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FINAL BENTHIC INVERTEBRATE SEDIMENT SAMPLING WORK PLAN AND SAMPLING AND ANALYSIS PLAN FOR SOLID WASTE MANAGEMENT UNIT 3 PIER 10 SANDBLAST YARD AND 7B DESERT COVE JEB LITTLE CREEK VA

08/01/2011

CH2M HILL

Final

SWMU 3 – Pier 10 Sandblast Yard and SWMU 7B – Desert Cove Benthic Invertebrate Sediment Sampling Work Plan and Sampling and Analysis Plan

Joint Expeditionary Base (JEB) Little Creek-Fort Story
Naval Amphibious Base (NAB) Little Creek
Virginia Beach, Virginia

NAVFAC
Naval Facilities Engineering Command
NAVFAC MID-ATLANTIC

Prepared for

Department of the Navy
Naval Facilities Engineering Command
Mid-Atlantic

Contract No. N62470-02-D-3052
CTO-0222

August 2011

Prepared by

CH2MHILL

SAP Worksheet #1—Title and Approval Page

FINAL

SWMU 3 - PIER 10 SANDBLAST YARD and SWMU 7B – DESERT COVE

BENTHIC INVERTEBRATE SEDIMENT SAMPLING WORK PLAN AND SAMPLING AND ANALYSIS PLAN

Joint Expeditionary Base Little Creek-Fort Story
Joint Expeditionary Base Little Creek
Virginia Beach, Virginia

August 2011

Prepared for:
DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
MID-ATLANTIC

Prepared by:
CH2M HILL

Prepared under:
Contract No. N62470-02-D-3052
Contract Task Order 0222

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Executive Summary

This Sampling and Analysis Plan (SAP) presents the rationale and technical approach for the Benthic Invertebrate Sediment Sampling to be conducted by CH2M HILL at Environmental Restoration Program (ERP) Solid Waste Management Unit (SWMU) 3—Pier 10 Sandblast Yard, and SWMU 7b – Desert Cove, at Joint Expeditionary Base (JEB) Little Creek-Fort Story, JEB Little Creek, Virginia Beach, Virginia. This investigation is being conducted for the Department of the Navy (DoN), Naval Facilities Engineering Command (NAVFAC) Mid-Atlantic Division, under the Comprehensive Long-term Environmental Action—Navy (CLEAN) III Program in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986, and, to the extent practicable, the National Oil and Hazardous Substances Contingency Plan.

On October 1, 2009, Hampton Roads' first Department of Defense Joint Base was established. This new installation comprises the former NAB Little Creek and Army post of Fort Story; the new name is JEB Little Creek-Fort Story. With the forming of this new command, the DoN assumes responsibility for management of both properties and will now merge public meetings regarding the ongoing environmental restoration programs. However, separate records will be maintained to ensure the integrity of ongoing efforts at both properties. For public notices and distributions, the former bases will be individually identified as JEB Little Creek and JEB Fort Story.

This SAP has been completed under contract number N62470-02-D-3052, Contract Task Order 0222, in accordance with the DoN's Uniform Federal Policy Sampling and Analysis Plan (UFP-SAP) policy guidance to ensure that environmental data collected are scientifically sound, of known and documented quality, and suitable for intended purposes. The objectives and technical approach included in this SAP were jointly scoped by the NAB Little Creek Tier I Partnering Team, which includes representatives from the DoN, United States Environmental Protection Agency (USEPA) Region III, and Virginia Department of Environmental Quality (VDEQ). This SAP supplements the *Master Project Plans for Naval Amphibious Base Little Creek, Virginia Beach, Virginia* which addresses the protocols and standard operating procedures (SOPs) to be used for all investigations (CH2M HILL, 2007).

The laboratory information cited in this Work Plan is specific to Empirical Laboratories (chemical analysis) and Water & Air Research, Inc. (benthic invertebrate analysis).[1] Empirical Laboratories and the Taxonomic Laboratory were selected based on a competitive selection process. If additional laboratory services are requested requiring modification to the existing SAP, revised SAP worksheets will be submitted to the DoN and regulatory agencies for approval.

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[1] http://www.empirlabs.com/
http://www.waterandair.com/

SWMU 3

SWMU 3 - Pier 10 Sandblast Yard is located in a developed area on the west side of Little Creek Harbor. SWMU 3 was used for sandblasting activities between 1962 and 1995. Boats, anchors, and chains were sandblasted on a concrete pad located on the western side of Building 1263 between 1962 and 1995. In 1995, the concrete pad was taken out of service, and a new sandblasting area was constructed in the northwestern corner of the SWMU 3. In 1996 all sandblasting activities were moved out of SWMU 3 to an indoor facility (CB 125). Historical releases at SWMU 3 likely occurred when sandblasting residue was lying directly on the ground surface. Prior to 1993, runoff from sandblasting operations occurred as sheet flow to Little Creek Harbor. In 1993, a catch basin was constructed that transported surface water drainage to a VDEQ-permitted outfall discharging to Little Creek Harbor. Runoff from some areas of SWMU 3 may continue to flow directly into the harbor. Little Creek Harbor is located east of the sandblasting area. A public marina for dependents is located south of the Pier 10 dry dock. Little Creek Channel, leading to the Chesapeake Bay, is located northeast of Little Creek Harbor. Dredging maintenance activities vary within the vicinity of SWMU 3. Little Creek Channel (not including the near-shore sediments that make up a part of SWMU 3) is maintained by the U.S. Army Corps of Engineers and has been regularly dredged since 1928. The surrounding area is maintained by NAB Little Creek. In 1965, the areas around Piers 1 through 8, south of the marina, were dredged and in 1999, 2 to 5 feet of sediment were removed from beneath the Pier 10 dry dock. The marina area has not been dredged in recent history.

A Remedial Investigation/Human Health Risk Assessment/Ecological Risk Assessment (RI/HHRA/ERA) was conducted in 2002 and a Supplemental RI (SRI) was conducted in 2007 to evaluate the nature and extent of contamination and potential human health and ecological risks associated with exposure to site media. Volatile organic compounds, metals, and polycyclic aromatic hydrocarbons (PAHs) have been detected in SWMU 3 soil, groundwater, and/or sediment above screening criteria. In addition, abrasive blast material (ABM), used for sandblasting, has been observed in surface and shallow subsurface soils as well as in Little Creek Harbor sediment. Potentially unacceptable risks to human health have been identified for future potable use of site groundwater. Additionally, potentially unacceptable ecological risks from lower trophic level organism exposure to sediment were identified based on metals (copper, lead, mercury, nickel, tin, and zinc) and PAHs. Copper, lead, nickel, tin, and zinc were correlated to ABM content in sediment and determined to be good indicators of site influence for defining the spatial extent of contamination and unacceptable risks. Although commonly used as an anti-fouling agent in marine paints, mercury concentrations detected in sediment were not correlated with ABM content and concentrations posing risk were spatially limited. PAHs were detected in sediment across the site at concentrations contributing to risk; however are not associated with historic sandblasting activities and therefore not considered a result of a CERCLA release. .

The SRI recommended remedial action objectives (RAOs) be established for sediment and PRGs be developed for the five ABM-related COCs, based on the extent of ABM, risk-based screening values, and comparison to urban background levels, while mercury and PAHs be considered as secondary factors based on their lack of correlation with ABM and poor spatial linkage to SWMU 3. As a result, the following RAO was developed for sediment:

remove ABM-containing sediments and associated metals from the site to the greatest extent practicable to allow a benthic invertebrate community consistent with the urban nature of Little Creek Harbor to become established. To meet this objective, ABM-based and metals-based PRGs were established. Based upon the established RAO and PRGs for sediment, additional sampling was conducted in November 2009 to refine the CERCLA remediation boundary based upon ABM content and metals concentrations. The revised remediation area is approximately 13.3 acres and consists of approximately 61,266 cubic yards of sediment.

SWMU 7b

For investigation purposes, SWMU 7 was divided into two sections: the terrestrial portion of the site (SWMU 7a) consists of the area along former Piers 44 - 55 as well as the area surrounding the northern portion of Building CB-125; the aquatic portion of the site (SWMU 7b) consists of Desert Cove and the Connector Channel. SWMU 7a was used to sandblast and paint ships until 1996, when sandblasting activities were moved to an indoor facility (CB-125). Approximately 4,000 cubic yards (yd^3) of spent ABM generated between 1960 and 1982 was stored in open piles in the construction footprint of CB-125 and in the area of CB-317 and CB-318. No release controls were identified at SWMU 7a; therefore, it is likely that spent ABM has historically been released to soils and Desert Cove. Following an Interim Removal Action in September 2004 to remove lead contaminated soils, the DoN, in partnership with USEPA and VDEQ, agreed no further action was required for SWMU 7a, and a Record of Decision (ROD) was signed in June 2005 (DON, 2005).

An RI/HHRA/ERA was conducted in 2002 to evaluate the nature and extent of contamination and potential human health and ecological risks associated with exposure to sediment at SWMU 7b. During the RI, to better evaluate potential risks where potential exposures could vary due to differences in the magnitude of contaminant concentrations, SWMU 7b was divided into three areas: the Connector Channel, Cove, and Pier Areas. ABM was observed in sediment samples collected throughout the Cove, Connector Channel, and Pier Area. Metals and PAHs were detected in sediment above human health and ecological screening values. However, the quantitative human health risk assessment identified no potentially unacceptable human health risks associated with exposure to sediment. Potentially unacceptable ecological risks to lower trophic level organisms from exposure to sediment were identified for each area due to metals [primary contaminants of potential concern (COPCs): copper, lead, mercury, tin, and zinc; secondary COPCs: arsenic, selenium, and silver] and PAHs. In 2008, a Military Construction (MILCON) action to demolish and replace Piers 44-51, construct a new quay wall along the eastern and southern edges of the cove, and dredge limited areas surrounding the former piers was completed. In November 2009 surface sediment sampling was conducted to evaluate post-MILCON dredge conditions. In general, post-MILCON dredge COPC concentrations in the Connector Channel and Desert Cove Areas were similar to pre-dredge conditions. Concentrations of COPCs detected within the dredged portion of the Pier Area are generally similar to, or lower than, those previously detected, with the exception of northeastern corner of the Pier Area. Concentrations detected within this area indicate subsurface sediment sampled in 2002 may currently be exposed at the sediment surface.

Project Objectives

The primary objective of the SWMU 3 investigation is to evaluate the current condition of the benthic invertebrate community within the remediation area to support the evaluation of remedial alternatives and assist in measuring remedy success against the RAO. The primary objective of the SWMU 7b investigation is to assess the current benthic invertebrate community at SWMU 7b to aid in determining whether further investigation/action/no action is required at the site.

The objectives for each site will be attained using a petite ponar dredge to facilitate the collection of surface sediment samples for visual observation of ABM content, analysis of ABM-related COC (SWMU 3) and primary COPC (SWMU 7b) concentrations (copper, lead, mercury, nickel, tin, and/or zinc), evaluation of habitat conditions [pH, total organic carbon (TOC), grain size, and acid volatile sulfides/simultaneously extractable metals (AVS/SEM)], and analysis of benthic invertebrate community structure.

Report Contents

This SAP consists of the 37 worksheets specific to the DoN's UFP-SAP guidance. All tables and figures are included following the Worksheets. A cross-reference review guide is provided as **Attachment A** to help locate USEPA Quality Assurance Project Plan (QAPP) elements in this DoN UFP-SAP format. Field SOPs are included as **Attachment B**, site-specific laboratory SOPs are included as **Attachment C**, and the Data Management Plan documents are included as **Attachment D**.

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A QAPP → UFP-SAP Completeness Checklist
B Field Standard Operating Procedures
C Laboratory Standard Operating Procedures (Provided to DoN Chemist only—Proprietary Laboratory Procedures)
D Data Management Plan

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9 Proposed SWMU 7b Sample Locations
10 SWMU 7b Decision Tree

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Abbreviations and Acronyms

ABM	abrasive blast material
AM	Activity Manager
AQM	Activity Quality Manager
ASTM	American Society for Testing and Materials
AVS/SEM	acid volatile sulfides/simultaneously extractable metals
bss	below sediment surface
°C	degrees Celsius
CA	corrective action
CCV	continuing calibration verification
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLEAN	Comprehensive Long-term Environmental Action—Navy
COC	contaminant of concern
CoC	chain of custody
COPC	contaminant of potential concern
CSM	conceptual site model
DL	detection limit
DO	dissolved oxygen
DoN	Department of the Navy
DQI	data quality indicator
DQO	data quality objective
EDD	electronic data deliverable
EIS	Environmental Information Specialist
ERA	Ecological Risk Assessment
ER-L	effects range-low
ER-M	effects range-median
ERP	Environmental Restoration Program
FTL	Field Team Leader
g	gram
H&S	health and safety
HHRA	Human Health Risk Assessment
HSP	Health and Safety Plan
ICAL	initial calibration
ICV	initial calibration verification
IDW	investigation-derived waste
JEB	Joint Expeditionary Base

LCL	lower control limit
LCS	laboratory control sample
LOD	limit of detection
LOQ	limit of quantitation
µmole/g	micromole per gram
MDL	method detection limit
mg/kg	milligrams per kilogram
MILCON	military construction
mlw	mean low water
MPC	measurement performance criteria
MS/MSD	matrix spike/matrix spike duplicate
N/A	not applicable
NAB	Naval Amphibious Base
NAVFAC	Naval Facilities Engineering Command
NIRIS	Navy Installation Restoration Information System
NOAA	National Oceanic and Atmospheric Association
ORP	oxygen reduction potential
PAH	polycyclic aromatic hydrocarbon
PAL	project action limit
PEL	probable effects level
PM	Project Manager
POC	point of contact
PPE	personal protective equipment
PQL	project quantitation limit
PRG	preliminary remediation goal
QA	quality assurance
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	quality control
QL	quantitation limit
RI	Remedial Investigation
RPD	relative percent difference
RPM	Remedial Project Manager
RQ	remediation quotient
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
SQUIRT	Screening Quick Reference Tables
SSC	Site Safety Coordinator
SWMU	Solid Waste Management Unit
TBD	to be determined
TOC	total organic carbon

UCL	upper control limit
UFP-SAP	Uniform Federal Policy Sampling and Analysis Plan
U.S.	United States
USCS	Unified Soil Classification System
USEPA	U.S. Environmental Protection Agency
VDEQ	Virginia Department of Environmental Quality

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SAP Worksheet #2—SAP Identifying Information

Site Name/Number: Solid Waste Management Unit (SWMU) 3 - Pier 10 Sandblast Yard and SWMU 7b – Desert Cove

Operable Unit: Not applicable (N/A)

Contractor Name: CH2M HILL

Contract Number: N62470-02-D-3052, Contract Task Order 0222

Contract Title: Department of the Navy (DoN) Comprehensive Long-term Environmental Action—Navy (CLEAN) III Program

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

Uniform Federal Policy for Quality Assurance Project Plans, EPA-505-B-04-900A (USEPA, 2005)
Guidance for Quality Assurance Project Plans, EPA QA/G-5 (USEPA, 2002)
Guidance on Systematic Planning Using the Data Quality Objectives Process, EPA QA/G-4 (USEPA, 2006).

2. Identify regulatory program:

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

3. This SAP is specific to:

The SWMU 3 and SWMU 7b Benthic Invertebrate Sampling

4. List dates of scoping sessions that were held:

Scoping Session	Date
Sampling Design with Tier 1 Partnering Team	May 18, 2010

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

Title	Date
Final SWMU 3 Vertical Removal Boundary Delineation and Waste Characterization Sediment Sampling Work Plan and Sampling and Analysis Plan	December 2009
Final SWMU 7b Revised Ecological Risk Assessment Work Plan and Sampling and Analysis Plan	November 2009
Final SWMU 3 Supplemental Remedial Investigation	August 2009
Final Technical Memorandum Work Plan for Pre-Feasibility Study Sediment Sampling	February 2009
Master Project Plans for Naval Amphibious Base Little Creek, Virginia Beach, Virginia	April 2007
Final SWMU 3 Remedial Investigation/Human Health Risk Assessment/Ecological Risk Assessment	August 2005

SAP Worksheet #2—SAP Identifying Information (continued)

Title	Date
Final SWMU 7b Remedial Investigation/Human Health Risk Assessment/Ecological Risk Assessment	December 2004
Final SWMU 7 and SWMU 8 Engineering Evaluation/Cost Analysis	June 2004
Final Site Investigation Report, SWMU 7 and SWMU 8	August 2001
Final Site Investigation Report, SWMU 3 and IR Site 8	December 1999

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

Virginia Department of Environmental Quality (VDEQ) – regulatory stakeholder

United States Environmental Protection Agency (USEPA) Region III – regulatory stakeholder

7. Lead organization (see Worksheet #7 for detailed list of data users):

DoN – Lead Agency.

All SAP elements required for this project are described herein on the 37 Uniform Federal Policy-Sampling and Analysis Plan (UFP-SAP) Worksheets and a crosswalk table for omitted elements is not necessary for this project. However, a cross-reference review guide is provided as **Attachment A** to help locate USEPA Quality Assurance Project Plan (QAPP) elements in this DoN UFP-SAP format.

SAP Worksheet #3—Distribution List

Name of SAP Recipients	Title/Role	Organization	Telephone Number (Optional)	E-mail Address or Mailing Address
Bryan Peed	Remedial Project Manager (RPM)	Naval Facilities Engineering Command (NAVFAC) Mid-Atlantic	757-341-0480	bryan.peed@navy.mil
Jeffrey Boylan	RPM	USEPA Region 3	215-814-2094	boylan.jeffrey@epamail.epa.gov
Paul Herman, P.E.	RPM	VDEQ	804-698-4464	peherman@deq.virginia.gov
Cecilia Landin	Joint Expeditionary Base (JEB) Little Creek-Fort Story Activity Manager (AM)/Project Manager (PM)	CH2M HILL	757-671-6266	cecilia.landin@ch2m.com
David Livingston	Deputy AM	CH2M HILL	757-671-6239	david.livingston@ch2m.com
Bill Kappleman	Senior Ecological Risk Assessor	CH2M HILL	703-376-5152	william.kappleman@ch2m.com
Field Team Leader (FTL)		CH2M HILL	To be determined (TBD)	TBD
Field Team Members		CH2M HILL	TBD	TBD
Sonya Gordon	PM	Empirical Laboratories	615-345-1115	sgordon@empirlabs.com
Pat Beaver	PM	Beaver Engineering (subcontracted by Empirical for grain size analysis)	615-350-8124	pat@beaverengineering.com
David Evans	PM	Water & Air Research, Inc. (Taxonomic Lab)	800-242-4927	devans@waterandair.com
Ward Dickens	Senior Chemist, Data Validator	CH2M HILL	352-384-7049	Ward.dickens@ch2m.com

Hardcopy and electronic versions will be made available to additional staff as requested.

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SAP Worksheet #4—Project Personnel Sign-Off Sheet

Each organization will read the SAP and provide an original copy of the sign-off sheet to the PM for maintenance in the central project file.

Name	Title/Role	Telephone Number	Signature/E-mail Receipt	Date SAP Read
Empirical Laboratories				
Sonya Gordon	PM	615-345-1115		
Marcia McGinnity	Quality Assurance Officer (QAO)	615-345-1115		
Beaver Engineering				
Pat Beaver	PM	615-350-8124		
Water & Air Research, Inc.				
David Evans	PM	800-242-4927		
CH2M HILL				
Cecilia Landin	JEB Little Creek-Fort Story AM/PM	757-671-6215		
David Livingston	Deputy AM	757-671-6239		
Brett Doerr	Navy CLEAN Program UFP-SAP Reviewer	352-384-7067		
Scott MacEwen, P.E.	Activity Quality Manager (AQM)	703-376-5179		
Anita Dodson	Navy CLEAN Program Chemist	757-671-6218		
Bill Kappleman	Senior Ecological Risk Assessor	703-376-5152		
Megan Morrison	Project Chemist	703-376-5053		
Victoria Brynildsen	Environmental Information Specialist (EIS)	757-671-8311		
Ward Dickens	Senior Chemist, Data Validator	352-384-7049		
FTL/Site Safety Coordinator (SSC)	TBD			
Field Team Members	TBD			

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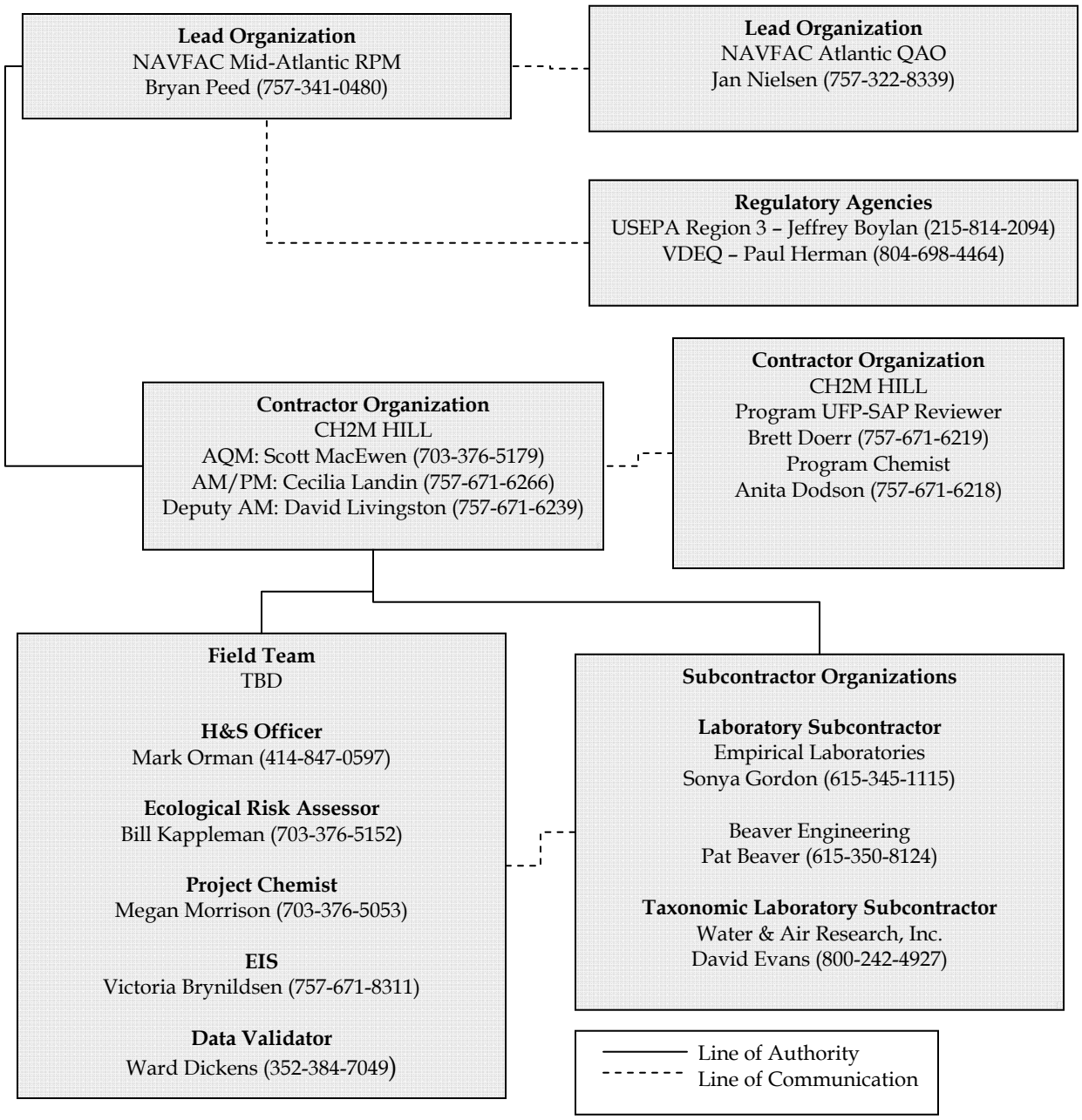
SAP Worksheet #5—Project Organizational Chart



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SAP Worksheet #6—Communication Pathways

Communication Drivers	Responsible Affiliation	Name	Phone Number	Procedure
Communication with DoN (lead agency)	RPM/Assistant RPM	Bryan Peed	757-341-0480	Primary point of contact (POC) for DoN; can delegate communication to other internal or external points of contact. Any issue that may impact project work should be reported to Bryan immediately.
Communication with USEPA (regulatory agency)	RPM	Jeffrey Boylan	215-814-2094	Primary POC for USEPA; can delegate communication to other internal or external points of contact. Upon notification of field changes, USEPA will have 24 hours to approve or comment on the field changes.
Communication with VDEQ (regulatory agency)	RPM	Paul Herman	804-698-4464	Primary POC for VDEQ; can delegate communication to other internal or external points of contact. Upon notification of field changes, VDEQ will have 24 hours to approve or comment on the field changes.
Oversight of Environmental Restoration Program (ERP) implementation	AM	Cecilia Landin	757-671-6266	Primary POC for stakeholder and agency managers; can delegate communication to other contract staff as appropriate. Issues reported to the DoN RPM immediately and followed up in writing within 2 business days.
Management of ERP Implementation	PM			Primary modes of communication are phone, email, letter, document submittal; timing dependent on nature of communication and predefined schedules as applicable and as requested by stakeholder agencies. All information and materials about the project will be forwarded to the AM on a daily basis.
Technical communications for UFP-SAP implementation, data interpretation	Senior Ecological Risk Assessor	Bill Kappleman	703-376-5152	Contact senior consultants regarding questions/issues encountered in the field, input on data interpretation, as needed. Senior consultants will have 24 hours to respond to technical field questions as necessary. Responses will be communicated to the PM via email or phone.
	AQM	Scott MacEwen	703-376-5179	
Health and Safety (H&S)	SSC	TBD		Responsible for the adherence of team members to the site safety requirements described in the Health and Safety Plan (HSP). Will report H&S incidents and near losses to PM.
QAPP Field Changes	FTL	TBD		Notify the PM by phone and email of changes to the SAP made in the field and the reasons within 24 hours. Documentation of deviations from the Work Plan will be kept in the field logbook; deviations made only with the approval of the contractor PM.

SAP Worksheet #6—Communication Pathways (continued)

Communication Drivers	Responsible Affiliation	Name	Phone Number	Procedure
Data tracking from collection through upload to database	EIS	Victoria Brynildsen	757-871-8311	EIS will track data from sample collection through upload to the database, ensuring Work Plan requirements are met by laboratory and field staff. EIS will act as main POC for laboratory QAO. Laboratory issues will be reported to the PM and Project Chemist within 4 hours.
Field Corrective Action (CA)	FTL	TBD		The need for CA for field and analytical issues will be determined by the FTL and/or senior consultants. The senior consultants will ensure QAPP requirements are met by field staff. 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.
Analytical CAs/ release of analytical data	Project Chemist	Megan Morrison	703-376-5053	The need for CA by the analytical laboratory will be determined by the Project Chemist. The Project Chemist will ensure QAPP requirements are met by the laboratory. No analytical data can be released until data usability is completed and approved by the Project Chemist. The Project Chemist will review all data as soon as possible upon receipt from the validator.
Reporting laboratory data quality issues	Laboratory QAO or PM	Marcia McGinnity/ Sonya Gordon (Empirical) Pat Beaver (Beaver) David Evans (Water & Air)	615-345-1115 615-350-8124 800-242-4927	All Quality Assurance (QA)/Quality Control (QC) issues with project field samples will be reported within 1 day to the Project Chemist (Megan Morrison) by the laboratory.
Reporting data quality issues	Data Validator	Ward Dickens	352-384-7049	The data validator reviews and qualifies analytical data as necessary. The data along with a validation narrative are returned to the EIS within 14 calendar days.

SAP Worksheet #7—Personnel Responsibilities and Qualifications Table

Name	Title/Role	Organizational Affiliation	Responsibilities
Bryan Peed	RPM	NAVFAC Mid-Atlantic	Coordinates the work of DoN resources to accomplish ERP goals and policies at JEB Little Creek-Fort Story
Cecilia Landin	AM	CH2M HILL	Oversees ERP activities at JEB Little Creek-Fort Story
David Livingston	Deputy AM	CH2M HILL	Assists AM with oversight of ERP activities at JEB Little Creek-Fort Story
Cecilia Landin	PM	CH2M HILL	Manages project; directs and oversees project staff. PM is responsible for implementation of Program quality management.
Scott MacEwen, P.E.	AQM	CH2M HILL	Provides senior technical support for investigative sampling and data assessments
Brett Doerr	Navy CLEAN Program UFP-SAP Reviewer	CH2M HILL	Provides project delivery support and program level review of UFP-SAP; responsible for reviewing audit results and CAs
Bill Kappleman	Senior Ecological Risk Assessor	CH2M HILL	Evaluate and document benthic community data with respect to ecological contaminant of concern (COC) and contaminant of potential concern (COPC) data and abrasive blast material (ABM) content to determine further action/investigation/no action requirements.
Anita Dodson	Navy CLEAN Program Chemist	CH2M HILL	Provides UFP-SAP project delivery support and QA oversight and program-level review of UFP-SAP
Megan Morrison	Project Chemist	CH2M HILL	Assists in SAP preparation, coordinates laboratory and data validation subcontractors, and performs oversight of laboratory and data validation
Victoria Brynildsen	EIS	CH2M HILL	Data Management: manages sample tracking, communicates with laboratory and data validator
FTL		CH2M HILL	Coordinates all field activities and sampling; tracks, stores, and retrieves all laboratory and field supplies
Mark Orman	H&S Officer	CH2M HILL	Prepares HSP; manages H&S for all field activities
SSC		CH2M HILL	Oversees H&S for all field activities
Sonya Gordon	Laboratory PM	Empirical	Manages samples tracking and maintains communication with Project Chemist and EIS
Marcia McGinnity	Laboratory QAO	Empirical	Responsible for audits, CA, checks of QA performance within the laboratory
Pat Beaver	PM	Beaver Engineering	Manages samples tracking and maintains communication with primary laboratory
David Evans	PM	Water & Air	Manages samples tracking and maintains communication with Project Chemist and EIS
Ward Dickens	Data Validator	CH2M HILL	Validate data received from laboratory prior to data use

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SAP Worksheet #8—Special Personnel Training Requirements Table

Project Function	Specialized Training By Title or Description of Course	Training Provider	Training Date	Personnel / Groups Receiving Training	Personnel Titles / Organizational Affiliation	Location of Training Records / Certificates
SWMU 3 Environmental Field Work	Hazardous Waste Operations and Emergency Response 40-hour training or 8-hour annual refresher, as appropriate	Registered training organization	Agency- and contractor-specific	FTL (TBD), field team members (TBD), SSC (TBD); DoN and regulatory agency representatives	Field team members SSCs from CH2M HILL; onsite visitors from DoN and regulatory agencies	Contractor, DoN, or regulatory agency human resources department
SWMU 3 Environmental Field Work	SSC – Hazardous Waste	Registered training organization	Agency-specific	SSC	SSC from CH2M HILL	Contractor human resources department

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

Project Name: SWMU 3 Benthic Sampling **Projected Date(s) of Sampling:** August/September 2010 **PM:** Cecilia Landin – CH2M HILL	**Site Name:** SWMU 3 – Pier 10 Sandblast yard **Site Location:** Naval Amphibious Base (NAB) Little Creek, Virginia Beach, Virginia

Date of Session: April 14, 2010

Scoping Session Purpose: Discuss path forward for remedial action at SWMU 3.

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Bryan Peed	RPM	NAVFAC Mid-Atlantic	757-341-0480	bryan.peed@navy.mil	RPM
Jeff Boylan	RPM	USEPA Region 3	215-814-2094	boylan.Jeffrey@ epamail.epa.gov	Regulator
Paul Herman	RPM	VDEQ	804-698-4464	peherman@deq. virginia.gov	Regulator
Cecilia Landin	AM/PM	CH2M HILL	757-671-6266	cecilia.landin@ch2m.com	AM/PM
Adina Carver	Former AM	CH2M HILL	757-671-6213	adina.carver@ch2m.com	Former AM
David Livingston	Deputy AM	CH2M HILL	757-671-6239	david.livingston@ch2m.com	Recorder

Overview:

The Navy confirmed the Military Construction (MILCON) dredge of Area A is going forward as planned under the maintenance dredge permit. The Navy recommended performing an Engineering Evaluation/Cost Analysis (EE/CA) for the near-shore areas. The Navy proposed the EE/CA be followed by a Feasibility Study (FS) to address the remaining portions of the site with the potential of long-term monitoring (LTM) for benthic organisms for the remaining portions of the site. EPA noted the team established the Preliminary Remediation Goals (PRGs) for the site and the PRGs needed to be attained to address ecological risk at the site and suggested LTM will be required once remedial action has been completed throughout the site; and recommended an action be completed in Area B before an LTM plan is established.

EPA noted the marina piers are recreational and should not preclude an environmental remediation. Navy suggested remediation of the marina area would have limited reduction in risk. EPA noted this limited reduction in risk is in relation to PRGs and not necessarily the benthic community; the reestablishment of the benthic community is important from an ecological perspective. EPA noted the SWMU 3 PRGs established by the NAB Little Creek Partnering Team are approximately at background levels except for zinc and suggested another method for establishing PRGs may be warranted.

VDEQ noted the approach of remediating the areas of highest risk (Area A, the rip rap area, and the near-shore area) followed by LTM of the benthic community, was a potentially acceptable path forward if it was agreed upon by EPA (including the Biological Technical Assistance Group [BTAG]). VDEQ suggested a robust benthic community background data set should be established prior to LTM. LTM results would be reported in the Five-Year Review. VDEQ recommended the background set include samples from the entire Little Creek area not impacted by Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) releases and not just SWMU 3. CH2M HILL clarified if the approach described by VDEQ was followed, an FS would be completed to evaluate alternatives for the remaining areas of interest at the site. A Proposed Remedial Action Plan (PRAP) and ROD would follow the FS and implement LTM. EPA noted the development of a ROD would be difficult under this scenario because there would still be PRG exceedances at the site. VDEQ noted if the benthic community was being established even though there were PRG exceedances, a ROD could still be developed. EPA suggested the PRGs were collectively accepted which defined the area requiring remediation. EPA agreed an EE/CA would be allowable, but if the EE/CA did not address all of the areas within the defined boundaries established by the PRGs, then a LTM ROD could not be issued.

CH2M HILL asked for clarification when the PRGs go from preliminary to established remediation goals. VDEQ noted they are finalized as goals in the ROD. CH2M HILL suggested the PRGs currently established are, by definition, preliminary and may be adjusted if the investigation shows a benthic community is being established despite PRG exceedances at the site. EPA noted the risk assessment process was truncated for SWMU 3 with the development of unconventional PRGs to more quickly define the area requiring remediation. Generally speaking, the alternatives in the FS are developed with the PRGs in mind. EPA agreed the collection of benthic community data would potentially factor into the remedial path forward.

The Team agreed to move forward with the dredging of Area A and perform an EE/CA for the rip-rap area and near-shore area in the northern portion of the site. The Team further discussed the establishment of a background data set for the benthic community at Little Creek. The Team discussed monitoring of the benthic community within the site following dredging of Area A and remedial action in the near-shore areas and the documentation of the data in the FS to establish a path forward for the site. VDEQ recommended establishing baseline levels of the benthic community at the site prior to any dredging or remedial action. VDEQ suggested the evaluation of the benthic community at SWMU 3 is important to determine what, if any, remedial actions are appropriate. EPA suggested this sampling may potentially bring the site back to the Baseline Ecological Risk Assessment (BERA) step. The Team agreed to the previous assumption that no benthic community exists in the area, based on the lack of benthic community in the near shore samples collected during the RI.

Path Forward:

CH2M HILL will move forward with developing the EE/CA for near-shore remediation and determining the cost components for remedial action at the site.

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

Project Name: SWMU 7b Benthic Invertebrate Sampling **Projected Date(s) of Sampling:** August/September 2010 **PM:** Cecilia Landin – CH2M HILL	**Site Name:** SWMU 7b – Desert Cove **Site Location:** Naval Amphibious Base (NAB) Little Creek, Virginia Beach, Virginia

Date of Session: May 18, 2010

Scoping Session Purpose: Discuss sampling design for site-specific and reference area benthic invertebrate sampling.

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Bryan Peed	RPM	NAVFAC Mid-Atlantic	757-341-0480	bryan.peed@navy.mil	RPM
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Paul Herman	RPM	VDEQ	804-698-4464	peherman@deq. virginia.gov	Regulator
Cecilia Landin	AM/PM	CH2M HILL	757-671-6266	cecilia.landin@ch2m.com	AM/PM
Adina Carver	Former AM	CH2M HILL	757-671-6213	adina.carver@ch2m.com	Former AM
David Livingston	Deputy AM	CH2M HILL	757-671-6239	david.livingston@ch2m.com	Recorder

Overview:

A dredging Military Construction (MILCON) action was completed in Desert Cove in 2007. In 2009, sediment samples were collected to assess existing site conditions. As presented during the March 2010 Team meeting, primary contaminant of potential concern (COPC) concentrations detected in the Cove and Connector Channel Areas in 2009 were similar to pre-dredge primary COPC concentrations indicating MILCON activities did not adversely impact these areas and risks remain generally acceptable. COC concentrations detected in the Pier Area in 2009 indicate potentially unacceptable risks to lower trophic level organisms remain in this area, mainly the northeast corner. As a result, the Team concluded an assessment of benthic invertebrates was needed to develop an appropriate path forward for SWMU 7b.

The team discussed the collection of site-specific samples within the northeast corner of Pier Area only and reference area samples from the Connector Channel Area where risks were determined to be acceptable. Reference area samples would not be collected from previous background sample locations within Little Creek Cove because the Desert Cove system is less dynamic than Little Creek Cove. VDEQ recommended using site-specific reference samples in close proximity to SWMU 7b and SWMU 3, but supplementing the data with samples collected from other areas (Little Creek

SAP Worksheet #9-2—Project Scoping Session Participants Sheet (continued)

Cove, Little Creek Channel, etc.) that could act as a background data set applied to both sites. It was noted operational activities associated with each area should be considered as they may significantly impact the benthic communities present.

Previous locations and two new locations within the northeast corner of the Pier Area will be sampled and analyzed for benthic invertebrates, total organic carbon (TOC), pH, and grain size. The two new sampling points will include COPC and acid volatile sulfides /simultaneously extracted metals (AVS/SEM) analysis to provide for complete data sets. USEPA questioned whether the AVS/SEM analysis may be affected by seasonal variation; therefore requiring analysis at all sample locations. USEPA noted the Team did not agree whether additional action was needed outside the northeast corner of the Pier Area and suggested providing the existing data to technical support to ensure the appropriate data set is used. The number of samples collected within the Pier Area should be considered in comparison to the number of reference samples to ensure the sample set is not skewed. The current ratio between site samples and reference samples was based on statistical recommendation. USEPA suggested if the entire Pier Area is still an area of potentially unacceptable risk, then the entire Pier Area should be sampled and an increased number of samples may be necessary. To aid in sample location selection, the Team agreed to re-align the existing grid system at SWMU 7b. Additionally, the team agreed samples will not be collected within the dredged area.

Statistical analysis of benthic community metrics will be used in the evaluation. USEPA noted any statistical difference between the site-specific reference samples collected in the Connector Channel Area and the installation-wide background samples should be taken into account. USEPA asked whether metrics need to be defined prior to sample collection and analysis. CH2M HILL noted the general metrics for evaluation were provided; however metrics cannot be finalized due to the uncertainty of the type of species or quantity of different species present in the system. USEPA clarified this UFP-SAP is only for sampling and analysis and does not apply to the statistical application of the data. Finalization of the metrics will take place during a separate Team meeting following receipt of the data. VDEQ suggested having technical experts develop initial, generic metrics prior to data collection for inclusion in the UFP-SAP.

Consensus:

- Samples will not be limited to the northeast corner of the Pier Area. Samples will be collected throughout the Pier Area with the exception of those areas recently dredged during the MILCON action.
- The Tier I partnering Team will reconvene following receipt of data to finalize metrics by which samples will be evaluated and compared.

Path Forward:

Continue SWMU 7b discussion, as appropriate, during the SWMU 3 agenda topic (**Worksheet #9-3**).

SAP Worksheet #9-2—Project Scoping Session Participants Sheet (continued)

Action Items:

CH2M HILL: Consult technical support to determine if AVS/SEM sample collection (bioavailability) may potentially be impacted by seasonal variation. If yes, determine whether all samples collected during the benthic invertebrate sampling event at SWMU 7b and SWMU 3 should include AVS/SEM analysis?

USEPA/CH2M HILL: Consult technical support to determine if initial benthic invertebrate metrics may be established for SWMU 3 and SWMU 7b prior to the collection of samples.

CH2M HILL: Consult technical support to determine the size and sediment volume collected by the ponar dredge necessary to ensure a representative sample is collected for each benthic sampling location at SWMU 3 and SWMU 7b.

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

Project Name: SWMU 3 Benthic Invertebrate Sampling **Projected Date(s) of Sampling:** August/September 2010 **PM:** Cecilia Landin – CH2M HILL	**Site Name:** SWMU 3 – Pier 10 Sandblast Yard **Site Location:** NAB Little Creek, Virginia Beach, Virginia

Date of Session: May 18, 2010

Scoping Session Purpose: Discuss sampling design for site-specific and reference area benthic invertebrate sampling.

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Bryan Peed	RPM	NAVFAC Mid-Atlantic	757-341-0480	bryan.peed@navy.mil	RPM
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Paul Herman	RPM	VDEQ	804-698-4464	peherman@deq. virginia.gov	Regulator
Cecilia Landin	AM/PM	CH2M HILL	757-671-6266	cecilia.landin@ch2m.com	AM/PM
Adina Carver	Former AM	CH2M HILL	757-671-6213	adina.carver@ch2m.com	Former AM
David Livingston	Deputy AM	CH2M HILL	757-671-6239	david.livingston@ch2m.com	Recorder

Overview:

PRGs were previously developed by the Team and horizontal and vertical delineation of the sediment remediation boundary has been completed. In the course of discussing potential remedial alternatives at the site during the March 2010 Team meeting and subsequent Team conference call on April 14, 2010, it was determined an assessment of benthic invertebrates was needed to further characterize the site and the extent of the area requiring action.

Site specific samples will be collected from within each grid located inside the remediation boundary and sampled for benthic invertebrates, TOC, pH, and grain size. Grids where no previously collected COC data in surface sediment are available will also be analyzed for COCs. If necessary, AVS/SEM samples will be collected as determined from the SWMU 7b discussion action item (**Worksheet #9-2**). Collection of reference data from former background sample locations within Little Creek Cove as well as additional samples from within Little Creek

SAP Worksheet #9-3—Project Scoping Session Participants Sheet (continued)

Harbor outside the remediation boundary was proposed. The potential for site boundary expansion due to the presence of ABM in sediment collected from Little Creek Harbor was discussed. Although small amounts of ABM have been observed within the SWMU 7b Connector Channel reference area, because a preliminary remediation goal (PRG) based on ABM content has been established for SWMU 3, any observation of ABM in exceedance of the PRG adjacent to the site boundary may warrant site expansion. ABM present within the Connector Channel and Little Cove is acceptable because ABM is not considered an indication of unacceptable risk. The Team agreed no reference area samples will be collected from within Little Creek Harbor.

The Team agreed to adjust the SWMU 3 flow chart to align with SWMU 7b discussion regarding finalization of benthic invertebrate metrics. CH2M HILL noted the benthic data evaluation will need to consider site specific activities such as the impacts of the operation of the dry dock which may disrupt the establishment of the benthic community independent of the presence or absence of ABM or metals in sediments.

USEPA questioned the different sampling strategies for SWMU 3 and SWMU 7b. SWMU 3 sampling includes the collection of a sample from each grid overlaying the site; whereas the proposed SWMU 7b sampling includes the collection of select sample points from the Pier Area. Additionally, proposed reference samples for SWMU 7b are located in the Connector Channel, which is within the current site boundary and does not include a comparison of data collected from Little Creek Cove which is the designated background area for metals concentrations used at both sites. USEPA questioned the applicability of comparing sediment COPC background data collected from Little Creek Cove with COPC data collected at SWMU 7b if the same data usability does not apply to benthic invertebrate data. The Team agreed site-specific benthic invertebrate samples will be collected from the Cove and Connector Channel Areas and the proposed background samples in Little Creek Cove will be the common data set used for both SWMU 3 and SWMU 7b.

VDEQ suggested collecting additional background samples from Little Creek in the western portion of the Installation to provide benthic invertebrate data from an area impacted by a marina, similar to that within the SWMU 3 remediation area. The Team agreed to review the possibility of utilizing this area with technical support.

USEPA noted that PRGs for SWMU 3 have already been established and agreed to by the Team; therefore changing the PRGs based upon the results of the benthic invertebrate sampling may not be an appropriate path forward. PRGs will not be changed but will be used in conjunction with benthic invertebrate data as part of a weight of evidence evaluation to determine if remedial action within each grid is the appropriate path forward. The Team agreed the establishment of a separate PRG for benthic invertebrates and subsequent re-evaluation of the need for remedial action may be necessary.

Consensus:

- Reference samples will not be collected from within Little Creek Harbor.

SAP Worksheet #9-3—Project Scoping Session Participants Sheet (continued)

- The Tier I partnering Team will reconvene following receipt of data to finalize metrics by which samples will be evaluated and compared.
- Site-specific benthic invertebrate samples will be collected from the SWMU 7b Cove and Connector Channel Areas and the proposed background samples in Little Creek Cove will be the common data set used for both SWMU 3 and SWMU 7b.

Path Forward:

Incorporate Team recommendations into the SWMU 3 and SWMU 7b benthic invertebrate UFP-SAP.

Action Items:

USEPA/CH2M HILL: Consult technical support to determine if background samples should be collected in Little Creek (in close proximity to the marina) for SWMU 3 and SWMU 7b (see **Worksheets #9-4 and #9-5** for resolution).

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

Project Name: SWMU 3 and 7b Benthic Invertebrate Sampling **Projected Date(s) of Sampling:** August/September 2010 **PM:** Cecilia Landin – CH2M HILL	**Site Name:** SWMU 3 – Pier 10 Sandblast Yard and SWMU 7b – Desert Cove **Site Location:** NAB Little Creek, Virginia Beach, Virginia

Date of Session: August 17, 2010

Scoping Session Purpose: Discuss VDEQ and EPA comments regarding draft UFP SAP for Team consensus to mobilize prior to UFP SAP finalization.

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Bryan Peed	RPM	NAVFAC Mid-Atlantic	757-341-0480	bryan.peed@navy.mil	RPM
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Paul Herman	RPM	VDEQ	804-698-4464	peherman@deq. virginia.gov	Regulator
Cecilia Landin	AM/PM	CH2M HILL	757-671-6266	cecilia.landin@ch2m.com	AM/PM
Adina Carver	Former AM	CH2M HILL	757-671-6213	adina.carver@ch2m.com	Former AM
David Livingston	Deputy AM	CH2M HILL	757-671-6239	david.livingston@ch2m.com	Recorder

Overview:

Environmental Protection Agency (EPA) noted no official comments were yet provided from Biological Technical Assistance Group (BTAG); however an informal discussion took place. EPA noted BTAG's concern with reference to Little Creek Cove being non-CERCLA impacted. Due to the interconnectedness of the water bodies and the dynamic nature of the system, there is uncertainty if the sediments in the reference area were transported from a CERCLA impacted area. CH2M HILL noted the October 2007 Team meeting minutes document the Team (including a BTAG and United States Fish and Wildlife representative) collectively came to the conclusion that Little Creek Cove was suitable for use as a reference area. EPA also noted BTAG's comment that the PRGs, which have already been established, are still applicable and should be used in development of a path forward for the site. The UFP-SAP documents the metals and ABM based PRGs will continue to be used as PRGs for the site. Benthic PRGs will be established based on the data collected, and will be used in conjunction with the metals and ABM PRGs to evaluate remedial alternatives to achieve the RAO for the site.

VDEQ noted the UFP-SAP documents mercury detected at SWMU 3 as a secondary COC not related to CERCLA activities, whereas mercury detected at SWMU 7b is attributed to historic sandblasting activities. VDEQ noted this was inconsistent based on the similar

nature of the historic activities at the two sites. Since the Team agreed during previous discussions, mercury concentrations were not correlated to ABM concentrations and the development of a PRG for mercury was not necessary at SWMU 3, VDEQ confirmed inclusion of a statement in the UFP-SAP clarifying the potential for mercury to be related to the sandblasting activities at SWMU 3 was sufficient and the establishment of a PRG for mercury is not required. EPA asked if the location of the high mercury concentration at SWMU 3 corresponds to high metal concentrations that will require remedial action. CH2M HILL confirmed the elevated mercury concentration was detected at a sample point currently designated as requiring remedial action.

VDEQ asked if the reference samples collected at Little Creek (in close proximity to the private marina in the northwest portion of the base) are appropriate for use during this sampling event. CH2M HILL noted Team meeting minutes from June 2003 indicate these samples were not reflective of conditions at SWMU 3 or SWMU 7b because sediment from those locations did not have the appropriate grain size or total organic carbon (TOC). Additionally, these locations may be influenced by outside activities (non-Navy sandblasting).

Consensus:

No benthic samples will be collected from Little Creek.

Path Forward:

CH2M HILL will revise the UFP-SAP based on comments provided by EPA and VDEQ. Benthic sampling will begin the week of August 30, 2010.

Action Items:

CH2M HILL: Develop language for the benthic sampling UFP-SAP concerning mercury concentrations at SWMU 3 and provide the text to the Team for review.

EPA/VDEQ: Provide the Team with a written (or electronic) consensus to mobilize for benthic sampling at SWMU 3 and SWMU 7b.

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

Project Name: SWMU 3 and SWMU 7b Benthic Invertebrate Sampling **Projected Date(s) of Sampling:** August/September 2010 **PM:** Cecilia Landin – CH2M HILL	**Site Name:** SWMU 3 – Pier 10 Sandblast Yard and SWMU 7b – Desert Cove **Site Location:** NAB Little Creek, Virginia Beach, Virginia

Date of Session: August 24, 2010

Scoping Session Purpose: Discuss BTAG comments regarding sampling design.

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Bryan Peed	RPM	NAVFAC Mid-Atlantic	757-341-0480	bryan.peed@navy.mil	RPM
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Cecilia Landin	AM/PM	CH2M HILL	757-671-6266	cecilia.landin@ch2m.com	AM/PM
Adina Carver	Former AM	CH2M HILL	757-671-6213	adina.carver@ch2m.com	Former AM
David Livingston	Deputy AM	CH2M HILL	757-671-6239	david.livingston@ch2m.com	Recorder

Overview:

EPA was concerned the SAP indicated the current PRGs for the site would be abandoned and a new PRG would be established based on the results from the benthic sampling event. EPA noted PRGs should not be re-established based on the benthic data. VDEQ noted benthic count would be used as an additional line of evidence for risk-management of particular grids. EPA noted the existing PRGs are such that they would adequately reduce the toxicity of the sediments to acceptable levels. EPA reaffirmed the benthic invertebrate data would further inform the appropriate remedial actions at specific sampling locations (grids) and would be considered an additional line of evidence for risk-management decisions rather than an alternative or supplemental PRG.

VDEQ questioned how benthic invertebrate sediment sampling data from the Little Creek Cove reference area would benefit this evaluation. CH2M clarified that the intent was to use the reference area data to statistically compare against data collected from each grid. VDEQ noted if ABM is found at a sediment sample location within the reference area, the UFP-SAP states the sample would be discarded and another sample location would be selected. VDEQ was concerned the detection of ABM in the reference area may require either the area be explored as a potential new site or the existing SWMU 3 remedial boundary be expanded to include that area. VDEQ suggested the presence or absence of benthic invertebrates at a particular sediment sampling point could alone be used in the decision process to address a

particular grid. EPA suggested if the PRGs are based on metals concentrations, a direct comparison with another reference area is not necessary and the concern with the use of the reference area in Little Creek Cove was the lack of sufficient data to demonstrate the area had not been indirectly impacted by a CERCLA site. CH2M HILL suggested using the Connector Channel and Cove areas of SWMU 7b as a comparison area. Although these areas are considered to be impacted by a CERCLA site, they are considered to not pose an unacceptable risk to human health or the environment. VDEQ agreed this comparison is logical. CH2M HILL confirmed the benthic samples collected in 2002 demonstrated the existence of a benthic community in the SWMU 7b Connector Channel and Cove. CH2M HILL noted SWMU 3 and SWMU 7b may have slightly different benthic organisms due to site conditions rather than CERCLA contaminants. Comparison of the relative abundance of species rather than the types of species may compensate for this difference. EPA asked how the metric comparison would be developed. CH2M HILL suggested that the metrics would be difficult to develop prior to the obtaining of sampling results. EPA suggested the confusion of the metric comparison between SWMU 3 and the Connector Channel/Cove areas may be avoided if the grids within SWMU 3 are statistically compared against themselves. Remedial actions would be "grid-specific". VDEQ agreed this internal statistical comparison is appropriate and more preferable than comparison against the Connector Channel and Cove areas.

CH2M HILL noted the Team was in agreement on the path forward and the UFP-SAP text would be revised to clarify the benthic data would not be used to establish a PRG, but would instead be used as a line of evidence for risk-management decisions. The UFP-SAP would also be revised to direct collection of COC data concurrently with benthic data at all sample points, thereby providing a clearer relationship between COC concentrations and benthic invertebrate concentrations.

The Engineering Evaluation / Cost Analysis (EE/CA) is being prepared to identify a removal action for the near-shore sediments (areas of highest concentration); the decisions of which are independent of the benthic invertebrate data. The conceptual site model (CSM) will be revised following the removal action after which the Team will collectively determine, per grid, the appropriate remedial actions. The process to evaluate the benthic invertebrate data and the remedial action associated with each grid will be presented more fully in the Feasibility Study (FS).

Consensus:

Collection of site-specific benthic invertebrate data for SWMU 3 and SWMU 7b is necessary.

Path Forward:

CH2M HILL will mobilize to begin benthic invertebrate sediment sample collection on August 30, 2010.

Action Items:

USEPA/VDEQ/CH2M HILL: Consult with technical support to determine the most appropriate utilization of the benthic invertebrate sediment sampling data and to determine if a reference area should be sampled. Provide technical support response and schedule subsequent discussion for reference area sampling if necessary.

SAP Worksheet #9-6—Project Scoping Session Participants Sheet

Project Name: SWMU 3 and SWMU 7b Benthic Invertebrate Sampling **Projected Date(s) of Sampling:** August/September 2010 **PM:** Cecilia Landin – CH2M HILL	**Site Name:** SWMU 3 – Pier 10 Sandblast Yard and SWMU 7b – Desert Cove **Site Location:** NAB Little Creek, Virginia Beach, Virginia

Date of Session: August 30, 2010

Scoping Session Purpose: Discuss applicability of reference area sampling in Little Creek Cove.

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Bryan Peed	RPM	NAVFAC Mid-Atlantic	757-341-0480	bryan.peed@navy.mil	RPM
Jeff Boylan	RPM	USEPA Region 3	215-814-2094	boylan.Jeffrey@ epamail.epa.gov	Regulator
Paul Herman	RPM	VDEQ	804-698-4464	peherman@deq. virginia.gov	Regulator
Cecilia Landin	AM/PM	CH2M HILL	757-671-6266	cecilia.landin@ch2m.com	AM/PM
Adina Carver	Former AM	CH2M HILL	757-671-6213	adina.carver@ch2m.com	Former AM
David Livingston	Deputy AM	CH2M HILL	757-671-6239	david.livingston@ch2m.com	Recorder

Overview:

USEPA provided input from BTAG regarding the proposed changes to the UFP-SAP per the August 17 and 24, 2010 conference calls (**Worksheets #9-4 and #9-5**). BTAG agreed with the NAB Little Creek Partnering Team's proposal to eliminate sampling at a reference area. The proposed methodology of internally comparing individual SWMU 3 benthic invertebrate sediment samples against results from the remainder of the site is considered acceptable. SWMU 7b benthic invertebrate sediment samples collected in the Pier area will likewise be compared internally against samples collected in the Cove and Connector Channel areas. VDEQ technical support similarly agreed with this path forward for both SWMU 3 and SWMU 7b. CH2M HILL's ecological risk assessor, Bill Kappleman, suggested a reference area in which to compare results against would be preferable, but he agreed it wasn't necessary to accomplish project objectives. The Navy also agreed with the proposed path forward.

Path Forward:

Reference area sampling will be eliminated from the sampling scheme and benthic invertebrate sediment sampling will begin immediately.

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SAP Worksheet #10-1—SWMU 3 Problem Definition

Site Description and History

NAB Little Creek encompasses 2,215 acres in the northwest corner of Virginia Beach, Virginia, adjacent to the Chesapeake Bay (**Figure 1**). SWMU 3, the Pier 10 Sandblast Yard, is located in a developed area on Little Creek Harbor's western side (**Figure 2**). SWMU 3 was used for sandblasting boats between 1962 and 1984 (Rogers, Golden, and Harpern, 1984). Sandblasting activities took place on a 0.04 acre concrete pad located to the west of Building 1263. After 1984, anchors and chains were sandblasted on the concrete pad. The used sandblast material was periodically sampled using extraction procedure toxicity testing protocols and removed from the site for disposal. Results of these toxicity tests indicated the sandblast residue was not hazardous. Paint chips and blast grit covered the unpaved ground south of the pad to the water's edge and the near-shore bottom of Little Creek Harbor. In 1982, a fence was installed around the sandblasting area to limit access to the site and prevent windblown sandblast materials from migrating outside the fenced area. In 1995, the concrete pad was taken out of service, and a new sandblasting area was constructed in the northwestern corner of the site. The new sandblasting area consisted of a 0.4 acre concrete pad surrounded by a 4 to 5-foot-high concrete wall. All sandblasting operations at SWMU 3 ceased in 1996 when the new indoor sandblasting facility, CB125 adjacent to SWMU 7b, was completed.

The conceptual site model (CSM) is presented on **Figure 3**. Historical releases from SWMU 3 likely occurred when sandblasting residue was lying directly on the ground surface. Prior to 1993, runoff from sandblasting operations occurred as sheet flow to Little Creek Harbor. In 1993, a catch basin connected to a Virginia Pollution Discharge Elimination System (VPDES)-permitted outfall was constructed. Surface drainage from the more recent sandblasting area flowed to this catch basin and emptied into Little Creek Harbor via VDEQ-permitted Outfall 008 (Permit Number VA0079928) located under Pier 10, about 35 feet from its easternmost edge. Under the VDEQ permit, Outfall 008 has no monitoring requirements. Some runoff from other areas of SWMU 3 may continue to flow directly into Little Creek Harbor. Currently, residual ABM is present on the unpaved ground surface south of the concrete pad to the water's edge and in Little Creek Harbor sediment in the vicinity of Pier 10, the recreational marina, and south to Pier 8.

Dredging maintenance activities vary within the vicinity of SWMU 3. Little Creek Channel (not including the near-shore sediments that make up a part of SWMU 3) is maintained by United States Army Corps of Engineers and has been regularly dredged since 1928 to maintain a depth of approximately 27 feet below mean low water (mlw) (**Figure 2**). The surrounding area is maintained by NAB Little Creek to depths ranging from approximately 18 to 31 feet below mlw plus a 1-foot over-dredge. In 1965, the areas around Piers 1 through 8, south of the recreational marina (just southwest of the Pier 10 dry dock), were dredged to 18 feet below mlw plus a 2-foot over-dredge. In 1999, 2 to 5 feet of sediment were removed from beneath the Pier 10 dry dock to a depth of approximately 31 feet below mlw plus a 1-foot over-dredge. The recreational marina area is permitted for a dredge depth of approximately 10 feet below mlw plus a 1-foot over-dredge, however, this area has not been dredged since 1965.

SAP Worksheet #10-1—SWMU 3 Problem Definition (continued)

Most of the aquatic activities within the SWMU 3 boundary are associated with the Pier 10 dry dock area and the recreational marina. The Pier 10 dry dock area of Little Creek Harbor is used for dive team training and boat maintenance. Boats are brought to the Pier 10 dry dock for maintenance with the assistance of a tug boat. Once boats are secured, water is removed from the dry dock at approximately 2000 gallons per minute using ballast pumps. During these activities, sediments are disturbed; therefore, vertical mixing of the sediment in this area is likely. The recreational marina is used by military dependents and former active-duty members. Personal watercraft docked at the marina may cause minimal vertical mixing in the sediment. Substantial mixing is unlikely since the marina area is a "no wake" zone for boaters. A fueling station and fish-cleaning station are located south of the boat slips. For security purposes, recreational swimming, fishing, and crabbing are not permitted in Little Creek Harbor.

Reasonable maximum exposure non-cancer hazards and cancer risks associated with current and future human exposure to site sediment and surface water are below or within the USEPA acceptable levels. The DoN, USEPA, and VDEQ agree there is no unacceptable human health risks associated with exposure to sediment or surface water.

A Screening Ecological Risk Assessment (ERA), constituting Steps 1 and 2 of the ERA process, and the first step (Step 3A) of a baseline ERA were conducted for SWMU 3 as part of the Remedial Investigation (RI) (CH2M HILL, 2005). Based on the results of the ERA, the DoN, USEPA, and VDEQ agreed there are no unacceptable ecological risks associated with direct or indirect exposure to surface water. However, a comparison of sediment data to screening values, and the evaluation of near-shore benthic community survey data in the ERA, indicate ABM-related constituents (copper, lead, nickel, tin, and zinc) from the site, as well as mercury and polycyclic aromatic hydrocarbons (PAHs) have adversely affected ecological receptors (primarily the benthic invertebrate community) in the portions of Little Creek Harbor adjacent to SWMU 3. A revised ERA was conducted as part of the SRI to define the spatial limits (lateral and vertical) of ABM and to determine if there is a correlation between metals and ABM in sediment (CH2M HILL, 2009). The revised ERA concluded ABM was significantly correlated with copper, lead, nickel, tin, and zinc in surface sediments and is a good indicator of site influence for defining the spatial extent of contamination and unacceptable risks. Although commonly used as an anti-fouling agent in marine paints, mercury concentrations detected in sediment were not correlated with ABM content and concentrations posing risk were spatially limited. PAHs were detected in sediment across the site at concentrations contributing to risk; however are not associated with historic sandblasting activities and therefore not considered a result of a CERCLA release. The revised ERA recommended that RAOs be established for sediment and that PRGs be developed for the five ABM-related COCs (copper lead, nickel, tin, and zinc), based on the extent of ABM, risk-based screening values, and comparison to urban background levels, while mercury and PAHs be considered as secondary factors based on their lack of correlation with ABM and poor spatial linkage to SWMU 3. As a result, the following RAO was developed for sediment: remove ABM-containing sediments and associated metals from the site to the greatest extent practicable to allow a benthic invertebrate community consistent with the urban nature of Little Creek Harbor to become established. To meet this

SAP Worksheet #10-1—SWMU 3 Problem Definition (continued)

objective, an ABM-based PRG of ≤ 1 percent ABM (based on visual observation) and metals-based PRGs, as presented in **Table 1**, were established.

TABLE 1
Sediment PRGs

Copper		Lead		Nickel		Tin		Zinc	
TEL	18.7	TEL	30.2	TEL	15.9	Mean Background	8.61	TEL	124
ER-L	34.0	Mean Background	45.2	ER-L	20.9	Max Background	9.80	ER-L	150
PEL	108	ER-L	46.7	Mean Background	23.2	1% ABM	11.2	PEL	271
Mean Background	155	Max Background	67.6	1% ABM	26.2	ER-L	NA	Mean Background	290
Max Background	184	1% ABM	107	Max Background	26.5	ER-M	NA	ER-M	410
1% ABM	232	PEL	112	PEL	42.8	TEL	NA	Max Background	421
ER-M	270	ER-M	218	ER-M	51.6	PEL	NA	1% ABM	454

Shaded cells indicate the selected PRG
Values are in milligrams per kilogram (mg/kg)
ER-L – effects range low
ER-M – effects range median
PEL – probable effects level
TEL – threshold effects level

Available surface sediment data was used to define the lateral extent of the ABM- and metals-based remediation area. In conjunction with ABM content, a remediation quotient (RQ) for the ABM-related COC PRGs was calculated. The RQ is defined as the ratio of the PRG to the sediment concentration. A sample location was considered "impacted" if: 1) ABM is present at > 1 percent, and 2) the average RQ for the five COCs exceeds 1.0 or if the RQ for one or more individual COCs exceeds 1.5. In November 2009, additional sediment sampling was conducted to define the vertical extent of the ABM- and metals-based remediation area. To perform the vertical delineation, the site was divided into a 100x100 foot grid system. Sediment cores were collected from within each grid located within the lateral remediation boundary and the maximum vertical extent of unacceptable ABM content (> 1 percent) was visually identified. Subsurface sediment samples were collected from below the unacceptable ABM and analyzed for the ABM-related COCs. The vertical extent of impact was defined as the shallowest depth at which the RQs were below established criteria. Following the November 2009 sampling event, the ABM- and metals-based remediation area was refined to include all "impacted" grids as defined above. The revised remediation area is approximately 13.3 acres and consists of approximately 61,266 cubic yards of sediment (**Figure 2**).

Project Objectives

Following discussions regarding potential remedial alternatives and their overall effectiveness in reducing site-wide risk as well as upcoming MILCON and dry dock maintenance activities, the NAB Little Creek Partnering Team discussed if additional information regarding the current condition of the benthic invertebrate community at

SAP Worksheet #10-1—SWMU 3 Problem Definition (continued)

SWMU 3 was necessary to aid in evaluating alternative effectiveness and measuring achievement of the RAO (**Worksheet #9-1**). Because the end receptor and measurement criterion for RAO achievement is the benthic community, it was concluded that such data were necessary. Therefore, the project objective for benthic invertebrate sampling at SWMU 3 (the subject of this SAP) is to evaluate the current condition of the benthic invertebrate community within the remediation area to support the evaluation of remedial alternatives and assist in measuring remedy success against the RAO.

Environmental Questions Answered by this Project:

What is the composition and condition of the existing benthic invertebrate community at SWMU 3 and how does it vary spatially throughout the site?

Surface sediment samples will be collected from within each grid located within the ABM- and metals-based remediation boundary (**Figure 4**). Three grab samples will be collected within each grid and composited for analysis of benthic invertebrates, pH, TOC, and grain size. To measure variability within a grid, the three grab samples will be analyzed for benthic invertebrates separately in 5 percent of the grids (randomly selected). The laboratory will identify benthic invertebrates to the lowest practical identification level. One randomly selected grab sample from each grid will be analyzed for AVS/SEM; this sample will not be composited in order to minimize the potential for volatilization. Samples for physical and chemical analysis will be analyzed on a standard turnaround time. Benthic invertebrate samples will be analyzed on a 60-day turnaround time. Surface water quality indicator parameter measurements for pH, specific conductivity, salinity, turbidity, temperature, dissolved oxygen (DO), and oxidation-reduction potential (ORP) will be collected from each grab sample location.

Is the composition and condition of the existing benthic invertebrate community at SWMU 3 correlated with the concentration of the COCs and/or the presence of ABM?

Following sample compositing, surface sediment ABM content within each grid will be visually estimated using percentage diagrams for estimating composition by volume (Compton, 1985), provided as a part of Standard Operating Procedure (SOP) 011 in **Attachment B**. Additionally, composite samples from each grid will be analyzed for copper, lead, nickel, tin, and zinc. Samples will be analyzed on a standard turnaround time. Surface water quality indicator parameter measurements for pH, specific conductivity, salinity, turbidity, temperature, DO, and ORP will be collected from each grab sample location.

Statistical methods appropriate to the distributions of the parameters evaluated will be used to determine if there are any significant correlations between benthic invertebrate community metrics and COC sediment concentrations, percent ABM, and/or physical parameters (such as SEM/AVS ratios and grain size distribution). The existence of significant correlations, or the lack of correlations, will be used as a line of evidence for future risk management decisions.

SAP Worksheet #10-1—SWMU 3 Problem Definition (continued)

What is the site conditions following completion of the NTCRA and what action is required at SWMU 3 to meet the RAO and what is the spatial extent of such an action?

The conceptual site model for SWMU 3 will be re-assessed utilizing the analytical and benthic invertebrate data in accordance with the decision analysis shown on **Figure 5**. A statistical comparison of SWMU 3 benthic invertebrate data will be conducted to assess the spatial differences across the site as well as the benthic invertebrate community's correlation to ABM content and metals concentrations in surface sediment. . Prior to completing the statistical comparison of the benthic invertebrate data, the NAB Little Creek Partnering Team will discuss and finalize the metrics to be used in the statistical evaluation of these data. Preliminary metrics focus on species richness, density, and diversity, and the contribution of various "indicator" taxa to the overall benthic community. These preliminary metrics are listed on **Figure 5**. ABM, COC, and benthic invertebrate data within each grid will then be evaluated against decision points (i.e., PRGs) to determine the most appropriate path forward for each grid while achieving the RAO to the greatest extent practicable. Prior to completion of this evaluation, the NAB Little Creek Partnering Team will establish the decision points, in the form of if/then statements.

SAP Worksheet #10-2—SWMU 7b Problem Definition

Site Description and History

SWMU 7 (Small Boats Sandblast Yard), formerly referred to as SWMU 137, is located at the intersection of Intercove Road and Signal Point Road in the north central portion of the Base (**Figure 6**). For investigation purposes, SWMU 7 was divided into two sections: the terrestrial portion of the site (SWMU 7a) consists of the area along former Piers 44 - 55 as well as the area surrounding the northern portion of Building CB-125; the aquatic portion of the site (SWMU 7b) consists of Desert Cove and the Connector Channel. SWMU 7a was used to sandblast and paint ships until 1996, when sandblasting activities were moved to an indoor facility (CB-125). Approximately 4,000 cubic yard (yd^3) of spent ABM generated between 1960 and 1982 was stored in open piles in the construction footprint of CB-125 and in the area of CB-317 and CB-318 while awaiting characterization extraction procedure toxicity testing prior to disposal. A small amount of ABM was also noted near Building 3869 (Kearney, 1989). The ABM has since been sampled, removed, and disposed of offsite. No release controls were identified at SWMU 7a; therefore, spent ABM has historically been released to soils and Desert Cove. Following an Interim Removal Action in September 2004 to remove lead contaminated soils, the DoN, in partnership with USEPA and VDEQ, agreed no further action was required for SWMU 7a, and a Record of Decision (ROD) was signed in June 2005 (DON, 2005).

The ground surface at SWMU 7a is mainly covered with buildings, concrete, asphalt, and hard-packed gravel. Precipitation runs off to Desert Cove and the Connector Channel or is discharged through one VPDES-permitted (Outfall 007) and eighteen non-permitted stormwater outfalls, with very little infiltration to groundwater. All drainage to the cove and channel is from on-base areas, consisting mainly of buildings and asphalt parking areas. Almost the entire shoreline of SWMU 7a is bulkheaded and currently used to moor small ships. Desert Cove is a tidal marine environment connected to the Chesapeake Bay via the Connector and Little Creek Channels. Prior to a MILCON action at Desert Cove completed in 2008, the area was last dredged in 1953 to a depth of 10 feet below mlw. As part of the MILCON action, a pre-dredge survey was conducted in January 2008. Results indicate the deposition rate for the cove is relatively low. The current and reasonably anticipated future land use of the SWMU 7 area is not expected to change.

In 2008, a MILCON action to demolish and replace Piers 44-51, construct a new quay wall along the eastern and southern edges of the cove, and dredge limited areas surrounding the former piers was completed. The new quay wall was constructed approximately 32 feet outboard of the former knee wall. Sheet piling was installed to a depth of 24 feet below sediment surface (bss) and all material between the sheet pile and knee wall was left in place. The roadway adjacent to the shoreline was demolished and debris was allowed to fall in place between the knee wall and the sheet pile. A new concrete roadway was constructed along the edge of the new quay wall. Following demolition and prior to construction of the new piers, the area around the former piers was dredged to a depth of 10 feet below mlw (**Figure 6**). **Figure 7** displays the CSM for SWMU 7b.

SAP Worksheet #10-2—SWMU 7b Problem Definition (continued)

Prior to the MILCON action, a RI/Human Health Risk Assessment (HHRA)/ERA was completed for SWMU 7b to evaluate the nature and extent of contamination and potential human health and ecological risks associated with exposure to sediment. During the RI, SWMU 7b was divided into three areas: the Connector Channel, Cove, and Pier Areas (**Figure 6**). This was done to better evaluate potential risks where potential exposures could vary due to differences in the magnitude of contaminant concentrations. ABM was observed in sediment throughout the cove and connector channel, with heavy ABM noted in the Pier Area adjacent to Pier 53. Metals and PAHs were detected in sediment above human health and ecological screening values. However, the quantitative human health risk assessment identified no potentially unacceptable human health risks associated with exposure to sediment. An ERA (through Step 3A) was conducted as part of the RI. Potentially unacceptable ecological risks from lower trophic level organism exposure to sediment were identified for each area due to metals (primary COPCs: copper, lead, mercury, tin, and zinc; and secondary COPCs: arsenic, selenium, and silver) and PAHs. In general, COPC concentrations were highest in the Pier Area and lowest in the Connector Channel. The RI recommended further investigation of SWMU 7b be conducted following completion of the scheduled MILCON action. During the November 2008 Partnering meeting the Navy, in partnership with USEPA and VDEQ, agreed potential risk associated with PAHs and secondary COCs arsenic, selenium, and silver are acceptable and do not require further investigation based on the following:

- PAHs are not likely attributable to a CERLCA release from SWMU 7.
- The site-wide maximum HQ for arsenic in surface sediment is low (1.54) and the site-wide mean HQ is less than one. Additionally, the similarity of the mean and maximum concentrations suggests this chemical is present at background levels.
- Selenium was only detected in a small number (about 25 percent) of the surface samples at very low concentrations (< 2.5J milligrams per kilogram [mg/kg]). Site-wide maximum HQ for selenium in surface sediment is low (2.50) and the site-wide mean HQ is less than one.
- Silver was detected in only a small percentage (about 15 percent) of surface samples and was not detected in subsurface sediment. Potential ecological risk was driven by samples located within the area since removed by the MILCON action.

In November 2009, surface sediment sampling was conducted to evaluate post-MILCON action conditions within the Cove, Connector Channel, and Pier Areas. Maximum and mean November 2009 COPC concentrations were generally similar to, or lower than, 2002 COPC concentrations in the Cove and Connector Channel Areas (**Figure 8**). In general, COPC concentrations in the non-dredged portion of the Pier Area were similar to 2002 COPC concentrations in these areas. Concentrations of COPCs detected within the dredged portion of the Pier area were generally similar to, or lower than, those previously detected with the exception of northeastern corner of the Pier Area. Concentrations detected within this area indicate subsurface sediment sampled in 2002 may currently be exposed at the sediment surface as a result of the MILCON dredge action. Although the Revised ERA UFP SAP

SAP Worksheet #10-2—SWMU 7b Problem Definition (continued)

(CH2M HILL, 2009) outlined a comparison of results against ecological screening values ER-L and PEL (no values available for tin), National Oceanic and Atmospheric Association (NOAA) Screening Quick Reference Tables (SQUIRT) (tin/TBT only), and maximum background values, results were also compared to ecological screening values ER-M and TEL (no values available for tin) to identify risks to ecological receptors based upon current site conditions (**Figure 8**). Although exceedances of ecological screening values were identified for COPCs in the Connector Channel area, with the exception of mercury in 2 of 5sample locations, detected concentrations in 2009 were below maximum background. The maximum mercury concentration detected (0.236 mg/kg) was only slightly elevated in comparison to the maximum background value (0.20 mg/kg). Exceedances of ecological screening values were also identified in the Cove area for all COPCs. However, with the exception of 2 locations (LW07-K3 and LW07-L2), mercury was the only COPC detected (maximum concentration of 0.381 mg/kg) above maximum background values. Lead, mercury, tin, and/or zinc were detected slightly above maximum background at LW07-K3 and LW07-L2 with a maximum concentration to background ratio of 1.51 for tin. Exceedances of ecological screening values were identified in all samples collected within the Pier Area. In the southern and eastern portion of the Pier Area, concentrations are below maximum background with the exception of mercury in 3 of 7 locations (maximum concentration of 0.309 mg/kg) and zinc in 1 of 7 locations (maximum concentration of 659 mg/kg). Maximum background values were exceeded for all COPCs in the northern portion of the Pier Area with maximum COPC concentrations detected in the LW07-M1 area.

Project Objectives

In accordance with the data quality objectives (DQOs) outlined in the Revised ERA UFP-SAP, potentially unacceptable risks in exceedance of maximum background values were identified at SWMU 7b; therefore, the NAB Little Creek Tier I partnering Team agreed that further investigation is warranted. The primary objective of this investigation is to assess the existing benthic community at SWMU 7b to assess the impacts of ABM and COPCs on lower trophic level receptors and determine if further investigation, action, or no action is required at the site.

Environmental Questions Answered by this Project:

What is the composition and condition of the existing benthic invertebrate community at SWMU 7b and how does it vary spatially throughout the site?

Surface sediment samples will be collected from all previous RI/post-MILCON sample locations within the Cove (6 locations) and Connector Channel (5 locations) Areas and from 4 previous RI/post-MILCON sample locations, as well as 4 new sample locations, with the Pier Area (**Figure 9**). Three grab samples will be collected at each location and composited for analysis of benthic invertebrates, pH, TOC, and grain size. To measure variability at a sample location, the three grab samples will be analyzed for benthic invertebrates separately at one sample location within each of the three areas (selected randomly). The laboratory will identify benthic invertebrates to the lowest practical identification level. One randomly selected grab sample from each location will be

SAP Worksheet #10-2—SWMU 7b Problem Definition (continued)

analyzed for AVS/SEM; this sample will not be composited in order to minimize potential volatilization. Samples for physical and chemical analysis will be analyzed on a standard turnaround time. Benthic invertebrate samples will be analyzed on a 60-day turnaround time. Surface water quality indicator parameter measurements for pH, specific conductivity, salinity, turbidity, temperature, DO, and ORP will be collected from each grab sample location.

Is the composition and condition of the existing benthic invertebrate community at SWMU 7b correlated with the concentration of the COPCs and/or the presence of ABM?

Following sample compositing, surface sediment ABM content at each location will be visually estimated using percentage diagrams for estimating composition by volume (Compton, 1985), provided as a part of SOP 011 in **Attachment B**. Additionally, composite samples from each grid will be analyzed for copper, lead, mercury, tin, and zinc (**Figure 9**). Samples will be analyzed

on a standard turnaround time. Surface water quality indicator parameter measurements for pH, specific conductivity, salinity, turbidity, temperature, DO, and ORP will be collected from each grab sample location.

Statistical methods appropriate to the distributions of the parameters evaluated will be used to determine if there are any significant correlations between benthic invertebrate community metrics and COPC sediment concentrations, percent ABM, and/or physical parameters (such as SEM/AVS ratios and grain size distribution). The existence of significant correlations, or the lack of correlations, will be used as a line of evidence in the overall evaluation to determine the need for further investigation/action/no action.

Is further investigation or action required for the Cove, Connector Channel, and/or Pier Areas at SWMU 7b?

Data collected during this investigation will be used in conjunction with the November 2009 post-MILCON dredge data to make this determination based on evaluation of the analytical and benthic invertebrate data in accordance with the decision analysis shown on **Figure 10**. Prior to completing the statistical comparison of the benthic invertebrate data, the NAB Little Creek Partnering Team will discuss and finalize the metrics to be used. Preliminary metrics focus on species richness, density, and diversity, and the contribution of various "indicator" taxa to the overall benthic community. These preliminary metrics are listed on **Figure 10**. ABM, COPC, and benthic invertebrate data will then be evaluated against decision points to determine the most appropriate path forward for the site. Prior to completion of this evaluation, the NAB Little Creek Partnering Team will establish the decision points in the form of if/then statements.

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

- **Who will use the data?**

SWMU 3

Ecological risk assessors and statisticians will use the data to determine the composition and condition of the existing benthic community at SWMU 3 and determine if there is a correlation between benthic invertebrate community metrics, ABM content, COC concentrations, and/or other physical/chemical parameters. Participants from the NAB Little Creek Tier I Partnering Team will use the SWMU 3 data to determine the most appropriate path forward for each grid while achieving the RAO to the greatest extent practicable.. Chemists will use data from the site to evaluate overall data quality with respect to subcontracted laboratory performance.

SWMU 7b

Ecological risk assessors and statisticians will use the data to determine the composition and condition of the existing benthic community at SWMU 7b and determine if there is a correlation between benthic invertebrate community metrics, ABM content, COPC concentrations, and/or other physical/chemical parameters. Participants from the NAB Little Creek Tier I Partnering Team will use the SWMU 7b data to determine if further investigation, action, or no action is required at the site. Chemists will use data from the site to evaluate overall data quality with respect to subcontracted laboratory performance.

- **What are the Project Action Limits (PALs)?**

SWMU 3

Surface sediment samples will be visually examined for ABM content. ABM content within each grid will be compared against the established ABM-based PRG of ≤ 1 percent; therefore the PAL for ABM is equal to 1 percent. COC data will be compared against maximum background concentrations, established metals-based PRGs, and ecological screening values (TEL, ER-L, ER-M, and PEL); there is no available TEL, ER-L, ER-M, or PEL for tin. Tin results will be compared to the NOAA SQUIRT value. Therefore, the PALs for copper, lead, nickel, and zinc are equivalent to the lower value between their respective background concentration, PRG, TEL, ER-L, ER-M, PEL, and NOAA SQUIRT (tin only). The PALs for TOC and AVS/SEM will be equivalent to the quantitation limits (QLs) for each respective analyte. Specific PAL values are listed on **Worksheet #15**. There is no formal PAL for benthic invertebrate data; samples will be collected and processed based upon a site-specific laboratory SOP (**Attachment C**). No PAL is necessary for media descriptive parameters pH and grain size and surface water quality indicator parameters (pH, specific conductivity, salinity, turbidity, temperature, DO, and ORP).

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

SWMU 7b

Surface sediment samples will be visually examined for ABM content to the lowest possible integer (1); therefore the PAL for ABM is equal to 1 percent. COPC data will be compared against background concentrations and ecological screening values TEL, ER-L, ER-M, and PEL; there is no available TEL, ER-L, ER-M, or PEL for tin. Tin results will be compared to the NOAA SQUIRT value. Therefore, the PALs for copper, lead, mercury, and zinc are equivalent to the lower value between their respective background concentration, TEL, ER-L, ER-M, PEL, and NOAA SQUIRT (tin only). The PALs for TOC and AVS/SEM will be equivalent to the quantitation limits (QLs) for each respective analyte. Specific PAL values are listed on **Worksheet #15**. There is no formal PAL for benthic invertebrate data; samples will be collected and processed based upon a site-specific laboratory SOP (**Attachment C**). No PAL is necessary for media descriptive parameters pH and grain size and surface water quality indicator parameters (pH, specific conductivity, salinity, turbidity, temperature, DO, and ORP).

- **What will the data be used for?**

SWMU 3

Benthic invertebrate data, in conjunction with ABM content in sediment and RQs calculated using new and existing sediment COC analytical data, will be used to evaluate suitable remedial alternatives to achieve the RAO. TOC, pH, AVS/SEM, grain size, and surface water quality indicator parameter data will be used to help describe habitat conditions and evaluate potential bioavailability (because these parameters may fluctuate seasonally, they will be measured at all sampling locations despite existing data sets).

SWMU 7b

Benthic invertebrate data, in conjunction with ABM content in sediment and COPC concentrations, will be used to determine if further investigation, action, or no action is required at the site. TOC, pH, AVS/SEM, grain size, and surface water quality indicator parameter data will be used to help describe habitat conditions and evaluate potential bioavailability (because these parameters may fluctuate seasonally, they will be measured at all sampling locations despite existing data sets).

- **What types of data are needed (matrix, target analytes, analytical groups, field screening, onsite analytical or offsite laboratory techniques, sampling techniques)?**

Worksheet #17 contains detailed information on the types of data needed for this project, including proposed sample locations and depth intervals. **Worksheet #15** details the laboratory analytical protocol. Surface sediment samples will be collected from each location (**Figures 4, and 9**) and analyzed for benthic invertebrates, site-specific COCs/COPCs [copper, lead, mercury (SWMU 7b only), nickel (SWMU 3 only), tin, and zinc], pH, TOC, AVS/SEM, and grain size.

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

All sediment samples will be collected using a ponar dredge. Visual observation of ABM in sediment will be completed on site by field personnel. Surface water quality indicator parameter data (pH, specific conductivity, salinity, turbidity, temperature, DO, and ORP) will be collected from each grab sample location (top, middle, and bottom of water column) using a Horiba U-22® water quality meter.

- **How "good" do the data need to be in order to support the environmental decision?**

Metals data will be used, in conjunction with benthic invertebrate and ABM data, to evaluate ecological risk at the sites and make further investigation and/or action decisions. Therefore, metals data will be distributed to a third-party validator for data quality evaluation purposes and benthic invertebrate data will be evaluated by the Senior Ecological Risk Assessor for usability. An USEPA Contract Laboratory Program (CLP) Level IV equivalent package and QC samples are required for all metals data. TOC, pH, and grain size data will be evaluated by the project chemist for usability. QC data requirements are detailed in **Worksheet #20**. Data that meet these requirements will be considered of sufficient quality for environmental decision-making.

The laboratory will follow the Measurement Performance Criteria (MPC) in **Worksheet #12** for field QC samples and **Worksheet #28** for laboratory QC samples. These MPC are consistent with the DoD Quality Systems Manual (QSM) version 4.1 as applicable and laboratory in-house limits where the QSM does not apply.

Data will be validated by a data validator using the procedure described in **Worksheet #36**. A data usability study will be conducted by the project team following data validation. This process is outlined in **Worksheet # 37**.

- **How much data should be collected (number of samples for each analytical group, matrix, and concentration)?**

Detailed information on how much data will be collected is provided on **Worksheet #17**. Sediment samples will be collected as discussed below; sample locations are provided on **Figures 4, and 9**.

  - **SWMU 3:** Surface sediment samples will be collected from 60 grids located within the ABM- and metals-based remediation area. Sixty-six samples (57 composite and 9 grab) will be analyzed for benthic invertebrates; 60 samples will be analyzed for copper, lead, nickel, tin, zinc, TOC, pH, AVS/SEM, and grain size.

  - **SWMU 7B:** Surface sediment samples will be collected from 5 locations within the Connector Channel Area, 6 locations within the Cove Area, and 8 locations within the Pier Area. Twenty-five samples (16 composite and 9 grab) will be analyzed for benthic invertebrates; 19 samples will be analyzed for copper, lead, mercury, tin, zinc, TOC, pH, AVS/SEM, and grain size.

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

To ensure the data sets are usable in a statistical evaluation, the overall completeness goal for this project is 90% for each area evaluated. Completeness will be calculated by the project chemist during the data usability assessment.

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

Detailed information on where, when, and how the data will be collected is provided in **Worksheet #14**.

  - SWMU 3 surface sediment samples will be collected from each previously established 100x100- foot grid block located within the ABM- and metals-based remediation area (**Figure 4**).
  - SWMU 7b surface sediment samples will be collected from all previous RI/post-MILCON sample locations within the Cove and Connector Channel Areas and from 4 previous RI/post-MILCON sample locations as well as 4 new sample locations with the Pier Area (**Figure 9**).
  - Three surface water quality indicator parameter readings (top, middle, and bottom of water column) will be collected from each sample location.

- **Who will collect and generate the data? How will the data be reported?**

CH2M HILL field personnel will collect all data subject to this SAP. All laboratory analytical data will be generated by Empirical Laboratories (chemical analysis), Beaver Engineering (grain size analysis), and Water & Air Research, Inc. (benthic invertebrate analysis).

SWMU 3

Data collected as part of this investigation will be provided to the NAB Little Creek Tier I Partnering Team and technical support staff via presentation to facilitate the finalization of the metrics by which the benthic invertebrate data will be evaluated. Preliminary metrics focus on species richness, density, and diversity, and the contribution of various "indicator" taxa to the overall benthic community. These preliminary metrics are listed on **Figure 5** and will form the starting point for the Partnering Team discussion. Following Partnering Team finalization of the metrics, ABM, metals, and benthic invertebrate data will be evaluated in conjunction with previously collected data to re-assess the conceptual site model following completion of the near-shore NTCRA. The NAB Little Creek Partnering Team will establish decision points, in the form of if/then statements, for determining the appropriate path forward for each grid while achieving the RAO to the greatest extent practicable. It may be determined by the Partnering Team that although ABM content and COC concentrations exceed PRGs, because a viable benthic community is present within a grid removal of sediments within that grid is not the appropriate remedial action. In turn, although a viable benthic community may be present within a grid, if elevated ABM content and COC concentrations are present it may be determined by the Partnering Team removal of sediment is required. This evaluation will be documented in a technical memorandum to be provided as an attachment to the Feasibility Study (FS).

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

SWMU 7b

Data collected as part of this investigation will be provided to the NAB Little Creek Tier I Partnering Team and technical support staff via presentation to facilitate the finalization of the metrics by which the benthic invertebrate data will be evaluated. Preliminary metrics focus on species richness, density, and diversity, and the contribution of various "indicator" taxa to the overall benthic community. These preliminary metrics are listed on **Figure 10** and will form the starting point for the Partnering Team discussion. Following Partnering Team finalization of the metrics, data collected as part of this investigation will be documented in a Revised ERA Technical Memorandum. Data collected as part of the November 2009 Post-MILCON action investigation, as well as new data collected under this UFP-SAP, will be evaluated to determine the effects of the 2008 MILCON action on the nature and extent of SWMU 7b contamination and associated ecological risks. A quantitative risk assessment through Step 7 will be conducted using the data to determine if potentially unacceptable ecological risks remain in sediment at the site. The revised ERA will contain recommendations for additional investigation/action/no action, as warranted, based on the DQOs developed in this, as well as the Revised ERA UFP-SAP.

- **How will the data be archived?**

Data will be archived according to procedures dictated via the Navy CLEAN program/ contract; all data will be uploaded into a centralized database used for DoN projects. At the end of the project, archived data will be returned to the DoN.

- **List the project conditions in the form of if/then qualitative and quantitative statements.**

Quantifiable analytical results will be the primary basis for project decisions. The quantitation limit (QL), which is defined as the minimum level, concentration, or quantity of a target analyte that can be reported with a specified degree of confidence, will be the metric to define whether an analytical result is quantifiable. The NAB Little Creek Partnering Team will reconvene follow receipt of the data to discuss and agree upon key decision conditions that will help answer the environmental questions being asked for each site. The preliminary decision trees are presented in **Figures 5 and 10**.

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SAP Worksheet #12-1—Measurement Performance Criteria- Field QC Samples

Matrix: Sediment

Analytical Group: Select Metals (varies by site)

Concentration Level: Medium

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S + A)
Equipment Rinsate Blank	Metals	One per day of sampling	Bias/Contamination	No analyte detected > ½ limit of quantitation (LOQ)	S + A
Cooler Temperature Blank		One per cooler to the laboratory	Accuracy / Representativeness	4 degrees Celsius (°C) (± 2° C)	S
Field Duplicate		One per 10 samples per matrix	Precision	Relative percent difference (RPD) < 35%	S + A

SAP Worksheet #12-2—Measurement Performance Criteria- Field QC Samples

Matrix: Sediment

Analytical Group: Mercury (SWMU 7B only)

Concentration Level: Medium

QC Sample	Analytical Group	Frequency	DQIs	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S + A)
Equipment Rinsate Blank	Metals	One per day of sampling	Bias/Contamination	No analyte detected > ½ LOQ	S + A
Cooler Temperature Blank		One per cooler to the laboratory	Accuracy / Representativeness	4°C (± 2° C)	S
Field Duplicate		One per 10 samples per matrix	Precision	RPD < 35%	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
NAB Little Creek Initial Assessment Study	Rogers, Golden, and Halpern, 1984. *Initial Assessment Study of Naval Amphibious Base Little Creek, Norfolk, Virginia*,	Rogers, Golden, and Halpern reviewed historical base information in 1984	Data used to determine types of appropriate samples based on historical use.	None known
SWMU 3				
SWMU 3 Site Investigation	CH2M HILL. 1999. *Final Site Investigation Report for Solid Waste Management Unit 3, Naval Amphibious Base Little Creek, Virginia Beach, Virginia.*	CH2M HILL with agreement from the DoN, VDEQ, and USEPA collected groundwater, sediment, and soil samples in 2000	Data used to determine the proposed sample locations for the SAP	None known
SWMU 3 RI/HHRA/ERA	CH2M HILL. 2005. *Final Remedial Investigation, Human Health Risk Assessment, and Ecological Risk Assessment for SWMU 3, Pier 10 Sandblast Yard, Naval Amphibious Base Little Creek, Virginia Beach, Virginia,*	CH2M HILL with agreement from the DoN, VDEQ, and USEPA collected groundwater, sediment, and soil samples in 2002	Data used to determine the proposed sample locations for the SAP and to determine if action is required within a grid through comparison of data against ABM- and metals-based PRGs	None known
SWMU 3 Supplemental RI/HHRA/ERA	CH2M HILL, *Draft Supplemental Remedial Investigation, Human Health Risk Assessment, and Ecological Risk Assessment for SWMU 3, Pier 10 Sandblast Yard, Naval Amphibious Base Little Creek, Virginia Beach, Virginia, 2008*	CH2M HILL with agreement from the DoN, VDEQ, and USEPA collected sediment background samples in July 2008	Data used to compare sample results from SWMU 3 and SWMU 7b with background conditions	None Known

SAP Worksheet #13—Secondary Data Criteria and Limitations Table (continued)

Secondary Data	Data Source	Data Generator(s)	How Data Will Be Used	Limitations on Data Use
SWMU 7b				
SWMU 7 Site Investigation	CH2M HILL. 2000. *Final Site Investigation Report for Solid Waste Management Unit 7 and 8, Naval Amphibious Base Little Creek, Virginia Beach, Virginia.*	CH2M HILL with agreement from the DoN, VDEQ, and USEPA collected groundwater, sediment, and soil samples in 2000	Data used to determine the proposed sample locations for the SAP	None known
SWMU 7 RI/HHRA/ERA	CH2M HILL. 2004. *Final Remedial Investigation, Human Health Risk Assessment, and Ecological Risk Assessment for SWMU 7, Small Boats Sandblasting Yard, Naval Amphibious Base Little Creek, Virginia Beach, Virginia,*	CH2M HILL with agreement from the DoN, VDEQ, and USEPA collected groundwater, sediment, and soil samples in 2002	Data used to determine the proposed sample locations for the SAP.	None known

SAP Worksheet #14—Summary of Project Tasks

Project Logistics

In general, work will be performed in Level D personal protective equipment (PPE), which includes safety glasses, safety-toed boots, and impermeable gloves. Upgrades to higher levels of PPE will be presented in the HSP which will be prepared as part of mobilization efforts.

Sampling efforts will be coordinated with the NAB Little Creek Port Operations and Little Creek Harbor Operations to minimize impacts to the installation.

Project Tasks

Applicable SOPs for project tasks outlined in this section are listed on **Worksheet #21** and provided in **Attachment B.**

- **Mobilization**
  - Following approval of the SAP, CH2M HILL will begin mobilization activities. Before mobilization, all field team members will review this SAP and the project-specific HSP. A field team kickoff meeting will be held to ensure that personnel are familiar with the scope of field activities and safety issues. Mobilization activities include coordination with base personnel, Port Operations, and subcontractors, and preparation of field equipment.
- **Sediment Sampling**
  - **Analytical**: Three sediment grab samples will be collected from 0 to 4 inches bss surrounding each sample location using a 6 inch by 6 inch petite ponar dredge. Each grab sample will be logged using the Unified Soil Classification System (USCS). ABM content will be visually determined by sieving a known quantity of sediment through a Number 200 sieve. The percentage of ABM in the material captured on the sieve will be estimated using percentage diagrams for estimating composition by volume (Compton, 1985), provided as a part of SOP 012 in **Attachment B,** and percent of ABM by volume will be calculated based upon the volume of materials captured on the sieve in comparison of the total volume sampled. Grab samples will be composited onsite prior to placement into sample containers. To avoid volatilization during sample composition, one grab sample from each location (randomly selected) will be placed into the sample container and analyzed for AVS/SEM. Composite samples will be analyzed for TOC, pH, and grain size. Select locations will also be analyzed for copper, lead, mercury (SWMU 7b only), nickel (SWMU 3 only), tin, and zinc.
  - **Benthic Invertebrate**: Three additional sediment grab samples will be collected at the corresponding analytical locations from 0 to 4 inches bss using a 6 inch by 6 inch petite ponar dredge. In accordance with SOP 011 (**Attachment B**), the entire contents of each grab will be placed in the sieve bucket. A grab sample will be considered acceptable if the jaws of sampler are closed upon retrieval, and the sediments inside are level and not in contact with the top of the sampler. If these conditions are not met, the sample will be discarded and a new sample collected. Following collection of three acceptable grabs samples, sediments will be composited and field sieved using a 500-micron sieve.

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

Contents collected on the sieve will be preserved with formaldehyde and submitted for analysis.

- Remaining sediments will be will returned to the water body.
- Surface water quality indicator parameter readings will be collected from the top, middle, and bottom of the water column at each grab sample location using a Horiba U-22® water quality meter. Water depth and point in the tidal cycle will also be measured.
- Sample location coordinates will be collected using a Global Positioning System.
- All relevant site-specific observations, onsite conditions, and sampling activities will be logged in the field notebook.
- All samples will be collected in laboratory-prepared sampling containers, packed on ice, and shipped overnight to an offsite laboratory every evening (see **Worksheet #27**).

- **Equipment Decontamination**
  - All non-disposable sampling equipment will be decontaminated before use and between each sample location in accordance with applicable SOPs (**Attachment B**). Between sample locations, the sampling tools will be scrubbed with a tap water and Liquinox solution, rinsed with deionized water, rinsed with methanol, and rinsed a second time with deionized water before use at each sample location. Between grab locations corresponding to a single sample location, sampling tools will be rinsed with site water. Decontamination fluids will be collected, contained, and disposed of in accordance with state and federal regulations for handling IDW.
- **Investigation Derived Waste**
  - IDW generated during the field activities will consist of decontamination fluids. Aqueous IDW will be stored in 55-gallon drums, which will be properly labeled and temporarily stored within secondary containment at Site 13.
  - The IDW will be properly disposed of based on the results of the waste characterization by subcontractors within 90 days of generation. Disposable equipment, including PPE, poly sheeting, and paper towels, will be disposed of as solid waste.
- **QC**
  - Implement SOPs for field (**Attachment B**) and laboratory (**Attachment C**) activities being performed.
  - QC samples to be collected are outlined on **Worksheet #20**.
- **Analytical Tasks**
  - The laboratories will maintain, test, inspect, and calibrate analytical instruments. (**Worksheets #24 and #25**).
  - The laboratories will process and prepare samples for analysis.

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

- The laboratories will analyze sediment samples for TOC, pH, AVS/SEM, grain size, copper, lead, mercury (SWMU 7b only), nickel (SWMU 3 only), tin, and zinc, and will identify and enumerate benthic invertebrates, as shown on **Worksheet #18**.

- **Data Management**
  - **Attachment D** provides guidance and checklists on data management steps such as data recording, data transformation, data reduction, data transfer and transmittal, data analysis, and data review. Procedures for data tracking, storage, archiving, retrieval and security for both electronic and hardcopy data are also provided in **Attachment D**. The Project EIS, Victoria Brynildsen, is responsible for data tracking and storage.

- **Procedures for recording data, including guidelines for recording and correcting data**
  - Project Assessment/Audit (**Worksheets #31 and #32**)
  - Data Review
    - Data Validation (**Worksheets #35 and #36**)
    - Data Usability Assessment (**Worksheet #37**)

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SAP Worksheet #15-1—Reference Limits and Evaluation Table

Matrix: Sediment (SWMU 3)

Analytical Group: Select Metals

Analyte	CAS Number	Eco PAL (mg/kg)	Project Quantitation Limit (PQL) Goal (mg/kg)	Laboratory-specific			Matrix Spike/Matrix Spike Duplicate (MS/MSD) and Laboratory Control Sample (LCS) Recoveries		
				LOQ (mg/kg)	Limit of Detection (LOD) (mg/kg)	Detection Limit (DL) (mg/kg)	Lower Control Limit (LCL) (%)	Upper Control Limit (UCL) (%)	RPD (%)
Copper	7440-50-8	18.7	9.35	2.00	1.60	0.800	80	120	30
Lead	7439-92-1	30.2	15.1	0.600	0.600	0.300	80	120	30
Nickel	7440-02-0	15.9	7.95	2.00	1.20	0.600	80	120	30
Tin	7440-31-5	3.4	1.7	1.50	1.00	0.500	80	120	30
Zinc	7440-66-6	124	62	4.00	2.00	1.00	80	120	30

PALs were developed to be protective of the environment.

Refer to **Worksheets #10 and #11** for a detailed discussion on development of PALs.

PQL Goals were determined on a case by case basis and are at least 2 times less than the PAL and greater than the laboratory LOD.

Note: PAL and PQL assumes dry weight basis.
Eco PALs are Ecological Sediment Screening Values (TEL or equivalent). Results will be compared to the values discussed in Worksheet 10. The most conservative value (TEL) has been used in WS 15-1 in order to ensure the laboratory reporting limits are lower than any of the possible PALs.

SAP Worksheet #15-2—Reference Limits and Evaluation Table

Matrix: Sediment (SWMU 7B)
Analytical Group: Select Metals

				Laboratory-specific			MS/MSD and LCS Recoveries		
Analyte	**CAS Number**	**Eco PAL (mg/kg)**	**PQL Goal (mg/kg)**	**LOQ (mg/kg)**	**LOD (mg/kg)**	**DL (mg/kg)**	**LCL (%)**	**UCL (%)**	**RPD (%)**
Copper	7440-50-8	18.7	9.35	2.00	1.60	0.800	80	120	30
Lead	7439-92-1	30.2	15.1	0.600	0.600	0.300	80	120	30
Mercury	7439-97-6	0.13	0.065	0.0330	0.0260	0.0130	80	120	30
Tin	7440-31-5	3.4	1.7	1.50	1.00	0.500	80	120	30
Zinc	7440-66-6	124	62	4.00	2.00	1.00	80	120	30

PALs were developed to be protective of the environment.

Refer to **Worksheets #10 and #11** for a detailed discussion on development of PALs.

PQL Goals were determined on a case by case basis and are at least 2 times less than the PAL and greater than the laboratory LOD.

Note: PAL and PQL assumes dry weight basis.
Eco PALs are Ecological Sediment Screening Values (TEL or equivalent). Results will be compared to the values discussed in Worksheet 10. The most conservative value (TEL) has been used in WS 15-2 in order to ensure the laboratory reporting limits are lower than any of the possible PALs.

SAP Worksheet #15-3—Reference Limits and Evaluation Table

Matrix: Sediment

Analytical Group: AVS/SEM

Analyte	CAS Number	PAL[1] (SEM/AVS ratio)	Laboratory-Specific Limits		MS/MSD and LCS Recovery Limits		
			QLs [micromole/gram (µmole/g)]	Method Detection Limit (MDL) (µmole/g)	Lower Limit (%)	Upper Limit (%)	RPD (%)
Cadmium	7440-43-9	>1	0.000440	0.000089	80	120	20
Copper	7440-50-8	>1	0.00160	0.00079	80	120	20
Lead	7439-92-1	>1	0.00014	0.000072	80	120	20
Mercury	7439-97-6	>1	0.0000	0.000004	80	120	20
Nickel	7440-02-0	>1	0.0017000	0.00051	80	120	20
Silver	7440-22-4	>1	0.00093	0.00028	80	120	20
Zinc	7440-66-6	>1	0.003100	0.00076	80	120	20
Acid Volatile Sulfide	ACIDSO2[2]	>1	0.20	0.05	75	125	20

[1] AVS/SEM results are provided as a ratio of SEM to AVS. SEM/AVS ratios > 1 are interpreted to indicate that the metals evaluated are potentially bioavailable. Note that individual AVS and SEM results will not be compared to anything; the SEM/AVS ratio is the only usable result. The Laboratory's QLs are acceptable for data use.

[2] Contractor-generated CAS number.

SAP Worksheet #15-4—Reference Limits and Evaluation Table

Matrix: Sediment
Analytical Group: Wet Chemistry (Various)

		Laboratory-Specific			MS/MSD and LCS Recovery Limits		
Analyte	**CAS Number**	**LOQ (mg/Kg)**	**LOD (mg/Kg)**	**DL (mg/Kg)**	**Lower Limit (%)**	**Upper Limit (%)**	**RPD (%)**
pH	PH	n/a	n/a	n/a	80	120	20
TOC	TOC	1600	800	500	80	120	20

TOC results are used to determine the bioavailability of organic chemicals.

pH results are used to determine the bioavailability of certain metals.

SAP Worksheet #15-5—Reference Limits and Evaluation Table

Matrix: Sediment
Analytical Group: Wet Chemistry (Grain size-sieve only)

Analyte	CAS Number
GS07 Sieve 1" (25.0 mm)	SIEVE25.0
GS08 Sieve 0.75" (19.0 mm)	SIEVE19.0
GS10 Sieve 0.5" (12.7 mm)	SIEVE12.7
Sieve No. 004 (4.75 mm)	SIEVE4.75
Sieve No. 010 (2.00 mm)	SIEVE2.0
Sieve No. 040 (425 µm)	SIEVE425
Sieve No. 100 (150 µm)	SIEVE150
Sieve No. 200 (75 µm)	SIEVE75

Grain size helps determine the nature of the substrate and how suitable it is as habitat for particular species; the distribution of particle sizes will also influence the bioavailability of some chemicals.

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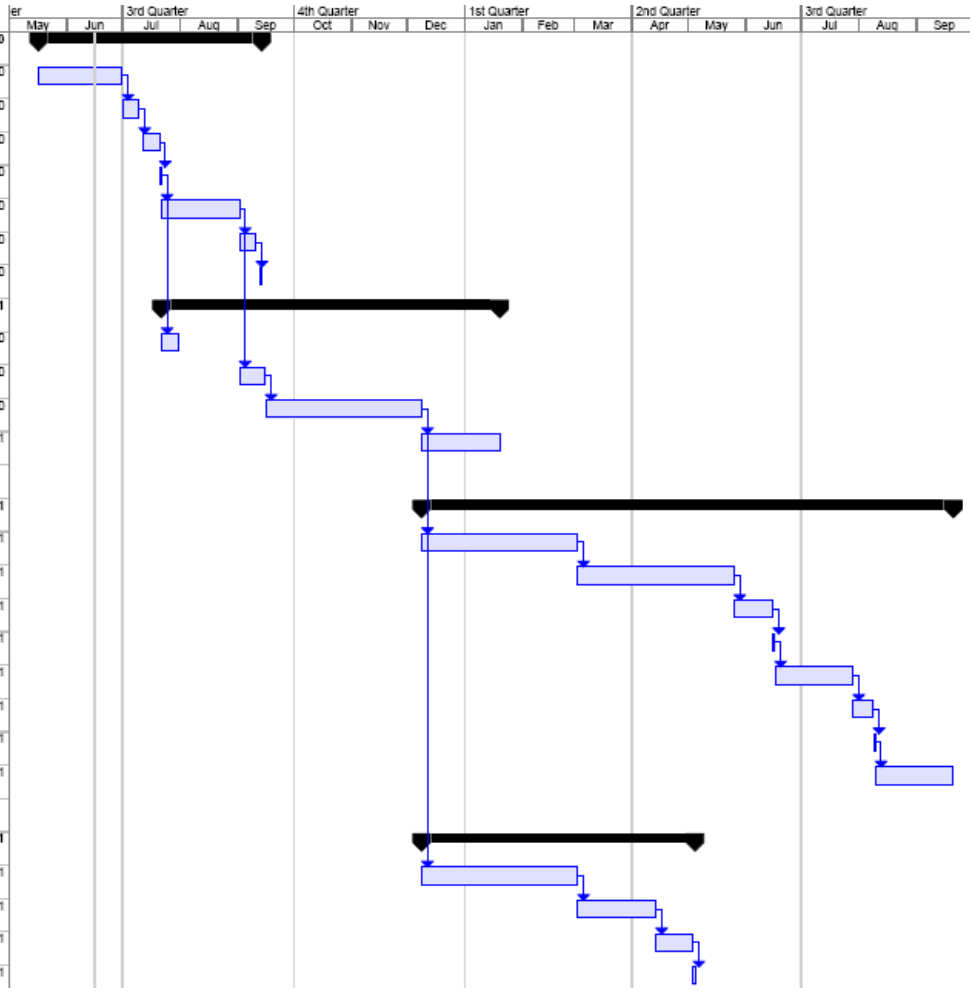
SAP Worksheet #16—Project Schedule / Timeline Table

ID		Task Name	Duration	Start	Finish
1		**SWMU 3 and SWMU 7b Benthic Sampling UFP SAP**	**86 days**	**Mon 5/17/10**	**Mon 9/13/10**
2		Pre-Draft UFP SAP	33 days	Mon 5/17/10	Wed 6/30/10
3		Chemist Review	7 days	Thu 7/1/10	Fri 7/9/10
4		Comment Resolution	7 days	Mon 7/12/10	Tue 7/20/10
5		Draft UFP SAP	1 day	Wed 7/21/10	Wed 7/21/10
6		Regulatory Review/Concurrence to Mob	30 days	Thu 7/22/10	Wed 9/1/10
7		Comment Resolution	7 days	Thu 9/2/10	Fri 9/10/10
8		Final UFP SAP	1 day	Mon 9/13/10	Mon 9/13/10
9		**SWMU 3 and SWMU 7b Benthic Sampling Field Investigation**	**130 days**	**Thu 7/22/10**	**Wed 1/19/11**
10		Preparation	7 days	Thu 7/22/10	Fri 7/30/10
11		Field Sampling	10 days	Thu 9/2/10	Wed 9/15/10
12		Sample Analysis	60 days	Thu 9/16/10	Wed 12/8/10
13		Data Management and Validation	30 days	Thu 12/9/10	Wed 1/19/11
14					
15		**SWMU 3 EE/CA and NEBA**	**204 days**	**Thu 12/9/10**	**Tue 9/20/11**
16		Draft EE/CA and NEBA	60 days	Thu 12/9/10	Wed 3/2/11
17		Regulatory Review	60 days	Thu 3/3/11	Wed 5/25/11
18		Comment Resolution	15 days	Thu 5/26/11	Wed 6/15/11
19		Draft Final EE/CA and NEBA	1 day	Thu 6/16/11	Thu 6/16/11
20		Public Comment Period	30 days	Fri 6/17/11	Thu 7/28/11
21		Comment Resolution	7 days	Fri 7/29/11	Mon 8/8/11
22		Final EE/CA and NEBA	1 day	Tue 8/9/11	Tue 8/9/11
23		SWMU 3 Action Memorandum	30 days	Wed 8/10/11	Tue 9/20/11
24					
25		**SWMU 7b Revised Ecological Risk Assessment**	**105 days**	**Thu 12/9/10**	**Wed 5/4/11**
26		Draft Revised ERA	60 days	Thu 12/9/10	Wed 3/2/11
27		Regulatory Review	30 days	Thu 3/3/11	Wed 4/13/11
28		Comment Resolution	14 days	Thu 4/14/11	Tue 5/3/11
29		Final Revised ERA	1 day	Wed 5/4/11	Wed 5/4/11



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SAP Worksheet #17—Sampling Design and Rationale

Sample Type	Location			Matrix	Depth of Samples	Analysis	Method	Number of Samples	Rationale	Sampling Strategy
Site-Specific	SWMU 3	100 x 100-foot squares located within ABM- and metals-based remediation boundary (**Figure 4**)		Surface Sediment	0-4 inches from sediment surface	Benthic invertebrates, copper, lead, nickel, tin, zinc, TOC, pH, AVS/SEM, and grain size	Benthic Invertebrates (laboratory specific) Copper, lead, mercury, nickel, tin, and zinc (SW846 6010B, 7471A) TOC (Lloyd Kahn) pH (SW846 9045D) AVS/SEM (EPA 821-R-91-100) Grain Size [American Society for Testing and Materials (ASTM) D422]	Benthic invertebrates - 66 (57 composite and 9 grab) TOC, pH, AVS/SEM, and grain size – 60 Copper, lead, nickel, tin, and zinc - 29	Benthic invertebrate samples will be collected to evaluate the composition and condition of the existing benthic invertebrate community at SWMU 3 and aid in the determination if remedial action is required. Surface sediment samples will be collected from corresponding November 2009 vertical delineation sampling grids that are located within the ABM- and metals-based remediation boundary. Select samples will be analyzed for COCs where existing surface sediment data are not currently available to supplement the existing data set and determine if there is a correlation between the SWMU 3 benthic invertebrate community and COC concentrations. All samples will be analyzed for TOC, pH, AVS/SEM, and grain size and surface water quality indicator parameters will be measured at each location to aid in habitat description and assessment of bioavailability.	Surface sediment samples will be collected using a petite ponar dredge. Three grab samples will be collected surrounding each location. Sediment grabs will be logged using the USCS classification system. ABM content will be noted in the field logbook. One randomly selected grab sample from each location will be analyzed for AVS/SEM; this sample will not be composited in order to minimize potential volatilization. Samples for metals, TOC, pH, and grain size analysis will be composited prior to placement in the sample container. Samples for benthic invertebrate analysis will be composited (except as noted) and field sieved using a 500-micron sieve. Contents collected on the sieve will be preserved with formaldehyde prior to placement into the sample container. All analytical samples will be analyzed on a standard 28-day turn around time. Benthic invertebrate samples will be analyzed on a 60-day turn around time. Surface water quality indicator parameters will be collected using a Horiba U-22® water quality meter.
	SWMU 7b	Connector Channel Area	Previous RI/post-MILCON sample locations (**Figure 9**)			Benthic invertebrates, TOC, pH, AVS/SEM, and grain size		Benthic invertebrates - 25 (16 composite and 9 grab) TOC, pH, AVS/SEM, and grain size – 19 Copper, lead, mercury, tin, and zinc - 4	Benthic invertebrate samples will be collected to evaluate the composition and condition of the existing benthic invertebrate community at SWMU 7b, assess whether historic site activities have impacted the benthic community, and determine if potentially unacceptable ecological risks are present at the site. Cove and Connector Channel Area surface sediment samples will be collected from previous 2004 RI discrete and 2009 MILCON sample locations. Pier Area surface sediment samples will be collected from four 2004 RI discrete and 2009 MILCON sample locations and 4 new locations located outside the dredged portion of the site. Select samples will be analyzed for COPCs where existing surface sediment data are not currently available to supplement currently available data and determine if there is a correlation between the SWMU 7b benthic invertebrate community and COPC concentrations. All samples will be analyzed for TOC, pH, AVS/SEM, and grain size and surface water quality indicator parameters will be measured at each location to aid in habitat description and assessment of bioavailability.	
		Cove Area								
		Pier Area	Previous RI/post-MILCON sample locations (**Figure 9**)							
			New locations outside of MILCON dredge area (**Figure 9**)			Benthic invertebrates, copper, lead, mercury, tin, zinc, TOC, pH, AVS/SEM, and grain size				

Sediment sample locations were jointly scoped by the NAB Little Creek Partnering Team (**Worksheet #9-2 and 9-3**). If sample locations become inaccessible (boats, piers, etc.) the DoN will be notified and efforts will be made to temporarily relocate the obstruction if feasible. If relocation is not feasible, samples will be collected as close to the proposed location as possible. All sample locations and associated data are critical. Deviations from the SAP will be reviewed to assess whether CA is warranted and to assess impacts to achievement of project objectives.

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

Sampling Location/ Identification Number	Sampling Area	Matrix	Depth	Analytical Group	Number of Samples (identify field duplicates)	Sampling SOP Reference
SWMU 3*						
LW03-SD501-00-10C	ABM- and Metals-Based Remediation Area	Surface Sediment	0.0-4.0" bss	Select Metals, Benthic Invertebrates, TOC, pH, AVS/SEM, grain size	See **Worksheets #14** and **#20**	**Worksheet #14** and **Attachment B**
LW03-SD502-00-10C						
LW03-SD503-00-10C						
LW03-SD504A-00-10C						
LW03-SD504-00-10C						
LW03-SD505-00-10C						
LW03-SD506-00-10C						
LW03-SD506P-00-10C (duplicate)				Select Metals		
LW03-SD507-00-10C				Select Metals, Benthic Invertebrates, TOC, pH, AVS/SEM, grain size		
LW03-SD508-00-10C						
LW03-SD509-00-10C						
LW03-SD510-00-10C						
LW03-SD511-00-10C						
LW03-SD512-00-10C						
LW03-SD513-00-10C						
LW03-SD514-00-10C						
LW04-SD514P-00-10C (duplicate)				Select Metals		
LW03-SD515-00-10C				Select Metals, Benthic Invertebrates, TOC, pH, AVS/SEM, grain size		
LW03-SD516-00-10C						
LW03-SD517-00-10C						
LW03-SD518-00-10C						
LW03-SD518-00-10C (MS/MSD)				Select Metals		
LW03-SD519-00-10C				Select Metals, Benthic Invertebrates, TOC, pH, AVS/SEM, grain size		
LW03-SD520-00-10C						
LW03-SD521-00-10C						
LW03-SD522-00-10C						
LW03-SD523-00-10C						
LW03-SD525-00-10C						
LW03-SD526-00-10C						
LW03-SD526P-00-10C (duplicate)				Select Metals		
LW03-SD527-00-10C				Select Metals, Benthic Invertebrates, TOC, pH, AVS/SEM, grain size		
LW03-SD528-00-10C						
LW03-SD529-00-10C						

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

Sampling Location/ Identification Number	Sampling Area	Matrix	Depth	Analytical Group	Number of Samples (identify field duplicates)	Sampling SOP Reference
LW03-SD530-00-10C	ABM- and Metals-Based Remediation Area	Surface Sediment	0.0-4.0" bss	Select Metals, Benthic Invertebrates, TOC, pH, AVS/SEM, grain size	See **Worksheets #14** and **#20**	**Worksheet #14** and **Attachment B**
LW03-SD533-00-10C						
LW03-SD534-00-10C						
LW03-SD535-00-10C						
LW03-SD537-00-10C						
LW03-SD537-00-10C (MS/MSD)				Select Metals		
LW03-SD538-00-10C				Select Metals, Benthic Invertebrates, TOC, pH, AVS/SEM, grain size		
LW03-SD539-00-10C						
LW03-SD540-00-10C						
LW03-SD540P-00-10C (duplicate)				Select Metals		
LW03-SD541-00-10C				Select Metals, Benthic Invertebrates, TOC, pH, AVS/SEM, grain size		
LW03-SD543-00-10C						
LW03-SD544-00-10C						
LW03-SD545-00-10C						
LW03-SD546-00-10C						
LW03-SD547-00-10C						
LW03-SD547P-00-10C (duplicate)				Select Metals		
LW03-SD548-00-10C				Select Metals, Benthic Invertebrates, TOC, pH, AVS/SEM, grain size		
LW03-SD549-00-10C						
LW03-SD550-00-10C						
LW03-SD551-00-10C						
LW03-SD552-00-10C						
LW03-SD553-00-10C						
LW03-SD555-00-10C						
LW03-SD556-00-10C						
LW03-SD556P-00-10C (duplicate)				Select Metals		
LW03-SD557-00-10C				Select Metals, Benthic Invertebrates, TOC, pH, AVS/SEM, grain size		
LW03-SD558-00-10C						
LW03-SD559-00-10C						
LW03-SD562-00-10C						
LW03-SD562-00-10C (MS/MSD)				Select Metals		
LW03-SD563-00-10C				Select Metals, Benthic Invertebrates, TOC, pH, AVS/SEM, grain size		

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

Sampling Location/ Identification Number	Sampling Area	Matrix	Depth	Analytical Group	Number of Samples (identify field duplicates)	Sampling SOP Reference
LW03-SD564-00-10C	ABM- and Metals-Based Remediation Area	Surface Sediment	0.0-4.0" bss	Select Metals, Benthic Invertebrates, TOC, pH, AVS/SEM, grain size	See **Worksheets #14** and **#20**	**Worksheet #14** and **Attachment B**
LW03-SD567-00-10C						
LW03-SD571-00-10C						
LW03-SD574-00-10C						
SWMU 7b**						
LW07-B5-SD401-00-10C	Cove/Connector Channel Areas	Surface Sediment	0.0-4.0" bss	Select Metals, Benthic Invertebrates, TOC, pH, AVS/SEM, grain size	See **Worksheets #14** and **#20**	**Worksheet #14** and **Attachment B**
LW07-B5-SD401P-00-10C (duplicate)				Select Metals		
LW07-B7-SD401-00-10C				Select Metals, Benthic Invertebrates, TOC, pH, AVS/SEM, grain size		
LW07-D5-SD401-00-10C						
LW07-F3-SD401-00-10C						
LW07-F5-SD401-00-10C						
LW07-H3-SD401-00-10C						
LW07-J4-SD401-00-10C						
LW07-K3-SD401-00-10C						
LW07-K4-SD401-00-10C						
LW07-K5-SD401-00-10C						
LW07-L2-SD401-00-10C						
LW07-H1-SD401-00-10C	Pier Area (non-dredged)					
LW07-K1-SD401-00-10C						
LW07-L5-SD401-00-10C						
LW07-M1-SD401-00-10C						
LW07-SD401-00-10C						
LW07-SD402-00-10C						
LW07-SD402P-00-10C (duplicate)				Select Metals		
LW07-SD403-00-10C				Select Metals, Benthic Invertebrates, TOC, pH, AVS/SEM, grain size		
LW07-SD404-00-10C						
LW07-SD404-00-10C (MS/MSD)				Select Metals		

*The 500 series indicates samples were collected during the 2010 SWMU 3 sampling event.
**The 400 series indicates samples were collected during the 2010 SWMU 7b sampling event.
Samples collected in the 2010 sampling event corresponding with previous sample grids or locations retained the same sample nomenclature except for series and date. New sample locations area named numerically.
The actual number of field duplicates, equipment blanks, and trip blanks will vary. See **Worksheet #20** for QA/QC detail.
One MS and one MSD will be collected at a frequency of 1 per 20 samples collected per event.

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SAP Worksheet #19—Analytical SOP Requirements Table

Matrix	Analytical Group	Analytical and Preparation Method/ SOP Reference[1]	Containers	Sample Volume	Preservation Requirements	Maximum Holding Time (Preparation/Analysis)[2]
Sediment	Select Metals	SW-846 6010B/ SOP105	(1) 4-ounce glass jar	2 gram (g)	Cool to 4 ± 2°C	180 days to analysis
	Mercury	SW-846 7471A/ SOP104		0.3g		28 days to analysis
	AVS/SEM	EPA 821-R-91-100/AVS/SEM		10g		14 days to preparation/ 7 days to analysis
	TOC	Lloyd Kahn/ SOP221		0.25g		14 days to analysis
	pH	SW-846 9045C/ SOP187		10g		7 days to analysis
	Grain Size	ASTM D422/ Beaver	(2) 16-ounce plastic	1kilogram minimum	None	NA
	Benthic Invertebrates	SOP IZ-06	Wide mouth plastic bottles	Volume attained by petite ponar dredge	10 percent formaldehyde	NA

[1] See **Worksheet 23**.

[2] Maximum holding time is calculated from the time the sample is collected to the time the sample is prepared/extracted. (Not VTSR)

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SAP Worksheet #20—Field Quality Control Sample Summary Table

Matrix	Analytical Group	No. of Sampling Locations	No. of Field Duplicates	No. of MS/MSDs	No. of Field Blanks	No. of Equip. Blanks	Total No. of Samples to Lab
SWMU 3							
Sediment	Copper, lead, nickel, tin, and zinc	60	6	3/3	0	One per day for reusable equipment (approx 10)	82
	TOC	60	0	0	0	0	60
	pH	60	0	0	0	0	60
	AVS/SEM	60	0	0	0	0	60
	Grain size	60	0	0	0	0	60
	Benthic Invertebrates	66	0	0	0	0	66
SWMU 7b							
Sediment	Copper, lead, mercury, tin, and zinc	19	2	1/1	0	One per day for reusable equipment (approx 3)	26
	TOC	19	0	0	0	0	19
	pH	19	0	0	0	0	19
	AVS/SEM	19	0	0	0	0	19
	Grain size	19	0	0	0	0	19
	Benthic Invertebrates	25	0	0	0	0	25

It is assumed that sampling will take 15 days to be completed. The number of QA/QC samples to be collected is based on the assumed number of samples that will be analyzed.
QA/QC samples will be collected based on the following guidelines:
1 Field duplicate will be collected for every 10 field samples.
1 MS/MSD pair will be collected for every 20 samples, including QA/QC and field samples.
Ambient field blanks will not be collected as part of this investigation.1 equipment blank will be collected per day for reusable equipment that is decontaminated daily.

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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
SOP-001	Decontamination of Personnel and Equipment	CH2M HILL	Sampling and H&S equipment	N	N/A
SOP-002	Disposal of Waste Fluids and Solids	CH2M HILL	N/A	N	N/A
SOP-003	Field Measurement of pH, Specific Conductance, Turbidity, DO, ORP, and Temperature	CH2M HILL	Horiba U-22	N	N/A
SOP-004	Preparing Field Log Books	CH2M HILL	N/A	N	N/A
SOP-005	Equipment Blank and Field Blank Preparation	CH2M HILL	Peristaltic pump	N	N/A
SOP-006	Sampling Contents of Tanks and Drums	CH2M HILL	Bailer, bung wrench	N	N/A
SOP-007	Chain-of Custody	CH2M HILL	N/A	N	N/A
SOP-008	Packaging and Shipping Samples	CH2M HILL	N/A	N	N/A
SOP-009	Homogenization of Soil and Sediment Samples	CH2M HILL	Bowl, trowel, spoons, bottles	N	N/A
SOP-010	Sediment Sampling	CH2M HILL	Sampling device (ponar dredge), bottles, spoons, classification tools	N	N/A
SOP-011	Sampling for Quantitative Benthic Community Structure Analysis	CH2M HILL	Sampling device (ponar dredge), sieve, bucket, preservative, bottles	N	N/A
SOP-012	Logging of Soil Borings	CH2M HILL	Classification tools, knife	N	N/A
SOP-013	Preserving Non-volatile organic compound (VOC) Aqueous Samples	CH2M HILL	Chemical preservatives, bottles	N	N/A
SOP-014	Flat Bottom Boat Operations	CH2M HILL	Motorized boat	N	N/A
SOP-015	Established NAB Little Creek Station and Sample Identification Naming Scheme	CH2M HILL	N/A	N	N/A

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

Field Equipment	Calibration Activity	Maintenance Activity	Testing/ Inspection Activity	Frequency	Acceptance Criteria	CA	Resp. Person	SOP Reference
Horiba U-22 pH probe	Calibrate probe using Horiba® U-22 Auto-Calibration Standard Solution	Check Mechanical and electronic parts, verify system continuity, check battery, and clean probes. Calibration check. Request replacement parts or equipment from supplier.	During calibration of other probes, check these readings against the day's atmospheric pressure and ambient temperature	Daily, before use	pH reads 4.0 +/- 3%	Clean probe with deionized water and calibrate again. Do not use this instrument if unable to calibrate properly. Return to supplier and request replacement equipment. Document CA, receipt of, and proper calibration of replacement equipment in field logbook.	FTL	**Attachment B**
Horiba® U-22 Specific conductance Probe					conductivity reads 4.49 +/- 3%			
Horiba® U-22 Turbidity Probe					turbidity reads 0+/-3%			
Horiba® U-22 DO and Temperature Probes					Consistent with the current atmospheric pressure and ambient temperature			
Horiba® U-22			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% Conductivity reads 4.49 +/- 3% Turbidity reads 0 +/- 3%			

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SAP Worksheet #23—Analytical SOP References Table

Lab SOP Number	Title, Revision Date, and / or Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (y/n)
IZ-04	Invertebrate Core/Grab/Dredge Sample Preparation, Rev2.3, 12/29/08	Screening	Benthic Invertebrate	n/a	Water and Air Research	Y[1]
IZ-06	Invertebrate Enumeration and Taxonomic Analysis, Rev2.7, 3/11/09					
IZ-12	Invertebrate Sorting Quality Control, Rev2.9, 3/10/10					
IZ-13	Invertebrate Taxonomic Identification Quality Control, Rev3.7, 3/10/10					
100	Metals Digestion/Preparation Methods 3005A, 3010A, 3020A, 3030, 3040A, 3050B USEPA CLPILMO 04.1 AQUEOUS & Soil/Sediment USEPA CLPILMO 05.2 Aqueous & Soil/Sediment, USEPA Method 200.7 (Standard Methods) 3030C, Rev20, 20100427	Definitive for select metals/ Screening for SEM metals	Metals - Digestion	None	Empirical	N
104	Mercury Analysis in Soil/Sediment by Manual Cold Vapor Technique Methods SW846 7471A, 7471B , 245.5 & CLPILM 04.1, Rev19, 20100411		Total Mercury/ SEM Mercury	Cold Vapor Atomic Absorption (CVAA)		
105	Metals Analysis by ICP Technique Methods 200.7, (SW846) 6010B, (SW-846) 6010C, (SM 19th Edition 2340B) USEPA CLP ILMO 4, Rev16, 20100411		Select Total Metals/ SEM Metals	Inductively Coupled Plasma- Atomic Emission Spectrometer (ICP-AES)		
AVS/SEM	Analytical Method for Determination of Acid Volatile Sulfide in Sediment, USEPA Method 821-R-91-100, December 1991	Screening	AVS	None		
187	Electrometric Determination of pH, Methods 150.1, Standard Methods 4500-H+B and 9040B for Waters, Liquids and Liquid Wastes, 9045C for Soils and Solid Wastes, Rev08, 20100712	Screening	Soil pH	Probe		
221	Total Organic Carbon SM5310C, USEPA Method 415.1 and SW846 Method 9060/9060A and Lloyd Kahn Method, Rev, 20100712	Screening	Soil TOC	TOC Analyzer		
404*	Sample Receipt, Handling and Processing, Rev13, 20090629	n/a	Login and Storage	n/a		
405*	Analytical Laboratory Waste Disposal, Rev05, 20090623	n/a	Waste Disposal	n/a		
410*	Standard Operating Procedures for Laboratory Sample Storage, Secure Areas and Sample Custody, Rev07, 20090623	n/a	Login and Storage	n/a		
ASTM D 422	Particle-Size Analysis of Soils, from ASTM method, 1990	Screening	Grain Size	n/a	Beaver Engineering	

*Currently in review

[1] SOPs provided are Water and Air research's standard procedures, based on Florida Department of Environmental Protection Quality Control requirements. These SOPs are customizable to specific state regulatory procedures, if applicable. CH2M HILL will work with the Partnering Team to modify these SOPs where necessary.

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SAP Worksheet #24—Analytical Instrument Calibration Table

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference
CVAA (Mercury)	Initial calibration (ICAL)	Beginning of each day or if QC exceeds criteria	Min 5 pt ICAL and a calibration blank Linear regression correlation coefficient >0.995	Correct problem, repeat ICAL	Lab Section Supervisor	SOP-104
	Initial calibration verification (ICV)	Second source, once after each ICAL, prior to beginning a sample run	Analytes must agree within 10% of the expected value	Correct problem and verify second source standard. Rerun ICV. If that fails, correct problem and repeat ICAL.		
	Continuing Calibration Verification (CCV)	Every 10 samples and at the end of the analytical sequence	Analyte must agree within 20% of the expected value	Correct problem, rerun CCV. If that fails, then repeat ICAL. Reanalyze all samples since the last acceptable CCV.		
	Calibration Blank	Before beginning a sample run, after every 10 samples, and at the end of the analysis sequence.	No analytes detected > LOD	Correct problem. Re-prep and reanalyze calibration blank. All samples following the last acceptable calibration blank must be reanalyzed.		

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

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference
ICP-AES (Select Metals)	ICAL	Beginning of each day or if QC exceeds criteria	Minimum one high standard and a calibration blank. If 3 standards plus calibration blank, linear regression correlation coefficient >0.995.	Correct problem, repeat ICAL	Lab Section Supervisor	SOP-105
	ICV	Second source, once after each ICAL, prior to beginning a sample run	Analytes must agree within 10% of the expected value	Correct problem and verify second source standard. Rerun ICV. If that fails, correct problem and repeat ICAL.		
	CCV	Every 10 samples and at the end of the analytical sequence	Analytes must agree within 10% of the expected value	Correct problem, rerun CCV. If that fails, then repeat ICAL. Reanalyze all samples since the last acceptable CCV.		
	High-level check standard	Every 6 months	Within 10% of true value	Correct problem, reanalyze		
	Low-level calibration check standard	Daily after ICAL	Analytes must agree within 20% of the true value	Correct problem, reanalyze		
	Calibration Blank	Before beginning a sample run, after every 10 samples, and at the end of the analysis sequence.	No analytes detected > LOD	Correct problem. Re-prep and reanalyze calibration blank. All samples following the last acceptable calibration blank must be reanalyzed.		
	Interference check solutions (ICS)	After beginning of the analytical run	ICS-A: Absolute value of concentration for all non-spiked analytes < LOD ICS-AB: Within 20% of true value	Terminate analysis; locate and correct problem; reanalyze ICS, reanalyze all samples.		

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

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference
TOC analyzer (TOC)	ICAL	Quarterly	R ≥ 0.995	Correct problem and repeat ICAL.	Analyst/ Laboratory Manager	SOP-221
	ICV/CCV	Beginning and end of analysis and every 10 samples	All target analytes within ± 15% of the true value.	Re-prepare and reanalyze. If it fails again, repeat ICAL.		

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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	Corrective Action	Responsible Person	SOP Reference
ICP-AES	Clean plasma torch; clean filters; clean spray and nebulizer chambers; replace pump tubing	Select Metals	Torch, filters, nebulizer chamber, pump, pump tubing	Maintenance is performed prior to initial calibration or as necessary.	See **Worksheet #24**	Repeat maintenance activity or remove from service.	Analyst/ Supervisor	SOP-105
CVAA	Change the tubing, filter, clean windows, and check gas flow. Check the reagents and standards.	Mercury	Inspect the tubing, filter, and the optical cell					SOP-104
TOC analyzer	Replace sample tubing, clean sample boat, replace syringe	TOC	Tubing, sample boat, syringe	As needed				SOP-221

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SAP Worksheet #26—Sample Handling System

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): FTL/ CH2M HILL
Sample Packaging (Personnel/Organization): FTL/ CH2M HILL
Coordination of Shipment (Personnel/Organization): FTL/ CH2M HILL
Type of Shipment/Carrier: Overnight Carrier/FedEx
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt and Custody: Empirical and Water & Air employees
Analysis: Empirical and Water & Air employees
Sample Preparation: Empirical and Water & Air employees
SAMPLE ARCHIVING
Field Sample Storage (No. of days from sample collection): 45 days from receipt
Sample Extract/Digestate Storage (No. of days from extraction/digestion): 90 days
SAMPLE DISPOSAL
Personnel/Organization: Empirical and Water & Air employees
Number of Days from Analysis: 90 days from receipt

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SAP Worksheet #27—Sample Custody Requirements Table

Field Sample Custody Procedures (sample collection, packaging, shipment, and delivery to laboratory): 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 degrees Celsius until they are received by the laboratory. The chain of custody will be placed into the cooler in a Ziploc bag. Coolers will be taped up and shipped to the laboratories via Fed Ex overnight, with the air bill number indicated on the CoC (to relinquish custody). Upon delivery, the laboratory will log in each cooler and report the status of the samples to CH2M HILL. See **Worksheet #21** for SOPs containing sample custody guidance. The CH2M HILL field team will ship all environmental samples to Empirical. Empirical will ship grain size samples to Beaver Engineering. All benthic macroinvertebrate samples will be shipped to Water & Air.
Laboratory Sample Custody Procedures (receipt of samples, archiving, disposal): Laboratory custody procedures can be found in the following SOP, which is referenced in **Worksheet #23** and can be found in Appendix D of this SAP: SOP-404, 410.
Sample Identification Procedures: 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 EIS to check that sample IDs and parameters are correct.
Chain-of-custody Procedures: 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 database for each sample.

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SAP Worksheet #28-1—Laboratory QC Samples Table

Measurement Performance Criteria is consistent with Department of Defense QSM version 4.1

Matrix	Sediment
Analytical Group	Select Metals
Analytical Method/ SOP Reference	SW846 6010B, 7471A/ SOP-104,105

QC Sample:	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One is performed for each batch of up to 20 samples.	Target analytes must be ≤½ LOQ	Correct the problem; if required, re-prep and reanalyze the method blank and all samples processed with the contaminated blank	Analyst/ Laboratory Area Supervisor	Contamination/ Bias	Target analytes must be ≤½ LOQ
LCS		Percent recoveries must meet the control limits listed in Worksheet #15-1	Re-prepare and analyze all associated samples.		Accuracy/Bias	Percent recoveries must meet the control limits listed in Worksheet #15-1
MS/MSD		Percent recoveries must meet the control limits and RPD listed in Worksheet #15-1	Examine results of LCS. If both the LCS and MS/MSD are unacceptable, re-prepare and analyze the associated samples and QC, otherwise report and narrate.		Precision / Accuracy / Bias	Percent recoveries must meet the control limits and RPD listed in Worksheet #15-1
Serial Dilution(does not apply to Cold Vapor)	One is performed for each preparation batch with sample concentration(s) > 50x LOQ	The five-fold dilution result must agree within ± 10% of the original sample result.	Perform Post Digestion Spike		Precision / Accuracy	The five-fold dilution result must agree within ± 10% of the original sample result.
Post Digestion Spike (does not apply to Cold Vapor)	One is performed when serial dilution fails or analyte concentration(s) in all samples < 50x LOD.	The result must agree within ± 25% of expected result.	Run all associated samples in the preparatory batch by method of standard additions or qualify results.		Precision / Accuracy	The result must agree within ± 25% of expected result.

SAP Worksheet #28-2—Laboratory QC Samples Table

Measurement Performance Criteria is consistent with the laboratory's internal criteria.

Matrix:	Sediment
Analytical Group:	AVS/SEM
Analytical Method / SOP Reference:	EPA 821-R-91-100/ SOP-104, 105, AVS/SEM

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One is performed for each batch of up to 20 samples.	Target analytes must be ≤½ LOQ	Re-extract, re-analyze all samples associated with the MB that do not have concentrations greater than 10X MB concentration. Flag data is samples cannot be reanalyzed.	Analyst/ Laboratory Area Supervisor	Contamination/ Bias	Target analytes must be ≤½ LOQ
LCS		Percent recoveries must meet the control limits listed in Worksheet #15-4	Re-extract, re-analyze all samples associated with the LCS where possible. Flag data if samples cannot be re-analyzed.		Accuracy/Bias	Percent recoveries must meet the control limits listed in Worksheet #15-4
MS/MSD		Percent recoveries must meet the control limits and RPD listed in Worksheet #15-4	Examine results of LCS. If both the LCS and MS/MSD are unacceptable, re-prepare and analyze the associated samples and QC, otherwise report and narrate.		Precision / Accuracy / Bias	Percent recoveries must meet the control limits and RPD listed in Worksheet #15-4
Serial Dilution(does not apply to Cold Vapor or AVS)	One is performed for each preparation batch with sample concentration(s) > 50x LOQ	The five-fold dilution result must agree within ± 10% of the original sample result.	Perform Post Digestion Spike		Precision / Accuracy	The five-fold dilution result must agree within ± 10% of the original sample result.
Post Digestion Spike (does not apply to Cold Vapor or AVS)	One is performed when serial dilution fails or analyte concentration(s) in all samples < 50x LOD.	The result must agree within ± 25% of expected result.	Run all associate samples in the preparatory batch by method of standard additions or qualify results.		Precision / Accuracy	The result must agree within ± 25% of expected result.

SAP Worksheet #28-3—Laboratory QC Samples Table

Measurement Performance Criteria is consistent with the laboratory's internal criteria.

Matrix:	Sediment
Analytical Group:	TOC
Analytical Method / SOP Reference:	Lloyd Kahn/ SOP-221

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	One is performed for each batch of up to 20 samples.	Target analytes must be < ½ LOQ	Re-prepare and analyze all associated samples. Discuss with client/qualify if re-extraction/re-analysis not feasible.	Analyst, Laboratory Supervisor	Contamination/ Bias	Target analytes must be < ½ LOQ
Lab duplicate		RPD < 20%			Precision/ Accuracy	RPD < 20%
LCS		See Worksheet #15-5			Accuracy/Bias	See Worksheet #15-5

SAP Worksheet #28-4—Laboratory QC Samples Table

Measurement Performance Criteria is consistent with the laboratory's internal criteria.

Matrix:	Sediment
Analytical Group:	pH
Analytical Method / SOP Reference:	SW-846 9045C/ SOP-187

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
QC Check	One per prep batch of twenty or fewer samples	See Worksheet #15-5	Reanalyze samples	Analyst, Laboratory Supervisor	Accuracy/Bias	See Worksheet #15-5
Lab Duplicate		See Worksheet #15-5	If RPD > 20%, sample should be reanalyzed. If still high, result is flagged.		Accuracy/Bias	See Worksheet #15-5

SAP Worksheet #28-5—Laboratory QC Samples Table

Matrix:	Sediment
Analytical Group:	Grain Size
Analytical Method / SOP Reference:	ASTM D422

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
No QA/QC						

SAP Worksheet #28-6—Laboratory QC Samples Table

Matrix:	Benthic Invertebrate
Analytical Group:	Benthic Invertebrate
Analytical Method / SOP Reference:	IZ-06

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Sorting QC	10% of samples of dishes are checked by a proficient analyst	≥ 95% picking efficiency	Technician receives training until they achieve 95% efficiency on three consecutive samples	Proficient Analysts	Precision, Accuracy	≥ 95% picking efficiency
Identification QC	5% of samples are re-identified by a proficient analyst	100% agreement	If disagreements are encountered they are addressed using available references and expertise		Precision, Accuracy	100% agreement

SAP Worksheet #29—Project Documents and Records Table

Document	Where Maintained
• Field Notebooks • Chain of custody (CoC) Records • Air Bills • Custody Seals • CA Forms • Electronic Data Deliverables (EDDs) • Identification of QC Samples • Release of Analytical Data • Meteorological Data from Field • Sampling instrument calibration logs • Sampling locations and sampling plan • Sampling notes • Sample Receipt, CoC, and Tracking Records • Standard Traceability Logs • Equipment Calibration Logs • Sample Prep Logs • Run Logs • Equipment Maintenance, Testing, and Inspection Logs • 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 • Sample disposal records • Extraction/Clean-up Records • Raw Data (stored on disk and in hardcopy format) • Data Validation Reports • MDL Study Information	• Field data deliverables such as logbooks entries, chain of custodies, air bills, EDDs, etc will be kept on CH2M HILL's local internet server. • Field parameter data will be loaded with the analytical data into Navy Installation Restoration Information System (NIRIS) • Analytical laboratory hardcopy deliverables and data validation reports will be saved on the network server. • Electronic data from the laboratory will be loaded into NIRIS • Following project completion, hardcopy deliverables such as logbooks, chain of custodies, raw data, data validation reports, etc will be archived indefinitely at Iron Mountain: **Iron Mountain Headquarters** 745 Atlantic Avenue Boston, MA 02111 (800) 899-IRON

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SAP Worksheet #30—Analytical Services Table

All sediment samples will be sent to Empirical. All benthic macroinvertebrate samples will be sent to Water & Air.

Matrix	Analytical Group	Sample Locations/ID Number	Analytical Method	Data Package Turnaround Time	Laboratory / Organization[1]	Backup Laboratory / Organization[1]
Benthic Macroinvertebrates		See Worksheet #18	IZ-06	60 calendar days	Water & Air David Evans 800-242-4927 6821 SW Archer Road Gainesville, FL 32608	TBD[1]
Sediment	Select Metals		SW-846 6010B	28 calendar days	Empirical Sonya Gordon 615-345-1115 621 Mainstream Drive, Suite 270 Nashville, TN 37228	
	Mercury		SW-846 7471A			
	AVS/SEM		EPA 821-R-91-100			
	TOC		Lloyd Kahn			
	pH		SW-846 9045C			
	Grain size		ASTM D422		Beaver Engineering Pat Beaver 615-350-8124 7378 Cockrill Bend Boulevard Nashville, TN 37209	

[1] A backup laboratory has not been determined. If circumstances render the subcontracted laboratory unable to perform analytical services, another laboratory will be determined at that time.

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SAP Worksheet #31—Planned Project Assessments Table

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment	Person(s) Responsible for Response to Assessment Findings	Person(s) Responsible for Identifying and Implementing CA	Person(s) Responsible for Monitoring Effectiveness of CA
Third Party Laboratory Technical Systems Audit	Laboratories must have current DoD ELAP accreditation which will identify the period of performance.	External	Third party accrediting body	TBD, Third party accrediting body	Empirical's QA Officer	Empirical's QA Officer	Anita Dodson, Program Chemist, CH2M HILL
Field Performance Audit	Once per definable feature of work	Internal	CH2M HILL	FTL	FTL and SSC	FTL and SSC	Cecilia Landin, CH2M HILL PM

Note: Stop Work Order: Any field member can immediately stop work if an unsafe condition, which is immediately threatening to human health, is observed. Ultimately, the FTL, PM, and AM can stop work for a period of time. NAVFAC Mid-Atlantic can stop work at any time.

DoD ELAP accreditation is required for definitive data only. Beaver Engineering and Water & Air are generating screening data only; therefore, they are not included in this worksheet.

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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 Performance Audit	Checklist and written audit report	Cecilia Landin, PM CH2M HILL	Within 1 week of audit	Memorandum	FTL CH2M HILL (TBD) AQM CH2M HILL - Scott MacEwen	Within 1 week of receipt of CA Form
Laboratory Performance and Systems Audits	Written Audit Report from Third party accrediting body	Empirical's QA Officer	Within 2 months of audit	Memorandum	Third Party Auditor, TBD	Within 2 months of receipt of initial notification.

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SAP Worksheet #32-1—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 (CA): (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/ Navy CLEAN Program Chemist

SAP Worksheet #32-2— Field Performance Audit Checklist

Project Responsibilities

Project No.: _____ Date: _____

Project Location: _____ Signature: _____

Team Members:

Yes __ No __ 1) Is the approved work plan being followed?
Comments _____

_____

Yes __ No __ 2) Was a briefing held for project participants?
Comments _____

_____

Yes __ No __ 3) Were additional instructions given to project participants?
Comments _____

_____

Sample Collection

Yes __ No __ 1) Is there a written list of sampling locations and descriptions?
Comments _____

_____

Yes __ No __ 2) Are samples collected as stated in the Master SOPs?
Comments _____

_____

Yes __ No __ 3) Are samples collected in the type of containers specified in the work plan?
Comments _____

_____

Yes __ No __ 4) Are samples preserved as specified in the work plan?
Comments _____

_____

SAP Worksheet #32-2— Field Performance Audit Checklist (continued)

Yes __ No __ 5) Are the number, frequency, and type of samples collected as specified in the work plan?
Comments _____

_____

Yes __ No __ 6) Are quality assurance checks performed as specified in the work plan?
Comments _____

_____

Yes __ No __ 7) Are photographs taken and documented?
Comments _____

_____

Document Control

Yes __ No __ 1) Have any accountable documents been lost?
Comments _____

_____

Yes __ No __ 2) Have any accountable documents been voided?
Comments _____

_____

Yes __ No __ 3) Have any accountable documents been disposed of?
Comments _____

Yes __ No __ 4) Are the samples identified with sample tags?
Comments _____

_____

Yes __ No __ 5) Are blank and duplicate samples properly identified?
Comments _____

_____

Yes __ No __ 6) Are samples listed on a chain-of-custody record?
Comments _____

SAP Worksheet #32-2— Field Performance Audit Checklist (continued)

_____

Yes __ No __ 7) Is chain-of-custody documented and maintained?
Comments _____

_____

SAP Worksheet #33—QA Management Reports Table

Type of Report	Frequency	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation	Report Recipient(s)
Field Performance CA Memorandum	After Field Audit	1 week after audit, if necessary	CH2M HILL FTL	Will be posted in project file.
QA Management Report/Technical Memorandum	Once results are received from data validator	Approximately 8 weeks following sample collection	CH2M HILL Project Team	Will be posted in project file.

The following will be addressed in the QA/QC section of QA Management Report/Technical Memorandum:

- Summary of project QA/QC programs and trainings
- Conformance of project activities to SAP requirements and procedures
- Status of project and schedule delays
- Deviations from approved SAP and approved amendments to SAP
- Description and findings of audits
- Results of data review activities in terms of amount of usable data generated (results of the Chemist's QC check on data prior to loading into CH2M HILL's database)
- Required CAs and effectiveness of CA implementation
- Data usability assessments in terms of accuracy, precision, representativeness, completeness, comparability and sensitivity.
- Limitations on use of measurement data generated.

The reports will also include data quality concerns:

- Narrative and timelines of project activities; summary of project quality objective development
- Reconciliation of project data with project quality objectives
- Summary of major problems encountered and their resolution
- Data summary, including tables, charts, graphs, with appropriate sample identification or station location numbers, concentration units, percent solids (not applicable), and data quality flags
- Conclusions and recommendations

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

Verification Input	Description	Internal / External	Responsible for Verification
Planning Documents	Evidence of approval and completeness of UFP-SAP.	Internal	Cecilia Landin (CH2M HILL)
Chain of Custody and shipping forms	CoC 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 CoC will be initialed by the reviewer, a copy of the CoC retained in the site file, and the original and remaining copies taped inside the cooler for shipment. See CoC SOP for further details.	Internal	FTL (CH2M HILL) Victoria Brynildsen (CH2M HILL)
Field Log Notebooks	Field notes will be reviewed to ensure completeness of field data parameters, shipping information, and 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	Cecilia Landin (CH2M HILL)
Sample Login/ Receipt	Upon their arrival at the laboratory, the samples will be cross-referenced against the CoC records. All sample labels will be checked against the CoC, 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	Empirical Laboratories, Beaver Engineering, and Water & Air employees
QC Summary Report	A summary of all QC sample results will be verified for completeness once the data is received from the laboratory.	External	Victoria Brynildsen (CH2M HILL)
Field Inspection Interpretive Data	Immediately following receipt of the analytical data from the laboratory and prior to submittal to the data validator, a population to population comparison will be conducted comparing site results and the results from the background sample set. The background population to population comparison for will be used to determine the likelihood of a release relative to background. The data will also be compared to screening criteria (see **Worksheet #15**).	Internal	Cecilia Landin (CH2M HILL)

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

Verification Input	Description	Internal / External	Responsible for Verification
Laboratory Data	All laboratory data packages will be verified internally by the laboratory performing the work for completeness and technical accuracy prior to submittal. All received data packages will be examined by an EIS and a Chemist according to the procedures specified in the Navy CLEAN Data Management Plan in Attachment C.	Internal/ External	Sonya Gordon (Empirical Laboratories) Pat Beaver (Beaver Engineering) David Evans (Water & Air Research, Inc.) Cecilia Landin (CH2M HILL) Victoria Brynildsen (CH2M HILL) Megan Morrison (CH2M HILL)

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

Step IIa / IIb[1]	Validation Input	Description	Responsible for Validation
IIb	Onsite Screening **Worksheet # 11**, **17**, **18**, **20**, and **22** and Fieldbook	Ensure that all field data meet Work Plan requirements for completeness and accuracy based on the field calibration records.	FTL (CH2M HILL)
IIa	SOPs **Worksheet # 19 and 21**, Fieldbook, and Laboratory Report	Ensure that all sampling and analytical SOPs were followed.	FTL (CH2M HILL) Empirical Laboratories, Beaver Engineering, and Water & Air Research, Inc. employees
IIa	Method QC Results **Worksheet # 12** and Laboratory Report	Ensure that all required QC samples were run and meet method and/or project required limits.	Ward Dickens (CH2M HILL)
IIb	Work Plan QC Sample Results **Worksheet # 20** and **15** and Laboratory Report	Ensure that all required Work Plan QC samples were run and meet required limits.	Megan Morrison (CH2M HILL) Ward Dickens (CH2M HILL)
IIb	QLs **Worksheet # 15** and Laboratory Report	Ensure all sample results met the project quantification limit specified in the Work Plan.	Cecilia Landin (CH2M HILL) Megan Morrison (CH2M HILL)
IIa	Raw Data Laboratory Report	Ten percent review of raw data to confirm laboratory calculations	Ward Dickens (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 measurement performance criteria 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	Data Validator
IIa	Sediment	Select Metals	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 that may be used are those presented in *Region III Modifications to National Functional Guidelines for Inorganic Data Review* (April 1993). 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.	Ward Dickens (CH2M HILL)
IIa		Benthic Invertebrates, AVS/SEM, TOC, pH, Grain Size	Data will be reviewed against the analytical methods for outstanding QA/QC issues, and anomalies by the laboratory. Issues will be summarized in the case narrative. The CH2M HILL Chemist and PM will review the analytical results and case narrative before the data are loaded to ensure no major problems exist.	Empirical Laboratories, Beaver Engineering, and Water & Air Research, Inc. employees Cecilia Landin (CH2M HILL) Megan Morrison (CH2M HILL)
IIb		Select Metals, Benthic Invertebrates, AVS/SEM, TOC, pH, Grain Size	See project action limits in **Worksheet #15**; See Method calibration and QC criteria in **Worksheets #24** and **28**.	Cecilia Landin (CH2M HILL) 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 QL goals in **Worksheet #15** were achieved. If project QLs were achieved and the verification and validation steps yielded acceptable data, the data is considered usable.
- 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 that 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 is not considered usable for project decisions.
  - J- Analyte present. Reported value may or may not be accurate or precise.
  - UJ- Analyte not detected. QL may be inaccurate or imprecise.
  - K- Analyte present. Interferences present that may cause the reported result to be biased high. Actual value is expected to be lower.
  - L- Analyte present. Reported value may be biased low. Actual value is expected to be higher.
  - UL- Analyte not detected. QL is probably higher.
  - R- Rejected result. Result not reliable.
- Additional qualifiers that may be given by the validator are:
  - B- Not detected substantially above the level reported in laboratory or field blanks (less than 5 times the concentration in the blanks).
  - N- Tentative Identification. Consider Present. Special methods may be needed to confirm its presence or absence in future sampling efforts
  - NJ- Qualitative identification questionable due to poor resolution. Presumptively present at approximate quantity.
  - U- Not Detected.
- For statistical comparisons, non-detect values will be represented by a concentration equal to one-half the sample reporting limit. For duplicate sample results, the most conservative value 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 EDD. 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 compared as RPD between the two results.
- Deviations from the SAP will be reviewed to assess whether CA is warranted and to assess impacts to achievement of project objectives.
- Benthic invertebrate data will be evaluated against the QA/QC criteria in the laboratory SOP related to sample processing (sorting efficiency) and identification.

SAP Worksheet #37—Usability Assessment (continued)

Describe the evaluative procedures used to assess overall measurement error associated with the project.

- To assess whether a sufficient quantity of acceptable data are available for decision-making, the data will be reconciled with MPC following validation and review of DQIs.
- If significant biases are detected with laboratory QA/QC samples, they will be evaluated to assess impact on decision making. Low biases will be described in greater detail because they represent a possible inability to detect compounds that may be present at the site.
- If significant deviations are noted between lab and field precision, the cause will be further evaluated to assess impact on decision making.

Describe the documentation that will be generated during the usability assessment and how usability assessment results will be presented so that they identify trends, relationships (correlations), and anomalies:

The following will be prepared by CH2M HILL and presented to and submitted to the Tier I Partnering Team (VDEQ, USEPA, DoN, and CH2M HILL) for review and decisions on the path forward for the site:

- Data tables will be produced to reflect detected and non-detected site COCs/COPCs as well as other parameters analyzed. Data qualifiers will be reflected in the tables and discussed in the data quality evaluation.
- Graphical representations will be produced to reflect spatial trends in ABM content and COC/COPC concentrations.
- A data quality evaluation considering all of the above will be provided as part of presentations and follow-up reporting presented to the Tier I Partnering Team. The presentations and reporting will identify any data usability limitations and make recommendations for CA if necessary.

Identify the personnel responsible for performing the usability assessment.

The CH2M HILL Project Team, including the PM and Project Chemist, will review the data and compile a presentation for the Partnering Team. The Tier I Partnering Team as a whole will assess the usability of the data.

References

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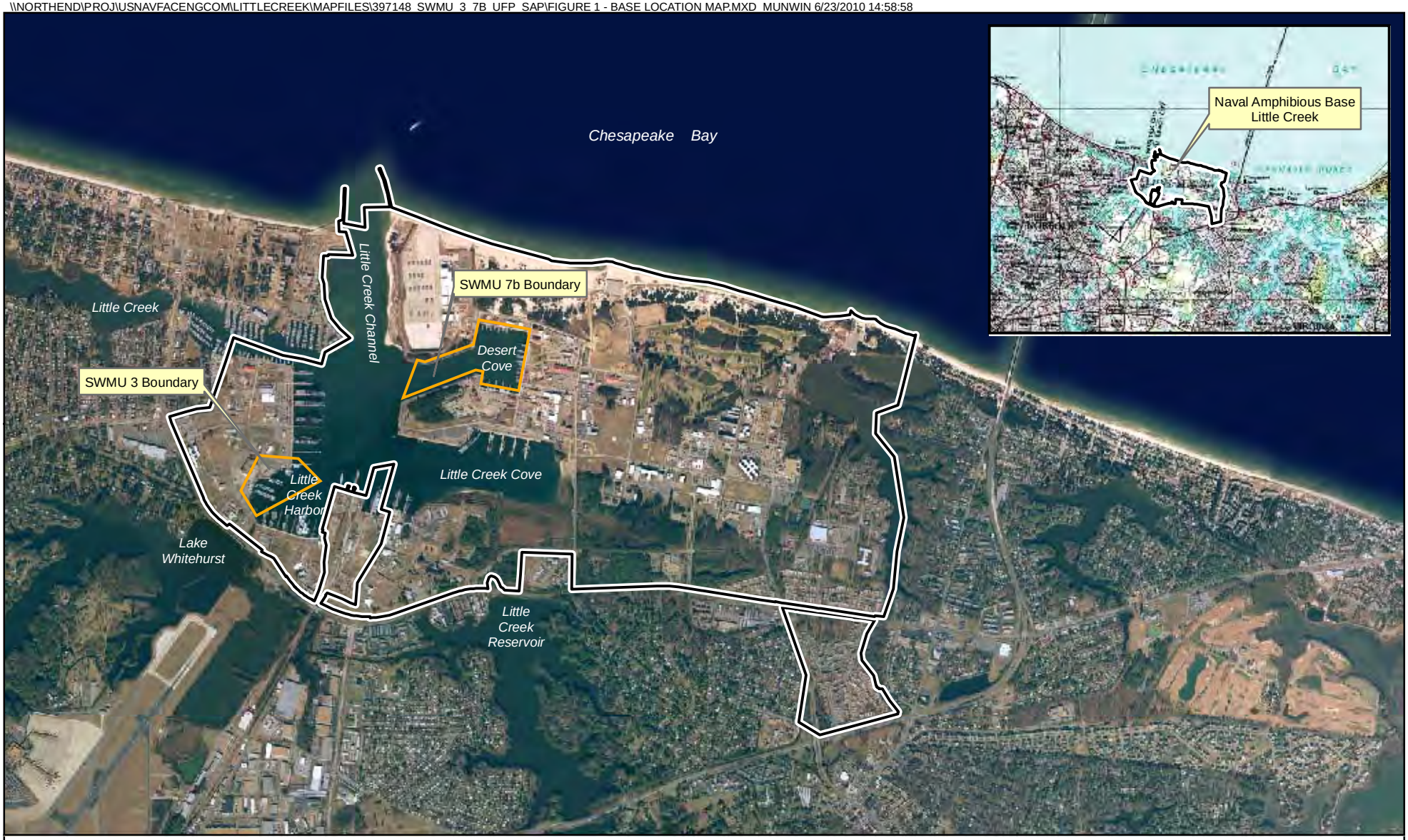
Figures

\\NORTHEND\PROJ\USNAVFACENGCOM\LITTLECREEK\MAPFILES\397148_SWMU_3_7B_UFP_SAP\FIGURE 1 - BASE LOCATION MAP.MXD MUNWIN 6/23/2010 14:58:58



Legend

- Installation Boundary
- SWMU Boundary

N
W E
S

0 1,500 3,000
Feet

Figure 1
SWMU Location Map
SWMU 3 and SWMU 7b Benthic Invertebrate UFP SAP
JEB Little Creek
Virginia Beach, Virginia

CH2MHILL

\\NORTHEND\PROJ\USNAVFACENGCOM\LITTLECREEK\MAPFILES\397148_SWMU_3_7B_UFP_SAP\FIGURE 2 - SWMU3 BOUNDARY AND VICINITY.MXD MUNWIN 6/23/2010 15:01:42

Legend

- Outfall Locations
- Underground Drain Pipe
- 1999 Dredging Limits
- Fenced Area
- ABM - and Metals - Based Remediation Area
- Picnic Area
- SWMU 3 Investigation Boundary
- Former Sandblasting Area (1962-1995)
- More Recent Sandblasting Area (1995-1996)
- NAB Little Creek Dredge Maintenance to -18' mean low water (mlw)
- NAB Little Creek Dredge Maintenance to -20' mlw
- NAB Little Creek Dredge Maintenance to -25' mlw
- USACE Dredge Maintenance to -27' mlw

N
W E
S

0 200 400
Feet

Figure 2
SWMU 3 Boundary and Immediate Vicinity
SWMU 3 and SWMU 7b Benthic Invertebrate UFP SAP
JEB Little Creek
Virginia Beach, Virginia

CH2MHILL

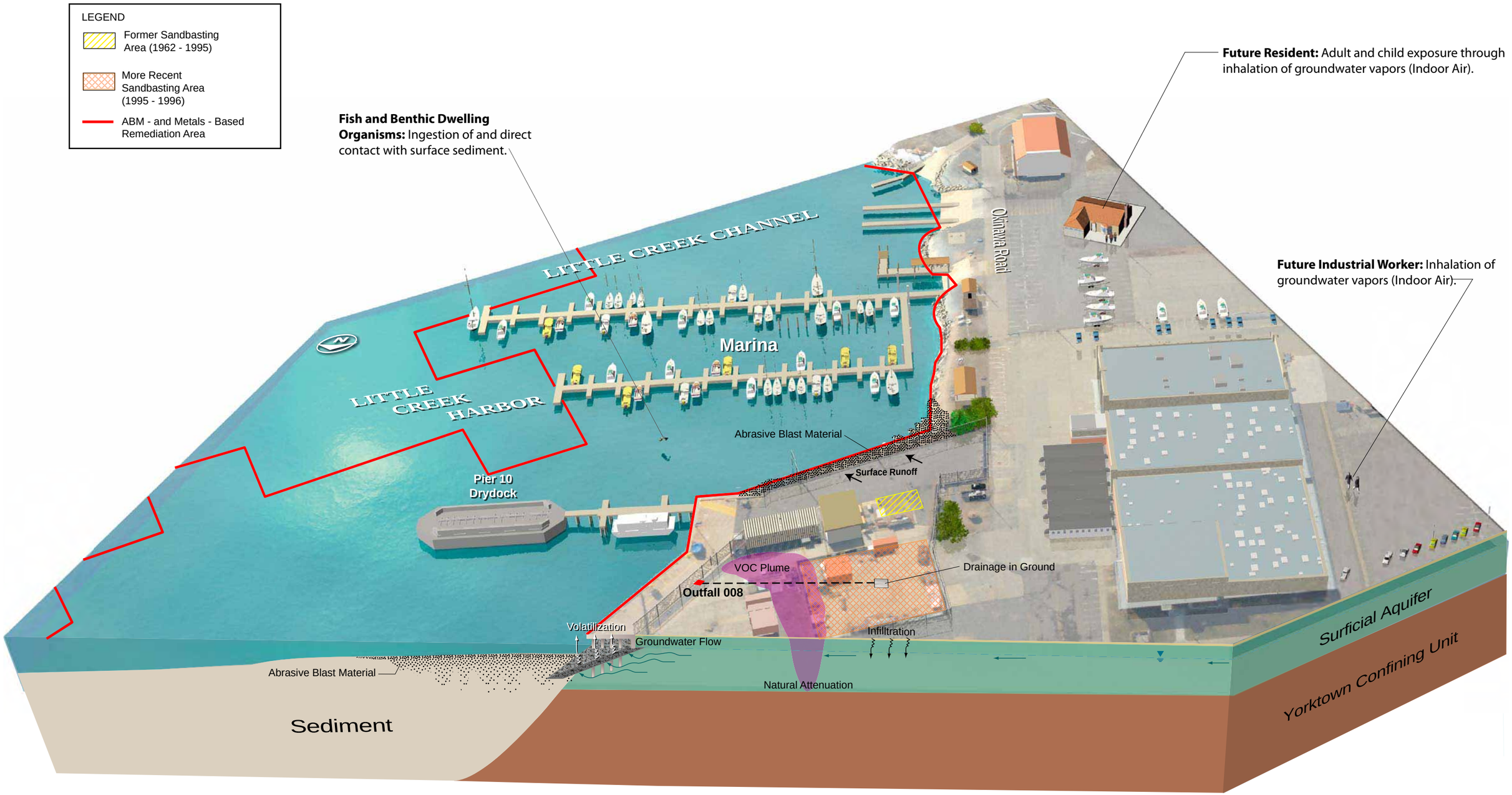
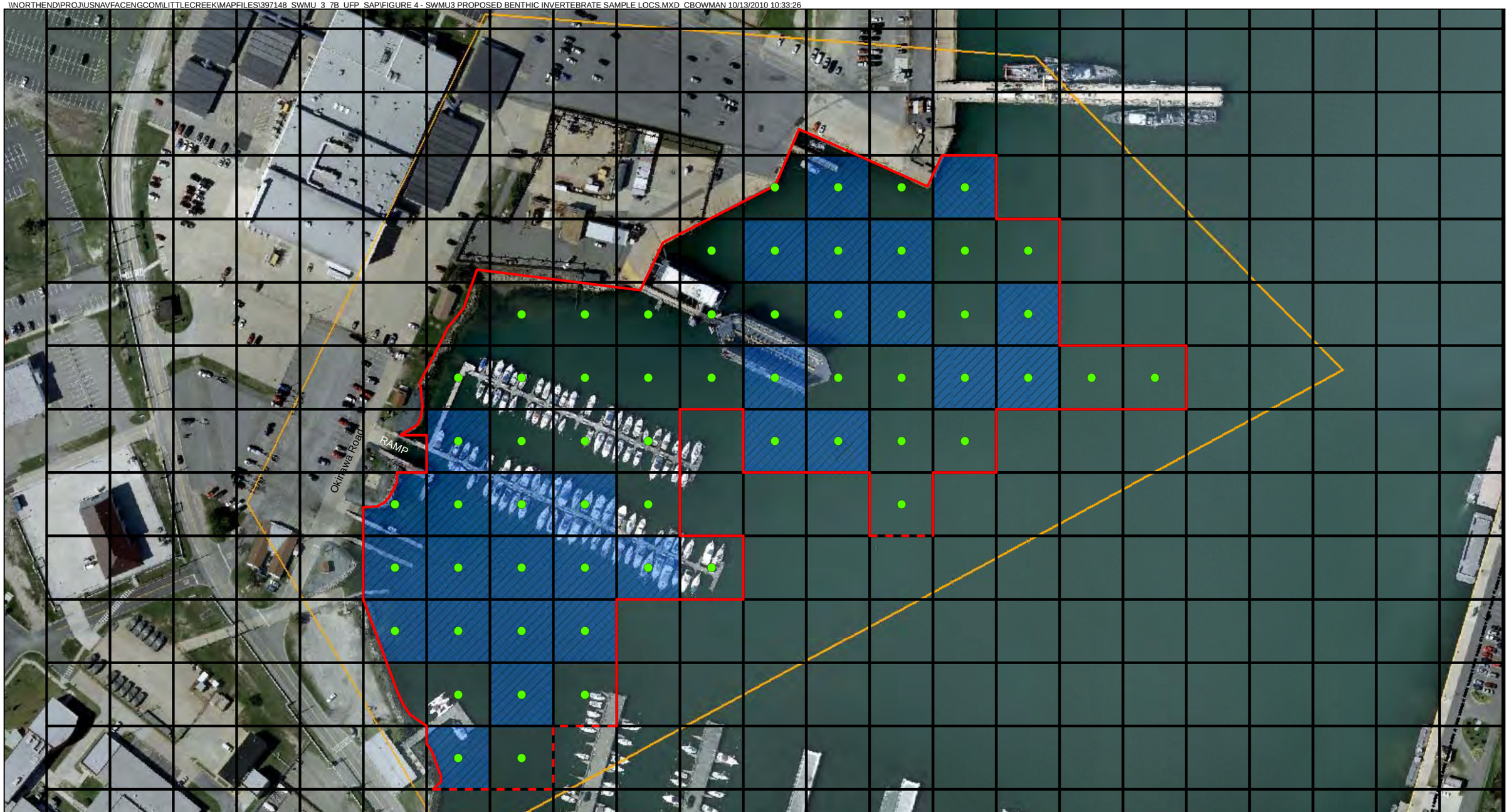


FIGURE 3
SWMU 3 Conceptual Site Model
SWMU 3 and SWMU 7b Benthic Invertebrate UFP SAP
JEB Little Creek
Virginia Beach, Virginia

\\NORTHEND\PROJ\USNAVFACENGCOM\LITTLECREEK\MAPFILES\397148_SWMU_3_7B_UFP_SAP\FIGURE 4 - SWMU3 PROPOSED BENTHIC INVERTEBRATE SAMPLE LOCS.MXD CBOWMAN 10/13/2010 10:33:26



Legend

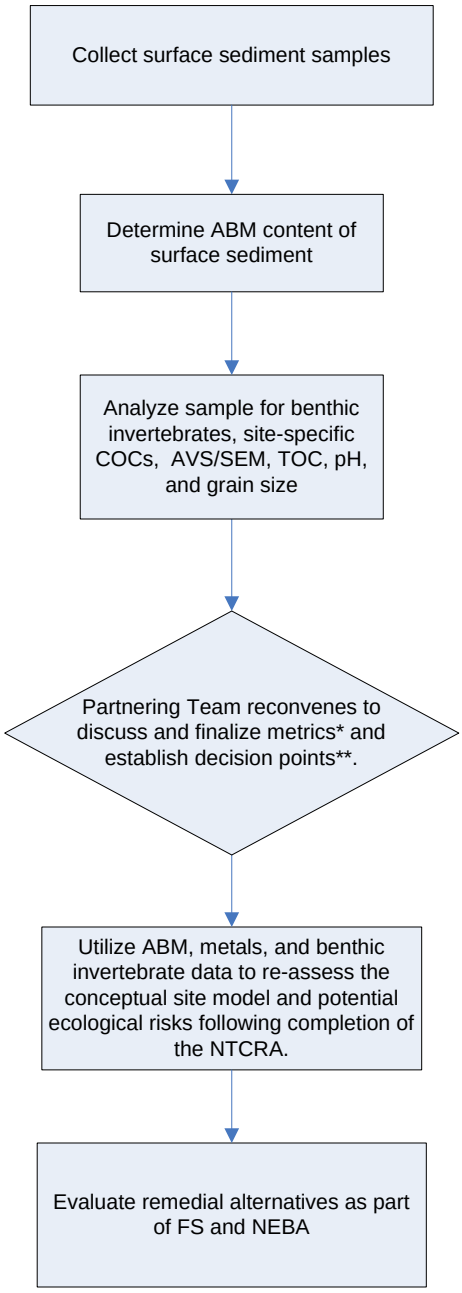
- Proposed Site-specific Sample Location
- ABM - and Metals - Based Remediation Area
- SWMU 3 Boundary
- No surface sediment COC data currently available

N
W E
S

0 150 300
Feet

Figure 4
Proposed SWMU 3 Sample Locations
SWMU 3 and SWMU 7b Benthic Invertebrate UFP SAP
JEB Little Creek
Virginia Beach, Virginia

CH2MHILL



* Benthic invertebrate communities will be evaluated using similar metrics as outlined below:

- Taxa richness
- Density
- Diversity (Shannon-Weiner Index)
- Percent contribution of dominant taxa
- Density of dominant taxon
- Percent amphipods
- Percent bivalves
- Percent Spionid polycheates
- Percent Mediomastus polycheates
- Percent deposit feeders

**Decision points will be developed in the form of if/then statements and documented in a technical memorandum.

Figure 5
SWMU 3 Decision Tree
SWMU 3 and SWMU 7b Benthic Invertebrate UFP SAP
JEB Little Creek
Virginia Beach, Virginia

\\NORTHEND\PROJ\USNAVFACENGCOM\LITTLECREEK\MAPFILES\397148_SWMU_3_7B_UFP_SAP\FIGURE 6 - SWMU 7 BOUNDARY AND IMMEDIATE VICINITY.MXD CBOWMAN 9/9/2010 12:46:43

Legend

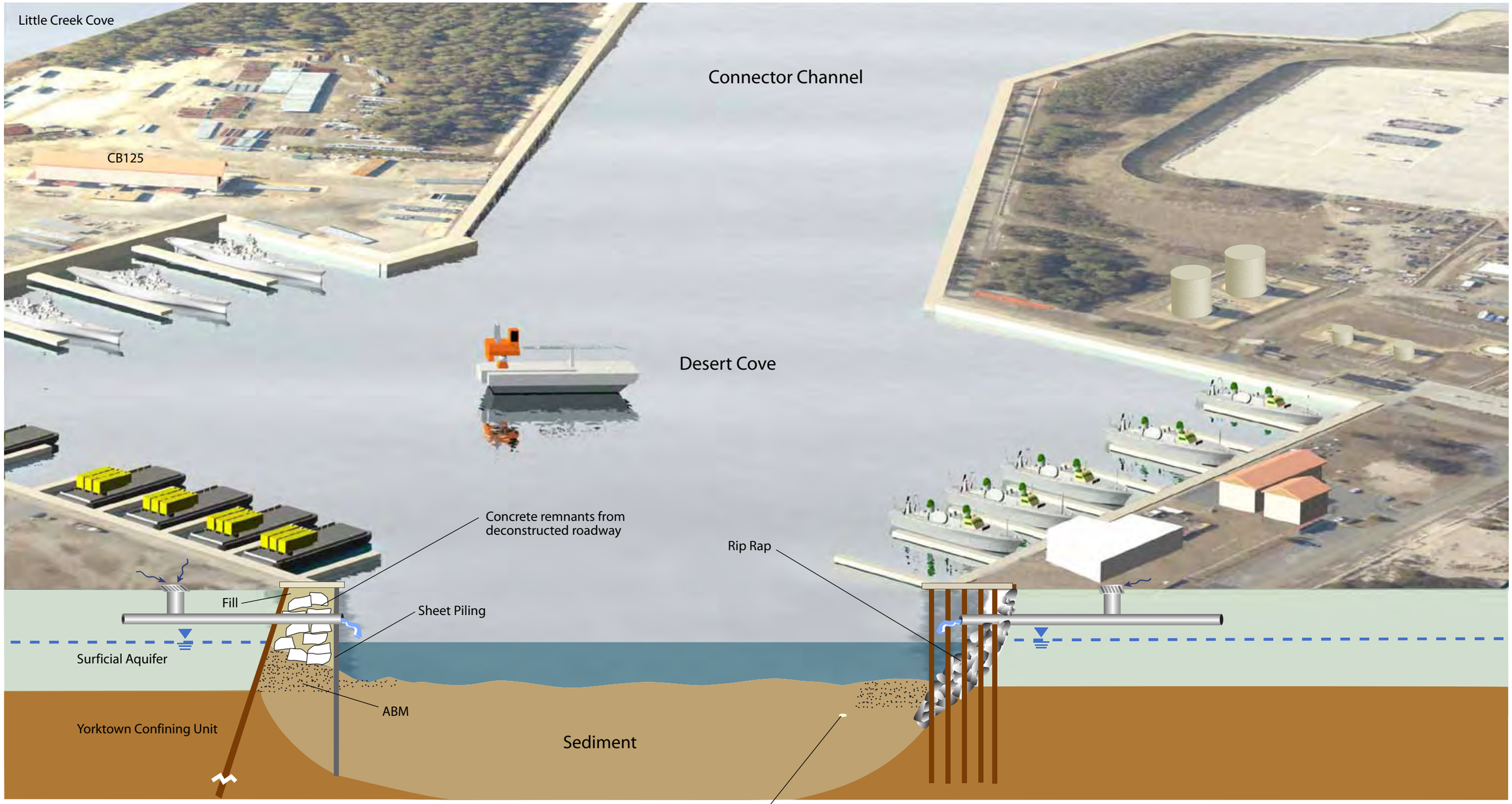
- Outfall
- Storm Sewer Line
- Installation Boundary
- SWMU 7 Boundary
- Area Boundary Line
- Limits of 2008 MILCON Dredge

N
W E
S

0 150 300
Feet

Figure 6
SWMU 7 Boundary and Immediate Vicinity
SWMU 3 and SWMU 7b Benthic Invertebrate UFP SAP
JEB Little Creek
Virginia Beach, Virginia

CH2MHILL



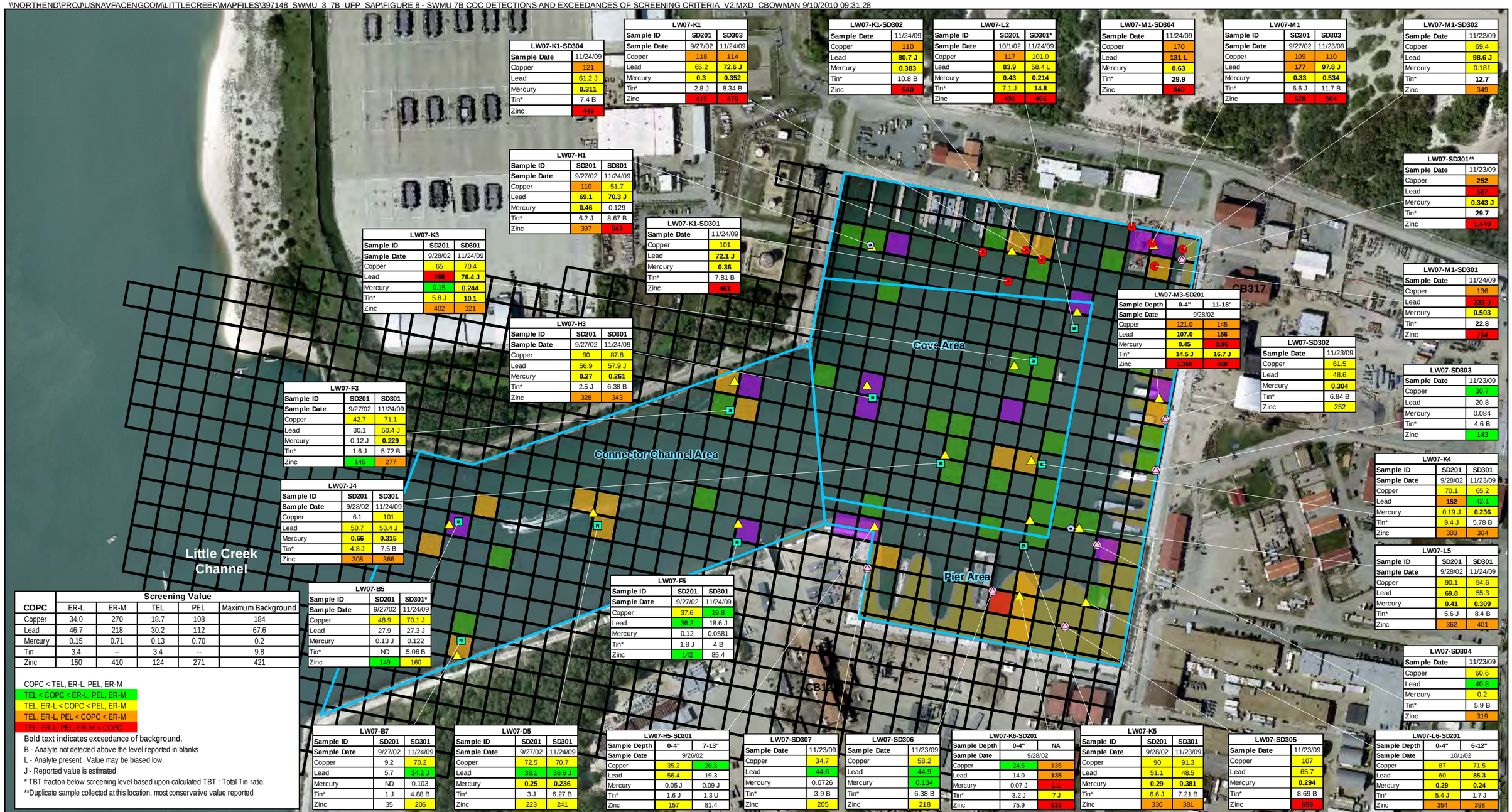
Benthic Dwelling Organisms (worms, insects, crustaceans)**:** Ingestion of and direct contact with surface sediment.

LEGEND

- Water Table
- Stormwater Runoff
- Sheet Flow

Vertical exageration 1" = 20'

FIGURE 7
SWMU 7b Conceptual Site Model
SWMU 3 and SWMU 7b Benthic Invertebrate UFP SAP
JEB Little Creek
Virginia Beach, Virginia



LW07-K1-SD304	
Sample Date	11/24/09
Copper	121
Lead	61.2 J
Mercury	0.311
Tin*	7.4 B
Zinc	449

LW07-K1		
Sample ID	SD201	SD303
Sample Date	9/27/02	11/24/09
Copper	118	114
Lead	65.2	72.6 J
Mercury	0.3	0.352
Tin*	2.8 J	8.34 B
Zinc	415	479

LW07-K1-SD302	
Sample Date	11/24/09
Copper	110
Lead	80.7 J
Mercury	0.383
Tin*	10.8 B
Zinc	540

LW07-L2		
Sample ID	SD201	SD301*
Sample Date	10/1/02	11/24/09
Copper	117	101.0
Lead	83.9	58.4 L
Mercury	0.43	0.214
Tin*	7.1 J	14.8
Zinc	491	466

LW07-M1-SD304	
Sample Date	11/24/09
Copper	170
Lead	131 L
Mercury	0.63
Tin*	29.9
Zinc	840

LW07-M1		
Sample ID	SD201	SD303
Sample Date	9/27/02	11/23/09
Copper	109	110
Lead	177	97.8 J
Mercury	0.33	0.534
Tin*	6.6 J	11.7 B
Zinc	628	504

LW07-M1-SD302	
Sample Date	11/22/09
Copper	69.4
Lead	98.6 J
Mercury	0.181
Tin*	12.7
Zinc	349

LW07-H1		
Sample ID	SD201	SD301
Sample Date	9/27/02	11/24/09
Copper	110	51.7
Lead	69.1	70.3 J
Mercury	0.46	0.129
Tin*	6.2 J	8.67 B
Zinc	397	943

LW07-K1-SD301	
Sample Date	11/24/09
Copper	101
Lead	72.1 J
Mercury	0.36
Tin*	7.81 B
Zinc	461

LW07-SD301**	
Sample Date	11/23/09
Copper	252
Lead	587
Mercury	0.343 J
Tin*	29.7
Zinc	1,440

LW07-K3		
Sample ID	SD201	SD301
Sample Date	9/28/02	11/24/09
Copper	65	70.4
Lead	255	76.4 J
Mercury	0.15	0.244
Tin*	5.8 J	10.1
Zinc	402	321

LW07-M1-SD301	
Sample Date	11/24/09
Copper	136
Lead	233 J
Mercury	0.503
Tin*	22.8
Zinc	794

LW07-M3-SD201		
Sample Depth	0-4"	11-18"
Sample Date	9/28/02	
Copper	121.0	145
Lead	107.0	156
Mercury	0.45	0.96
Tin*	14.5 J	16.7 J
Zinc	1,360	828

LW07-SD302	
Sample Date	11/23/09
Copper	61.5
Lead	48.6
Mercury	0.304
Tin*	6.84 B
Zinc	252

LW07-SD303	
Sample Date	11/23/09
Copper	30.7
Lead	20.8
Mercury	0.084
Tin*	4.6 B
Zinc	143

LW07-H3		
Sample ID	SD201	SD301
Sample Date	9/27/02	11/24/09
Copper	90	87.8
Lead	56.9	57.9 J
Mercury	0.27	0.261
Tin*	2.5 J	6.38 B
Zinc	328	343

LW07-F3		
Sample ID	SD201	SD301
Sample Date	9/27/02	11/24/09
Copper	42.7	71.1
Lead	30.1	50.4 J
Mercury	0.12 J	0.229
Tin*	1.6 J	5.72 B
Zinc	146	277

LW07-K4		
Sample ID	SD201	SD301
Sample Date	9/28/02	11/23/09
Copper	70.1	65.2
Lead	152	42.1
Mercury	0.19 J	0.236
Tin*	9.4 J	5.78 B
Zinc	303	304

LW07-J4		
Sample ID	SD201	SD301
Sample Date	9/28/02	11/24/09
Copper	6.1	101
Lead	50.7	53.4 J
Mercury	0.66	0.315
Tin*	4.8 J	7.5 B
Zinc	308	366

LW07-L5		
Sample ID	SD201	SD301
Sample Date	9/28/02	11/24/09
Copper	90.1	94.6
Lead	69.8	55.3
Mercury	0.41	0.309
Tin*	5.6 J	8.4 B
Zinc	362	401

LW07-B5		
Sample ID	SD201	SD301*
Sample Date	9/27/02	11/24/09
Copper	48.9	70.1 J
Lead	27.9	27.3 J
Mercury	0.13 J	0.122
Tin*	ND	5.06 B
Zinc	149	160

LW07-F5		
Sample ID	SD201	SD301
Sample Date	9/27/02	11/24/09
Copper	37.6	19.8
Lead	36.2	18.6 J
Mercury	0.12	0.0581
Tin*	1.8 J	4 B
Zinc	142	85.4

LW07-SD304	
Sample Date	11/23/09
Copper	60.6
Lead	40.8
Mercury	0.2
Tin*	5.9 B
Zinc	319

COPC	Screening Value				
	ER-L	ER-M	TEL	PEL	Maximum Background
Copper	34.0	270	18.7	108	184
Lead	46.7	218	30.2	112	67.6
Mercury	0.15	0.71	0.13	0.70	0.2
Tin	3.4	--	3.4	--	9.8
Zinc	150	410	124	271	421

COPC < TEL, ER-L, PEL, ER-M
TEL < COPC < ER-L, PEL, ER-M
TEL, ER-L < COPC < PEL, ER-M
TEL, ER-L, PEL < COPC < ER-M
TEL, ER-L, PEL, ER-M < COPC

Bold text indicates exceedance of background.
B - Analyte not detected above the level reported in blanks
L - Analyte present. Value may be biased low.
J - Reported value is estimated
* TBT fraction below screening level based upon calculated TBT : Total Tin ratio.
**Duplicate sample collected at this location, most conservative value reported

LW07-B7		
Sample ID	SD201	SD301
Sample Date	9/27/02	11/24/09
Copper	9.2	70.2
Lead	5.7	34.2 J
Mercury	ND	0.103
Tin*	1 J	4.88 B
Zinc	35	206

LW07-D5		
Sample ID	SD201	SD301
Sample Date	9/27/02	11/24/09
Copper	72.5	70.7
Lead	38.1	36.6 J
Mercury	0.25	0.236
Tin*	3 J	6.27 B
Zinc	223	241

LW07-H5-SD201		
Sample Depth	0-4"	7-13"
Sample Date	9/26/02	
Copper	35.2	20.3
Lead	56.4	19.3
Mercury	0.05 J	0.09 J
Tin*	1.6 J	1.3 U
Zinc	157	81.4

LW07-SD307	
Sample Date	11/23/09
Copper	34.7
Lead	44.6
Mercury	0.0726
Tin*	3.9 B
Zinc	205

LW07-SD306	
Sample Date	11/23/09
Copper	58.2
Lead	44.9
Mercury	0.134
Tin*	6.38 B
Zinc	218

LW07-K6-SD201		
Sample Depth	0-4"	NA
Sample Date	9/28/02	
Copper	24.5	135
Lead	14.0	135
Mercury	0.07 J	1.1
Tin*	3.2 J	7 J
Zinc	75.9	633

LW07-K5		
Sample ID	SD201	SD301
Sample Date	9/28/02	11/23/09
Copper	90	91.3
Lead	51.1	48.5
Mercury	0.29	0.381
Tin*	6.6 J	7.21 B
Zinc	336	381

LW07-SD305	
Sample Date	11/23/09
Copper	107
Lead	65.7
Mercury	0.294
Tin*	8.69 B
Zinc	659

LW07-L6-SD201		
Sample Depth	0-4"	6-12"
Sample Date	10/1/02	
Copper	87	71.5
Lead	60	85.3
Mercury	0.29	0.24
Tin*	5.4 J	1.7 J
Zinc	354	398

Legend

- 2009 Cove/Connector Channel Sediment Sample Location
- 2009 Dredged Area Sediment Sample Location
- 2009 Pier Area Sediment Sample Location - Low Concentrations
- 2009 Pier Area Sediment Sample Location - High Concentrations
- 2002 RI Discrete Sediment Sample Location
- Limits of 2008 MILCON Dredge
- Area Boundary Line

Pre-Dredge ABM Content

- No ABM
- Trace/Small ABM
- ABM Present
- Heavy ABM

N
W E
S

0 150 300
Feet

Figure 8
SWMU 7b COPC Detections and Exceedances of Screening Criteria
SWMU 3 and SWMU 7b Benthic Invertebrate UFP SAP
JEB Little Creek
Virginia Beach, Virginia

CH2MHILL

Legend

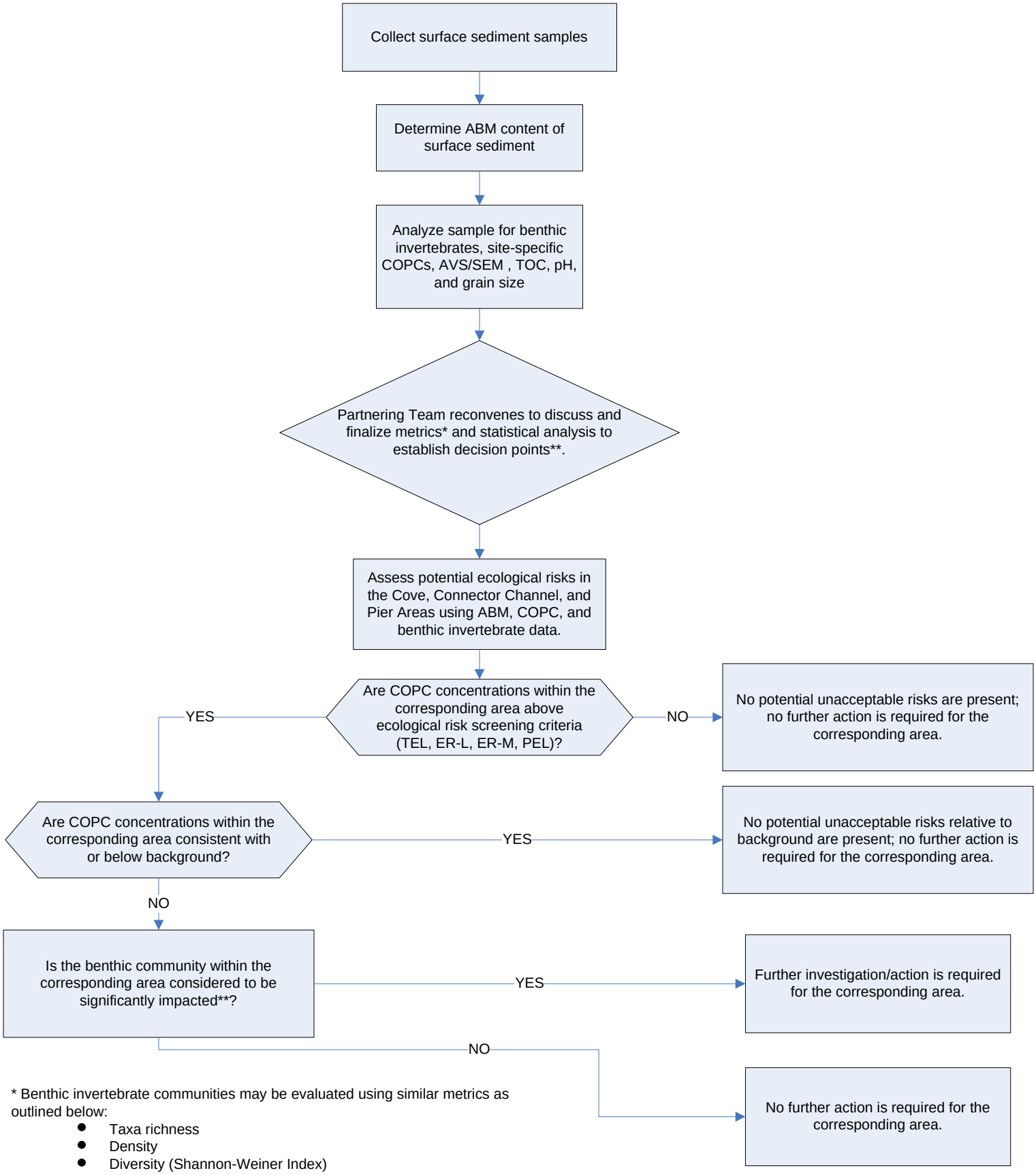
- Proposed Site-specific Sample Location (new location, no Surface Sediment COC data currently available)
- Proposed Site-specific Sample Location (previous RI/Post-MILCON Sample Location)
- Limits of 2008 MILCON Dredge
- Area Boundary Line

N
W E
S

0 150 300 600
Feet

Figure 9
Proposed SWMU 7b Sample Locations
SWMU 3 and SWMU 7b Benthic Invertebrate UFP SAP
JEB Little Creek
Virginia Beach, Virginia

CH2MHILL



* Benthic invertebrate communities may be evaluated using similar metrics as outlined below:

- Taxa richness
- Density
- Diversity (Shannon-Weiner Index)
- Percent contribution of dominant taxa
- Density of dominant taxon
- Percent amphipods
- Percent bivalves
- Percent Spionid polycheates
- Percent Mediomastus polycheates
- Percent deposit feeders

**Decision points will be developed in the form of if/then statements and will be documented in the Revised ERA.

Figure 10
SWMU 7b Decision Tree
SWMU 3 and SWMU 7b Benthic Invertebrate UFP SAP
JEB Little Creek
Virginia Beach, Virginia

Attachment A
QAPP – UFP-SAP Completeness Checklist

"EPA QAPP ⟶ Navy UFP-SAP" Completeness Checklist

This form (adapted from *EPA QA/G-5, QAPP Completeness Checklist* [EPA, 2002]), is intended to facilitate review of the Navy's Uniform Federal Policy (UFP) – Sampling and Analysis Plans (SAP). It provides a cross-referenced list of QAPP elements (*EPA QA/R-5, Requirements for QA Project Plans*, [EPA, 2001]) to the equivalent information in the Navy's UFP-SAP. The Navy's UFP-SAP policy was implemented by Naval Facilities Engineering Command (NAVFAC) in October 2007.

PROJECT TITLE: _____ **Reference Number:** _____

Project site name or descriptor: _____

Preparer: _____ **Date Submitted for Review:** _____

Requestor, Mail code, telephone email address: _____

Reviewer: _____ **Date of Review:** _____

Additional Technical Review requested from: **Date for Completion - Technical Review:** _____

Review Status: ☐ **Complete/Approved** ☐ **Complete with comments** ☐ **Incomplete with comments**

Comments in Separate Report dated: _____ **Response expected by:** _____

Date Submitted for Response/Final Signature: _____ **Implementation Scheduled Date:** _____

"EPA QAPP ⟶ Navy UFP-SAP" Completeness Checklist

Note: A = Acceptable **U = Unacceptable** **NI = Not Included** **NA = Not Applicable**

Corresponding UFP QAPP Section (July 2004)	EPA QA/R 5	Required EPA Elements & Required Information (Numbers in parenthesis indicate worksheet # associated with Elements and Required Information)	A	U	NI	NA	Location of Element in the Navy UFP-SAP (Worksheet #, Appendix #, etc.)	COMMENTS
PROJECT MANAGEMENT								
2.1	**A.1**	**Title and Approval Sheet (#1)**					**Worksheet 1**	
2.1		Contains project title					**Worksheet 1**	
2.1		Indicates revision number, if applicable					**Worksheet 1**	
2.1		Indicates organization's name					**Worksheet 1**	
2.1		Dated signature of organization's project manger present					**Worksheet 1**	
2.1		Dated signature of organization's QA manager present					**Worksheet 1**	
2.1		Other signatures, as needed					**Worksheet 1**	
2.2.3	**A.2**	**Table of Contents (#2)**					**"SAP Worksheets", after Executive Summary**	
2.2.4		Lists QA Project Plan information sections					**Worksheet 2**	
2.2.1, 2.2.2		Document control information indicated					**Worksheet 3**	
2.3.1	**A.3**	**Distribution List (#3)**					**Worksheet 3**	
2.3.2		Includes all individuals who are to receive a copy of the QA Project Plan and identifies their organization					**Worksheet 3**	
2.4	**A.4**	**Project/Task Organization (#5 and 7)**					**Worksheets 4 and 5**	

"EPA QAPP ⟶ Navy UFP-SAP" Completeness Checklist

Corresponding UFP QAPP Section (July 2004)	EPA QA/R 5	Required EPA Elements & Required Information (Numbers in parenthesis indicate worksheet # associated with Elements and Required Information)	A	U	NI	NA	Location of Element in the Navy UFP-SAP (Worksheet #, Appendix #, etc.)	COMMENTS
2.4.3		Identifies key individuals involved in all major aspects of the project, including contractors					**Worksheet 4**	
2.4.3		Discusses their responsibilities					**Worksheet 7**	
2.4.1		Project QA Manager position indicates independence from unit generating data					**Worksheet 5**	
2.4.3		Identifies individual responsible for maintaining the official, approved QA Project Plan					**Worksheets 6 and 7**	
2.4.1		Organizational chart shows lines of authority and reporting responsibilities					**Worksheet 5**	
2.5	**A.5**	**Problem Definition/Background (#10)**					**Worksheet 10**	
2.6		States decision(s) to be made, actions to be taken, or outcomes expected from the information to be obtained					**Worksheet 10**	
2.5.2		Clearly explains the reason (site background or historical context) for initiating this project					**Worksheet 10**	
2.5.1		Identifies regulatory information, applicable criteria, action limits, etc. necessary to the project					**Worksheet 11**	
2.6, 2.8	**A.6**	**Project/Task Description (#9, 14 and 16)**					**Worksheet 14**	

"EPA QAPP ⟶ Navy UFP-SAP" Completeness Checklist

Corresponding UFP QAPP Section (July 2004)	EPA QA/R 5	Required EPA Elements & Required Information (Numbers in parenthesis indicate worksheet # associated with Elements and Required Information)	A	U	NI	NA	Location of Element in the Navy UFP-SAP (Worksheet #, Appendix #, etc.)	COMMENTS
2.6, 2.7, 2.8		Summarizes work to be performed, for example, measurements to be made, data files to be obtained, etc., that support the project's goals					**Worksheet 14**	
2.8.2		Provides work schedule indicating critical project points, e.g., start and completion dates for activities such as sampling, analysis, data or file reviews, and assessments					**Worksheet 16**	
2.5.2, 2.8.1		Details geographical locations to be studied, including maps where possible					**Worksheets 10 and 17; attached figures**	
2.8.2		Discusses resource and time constraints, if applicable					**Worksheets 10 and 11**	
2.6	**A.7**	**Quality Objectives and Criteria (#11, 12 and 15)**					**Worksheets 11, 12, and 15**	
2.6.2		Identifies performance/measurement criteria for all information to be collected and acceptance criteria for information obtained from previous studies, including project action limits and laboratory detection limits and range of anticipated concentrations of each parameter of interest					**Summary: Worksheet 11** **Measurement Performance Criteria:** **Field QC Samples- Worksheet 12** **Laboratory QC Samples- Worksheet 28** **Project Action Limits: Worksheet 15**	
2.6.2		Discusses precision					**Worksheet 12**	
2.6.2		Addresses bias					**Worksheet 12**	

"EPA QAPP ⟶ Navy UFP-SAP" Completeness Checklist

Corresponding UFP QAPP Section (July 2004)	EPA QA/R 5	Required EPA Elements & Required Information (Numbers in parenthesis indicate worksheet # associated with Elements and Required Information)	A	U	NI	NA	Location of Element in the Navy UFP-SAP (Worksheet #, Appendix #, etc.)	COMMENTS
2.6.2		Discusses representativeness					**Worksheet 12**	
2.6.2		Identifies the need for completeness					**Worksheet 12**	
2.6.2		Describes the need for comparability					**Worksheet 12**	
2.6.2		Discusses desired method sensitivity					**Worksheet 28**	
2.4.4	**A.8**	**Special Training/Certifications (#8)**					**Worksheet 8**	
2.4.4		Identifies any project personnel specialized training or certifications					**Worksheet 8**	
2.4.4		Discusses how this training will be provided					**Worksheet 8**	
2.4.3		Indicates personnel responsible for assuring these are satisfied					**Worksheet 8**	
2.4.4		Identifies where this information is documented					**Worksheet 8**	
3.5	**A.9**	**Documentation and Records (#4, 6 and 29)**					**Worksheet 29**	
4.3		Identifies report format and summarizes all data report package information					**Worksheet 29**	
3.5		Lists all other project documents, records, and electronic files that will be produced					**Worksheet 29**	
3.5.4		Identifies where project information should be kept and for how long					**Worksheet 29**	

"EPA QAPP ⟶ Navy UFP-SAP" Completeness Checklist

Corresponding UFP QAPP Section (July 2004)	EPA QA/R 5	Required EPA Elements & Required Information (Numbers in parenthesis indicate worksheet # associated with Elements and Required Information)	A	U	NI	NA	Location of Element in the Navy UFP-SAP (Worksheet #, Appendix #, etc.)	COMMENTS
3.5.4		Discusses back up plans for records stored electronically					**Worksheet 29**	
2.3.1, 2.2.1		States how individuals identified in A3 will receive the most current copy of the approved QA Project Plan, identifying the individual responsible for this					**Worksheet 4**	
DATA GENERATION and ACQUISITION								
3.1	**B.1**	**Sampling Process Design (Experimental Design) (#16, 17, 18, 24 and 37)**					**Worksheet 17**	
3.1.1		Describes and justifies design strategy, indicating size of the area, volume, or time period represented by a sample					**Worksheet 17**	
3.1.1		Details the type and total number of sample types/matrix or test runs/trials expected and needed					**Worksheets 17 and 18**	
3.1.2		Indicates where samples should be taken, how sites will be identified/located					**Worksheet 18**	
3.1.2		Discusses what to do if sampling sites become inaccessible					**Worksheet 17**	
3.1.2		Identifies project activity schedules such as each sampling event, times samples should be sent to the laboratory, etc.					**Worksheet 16**	
3.1.2		Specifies what information is critical and what is for informational purposes only					**Worksheet 37**	

"EPA QAPP ⟶ Navy UFP-SAP" Completeness Checklist

Corresponding UFP QAPP Section (July 2004)	EPA QA/R 5	Required EPA Elements & Required Information (Numbers in parenthesis indicate worksheet # associated with Elements and Required Information)	A	U	NI	NA	Location of Element in the Navy UFP-SAP (Worksheet #, Appendix #, etc.)	COMMENTS
3.1.2		Identifies sources of variability and how this variability should be reconciled with project information					**Worksheet 37**	
3.1.2	**B.2**	**Sampling Methods (#21)**					**Worksheet 21**	
3.1.2.1		Identifies all sampling SOPs by number, date, and regulatory citation, indicating sampling options or modifications to be taken					**Worksheet 21**	
3.1.2		Indicates how each sample/matrix type should be collected					**Worksheet 18**	
3.1.2		If *in situ monitoring, indicates how instruments should be deployed and operated to avoid contamination and ensure maintenance of proper data*					**Worksheet 14, 21, and Field SOPs in Appendix**	
3.1.2		*If continuous monitoring, indicates averaging time and how instruments should store and maintain raw data, or data averages*					**Worksheet 14, 21, and Field SOPs in Appendix**	
3.1.2		*Indicates how samples are to be homogenized, composited, split, or filtered, if needed*					**Worksheet 14, 21, and Field SOPs in Appendix**	
3.1.2		*Indicates what sample containers and sample volumes should be used*					**Worksheet 19**	
3.1.2		*Identifies whether samples should be preserved and indicates methods that should be followed*					**Worksheet 19**	

"EPA QAPP ⟶ Navy UFP-SAP" Completeness Checklist

Corresponding UFP QAPP Section (July 2004)	EPA QA/R 5	Required EPA Elements & Required Information (Numbers in parenthesis indicate worksheet # associated with Elements and Required Information)	A	U	NI	NA	Location of Element in the Navy UFP-SAP (Worksheet #, Appendix #, etc.)	COMMENTS
3.1.2		*Indicates whether sampling equipment and samplers should be cleaned and/or decontaminated, identifying how this should be done and by-products disposed of*					**Worksheet 14, 21, 22, and Field SOPs in Appendix**	
3.1.2		*Identifies any equipment and support facilities needed*					**Worksheet 14**	
3.1.2		*Addresses actions to be taken when problems occur, identifying individual(s) responsible for corrective action and how this should be documented*					**Worksheet 6**	
3.3.	**B.3**	**Sample Handling and Custody (#19, 26 and 27)**					**Worksheets 26 and 27**	
3.3.2		States maximum holding times allowed from sample collection to extraction and/or analysis for each sample type and, for in-situ or continuous monitoring, the maximum time before retrieval of information					**Worksheet 19**	
3.3.2		Identifies how samples or information should be physically handled, transported, and then received and held in the laboratory or office (including temperature upon receipt)					**Worksheet 27**	

"EPA QAPP ⟶ Navy UFP-SAP" Completeness Checklist

Corresponding UFP QAPP Section (July 2004)	EPA QA/R 5	Required EPA Elements & Required Information (Numbers in parenthesis indicate worksheet # associated with Elements and Required Information)	A	U	NI	NA	Location of Element in the Navy UFP-SAP (Worksheet #, Appendix #, etc.)	COMMENTS
3.3.1		Indicates how sample or information handling and custody information should be documented, such as in field notebooks and forms, identifying individual responsible					**Worksheets 26 and 27**	
3.3.2		Discusses system for identifying samples, for example, numbering system, sample tags and labels, and attaches forms to the plan					**Worksheet 27**	
3.3.3		Identifies chain-of-custody procedures and includes form to track custody					**Worksheet 27**	
3.2	**B.4**	**Analytical Methods (#23, 24 and 25)**					**Worksheet 23**	
3.2.1		Identifies all analytical SOPs (field, laboratory and/or office) that should be followed by number, date, and regulatory citation, indicating options or modifications to be taken, such as sub-sampling and extraction procedures					**Worksheet 23**	
3.2.2		Identifies equipment or instrumentation needed					**Worksheet 23**	
3.2.1		Specifies any specific method performance criteria					**Worksheets 12 and 28**	
3.2.4		Identifies procedures to follow when failures occur, identifying individual responsible for corrective action and appropriate documentation					**Worksheet 24**	

"EPA QAPP ⟶ Navy UFP-SAP" Completeness Checklist

Corresponding UFP QAPP Section (July 2004)	EPA QA/R 5	Required EPA Elements & Required Information (Numbers in parenthesis indicate worksheet # associated with Elements and Required Information)	A	U	NI	NA	Location of Element in the Navy UFP-SAP (Worksheet #, Appendix #, etc.)	COMMENTS
3.3.2		Identifies sample disposal procedures					**Worksheets 26, 23, and applicable laboratory SOPs in Appendix**	
3.2.3		Specifies laboratory turnaround times needed					**Worksheet 30**	
3.2.1		Provides method validation information and SOPs for nonstandard methods					**Worksheets 23 and 35**	
3.4	**B.5**	**Quality Control (# 20 and 28)**					**Worksheets 20 and 28**	
3.4		For each type of sampling, analysis, or measurement technique, identifies QC activities which should be used, for example, blanks, spikes, duplicates, etc., and at what frequency					**Worksheet 20**	
3.4		Details what should be done when control limits are exceeded, and how effectiveness of control actions will be determined and documented					**Worksheet 28**	
3.2.1, 3.5		Identifies procedures and formulas for calculating applicable QC statistics, for example, for precision, bias, outliers and missing data					**Worksheet 23 and applicable laboratory SOPs in Appendix**	
3.1.2.4, 3.2.4	**B.6**	**Instrument/Equipment Testing, Inspection, and Maintenance (#22 and 25)**					**Worksheets 22 and 25**	
3.1.2.4, 3.2.4		Identifies field and laboratory equipment needing periodic maintenance, and the schedule for this					**Worksheets 22 and 25**	
3.3		Identifies testing criteria					**Worksheets 22 and 25**	

"EPA QAPP ⟶ Navy UFP-SAP" Completeness Checklist

Corresponding UFP QAPP Section (July 2004)	EPA QA/R 5	Required EPA Elements & Required Information (Numbers in parenthesis indicate worksheet # associated with Elements and Required Information)	A	U	NI	NA	Location of Element in the Navy UFP-SAP (Worksheet #, Appendix #, etc.)	COMMENTS
3.1.2.5		Notes availability and location of spare parts					**Worksheets 22 and 25**	
3.1.2.3		Indicates procedures in place for inspecting equipment before usage					**Worksheets 22 and 25**	
2.4.3		Identifies individual(s) responsible for testing, inspection and maintenance					**Worksheets 22 and 25**	
4.1.2		Indicates how deficiencies found should be resolved, re-inspections performed, and effectiveness of corrective action determined and documented					**Worksheets 22 and 25**	
3.1.2.4, 3.2.2	**B.7**	**Instrument/Equipment Calibration and Frequency (#22 and 25)**					**Worksheets 22 and 24**	
3.1.2.4, 3.2.2		Identifies equipment, tools, and instruments that should be calibrated and the frequency for this calibration					**Worksheets 22 and 24**	
3.1.2.4, 3.2.2		Describes how calibrations should be performed and documented, indicating test criteria and standards or certified equipment					**Worksheets 22 and 24**	
4.1.2		Identifies how deficiencies should be resolved and documented					**Worksheets 22 and 24**	
3.1, 3.2	**B.8**	**Inspection/Acceptance for Supplies and Consumables (#22)**					**Worksheets 22 and 24**	

"EPA QAPP ⟶ Navy UFP-SAP" Completeness Checklist

Corresponding UFP QAPP Section (July 2004)	EPA QA/R 5	Required EPA Elements & Required Information (Numbers in parenthesis indicate worksheet # associated with Elements and Required Information)	A	U	NI	NA	Location of Element in the Navy UFP-SAP (Worksheet #, Appendix #, etc.)	COMMENTS
3.1.2.5, 3.2.4		Identifies critical supplies and consumables for field and laboratory, noting supply source, acceptance criteria, and procedures for tracking, storing and retrieving these materials					**Worksheets 22 and 24**	
2.4.3		Identifies the individual(s) responsible for this					**Worksheets 22 and 24**	
3.5	**B.9**	**Non-direct Measurements (#13)**					**Worksheet 13**	
3.5.1		Identifies data sources, for example, computer databases or literature files, or models that should be accessed and used					**Worksheet 13**	
3.5.4		Describes the intended use of this information and the rationale for their selection, i.e., its relevance to project					**Worksheet 13**	
3.5.4		Indicates the acceptance criteria for these data sources and/or models					**Worksheet 13**	
2.4.3		Identifies key resources/support facilities needed					**Worksheet 13**	
3.5.5, 5.2		Describes how limits to validity and operating conditions should be determined, for example, internal checks of the program and Beta testing					**Worksheet 13**	
3.5	**B.10**	**Data Management (#30)**					**Worksheet 14**	
3.5.2		Describes data management scheme from field to final use and storage					**Worksheet 14 and Data Management Plan in Appendix**	

"EPA QAPP ⟶ Navy UFP-SAP" Completeness Checklist

Corresponding UFP QAPP Section (July 2004)	EPA QA/R 5	Required EPA Elements & Required Information (Numbers in parenthesis indicate worksheet # associated with Elements and Required Information)	A	U	NI	NA	Location of Element in the Navy UFP-SAP (Worksheet #, Appendix #, etc.)	COMMENTS
3.5.1, 3.5.5		Discusses standard record-keeping and tracking practices, and the document control system or cites other written documentation such as SOPs					**Worksheet 14 and Data Management Plan in Appendix**	
3.5.3, 3.5.4		Identifies data handling equipment/procedures that should be used to process, compile, analyze, and transmit data reliably and accurately					**Worksheet 14 and Data Management Plan in Appendix**	
2.4.3		Identifies individual(s) responsible for this					**Worksheets 7 and 14**	
3.5.4		Describes the process for data archival and retrieval					**Worksheet 14 and Data Management Plan in Appendix**	
3.5.3		Describes procedures to demonstrate acceptability of hardware and software configurations					**Worksheet 14 and Data Management Plan in Appendix**	
3.5.1		Attaches checklists and forms that should be used					**Worksheet 14 and Data Management Plan in Appendix**	
ASSESSMENT and OVERSIGHT								
4.1	**C.1**	**Assessments and Response Actions (#31 and 32)**					**Worksheets 31 and 32**	
4.1.1		Lists the number, frequency, and type of assessment activities that should be conducted, with the approximate dates					**Worksheet 31**	

"EPA QAPP ⟶ Navy UFP-SAP" Completeness Checklist

Corresponding UFP QAPP Section (July 2004)	EPA QA/R 5	Required EPA Elements & Required Information (Numbers in parenthesis indicate worksheet # associated with Elements and Required Information)	A	U	NI	NA	Location of Element in the Navy UFP-SAP (Worksheet #, Appendix #, etc.)	COMMENTS
2.4.3		Identifies individual(s) responsible for conducting assessments, indicating their authority to issue stop work orders, and any other possible participants in the assessment process					**Worksheet 31**	
4.1.2		Describes how and to whom assessment information should be reported					**Worksheets 31 and 32**	
4.1.2		Identifies how corrective actions should be addressed and by whom, and how they should be verified and documented					**Worksheet 32**	
4.2	**C.2**	**Reports to Management (#33)**					**Worksheet 33**	
4.2		Identifies what project QA status reports are needed and how frequently					**Worksheet 33**	
2.4.3		Identifies who should write these reports and who should receive this information					**Worksheet 33**	
DATA VALIDATION and USABILITY								
5.1, 5.2	**D.1**	**Data Review, Verification, and Validation (#34, 35 and 36)**					**Worksheets 34, 35, and 36**	
5.2		Describes criteria that should be used for accepting, rejecting, or qualifying project data					**Worksheets 34, 35, and 36**	
5.2	**D.2**	**Verification and Validation Methods (#34 and 35)**					**Worksheets 34, 35, and 36**	

"EPA QAPP ⟶ Navy UFP-SAP" Completeness Checklist

Corresponding UFP QAPP Section (July 2004)	EPA QA/R 5	Required EPA Elements & Required Information (Numbers in parenthesis indicate worksheet # associated with Elements and Required Information)	A	U	NI	NA	Location of Element in the Navy UFP-SAP (Worksheet #, Appendix #, etc.)	COMMENTS
5.2		Describes process for data verification and validation, providing SOPs and indicating what data validation software should be used, if any					**Worksheets 34 and 35**	
2.4.3		Identifies who is responsible for verifying and validating different components of the project data/information, for example, chain-of-custody forms, receipt logs, calibration information, etc.					**Worksheets 34 and 35**	
2.4.3, 5.3		Identifies issue resolution process, and method and individual responsible for conveying these results to data users					**Worksheets 34, 35, and 36**	
5.2		Attaches checklists, forms, and calculations					**Worksheets 34, 35, and 36**	
5.2	**D.3**	**Reconciliation with User Requirements (#37)**					**Worksheet 37**	
5.2.3		Describes procedures to evaluate the uncertainty of the validated data					**Worksheet 37**	
5.2.3		Describes how limitations on data use should be reported to the data users					**Worksheet 37**	

Attachment B
Field Standard Operating Procedures

SOP - 001
STANDARD OPERATING PROCEDURE

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)
- Distilled 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
- Phthalate-free gloves such as Nitrile
- 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 DOT-approved 55-gallon drums.

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.

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.

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.

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.

SOP-002
STANDARD OPERATING PROCEDURE

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 potentially hazardous 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 rolloffs 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.

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 fenced drum storage area by the drilling services subcontractor. Drums should be stored on pallets on plastic sheeting 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. Prior to disposal to the sanitary sewer system, 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.

SOP-003
STANDARD OPERATING PROCEDURE

Field Measurement of pH, Specific Conductance, Turbidity, Dissolved Oxygen, ORP, and Temperature Using the Horiba® U-22 with Flow-through Cell

I. Purpose and Scope

The purpose of this procedure is to provide a general guideline for using the Horiba® U-22 for field measurements of pH, specific conductance, turbidity, dissolved oxygen, oxidation-reduction potential (ORP), and temperature of groundwater samples. The operator's manual should be consulted for detailed operating procedures.

II. Equipment and Materials

- Horiba® U-22 Water Quality Checker with flow-though cell
- Distilled water in squirt bottle
- Horiba® U-22 Auto-Calibration Standard Solution

III. Procedures and Guidelines

A. Parameters and Specifications:

Parameter	Range of measurement	Accuracy
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 ^{o}C	+/- 1.0 ^{o}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 Horiba® Standard Solution. Calibration procedure:

1. Fill the calibration beaker to about 2/3 with the pH 4 standard solution.

2. Fit 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.

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, pH will read 4.0 +/- 3%, conductivity will read 4.49 +/- 3%, and turbidity will read 0 +/- 3%

C. Sample Measurement:

As water passes through the flow-through Cell, press MEAS to obtain reading; record in the field notebook.

IV. Key Checks and Preventive Maintenance

- Calibrate meter
- Clean probe with deionized water when done
- Refer to operations manual for recommended maintenance
- 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.

SOP-004
STANDARD OPERATING PROCEDURE

Preparing Field Log Books

I. Purpose

To provide general guidelines for entering field data into log books during site investigation and remediation field 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 of 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, orange-covered 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. Heath 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.

(47) MAY 12, 2003 (EXAMPLE)

0715 ARRIVE ON SITE AT XYZ SITE.
CH2M HILL STAFF:
JOHN SMITH: FIELD TEAM LEADER
Bob Builder: SITE SAFETY COORD.
WEATHER: OVERCAST + COOL, 45°F
CHANCE OF LATE SHOWERS
SCOPE: • COLLECT GROUNDWATER SAMPLES for LTM work at SITE 14
• SUPERVISE SURVEY CREW AT SITE 17

0725 BB ~~CAL~~ ~~JS~~ (JS) Calibrates PID: 101 ppm/100 ppm ok
PID Model #, SERIAL #

0730 BB CALIBRATES HORIBA METER
Model #, SERIAL #
→ List calibration RESULTS

0738 SURVEY CREW ARRIVES ON SITE
→ List NAMES

0745 BB Holds H+S TALK on Slips, Trips, Falls, Ticks + AIR MONITORING
JS + SURVEY CREW ATTEND
No H+S ISSUES IDENTIFIED as CONCERNS. All work is in "LEVEL D."

0755 JS conducts SITE-WIDE AIR MONITORING
All readings = 0.0 ppm in

JS 5-12-03

MAY 12, 2003 (EXAMPLE) (48)

SITE 14 LTM
BREATHING ZONE (BZ)

0805 Mobilize to well MW-22 to SAMPLE, surveyors SETTING UP AT SITE 17

0815 PM (PAUL PAPER PUSHER) CALLS AND INFORMS JS to collect GW SAMPLE AT WELL MW-44 today for 24 hour TAT ANALYSIS OF VOC'S

0820 Purging MW-22
→ RECORD WATER QUALITY DATA

JS 5-12-03

0843 Collect SAMPLE AT MW-22 for total TAL Metals AND VOC'S. No Dissolved Metals Needed PER PM

0905 JS + BB Mobilize to SITE 17 to show surveyors wells to Survey.

0942 Mobilize to well MW-22 to Collect SAMPLE

0950 CAN not ACCESS WELL MW-22 due to BASE OPERATIONS; CONTACT PAUL PAPERPUSHER AND HE STATED HE will check on GAINING ACCESS with BASE contact.

0955 Mobilize to well MW-19

JS 5-12-03

SOP-005
STANDARD OPERATING PROCEDURE

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.

SOP-006
STANDARD OPERATING PROCEDURE

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 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 grappler, 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:

<u>Drum</u>

Glass tube	–	Procedure 1
COLIWASA	–	Procedure 2

<u>Storage Tank and Tank Trailer</u>

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

_____ Sampling Instruments

_____ Tools

_____ Rubber Mallet

_____ Logbook

_____ Safety Glasses or Monogoggles

_____ Safety Shoes

_____ Ice/Cooler, as required

_____ Custody Seals, as required

_____ Chain-of-Custody Forms

_____ Drum Labels, as required

_____ Paint Marker, if drum sampling

_____ Black Indelible Pen

_____ Monitoring Instruments

_____ Labels

_____ Sampling and Analysis Plan

_____ Health and Safety Plan

_____ Decontamination Equipment

_____ Lab Wipes

_____ Lab Spatulas or Stainless Steel Spoons

_____ Chemical Preservatives, as required

_____ Appropriate Containers for Waste and Equipment

_____ Duct Tape

_____ Plastic Sheeting

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, dimethylforamide, 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 volumemetric 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 he 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 PFTE 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 though 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 constructed of forged

[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.

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.

SOP-007
STANDARD OPERATING PROCEDURE

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.

- 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 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.

QAL

Quality Analytical Laboratories, Inc.
2567 Fairlane Drive
Montgomery, Alabama 36116
PH. (334)271-2440

Client _____
Sample No. _____
Location _____
_____
Analysis _____
_____
Preservative HCL
Date _____ By _____

CEIMIC
CORPORATION
10 Dean Knauss Drive, Narragansett, R.I. 02882 • (401) 782-8900

SITE NAME	DATE
ANALYSIS	TIME
	PRESERVATIVE

SAMPLE TYPE

☐ Grab ☐ Composite ☐ Other _____

COLLECTED BY:

CH2M HILL
APPLIED SCIENCES LABORATORY

CHAIN OF CUSTODY ...CORD AND AGREEMENT TO PERFORM SERVICES

CH2M Hill Project #

Purchase Order #

Project Name

Company Name CH2M HILL Office

Project Manager & Phone #
Mr. [ ]
Ms. [ ]
Dr. [ ]

Report Copy to:

Requested Completion Date:

Sampling Requirements: SDWA ☐ NPDES ☐ RCRA ☐ OTHER ____

Sample Disposal: Dispose ☐ Return ☐

Sampling Date	Sampling Time	Type: COMP	Type: GRAB	Matrix: WATER	Matrix: SOIL	Matrix: AIR	CLIENT SAMPLE ID (9 CHARACTERS)	# OF CONTAINERS	LAB TEST CODES	ANALYSES REQUESTED	REMARKS	LAB 1 ID	LAB 2 ID

SHADED AREA– FOR LAB USE ONLY

Lab 1 #

Lab 2 #

Quote #

Kit Request #

Project #

No. of Samples

Page of

Login

LIMS Ver

Sampled By & Title (Please sign and print name)	Date/Time	Relinquished By (Please sign and print name) Date/Time
Received By (Please sign and print name)	Date/Time	Relinquished By (Please sign and print name) Date/Time
Received By (Please sign and print name)	Date/Time	Relinquished By (Please sign and print name) Date/Time
Received By (Please sign and print name)	Date/Time	Shipped Via UPS BUS Fed-Ex Hand Other ____ Shipping #
Work Authorized By (Please sign and print name)	Remarks	

QC Level: 1 2 3 Other: ____

COC Rec	ICE
Ana Req	TEMP
Cust Seal	Ph

Instructions and Agreement Provisions on Reverse Side

DISTRIBUTION: Original - LAB, Yellow - LAB, Pink - Client

REV 3/94 FORM 340

CRM HILL

CUSTODY SEAL

Date _____ _____

Signature _____ _____

SOP 008
STANDARD OPERATING PROCEDURE

Packaging and Shipping Samples

I. Purpose and Scope

These general procedures describe the proper packaging and shipping of samples.

II. Equipment and Materials

- Coolers
- Ice
- Tape (strapping, duct and/or packing tapes)
- Ball-point pens and indelible makers
- Chains of Custody forms
- Heavy-duty garbage bags
- Ziploc® bags
- Blanks (temperature and trip blanks as necessary)

III. Procedures and Guidelines

A. Standard Parameters

- Prepare coolers for shipment:
    - Tape drains shut.
    - Affix "This Side Up" labels on all four sides and "Fragile" labels on at least two sides of each cooler.
    - Place mailing label with laboratory address on top of coolers.
- Arrange sample containers in groups by sample number. Consolidate VOC samples into one cooler to minimize the need for trip blanks.
- Affix appropriate adhesive sample labels to each container. Protect with clear label protection tape after labeling.

- Seal each sample bottle within a separate Ziploc® plastic bag or bubble wrap, if available. Tape the bag around bottle. Sample label should be visible through the bag.
- Arrange sample bottles in coolers so that they do not touch.
- If ice is required to preserve the samples, cubes should be repackaged in zip-lock bags and placed on and around the containers.
- Sign chain-of-custody form (or obtain signature) and indicate the time and date it was relinquished to Federal Express or the courier.
- Separate copies of forms. Seal proper copies (traffic reports, packing lists) along with a return address label within a large zip-lock bag and tape to inside lid of cooler.
- Close lid and latch.
- Carefully peel custody seals from backings and place intact over lid openings (right front and left back). Cover seals with clear protection tape.
- Tape cooler shut on both ends, making several complete revolutions with strapping tape. Do not cover custody seals.
- Relinquish to Federal Express or to a courier arranged with the laboratory. Place airbill receipt inside the mailing envelope and send to the sample documentation coordinator along with the other documentation.
- Complete an original FedEx Airbill as instructed. That is, under Section 6, fill in the number of packages and net quantity per box next to the dry ice box in the "Special Handling" section on the Airbill. There is no need for a "Shipper's Declaration" if dry ice is the only Dangerous Good in the shipment.

V. Attachments

None.

SOP-009
STANDARD OPERATING PROCEDURE

Homogenization of Soil and Sediment Samples

I. Purpose

The homogenization of soil and sediment samples is performed to minimize any bias of sample representativeness introduced by the natural stratification of constituents within the sample.

II. Scope

Standard techniques for soil and sediment homogenization and equipment are provided in this SOP. These procedures do not apply to aliquots collected for VOCs or field GC screening; samples for these analyses should NOT be homogenized.

III. Equipment and Materials

Sample containers, stainless steel spoons or spatulas, and stainless steel pans.

IV. Procedures and Guidelines

Soil and sediment samples to be analyzed for semivolatiles, pesticides, PCBs, metals, cyanide, or field XRF screening should be homogenized in the field. After a sample is taken, a stainless steel spatula should be used to remove the sample from the split spoon or other sampling device. The sampler should not use fingers to do this, as gloves may introduce organic interferences into the sample.

Samples for VOCs should be taken immediately upon opening the spoon and should not be homogenized.

Prior to homogenizing the soil or sediment sample, any rocks, twigs, leaves, or other debris should be removed from the sample. The sample should be placed in a decontaminated stainless steel pan and thoroughly mixed using a stainless steel spoon. The soil or sediment material in the pan should be scraped from the sides, corners, and bottom, rolled into the middle of the pan, and initially mixed. The sample should then be quartered and moved to the four corners of the pan. Each quarter of the sample should be mixed individually, and then rolled to the center of the pan and mixed with the entire sample again.

All stainless steel spoons, spatulas, and pans must be decontaminated following procedures specified in SOP *Decontamination of Personnel and Equipment* prior to homogenizing the sample. A composite equipment rinse blank of homogenization equipment should be taken each day it is used.

V. Attachments

None.

VI. Key Checks and Items

- Take VOC samples immediately and do not homogenize the soil.
- Homogenize soil for analyses other than VOCs in a clean, stainless steel bowl.

SOP-010
STANDARD OPERATING PROCEDURE

Sediment Sampling

I. Purpose

These general outlines describe the collection and handling of sediment samples during field operations.

II. Scope

The sediment sampling procedures generally describe the equipment and techniques needed to collect representative sediment samples. Operators manual , if available, should be consulted for specific details

III. Equipment and Materials

- Sample collection device (hand corer, scoop, dredge, grab sampler, or other suitable device)
- Stainless steel spoon or spatula for media transfer
- Measuring tape
- Log book
- Personal protection equipment (rubber or latex gloves, boots, hip waders, etc.)
- Materials for classifying soils, particularly the percentage of fines
- Sample jars, including jars for Total Organic Carbon and pH, as appropriate

IV. Procedures and Guidelines

1. Field personnel will start downstream and work upstream to prevent contamination of unsampled areas. In surface water bodies that are tidally influenced, sampling will be performed at low tide and under low flow conditions to minimize the dilution of possible contaminants. Sediment sampling activities will not occur immediately after periods of heavy rainfall.
2. Make a sketch of the sample area that shows important nearby river features and permanent structures that can be used to locate the sample points on a map. Whenever possible, include measured distances from such identifying features. Also include depth and width of waterway, rate of flow, type and consistency of sediment, and point and depth of sample removal (along shore, mid-channel, etc).

3. Note in the field book any possible outside sources of contamination. For example, the outlet to a drainage culvert in the water body near your sampling location.

4. Transfer sample into appropriate sample jars with a stainless steel utensil. Be especially careful to avoid the loss of the very fine clay/silt particles when collecting the sample. The fine particles have a higher adsorption capacity than larger particles. Minimize the amount of water that is collected within the sample matrix. Decant the water off of the sample slowly and carefully to maximize retention of the very fine particles. The sampler's fingers should never touch the sediment since gloves may introduce organic interference into the sample. Classify the soil type of the sample using the Unified Soil Classification System, noting particularly the percentage of silt and clay.

5. Samples for volatile organics should immediately be placed in jars. Rocks and other debris should be removed before placement in jars.

6. For channel sampling, be on the alert for submerged hazards (rocks, tree roots, drop-offs, loss silt and muck) which can make wading difficult.

7. Sample sediment for TOC and pH also, to give context to organic and inorganic data during the risk assessment.

8. Follow the site safety plan designed for the specific nature of the site's sampling activities and locations.

9. Decontaminate all sampling implements and protective clothing according to prescribed procedures.

V. Attachments

None.

VI. Key Checks and Items

- Start downstream, work upstream.
- Log exact locations using permanent features.
- Beware of hidden hazards.

SOP-011
STANDARD OPERATING PROCEDURE

Sampling for Quantitative Benthic Community Structure Analysis

I. Purpose

To provide a guideline for quantitative sampling of benthic macroinvertebrate communities.

II. Scope

A standard benthic macroinvertebrate sampling procedure is described. Site-specific details are discussed in related sections of the field sampling plan.

III. Equipment and Materials

- Petite Ponar or Young grab sampler
- Benthic wash buckets or U.S Standard No. 30 screens
- Outer and inner rubber or Nitrile gloves
- 1-liter plastic jars
- Rinse bottles
- Cooler
- Site Health and Safety Plan
- 10% buffered formalin or 70% alcohol solution containing Rose Bengal stain
- Field log book
- Sampling boat
- Dissolved oxygen/temperature meter

IV. Procedures and Guidelines

1. Identify the appropriate sample station and record the time of sample collection, station ID, water depth, dissolved oxygen and temperature near the bottom of the water column, and the habitat type in the log book.

2. Select the appropriate sampling device (i.e. petite Ponar or Young grab sampler) and collect the number of replicate samples at each station specified in the Project Instructions/Work Plan.

3. If a large volume of sediment is required at each station for other analyses (e.g. chemical or toxicity testing), the Young sampler may be more efficient and require a fewer deployments. If the Young sampler is used, a 6 inch by 6 inch subsample should be collected for the macroinvertebrate sample. It is

important to record the surface area sampled and remain consistent for each station. If the petite Ponar sampler is used, the entire contents of each grab should be placed in the sieve bucket.

4. A grab sample is accepted if the jaws of sampler are closed upon retrieval, and the sediments inside are level and not in contact with the top of the sampler. If these conditions are not met, the sample should be discarded and a new sample collected.

5. Sieve the top 4 inches of the grab sample through a U.S. Standard No. 30 (0.5 mm) mesh screen or bucket with screened bottom. Use a rinse bottle filled with site water to aid in sieving the samples.

6. Transfer contents of the screen to a labeled sample container and preserve with the 70% alcohol or 10% buffered formalin solution and place in cooler.

7. Wash and rinse sampling equipment with site water between stations.

8. Photograph sample stations to supplement written descriptions.

V. Attachments

None

SOP-012
STANDARD OPERATING PROCEDURE

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 the 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, 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.

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 initial and full 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 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.

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, CH2M HILL Form D1586, and a completed example

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

ASTM 1586 *Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils*

Tables 1 through 4

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*.

CH2M HILL

PROJECT NUMBER	BORING NUMBER SHEET OF

SOIL BORING LOG

PROJECT _____ LOCATION _____

ELEVATION _____ DRILLING CONTRACTOR _____

DRILLING METHOD AND EQUIPMENT _____

WATER LEVELS _____ START _____ FINISH _____ LOGGER _____

DEPTH BELOW SURFACE (FT)	SAMPLE			STANDARD PENETRATION TEST RESULTS	SOIL DESCRIPTION	COMMENTS
	INTERVAL	NUMBER AND TYPE	RECOVERY (FT)	6"-6"-6" (N)	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION

Figure 1
SOIL BORING LOG,
FORM D1586

REV 11/89 FORM D1586

(8.30)

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET 1 OF 3
DEN 22371.G5	BL-3	

SOIL BORING LOG

PROJECT Howard Ave Landslide LOCATION Howard & 24th Ave, Centennial, Co.

ELEVATION 5136 Feet DRILLING CONTRACTOR Kendall Explorations, Ashcan, Colorado

DRILLING METHOD AND EQUIPMENT 4"-inch H.S. Augers, Mobil B-61 rotary drilling

WATER LEVELS 3.2 Feet, 8/5/89 START August 4, 1989 FINISH August 8, 1989 LOGGER J.A. Michner

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0					Surface material consist of 4 inches AC underlain by 6 inches of 3/4 inch minus base rock	Start Drilling @ 3:00
	2.5					
	4.0	1-S	1.5	2-3-4 (7)	POORLY-GRADED SAND WITH SILT, (SP-SM), fine, light brown, wet, loose	Driller notes water at 4 feet
	5.0					
5	6.5	2-S	0.9	WOH/12"-1	ORGANIC SILT, (OL), very dark, gray to black, wet, very soft, strong H_2S odor, many fine roots up to about 1/4 inch	Driller notes very soft drilling 4 ft. dark grey, wet silty cuttings.
	8.0					
	10.0	3-ST	1.3	—	ORGANIC SILT, similar to 2-S, except includes fewer roots (by volume)	
10	11.5	4-S	1.3	2-2-2 (4)	SILT, (ML), very dark gray to black, wet, soft	water level @ 3.2 feet on 8/5/89 @ 0730
						Driller notes rough drilling action and chatter @ 13 ft
	15.0					
15	15.5	5-S	0.5	60/6"	SILTY GRAVEL, (GM), rounded gravel up to about 1 inch maximum observed size, wet, very dense	
	20.0					Driller notes smoother, firm drilling @ 19 ft
20	21.0	6-S	1.0	12-50/6"	LEAN CLAY WITH SAND, (CL), medium to light green, moist, very stiff	some angular rock chips @ bot. tip of 6-S, poss boulders or rock
	23.0					Driller notes very hard, slow grinding, smooth drilling action from 21 to 23 ft, possibly bedrock
	23.1	7-S	0	50/1"	NO RECOVERY	
					END SOIL BORING @ 23.1 FEET SEE ROCK CORE LOG FOR CONTINUATION OF BL-3	

Figure 2
EXAMPLE OF COMPLETED LOG FORM

Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)[1]

This standard is issued under the fixed designation D 2488; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense. Consult the DoD Index of Specifications and Standards for the specific year of issue which has been adopted by the Department of Defense.

1. Scope

1.1 This practice covers procedures for the description of soils for engineering purposes.

1.2 This practice also describes a procedure for identifying soils, at the option of the user, based on the classification system described in Test Method D 2487. The identification is based on visual examination and manual tests. It must be clearly stated in reporting an identification that it is based on visual-manual procedures.

1.2.1 When precise classification of soils for engineering purposes is required, the procedures prescribed in Test Method D 2487 shall be used.

1.2.2 In this practice, the identification portion assigning a group symbol and name is limited to soil particles smaller than 3 in. (75 mm).

1.2.3 The identification portion of this practice is limited to naturally occurring soils (disturbed and undisturbed).

NOTE 1—This practice may be used as a descriptive system applied to such materials as shale, claystone, shells, crushed rock, etc. (See Appendix X2).

1.3 The descriptive information in this practice may be used with other soil classification systems or for materials other than naturally occurring soils.

1.4 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For specific precautionary statements see Section 8.

1.5 The values stated in inch-pound units are to be regarded as the standard.

2. Referenced Documents

2.1 *ASTM Standards:*

D 653 Terminology Relating to Soil, Rock, and Contained Fluids[2]

D 1452 Practice for Soil Investigation and Sampling by Auger Borings[2]

D 1586 Method for Penetration Test and Split-Barrel Sampling of Soils[2]

D 1587 Practice for Thin-Walled Tube Sampling of Soils[2]

D 2113 Practice for Diamond Core Drilling for Site Investigation[2]

D 2487 Classification of Soils for Engineering Purposes (Unified Soil Classification System)[2]

D 4083 Practice for Description of Frozen Soils (Visual-Manual Procedure)[2]

3. Terminology

3.1 *Definitions:*

3.1.1 Except as listed below, all definitions are in accordance with Terminology D 653.

NOTE 2—For particles retained on a 3-in. (75-mm) US standard sieve, the following definitions are suggested:

Cobbles—particles of rock that will pass a 12-in. (300-mm) square opening and be retained on a 3-in. (75-mm) sieve, and

Boulders—particles of rock that will not pass a 12-in. (300-mm) square opening.

3.1.1.2 *clay*—soil passing a No. 200 (75-μm) sieve that can be made to exhibit plasticity (putty-like properties) within a range of water contents, and that exhibits considerable strength when air-dry. For classification, a clay is a fine-grained soil, or the fine-grained portion of a soil, with a plasticity index equal to or greater than 4, and the plot of plasticity index versus liquid limit falls on or above the "A" line (see Fig. 3 of Test Method D 2487).

3.1.1.3 *gravel*—particles of rock that will pass a 3-in. (75-mm) sieve and be retained on a No. 4 (4.75-mm) sieve, with the following subdivisions:

coarse—passes a 3-in. (75-mm) sieve and is retained on a ¾-in. (19-mm) sieve.

fine—passes a ¾-in. (19-mm) sieve and is retained on a No. 4 (4.75-mm) sieve.

3.1.1.4 *organic clay*—a clay with sufficient organic content to influence the soil properties. For classification, an organic clay is a soil that would be classified as a clay, except that its liquid limit value after oven drying is less than 75 % of its liquid limit value before oven drying.

3.1.1.5 *organic silt*—a silt with sufficient organic content to influence the soil properties. For classification, an organic silt is a soil that would be classified as a silt except that its liquid limit value after oven drying is less than 75 % of its liquid limit value before oven drying.

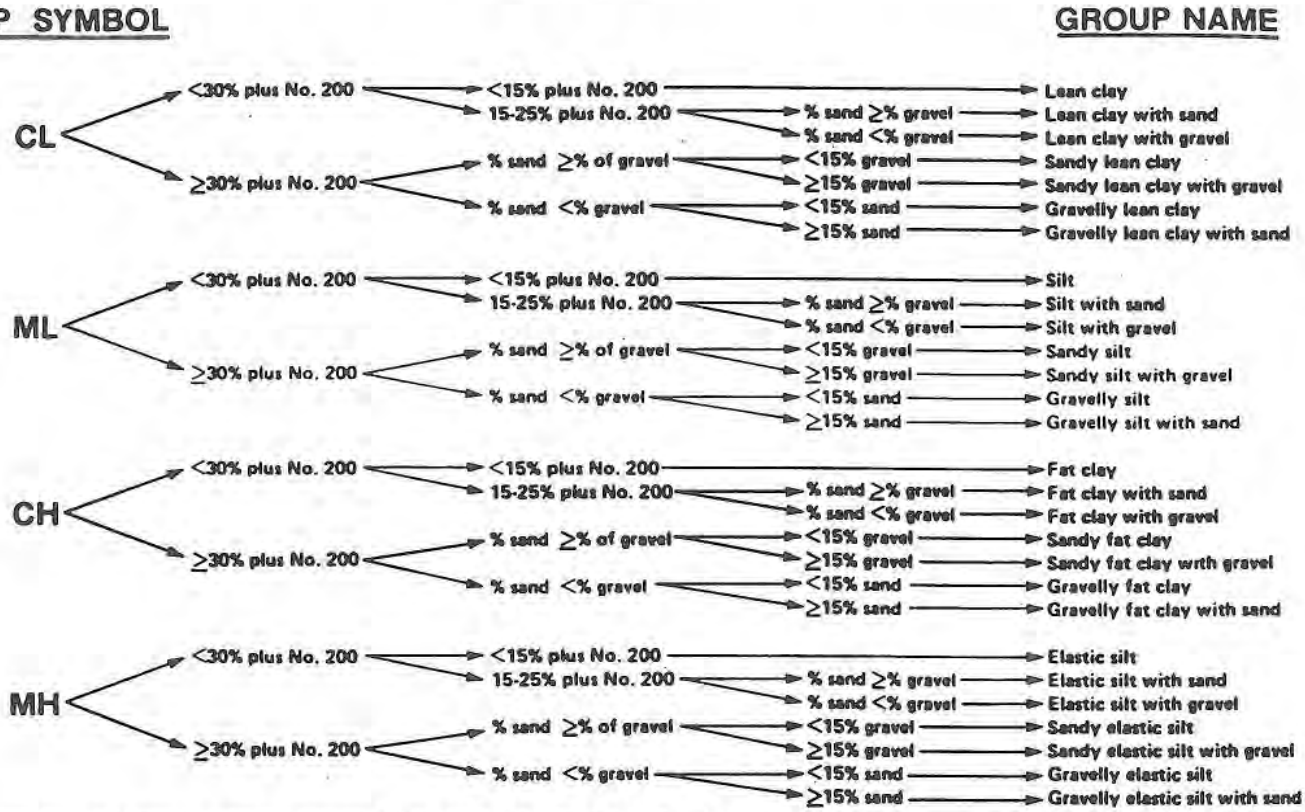
3.1.1.6 *peat*—a soil composed primarily of vegetable tissue in various stages of decomposition usually with an organic odor, a dark brown to black color, a spongy consistency, and a texture ranging from fibrous to amorphous.

3.1.1.7 *sand*—particles of rock that will pass a No.

[1] This practice is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.07 on Identification and Classification of Soils.

Current edition approved Sept. 15, 1993. Published November 1993. Originally published as D 2488 – 66 T. Last previous edition D 2488 – 90.

[2] *Annual Book of ASTM Standards*, Vol 04.08.



NOTE—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 1a Flow Chart for Identifying Inorganic Fine-Grained Soil (50 % or more fines)

(4.75-mm) sieve and be retained on a No. 200 (75-μm) sieve with the following subdivisions:

coarse—passes a No. 4 (4.75-mm) sieve and is retained on a No. 10 (2.00-mm) sieve.

medium—passes a No. 10 (2.00-mm) sieve and is retained on a No. 40 (425-μm) sieve.

fine—passes a No. 40 (425-μm) sieve and is retained on a No. 200 (75-μm) sieve.

3.1.1.8 *silt*—soil passing a No. 200 (75-μm) sieve that is nonplastic or very slightly plastic and that exhibits little or no strength when air dry. For classification, a silt is a fine-grained soil, or the fine-grained portion of a soil, with a plasticity index less than 4, or the plot of plasticity index versus liquid limit falls below the "A" line (see Fig. 3 of Test Method D 2487).

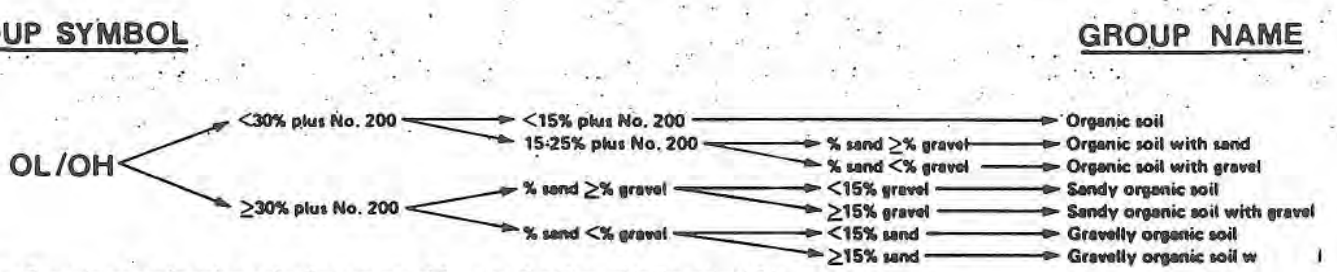
4. Summary of Practice

4.1 Using visual examination and simple manual tests, this practice gives standardized criteria and procedures for describing and identifying soils.

4.2 The soil can be given an identification by assigning a group symbol(s) and name. The flow charts, Figs. 1a and 1b for fine-grained soils, and Fig. 2, for coarse-grained soils, can be used to assign the appropriate group symbol(s) and name. If the soil has properties which do not distinctly place it into a specific group, borderline symbols may be used, see Appendix X3.

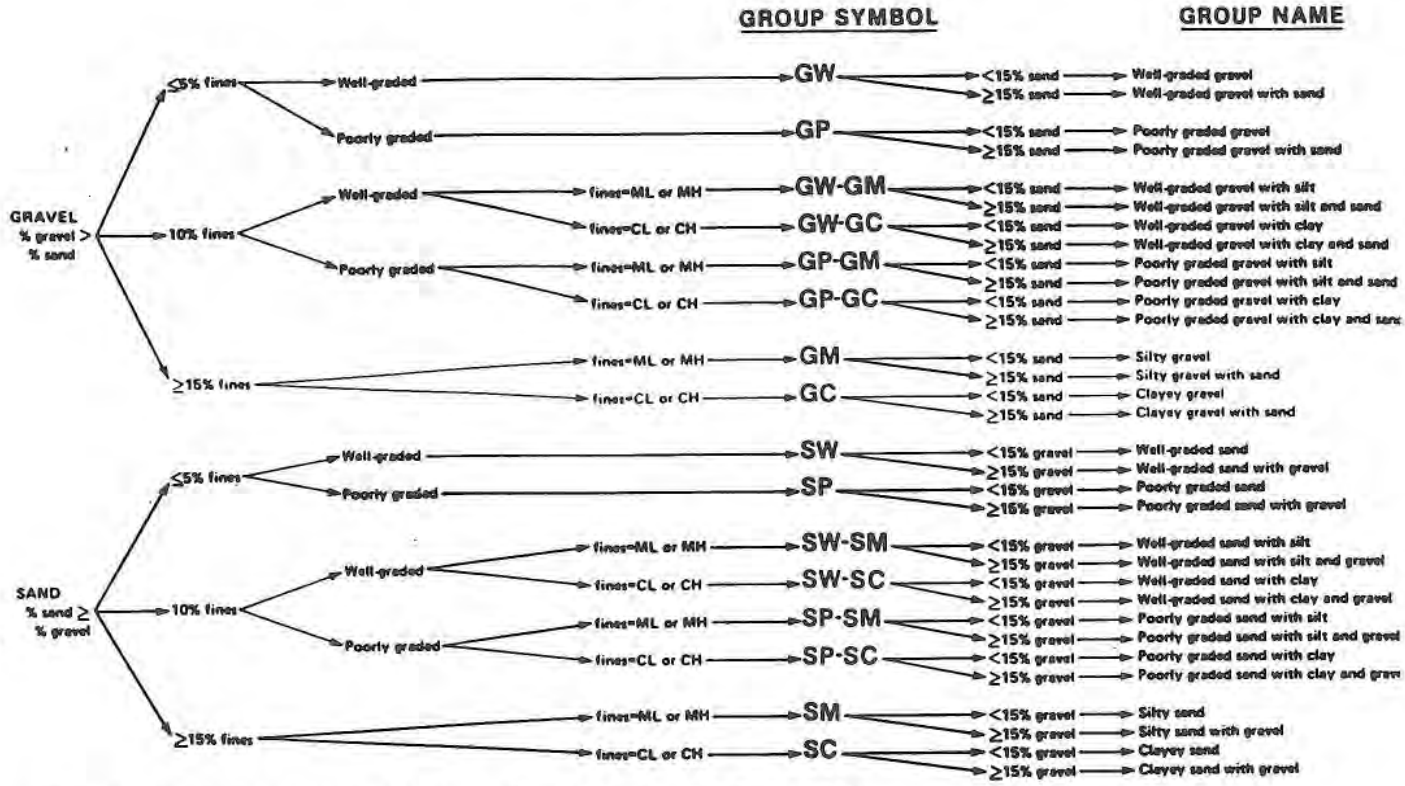
NOTE 3—It is suggested that a distinction be made between *dual symbols* and *borderline symbols*.

Dual Symbol—A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC, CL-ML used to indicate that the soil has been identified as having the properties of a classification in accordance with Test Method D 2487 where two symbols are required. Two symbols are required when the soil has between 5 and 12 % fines or



NOTE—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 1b Flow Chart for Identifying Organic Fine-Grained Soil (50 % or more fines)



NOTE—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 2 Flow Chart for Identifying Coarse-Grained Soils (less than 50 % fines)

when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart.

Borderline Symbol—A borderline symbol is two symbols separated by a slash, for example, CL/CH, GM/SM, CL/ML. A borderline symbol should be used to indicate that the soil has been identified as having properties that do not distinctly place the soil into a specific group (see Appendix X3).

5. Significance and Use

5.1 The descriptive information required in this practice can be used to describe a soil to aid in the evaluation of its significant properties for engineering use.

5.2 The descriptive information required in this practice should be used to supplement the classification of a soil as determined by Test Method D 2487.

5.3 This practice may be used in identifying soils using the classification group symbols and names as prescribed in Test Method D 2487. Since the names and symbols used in this practice to identify the soils are the same as those used in Test Method D 2487, it shall be clearly stated in reports and all other appropriate documents, that the classification symbol and name are based on visual-manual procedures.

5.4 This practice is to be used not only for identification of soils in the field, but also in the office, laboratory, or wherever soil samples are inspected and described.

5.5 This practice has particular value in grouping similar soil samples so that only a minimum number of laboratory tests need be run for positive soil classification.

NOTE 4—The ability to describe and identify soils correctly is learned more readily under the guidance of experienced personnel, but it may also be acquired systematically by comparing numerical laboratory test results for typical soils of each type with their visual and manua characteristics.

5.6 When describing and identifying soil samples from a given boring, test pit, or group of borings or pits, it is no necessary to follow all of the procedures in this practice fo every sample. Soils which appear to be similar can b grouped together; one sample completely described an identified with the others referred to as similar based o performing only a few of the descriptive and identificatio procedures described in this practice.

5.7 This practice may be used in combination wit Practice D 4083 when working with frozen soils.

6. Apparatus

6.1 *Required Apparatus:*

6.1.1 *Pocket Knife or Small Spatula.*

6.2 *Useful Auxiliary Apparatus:*

6.2.1 *Small Test Tube and Stopper* (or jar with a lid).

6.2.2 *Small Hand Lens.*

7. Reagents

7.1 *Purity of Water*—Unless otherwise indicated, refe ences to water shall be understood to mean water from a cit water supply or natural source, including non-potable wate

7.2 *Hydrochloric Acid*—A small bottle of dilute hydr chloric acid, HCl, one part HCl (10 *N*) to three parts wat (This reagent is optional for use with this practice). S Section 8.

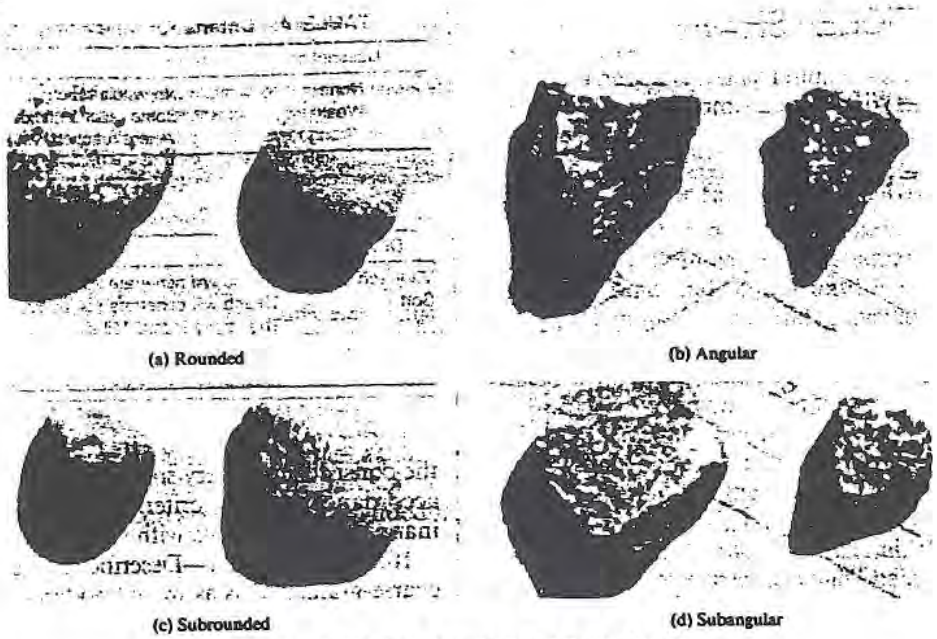


FIG. 3 Typical Angularity of Bulky Grains

8. Safety Precautions

8.1 When preparing the dilute HCl solution of one part concentrated hydrochloric acid (10 *N*) to three parts of distilled water, slowly add acid into water following necessary safety precautions. Handle with caution and store safely. If solution comes into contact with the skin, rinse thoroughly with water.

8.2 **Caution**—Do not add water to acid.

9. Sampling

9.1 The sa nple shall be considered to be representative of the stratum from which it was obtained by an appropriate, accepted, or standard procedure.

NOTE 5—Preferably, the sampling procedure should be identified as having been conducted in accordance with Practices D 1452, D 1587, or D 2113, or Method D 1586.

9.2 The sample shall be carefully identified as to origin.

NOTE 6—Remarks as to the origin may take the form of a boring number and sample number in conjunction with a job number, a geologic stratum, a pedologic horizon or a location description with respect to a permanent monument, a grid system or a station number and offset with respect to a stated centerline and a depth or elevation.

9.3 For accurate description and identification, the minimum amount of the specimen to be examined shall be in accordance with the following schedule:

Maximum Particle Size, Sieve Opening	Minimum Specimen Size, Dry Weight
4.75 mm (No. 4)	100 g (0.25 lb)
9.5 mm (⅜ in.)	200 g (0.5 lb)
19.0 mm (¾ in.)	1.0 kg (2.2 lb)
38.1 mm (1½ in.)	8.0 kg (18 lb)
75.0 mm (3 in.)	60.0 kg (132 lb)

NOTE 7—If random isolated particles are encountered th significantly larger than the particles in the soil matrix, the soil m x can be accurately described and identified in accordance with the preceeding schedule.

9.4 If the field sample or specimen being examined is smaller than the minimum recommended amount, the report shall include an appropriate remark.

10. Descriptive Information for Soils

10.1 *Angularity*—Describe the angularity of the sand (coarse sizes only), gravel, cobbles, and boulders, as angular, subangular, subrounded, or rounded in accordance with the criteria in Table 1 and Fig. 3. A range of angularity may be stated, such as: subrounded to rounded.

10.2 *Shape*—Describe the shape of the gravel, cobbles, and boulders as flat, elongated, or flat and elongated if they meet the criteria in Table 2 and Fig. 4. Otherwise, do not mention the shape. Indicate the fraction of the particles that have the shape, such as: one-third of the gravel particles are flat.

10.3 *Color*—Describe the color. Color is an important property in identifying organic soils, and within a given

TABLE 1 Criteria for Describing Angularity of Coarse-Grained Particles (see Fig. 3)

Description	Criteria
Angular	Particles have sharp edges and relatively plane sides with unpolished surfaces
Subangular	Particles are similar to angular description but have rounded edges
Subrounded	Particles have nearly plane sides but have well-rounded corners and edges
Rounded	Particles have smoothly curved sides and no edges

TABLE 2 Criteria for Describing Particle Shape (see Fig. 4)

The particle shape shall be described as follows where length, width, and thickness refer to the greatest, intermediate, and least dimensions of a particle, respectively.

Flat	Particles with width/thickness > 3
Elongated	Particles with length/width > 3
Flat and elongated	Particles meet criteria for both flat and elongated

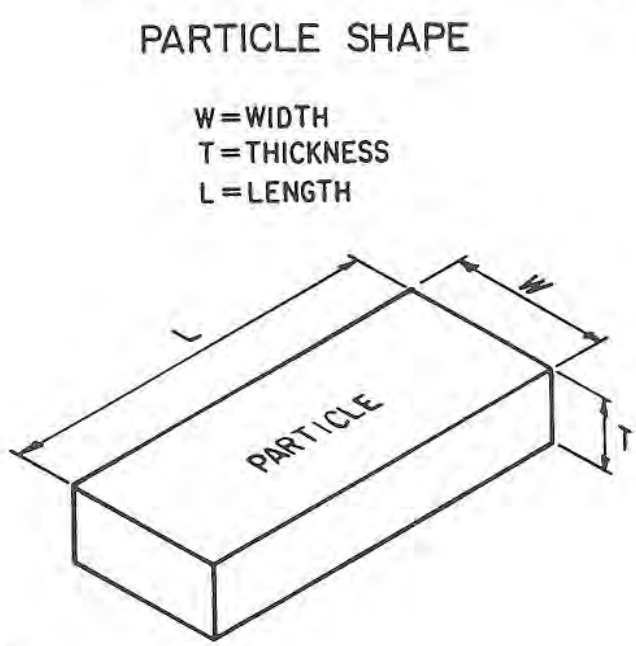


FIG. 4 Criteria for Particle Shape

TABLE 3 Criteria for Describing Moisture Condition

Description	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

locality it may also be useful in identifying materials of similar geologic origin. If the sample contains layers or patches of varying colors, this shall be noted and all representative colors shall be described. The color shall be described for moist samples. If the color represents a dry condition, this shall be stated in the report.

10.4 *Odor*—Describe the odor if organic or unusual. Soils containing a significant amount of organic material usually have a distinctive odor of decaying vegetation. This is especially apparent in fresh samples, but if the samples are dried, the odor may often be revived by heating a moistened sample. If the odor is unusual (petroleum product, chemical, and the like), it shall be described.

10.5 *Moisture Condition*—Describe the moisture condition as dry, moist, or wet, in accordance with the criteria in Table 3.

10.6 *HCl Reaction*—Describe the reaction with HCl as none, weak, or strong, in accordance with the critera in Table 4. Since calcium carbonate is a common cementing agent, a report of its presence on the basis of the reaction with dilute hydrochloric acid is important.

TABLE 4 Criteria for Describing the Reaction With HCl

Description	Criteria
None	No visible reaction
Weak	Some reaction, with bubbles forming slowly
Strong	Violent reaction, with bubbles forming immediately

TABLE 5 Criteria for Describing Consistency

Description	Criteria
Very soft	Thumb will penetrate soil more than 1 in. (25 mm)
Soft	Thumb will penetrate soil about 1 in. (25 mm)
Firm	Thumb will indent soil about ¼ in. (6 mm)
Hard	Thumb will not indent soil but readily indented with thumbnail
Very hard	Thumbnail will not indent soil

10.7 *Consistency*—For intact fine-grained soil, describe the consistency as very soft, soft, firm, hard, or very hard, in accordance with the criteria in Table 5. This observation is inappropriate for soils with significant amounts of gravel.

10.8 *Cementation*—Describe the cementation of intact coarse-grained soils as weak, moderate, or strong, in accordance with the criteria in Table 6.

10.9 *Structure*—Describe the structure of intact soils in accordance with the criteria in Table 7.

10.10 *Range of Particle Sizes*—For gravel and sand components, describe the range of particle sizes within each component as defined in 3.1.2 and 3.1.6. For example, about 20 % fine to coarse gravel, about 40 % fine to coarse sand.

10.11 *Maximum Particle Size*—Describe the maximum particle size found in the sample in accordance with the following information:

10.11.1 *Sand Size*—If the maximum particle size is a sand size, describe as fine, medium, or coarse as defined in 3.1.6. For example: maximum particle size, medium sand.

10.11.2 *Gravel Size*—If the maximum particle size is a gravel size, describe the maximum particle size as the smallest sieve opening that the particle will pass. For example, maximum particle size, 1½ in. (will pass a 1½-in. square opening but not a ¾-in. square opening).

10.11.3 *Cobble or Boulder Size*—If the maximum particle size is a cobble or boulder size, describe the maximum dimension of the largest particle. For example: maximum dimension, 18 in. (450 mm).

10.12 *Hardness*—Describe the hardness of coarse sand and larger particles as hard, or state what happens when the particles are hit by a hammer, for example, gravel-size particles fracture with considerable hammer blow, some gravel-size particles crumble with hammer blow. "Hard" means particles do not crack, fracture, or crumble under a hammer blow.

10.13 Additional comments shall be noted, such as the presence of roots or root holes, difficulty in drilling or augering hole, caving of trench or hole, or the presence of mica.

10.14 A local or commercial name or a geologic interpretation.

TABLE 6 Criteria for Describing Cementation

Description	Criteria
Weak	Crumbles or breaks with handling or little finger pressure
Moderate-	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

TABLE 7 Criteria for Describing Structure

Description	Criteria
Stratified	Alternating layers of varying material or color with layers at least 6 mm thick; note thickness
Laminated	Alternating layers of varying material or color with the layers less than 6 mm thick; note thickness
Fissured	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided	Fracture planes appear polished or glossy, sometimes striated
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness
Homogeneous	Same color and appearance throughout

tation of the soil, or both, may be added if identified as such.

10.15 A classification or identification of the soil in accordance with other classification systems may be added if identified as such.

11. Identification of Peat

11.1 A sample composed primarily of vegetable tissue in various stages of decomposition that has a fibrous to amorphous texture, usually a dark brown to black color, and an organic odor, shall be designated as a highly organic soil and shall be identified as peat, PT, and not subjected to the identification procedures described hereafter.

12. Preparation for Identification

12.1 The soil identification portion of this practice is based on the portion of the soil sample that will pass a 3-in. (75-mm) sieve. The larger than 3-in. (75-mm) particles must be removed, manually, for a loose sample, or mentally, for an intact sample before classifying the soil.

12.2 Estimate and note the percentage of cobbles and the percentage of boulders. Performed visually, these estimates will be on the basis of volume percentage.

NOTE 8—Since the percentages of the particle-size distribution in Test Method D 2487 are by dry weight, and the estimates of percentages for gravel, sand, and fines in this practice are by dry weight, it is recommended that the report state that the percentages of cobbles and boulders are by volume.

12.3 Of the fraction of the soil smaller than 3 in. (75 mm), estimate and note the percentage, by dry weight, of the gravel, sand, and fines (see Appendix X4 for suggested procedures).

NOTE 9—Since the particle-size components appear visually on the basis of volume, considerable experience is required to estimate the percentages on the basis of dry weight. Frequent comparisons with laboratory particle-size analyses should be made.

12.3.1 The percentages shall be estimated to the closest 5 %. The percentages of gravel, sand, and fines must add up to 100 %.

12.3.2 If one of the components is present but not in sufficient quantity to be considered 5 % of the smaller than 3-in. (75-mm) portion, indicate its presence by the term *trace*, for example, trace of fines. A trace is not to be considered in the total of 100 % for the components.

13. Preliminary Identification

13.1 The soil is *fine grained* if it contains 50 % or more fines. Follow the procedures for identifying fine-grained soils of Section 14.

13.2 The soil is *coarse grained* if it contains less than 50 % fines. Follow the procedures for identifying coarse-grained soils of Section 15.

14. Procedure for Identifying Fine-Grained Soils

14.1 Select a representative sample of the material for examination. Remove particles larger than the No. 40 sieve (medium sand and larger) until a specimen equivalent to about a handful of material is available. Use this specimen for performing the dry strength, dilatancy, and toughness tests.

14.2 *Dry Strength:*

14.2.1 From the specimen, select enough material to mold into a ball about 1 in. (25 mm) in diameter. Mold the material until it has the consistency of putty, adding water if necessary.

14.2.2 From the molded material, make at least three test specimens. A test specimen shall be a ball of material about ½ in. (12 mm) in diameter. Allow the test specimens to dry in air, or sun, or by artificial means, as long as the temperature does not exceed 60°C.

14.2.3 If the test specimen contains natural dry lumps, those that are about ½ in. (12 mm) in diameter may be used in place of the molded balls.

NOTE 10—The process of molding and drying usually produces higher strengths than are found in natural dry lumps of soil.

14.2.4 Test the strength of the dry balls or lumps by crushing between the fingers. Note the strength as none, low, medium, high, or very high in accorance with the criteria in Table 8. If natural dry lumps are used, do not use the results of any of the lumps that are found to contain particles of coarse sand.

14.2.5 The presence of high-strength water-soluble cementing materials, such as calcium carbonate, may cause exceptionally high dry strengths. The presence of calcium carbonate can usually be detected from the intensity of the reaction with dilute hydrochloric acid (see 10.6).

14.3 *Dilatancy:*

14.3.1 From the specimen, select enough material to mold into a ball about ½ in. (12 mm) in diameter. Mold the material, adding water if necessary, until it has a soft, but not sticky, consistency.

14.3.2 Smooth the soil ball in the palm of one hand with the blade of a knife or small spatula. Shake horizontally, striking the side of the hand vigorously against the other hand several times. Note the reaction of water appearing on

TABLE 8 Criteria for Describing Dry Strength

Description	Criteria
None	The dry specimen crumbles into powder with mere pressure of handling
Low	The dry specimen crumbles into powder with some finger pressure
Medium	The dry specimen breaks into pieces or crumbles with considerable finger pressure
High	The dry specimen cannot be broken with finger pressure. Specimen will break into pieces between thumb and a hard surface
Very high	The dry specimen cannot be broken between the thumb and a hard surface

TABLE 9 Criteria for Describing Dilatancy

Description	Criteria
None	No visible change in the specimen
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing

TABLE 10 Criteria for Describing Toughness

Description	Criteria
Low	Only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and soft
Medium	Medium pressure is required to roll the thread to near the plastic limit. The thread and the lump have medium stiffness
High	Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness

the surface of the soil. Squeeze the sample by closing the hand or pinching the soil between the fingers, and note the reaction as none, slow, or rapid in accordance with the criteria in Table 9. The reaction is the speed with which water appears while shaking, and disappears while squeezing.

14.4 *Toughness:*

14.4.1 Following the completion of the dilatancy test, the test specimen is shaped into an elongated pat and rolled by hand on a smooth surface or between the palms into a thread about ⅛ in. (3 mm) in diameter. (If the sample is too wet to roll easily, it should be spread into a thin layer and allowed to lose some water by evaporation.) Fold the sample threads and reroll repeatedly until the thread crumbles at a diameter of about ⅛ in. The thread will crumble at a diameter of ⅛ in. when the soil is near the plastic limit. Note the pressure required to roll the thread near the plastic limit. Also, note the strength of the thread. After the thread crumbles, the pieces should be lumped together and kneaded until the lump crumbles. Note the toughness of the material during kneading.

14.4.2 Describe the toughness of the thread and lump as low, medium, or high in accordance with the criteria in Table 10.

14.5 *Plasticity*—On the basis of observations made during the toughness test, describe the plasticity of the material in accordance with the criteria given in Table 11.

14.6 Decide whether the soil is an *inorganic* or an *organic* fine-grained soil (see 14.8). If inorganic, follow the steps given in 14.7.

14.7 *Identification of Inorganic Fine-Grained Soils:*

TABLE 11 Criteria for Describing Plasticity

Description	Criteria
Nonplastic	A ⅛-in. (3-mm) thread cannot be rolled at any water content
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit

14.7.1 Identify the soil as a *lean clay*, CL, if the soil has medium to high dry strength, no or slow dilatancy, and medium toughness and plasticity (see Table 12).

14.7.2 Identify the soil as a *fat clay*, CH, if the soil has high to very high dry strength, no dilatancy, and high toughness and plasticity (see Table 12).

14.7.3 Identify the soil as a *silt*, ML, if the soil has no to low dry strength, slow to rapid dilatancy, and low toughness and plasticity, or is nonplastic (see Table 12).

14.7.4 Identify the soil as an *elastic silt*, MH, if the soil has low to medium dry strength, no to slow dilatancy, and low to medium toughness and plasticity (see Table 12).

NOTE 11—These properties are similar to those for a lean clay. However, the silt will dry quickly on the hand and have a smooth, silky feel when dry. Some soils that would classify as MH in accordance with the criteria in Test Method D 2487 are visually difficult to distinguish from lean clays, CL. It may be necessary to perform laboratory testing for proper identification.

14.8 *Identification of Organic Fine-Grained Soils:*

14.8.1 Identify the soil as an *organic soil*, OL/OH, if the soil contains enough organic particles to influence the soil properties. Organic soils usually have a dark brown to black color and may have an organic odor. Often, organic soils will change color, for example, black to brown, when exposed to the air. Some organic soils will lighten in color significantly when air dried. Organic soils normally will not have a high toughness or plasticity. The thread for the toughness test will be spongy.

NOTE 12—In some cases, through practice and experience, it may be possible to further identify the organic soils as organic silts or organic clays, OL or OH. Correlations between the dilatancy, dry strength, toughness tests, and laboratory tests can be made to identify organic soils in certain deposits of similar materials of known geologic origin.

14.9 If the soil is estimated to have 15 to 25 % sand or gravel, or both, the words "with sand" or "with gravel" (whichever is more predominant) shall be added to the group name. For example: "lean clay with sand, CL" or "silt with gravel, ML" (see Figs. 1a and 1b). If the percentage of sand is equal to the percentage of gravel, use "with sand."

14.10 If the soil is estimated to have 30 % or more sand or gravel, or both, the words "sandy" or "gravelly" shall be added to the group name. Add the word "sandy" if there appears to be more sand than gravel. Add the word "gravelly" if there appears to be more gravel than sand. For example: "sandy lean clay, CL", "gravelly fat clay, CH", "sandy silt, ML" (see Figs. 1a and 1b). If the percentage of sand is equal to the percent of gravel, use "sandy."

15. Procedure for Identifying Coarse-Grained Soils (Contains less than 50 % fines)

15.1 The soil is a *gravel* if the percentage of gravel is estimated to be more than the percentage of sand.

TABLE 12 Identification of Inorganic Fine-Grained Soils from Manual Tests

Soil Symbol	Dry Strength	Dilatancy	Toughness
ML	None to low	Slow to rapid	Low or thread cannot be formed
CL	Medium to high	None to slow	Medium
MH	Low to medium	None to slow	Low to medium
CH	High to very high	None	High

15.2 The soil is a *sand* if the percentage of gravel is estimated to be equal to or less than the percentage of sand.

15.3 The soil is a *clean gravel* or *clean sand* if the percentage of fines is estimated to be 5 % or less.

15.3.1 Identify the soil as a *well-graded gravel*, GW, or as a *well-graded sand*, SW, if it has a wide range of particle sizes and substantial amounts of the intermediate particle sizes.

15.3.2 Identify the soil as a *poorly graded gravel*, GP, or as a *poorly graded sand*, SP, if it consists predominantly of one size (uniformly graded), or it has a wide range of sizes with some intermediate sizes obviously missing (gap or skip graded).

15.4 The soil is either a *gravel with fines* or a *sand with fines* if the percentage of fines is estimated to be 15 % or more.

15.4.1 Identify the soil as a *clayey gravel*, GC, or a *clayey sand*, SC, if the fines are clayey as determined by the procedures in Section 14.

15.4.2 Identify the soil as a *silty gravel*, GM, or a *silty sand*, SM, if the fines are silty as determined by the procedures in Section 14.

15.5 If the soil is estimated to contain 10 % fines, give the soil a dual identification using two group symbols.

15.5.1 The first group symbol shall correspond to a clean gravel or sand (GW, GP, SW, SP) and the second symbol shall correspond to a gravel or sand with fines (GC, GM, SC, SM).

15.5.2 The group name shall correspond to the first group symbol plus the words "with clay" or "with silt" to indicate the plasticity characteristics of the fines. For example: "well-graded gravel with clay, GW-GC" or "poorly graded sand with silt, SP-SM" (see Fig. 2).

15.6 If the specimen is predominantly sand or gravel but contains an estimated 15 % or more of the other coarse-grained constituent, the words "with gravel" or "with sand" shall be added to the group name. For example: "poorly graded gravel with sand, GP" or "clayey sand with gravel, SC" (see Fig. 2).

15.7 If the field sample contains any cobbles or boulders, or both, the words "with cobbles" or "with cobbles and boulders" shall be added to the group name. For example: "silty gravel with cobbles, GM."

16. Report

16.1 The report shall include the information as to origin, and the items indicated in Table 13.

NOTE 13—*Example: Clayey Gravel with Sand and Cobbles, GC*—About 50 % fine to coarse, subrounded to subangular gravel; about 30 % fine to coarse, subrounded sand; about 20 % fines with medium plasticity, high dry strength, no dilatancy, medium toughness; weak reaction with HCl; original field sample had about 5 % (by volume) subrounded cobbles, maximum dimension, 150 mm.

In-Place Conditions—Firm, homogeneous, dry, brown

Geologic Interpretation—Alluvial fan

NOTE 14—Other examples of soil descriptions and identification are given in Appendixes X1 and X2.

NOTE 15—If desired, the percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages, as follows:

Trace—Particles are present but estimated to be less than 5 %

Few—5 to 10 %

Little—15 to 25 %

Some—30 to 45 %

Mostly—50 to 100 %

TABLE 13 Checklist for Description of Soils

1. Group name
2. Group symbol
3. Percent of cobbles or boulders, or both (by volume)
4. Percent of gravel, sand, or fines, or all three (by dry weight)
5. Particle-size range:
   Gravel—fine, coarse
   Sand—fine, medium, coarse
6. Particle angularity: angular, subangular, subrounded, rounded
7. Particle shape: (if appropriate) flat, elongated, flat and elongated
8. Maximum particle size or dimension
9. Hardness of coarse sand and larger particles
10. Plasticity of fines: nonplastic, low, medium, high
11. Dry strength: none, low, medium, high, very high
12. Dilatancy: none, slow, rapid
13. Toughness: low, medium, high
14. Color (in moist condition)
15. Odor (mention only if organic or unusual)
16. Moisture: dry, moist, wet
17. Reaction with HCl: none, weak, strong

For intact samples:

18. Consistency (fine-grained soils only): very soft, soft, firm, hard, very hard
19. Structure: stratified, laminated, fissured, slickensided, lensed, homogeneous
20. Cementation: weak, moderate, strong
21. Local name
22. Geologic interpretation
23. Additional comments: presence of roots or root holes, presence of mica, gypsum, etc., surface coatings on coarse-grained particles, caving or sloughing of auger hole or trench sides, difficulty in augering or excavating, etc.

16.2 If, in the soil description, the soil is identified using a classification group symbol and name as described in Test Method D 2487, it must be distinctly and clearly stated in log forms, summary tables, reports, and the like, that the symbol and name are based on visual-manual procedures.

17. Precision and Bias

17.1 This practice provides qualitative information only, therefore, a precision and bias statement is not applicable.

18. Keywords

18.1 classification; clay; gravel; organic soils; sand; silt; soil classification; soil description; visual classification

APPENDIXES

(Nonmandatory Information)

X1. EXAMPLES OF VISUAL SOIL DESCRIPTIONS

X1.1 The following examples show how the information required in 16.1 can be reported. The information that is included in descriptions should be based on individual circumstances and need.

X1.1.1 *Well-Graded Gravel with Sand (GW)*—About 75 % fine to coarse, hard, subangular gravel; about 25 % fine to coarse, hard, subangular sand; trace of fines; maximum size, 75 mm, brown, dry; no reaction with HCl.

X1.1.2 *Silty Sand with Gravel (SM)*—About 60 % predominantly fine sand; about 25 % silty fines with low plasticity, low dry strength, rapid dilatancy, and low toughness; about 15 % fine, hard, subrounded gravel, a few gravel-size particles fractured with hammer blow; maximum size, 25 mm; no reaction with HCl (Note—Field sample size smaller than recommended).

In-Place Conditions—Firm, stratified and contains lenses of silt 1 to 2 in. (25 to 50 mm) thick, moist, brown to gray; in-place density 106 lb/ft^3; in-place moisture 9 %.

X1.1.3 *Organic Soil (OL/OH)*—About 100 % fines with low plasticity, slow dilatancy, low dry strength, and low toughness; wet, dark brown, organic odor; weak reaction with HCl.

X1.1.4 *Silty Sand with Organic Fines (SM)*—About 75 % fine to coarse, hard, subangular reddish sand; about 25 % organic and silty dark brown nonplastic fines with no dry strength and slow dilatancy; wet; maximum size, coarse sand; weak reaction with HCl.

X1.1.5 *Poorly Graded Gravel with Silt, Sand, Cobbles and Boulders (GP-GM)*—About 75 % fine to coarse, hard, subrounded to subangular gravel; about 15 % fine, hard, subrounded to subangular sand; about 10 % silty nonplastic fines; moist, brown; no reaction with HCl; original field sample had about 5 % (by volume) hard, subrounded cobbles and a trace of hard, subrounded boulders, with a maximum dimension of 18 in. (450 mm).

X2. USING THE IDENTIFICATION PROCEDURE AS A DESCRIPTIVE SYSTEM FOR SHALE, CLAYSTONE, SHELLS, SLAG, CRUSHED ROCK, AND THE LIKE

X2.1 The identification procedure may be used as a descriptive system applied to materials that exist in-situ as shale, claystone, sandstone, siltstone, mudstone, etc., but convert to soils after field or laboratory processing (crushing, slaking, and the like).

X2.2 Materials such as shells, crushed rock, slag, and the like, should be identified as such. However, the procedures used in this practice for describing the particle size and plasticity characteristics may be used in the description of the material. If desired, an identification using a group name and symbol according to this practice may be assigned to aid in describing the material.

X2.3 The group symbol(s) and group names should be placed in quotation marks or noted with some type of distinguishing symbol. See examples.

X2.4 Examples of how group names and symbols can be incororated into a descriptive system for materials that are not naturally occurring soils are as follows:

X2.4.1 *Shale Chunks*—Retrieved as 2 to 4-in. (50 to 100-mm) pieces of shale from power auger hole, dry, brown, no reaction with HCl. After slaking in water for 24 h, material identified as "Sandy Lean Clay (CL)"; about 60 % fines with medium plasticity, high dry strength, no dilatancy, and medium toughness; about 35 % fine to medium, hard sand; about 5 % gravel-size pieces of shale.

X2.4.2 *Crushed Sandstone*—Product of commercial crushing operation; "Poorly Graded Sand with Silt (SP-SM)"; about 90 % fine to medium sand; about 10 % nonplastic fines; dry, reddish-brown, strong reaction with HCl.

X2.4.3 *Broken Shells*—About 60 % gravel-size broken shells; about 30 % sand and sand-size shell pieces; about 10 % fines; "Poorly Graded Gravel with Sand (GP)."

X2.4.4 *Crushed Rock*—Processed from gravel and cobbles in Pit No. 7; "Poorly Graded Gravel (GP)"; about 90 % fine, hard, angular gravel-size particles; about 10 % coarse, hard, angular sand-size particles; dry, tan; no reaction with HCl.

X3. SUGGESTED PROCEDURE FOR USING A BORDERLINE SYMBOL FOR SOILS WITH TWO POSSIBLE IDENTIFICATIONS.

X3.1 Since this practice is based on estimates of particle size distribution and plasticity characteristics, it may be difficult to clearly identify the soil as belonging to one category. To indicate that the soil may fall into one of two possible basic groups, a borderline symbol may be used with the two symbols separated by a slash. For example: SC/CL or CL/CH.

X3.1.1 A borderline symbol may be used when

percentage of fines is estimated to be between 45 and 55 %. One symbol should be for a coarse-grained soil with fines and the other for a fine-grained soil. For example: GM/ML or CL/SC.

X3.1.2 A borderline symbol may be used when the percentage of sand and the percentage of gravel are estimated to be about the same. For example: GP/SP, SC/GC, GM/SM. It is practically impossible to have a soil that would have a borderline symbol of GW/SW.

X3.1.3 A borderline symbol may be used when the soil could be either well graded or poorly graded. For example: GW/GP, SW/SP.

X3.1.4 A borderline symbol may be used when the soil could either be a silt or a clay. For example: CL/ML, CH/MH, SC/SM.

X3.1.5 A borderline symbol may be used when a fine-grained soil has properties that indicate that it is at the boundary between a soil of low compressibility and a soil of high compressibility. For example: CL/CH, MH/ML.

X3.2 The order of the borderline symbols should reflect similarity to surrounding or adjacent soils. For example: soils in a borrow area have been identified as CH. One sample is considered to have a borderline symbol of CL and CH. To show similarity, the borderline symbol should be CH/CL.

X3.3 The group name for a soil with a borderline symbol should be the group name for the first symbol, except for:

CL/CH lean to fat clay
ML/CL clayey silt
CL/ML silty clay

X3.4 The use of a borderline symbol should not be used indiscriminately. Every effort shall be made to first place the soil into a single group.

X4. SUGGESTED PROCEDURES FOR ESTIMATING THE PERCENTAGES OF GRAVEL, SAND, AND FINES IN A SOIL SAMPLE

X4.1 *Jar Method*—The relative percentage of coarse- and fine-grained material may be estimated by thoroughly shaking a mixture of soil and water in a test tube or jar, and then allowing the mixture to settle. The coarse particles will fall to the bottom and successively finer particles will be deposited with increasing time; the sand sizes will fall out of suspension in 20 to 30 s. The relative proportions can be estimated from the relative volume of each size separate. This method should be correlated to particle-size laboratory determinations.

X4.2 *Visual Method*—Mentally visualize the gravel size particles placed in a sack (or other container) or sacks. Then, do the same with the sand size particles and the fines. Then, mentally compare the number of sacks to estimate the percentage of plus No. 4 sieve size and minus No. 4 sieve size present. The percentages of sand and fines in the minus sieve size No. 4 material can then be estimated from the wash test (X4.3).

X4.3 *Wash Test (for relative percentages of sand and fines)*—Select and moisten enough minus No. 4 sieve size material to form a 1-in (25-mm) cube of soil. Cut the cube in half, set one-half to the side, and place the other half in a small dish. Wash and decant the fines out of the material in the dish until the wash water is clear and then compare the two samples and estimate the percentage of sand and fines. Remember that the percentage is based on weight, not volume. However, the volume comparison will provide a reasonable indication of grain size percentages.

X4.3.1 While washing, it may be necessary to break down lumps of fines with the finger to get the correct percentages.

X5. ABBREVIATED SOIL CLASSIFICATION SYMBOLS

X5.1 In some cases, because of lack of space, an abbreviated system may be useful to indicate the soil classification symbol and name. Examples of such cases would be graphical logs, databases, tables, etc.

X5.2 This abbreviated system is not a substitute for the full name and descriptive information but can be used in supplementary presentations when the complete description is referenced.

X5.3 The abbreviated system should consist of the soil classification symbol based on this standard with appropriate lower case letter prefixes and suffixes as:

Prefix:	Suffix:
s = sandy	s = with sand
g = gravelly	g = with gravel
	c = with cobbles
	b = with boulders

X5.4 The soil classification symbol is to be enclosed in parenthesis. Some examples would be:

Group Symbol and Full Name	Abbreviated
CL, Sandy lean clay	s(CL)
SP-SM, Poorly graded sand with silt and gravel	(SP-SM)g
GP, poorly graded gravel with sand, cobbles, and boulders	(GP)scb
ML, gravelly silt with sand and cobbles	g(ML)sc

X6. RATIONALE

Changes in this version from the previous version, D 2488 – 90, include the addition of X5 on Abbreviated Soil Classification Symbols.

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This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, 1916 Race St., Philadelphia, PA 19103.

Table 1
EXAMPLE SOIL DESCRIPTIONS

POORLY GRADED SAND (SP), light brown, moist, loose, fine sand size

FAT CLAY (CH), dark gray, moist, stiff

SILT (ML), light greenish gray, wet, very loose, some mica, lacustrine

WELL-GRADED SAND WITH GRAVEL (SM), reddish brown, moist, dense, subangular gravel to 0.6 inches max

POORLY GRADED SAND WITH SILT (SP-SM), white, wet, medium dense

ORGANIC SOIL WITH SAND (OH), dark brown to black, wet, firm to stiff but spongy undisturbed, becomes soft and sticky when remolded, many fine roots, trace of mica

SILTY GRAVEL WITH SAND (GM), brownish red, moist, very dense, subrounded gravel to 1.2 inches max

INTERLAYERED SILT (60 percent) AND CLAY (40 percent): SILT WITH SAND (ML), medium greenish gray, nonplastic, sudden reaction to shaking, layers mostly 1.5 to 8.3 inches thick; LEAN CLAY (CL), dark gray, firm and brittle undisturbed, becomes very soft and sticky when remolded, layers 0.2 to 1.2 inches thick

SILTY SAND WITH GRAVEL (SM), light yellowish brown, moist, medium dense, weak gravel to 1.0 inches max, very few small particles of coal, fill

SANDY ELASTIC SILT (MH), very light gray to white, wet, stiff, weak calcareous cementation

LEAN CLAY WITH SAND (CL/MH), dark brownish gray, moist, stiff

WELL-GRADED GRAVEL WITH SILT (GW-GM), brown, moist, very dense, rounded gravel to 1.0 inches max

Date: September 13, 1989

Table 2
CRITERIA FOR DESCRIBING MOISTURE CONDITION

Description	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp, but no visible water
Wet	Visible free water, usually soil is below water table

Table 3
RELATIVE DENSITY OF COARSE-GRAINED SOIL
(Developed from Sowers, 1979)

Blows/Ft	Relative Density	Field Test
0-4	Very loose	Easily penetrated with ½-in. steel rod pushed by hand
5-10	Loose	Easily penetrated with ½-in. steel rod pushed by hand
11-30	Medium	Easily penetrated with ½-in. steel rod driven with 5-lb hammer
31-50	Dense	Penetrated a foot with ½-in. steel rod driven with 5-lb hammer
>50	Very dense	Penetrated only a few inches with ½-in. steel rod driven with 5-lb hammer

Table 4
CONSISTENCY OF FINE-GRAINED SOIL
(Developed from Sowers, 1979)

Blows/Ft	Consistency	Pocket Penetrometer (TSF)	Torvane (TSF)	Field Test
<2	Very soft	<0.25	<0.12	Easily penetrated several inches by fist
2-4	Soft	0.25-0.50	0.12-0.25	Easily penetrated several inches by thumb
5-8	Firm	0.50-1.0	0.25-0.5	Can be penetrated several inches by thumb with moderate effort
9-15	Stiff	1.0-2.0	0.5-1.0	Readily indented by thumb, but penetrated only with great effort
16-30	Very stiff	2.0-4.0	1.0-2.0	Readily indented by thumbnail
>30	Hard	>4.0	>2.0	Indented with difficulty by thumbnail

Designation: D 1586 – 84 (Reapproved 1992)$^{\epsilon 1}$

Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils[1]

This standard is issued under the fixed designation D 1586; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense. Consult the DOD Index of Specifications and Standards for the specific year of issue which has been adopted by the Department of Defense.

$^{\epsilon 1}$NOTE—Editorial changes were made throughout October 1992.

1. Scope

1.1 This test method describes the procedure, generally known as the Standard Penetration Test (SPT), for driving a split-barrel sampler to obtain a representative soil sample and a measure of the resistance of the soil to penetration of the sampler.

1.2 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For a specific precautionary statement, see 5.4.1.

1.3 The values stated in inch-pound units are to be regarded as the standard.

2. Referenced Documents

2.1 *ASTM Standards:*

D 2487 Test Method for Classification of Soils for Engineering Purposes[2]

D 2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)[2]

D 4220 Practices for Preserving and Transporting Soil Samples[2]

D 4633 Test Method for Stress Wave Energy Measurement for Dynamic Penetrometer Testing Systems[2]

3. Terminology

3.1 *Descriptions of Terms Specific to This Standard*

3.1.1 *anvil*—that portion of the drive-weight assembly which the hammer strikes and through which the hammer energy passes into the drill rods.

3.1.2 *cathead*—the rotating drum or windlass in the rope-cathead lift system around which the operator wraps a rope to lift and drop the hammer by successively tightening and loosening the rope turns around the drum.

3.1.3 *drill rods*—rods used to transmit downward force and torque to the drill bit while drilling a borehole.

3.1.4 *drive-weight assembly*—a device consisting of the hammer, hammer fall guide, the anvil, and any hammer drop system.

3.1.5 *hammer*—that portion of the drive-weight assembly consisting of the 140 ± 2 lb (63.5 ± 1 kg) impact weight which is successively lifted and dropped to provide the energy that accomplishes the sampling and penetration.

3.1.6 *hammer drop system*—that portion of the drive-weight assembly by which the operator accomplishes the lifting and dropping of the hammer to produce the blow.

3.1.7 *hammer fall guide*—that part of the drive-weight assembly used to guide the fall of the hammer.

3.1.8 *N-value*—the blowcount representation of the penetration resistance of the soil. The *N*-value, reported in blows per foot, equals the sum of the number of blows required to drive the sampler over the depth interval of 6 to 18 in. (150 to 450 mm) (see 7.3).

3.1.9 ΔN—the number of blows obtained from each of the 6-in. (150-mm) intervals of sampler penetration (see 7.3).

3.1.10 *number of rope turns*—the total contact angle between the rope and the cathead at the beginning of the operator's rope slackening to drop the hammer, divided by 360° (see Fig. 1).

3.1.11 *sampling rods*—rods that connect the drive-weight assembly to the sampler. Drill rods are often used for this purpose.

3.1.12 *SPT*—abbreviation for Standard Penetration Test, a term by which engineers commonly refer to this method.

4. Significance and Use

4.1 This test method provides a soil sample for identification purposes and for laboratory tests appropriate for soil obtained from a sampler that may produce large shear strain disturbance in the sample.

4.2 This test method is used extensively in a great variety of geotechnical exploration projects. Many local correlations and widely published correlations which relate SPT blowcount, or *N*-value, and the engineering behavior of earthworks and foundations are available.

5. Apparatus

5.1 *Drilling Equipment*—Any drilling equipment that provides at the time of sampling a suitably clean open hole before insertion of the sampler and ensures that the penetration test is performed on undisturbed soil shall be acceptable. The following pieces of equipment have proven to be

[1] This method is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.02 on Sampling and Related Field Testing for Soil Investigations.

Current edition approved Sept. 11, 1984. Published November 1984. Originally published as D 1586 – 58 T. Last previous edition D 1586 – 67 (1974).

[2] *Annual Book of ASTM Standards*, Vol 04.08.

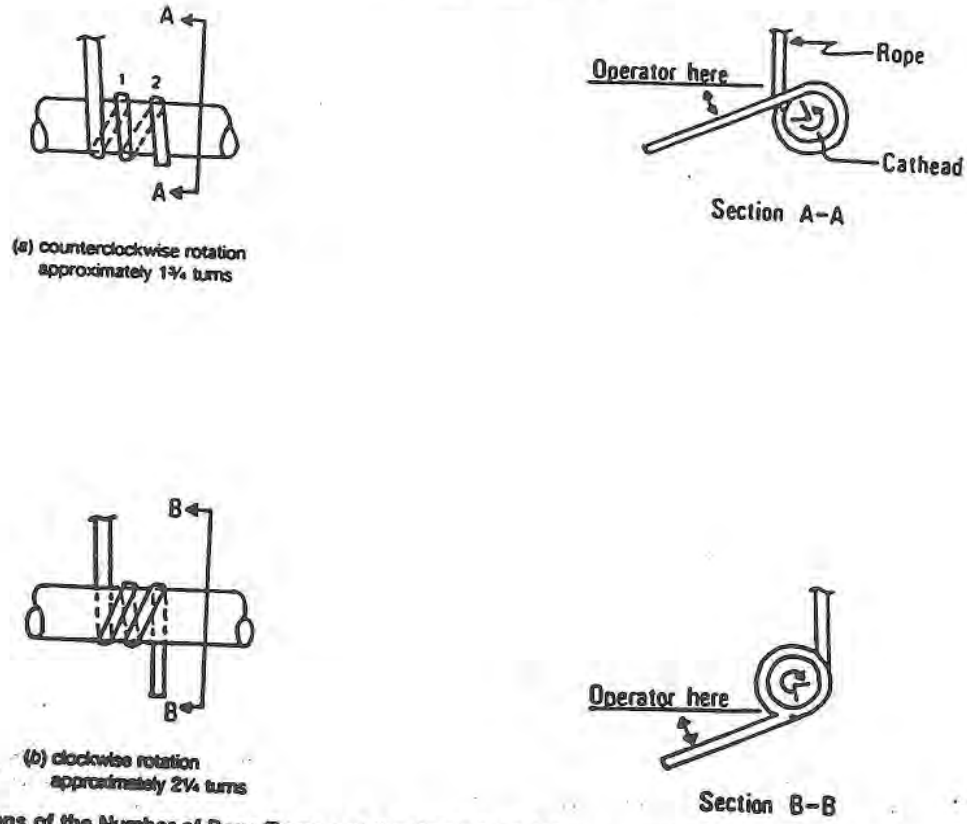


FIG. 1 Definitions of the Number of Rope Turns and the Angle for (a) Counterclockwise Rotation and (b) Clockwise Rotation of the Cathead

suitable for advancing a borehole in some subsurface conditions.

5.1.1 *Drag, Chopping, and Fishtail Bits*, less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm) in diameter may be used in conjuction with open-hole rotary drilling or casing-advancement drilling methods. To avoid disturbance of the underlying soil, bottom discharge bits are not permitted; only side discharge bits are permitted.

5.1.2 *Roller-Cone Bits*, less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm) in diameter may be used in conjunction with open-hole rotary drilling or casing-advancement drilling methods if the drilling fluid discharge is deflected.

5.1.3 *Hollow-Stem Continuous Flight Augers*, with or without a center bit assembly, may be used to drill the boring. The inside diameter of the hollow-stem augers shall be less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm).

5.1.4 *Solid, Continuous Flight, Bucket and Hand Augers*, less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm) in diameter may be used if the soil on the side of the boring does not cave onto the sampler or sampling rods during sampling.

5.2 *Sampling Rods*—Flush-joint steel drill rods shall be used to connect the split-barrel sampler to the drive-weight assembly. The sampling rod shall have a stiffness (moment of inertia) equal to or greater than that of parallel wall "A" rod (a steel rod which has an outside diameter of 1⅝ in. (41.2 mm) and an inside diameter of 1⅛ in. (28.5 mm).

NOTE 1—Recent research and comparative testing indicates the type rod used, with stiffness ranging from "A" size rod to "N" size rod, will usually have a negligible effect on the *N*-values to depths of at least 100 ft (30 m).

5.3 *Split-Barrel Sampler*—The sampler shall be constructed with the dimensions indicated in Fig. 2. The driving shoe shall be of hardened steel and shall be replaced or repaired when it becomes dented or distorted. The use of liners to produce a constant inside diameter of 1⅜ in. (35 mm) is permitted, but shall be noted on the penetration record if used. The use of a sample retainer basket is permitted, and should also be noted on the penetration record if used.

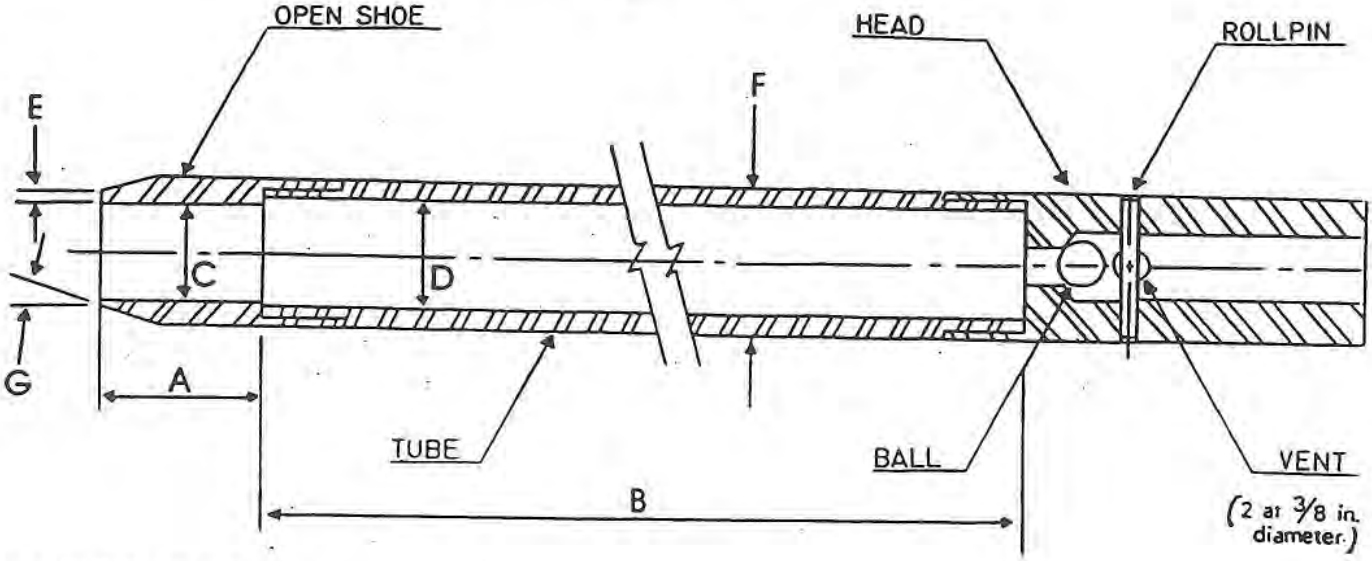
NOTE 2—Both theory and available test data suggest that *N*-values may increase between 10 to 30 % when liners are used.

5.4 *Drive-Weight Assembly:*

5.4.1 *Hammer and Anvil*—The hammer shall weigh 140 ± 2 lb (63.5 ± 1 kg) and shall be a solid rigid metallic mass. The hammer shall strike the anvil and make steel on steel contact when it is dropped. A hammer fall guide permitting a free fall shall be used. Hammers used with the cathead and rope method shall have an unimpeded overlift capacity of at least 4 in. (100 mm). For safety reasons, the use of a hammer assembly with an internal anvil is encouraged.

NOTE 3—It is suggested that the hammer fall guide be permanently marked to enable the operator or inspector to judge the hammer drop height.

5.4.2 *Hammer Drop System*—Rope-cathead, trip, semi-automatic, or automatic hammer drop systems may be used, providing the lifting apparatus will not cause penetration of



A = 1.0 to 2.0 in. (25 to 50 mm)
B = 18.0 to 30.0 in. (0.457 to 0.762 m)
C = 1.375 ± 0.005 in. (34.93 ± 0.13 mm)
D = 1.50 ± 0.05 − 0.00 in. (38.1 ± 1.3 − 0.0 mm)
E = 0.10 ± 0.02 in. (2.54 ± 0.25 mm)
F = 2.00 ± 0.05 − 0.00 in. (50.8 ± 1.3 − 0.0 mm)
G = 16.0° to 23.0°

The 1½ in. (38 mm) inside diameter split barrel may be used with a 16-gage wall thickness split liner. The penetrating end of the drive shoe may be slightly rounded. Metal or plastic retainers may be used to retain soil samples.

FIG. 2 Split-Barrel Sampler

the sampler while re-engaging and lifting the hammer.

5.5 *Accessory Equipment*—Accessories such as labels, sample containers, data sheets, and groundwater level measuring devices shall be provided in accordance with the requirements of the project and other ASTM standards.

6. Drilling Procedure

6.1 The boring shall be advanced incrementally to permit intermittent or continuous sampling. Test intervals and locations are normally stipulated by the project engineer or geologist. Typically, the intervals selected are 5 ft (1.5 mm) or less in homogeneous strata with test and sampling locations at every change of strata.

6.2 Any drilling procedure that provides a suitably clean and stable hole before insertion of the sampler and assures that the penetration test is performed on essentially undisturbed soil shall be acceptable. Each of the following procedures have proven to be acceptable for some subsurface conditions. The subsurface conditions anticipated should be considered when selecting the drilling method to be used.

6.2.1 Open-hole rotary drilling method.

6.2.2 Continuous flight hollow-stem auger method.

6.2.3 Wash boring method.

6.2.4 Continuous flight solid auger method.

6.3 Several drilling methods produce unacceptable borings. The process of jetting through an open tube sampler and then sampling when the desired depth is reached shall not be permitted. The continuous flight solid auger method shall not be used for advancing the boring below a water table or below the upper confining bed of a confined non-cohesive stratum that is under artesian pressure. Casing may not be advanced below the sampling elevation prior to sampling. Advancing a boring with bottom discharge bits is not permissible. It is not permissible to advance the boring for subsequent insertion of the sampler solely by means of previous sampling with the SPT sampler.

6.4 The drilling fluid level within the boring or hollow-stem augers shall be maintained at or above the in situ groundwater level at all times during drilling, removal of drill rods, and sampling.

7. Sampling and Testing Procedure

7.1 After the boring has been advanced to the desired sampling elevation and excessive cuttings have been removed, prepare for the test with the following sequence of operations.

7.1.1 Attach the split-barrel sampler to the sampling rods and lower into the borehole. Do not allow the sampler to drop onto the soil to be sampled.

7.1.2 Position the hammer above and attach the anvil to the top of the sampling rods. This may be done before the sampling rods and sampler are lowered into the borehole.

7.1.3 Rest the dead weight of the sampler, rods, anvil, and drive weight on the bottom of the boring and apply a seating blow. If excessive cuttings are encountered at the bottom of the boring, remove the sampler and sampling rods from the boring and remove the cuttings.

7.1.4 Mark the drill rods in three successive 6-in. (0.15-m) increments so that the advance of the sampler under the impact of the hammer can be easily observed for each 6-in. (0.15-m) increment.

7.2 Drive the sampler with blows from the 140-lb (63.5-

kg) hammer and count the number of blows applied in each 6-in. (0.15-m) increment until one of the following occurs:

7.2.1 A total of 50 blows have been applied during any one of the three 6-in. (0.15-m) increments described in 7.1.4.

7.2.2 A total of 100 blows have been applied.

7.2.3 There is no observed advance of the sampler during the application of 10 successive blows of the hammer.

7.2.4 The sampler is advanced the complete 18 in. (0.45 m) without the limiting blow counts occurring as described in 7.2.1, 7.2.2, or 7.2.3.

7.3 Record the number of blows required to effect each 6 in. (0.15 m) of penetration or fraction thereof. The first 6 in. is considered to be a seating drive. The sum of the number of blows required for the second and third 6 in. of penetration is termed the "standard penetration resistance," or the "*N*-value." If the sampler is driven less than 18 in. (0.45 m), as permitted in 7.2.1, 7.2.2, or 7.2.3, the number of blows per each complete 6-in. (0.15-m) increment and per each partial increment shall be recorded on the boring log. For partial increments, the depth of penetration shall be reported to the nearest 1 in. (25 mm), in addition to the number of blows. If the sampler advances below the bottom of the boring under the static weight of the drill rods or the weight of the drill rods plus the static weight of the hammer, this information should be noted on the boring log.

7.4 The raising and dropping of the 140-lb (63.5-kg) hammer shall be accomplished using either of the following two methods:

7.4.1 By using a trip, automatic, or semi-automatic hammer drop system which lifts the 140-lb (63.5-kg) hammer and allows it to drop 30 ± 1.0 in. (0.76 m ± 25 mm) unimpeded.

7.4.2 By using a cathead to pull a rope attached to the hammer. When the cathead and rope method is used the system and operation shall conform to the following:

7.4.2.1 The cathead shall be essentially free of rust, oil, or grease and have a diameter in the range of 6 to 10 in. (150 to 250 mm).

7.4.2.2 The cathead should be operated at a minimum speed of rotation of 100 RPM, or the approximate speed of rotation shall be reported on the boring log.

7.4.2.3 No more than 2¼ rope turns on the cathead may be used during the performance of the penetration test, as shown in Fig. 1.

NOTE 4—The operator should generally use either 1¾ or 2¼ rope turns, depending upon whether or not the rope comes off the top (1¾ turns) or the bottom (2¼ turns) of the cathead. It is generally known and accepted that 2¾ or more rope turns considerably impedes the fall of the hammer and should not be used to perform the test. The cathead rope should be maintained in a relatively dry, clean, and unfrayed condition.

7.4.2.4 For each hammer blow, a 30-in. (0.76-m) lift and drop shall be employed by the operator. The operation of pulling and throwing the rope shall be performed rhythmically without holding the rope at the top of the stroke.

7.5 Bring the sampler to the surface and open. Record the percent recovery or the length of sample recovered. Describe the soil samples recovered as to composition, color, stratification, and condition, then place one or more representative portions of the sample into sealable moisture-proof containers (jars) without ramming or distorting any apparent stratification. Seal each container to prevent evaporation of soil moisture. Affix labels to the containers bearing designation, boring number, sample depth, and the b count per 6-in. (0.15-m) increment. Protect the samples against extreme temperature changes. If there is a soil change within the sampler, make a jar for each stratum and note its location in the sampler barrel.

8. Report

8.1 Drilling information shall be recorded in the field and shall include the following:

8.1.1 Name and location of job,

8.1.2 Names of crew,

8.1.3 Type and make of drilling machine,

8.1.4 Weather conditions,

8.1.5 Date and time of start and finish of boring,

8.1.6 Boring number and location (station and coordinates, if available and applicable),

8.1.7 Surface elevation, if available,

8.1.8 Method of advancing and cleaning the boring,

8.1.9 Method of keeping boring open,

8.1.10 Depth of water surface and drilling depth at the time of a noted loss of drilling fluid, and time and date when reading or notation was made,

8.1.11 Location of strata changes,

8.1.12 Size of casing, depth of cased portion of boring,

8.1.13 Equipment and method of driving sampler,

8.1.14 Type sampler and length and inside diameter of barrel (note use of liners),

8.1.15 Size, type, and section length of the sampling rc and

8.1.16 Remarks.

8.2 Data obtained for each sample shall be recorded in the field and shall include the following:

8.2.1 Sample depth and, if utilized, the sample number,

8.2.2 Description of soil,

8.2.3 Strata changes within sample,

8.2.4 Sampler penetration and recovery lengths, and

8.2.5 Number of blows per 6-in. (0.15-m) or partial increment.

9. Precision and Bias

9.1 *Precision*—A valid estimate of test precision has not been determined because it is too costly to conduct the necessary inter-laboratory (field) tests. Subcommittee D18.02 welcomes proposals to allow development of a valid precision statement.

9.2 *Bias*—Because there is no reference material for this test method, there can be no bias statement.

9.3 Variations in *N*-values of 100 % or more have been observed when using different standard penetration test apparatus and drillers for adjacent borings in the same soil formation. Current opinion, based on field experience, indicates that when using the same apparatus and driller, *N*-values in the same soil can be reproduced with a coefficient of variation of about 10 %.

9.4 The use of faulty equipment, such as an extrem massive or damaged anvil, a rusty cathead, a low sp cathead, an old, oily rope, or massive or poorly lubricated rope sheaves can significantly contribute to differences in *N*-values obtained between operator-drill rig systems.

9.5 The variability in *N*-values produced by different drill rigs and operators may be reduced by measuring that part of the hammer energy delivered into the drill rods from the sampler and adjusting *N* on the basis of comparative energies. A method for energy measurement and *N*-value adjustment is given in Test Method D 4633.

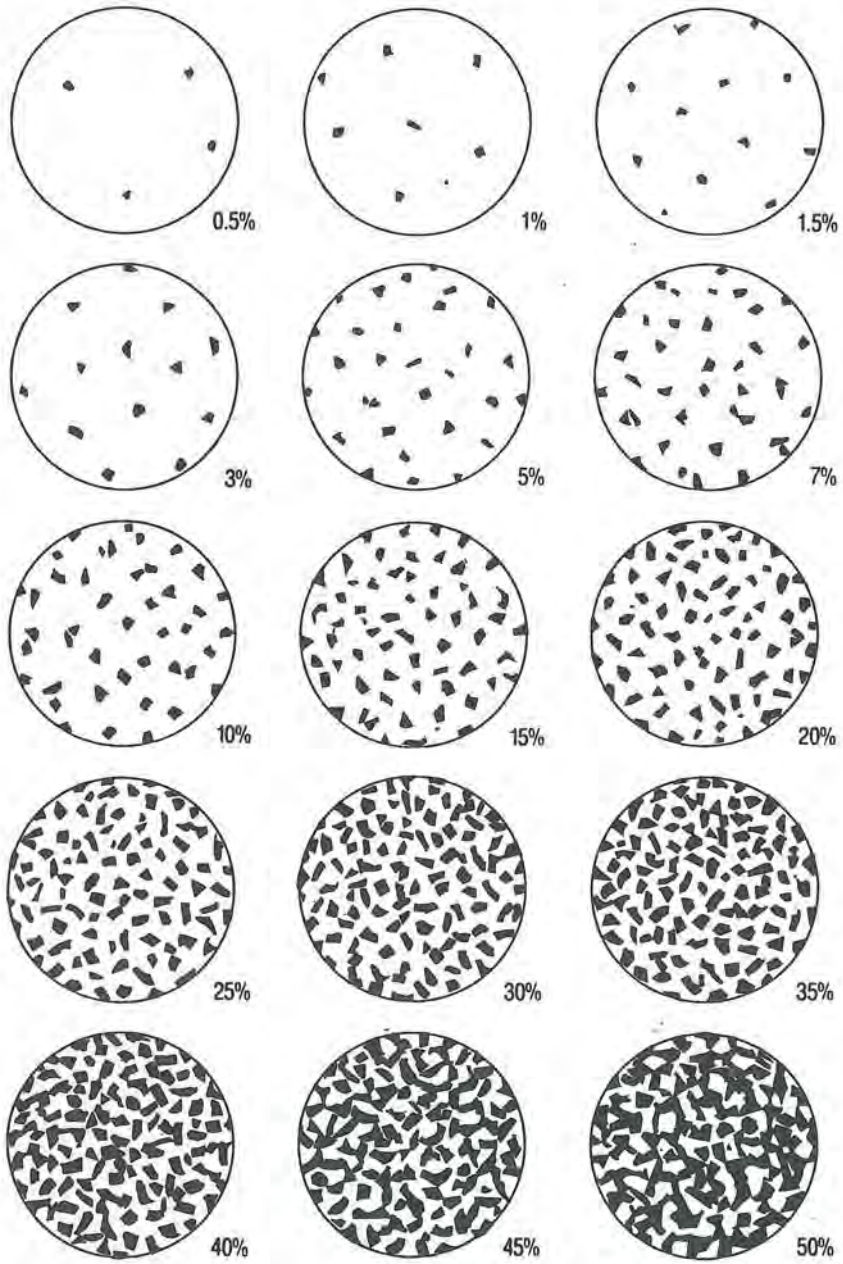
10. Keywords

10.1 blow count; in-situ test; penetration resistance; split-barrel sampling; standard penetration test

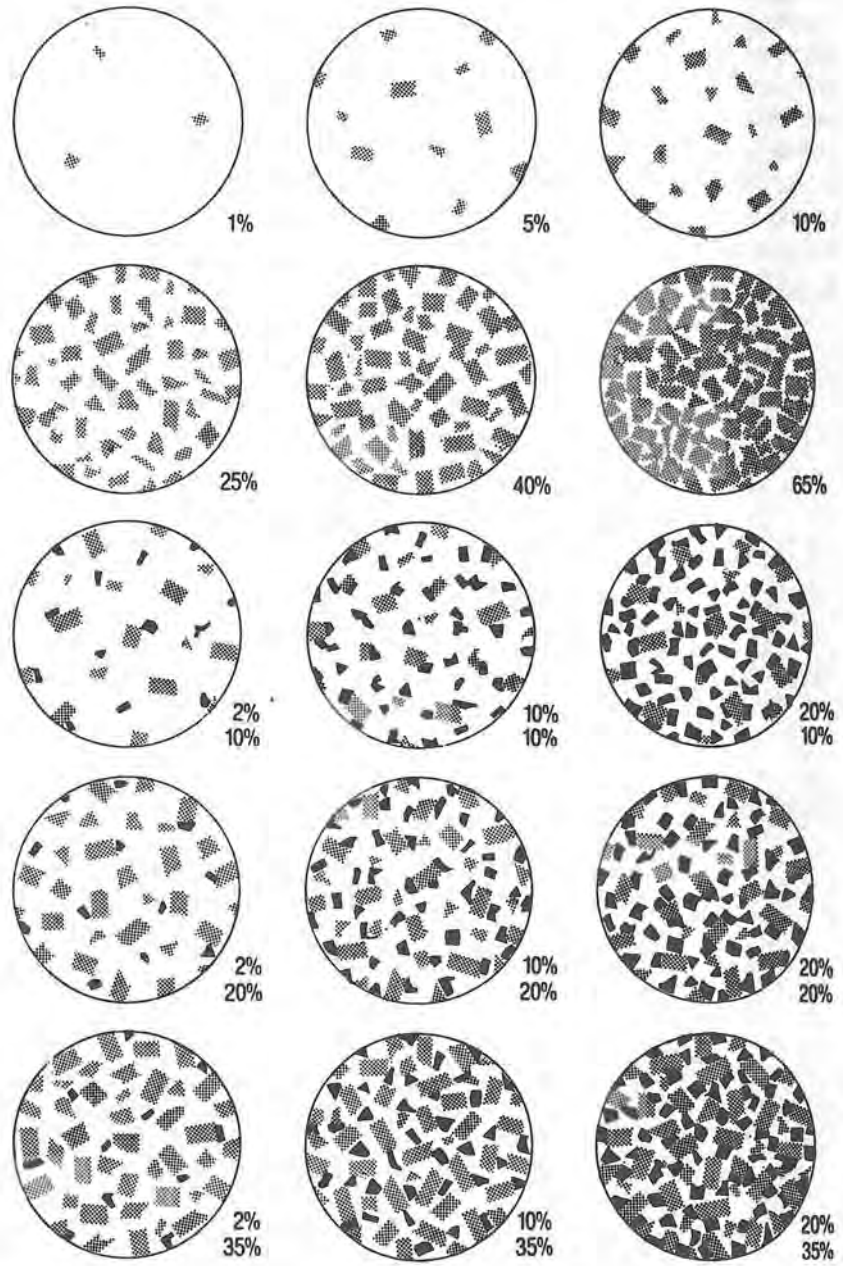
The American Society for Testing and Materials takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, 1916 Race St., Philadelphia, PA 19103.

APPENDIX 3. Percentage Diagrams For Estimating Compositon By Volume*



*To convert the results to weight percentages, multiply each volume percentage by the specific gravity of that mineral and recalculate the resulting numbers so that they sum to 100.



SOP 013
STANDARD OPERATING PROCEDURE

Preserving Non-VOC Aqueous Samples

I. Purpose

To provide general guidelines for preserving aqueous samples.

II. Scope

Standard aqueous sample preservation procedures for non-VOC samples are provided.

III. Equipment and Materials

- Disposable eye droppers
- Clean beakers for transfer of small portions of chemical preservative
- pH paper strips (range 0 to 14)
- Chemical preservatives, as appropriate
- Personal protection, as appropriate
- Clean out door or vented indoor area

IV. Procedures and Guidelines

1. Remove caps from sample containers to be chemically preserved in designated area. Add appropriate amount of chemical preservative to opened container. To determine the approximate amount of preservative required, preserve a sample of potable water and calculate the volume of preservative required.

2. After adding the appropriate preservatives to the sample containers, cap containers tightly. Invert sample container a few times to mix.

3. After preserving all the sample containers and mixing, open the container and check the pH of the sample by pouring out a small quantity of the sample to a clean receptacle and dipping a pH indicating strip into the sample. Add more preservative to the sample to adjust the pH, if necessary repeating steps 1 and 2. When three times the amount of preservative used to preserve a sample of potable water has been added, record the pH and notify the sample manager that the sample could not be preserved.

V. Attachments

None.

VI. Key Check Items

Be sure appropriate preservatives are used.

SOP 014
STANDARD OPERATING PROCEDURE

Flat Bottom Boat Sampling Operations

I. Purpose

Flat bottom boat sampling operations are a non-standard practice of RCRA/ CERCLA investigations. The objective of these operations is to access those sample locations inaccessible to larger, deeper draft, motorized water craft.

II. Scope

The provisions of this SOP apply to all program and project personnel engaged directly in technical boating operations, whether planning or executing those operations. These provisions apply whenever technical boating equipment or activities are used or included in project operations.

III. Responsibilities

Project Manager - The Project Manager is responsible for ensuring that project-specific plans for boating operations and federal and state boating safety regulations are in accordance with these procedures, where applicable, or that other approved procedures are developed.

Field Team Leader - The Field Team Leader is responsible for ensuring that these boating procedures are implemented in the field, and for ensuring that personnel performing these activities have been briefed and trained to execute these procedures.

Sampling Personnel - It is the responsibility of the SSC and sampling personnel to follow these procedures or to follow documented, project-specific procedures as directed by the Field Team Leader and/or the Project Manager. The sampling personnel are responsible for the proper sampling procedures, proper operation of the boat and adherence to waterborne health and safety procedures.

IV. Procedures

The following procedures outline the planning and execution of flat bottom boat sampling operations:

1. All operations involving technical boating will be directed by qualified and experienced boater as the team leader.

2. All persons participating in boating operations will be directed by the Team Leader.

3. All persons participating in boating operations will have been trained by the Team Leader or provide proof of experience in operating such water craft.
4. All water craft shall operate on a "line of sight" rule. No water craft will go out of sight of each other.
5. All personnel shall wear their Personnel Floatation Devices at all times while they are on the water.
6. The boat and equipment should comply with US Coast Guard Regulations and must be registered.
7. The boating team will include at least one person qualified in First Aid/CPR for nonstandard conditions (for example: fire rescue, air/land/sea rescue).
8. All personnel shall wear bright colors (for example: hunter orange, yellow, etc.) to enhance their visibility to one another.
9. All personnel shall collect one sample at a time, and return that sample to the "mother ship," the dock, or other location as determined by site conditions and situation.
10. Team Leader has final authority on operations with regards to weather and water conditions.

Established NAB Little Creek Station and Sample Identification Naming Scheme

TABLE 4-1
Field Station Naming Scheme
NAB Little Creek Master Project Plans
Virginia Beach, Virginia

First Segment			Second Segment		
Facility	Site Type	Site Number	Station Type	Station Number	Qualifier
A	*AA*	*NNN*	*AA*	*NNN*	*AAAA*

Note: "N" = numeric, "A" = alphanumeric

Facility:
L = Little Creek

Location Type:
S = Installation restoration site
W = Solid waste management unit (SWMU)
BG = Non-site-specific background samples
A = Area of concern (AOC)
REF = Reference samples

Location Number
003 – Pier 10 Sandblast Yard (SWMU 3)
005 – Port Ops Boat Painting Area (SWMU 5)
006 – Seabee Area-CB124 (SWMU 6)
007 – Small Boats Sandblast Yard (SWMU 7)
008 – West Annex Sandblast Yard (SWMU 8)
013 – Former Pesticide Shop (SWMU 13)
018 – PWC Transportation Garage Spent Battery Shop, Collection Area, Bldg. 3661 (SWMU 118)
07 – Amphibious Base Landfill (Site 7)
08 – Demolition Debris Landfill (Site 8)
09 – Driving Range Landfill (Site 9)
096 – CB301 Seabee Vehicle Maintenance Facility Scrap Storage Area (SWMU 96)
097 – CB301 Seabee Vehicle Maintenance Facility Storm Drain (SWMU 97)
098 – Elevated Causeways Mechanic Shop Material Dispensing Area (SWMU 98)
10 – Sewage Treatment Plant (Site 10)
11 – School of Music Plating Shop (Site 11)
11a – TCE Plume adjacent to Site 11 (Site 11a)
12 – Exchange Laundry Waste Disposal Area (Site 12)
13 – Public Works PCP Dip Tank and Wash Rack (Site 13)
116 – MWR Recreation Boat Maintenance Facility, Bldg. 3021)
119 – Former Special Warfare Group 2 Electronics Shop, Bldg. W112 (SWMU 119)
D – PCB Transformer Leak, Bldg. 3530 (AOC D)

Station Type:
BI* = Biota sample stations (i.e., benthic [B], crabs [C], fish [F], mussels [M], etc.)
DR = Drum
GP = In-situ sample groundwater station (i.e., geoprobe and hydropunch)
IS = IDW soil
IW = IDW water
ML = Multilevel sampler
MM = Multimedia station (e.g: surface water and sediment)
MW = Monitoring well
PW = Potable supply well
PZ = Piezometer
RW = Groundwater recovery well
SA = Sanitary sewer
SD = Sediment sample location
SEEP = Groundwater Seep Location
SG = Soil gas
SL = Sewer line (sanitary)
SO = Soil sample location
ST = Storm sewer
SW = Surface water sample location
TP = Test pit location
TW = Temporary well

Number:
Monitoring Well Number

Qualifier:
S = Shallow Well (<15 ft)
D = Deep Well (15-30 ft)
P = duplicate sample
Y = Yorktown Aquifer Well
T = Screened Across Shallow and Deep

TABLE 4-2
Field Sampling Naming Scheme
NAB Little Creek Master Project Plans
Virginia Beach, Virginia

First Segment			Second Segment			Third Segment
Facility	Site Type	Site Number	Sample Type	Sample Number	Qualifier	Additional Qualifiers (sample depth, sampling round, etc.)
A	*AA*	*NNN*	*AA*	*NNN or NNNN*	*A*	*As applicable*

Notes: "A" = alphabetic "N" = numeric

Facility:
L = Little Creek

Location Type:
S = Installation restoration site
W = Solid waste management unit (SWMU)
BG = Non-site-specific background samples
A = Area Of Concern (AOC)
REF = Reference samples

Location Number
003 – Pier 10 Sandblast Yard (SWMU 3)
005 – Port Ops Boat Painting Area (SWMU 5)
006 – Seabee Area-CB124 (SWMU 6)
007 – Small Boats Sandblast Yard (SWMU 7)
008 – West Annex Sandblast Yard (SWMU 8)
013 – Former Pesticide Shop (SWMU 13)
018 – PWC Transportation Garage Spent Battery Shop, Collection Area, Bldg. 3661 (SWMU118)
07 – Amphibious Base Landfill (Site 7)
08 – Demolition Debris Landfill (Site 8)
09 – Driving Range Landfill (Site 9)
096 – CB301 Seabee Vehicle Maintenance Facility Scrap Storage Area (SWMU 96)
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10 – Sewage Treatment Plant (Site 10)
11 – School of Music Plating Shop (Site 11)
11a – TCE Plume adjacent to Site 11 (Site 11a)
12 – Exchange Laundry Waste Disposal Area (Site 12)
13 – Public Works PCP Dip Tank and Wash Rack (Site 13)
116 – MWR Recreation Boat Maintenance Facility, Bldg. 3021)
119 – Former Special Warfare Group 2 Electronics Shop, Bldg. W112 (SWMU 119)
D – PCB Transformer Leak, Bldg. 3530 (AOC D)

Sample Type:
DP = Direct Push Groundwater Sample
MW = Monitoring Well
SB = Subsurface Soil
SD = Sediment
SS = Surface Soil
SW = Surface Water
TB = Trip Blank
FB = Field Blank
EB = Equipment Blank

Sample Number:
1. Station Samples (*NN*)
   Well number
2. QC Samples (*NNNNNN*)
   MMDDYY : month, day, and year of sampling event

Qualifier:
S = Shallow Well (<15 ft)
D = Deep Well (15-30 ft)
P = Duplicate sample
Y = Yorktown Aquifer Well
T = Screened Across Shallow and Deep

Additional Qualifiers:
1. QC Samples (*NN*)
   Sequential QC sample number for that day (if needed)

   Example:
   LS07-MW03-04C
   Groundwater samples collected from monitoring well 3 at Site 7 in the third quarter of 2004.

   A = 1st Quarter
   B = 2nd Quarter
   C = 3rd Quarter
   D = 4th Quarter

   LS07-EB011304
   Equipment blank collected on January 13, 2004 during sampling at Site 7.

Notes:

- Segments are separated by a dash.
- Qualifiers are as applicable only

Attachment C
Laboratory Standard Operating Procedures (Provided to Navy Chemist only—Proprietary Laboratory Procedures)

Laboratory SOPs are proprietary and confidential.
They are provided upon request at the discretion of the Project Manager.

Attachment D
Data Management Plan

Version 1

Navy CLEAN
Data Management Plan

Prepared for

Navy CLEAN & Joint Venture Programs

December 2009

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

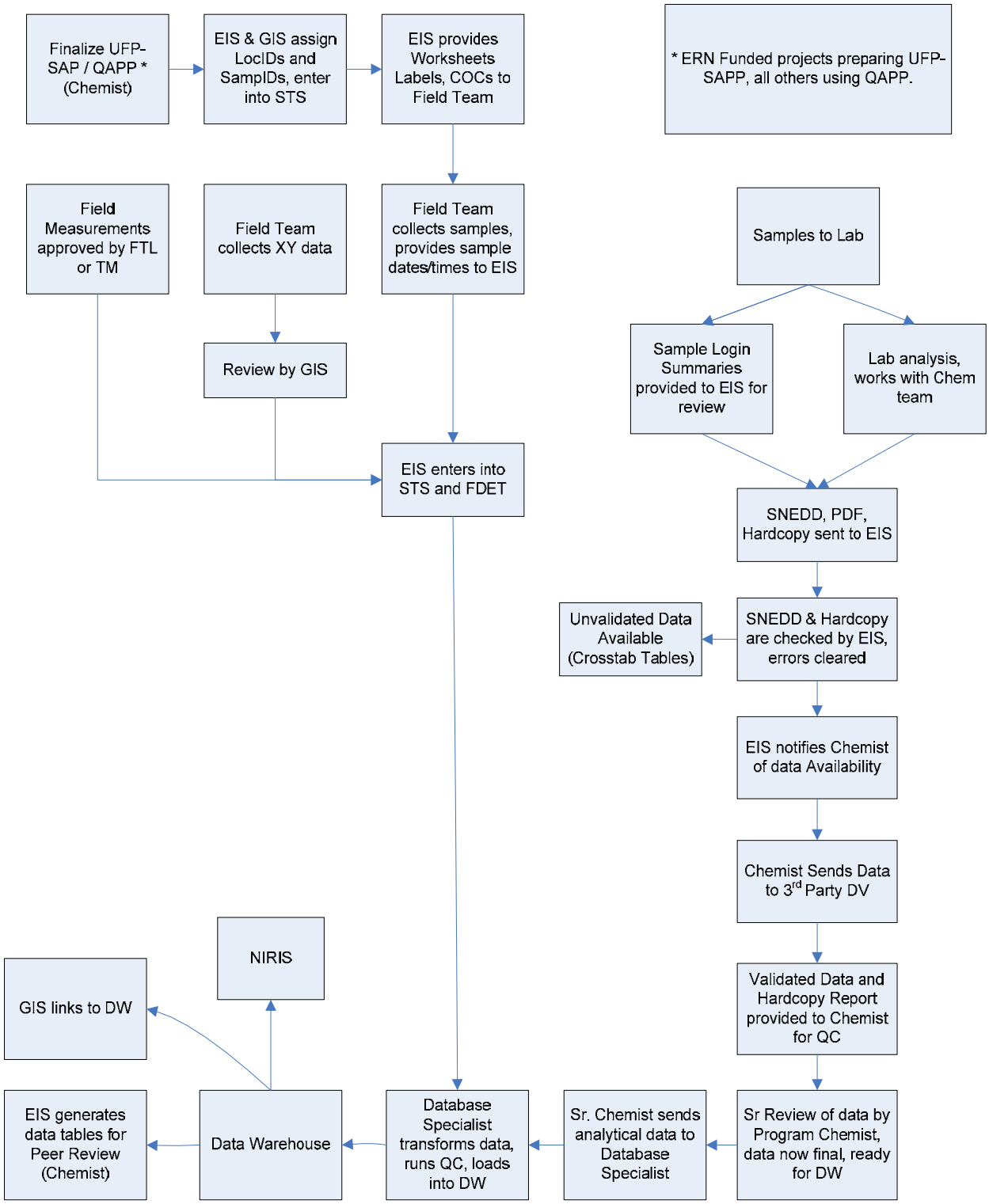

FIGURE P-1
ENVIRONMENTAL DATA MANAGEMENT WORKFLOW PROCESS

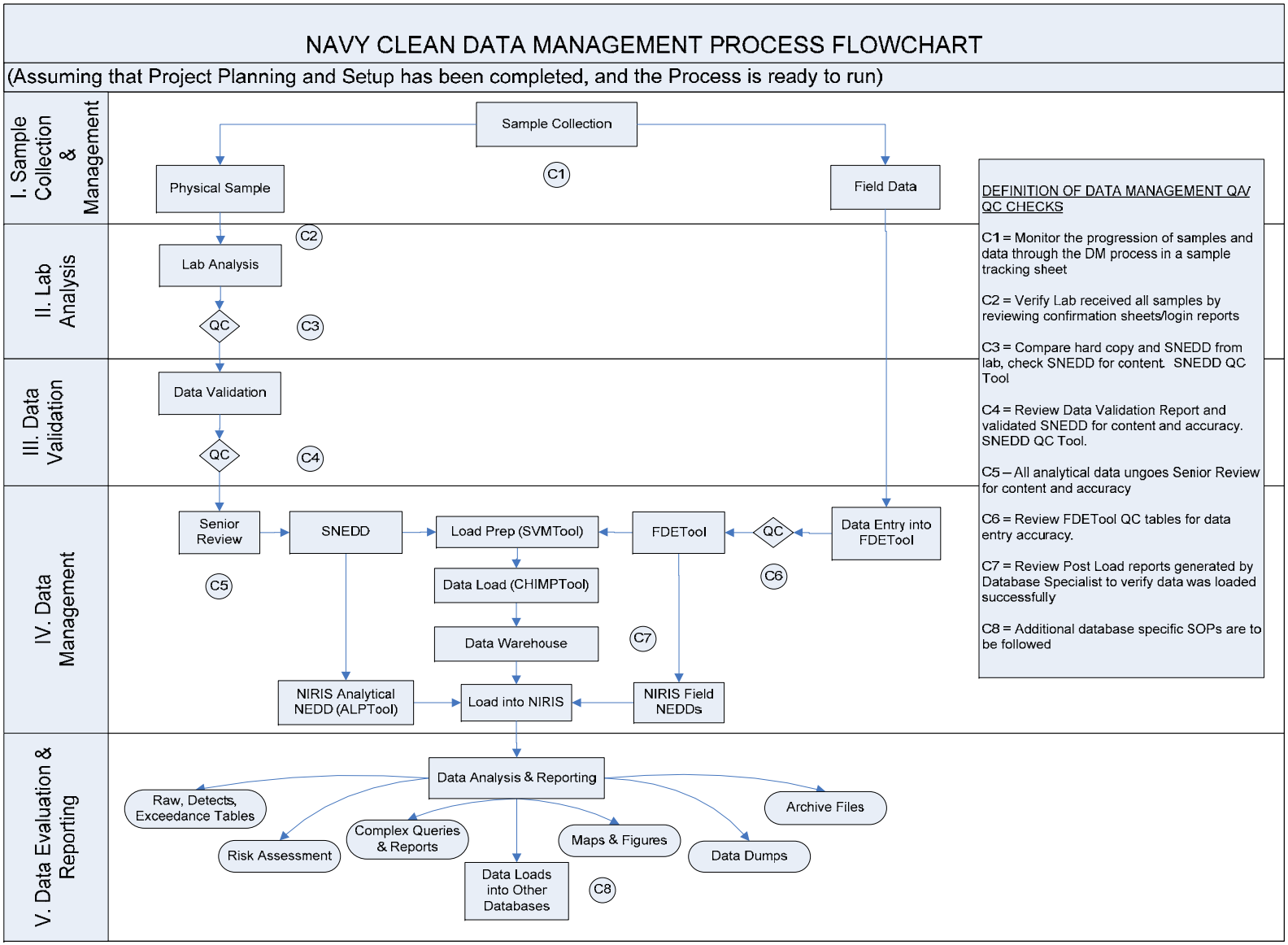

FIGURE P-2
DBMS PROCESS

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Figure 4 Field Sampling **4-4**

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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
EIS	Environmental Information Specialist
DMP	Data Management Plan
EDD	electronic data deliverable
EDM	Environmental Data Management
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
SVMTool	SNEDD to VDMS Mapping Tool
VDMS	Validated Data Management System

SECTION 1

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
Project Chemist (PC)	Juan Acaron 3011 S.W. Williston Road. Gainesville, FL 32608	352-384-7002-		juan.acaron@ch2m.com
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
GIS Analyst (GA)	Mary Beth Artese 5700 Cleveland Street. Suite 101 Virginia Beach, VA 23462	757-671-6228	757-497-6885	martese@critigen.com
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	mrissing@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.

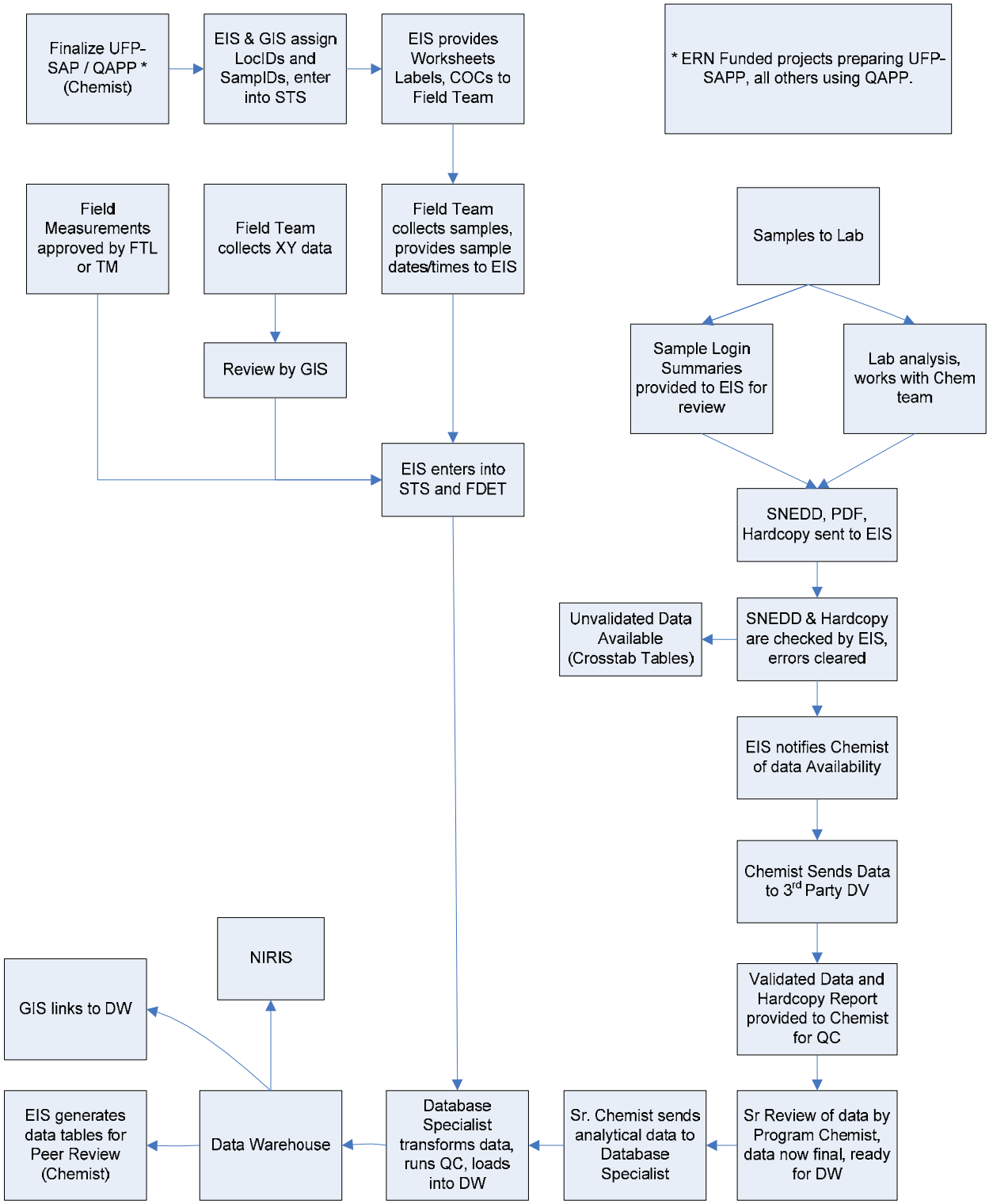


FIGURE 1
ENVIRONMENTAL DATA MANAGEMENT WORKFLOW PROCESS

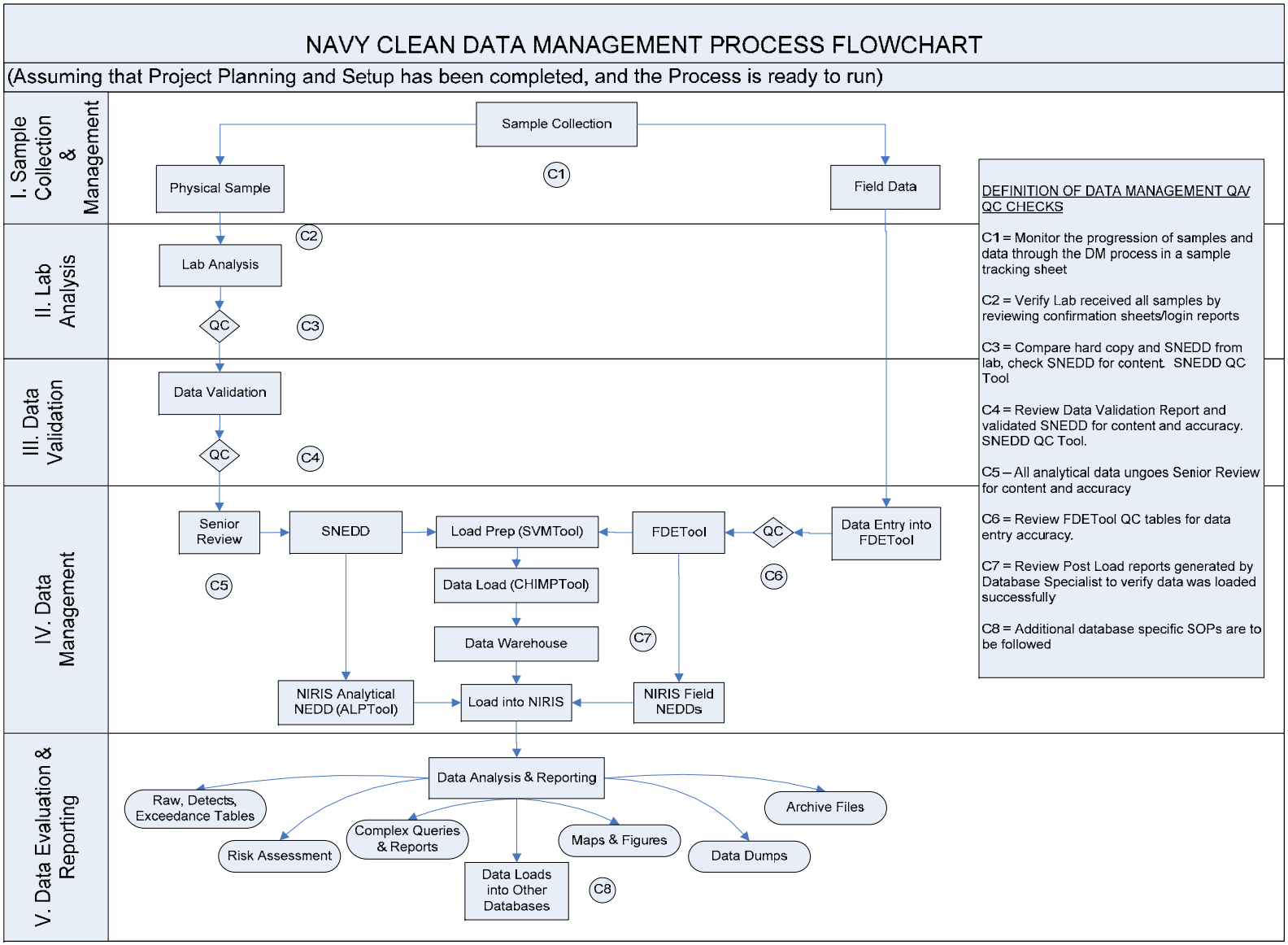


FIGURE 2
DBMS PROCESS

SECTION 4

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.

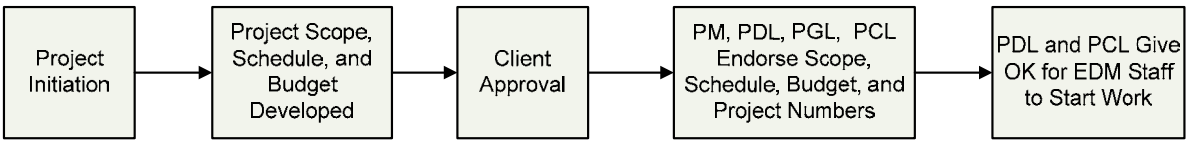


FIGURE 3
PROJECT PLANNING

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.

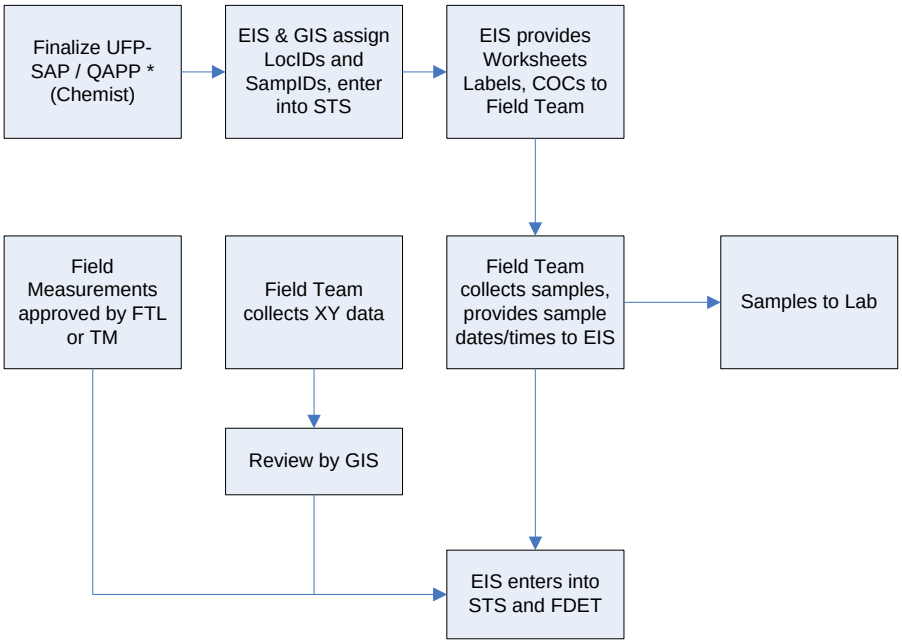


FIGURE 4
FIELD SAMPLING

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		

Facility:

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

Site/AOC/SWMU Number – Sequential Number:

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)

QC and IDW Stations
Site ID (First Segment) followed by –QC or -IDW

Station Type:

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

Station Number:
Sequential Station Number (i.e., 01, 02, 03…)

Modifier (used selectively):
D = Deep monitoring well
S = Shallow monitoring well

Example Station IDs:

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	AANNN$_A$	A	NNNN$_A$
Notes: "A"= alphabetic "N"= numeric			

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

Site/AOC/SWMU – Sequential Number:

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)

Sample Type:
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

Station Number:
Sequential Number (e.g., 001, 002, 003)

Modifier (used selectively):
D = Deep monitoring well
S = Shallow monitoring well
P = Duplicate

Depth:

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…

Sample Number:

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

Qualifier Codes:
TB = Trip Blank
FB = Field Blank
EB = Equipment Blank
WQ = Source Blank
WS = Waste Char. Soil
WW = Waste Char. Water

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…

Example Sample IDs:

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.

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.

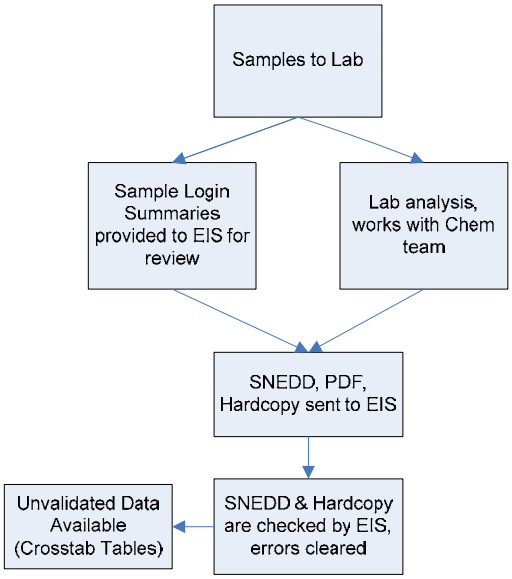


FIGURE 5
LABORATORY ANALYSIS

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, hyrdography, 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

Step 1

Planning Phase

- Staffing Schedules
- Kickoff Meeting – Include the EIS & PC
- Project Instructions (PIs)
  - Sample Nomenclature provided in table
  - Reviewed by DMC (Chelsea Bennet) or Database Specialist

Step 2A

Sample Collection

- Daily collection and shipments of samples
- One COC/cooler; One FedEx slip/cooler
- Coordinate w/ EIS for tracking & Lab notification
- GPS conducted (if applicable)

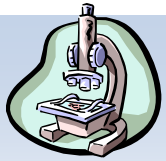
Step 2B

Sample Tracking

- EIS cross checks COC against PIs
- Also reviews lab confirmation sheets to verify all samples were received and in appropriate condition

Step 3

Lab Analysis



- Standard 28-day unless otherwise arranged
- EIS reviews data for accuracy and works with lab to resolve discrepancies
- EIS tracks schedule and keeps PM informed
- EIS inputs STSP information from Log Books
- EIS can generate Unvalidated Raw and Detects Data Tables

Step 4

Data Validation

- PC reviews all data for accuracy against the PIs
- PC sends data from lab to Data Validator
- Delays may occur if there is missing data or data is late from the lab\
- EIS can generate Validated Raw and Detects Data Tables

Step 5

Data Load

- PCL sends data to Database Specialist to be loaded into the Data Warehouse (DW)
- (Sometimes this involves assistance from PM, FTL, PC, and/or EIS)

Step 6

Quality Assurance/ Quality Control

- EIS & PC are notified that data is loaded
- EIS verifies info loaded is correct (Sample, Station, Analyses, Result)
- EIS then helps decide whether info needs to be updated or not
- File and archive all Lab and DV deliverables

Step 7

Report Generation

- Raw, Detects, Exceedance Reports
- Data Requests
- Exceedance Reports (criteria needed prior to this step and selected by PM)
- Human Health Risk Assessment
- Eco Risk Assessment

End of our Sample's Life?

- Data may be used in reports, posted on web, put into GIS, etc
- In that regard, a sample's life doesn't really ever end!
- Hopefully our sample had no exceedances and everyone is happy.

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.

CH2M HILL SNEDD Format			
Field Name	**Field Format**	**REQ**	**Field Description**
Dilution	N10,2	R	Dilution factor used. Default value is 1 (e.g. 10)
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.