the proposed work, and ask them to establish the location of the utility underground installations prior to the start of actual excavation: this is a law. These services will only mark the location of public-utility-owned lines and not Navy-owned utilities. In many cases there will not be any public-utility-owned lines on the Activity. There may also be Base-access issues to overcome.
- Procure and schedule the independent survey.
- The survey contractor shall determine the most appropriate geophysical technique or combinations of techniques to identify the buried utilities on the project site, based on the survey contractor's experience and expertise, types of utilities anticipated to be present and specific site conditions. *The types of utilities must be provided to the bidding subcontractors in the SOW and procedures to be used must be specified by the bidder in their bid. It is extremely helpful to provide the sub with utility maps, with the caveat that all utilities are not necessarily depicted.*
- The survey subcontractor shall employ the same geophysical techniques used to identify the buried utilities, to survey the proposed path of subsurface investigation/construction work to confirm no buried utilities are present.
- Obtain utility clearances for subsurface work on both public and private property.
- Clearances provided by both the "Miss Utility" service and the CH2M HILL-subcontracted service are to be in writing, signed by the party conducting the clearance. The Miss Utility service will have standard notification forms/letters which typically simply state that they have been to the site and have done their work. The CH2M HILL subcontractor shall be required to fill out the form provided in Attachment D (this can be modified for a particular project) indicating that each dig/drill location has been addressed. *This documentation requirement (with a copy of the form) needs to be provided in the subcontractor SOW.*

- Marking shall be done using the color coding presented in Attachment E. The type of material used for marking must be approved by the Activity prior to marking. Some base commanders have particular issues with persistent spray paint on their sidewalks and streets. *Any particular marking requirements need to be provided in the subcontractor SOW.*
- Protect and preserve the markings of approximate locations of facilities until the markings are no longer required for safe and proper excavations. If the markings of utility locations are destroyed or removed before excavation commences or is completed, the Project Manager must notify the utility company or utility protection service to inform them that the markings have been destroyed.
- Perform a field check prior to drilling/digging (preferably while the utility location sub is still at the site) to see if field utility markings coincide with locations on utility maps. Look for fire hydrants, valves, manholes, light poles, lighted signs, etc to see if they coincide with utilities identified by the subcontractor.
- Underground utility locations must be physically verified (or dig locations must be physically cleared) by hand digging using wood or fiberglass-handled tools, air knifing, or by some other acceptable means approved by CH2M HILL, when the dig location (e.g. mechanical drilling, excavating) is expected to be within 5 feet of a marked underground system. Hand clearance shall be done to a depth of four feet unless a utility cross-section is available that indicates the utility is at a greater depth. In that event, the hand clearance shall proceed until the documented depth of the utility is reached.
- Conduct a site briefing for employees at the start of the intrusive work regarding the hazards associated with working near the utilities and the means by which the operation will maintain a safe working environment. Detail the method used to isolate the utility and the hazards presented by breaching the isolation.
- Monitor for signs of utilities during advancement of intrusive work (e.g., sudden change in advancement of auger or split spoon during drilling or change in color, texture or density during excavation that could indicate the ground has been previously disturbed).

IV. Attachments

- A- Example SOW for Utility Location Subcontractor Procurement
- B - Services Available for Identifying and Marking Underground Utilities
- C - Equipment Used for Identifying Underground Utilities
- D - Utility Clearance Documentation Form
- E - Utility Marking Color Codes

Attachment A – Example SOW for Subcontracting Underground Utilities Locating Services

CTO-**XXX**

Scope of Work

Subsurface Utility Locating

Site **XX**

Navy Activity

City, State

A licensed and insured utility locator will be subcontracted to identify and mark out subsurface utilities for an environmental investigation/remediation project at Site **XX** of **<<insert name of base, city, and state>>**. The subcontractor will need to be available beginning at **<<insert time>>** on **<<insert date>>**. It is estimated that the work can be completed within **XX** days.

Proposed Scope of Work

The subcontractor will identify and mark all subsurface utilities **(CHOOSE 1)** that lie within a radius of 20 feet of each of **XX** sampling locations at Site **XX** shown on the attached Figure 1; **(OR)** that lie within the bounds of Site **XX** as delineated on the attached Figure 1. (If multiple sites are to be cleared, provide maps of each site with sample locations or clearance boundaries clearly delineated and a scale provided.)

Utilities will be identified using all reasonably available as-built drawings, electronic locating devices, and any other means necessary to maintain the safety of drilling and sampling personnel and the protection of the base infrastructure. The location of utilities identified from as-built drawings or other maps must be verified in the field prior to marking.

Base utility drawings for the Site(s) **(CHOOSE 1)** can be found at **<<insert specific department and address or phone number on the base>>** and should be reviewed by the subcontractor and referenced as part of the utility locating. **(OR)**, will be provided to the subcontractor by **CH2M HILL** upon the award of the subcontract. **(OR)**, are not available. Utility drawings shall not be considered definitive and must be field verified.

Field verification will include detection using nonintrusive subsurface detection equipment (magnetometers, GPR, etc) as well as opening manhole covers to verify pipe directions. As part of the bid, the Subcontractor shall provide a list of the various subsurface investigation tools they propose to have available and use at the site and what the limitations are of each tool.

A CH2M HILL representative shall be present to coordinate utility clearance activities and identify points and features to be cleared.

Field Marking and Documentation

All utilities located within **(CHOOSE 1) a 20-ft radius of the XX proposed soil boring locations (OR) within the boundary of the site(s)** as identified on the attached figure(s) will be marked using **paint (some Bases such as the WNY may have restrictions on the use of permanent paint)** and/or pin flags color coded to indicate electricity, gas, water, steam, telephone, TV cable, fiber optic, sewer, etc. The color coding shall match the industry standard as described on the attached form. In addition, the **Buried Utility Location Tracking Form** (attached) will be completed by the Subcontractor based upon what is identified in the field during the utility locating and submitted back to CH2M HILL (field staff or project manager) within 24 hours of completing the utility locating activities.

(OPTIONAL) The subcontractor shall also provide a map (or hand sketch) of the identified utilities to the Engineer within XX days of field demobilization. The map shall include coordinates or ties from fixed surface features to each identified subsurface utility.

Bid Sheet/Payment Units

The subcontractor will bid on a time and materials basis for time spent on site and researching utility maps. Mobilization (including daily travel to the site) should be bid as a lump sum, as well as the preparation of the AHA **and any required mapping**. The per diem line item should be used if the field crew will require overnight accommodations at the project site.

Health and Safety Requirements

The utility locating subcontractor is to provide and assume responsibility for an adequate corporate Health and Safety Plan for onsite personnel. Standard personal safety equipment including: hard hat, safety glasses, steel-toed boots, gloves are recommended for all project activities. Specific health and safety requirements will be established by the Subcontractor for each project. The health and safety requirements will be subject to the review of CH2M HILL.

The subcontractor shall also prepare and provide to the Engineer, at least 48 hours prior to mobilization, an acceptable Activity Hazard Analysis (AHA) using the attached AHA form or similar.

It is also required that all subcontractor personnel who will be on site attend the daily 15-minute health and safety tailgate meeting at the start of each day in the field.

Subcontractor personnel showing indications of being under the influence of alcohol or illegal drugs will be sent off the job site and their employers will be notified. Subcontractor personnel under the influence of prescription or over-the-counter medication that may impair their ability to operate equipment will not be permitted to do so. It is expected that the subcontractor will assign them other work and provide a capable replacement (if necessary) to operate the equipment to continue work.

Security

The work will be performed on US Navy property. CH2M HILL will identify the Subcontractor personnel who will perform the work to the appropriate Navy facility point-of-contact, and will identify the Navy point-of-contact to the Subcontractor crew. The Subcontractor bears final responsibility for coordinating access of his personnel onto Navy property to perform required work. This responsibility includes arranging logistics and providing to CH2M HILL, in advance or at time of entry as specified, any required identification information for the Subcontractor personnel. Specifically, the following information should be submitted with the bid package for all personnel that will perform the work in question (this information is required to obtain a base pass):

- Name
- Birth Place
- Birth Date
- Social Security Number
- Drivers License State and Number
- Citizenship

Please be advised that no weapons, alcohol, or drugs will be permitted on the Navy facility at any time. If any such items are found, they will be confiscated, and the Subcontractor will be dismissed.

Quality Assurance

The Subcontractor will be licensed and insured to operate in the State of <<state>> and will comply with all applicable federal, state, county and local laws and regulations. The subcontractor will maintain, calibrate, and operate all electronic locating instruments in accordance with the manufacturer's recommendations. Additionally, the Subcontractor shall make all reasonable efforts to review as-built engineering drawings maintained by Base personnel, and shall notify the CH2M HILL Project Manager in writing (email is acceptable) whenever such documentation was not available or could not be reviewed.

Subcontractor Standby Time

At certain periods during the utility locating activities, the Subcontractor's personnel may be asked to stop work and standby when work may normally occur. During such times, the Subcontractor will cease activities until directed by the CH2M HILL representative to resume operations. Subcontractor standby time also will include potential delays caused by the CH2M HILL representative not arriving at the site by the agreed-upon meeting time for start of the work day. Standby will be paid to the

Subcontractor at the hourly rate specified in the Subcontractor's Bid Form attached to these specifications.

Cumulative Subcontractor standby will be accrued in increments no shorter than 15 minutes (i.e., an individual standby episode of less than 15 minutes is not chargeable).

During periods for which standby time is paid, the surveying equipment will not be demobilized and the team will remain at the site. At the conclusion of each day, the daily logs for the Subcontractor and CH2M HILL representative will indicate the amount of standby time incurred by the Subcontractor, if any. Payment will be made only for standby time recorded on CH2M HILL's daily logs.

Down Time

Should equipment furnished by the Subcontractor malfunction, preventing the effective and efficient prosecution of the work, or inclement weather conditions prevent safe and effective work from occurring, down time will be indicated in the Subcontractor's and CH2M Hill representative's daily logs. No payment will be made for down time.

Schedule

It is anticipated that the subsurface utility locating activities will occur on <<insert date>>. It is estimated that the above scope will be completed within XXX days.

Attachment B - Services Available for Identifying and Marking Underground Utilities

The services that are available to us for identifying and marking underground utilities are:

- The Activity's PWC (or similar organization)
- The local public/private utility -run service such as Miss Utility
- Utility location subcontractors (hired by CH2M HILL)

Each are discussed below.

Navy Public Works Department

A Public Works Department (PWD) is usually present at each Activity. The PWD is responsible for maintaining the public works at the base including management of utilities. In many cases, the PWD has a written permit process in place to identify and mark-out the locations of Navy-owned utilities [Note: The PWD is usually NOT responsible for the locations/mark-outs of non-Navy owned, public utilities (e.g., Washington Gas, Virginia Power, municipal water and sewer, etc.). Therefore, it is likely that we will have to contact other organizations besides the PWD in order to identify non-Navy owned, public utilities].

At some Activities, there may not be a PWD, the PWD may not have a written permit process in place, or the PWD may not take responsibility for utility locating and mark-outs. In these cases, the PWD should still be contacted since it is likely that they will have the best understanding of the utility locations at the Activity (i.e., engineering drawings, institutional knowledge, etc.). Subsequently, the PWD should be brought into a cooperative arrangement (if possible) with the other services employed in utility locating and mark-out in order to have the most comprehensive assessment performed.

At all Activities we should have a contact (name and phone number), and preferably an established relationship, with PWD, either directly or through the NAVFAC Atlantic, Midlant, or Washington NTR or Activity Environmental Office that we can work with and contact in the event of problems.

Miss Utility or "One Call" Services for Public Utility Mark-outs

Miss Utility or "One Call" service centers are information exchange centers for excavators, contractors and property owners planning any kind of excavation or digging. The "One Call" center notifies participating public utilities of the upcoming excavation work so they can locate and mark their underground utilities in advance to prevent possible damage to underground utility lines, injury, property damage and service outages. In some instances, such with southeastern Virginia bases, the Navy has entered into agreement with Ms. Utilities and is part of the response process for Miss

Utilities. Generally, a minimum of 48 hours is required for the public utility mark-outs to be performed. The “One Call” services are free to the public. Note that the “One Call” centers only coordinate with participating public utilities. There may be some public utilities that do NOT participate in the “One Call” center which may need to be contacted separately. For example, in Washington, DC, the Miss Utility “One Call” center does not locate and mark public sewer and water lines. Therefore, the municipal water and sewer authority must be contacted separately to have the sewer and water lines marked out. The AM should contact the appropriate one-call center to determine their scope of services.

A national listing of the “One Call” service centers for each state is presented on the web at <http://www.underspace.com/refs/ocdir.htm>. For the Mid-Atlantic region, the following “One Call” service centers are available.

Name	Phone	Website	Comments
Miss Utility of DELMARVA	800-257-7777	www.missutility.net	Public utility mark-outs in Delaware, Maryland, Washington, DC, and Northern Virginia
Miss Utility of Southern Virginia (One Call)	800-552-7001	not available	Public utility mark-outs in Southern Virginia
Miss Utility of Virginia	800-257-7777 800-552-7007	www.missutilityofvirginia.com	General information on public utility mark-outs in Virginia, with links to Miss Utility of DELMARVA and Miss Utility of Southern Virginia (One Call)
Miss Utility of West Virginia, Inc	800-245-4848	none	Call to determine what utilities they work with in West Virginia
North Carolina One Call Center	800-632-4949	www.ncocc.org/ncocc/default.htm	Public Utility Markouts in North Carolina

Private Subcontractors

- Utility-locating support is required at some level for most all CH2M HILL field projects in "clearing" proposed subsurface boring locations on the project site. Utility location and sample clearance can include a comprehensive effort of GIS map interpretation, professional land surveying, field locating, and geophysical surveying. Since we can usually provide our own GIS-related services for projects and our professional land surveying services are normally procured separately, utility-locating subcontractors will normally only be required for some level of geophysical surveying support in the field. This level of geophysical surveying support can range widely from a simple electromagnetic (EM) survey over a known utility line, to a blind geophysical effort, including a ground-penetrating radar (GPR) survey and/or a comprehensive EM survey to delineate and characterize all unknown subsurface anomalies.

The level of service required from the subcontractor will vary depending on the nature of the site. At sites where utility locations are well defined on the maps and

recent construction is limited, CH2M HILL may be confident with a limited effort from a traditional utility-locating subcontractor providing a simple EM survey. At sites where utility locations are not well defined, where recent constructions may have altered utility locations, or the nature of the site makes utility location difficult, CH2M HILL will require the services of a comprehensive geophysical surveying subcontractor, with a wide range of GPR and EM services available for use on an "as-needed" basis. Typical costs for geophysical surveying subcontractors will range from approximately \$200 per day for a simple EM effort (usually one crew member and one instrument) to approximately \$1,500 per day for a comprehensive geophysical surveying effort (usually a two-person crew and multiple instruments). Comprehensive geophysical surveying efforts may also include field data interpretation (and subsequent report preparation) and non-destructive excavation to field-verify utility depths and locations.

The following table provides a list of recommended geophysical surveying support subcontractors that can be used for utility-locating services:

Company Name and Address	Contact Name and Phone Number	Equipment ¹					Other Services ²		
		1	2	3	4	5	A	B	C
US Radar, Inc.* PO Box 319 Matawan, NJ 07747	Ron LaBarca 732-566-2035			4					
Utilities Search, Inc.*	Jim Davis 703-369-5758	4				4	4	4	4
So Deep, Inc.* 8397 Euclid Avenue Manassas Park, VA 20111	703-361-6005	4					4	4	4
Accurate Locating, Inc. 1327 Ashton Rd., Suite 101 Hanover, MD 21076	Ken Shipley 410-850-0280	4	4						
NAEVA Geophysics, Inc. P.O. Box 7325 Charlottesville, VA 22906	Alan Mazurowski 434-978-3187	4	4	4	4	4	4	4	4
Earth Resources Technology, Inc. 8106 Stayton Rd. Jessup, MD 20794	Peter Li 240-554-0161	4	4	4	4	4	4	4	
Geophex, Ltd 605 Mercury Street Raleigh, NC 27603	I. J. Won 919-839-8515	4	4	4	4	4	4	4	4

Notes:

*Companies denoted with an asterisk have demonstrated reluctance to assume responsibility for damage to underground utilities or an inability to accommodate the insurance requirements that CH2M HILL requests for this type of work at many Navy sites.

¹Equipment types are:

1. Simple electromagnetic instruments, usually hand-held
2. Other, more innovative, electromagnetic instruments, including larger instruments for more area coverage
3. Ground-penetrating radar systems of all kinds
4. Audio-frequency detectors of all kinds
5. Radio-frequency detectors of all kinds

²Other services include:

- A. Data interpretation and/or report preparation to provide a permanent record of the geophysical survey results and a professional interpretation of the findings, including expected accuracy and precision.
- B. Non-destructive excavation to field-verify the depths, locations, and types of subsurface utilities.
- C. Concrete/asphalt coring and pavement/surface restoration.

Attachment C – Equipment Used for Identifying Underground Utilities

This attachment provides a summary of the various types of equipment used for subsurface utility location. It describes the capabilities and limitations of each in order to help the AM and PM determine if the equipment being proposed by a subcontractor or Navy is adequate. A list of in-house experts that can be used to answer questions you may have is provided below.

CH2M HILL In-house Utility Location Experts

Tamir Klaff/WDC

Home Office Phone – 703-669-9611

Electromagnetic Induction (EMI) Methods

EMI instruments, in general, induce an electromagnetic field into the ground (the primary field) and then record the response (the secondary field), if any. Lateral changes in subsurface conductivity, such as caused by the presence of buried metal or by significant soil variations, cause changes in the secondary field recorded by the instrument and thus enable detection and mapping of the subsurface features. It should be noted that EMI only works for electrically conductive materials--plastic or PVC pipes are generally not detected with EMI. Water and gas lines are commonly plastic, although most new lines include a copper “locator” strip on the top of the PVC to allow for detection with EMI.

EMI technology encompasses a wide range of instruments, each with inherent strengths and weaknesses for particular applications. One major division of EMI is between “time-domain” and “frequency-domain” instruments that differ in the aspect of the secondary field they detect. Another difference in EMI instruments is the operating frequency they use to transmit the primary field. Audio- and radio-frequencies are often used for utility detection, although other frequencies are also used. Consideration of the type of utility expected, surface features that could interfere with detection, and the “congestion” of utilities in an area, should be made when choosing a particular EMI instrument for a particular site.

One common EMI tool used for utility location is a handheld unit that can be used to quickly scan an area for utilities and allows for marking locations in “real time”. This method is most commonly used by “dig-safe” contractors marking out known utilities prior to excavation. It should be noted that this method works best when a signal (the primary field) can be placed directly onto the line (i.e., by clamping or otherwise connecting to the end of the line visible at the surface, or for larger utilities such as sewers, by running a transmitter through the utility). These types of tools also have a limited capability to scan an area for unknown utilities. Usually this requires having enough area to separate a hand held transmitter at least a hundred feet from the

receiver. Whether hunting for unknown, or confirming known, utilities, this method will only detect continuous lengths of metallic conductors.

In addition to the handheld EMI units, larger, more powerful EMI tools are available that provide more comprehensive detection and mapping of subsurface features. Generally, data with these methods are collected on a regular grid in the investigation area, and are then analyzed to locate linear anomalies that can be interpreted as utilities. These methods will usually detect *all* subsurface metal (above a minimum size), including pieces of abandoned utilities. In addition, in some situations, backfill can be detected against native soils giving information on trenching and possible utility location. Drawbacks to these methods are that the secondary signals from utilities are often swamped (i.e., undetectable) close to buildings and other cultural features, and that the subsurface at heavily built-up sites may be too complicated to confidently interpret completely.

Hand-held metal detectors (treasure-finders) are usually based on EMI technology. They can be used to locate shallow buried metal associated with utilities (e.g., junctions, manholes, metallic locators). Advantages of these tools is the ease of use and real-time marking of anomalies. Drawbacks include limited depths of investigations and no data storage capacity.

Ground Penetrating Radar (GPR)

GPR systems transmit radio and microwave frequency (e.g., 80 megaHertz to 1,000 megaHertz) waves into the ground and then record reflections of those waves coming back to the surface. Reflections of the radar waves typically occur at lithologic changes, subsurface discontinuities, and subsurface structures. Plastic and PVC pipes can sometimes be detected in GPR data, especially if they are shallow, large, and full of a contrasting material such as air in a wet soil, or water in a dry soil. GPR data are usually collected in regular patterns over an area and then analyzed for linear anomalies that can be interpreted as utilities. GPR is usually very accurate in x-y location of utilities, and can be calibrated at a site to give very accurate depth information as well. A significant drawback to GPR is that depth of investigation is highly dependant on background soil conductivity, and it will not work on all sites. It is not uncommon to get only 1-2 feet of penetration with the signal in damp, clayey environments. Another drawback to GPR is that sites containing significant fill material (e.g., concrete rubble, scrap metal, garbage) will result in complicated anomalies that are difficult or impossible to interpret.

Magnetic Field Methods

Magnetic field methods rely on detecting changes to the earth's magnetic field caused by ferrous metal objects. This method is usually more sensitive to magnetic metal (i.e., deeper detection) than EMI methods. A drawback to this method is it is more susceptible to being swamped by surface features such as fences and cars. In addition, procedures must usually be implemented that account for natural variations in the earth's background field as it changes throughout the day. One common use of the method is to measure and analyze the gradient of the magnetic field, which eliminates most of the drawbacks to the method. It should be noted this method only detects

ferrous metal, primarily iron and steel for utility location applications. Some utility detector combine magnetic and EMI methods into a single hand-held unit.

Optical Methods

Down the hole cameras may be useful in visually reviewing a pipe for empty conduits and/or vaults.

Attachment D – Utility Clearance Documentation Form

Attachment E – Utility Marking Color Codes

The following is the standard color code used by industry to mark various types of utilities and other features at a construction site.

White – Proposed excavations and borings

Pink – Temporary survey markings

Red – Electrical power lines, cables, conduits and lighting cables

Yellow – Gas, oil, steam, petroleum or gaseous materials

Orange – Communication, alarm or signal lines, cables, or conduits

Blue – Potable water

Purple – Reclaimed water, irrigation and slurry lines

Green – Sewer and storm drain lines

Direct-Push Soil Sample Collection

I. Purpose

To provide a general guideline for the collection of soil samples using direct-push (e.g., Geoprobe®) sampling methods.

II. Scope

Standard direct-push (e.g., Geoprobe®) soil sampling methods.

III. Equipment and Materials

- Truck-mounted hydraulic percussion hammer
- Sampling rods
- Sampling tubes and acetate liners
- Pre-cleaned sample containers and stainless-steel sampling implements
- Personal Protective Equipment as specified by the Health and Safety Plan

IV. Procedures and Guidelines

1. Decontaminate sampling tubes and other non-dedicated downhole equipment in accordance with SOP *Decontamination of Personnel and Equipment*.
2. Drive sampling tube to the desired sampling depth using the truck-mounted hydraulic percussion hammer. If soil above the desired depth is not to be sampled, first drive the lead rod, without a sampling tube, to the top of the desired depth.
3. Remove the rods and sampling tube from the borehole and remove the sampling tube from the lead rod.
4. Cut open the acetate liner using a specific knife designed to slice the acetate liners (see below).



5. Fill all sample containers, beginning with the containers for VOC analysis, using a decontaminated or dedicated sampling implement. For the VOC samples, place the sample into a pre-preserved VOA vial or direct sample container such as an **En Core®** sampler and seal the cap tightly. Ideally, the operation should be completed in one minute. Label the vials and place on ice for shipment to the laboratory.
6. Decontaminate all non-dedicated downhole equipment (rods, sampling tubes, etc.) in accordance with SOP *Decontamination of Personnel and Equipment*.
7. Backfill borehole at each sampling location with grout or bentonite and repair the surface with like material (bentonite, asphalt patch, concrete, etc.), as required.

V. Key Checks and Items

1. Verify that the hydraulic percussion hammer is clean and in proper working order.
2. Ensure that the direct-push operator thoroughly completes the decontamination process between sampling locations.
3. Verify that the borehole made during sampling activities has been properly backfilled.

Appendix B
Navy CLEAN Data Management Plan

Version 1

Navy CLEAN Data Management Plan

Prepared for
Navy CLEAN & Joint Venture Programs

July 2010

CH2MHILL

Preface

This document presents the standardized six-step workflow process for environmental data management being performed for the Navy Comprehensive Long-Term Environmental Action - Navy (CLEAN) and Joint Venture Programs. Included in Appendix A is the responsible, approve, support, consult, and inform (RASCI) diagram along with the associated roles and responsibilities, which is the basis for the Navy CLEAN and Joint Venture Programs Data Management Plan (DMP). Following are the six steps in the workflow process:

1. Project planning and database setup
2. Sample collection and management
3. Laboratory analysis
4. Data validation and loading
5. Data management
6. Data evaluation and reporting

Figure P-1 presents a simplified presentation of the workflow process specific to the Navy CLEAN and Joint Venture Programs.

Figure P-2 presents, in more detail, the tools used in each step of the process. CH2M HILL uses the Sample Tracking Sheet (STS) to initiate the sample collection, documentation, and tracking processes. All field-related data is captured in the Field Data Entry Tool (FDETool). During the laboratory analysis and data validation phase, the SNEDD-QC-Tool software will be used to help evaluate the quality of the data. At the data management step, the SVMTool will be used to format the data and the CH-IMPTool will be used to transfer the data into the Navy CLEAN data warehouse. At the data evaluation stage, the XTabReports Tool will be used to query data from the data warehouse, and the Crosstab Cleanup Tool (CCTool) and the Raw, Detects, and Exceedance (RDE) Formatting Tool will produce and format data tables and comparisons to project action levels. Appropriate section(s) of the DMP include additional details on each of the tools used.

Change Management

This DMP is a “living” document and content may be revised or amended to accommodate changes in the scope of environmental investigations or data management requirements that affect the entire Navy CLEAN and Joint Venture Programs. In addition, the DMP appendices will be subject to modification as new or improved methods of data management are developed and implemented.

Any modifications made to the tools will be communicated to the project team via e-mail. As revisions are finalized, they will be distributed electronically to all users. After revision, it is the user’s responsibility to conform to revised portions of the DMP.

Amendments will be versioned and released according to the following naming scheme: [Document Name_v#.#_yymmdd]. If a significant change is made to any of these files, the version number will increase by one integer. The revision history is shown in the following table.

REVISION HISTORY

Navy CLEAN and Joint Venture Programs Data Management Plan

Revision Date	Initiator	Purpose

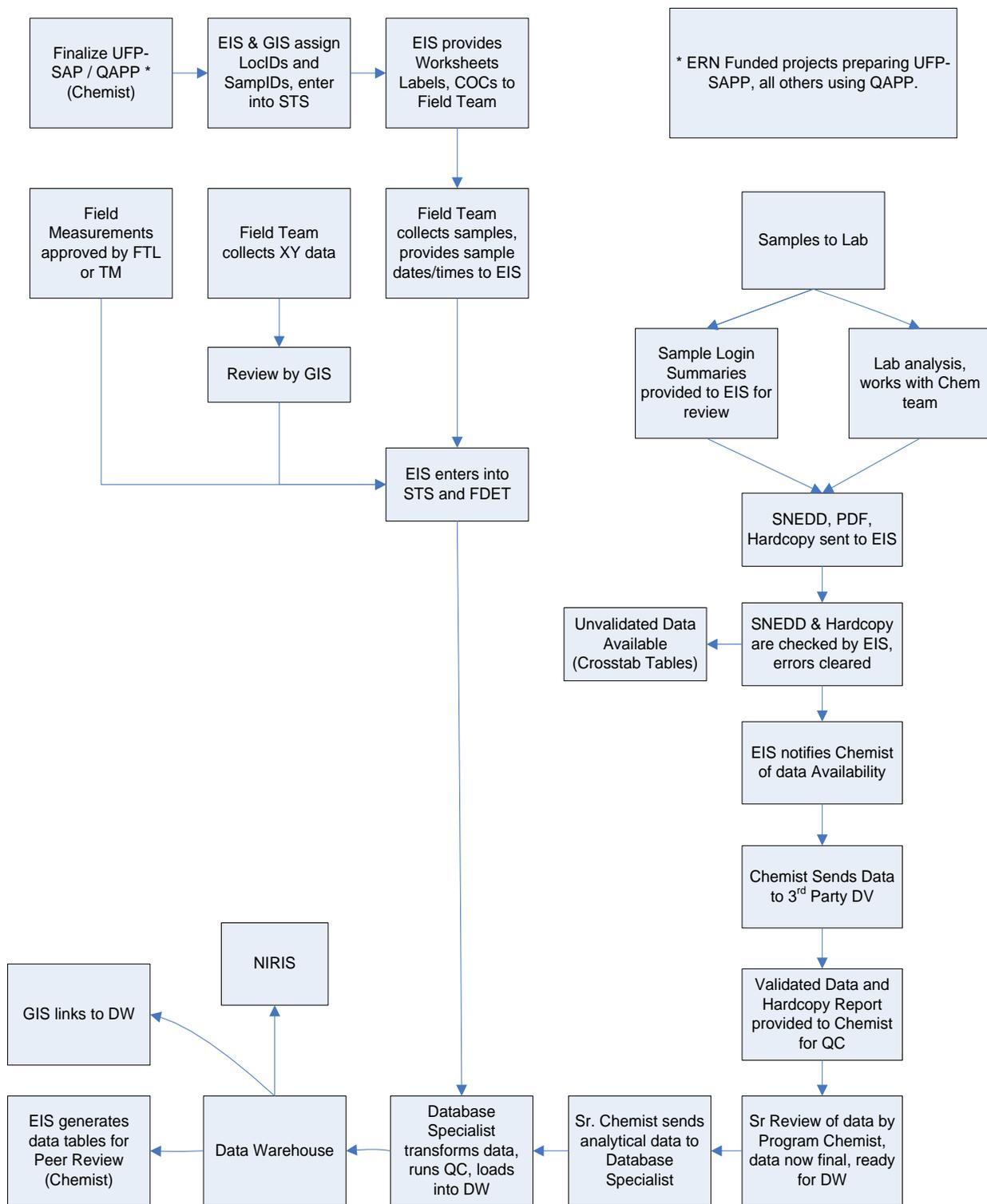


FIGURE P-1 ENVIRONMENTAL DATA MANAGEMENT WORKFLOW PROCESS

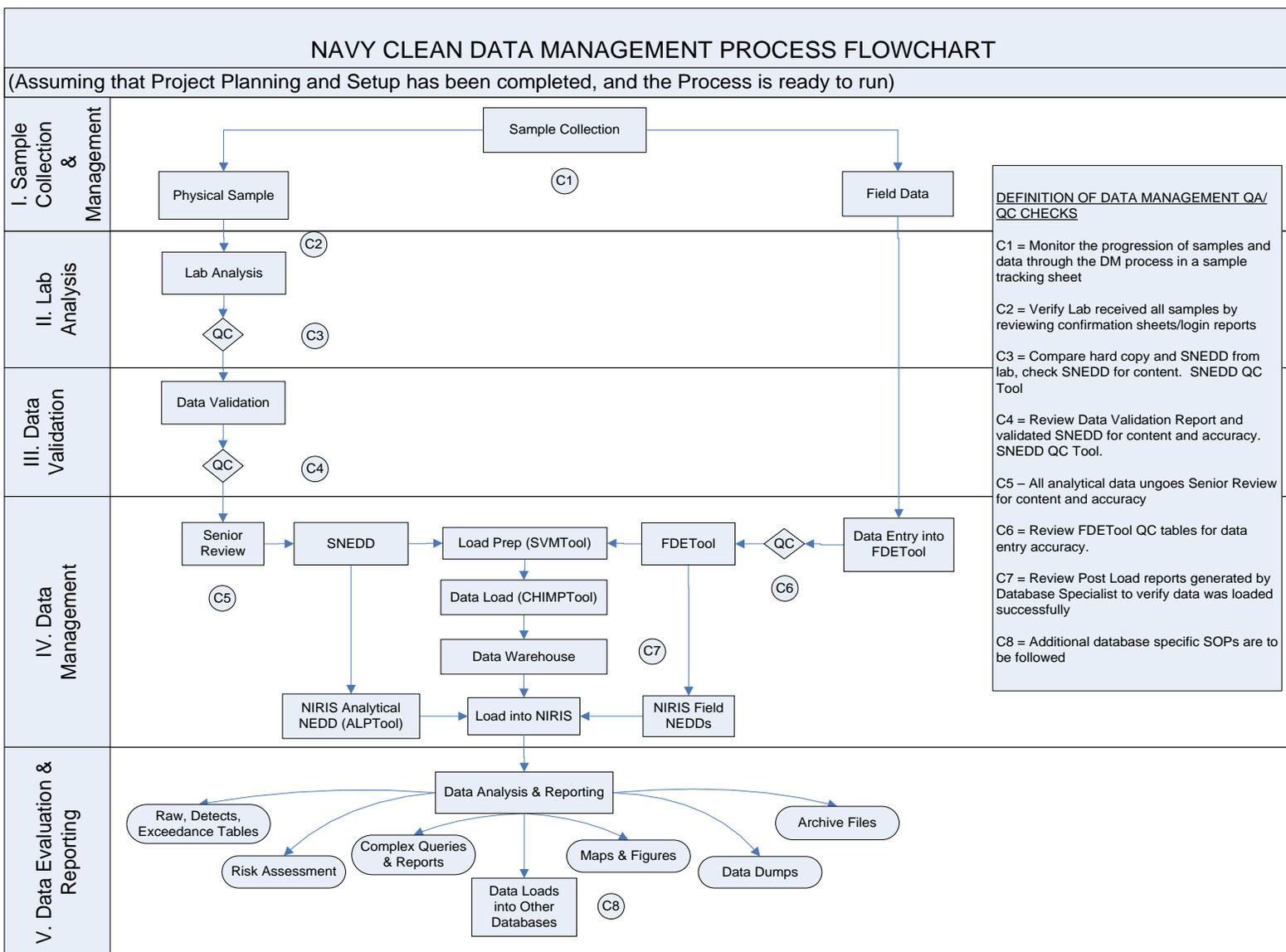


FIGURE P-2
DBMS PROCESS

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Acronyms and Abbreviations

AFCEE	Air Force Center for Engineering and the Environment
ALPTool	Archive Load and Prep Tool
AM	Activity Manager
CAD	computer-aided design
COC	chain-of-custody
DBMS	Database Management System
DBS	Database Specialist
DMP	Data Management Plan
EDD	electronic data deliverable
EDM	Environmental Data Management
EIS	Environmental Information Specialist
EMS	Enterprise Management Solutions
ERP	Environmental Restoration Program
ERPIMS	Environmental Restoration Program Information Management System
EVS	Environmental Visualization System
FD	Field Duplicate
FDETool	Field Data Entry Tool
FTL	Field Team Leader
GA	GIS Analyst
GIS	geographic information system
ID	identification
IDW	investigation-derived waste
IRP	Installation Restoration Program
MS	matrix spike
MSD	matrix spike duplicate
N/FD	normal/field duplicate
NAVFAC	Naval Facilities Engineering Command
NEDD	NIRIS Electronic Data Deliverable
NIRIS	Naval Installation Restoration Information Solution
ODBC	open database connectivity
PC	Project Chemist
PCL	Program Chemistry Lead
PDL	Program Data Management Lead
PGL	Program GIS Lead
PM	Project Manager

QA	quality assurance
QC	quality control
RASCI	responsible, approve, support, consult, and inform
RDM	Regional Database Manager
SDG	Sample Delivery Group
SIMS	Site Information Management System
SNEDD	Supplemental NIRIS Electronic Data Deliverable
SOP	standard operating procedure
STS	Sample Tracking Sheet
SVMTTool	SNEDD to VDMS Mapping Tool
VDMS	Validated Data Management System

Introduction

This Data Management Plan (DMP) describes the methods CH2M HILL will use to manage and present environmental data to support work it is conducting for the Navy CLEAN and Joint Venture Programs. These processes and procedures are part of an overall environmental data management system called the SNEDD Approach to the Validation Data Management System (VDMS), hosted by CH2M HILL.

Project members and any subcontractors supporting program data needs for site characterization and remediation activities can use this DMP. It is a living document that is flexible enough to meet the dynamic needs of the teams and stakeholders. Data management program details and procedures are included in the appendices.

1.1 Purpose

This document outlines how environmental data for the Navy CLEAN and Joint Venture Programs will be obtained and managed using an Enterprise Management Solutions (EMS) approach. The systematic approach will facilitate the retrieval of data from project files and the data warehouse when they are needed, help ensure that the required data are collected and are of the appropriate quality, and help ensure that data records are not lost during transfer to the central program database repository.

1.2 Scope of the Data Management Plan

The scope of the data management activities addressed by this plan includes the following:

- **Roles.** Definition of staff roles and responsibilities.
- **Project Planning and Setup.** Use standard templates and database applications; provide guidance and standard operating procedures (SOPs) for formatting, reviewing, and transferring data collected in the field to the Database Management System (DBMS).
 - **Provide a structured, yet flexible data set.** The DBMS will store all types of environmental data and provides a standard framework for all projects within the Navy CLEAN Program to use. The DBMS is organized and structured, yet flexible enough to allow additional data and data types to be added at any time over the life of the program.
 - **Provide data that are well documented.** The DBMS will retain enough descriptive and source information for technical defensibility and legal admissibility of the data.
- **Sample Collection and Management.** Items that will be captured through standardized forms or applications include chains-of-custody (COCs), field parameter information, groundwater elevation data, and sample tracking records.
- **Laboratory Analysis.** Laboratory data will be reported in the Supplemental Naval Installation Restoration Information Solution (NIRIS) Electronic Data Deliverable (SNEDD)

format specifications that analytical laboratories are required to use to transfer analytical data electronically to CH2M HILL. (Provided to laboratories via a scope of work.) Management and archive procedures will be implemented for hard copy and electronic project documentation.

- **Data Validation.** Internal and external data validation will be conducted in accordance with the appropriate Program and EPA requirements. All deliverables will be subjected to Senior Review quality assurance (QA) and quality control (QC) measures. Management and archive procedures will be implemented for hard copy and electronic project documentation.
- **Data Management.** QA and QC measures will be implemented to provide accurate representation of all data collected and to be stored in the DBMS. QA/QC procedures include restricting data import or entry to specific valid value lists that will not allow incorrect data to be included in the DBMS.
- **Data Evaluation and Reporting.** Reporting and delivery support will be provided from a single DBMS source and allow relatively simple and rapid access to stored data for environmental characterization, report generation, modeling, geographic information system (GIS) mapping, statistical analyses, and risk assessments.
 - **Provide data visualization capabilities.** Data will be accurately represented for use in models, GIS, boring log programs (Environmental Visualization System [EVS], computer-aided design (CAD), graphics, and other software used for mapping, graphing, charting, analyzing, and displaying environmental data.
 - **Provide the ability to compare data electronically.** Tools will allow the electronic comparison of project data to specific reference or screening criteria.
 - **Provide the ability to transfer data to different formats.** The DBMS will provide the ability to reformat, convert, and transfer the data to any format as required by specific end-user applications.

SECTION 2

Roles and Responsibilities

The Navy CLEAN and Joint Venture Programs Environmental Data Management (EDM) team will work together to properly execute the DMP and ensure that the project objectives and scope are realized. The EDM team is composed of data management, chemistry, and GIS resources. The EDM team is responsible for all aspects of planning, execution, management and reporting environmental of data. Data are derived from sampling events related to investigative and remedial activities for Navy CLEAN and Joint Venture projects.

Responsibilities related to data management and information solutions functions are grouped into roles, as listed in Table 1. The SNEDD DM Process Checklist referenced in Appendix C documents the specific responsibilities associated with each of these roles.

TABLE 1
 Navy CLEAN and Joint Venture Environmental Data Management Program Team
The Navy CLEAN Program Data Management Plan

Title	Name/Address	Phone	Fax	E-mail
Navy CLEAN Activity Manager (AM)	Various	Various	Various	Various
Navy CLEAN Project Manager (PM)	Various	Various	Various	Various
Field Team Leader (FTL)	Various	Various	Various	Various
Program Critigen Team Lead	Mike Dierstein 5700 Cleveland Street Suite 101 Virginia Beach, VA 23462	757-671-6216	757-497-6885	mdierste@critigen.com
Program Data Management Lead (PDL)	Chelsea Leigh 5700 Cleveland Street. Suite 101 Virginia Beach, VA 23462	757-671-6208	773-695-1378	cleigh@critigen.com
Database Specialist (DBS)	Bhavana Reddy 15010 Conference Center Dr. Suite 200 Chantilly, VA 20151	703- 462-3784	703- 376-5010	breddy@critigen.com
Program Chemistry Lead (PCL)	Anita Dodson 5700 Cleveland Street Suite 101 Virginia Beach, VA 23462	757-671-6218	757-497-6885	adodson@ch2m.com
Project Chemist (PC)	Mike Zamboni 15010 Conference Center Dr. Suite 200 Chantilly, VA 20151	703-376-5111	703-376-5801	mzamboni@ch2m.com
Project Chemist (PC)	Megan Morrison 15010 Conference Center Dr. Suite 200 Chantilly, VA 20151	703-376-5053	703-376-5801	megan.morrison@ch2m.com

TABLE 1
 Navy CLEAN and Joint Venture Environmental Data Management Program Team
The Navy CLEAN Program Data Management Plan

Title	Name/Address	Phone	Fax	E-mail
Project Chemist (PC)	Bianca Kleist 5700 Cleveland Street. Suite 101 Virginia Beach, VA 23462	757-671-6281	757-497-6885	bkleist@ch2m.com
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Project Chemist (PC)	Kristina Lambert 3011 S.W. Williston Road. Gainesville, FL 32608	352-335-5877		kristina.lambert@ch2m.com
Environmental Information Specialist (EIS)	Genevieve Moore 5700 Cleveland Street. Suite 101 Virginia Beach, VA 23462	757-671-6284	757-497-6885	gmoore@ch2m.com
Environmental Information Specialist (EIS)	Rebekha Shaw 5700 Cleveland Street. Suite 101 Virginia Beach, VA 23462	757-671-6279	757-497-6885	rshaw22@ch2m.com
Environmental Information Specialist (EIS)	Gwendolyn Buckley 5700 Cleveland Street. Suite 101 Virginia Beach, VA 23462	757-671-8311	757-497-6885	Gbuckle1@ch2m.com
Environmental Information Specialist (EIS)	Victoria Brynildsen 5700 Cleveland Street. Suite 101 Virginia Beach, VA 23462	757-671-6252	757-497-6885	vbrynildsen@ch2m.com
Program GIS Lead (PGL)	Mike Dierstein 5700 Cleveland Street. Suite 101 Virginia Beach, VA 23462	757-671-6216	757-497-6885	mdierstein@critigen.com

TABLE 1
 Navy CLEAN and Joint Venture Environmental Data Management Program Team
The Navy CLEAN Program Data Management Plan

Title	Name/Address	Phone	Fax	E-mail
GIS Analyst (GA)	Blake Hathaway 5700 Cleveland Street. Suite 101 Virginia Beach, VA 23462	757-671-6230	757-497-6885	bhathawa@critigen.com
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GIS Analyst (GA)	Mark Unwin 5700 Cleveland Street. Suite 101 Virginia Beach, VA 23462	757-671-6261	757-497-6885	munwin@critigen.com
GIS Analyst (GA)	Chris Bowman 5700 Cleveland Street. Suite 101 Virginia Beach, VA 23462	757-671-6276	757-497-6885	cbowman@critigen.com
GIS Analyst (GA)	Matt Rissing 5700 Cleveland Street. Suite 101 Virginia Beach, VA 23462	757-671-6243	757-497-6885	mrrissing@critigen.com
GIS Analyst (GA)	Forrest Cain 5700 Cleveland Street. Suite 101 Virginia Beach, VA 23462	757-671-6271	757-497-6885	fcain@critigen.com

SECTION 3

Data Management System Description

During field investigation, monitoring, and remedial activities, CH2M HILL will collect a variety of environmental information to support data analysis, reporting, and decision-making activities. To meet current regulatory QA requirements, a complete audit trail of the information flow must be implemented. The six steps in the workflow process are (Appendix B):

1. Project planning and database setup
2. Sample collection and management
3. Laboratory analysis
4. Data validation
5. Data management and loading
6. Data evaluation and reporting

Each step in the data management process must be adequately planned, executed, and documented. Figure 1 presents a simplified presentation of the workflow process specific to the Navy CLEAN and Joint Venture Programs. Figure 2 presents, in more detail, the tools used in each step of the process.

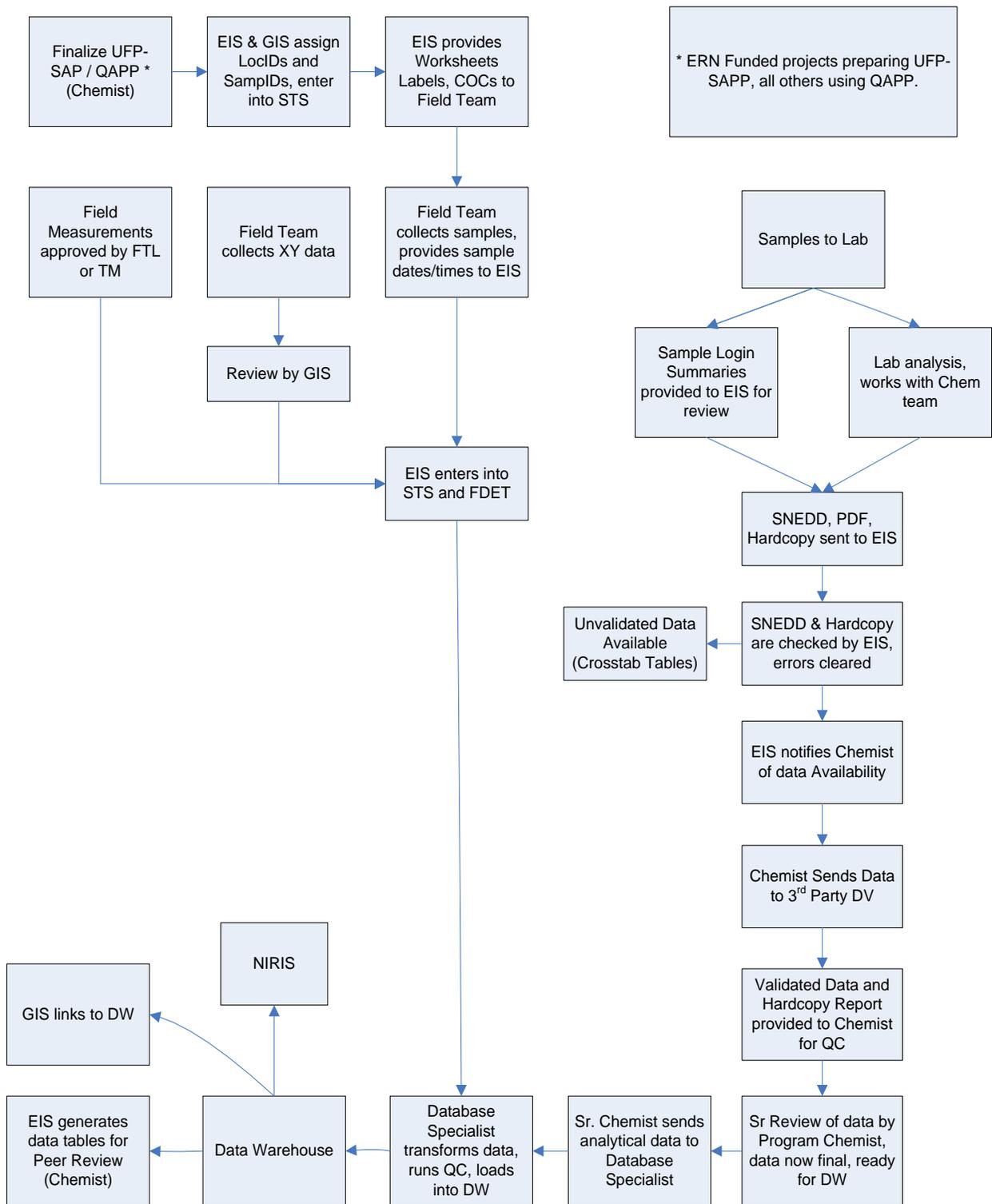


FIGURE 1 ENVIRONMENTAL DATA MANAGEMENT WORKFLOW PROCESS

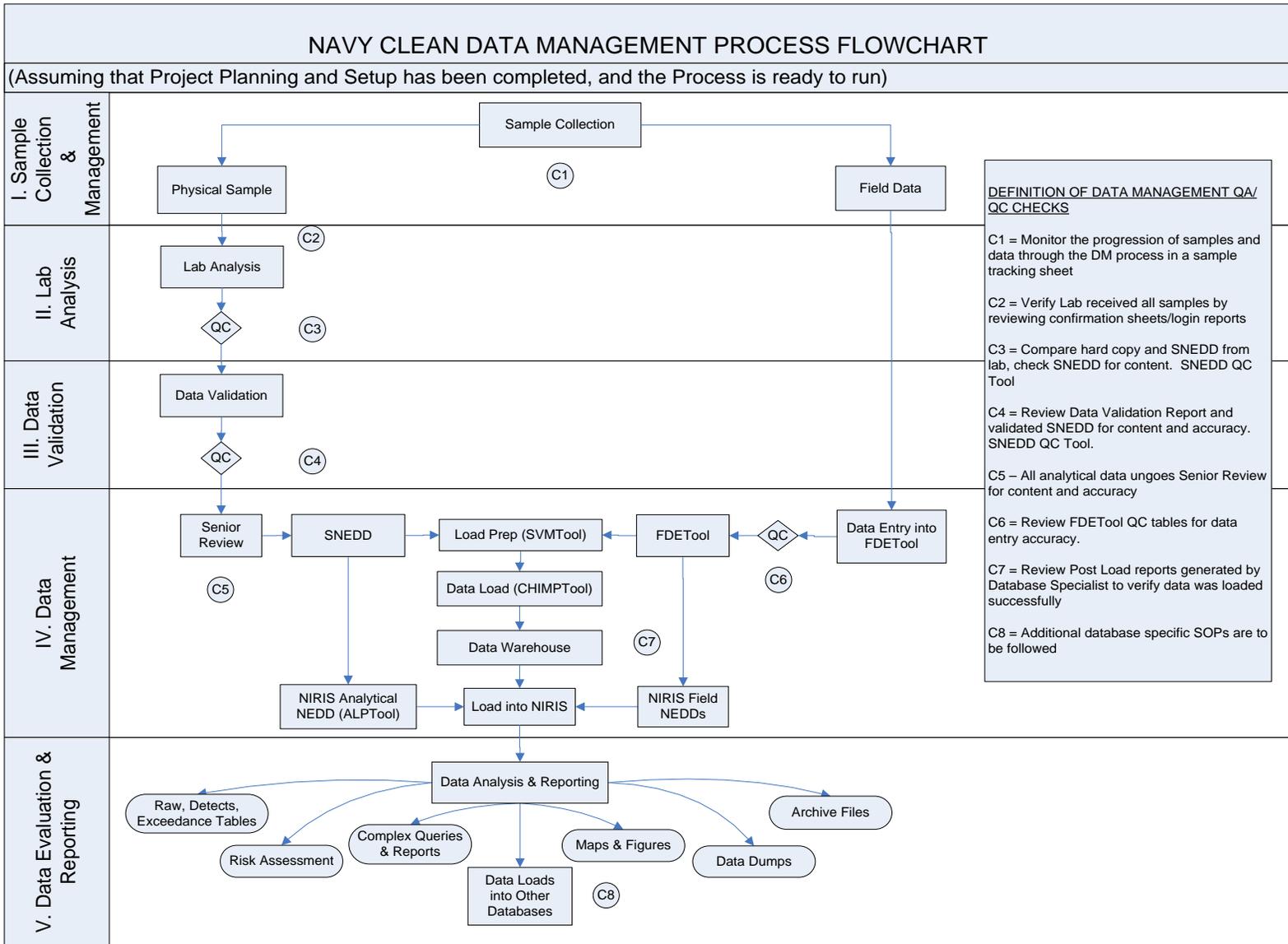


FIGURE 2
DBMS PROCESS

Phases of Data Management

4.1 Project Planning and Setup

Project planning starts when a new project or task is identified in the program. Evaluation of what is required from data management and visualization occurs to determine the data needs. The Program Critigen Team Lead (Critigen Lead) works with the Program Data Management Lead (PDL) and the project and/or activity manager to determine what is expected and required from the data management and visualization team. Specific items that should be considered are as follows:

- Inputs – Determine what data will be collected and stored in the database. Determine frequency and quantity. Determine what tools will be used to handle data input.
- Historical Data – This is a unique data input and requires special consideration. The PDL *must* work with the other technical leads to assess what effort will be required. This step is often missed, and the resulting data quality issues created from inadequate planning in this area can plague the project for its entire duration.
- Outputs – Determine what data will need to be presented in reports, figures, and electronic deliverables. Determine frequency and quality requirements. Determine preliminary data, validated data, and what tools will most effectively handle the output requirements. Discuss how the outputs needed by the team will be requested and documented.
- Visualization – Determine necessity for GIS and CAD.

After the information above is determined, the data management scope, schedule, and budget are developed and endorsed by the Project Manager (PM), PDL, Program GIS Lead (PGL) and Program Chemistry Lead (PCL). The team can then proceed upon client authorization of the overall project budget. Figure 3 shows the process for project planning.

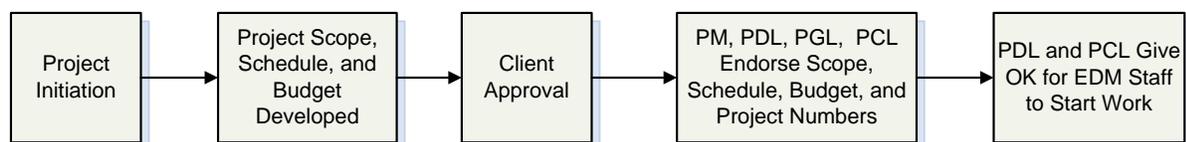


FIGURE 3
PROJECT PLANNING

4.1.1 Database Setup and Administration

CH2M HILL Database

The PDL will oversee the administration of the DBMS, including the design, development, and maintenance of the program database, tools and data management processes. Database and data management process design and development will focus on providing rapid data entry

and data retrieval while promoting data integrity through various automated procedures. The PDL will perform the database maintenance, which consists of the following:

- Assisting with the allocation of sufficient system storage for the program database
- Adding, altering, and deleting users, roles, and privileges
- Periodically defragmenting and compacting the database for more efficient operation
- Upgrading database software and associated applications as necessary
- Maintaining an approved list of valid values for data consistency
- Maintaining redundancy control to ensure that each data record is unique and consistent with conventions
- Performing routine virus checks on incoming and outgoing data

The DBMS is comprised of the Data Warehouse and associated SNEDD-Approach tools, and will support the storage, analysis, display, and reporting of the Navy's environmental, analytical, and geotechnical data. The DBMS will consist of primary data tables that store the environmental data, dependent tables that store more details related to the data in the primary tables, and look-up tables that store valid values to provide input to the primary tables. The EIS will maintain the table content and the PDL will manage it.

Valid values are critical to any large relational database. Tables 2 and 3 provide examples of valid values for the Navy CLEAN and Joint Venture Programs' sites, stations, and samples. Inconsistencies in naming conventions, subtle analyte or method spelling differences, and the use of non-standard abbreviations can result in lost data and incorrect conclusions. Most tables and forms in the program database will use look-up tables for acceptable valid values and will not allow the entry of data that do not conform.

The primary purpose of managing data in a relational database environment is to ensure that each data record is unique and that the information contained within each field is consistent with conventions defined in other areas of the database. To ensure that each record is unique, a key field or fields will be identified within each data table. The VDMS Data Warehouse architecture supports this approach and eliminates the possibility of data redundancy.

NIRIS Database

All Navy CLEAN and Joint Venture data must be loaded into the Navy's own internal database system, the Naval Installation Restoration Information Solution (NIRIS). NIRIS is a web-based centralized database that has been implemented across all Naval Facilities Engineering Command (NAVFAC) offices and will be used by the Navy and contractors to manage, evaluate, and visualize data, documents and records for Navy and the Marine Corps sites. NIRIS manages all Environmental Restoration Program (ERP) analytical and spatial data, which includes the Munitions Response and Installation Restoration Program (IRP) data, ensuring institutional memory is preserved, land use controls are maintained, and remedial actions are effective.

CH2M HILL will use the SNEDD Approach to VDMS system to track, collect, review, and prepare Navy-related sample and project data for loading into NIRIS. Project data stored in the

VDMS Data Warehouse must be consistent and comparable with data that is loaded and stored within NIRIS. As such, all associations between VDMS and NIRIS valid values, output reports, and data tables will be tracked and maintained.

4.1.2 Data Security Procedures

Some SNEDD Approach to VDMS applications and data are stored in a secure location with login and password protection. Authorized users will have logins and passwords in advance. The PDL will provide security access to these tools. Access2003 must be installed on the computer that the user will be using to run these applications, and proper licenses distributed. Files received from any subcontractors will be scanned for common viruses using industry standard, current virus protection programs. The file servers storing the data must be running current virus software, with automatic virus signature updates.

NIRIS data are stored in a secure location with login and password protection. Users who require access to NIRIS and the data contained therein will need to follow procedures outlined in the SOP Access to NIRIS to procure security certificates, training, and access rights to installation-specific data. Authorized users of NIRIS will be assigned logins and passwords maintained by the Navy. For further information on NIRIS or obtaining NIRIS access, consult with the Critigen Lead or PDL.

4.1.3 Data Backup and Recovery

All project data management files will reside on CH2M HILL's terminal server, "Gaia," and will have a tape backup or equivalent created in accordance with CH2M HILL's network server management policy.

4.2 Sample Collection and Management

Sample control during the sampling phase is required to ensure the integrity of the associated data. Sample control must be maintained and documented from the point of collection through the point of disposal. Sample control will be managed both in the field and in the laboratory, and will be documented using field logbooks and a Chain of Custody (COC). When custody of a sample is transferred from one party to another, the recipient of the sample assumes responsibility for maintaining control of the sample and documenting that control on the COC. Figure 4 shows the process for planning and executing field sampling events.

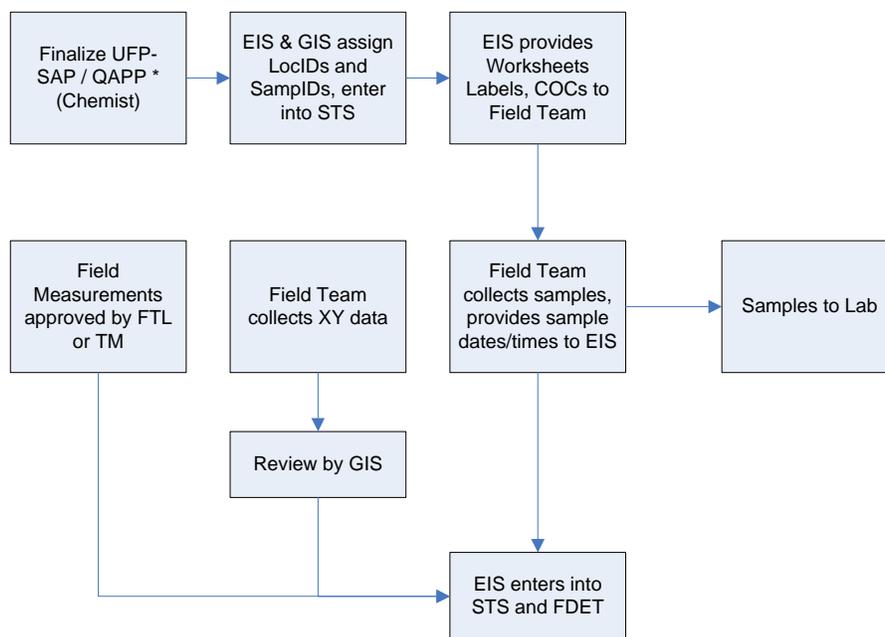


FIGURE 4
FIELD SAMPLING

4.2.1 Sample Tracking Sheet

During the planning stage, the PM specifies the data requirements for the sampling event. The work plan or similar document will provide project-specific data requirements for a given sampling event. The Project Chemist (PC) is responsible for reviewing the Sampling and Analysis Plan and ensuring that the FTL is aware of the number of field and laboratory QC samples required for the sampling event (trip blanks, equipment blanks, field blanks, field duplicates, matrix spikes, and matrix spike duplicates). All of this information is to be entered into the STS.

The STS will be used in advance to identify sampling container and preservation requirements, identify analytical laboratories for samples, aid in the generation of labels for sample bottles before the sampling event, and prepare COC forms after sampling is complete.

4.2.2 Sample Nomenclature Guidelines

The following guidelines are provided for sample nomenclature, COC clarification, and eData expectations.

Station ID (Location)

Field station data are information assigned to a physical location in the field at which some sort of sample is collected. For example, a monitoring well that has been installed will require a name that will uniquely identify it with respect to other monitoring wells or other types of sample locations. The station name provides a key in a database to which any samples collected from that location can be linked to form a relational database structure.

Before beginning fieldwork, the FTL will review the proposed level of effort and coordinate a list of unique station identification names, or station IDs, with the PDL or EIS. The FTL will be

responsible for enforcing the use of the standardized ID system and agreed upon station IDs during all field activities.

Each station will be uniquely identified by an alphanumeric code that will describe the station's attributes. These attributes are facility, Area of Concern (AOC)/Site/Operable Unit (OU) number, station type, sequential station number, and possibly an additional qualifier as needed. The naming scheme to be used for the identification of a sampling station is documented in Table 2.

For example, if the first sample location at next month's event within Yorktown Site 30 is at a soil location, then the location ID could possibly be YS30-SO391 because that was the next available sequence number for soil locations. This should also be reflected in the Sample ID. QC and IDW station IDs must be established for each site that they are associated with.

Please consult with the PDL or EIS should any questions arise. This will avoid complications that could occur if a station is mislabelled and ensure there are unique identifiers for every sampling location. Required deviations to this format in response to field conditions will be documented in the field logbook.

Sample ID

Field sample data are information assigned to a physical piece of material collected in the field for which some sort of analysis will be run. Before collecting samples, the FTL will review the proposed level of effort and coordinate a list of unique sample identification names, or sample IDs, with the PDL or EIS. The FTL will be responsible for enforcing the use of the standardized ID system and agreed upon sample IDs during all field activities.

Each sample will be uniquely identified by an alphanumeric code that will describe the sample's attributes. These attributes are facility, Area of Concern (AOC)/Site/Operable Unit (OU) number, sample/station type, sequential station number, modifier (as needed), depth (as needed), date, and date modifier (as needed). The naming scheme to be used for the identification of samples is documented in Table 3.

The standardized ID system will identify all samples collected during sampling activities. The system will provide a tracking procedure to ensure accurate data retrieval of all samples taken. For example, a surface soil sample collected from station YS30-SO391 reference above in June of 2009 will result in a sample ID of YS30-SS391-0609.

Please consult with the PDL or EIS should any questions arise. This will avoid complications that could occur if a sample is mislabelled and ensure there are unique identifiers for every sample. Required deviations to this format in response to field conditions will be documented in the field logbook.

Navy Clean		
First Segment	Second Segment	
Facility, Site Number	Station Type	Station Number, Modifier
AA,ANN	AA	NNN _A
Notes: "A" = alphabetic "N" = numeric		
<u>Facility:</u> A = ABL AN = Anacostia BA = Bainbridge BW = Bloodsworth Island BR = Bremerton CA = Cheatham Annex CH = Cherry Point CI = Craney Island CL = Camp Lejeune CP = Camp Peary CR = Carderock DA = Dahlgren DN = Dam Neck DR = Driver IH = Indian Head LS = Little Creek NA = Naval Academy NB = Naval Station Norfolk NM = NNMC (Bethesda Naval Hospital) NN = Norfolk Naval Shipyard NR = Naval Research Laboratory NWA = Northwest Annex OC = Oceana PA = Pax River PI = Pineros Islands QU = Quantico RO = Rota RR = Roosevelt Roads SI = Sigonella SJ = St. Juliens SS = Sabana Seca VE = Vieques East VW = Vieques West WN = Washington Navy Yard WO = White Oak Y = Yorktown <u>Site/AOC/SWMU Number - Sequential Number:</u> Site = S01, S02, S03... Site Screening Area = SA01, SA02, SA03... AOC = A01, A02, A03... AOI = AI01, AI02, AI03... SWMU = W01, W02... Building = B01, B02, B03... Range = R01, R02... LIA - LI Area, East Vieques BSxx = Background locations outside of site (BS25 = Background Site 25) BKL = Background locations outside of the facility BKG = Background locations (inside base) <u>QC and IDW Stations</u> Site ID (First Segment) followed by -QC or -IDW	<u>Station Type:</u> AGT = Above Ground Tank AS = Ash BH = Borehole CO = Concrete DP = Direct Push DR = Drill Rig EW = Extraction Well FG = Frog FS = Fish GB = Geotechnical Boring GP = Geoprobe GV = Gas Vent HP = Holding Pond/Lagoon IDW = Investigative Derived Waste IW = Injection Well LW = Leach Well MA = Alluvial Monitoring Well MB = Bedrock Monitoring Well MU = UST Monitoring Well MW = Monitoring Well (GW for Y) PC = Paint Chip PW = Production Well QC = Quality Control RK = Rock RC = Recovery Well RM = Remediation Well RW = Residential Well SD = Sediment Location SG = Soil Gas SL = Storm Sewer Line Sediment SO = Soil Location SP = Seep ST = Storm Water SU = Sump SV = Soil Vapor SW = Surface Water SWS = Surface Water Body (for SW and SD) UST = Underground Storage Tank TA = Tap Water TD = Tidal Station TI = Tissue Sample (general) TO = Tadpole TP = Test Pit TR = Trench Sediment TS = Treatment System TW = Temporary Well WA = Alluvial Extraction Well WB = Bedrock Extraction Well WL = Water Supply Well WN = Pore Water WP = Wipe Sample WT = Water Table Piezometer <u>Station Number:</u> Sequential Station Number (i.e., 01, 02, 03...)	<u>Modifier (used selectively):</u> D = Deep monitoring well S = Shallow monitoring well
<u>Example Station IDs:</u> YS01-DP02 = Direct push soil location #2 at Yorktown Naval Weapons Station Site 1 CHR05-MW02S = Shallow monitoring well location 2, at the Cheatham Annex facility, Range 5. NMBKL-SD02 = Background sediment location #2 located outside of NNMC CHBS03-SO05 = Soil location #5, located in reference area outside of Site 3 in Cherry Point VEW04-QC = QC Station at East Vieques SWMU-4 CAA08-IDW = IDW Station at Cheatham Annex AOC-8		

TABLE 2
STATION ID SCHEME

Navy Clean			
First Segment	Second Segment	3rd Segment	Fourth Segment
Site ID Facility, AOC Number	Station/Sample Type, Station Number, Modifier	Depth (As Needed)	Date (MMYY) _A
AA,ANN	AANNNA	A	NNNN _A
Notes: "A" = alphabetic "N" = numeric			
<p>A = ABL AN = Anacostia BA = Bainbridge BW = Bloodsworth Island BR = Bremerton CA = Cheatham Annex CH = Cherry Point CI = Craney Island CL = Camp Lejeune CP = Camp Peary CR = Carderock DA = Dahlgren DN = Dam Neck DR = Driver IH = Indian Head LS = Little Creek NA = Naval Academy NB = Naval Station Norfolk NM = NNMC (Bethesda Naval Hospital) NN = Norfolk Naval Shipyard NR = Naval Research Laboratory NWA = Northwest Annex OC = Oceana PA = Pax River PI = Pineros Islands QU = Quantico RO = Rota RR = Roosevelt Roads SI = Sigonella SJ = St. Juliens SS = Sabana Seca VE = Vieques East VW = Vieques West WN = Washington Navy Yard WO = White Oak Y = Yorktown</p> <p><u>Site/AOC/SWMU - Sequential Number:</u> Site = S01, S02, S03... Site Screening Area = SA01, SA02, SA03... AOC = A01, A02, A03... AOI = AI01, AI02, AI03... SWMU = W01, W02... Building = B01, B02, B03... Range = R01, R02... LIA - LI Area, East Vieques</p> <p>BSxx = Background locations outside of site (BS25 = Background Site 25) BKL = Background locations outside of the facility BKG Background locations (inside base)</p>	<p><u>Sample Type:</u> AGT = Above Ground Tank AH = Air - Headspace AS = Ash BH = Borehole CO = Concrete DR = Drill Rig DS = Direct Push - Soil DW = Direct Push - Groundwater EW = Extraction Well FG = Frog FS = Fish GB = Geotechnical Boring GP = Geoprobe GV = Gas Vent HP = Holding Pond/Lagoon IW = Injection Well LF = Free Product LW = Leach Well MA = Alluvial Monitoring Well MB = Bedrock Monitoring Well MU = UST Monitoring Well MW = Monitoring Well (GW for Y) PC = Paint Chip PW = Production Well RK = Rock SW = Surface Water RC = Recovery Well RM = Remediation Well RW = Residential Well SB = Subsurface Soil SD = Sediment Location SG = Soil Gas SL = Storm Sewer Line Sediment SO = Soil Location (Composite) SP = Seep SS = Surface Soil SSD = Subsurface Sediment ST = Storm Water SU = Sump SV = Soil Vapor SW = Surface Water UST = Underground Storage Tank TA = Tap Water TD = Tidal Station TI = Tissue Sample (general) TO = Tadpole TP = Test Pit TR = Trench Sediment TS = Treatment System TW = Temporary Well WA = Alluvial Extraction Well WB = Bedrock Extraction Well WL = Water Supply Well WN = Pore Water WP = Wipe Sample WT = Water Table Piezometer</p> <p><u>Station Number:</u> Sequential Number (e.g., 001, 002, 003)</p> <p><u>Modifier (used selectively):</u> D = Deep monitoring well S = Shallow monitoring well P = Duplicate</p>	<p><u>Depth:</u> Use only if applicable. A sequential letter is used to reflect varying depths, as actual depths can change in the field after sample planning has occurred. E.g. A, B, C...</p> <p><u>Sample Number:</u> 1. Duplicate Samples - Use a 'P' modifier in the second segment of the sample ID, directly after the location number to indicate a duplicate sample. E.g. AB01-MW11P-0506 2. MS/MSD Samples - Append a modifier of '-MS' for matrix spike or '-SD' for matrix spike duplicate to the end of the sample ID. 3. QC & IDW Samples (Blank Samples & Waste Char.) - Format consists of Facility, AOC Number, Qualifier Code, Sequential Qualifier Number-Date (AAANN-AANN-MMDDYY). E.g. LSA05-TB02-061106</p> <p><u>Qualifier Codes:</u> TB = Trip Blank FB = Field Blank EB = Equipment Blank WQ = Source Blank WS = Waste Char. Soil WW = Waste Char. Water</p> <p>4. Drill Rig Samples - Format consists of Facility, AOC Number, Station Type, Station Number, Date. E.g. YS12-DR02-020507 5. Multiple samples - Should multiple samples be collected from the same location in a given day/month (affects only samples not differentiated by depth), a sequential letter will be added to the end of the fourth segment (date). E.g. A, B, C...</p>	
<p><u>Example Sample IDs:</u> WNA01-MW102S-0105A = The first shallow groundwater sample collected at monitoring well location 102 in January 2005 in AOC01 at the Washington Navy Yard facility. PIW01-SW023P-0306 = Pineros Island duplicate surface water sample collected at location 23, at SMWU-1 in March 2006. SSW06-FB01-061106 = The first field blank collected on June 11, 2006 at SMWU-6 in Sabana Seca.</p>			

TABLE 3
STATION ID SCHEME

4.2.3 Sample Collection

A photocopy of each field logbook page completed during sampling and of each COC will be made by the FTL and forwarded to the EIS at predefined intervals during sampling events. This information will serve as notification to the EIS of samples being shipped to an offsite lab and of the field crew's sampling progress.

Communication with field and laboratory staff will occur daily during the field event. The EIS will resolve issues that arise in the field (i.e. bottle ware shortage, equipment failure, etc). The lab will be informed of the shipment dates and the number of coolers or samples being sent. Laboratory login reports will be reviewed to ensure samples were received in good condition (i.e. no breakage, within holding time, within designated temperature). The field crew and PM will be notified if there were problems with shipment.

4.2.4 Chain-of-Custody

A single COC number per laboratory / cooler should be generated each day (there can be multiple pages to one COC number). MSs and MSDs will be requested at a set frequency for each project (usually one per 20 samples collected). MS and MSD samples should not be taken from field duplicates (FDs) or field blanks. FDs will be requested at a set frequency for each project (usually one per 10 samples). FDs should not be taken from MSs, MSDs, or field blanks. The MS and MSD samples listed on the COC should be spiked and analyzed by the laboratory.

A 100% QC will be performed on COCs received from the field crew. The field crew and/or lab will be notified if corrections need to be made to the COCs or lab login reports. Any corrections or modifications made will be noted in a Corrections-To-File Letter.

4.2.5 Sample and Document Tracking

The STS will be updated with sample collection and tracking information, and kept current throughout the data management process. All samples collected, resulting deliverables, and deliverable dates will be tracked throughout the data management process to ensure that the project schedule is met and subcontractor invoices are evaluated correctly.

All documentation acquired during the data management process, including Statements of Work (SOWs), Bids, COCs, Field Notes, Sample Tracking Sheets, Login Reports, Corrections-to-File Letters, FDETool QC tables, Post Load Reports, Invoices, and Communication Logs shall be compiled throughout the process to be stored in the appropriate Activity's Project Notebook.

4.2.6 Field Data

Once the field data and samples are collected, necessary field measurements, such as water levels and other data collected in the field should be entered into the FDETool. Any data entered into the FDETool must be exported into an excel file to facilitate a manual QC review of the data. The correction of any anomalies should be verified with the PM and PC. The information entered into the FDETool will be linked with related analytical data reported in the SNEDD within the SVMTool. Field data and laboratory analytical data are linked by sample ID and date/time. This allows verification analytical results for all samples have been received and reported by the laboratory.

4.3 Laboratory Analysis

Figure 5 shows the laboratory analysis process. Upon receipt of samples from the field, the laboratory will verify that the COC forms correctly identify and detail all samples submitted. Each COC form must be signed with the date and time of receipt by the laboratory. Samples will be logged in by the laboratory using information from the COC forms and the project instructions.

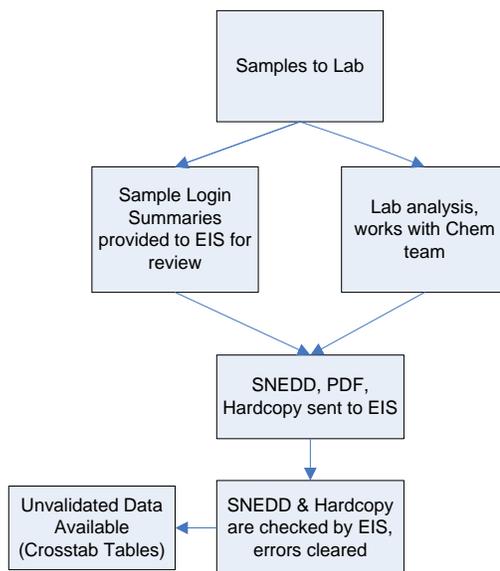


FIGURE 5
LABORATORY ANALYSIS

Samples will be analyzed as specified on the accompanying COC forms and in the Laboratory SOW. Generally, questions or noted inconsistencies identified by the laboratory should be addressed directly to the EIS. Login summaries detailing all samples and analyses received by the lab should be provided daily to the EIS for review. All discrepancies should be corrected to ensure that all samples are analyzed as per project instructions.

The SNEDD-QC-Tool is used to QC the laboratory's SNEDD. Before the laboratory analytical data is formatted into data tables or sent for validation, the laboratory SNEDD must be processed through CH2M Hill's SNEDD-QC-Tool Microsoft Access database application. The SNEDD-QC-Tool includes several automated diagnostic checks to verify format and content compliance with SNEDD specifications.

- The analytical laboratory may, at their discretion, utilize the tool to QC and correct any errors before transmitting the SNEDD to CH2M HILL. The laboratory will forward the checked SNEDD and a hard copy of the data to the EIS, who will manage the SNEDD verification process.
- Upon receipt at CH2M HILL, the EIS will check the SNEDD using the SNEDD-QC-Tool to verify correct format and content. If errors are found, the laboratory will be notified of the errors, and the SNEDD corrected.

The laboratory will attach the signed COCs to their hard copy data deliverables to officially relinquish control of the data back to the Environmental Contractor within the specified turnaround time. Data archiving forms will be generated and affixed to each laboratory report received per Sample Delivery Group (SDG) for cataloguing, tracking, and archiving purposes.

Hard copy data and SNEDDs will be reviewed to ensure that they are complete and acceptable as outlined in the Data QC Checklist. A 10% comparison between the hard copy and SNEDD content will be conducted to ensure consistency, resolve discrepancies, and document data error issues (for example, EDD re-submissions, turnaround time problems, hard copy incompleteness). All detected errors should be resolved with the laboratory.

These checks ensure the consistency and the validity of the SNEDD and hardcopy content before the data are reported in preliminary tables or sent for validation. The objective of using the SNEDD-QC-Tool is to ensure that the validation process is performed on consistently high-quality data and minimize the chance of finding data errors later in the validation process, which would require the laboratory to resend corrected data and start the validation process over again.

Preliminary raw and detects tables will be generated from data reported in the SNEDD by the Navy RD Formatting Tool – Unval/Val SNEDD. A separate table must be created for each matrix, and provided to the PM for review.

4.4 Data Validation

Once the preliminary data verification is complete, the PC is notified by the EIS that the data is available for validation. The PC will notify the data validator in advance of when to expect data and of any samples or analyses that should not be validated (i.e. grain size should not be validated). For internal data validation, the EIS will notify the PC of data availability, and provide the hardcopy data and a QC Association Table.

Upon receipt of data from CH2M HILL, data validation will be performed in accordance with the Data Validation SOW, UFP SAP, and any other documents required. Generally, questions or noted inconsistencies identified by the validator should be addressed directly to laboratory, with the PC notified of issues and resolutions identified.

4.4.1 External Data Validation

For external data validation, a copy of the SNEDD, hard copy data, and a QC Association Table will be provided to the data validator. The PC will coordinate the return of the data package to CH2M HILL for archiving with the data validator.

Data Validators will provide the following materials to the PC within the required turn around time:

- Hardcopy Data Validation Report
- Validated Version of the SNEDD (external validation)

Once returned to CH2M HILL, the SNEDD will be run through the SNEDD-QC-Tool, which includes automated diagnostic checks for validated data to verify format and content compliance with SNEDD validation specifications. The PC will review the validated data to ensure that they are complete and acceptable as outlined in the Data QC Checklist. A 100% QC

check will be performed on the validated results to ensure that the hard copy data matches the SNEDD. All detected errors should be resolved with the data validator.

Data archiving forms will be generated and affixed to each Data Validation Report per SDG received for cataloguing, tracking, and archiving purposes.

Validated raw and detects tables will be generated from data reported in the validated SNEDD by the Navy RD Formatting Tool – Unval/Val SNEDD. A separate table must be created for each matrix, and provided to the PM for review.

4.4.2 Internal Data Validation

For internal data validation, a copy of the SNEDD, hard copy data, and a QC Association Table will be provided to the PC.

The PC will evaluate QC information, associated validation logic, and apply qualifiers to data in the SNEDD and on the laboratory Form Is when QC criteria are not achieved. Qualifier criteria will be based on the Quality Assurance Project Plan. A hardcopy data validation report will be generated. Data archiving forms will be generated and affixed to each Data Validation Report per SDG validated for cataloguing, tracking, and archiving purposes

Validated raw and detects tables will be generated from data reported in the validated SNEDD by the Navy RD Formatting Tool – Unval/Val SNEDD. A separate table must be created for each matrix, and provided to the PM for review.

4.4.3 Unvalidated Data Preload Check

Occasionally, unvalidated data will need to be loaded into the database. Although the data will not be validated, it will undergo a basic Preload Check by the PC to ensure laboratory compliance with project guidelines and determine results to be reported as the best result where multiple runs were conducted for a given sample/analysis. The PCL will provide input and oversight to ensure that data flags are applied correctly by the PC.

4.4.4 Senior Review

The PCL will verify that the final SNEDD and hardcopy data are complete and acceptable. Any identified discrepancies will be resolved with the assistance of the PC, EIS, laboratory, or validator as needed.

4.5 Data Preparation and Loading

Once the data are considered final and approved by the PCL, they are exported from the SNEDD to the project Data Warehouse. Field and laboratory data are merged into a format that is amenable to the warehouse. The backbone is a SQL-server-based data warehouse.

4.5.1 Data Preparation

As part of the normal process of loading data into the warehouse, data standardization tasks must be completed. A Database Specialist (DBS) will load data into the warehouse using the following three programs: SNEDD-QC-Tool, SVMTool and CH-IMPTool.

A final QC of the data reported in the SNEDD is conducted with the SNEDD-QC-Tool. Any identified discrepancies will be resolved with the assistance of the PCL, PC, or EIS as needed.

SNEDDs that pass all of the QA/QC checks in the SNEDD-QC-Tool are then processed with the SVMTool.

The SVMTool links the field data contained in the FDETool to the analytical data contained in the SNEDD. A series of logical QC checks are run to ensure that all data links correctly minimum data requirements are met. The tool then merges the data into a format compatible with the data warehouse structure.

4.5.2 Data Loading

CH2M HILL Loading

The CH-IMPTool runs an additional series of QC checks and adds project-specific formatting, and loads the data into the warehouse. The following tasks need to be completed to load the data for project use:

- **Unit Standardization:** Analytical units and the associated results, reporting limits, and method detection limits will need to be converted to a consistent set of units as required by the project.
- **Resolve Reanalysis and Dilutions:** All samples that had an associated reanalysis or dilution run by the laboratory must have all of the excluded or rejected results marked as not the best result for reporting.
- **Resolve Analytical Overlap and Split Samples:** Analytical overlap occurs when a sample is analyzed by two or more methods that report the same analyte. To resolve any issues not previously resolved, the following logic is used to select the usable result:
 - If the overlapping results are all non-detections, the lowest non-detection result is selected.
 - If the overlapping results are all detected, the highest detected result is selected.
 - If the overlapping results consist of a mixture of detections and non-detections, the highest detected result is selected.

When data are loaded into the warehouse, an automated script will run to identify the “best” result when more than one analytical result exists.

NIRIS Loading

All Navy CLEAN and Joint Venture data must be loaded into NIRIS. Following the successful loading of data into the data warehouse, the DBS will use the FDETool and ALPTool to generate project NIRIS Electronic Data Deliverables (NEDD) files. Field-related NEDDs will be generated from the final version of the FDETool. The final version of the project SNEDD will be processed through the ALPTool to generate the analytical NEDD.

The DBS will use NIRIS’s Data Checker Loader Tool to QC and submit the project NEDD files into NIRIS. The NIRIS Regional Database Manager (RDM) will load the data into NIRIS, and will work with the DBS to resolve any potential issue that may arise during loading. Following notification of successful data loading from the RDM, the DBS will query the data from NIRIS for review to ensure data integrity and accuracy.

4.5.3 Data Warehouse

The data warehouse is a Microsoft SQL Server 2005 relational database. This database, and all other “CH” tools used, has a data structure designed to achieve compliance with the Environmental Restoration Program Information Management System (ERPIMS) standard specified by Air Force Center for Engineering and the Environment (AFCEE). ERPIMS is an effective, comprehensive standard for environmental management.

The warehouse will use valid value tables when applying reference attributes to project data. Such reference data include the names of site objects and sampling locations, sampling matrix and method categories, analyte names, units. These reference tables are critical for maintaining the completeness and accuracy of data sets and are essential for accurate querying of the data.

Data are loaded and stored so that relationships among categories of data are enforced. For instance, all sampling records must be associated with a valid site object such as a planned sediment sampling location. The project repository database and collection, analysis, and reporting tools used in the DBMS are designed to enforce, for any project data record, entries in fields that refer to other types of data as required by the overall data model.

4.6 Data Reporting

Data reporting includes the following tasks:

- Retrieving data from the data warehouse for project deliverables, data visualization, or consumption by third parties
- Reviewing initial data and producing data queries and draft reports to dissect and disassemble the data
- Producing any requested client and regulatory agency data deliverables

Data for project deliverables, data visualization, or consumption by third parties will be retrieved from the warehouse, and will be equivalent to the real-time state of the project repository database. PMs and GIS Analysts (GAs) will work with the EIS and PCL for quality queries and data for reports.

4.6.1 Tables, Figures, and Diagrams

Once the data have been sufficiently analyzed, the list of requested data reports (tables, figures, diagrams) can be developed and finalized by the project team and submitted to the PCL and PM for review.

All requests for figures or graphics are to be directed to the GA assigned as the Point of Contact (POC) for that particular Navy installation. All requests for analytical data (crosstab tables, data dumps, third party deliverables etc) should be directed to the EIS assigned as the POC for that particular Navy installation. The EIS will generate a data deliverable from the data warehouse or NIRIS (as needed) suitable for end use and will provide data support to the end user. All requests for data statistics and calculations should be directed to the Risk Assessor assigned to the project.

4.6.2 GIS

The Navy CLEAN program will utilize ESRI's suite of GIS software for the majority of GIS-related tasks. The GIS data model will consist of one or more geodatabases (GDBs) per installation. Each installation will maintain one common installation GDB, which will store the common infrastructure data such as buildings, roads, topography, hydrography, utilities, etc. The common installation GDB should adhere, as much as possible, to the Spatial Data Standards for Facilities, Infrastructure, and Environment (SDSFIE) data model. All project specific GDBs shall be developed and named for ease of interpretation by the GA.

All station location information for each installation will be pulled directly from the data warehouse and stored in the common installation GDB as a data table. The data warehouse must contain valid coordinate information for the locations to be displayed correctly. Valid coordinate information will be maintained in the data warehouse by the EIS, and updated as necessary by the DBS.

ESRI's ArcMap 9.3 (or the latest version available) will be utilized for spatially displaying the environmental data within maps and figures, as well as for spatial analysis. The GA will need to coordinate efforts with the EIS on all requests that require the display of environmental sample data on a map to ensure that the appropriate data is queried from the data warehouse and linked to the appropriate station location table within the GIS.

4.6.3 Site Information Management System

This is currently not being used on the Navy CLEAN and Joint Venture Programs.

SIMS is a tool for publishing data of sufficient quality from the project. However, the project data warehouse will remain the database of record for the project.

SIMS provides many standard report formats, all of which are used in conjunction with the Query Tool feature, to isolate and retrieve information. Users can generate and save their queries using a graphical point-and-click tool. Reports in a wide variety of formats also can be requested and produced.

4.6.4 Legacy Data

Legacy data are those collected from any contractor other than CH2M HILL and data collected by CH2M HILL that have not been managed in accordance with Navy CLEAN and Joint Venture Program requirements. Legacy data are commonly compiled from various electronic and hard copy sources including spreadsheets, databases, technical reports, and laboratory hard copy data reports. When working with legacy data, usability assessment must be completed for the project team to be able to use the data with confidence. In order to assess the data properly, the legacy data needs to be evaluated by skilled professionals that are familiar with the type of data being evaluated so that any errors identified in the data can be corrected when possible or qualified in a manner to reflect the limitations of the data's use.

The PM has overall responsibility for the selection for inclusion of legacy data into the data management process. The PDL and PCL will work with the PM to establish the data review and import process, compile a comprehensive data inventory, and identify staff to facilitate data review.

The PDL and PCL will work with the EIS to determine the appropriate intermediary files and tools used to collect the data. The PDL and PCL will oversee the data review and flagging process and approve the data for upload into the Data Warehouse. The EIS is responsible for assembling the field and laboratory data in formats that facilitate data review, aid the PDL and PCL in overseeing the data review and flagging process, schedule, conversion of the data to the proper data warehouse format, and then loading the data into the Data Warehouse after approval by the PDL and PCL.

The GA, PDL, PCL, and PM have the primary responsibility for reviewing the data in their area of expertise and providing the PCL with data usability flags to be associated with each record.

SECTION 5

Project Closeout

The project completion/closeout phase includes the following:

- Archive hard copy and electronic documents
- Conduct project closeout meeting

5.1 Archive Procedures

A large variety of technical data will be generated during the field investigations. The EIS and PC will collect all hard copy and electronic data they are responsible for and verify that the incoming records are legible and in suitable condition for storage. Record storage will be performed in two stages:

- Storage during the project
- Permanent storage following project completion

During the project, CH2M HILL will store data hardcopy reports in CH2M HILL offices. Physical records will be secured in steel file cabinets or shelves, and labelled with the appropriate project identification. Electronic data will be maintained on CH2M HILL's corporate local area network servers.

Information generated from field activities will be documented on appropriate forms and will be maintained in the project file. These include COC records, field logbooks, well construction forms, boring logs, location sketches, and site photographs. In addition, notes from project meetings and telephone conversations will be filed.

Following project completion, both hard copy and electronic data deliverables will be archived. Team staff will provide all hard copies of laboratory and validation reports to the Data Closeout Coordinator to be prepped and shipped to Stone Mountain for archiving. Final laboratory SNEDDs and loading files will be provided to the PDL, to be archived on CH2M HILL's corporate local area network servers.

Any modifications made to the tools will be communicated to the project team via e-mail. As revisions are finalized, they will be distributed electronically to all users. After revision, it is the user's responsibility to conform to revised portions of the DMP.

5.2 Invoice Review and Approval

The EIS is responsible for tracking all data deliverables throughout the data management process to ensure that the project schedule is maintained, subcontractors comply with all required turn around times, and data provided are complete and acceptable. Following project completion, EISs are to review and provide comments on all laboratory and data validator invoices regarding data quality and schedule compliance prior to approval by the PM.

5.3 Project Closeout

At the end of each project, the PM will notify team staff of project closeout. The PM will coordinate and verify that all pertinent data has been archived. The PM may also review lessons learned, suggest process improvements, or revisions to the DMP and other project documentation as deemed necessary.

Appendix A

Environmental Data Management Work Process

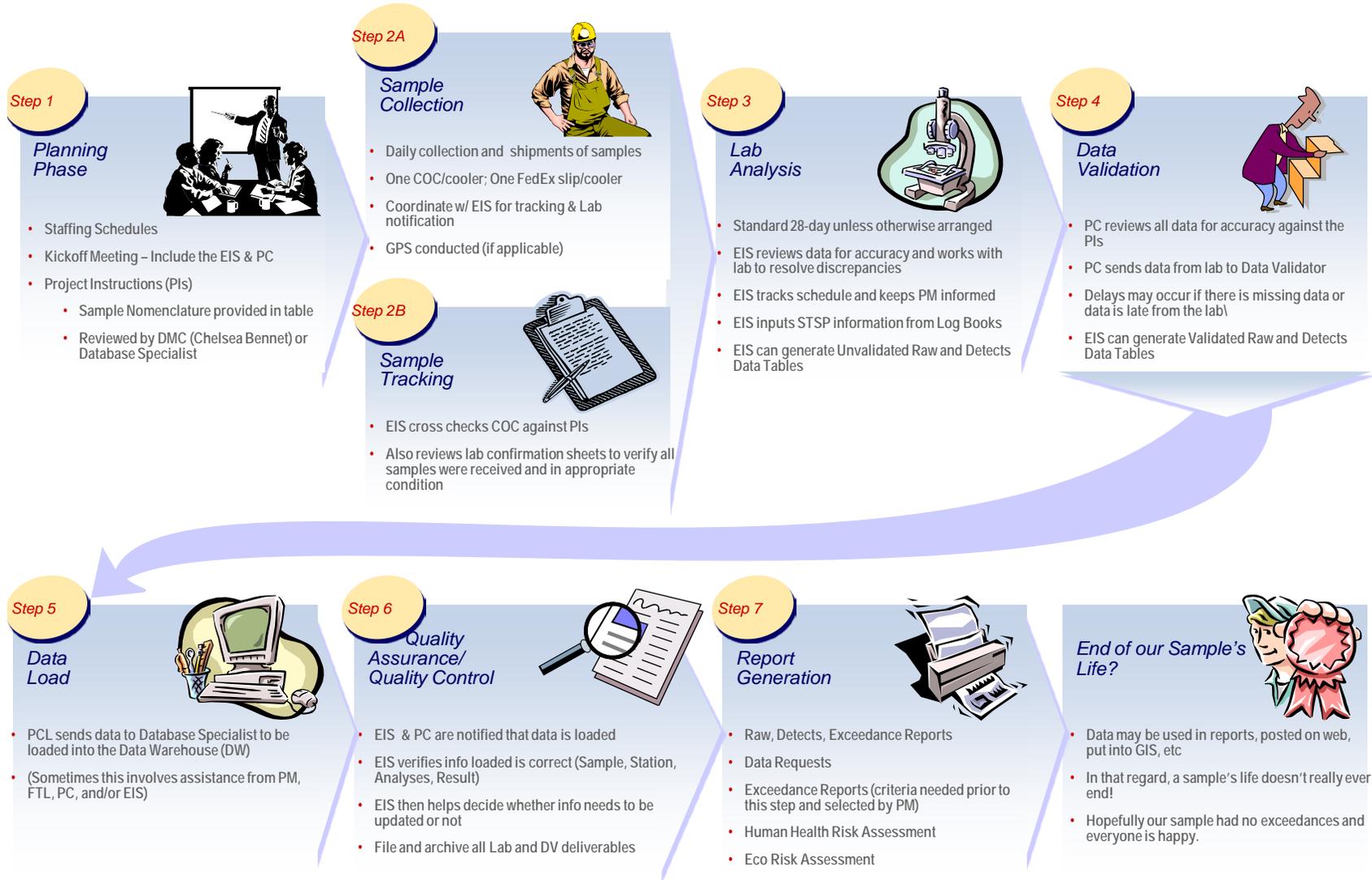
Environmental Data Management Work Process

1.0 Project Planning & Setup	2.0 Sample Collection & Management	3.0 Lab Analysis	4.0 Data Validation	5.0 Data Management	6.0 Data Evaluation & Reporting
1.1 Project Setup	2.1 Sample Management	3.1 Sample Analysis	4.1 Internal Chemical Data Validation	5.1 CH2M HILL Data	6.1 Data Prep & Processing for Reporting
1.2 QAPP, SAP, DMP, DQOs Integration	2.2 Sample Collection	3.2 EDD Management	4.2 External Chemical Data Validation	5.2 Other Contractor & Legacy Data	6.2 Tabular Data Queries & Reports
1.3 Laboratory Setup	2.3 Sample Data Management	3.3 Hard Copy Management	4.3 Senior Review of Validated Data	5.3 Database Maintenance & Administration	6.3 Field Logs and Graphs
1.4 Database Setup					6.4 GIS Queries and Maps

Appendix B
Life of a Sample

A Sample's Life

Step-by-Step Outline of Navy CLEAN and JV Data Management Process, and Roles & Responsibilities



Appendix C
Standard Operating Procedures

Checklist - Archive and NIRIS Load Prep
Checklist - Data QC
Checklist - EIS Project Start-up Questions
Checklist - Generating RDE Tables
Checklist - Historic Data Cleanup
Checklist - SNEDD DM Process
Roles - Data Management Coordinator
Roles - EIS
Roles - Project Manager
Template - STS & QC Association Table
SOP-114 - CHIMPTool
SOP-126 - XTab Reports Tool
SOP - Access to NIRIS
SOP - Cherry Point Exceedance Formatting Wizard
SOP - CLEAN SNEDD Loading with CHIMPTool
SOP - Corrections to File
SOP - Data Archiving Procedures
SOP - Data Shipping
SOP - FDET
SOP - FDET Setup
SOP - NIRIS Importer Validator Tool
SOP - SVMTool
SOP - Valid Value Setup

Appendix D

Electronic Data Deliverable Specifications

CH2M HILL SNEDD Format

Field Name	Field Format	REQ	Field Description
Contract_ID	A13	R	Contract ID assigned by Division Contracting Office, not including dashes. Found on Statement of Work. (e.g. D459559365800)
DO_CTO_Number	A4	R	CTO or TO # assigned by Navy. (e.g. CTO-12 = 0012, TO-54 = TO54)
Phase	A8	NR	Task Phase, SubTask Number or Annual Quarter. (e.g. QTR1)
Installation_ID	A20*	R	Unique identifier for installation. (e.g. WHIDBEY)
Sample_Name	A50	R	CH2M HILL Sample ID (from Chain Of Custody).
CH2M_Code	A4*	R	CH2M HILL Preparation Method Code (e.g. NONS)
Analysis_Group	A9*	R	The CH2M HILL code for the analysis performed on the sample.
Analytical_Method	A20*	R	Analytical Method used to analyze sample fraction. (e.g. 6010)
PRC_Code	A15*	R	NIRIS code for the analytical method category (e.g. PCHAR)
Lab_Code	A10*	R	CH2M HILL Code assigned to the laboratory (e.g. COMP)
Lab_Name	A50*	R	The name of the laboratory that conducted the analysis, in all CAPS.
Leachate_Method	A16*	RA	Code for the leachate method used on sample. (e.g. SW1310)
Sample_Basis	A16*	R	Sample basis of analysis; wet weight, dry weight etc. (e.g. DRY)
Extraction_Method	A16*	RA	Code for the extraction method used on sample. (e.g. FLTRES)
Result_Type	A16*	R	Type of results; dilution, reanalysis etc. (e.g. 000)
Lab_QC_Type	A15*	R	Code for Laboratory Sample (MS, MSD, LBLK, LCS)
Sample_Medium	A16*	R	Sample medium reported by the laboratory. (e.g. L)
QC_Level	A16*	R	QC Level of data package : EPA levels I to IV. (e.g. 3)
DateTime_Collected	MM/DD/YYYY 00:00	R	Date and time sample was collected. Use 24 hour clock. (e.g. 02/13/2007 15:34)
Date_Received	MM/DD/YYYY	R	The date the sample was received in the lab (in 10 characters). (e.g. 03/24/2007)
Leachate_Date	YYYYMMDD	RA	Date the sample was leached. Req'd if sample was leached and/or Leachate Method provided. (e.g. March 12, 2007 = 20070312)
Leachate_Time	HH:MM:SS	RA	Time the sample was leached. Use 24 hour clock, with 8 characters. (e.g. 14:30:05). Req'd if sample was leached and/or Leachate Method provided.
Extraction_Date	YYYYMMDD	RA	Date that the lab extracted the sample. Req'd if Extraction Method provided.
Extraction_Time	HH:MM:SS	RA	Time of day lab extracted the sample. Use 24 hour clock, with 8 characters. Req'd if Extraction Method provided. (e.g. 02:15:00)
Analysis_Date	YYYYMMDD	R	Date that the lab performed the analysis.
Analysis_Time	HH:MM:SS	R	Time of day that the lab extracted the sample. Use 24 hour clock, with 8 characters.
Lab_Sample_ID	A20	R	Unique ID assigned to the sample by the laboratory.
Dilution	N10,2	R	Dilution factor used. Default value is 1 (e.g. 10)

CH2M HILL SNEDD Format

Field Name	Field Format	REQ	Field Description
Run_Number	N4	R	Number distinguishing multiple or repeat analyses by the same method (incl. RA, RE, DL, etc). Must be equal to or greater than 1.
Percent_Moisture	N6,3	RA	Percent moisture of the sample. (e.g. 20)
Percent_Lipid	N6,3	RA	Percent lipid of the sample.
Chem_Name	A55*	R	The name of the compound being analyzed.
Analyte_ID	A20*	R	Analyte ID (CAS Number) assigned to the analyte. (e.g. 7440-47-3)
Analyte_Value	N18,7	R	Leave Blank for Validator to enter the final analyte concentration.
Original_Analyte_Value	N18,7	R	Analyte concentration value originally generated by the Laboratory.
Result_Units	A16*	R	Unit of measure for the analyte value. (e.g. UG_L)
Lab_Qualifier	A16*	RA	Lab data qualifier. Values will not be rejected if not in domain table.
Validator_Qualifier	A16*	RA	Leave blank for Validator. Values will not be rejected if not in domain table.
GC_Column_Type	A16*	RA	Data code for the type of GC column used in an analysis.
Analysis_Result_Type	A4*	R	Type of analysis performed (allowed: SURR or TRG).
Result_Narrative	A120	RA	Additional information or comments associated with the result.
QC_Control_Limit_Code	A16*	RA	Type of quality control limit. Req'd if QC criteria and upper/lower accuracy included. (e.g. CLPA)
QC_Accuracy_Upper	N6,3	RA	Upper QC limit of % recovery as measured for a known target analyte spiked into a QC sample. (e.g. 25.45)
QC_Accuracy_Lower	N6,3	RA	Lower QC limit of % recovery as measured for a known target analyte spiked into a QC sample. (e.g. 10.15)
Control_Limit_Date	YYYYMMDD	RA	Date a control limit is established.
QC_Narrative	A120	RA	Leave blank for Validator. Enter DV_Qual_Code.
MDL	N18,7	RA	Method Detection Limit
Detection_Limit	N18,7	RA	Reported Detection Limit
SDG	A50	R	Lab code for a group of samples in a data deliverable package.
Analysis_Batch	A20	R	Laboratory code for a batch of analyses analyzed together.
Validator_Name	A50*	R	Leave Blank. Name of Validator in all CAPS. (e.g. CONTRACTOR INC.)
Val_Date	YYYYMMDD	RA	Populated by Validator/Reviewer. Validation/Review QC date.

Appendix C
Laboratory DoD ELAP Letter



The American Association for Laboratory Accreditation

World Class Accreditation

Accredited DoD ELAP Laboratory

A2LA has accredited

ENVIRONMENTAL CONSERVATION LABORATORIES - ORLANDO

Orlando, FL

for technical competence in the field of

Environmental Testing

In recognition of the successful completion of the A2LA evaluation process that includes an assessment of the laboratory's compliance with ISO/IEC 17025:2005, the 2003 NELAC Chapter 5 Standard, and the requirements of the Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in the DoD Quality Systems Manual for Environmental Laboratories (QSM v4.1); accreditation is granted to this laboratory to perform recognized EPA methods as defined on the associated A2LA Environmental Scope of Accreditation. This accreditation demonstrates technical competence for this defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009).



Presented this 29th day of March 2010.

A handwritten signature in black ink, appearing to read "Peter Meyer".

President & CEO
For the Accreditation Council
Certificate Number 3000.01
Valid to March 31, 2012

For the tests or types of tests to which this accreditation applies, please refer to the laboratory's Environmental Scope of Accreditation.



SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005

ENVIRONMENTAL CONSERVATION LABORATORIES – ORLANDO
 10775 Central Port Drive
 Orlando, FL 32824
 Dorian Pearson-Shaver Phone: 407 826 5314
 dpearsonshaver@encolabs.com

ENVIRONMENTAL

Valid To: March 31, 2012

Certificate Number: 3000.01

In recognition of the successful completion of the A2LA evaluation process, (including an assessment of the laboratory's compliance with ISO IEC 17025:2005, the 2003 NELAC Chapter 5 Standard, and the requirements of the DoD Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in the DoD Quality Systems Manual for Environmental Laboratories (DoD QSM v4.1)) accreditation is granted to this laboratory to perform recognized EPA methods using the following testing technologies and in the analyte categories identified below:

Testing Technologies

Analyte / Parameter	Non-Potable Water	Solid Hazardous Waste
<u>Metals</u>	EPA 6020A/200.8	EPA 6020A
Aluminum	EPA 6020A/200.8	EPA 6020A
Antimony	EPA 6020A/200.8	EPA 6020A
Arsenic	EPA 6020A/200.8	EPA 6020A
Barium	EPA 6020A/200.8	EPA 6020A
Beryllium	EPA 6020A/200.8	EPA 6020A
Cadmium	EPA 6020A/200.8	EPA 6020A
Calcium	EPA 6020A/200.8	EPA 6020A
Chromium	EPA 6020A/200.8	EPA 6020A
Cobalt	EPA 6020A/200.8	EPA 6020A
Copper	EPA 6020A/200.8	EPA 6020A
Hardness	SM 2340 B	-----
Iron	EPA 6020A/200.8	EPA 6020A
Lead	EPA 6020A/200.8	EPA 6020A
Magnesium	EPA 6020A/200.8	EPA 6020A
Manganese	EPA 6020A/200.8	EPA 6020A
Mercury	EPA 245.1/7470A	EPA 7471B
Molybdenum	EPA 6020A/200.8	EPA 6020A
Nickel	EPA 6020A/200.8	EPA 6020A
Potassium	EPA 6020A/200.8	EPA 6020A
Selenium	EPA 6020A/200.8	EPA 6020A
Silver	EPA 6020A/200.8	EPA 6020A

Peter Shaver

Analyte / Parameter	Non-Potable Water	Solid Hazardous Waste
Sodium	EPA 6020A/200.8	EPA 6020A
Thallium	EPA 6020A/200.8	EPA 6020A
Tin	EPA 6020A/200.8	EPA 6020A
Titanium	EPA 6020A/200.8	EPA 6020A
Vanadium	EPA 6020A/200.8	EPA 6020A
Zinc	EPA 6020A/200.8	EPA 6020A
<u>Microbiology</u>		
Total Coliforms	SM 9222B	-----
Fecal Coliforms	SM 9222D	-----
<u>General Chemistry</u>		
Acidity, as CaCO ₃	EPA 305.1/SM 2310 B (4A)	-----
Alkalinity as CaCO ₃	EPA 310.1/SM 2320 B	EPA 310.1/SM 2320 B
Alkalinity as CaCO ₄	EPA 310.2	EPA 310.2
Ammonia as N	-----	EPA 350.1
Biochemical oxygen demand	EPA 405.1/SM 5210 B	-----
Bromide	EPA 300.0/9056A	EPA 9056A
Carbonaceous BOD (CBOD)	SM 5210 B	-----
Chemical oxygen demand	EPA 410.4	-----
Chloride	EPA 300.0/9056A	EPA 9056A
Chromium VI	EPA 7196/ SM 3500-Cr D	EPA 7196
Conductivity	EPA 120.1	-----
Cyanide	EPA 335.2/SM 4500-CN E	EPA 9014
Ferric iron (calculated)	SM 3500-Fe D	-----
Ferrous iron	SM 3500-Fe D	-----
Fluoride	EPA 300.0/9056A	EPA 9056A
Hardness	EPA 130.2/SM 2340 C	-----
Kjeldahl nitrogen -total	EPA 351.2	EPA351.2
Nitrate as N	EPA 300.0/353.1/9056A	EPA 353.1/9056A
Nitrate-nitrite	EPA 300.0/353.1/9056A	EPA 353.1/9056A
Nitrite as N	EPA 300.0/354.1/9056A/SM 4500-NO ₂ B	EPA 9056A/ SM 4500-NO ₂ B
Organic nitrogen	EPA 351.2/350.1	EPA 351.2/350.1
Orthophosphate as P	EPA 365.1	-----
Orthophosphate as P	EPA 365.3	-----
pH	EPA 150.1/9040C/SM 4500-H ⁺ -B	EPA 9040C
Phosphorus, total	EPA 365.4	EPA 365.4
Residue-filterable (TDS)	SM 2540 C	-----
Residue-nonfilterable (TSS)	SM 2540 D	-----
Residue-total	SM 2540 B/SM 2540 G/EPA 160.3	SM 2540G/EPA 160.3
Residue-volatile	EPA 160.4	EPA 160.4
Sulfate	EPA 300.0/9056A	EPA 9056A
Sulfide	EPA 376.1/SM 4500-S E	-----
Surfactants -MBAS	SM 5540 C	-----
Total nitrate-nitrite	EPA 9056 A/SM 4500-NO ₃ H	EPA 9056 A/SM 4500-NO ₃ H
Total cyanide	EPA 9014	EPA 9014
Total nitrogen	TKN + Total nitrate-nitrite	TKN + Total nitrate-nitrite
Total Organic Carbon	EPA 9060A/SM 5310B	TOC Walkley Black
Total phenolics	EPA 420.1	EPA 420.1
Total, fixed, and volatile residue	SM 2540 G	SM 2540 G
Turbidity	EPA 180.1	-----

Peter Blayze

Analyte / Parameter	Non-Potable Water	Solid Hazardous Waste
Un-ionized ammonia	DEP SOP 10/03/83	DEP SOP 10/03/83
<u>Extractable Organics</u>		
1,2,4-Trichlorobenzene	EPA 8270D/625	EPA 8270D
1,2,4,5-Tetrachlorobenzene	EPA 8270D/625	EPA 8270D
1,2-Dichlorobenzene	EPA 8270D/625	EPA 8270D
1,3-Dichlorobenzene	EPA 8270D/625	EPA 8270D
1,4-Dichlorobenzene	EPA 8270D/625	EPA 8270D
2,3,4,6-Tetrachlorophenol	EPA 8270D/625	EPA 8270D
2,4,5-Trichlorophenol	EPA 8270D/625	EPA 8270D
2,4,6-Trichlorophenol	EPA 8270D/625	EPA 8270D
2,4-Dichlorophenol	EPA 8270D/625	EPA 8270D
2,4-Dimethylphenol	EPA 8270D/625	EPA 8270D
2,4-Dinitrophenol	EPA 8270D/625	EPA 8270D
2,4-Dinitrotoluene (2,4-DNT)	EPA 8270D/625/ Scan-Sim	EPA 8270D
2,6-Dinitrotoluene (2,6-DNT)	EPA 8270D/625	EPA 8270D
2-Chloronaphthalene	EPA 8270D/625	EPA 8270D
2-Chlorophenol	EPA 8270D/625	EPA 8270D
2-Methyl-4,6-dinitrophenol	EPA 8270D/625	EPA 8270D
2-Methylnaphthalene	EPA 8270D/625	EPA 8270D
2-Methylphenol (o-Cresol)	EPA 8270D/625	EPA 8270D
2-Nitroaniline	EPA 8270D/625	EPA 8270D
2-Nitrophenol	EPA 8270D/625	EPA 8270D
3,3'-Dichlorobenzidine	EPA 8270D/625	EPA 8270D
3/4-Methylphenols (m/p-Cresols)	EPA 8270D/625	EPA 8270D
3-Nitroaniline	EPA 8270D/625	EPA 8270D
4-Bromophenyl phenyl ether	EPA 8270D/625	EPA 8270D
4-Chloro-3-methylphenol	EPA 8270D/625	EPA 8270D
4-Chloroaniline	EPA 8270D/625	EPA 8270D
4-Chlorophenyl phenyl ether	EPA 8270D/625	EPA 8270D
4-Nitrophenol	EPA 8270D/625	EPA 8270D
Acenaphthene	EPA 8270D/625	EPA 8270D
Acenaphthylene	EPA 8270D/625	EPA 8270D
4-Methylphenol (p-Cresol)	EPA 8270D/625	EPA 8270D
4-Nitroaniline	EPA 8270D/625	EPA 8270D
Acetophenone	EPA 8270D/625	EPA 8270D
Anthracene	EPA 8270D/625/ Scan-Sim	EPA 8270D
Atrazine	EPA 8270D/625	EPA 8270D
Benzaldehyde	EPA 8270D/625	EPA 8270D
Benzidine	EPA 8270D/625/ Scan-Sim	EPA 8270D
Benzo(a)anthracene	EPA 8270D/625/ Scan-Sim	EPA 8270D
Benzo(a)pyrene	EPA 8270D/625/ Scan-Sim	EPA 8270D
Benzo(b)fluoranthene	EPA 8270D/625/ Scan-Sim	EPA 8270D
Benzo(g,h,i)perylene	EPA 8270D/625/ Scan-Sim	EPA 8270D
Benzo(k)fluoranthene	EPA 8270D/625/ Scan-Sim	EPA 8270D
1,1-Biphenyl	EPA 8270D/625	EPA 8270D
bis(2-Chloroethoxy) methane	EPA 8270D/625	EPA 8270D
bis(2-Chloroethyl) ether	EPA 8270D/625	EPA 8270D
bis(2-Chloroisopropyl) ether (2,2'-Oxybis(1-chloropropane))	EPA 8270D/625	EPA 8270D
bis(2-Ethylhexyl) phthalate (DEHP)	EPA 8270D/625	EPA 8270D



Analyte / Parameter	Non-Potable Water	Solid Hazardous Waste
Butyl benzyl phthalate	EPA 8270D/625	EPA 8270D
Caprolactam	EPA 8270D/625	EPA 8270D
Carbazole	EPA 8270D/625	EPA 8270D
Chrysene	EPA 8270D/625/ Scan-Sim	EPA 8270D
Dibenz(a,h)anthracene	EPA 8270D/625/ Scan-Sim	EPA 8270D
Dibenzofuran	EPA 8270D/625	EPA 8270D
Diethyl phthalate	EPA 8270D/625	EPA 8270D
Dimethyl phthalate	EPA 8270D/625/ Scan-Sim	EPA 8270D
Di-n-butyl phthalate	EPA 8270D/625	EPA 8270D
Di-n-octyl phthalate	EPA 8270D/625	EPA 8270D
Fluoranthene	EPA 8270D/625/ Scan-Sim	EPA 8270D
Fluorene	EPA 8270D/625	EPA 8270D
Hexachlorobenzene	EPA 8270D/625/ Scan-Sim	EPA 8270D
Hexachlorobutadiene	EPA 8270D/625/ Scan-Sim	EPA 8270D
Hexachlorocyclopentadiene	EPA 8270D/625	EPA 8270D
Hexachloroethane	EPA 8270D/625	EPA 8270D
Indeno(1,2,3-cd)pyrene	EPA 8270D/625/ Scan-Sim	EPA 8270D
Isodrin	EPA 8270D/625	EPA 8270D
Isophorone	EPA 8270D/625	EPA 8270D
Naphthalene	EPA 8270D/625	EPA 8270D
Nitrobenzene	EPA 8270D/625	EPA 8270D
n-Nitrosodi-n-propylamine	EPA 8270D/625	EPA 8270D
n-Nitrosodiphenylamine	EPA 8270D/625	EPA 8270D
Pentachlorophenol	EPA 8270D/625/ Scan-Sim	EPA 8270D
Phenanthrene	EPA 8270D/625	EPA 8270D
Phenol	EPA 8270D/625	EPA 8270D
Pyrene	EPA 8270D/625	EPA 8270D
Total Petroleum Hydrocarbons (TPH)	FL-PRO	FL-PRO
<u>Volatile Organics</u>		
1,1,1,2-Tetrachloroethane	EPA 8260B/624	EPA 8260B
1,1,1-Trichloroethane	EPA 8260B/624	EPA 8260B
1,1,2,2-Tetrachloroethane	EPA 8260B/624	EPA 8260B
1,1,2-Trichloro-1,2,2-trifluoroethane	EPA 8260B/624	EPA 8260B
1,1,2-Trichloroethane	EPA 8260B/624	EPA 8260B
1,1-Dichloroethane	EPA 8260B/624	EPA 8260B
1,1-Dichloroethene	EPA 8260B/624	EPA 8260B
1,1-Dichloropropene	EPA 8260B/624	EPA 8260B
1,2,3-Trichlorobenzene	EPA 504.1/8260B/624	EPA 8260B
1,2,3-Trichloropropane	EPA 8260B/624	EPA 8260B
1,2,4-Trichlorobenzene	EPA 8260B/624	EPA 8260B
1,2,4-Trimethylbenzene	EPA 8260B/624	EPA 8260B
1,2-Dibromo-3-chloropropane (DBCP)	EPA 504 /504.1/8011/8260B	EPA 8260B
1,2-Dibromoethane (EDB, Ethylene dibromide)	EPA 504 /504.1/8011/8260B	EPA 8260B
1,2-Dichlorobenzene	EPA 8260B/624	EPA 8260B
1,2-Dichloroethane	EPA 8260B/624	EPA 8260B
1,2-Dichloropropane	EPA 8260B/624	EPA 8260B
1,3,5-Trimethylbenzene	EPA 8260B/624	EPA 8260B



Analyte / Parameter	Non-Potable Water	Solid Hazardous Waste
1,3-Dichlorobenzene	EPA 8260B/624	EPA 8260B
1,3-Dichloropropane	EPA 8260B/624	EPA 8260B
1,4-Dichlorobenzene	EPA 8260B/624	EPA 8260B
1,4-Dioxane (1,4-Diethylenoxide)	EPA 8260B/624	EPA 8260B
2,2-Dichloropropane	EPA 8260B/624	EPA 8260B
2-Butanone (Methyl ethyl ketone, MEK)	EPA 8260B/624	EPA 8260B
2-Chloroethyl vinyl ether	EPA 8260B/624	EPA 8260B
2-Chlorotoluene	EPA 8260B/624	EPA 8260B
2-Hexanone	EPA 8260B/624	EPA 8260B
4-Chlorotoluene	EPA 8260B/624	EPA 8260B
4-Methyl-2-pentanone (MIBK)	EPA 8260B/624	EPA 8260B
Acetone	EPA 8260B/624	EPA 8260B
Acetonitrile	EPA 8260B/624	EPA 8260B
Acrolein (Propenal)	EPA 8260B/624	EPA 8260B
Acrylonitrile	EPA 8260B/624	EPA 8260B
Allyl chloride (3-Chloropropene)	EPA 8260B/624	EPA 8260B
Benzene	EPA 8260B/624	EPA 8260B
Bromobenzene	EPA 8260B/624	EPA 8260B
Bromochloromethane	EPA 8260B/624	EPA 8260B
Bromodichloromethane	EPA 8260B/624	EPA 8260B
Bromoform	EPA 8260B/624	EPA 8260B
Carbon tetrachloride	EPA 8260B/624	EPA 8260B
Carbon disulfide	EPA 8260B/624	EPA 8260B
Chlorobenzene	EPA 8260B/624	EPA 8260B
Chloroethane	EPA 8260B/624	EPA 8260B
Chloroform	EPA 8260B/624	EPA 8260B
Chloroprene	EPA 8260B/624	EPA 8260B
cis-1,2-Dichloroethene	EPA 8260B/624	EPA 8260B
cis-1,3-Dichloropropene	EPA 8260B/624	EPA 8260B
Cyclohexane	EPA 8260B/624	EPA 8260B
Dibromochloromethane	EPA 8260B/624	EPA 8260B
Dibromomethane	EPA 8260B/624	EPA 8260B
Dichlorodifluoromethane	EPA 8260B/624	EPA 8260B
Ethyl methacrylate	EPA 8260B/624	EPA 8260B
Hexachlorobutadiene	EPA 8260B/624	EPA 8260B
Ethylbenzene	EPA 8260B/624	EPA 8260B
Iodomethane (Methyl iodide)	EPA 8260B/624	EPA 8260B
Isobutyl alcohol (2-Methyl-1-propanol)	EPA 8260B/624	EPA 8260B
Isopropylbenzene	EPA 8260B/624	EPA 8260B
m+p-Xylenes	EPA 8260B/624	EPA 8260B
Methacrylonitrile	EPA 8260B/624	EPA 8260B
Methyl acetate	EPA 8260B/624	EPA 8260B
Methyl bromide (Bromomethane)	EPA 8260B/624	EPA 8260B
Methyl chloride (Chloromethane)	EPA 8260B/624	EPA 8260B
Methyl methacrylate	EPA 8260B/624	EPA 8260B
Methyl tert-butyl ether (MTBE)	EPA 8260B/624	EPA 8260B
Methylcyclohexane	EPA 8260B/624	EPA 8260B
Methylene chloride	EPA 8260B/624	EPA 8260B
Naphthalene	EPA 8260B/624	EPA 8260B
n-Butylbenzene	EPA 8260B/624	EPA 8260B



Analyte / Parameter	Non-Potable Water	Solid Hazardous Waste
n-Propylbenzene	EPA 8260B/624	EPA 8260B
o-Xylene	EPA 8260B/624	EPA 8260B
Pentachloroethane	EPA 8260B/624	EPA 8260B
p-Isopropyltoluene	EPA 8260B/624	EPA 8260B
Propionitrile (Ethyl cyanide)	EPA 8260B/624	EPA 8260B
sec-Butylbenzene	EPA 8260B/624	EPA 8260B
Styrene	EPA 8260B/624	EPA 8260B
tert-Butylbenzene	EPA 8260B/624	EPA 8260B
Tetrachloroethene (Perchloroethylene)	EPA 8260B/624	EPA 8260B
Toluene	EPA 8260B/624	EPA 8260B
trans-1,2-Dichloroethene	EPA 8260B/624	EPA 8260B
trans-1,3-Dichloropropene	EPA 8260B/624	EPA 8260B
trans-1,4-Dichloro-2-butene	EPA 8260B/624	EPA 8260B
Trichloroethene (Trichloroethylene)	EPA 8260B/624	EPA 8260B
Trichlorofluoromethane	EPA 8260B/624	EPA 8260B
Vinyl acetate	EPA 8260B/624	EPA 8260B
Vinyl chloride	EPA 8260B/624	EPA 8260B
Xylene (total)	EPA 8260B/624	EPA 8260B
<u>Pesticides-Herbicides-PCBs</u>		
2,4,5-T	EPA 8151A /615	EPA 8151A
2,4-D	EPA 8151A /615	EPA 8151A
2,4-DB	EPA 8151A /615	EPA 8151A
3,5-Dichlorobenzoic acid	EPA 8151A /615	EPA 8151A
4,4'-DDD	EPA 8081B/608	EPA 8081B
4,4'-DDE	EPA 8081B/608	EPA 8081B
4,4'-DDT	EPA 8081B/608	EPA 8081B
4-Nitrophenol	EPA 8151A/615	EPA 8151A
Acifluorfen	EPA 8151A/615	EPA 8151A
Aldrin	EPA 8081B/608	EPA 8081B
alpha-BHC (alpha- Hexachlorocyclohexane)	EPA 8081B/608	EPA 8081B
alpha-Chlordane	EPA 8081B/608	EPA 8081B
Aroclor-1016(PCB-1016)	EPA 8082A/608	EPA 8082A
Aroclor-1221 (PCB-1221)	EPA 8082A/608	EPA 8082A
Aroclor-1232 (PCB-1232)	EPA 8082A/608	EPA 8082A
Aroclor-1242 (PCB-1242)	EPA 8082A/608	EPA 8082A
Aroclor-1248 (PCB-1248)	EPA 8082A/608	EPA 8082A
Aroclor-1254 (PCB-1254)	EPA 8082A/608	EPA 8082A
Aroclor-1260 (PCB-1260)	EPA 8082A/608	EPA 8082A
Azinphos-methyl (Guthion)	EPA 8141B/614	EPA 8141B
Bentazon	EPA 8151A/615	EPA 8151A
beta-BHC (beta- Hexachlorocyclohexane)	EPA 8081B/608	EPA 8081B
Bolstar (Sulprofos)	EPA 8141B/614	EPA 8141B
Chloramben	EPA 8151A/615	EPA 8151A
Chlordane (tech.)	EPA 8081B/608	EPA 8081B
Chlorpyrifos	EPA 8141B/614	EPA 8141B
Coumaphos	EPA 8141B/614	EPA 8141B
Dacthal (DCPA)	EPA 8151A/615	EPA 8151A
Dalapon	EPA 8151A/615	EPA 8151A



Analyte / Parameter	Non-Potable Water	Solid Hazardous Waste
delta-BHC	EPA 8081B/608	EPA 8081B
Demeton-o	EPA 8141B/614	EPA 8141B
Demeton-s	EPA 8141B/614	EPA 8141B
Diazinon	EPA 8141B/614	EPA 8141B
Dicamba	EPA 8151A/615	EPA 8151A
Dichlorofenthion	EPA 8141B/614	EPA 8141B
Dichloroprop (Dichlorprop)	EPA 8151A/615	EPA 8151A
Dlchlorovos (DDVP, Dichtorvos)	EPA 8141B/614	EPA 8141B
Dieldrin	EPA 8081B/608	EPA 8081B
Dimethoate	EPA 8141B/614	EPA 8141B
Dinoseb (2-sec-butyl-4,6-dinitrophenol, DNB P)	EPA 8151A/615	EPA 8151A
Disulfoton	EPA 8141B/614	EPA 8141B
Endosulfan I	EPA 8081B/608	EPA 8081B
Endosulfan II	EPA 8081B/608	EPA 8081B
Endosulfan sulfate	EPA 8081B/608	EPA 8081B
Endrin	EPA 8081B/608	EPA 8081B
Endrin aldehyde	EPA 8081B/608	EPA 8081B
Endrin ketone	EPA 8081B/608	EPA 8081B
EPN	EPA 8141B/614	EPA 8141B
Ethion	EPA 8141B/614	EPA 8141B
Ethoprop	EPA 8141B/614	EPA 8141B
fensulfothion	EPA 8141B/614	EPA 8141B
fenthion	EPA 8141B/614	EPA 8141B
gamma-BHC (Lindane, gamma-Hexachlorocyclohexane)	EPA 8081B/608	EPA 8081B
gamma-Chlordane	EPA 8081B/608	EPA 8081B
Heptachlor	EPA 8081B/608	EPA 8081B
Heptachlor epoxide	EPA 8081B/608	EPA 8081B
Isodrin	EPA 8081B/608	EPA 8081B
Malathion	EPA 8141B/614	EPA 8141B
MCPA	EPA 8151A/615	EPA 8151A
Merphos	EPA 8141B/614	EPA 8141B
Methoxychlor	EPA 8081B/608	EPA 8081B
Methyl parathion (Parathion, methyl)	EPA 8141B/614	EPA 8141B
Mevinphos	EPA 8141B/614	EPA 8141B
Mirex	EPA 8081B/608	EPA 8081B
Monocrotophos	EPA 8141B/614	EPA 8141B
Naled	EPA 8141B/614	EPA 8141B
Parathion, ethyl	EPA 8141B/614	EPA 8141B
Pentachlorophenol	EPA 8151A/615	EPA 8151A
Phorate	EPA 8141B/614	EPA 8141B
Picloram	EPA 8151A/615	EPA 8151A
Ronnel	EPA 8141B/614	EPA 8141B
Silvex (2A.5-TP)	EPA 8151B/615	EPA 8151B
Stirofos	EPA 8141B/614	EPA 8141B
Sulfotepp	EPA 8141B/614	EPA 8141B
Tetraethyl pyrophosphate (TEPP)	EPA 8141B/614	EPA 8141B
Tokuthion (Prothiophos)	EPA 8141B/614	EPA 8141B
Toxaphene (Chlorinated camphene)	EPA 8081B/608	EPA 8081B
Trichloronate	EPA 8141B/614	EPA 8141B



Preparation Methods

Fraction	Analytical Method	Preparation Method
Cyanide	EPA 9014 EPA 335.2 /SM 4500-CN E	EPA 9010C
TX	EPA 9056A	EPA 5050
Metal water prep	EPA 6020A/200.8	EPA 3005A
Metals soil prep	EPA 6020A	EPA 3050B
Metals TCLP prep	EPA 6020A/200.8	EPA 3010A
Extractable organics and Pesticides water prep	EPA 8270D/625/8081B/8082A/ 608/ 8141B/ 614	EPA 3510C
Extractable organics and Pesticides waste prep	EPA 8270D/625/8081B/8082A/ 608/ 8141B/ 614	EPA 3580A
Extractable organics and Pesticides soil prep	EPA 8270D/625/8081B/8082A/ 608/ 8141B/ 614	EPA 3550C
Organics water and mid-level soil prep	EPA 8260B/624	EPA 5030B
Organics low-level soil prep	EPA 8260B/624	EPA 5035
Soil/water leachate	Wets	ENCO WETS-88
SPLP	Wets, Organics, and Metals	EPA 1312
TCLP	Wets, Organics, and Metals	EPA 1311

