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FINAL TIER II SAMPLING AND ANALYSIS PLAN FOR REMEDIAL INVESTIGATION AT
UNEXPLODED ORDNANCE SITE UXO-23 D-9 SKEET RANGE MCB CAMP LEJEUNE NC
10/1/2012
CH2M HILL

An aerial photograph of a fleet of ships at sea, including several large oil tankers and smaller vessels, moving in a line across the blue ocean. The ships are leaving white wakes behind them.

Final
Tier II Sampling and Analysis Plan

Remedial Investigation, UXO-23 D-9 Skeet Range, ASR 2.82

Marine Corps Installations East-
Marine Corps Base Camp Lejeune
Jacksonville, North Carolina

October 2012

Contract No. N62470-11-D-8012 | CTO-WE40

prepared by **CH2MHILL.**

Title and Approval Page

[\(UFP-QAPP Manual Section 2.1 – Worksheet #1\)](#)

Final
Tier II Sampling and Analysis Plan
Remedial Investigation, UXO-23
D-9 Skeet Range, ASR 2.82
Marine Corps Installations East-Marine Corps Base Camp Lejeune
Jacksonville, North Carolina

Contract Task Order WE40
October 2012

Prepared for:
Department of the Navy
Naval Facilities Engineering Command
Mid-Atlantic

Under the
NAVFAC CLEAN 8012 Program
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Prepared by:



Charlotte, North Carolina

Review Signature:

G. Brett Doerr

Digitally signed by G. Brett Doerr
DN: cn=G. Brett Doerr, o=CH2M HILL, ou,
email=brett.doerr@ch2m.com, c=US
Date: 2012.10.15 13:38:19 -04'00'

G. Brett Doerr/CLEAN Program Quality Assurance Manager Date

10-15-12

Tegwyn Williams, L.G./Senior Technical Consultant Date

10-15-12

Keri Hallberg, P.E./Project Manager Date



Executive Summary

CH2M HILL has prepared this document under the Naval Facilities Engineering Command (NAVFAC) Mid-Atlantic Division, Comprehensive Long-term Environmental Action—Navy (CLEAN) 8012 Contract No. N62470-11-D-8012, Contract Task Order (CTO) WE40, in accordance with the Navy'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 uses. This UFP-SAP supports the field sampling activities associated with the Remedial Investigation (RI) at the D-9 Skeet Range, also referred to as unexploded ordnance (UXO) Site 23, at Marine Corps Installations East-Marine Corps Base Camp Lejeune (MCIEAST-MCB CAMLEJ), as shown in **Figure 1**.

UXO-23 is located north of Birch Street and west of Holcomb Boulevard and encompasses 200 acres in the Mainside area of the Base. The UXO-23 Skeet Range began operation in 1953 (United States Army Corps of Engineers [USACE], 2001) and was closed in July 2011 due to a planned military construction (MILCON) project covering approximately 100 acres north of Hadnot Point and south of Wallace Creek. It is estimated that several hundred thousand rounds were fired at the Skeet Range each year (Singhas, 2007). The weapons used at the Skeet Range included 12, 16, 20, 28, and 410-gauge shot guns and the sizes of lead shot used included 7.5, 8, 8.5, and 9 millimeter (mm). The types of clay pigeons used on the Skeet Range included White Flyer clays and biodegradable targets (White Flyer, 2007). Environmental investigations have been ongoing in the area of the Skeet Range since 2007 in support of the MILCON project. The associated documents are listed below:

- Focused Site Inspection (SI) (CH2M HILL, 2008b)
- Focused Preliminary Assessment/Site Investigation (PA/SI) (CH2M HILL, 2010a)
- Wallace Creek Expanded SI (CH2M HILL, 2010b)
- Engineering Evaluation/Cost Analysis (EE/CA) (CH2M HILL, 2012a)
- Soil Removal Non-Time-Critical Removal Action (NTCRA), Action Memorandum (CH2M HILL, 2012b)

Based on the results of these environmental investigations, five areas and associated media of UXO-23 have been identified for further characterization (**Figure 2**):

- Polycyclic aromatic hydrocarbons (PAHs) in **North Area** shallow groundwater
- Lead in groundwater in the **theoretical shot fall zone**
- Lead in surface soil within in the **South Area** (Grid D10)
- Lead in **Bearhead Creek** sediment and drainage features
- Lead and PAHs in **Beaver Dam Creek** sediment, surface water, and drainage features

The Skeet Range was closed in July 2011. An NTCRA for *in situ* stabilization with excavation and offsite disposal of lead- and PAH-impacted soil within the theoretical shot fall zone and nearby drainages to Beaver Dam Creek is scheduled for completion in 2012. The activities described in this UFP-SAP will not commence until the completion of the NTCRA.

This UXO-23 RI will be conducted: (1) to characterize potential lead and/or PAH impacts associated with the North Area and theoretical shot fall zone groundwater, Bearhead Creek sediment, and Beaver Dam Creek surface water and sediment; (2) to confirm the results of the XRF screening conducted during previous investigations within Grid D10(CH2M HILL 2012a); (3) to evaluate potential risks to human health and the environment posed by any identified impacts; and (4) to conduct additional sampling and/or delineation based on these results if needed.

In addition, based on the results of the NTCRA, additional investigation may be required to further delineate lead and PAH impacts in soil located within the theoretical shotfall zone. Prior to conducting additional investigation activities, an amendment to this UFP-SAP will be prepared.

Field activities to be completed under this UFP-SAP will include:

- Site walk to identify any potential dumping areas or unnatural disturbances
- Vegetation clearance
- Utility locating
- Ecological surveys of Beaver Dam Creek and Bearhead Creek to provide habitat and water quality information for use in the ecological risk assessment (ERA) and to serve as a field reconnaissance to help identify sediment deposits along each creek that are ideal for sampling.
- Installation and groundwater sampling of up to 10 surficial aquifer monitoring wells in the North Area (**Figure 2**); samples to be analyzed for PAHs
- Installation and groundwater sampling of 8 surficial aquifer monitoring wells and 1 upper Castle Hayne aquifer monitoring well within and downgradient of the theoretical shot fall zone (**Figure 2**); samples to be analyzed for lead
- Collection of up to 50 sediment samples along Bearhead Creek and drainages; samples to be analyzed for lead, 10 of which will also be analyzed for TOC
- Collection of 6 surface water samples along Beaver Dam Creek and analysis for lead and PAHs
- Collection of 16 sediment samples along Beaver Dam Creek and drainages; samples to be analyzed for lead, PAHs, and total organic carbon (TOC)
- Collection of 2 confirmation surface soil samples within Grid D10; samples to be analyzed for lead
- Surveying of sample locations
- Investigation-derived waste (IDW) disposal
- Collection of additional groundwater, surface water, and sediment samples to further delineate the nature and extent of contamination if needed

The laboratory information cited in this SAP is specific to TriMatrix Laboratories. If additional laboratory services are requested requiring modification to the existing SAP, revised SAP worksheets will be submitted to the Navy and regulatory agencies for approval.

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Acronyms and Abbreviations

AM	Activity Manager
NAWQC	National Ambient Water Quality Criteria
ARAR	applicable and relevant and appropriate requirement
ASR	Archives Search Report
bgs	below ground surface
BTVs	background threshold values
CA	corrective action
COCs	chemicals of concern
COPC	contaminant of potential concern
CSM	conceptual site model
CTO	Contract Task Order
DL	detection limit
DO	dissolved oxygen
DoD	Department of Defense
DoD ELAP	Department of Defense Environmental Laboratory Accreditation Program
DPT	direct push technology
DQI	data quality Indicator
DV	data validation
EE/CA	Engineering Evaluation/Cost Analysis
EIS	Environmental Information Specialist
ERA	ecological risk assessment
ERS	ecological risk screening
ESV	ecological screening value
ft bgs	feet below ground surface
ft BTOC	feet below top-of-casing
ft msl	feet above mean sea level
ft/ft	foot per foot
FQM	Field Quality Manager
FTL	Field Team Leader
GC-MS	gas chromatograph/mass spectrometer
GW	groundwater
HHRA	human health risk assessment
HHRS	human health risk screening
HSM	Health & Safety Manager
HSP	Health and Safety Plan
ICAL	initial calibration
ID	inner diameter
IDW	investigation-derived waste
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LOD	limit of detection
LOQ	limit of quantitation

µg/L	micrograms per liter
mg/L	milligrams per liter
mg/kg	milligrams per kilogram
mm	millimeter
MCCS	Marine Corps Community Services
MCIEAST-MCB CAMLEJ	Marine Corps Installations East-Marine Corps Base Camp Lejeune
MCL	Maximum Contaminant Level
MILCON	military construction
MPC	measurement performance criteria
MS/MSD	matrix spike/matrix spike duplicate
mV	millivolts
NCAC	North Carolina Administrative Code
NCDENR	North Carolina Department of Environment and Natural Resources
NCGWQS	North Carolina Administrative Code 2L Title 15A, Subchapter 2L, Groundwater Quality Standards
NC SSLs	North Carolina Soil Screening Levels
NIRIS	Navy Installation Restoration Information Solution
NJDEP	New Jersey Department of Environmental Protection
NRWQC	National Recommended Water Quality Criteria
NTCRA	Non-Time-Critical Removal Action
NTR	Navy Technical Representative
ORP	oxidation reduction potential
PAHs	polycyclic aromatic hydrocarbons
PAL	Project Action Limit
PA/SI	Preliminary Assessment/Site Inspection
PC	Project Chemist
PDM	Project Data Manager
PM	Project Manager
POC	point of contact
PQL	practical quantitation limit
PVC	polyvinyl chloride
QA	Quality Assurance
QAO	Quality Assurance Officer
QAM	Quality Assurance Manager
QAPP	Quality Assurance Project Plan
QC	Quality Control
QL	Quantitation Limit
QSM	Quality Systems Manual
RI	Remedial Investigation
RPD	relative percent difference
RPM	Remedial Project Manager
RSL	Regional Screening Level
SAP	Sampling and Analysis Plan
SC	Safety Coordinator
SI	Site Inspection
SOP	Standard Operating Procedure

STC	Senior Technical Consultant
SVOC	Semivolatile Organic Compound
SW	surface water
TAT	turnaround time
TBC	to be considered
TBD	to be determined
TDS	total dissolved solids
TOC	total organic carbon
UFP	Uniform Federal Policy
USACE	United States Army Corps of Engineers
USCS	Unified Soil Classification System
USEPA	U.S. Environmental Protection Agency
UXO	unexploded ordnance
VOC	volatile organic compound
WQPs	water quality parameters
XRF	X-ray fluorescence

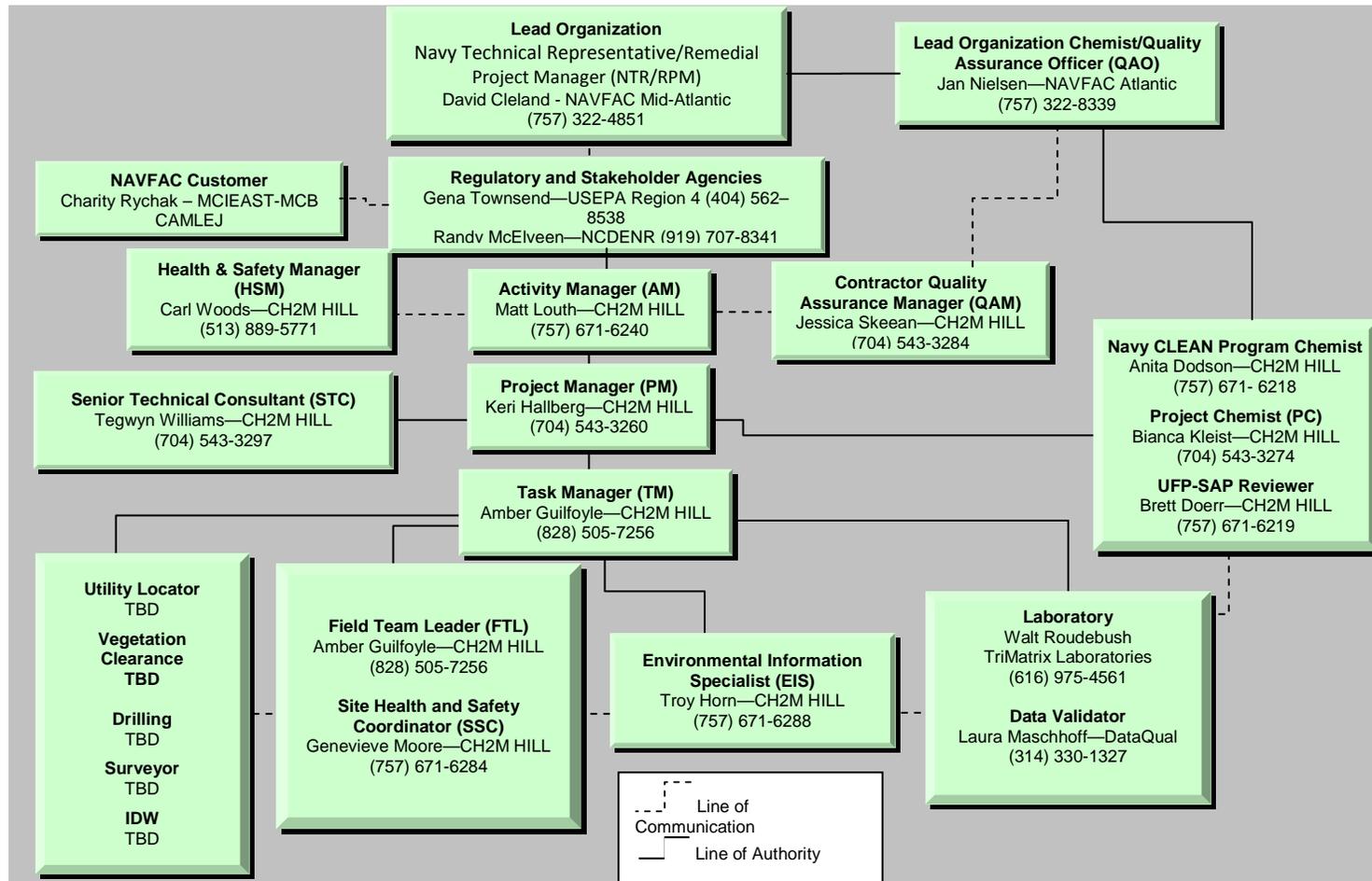
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1 Project Organization

(UFP-QAPP Manual Section 2.4.1 – Worksheet #3, #4, #5, #6, #7, and #8 Elements)

1.1 Project Organizational Chart

(UFP-QAPP Manual Section 2.4.1 – Worksheet #5)



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1.2 Communication Pathways

[\(UFP-QAPP Manual Section 2.4.2 – Worksheet #6\)](#)

The communication pathways for the Sampling and Analysis Plan (SAP) are shown below.

Communication Drivers	Responsible Affiliation	Name	Phone Number and/or E-mail	Procedure, Pathway, etc.
Communication with Navy (lead agency)	Navy Technical Representative (NTR)/ Remedial Project Manager (RPM)	Dave Cleland	david.t.cleland@navy.mil (757) 322-4851	Primary point of contact (POC) for Navy; can delegate communication to other internal or external POCs. RPM will notify the U.S. Environmental Protection Agency (USEPA) and North Carolina Department of Environment and Natural Resources (NCDENR) via email or telephone within 24 hours of field changes affecting the scope or implementation of the design. Navy will have 30 days for SAP review. All sampling data will be presented and discussed during partnering meetings.
Communication with USEPA Region 4	USEPA Region 4 RPM	Gena Townsend	townsend.gena@epa.gov (404) 562-8538	Primary POC for USEPA; can delegate communication to other internal or external POCs. Upon notification of field changes, USEPA will have 24 hours to approve or comment on the field changes. All data results will be presented and discussed during partnering meetings.
Communication with NCDENR	NCDENR RPM	Randy McElveen	Randy.McElveen@ncdenr.gov (919) 707-8341	Primary POC for NCDENR; can delegate communication to other internal or external POCs. Upon notification of field changes, NCDENR will have 24 hours to approve or comment on the field changes. All data results will be presented and discussed during partnering meetings.
Communication regarding overall project status and implementation and primary POC with Navy RPM, USEPA, and NCDENR	CH2M HILL AM	Matt Louth	Matt.Louth@ch2m.com (757) 671-8311	Oversees project and will be informed of project status by the PM. If field changes occur, the AM will work with the Navy RPM to communicate field changes to the team via email within 24 hours. All data results will be communicated to the project team during the first partnering meeting following data receipt.
Technical communications for project implementation, as well as data interpretation	CH2M HILL Senior Technical Consultant (STC)	Tegwyn Williams	tegwyn.williams@ch2m.com (704) 543-3297	Team members will contact the STC regarding questions/issues encountered in the field, input on data interpretation, etc., as needed. The STC will have 24 hours to respond to technical field questions as necessary. Additionally, the STC will review the data (as necessary) prior to partnering team discussion and reporting review.

Communication Drivers	Responsible Affiliation	Name	Phone Number and/or E-mail	Procedure, Pathway, etc.
Quality issues during project implementation and data interpretation	CH2M HILL Quality Assurance Manager (QAM) for MCIEAST-MCB CAMLEJ	Jessica Skeean	jessica.skeean@ch2m.com (704) 543-3284	Team members will contact the QAM regarding quality issues during project implementation. The QAM will report to the AM, the CH2M HILL Program Quality Manager, and the NAVFAC Atlantic Quality Assurance Officer (QAO).
Communications regarding project management and implementation	PM	Keri Hallberg	keri.hallberg@ch2m.com (704) 543-3260	Responsible for forwarding all information and materials about the project to the Navy, AM, QAM, and the STC as necessary. POC for field sampling team.
Assists with communications regarding project management and implementation	TM	Amber Guilfoyle	amber.guilfoyle@ch2m.com (828) 505-7256	Assists PM with communication with project team and the STC as necessary. Additional POC for field sampling team.
Health and Safety (H&S)	CH2M HILL Safety Coordinator (SC)	Genevieve Moore	genevieve.moore@ch2m.com (757) 671-6284	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 misses to the PM.
SAP changes in field	Field Quality Manager (FQM)	Amber Guilfoyle	amber.guilfoyle@ch2m.com (828) 505-7256	Prepares documentation of deviations from the SAP in the field log book and immediately notifies the PM. Deviations will be made only with approval from the PM.
Quality Assurance Project Plan (QAPP) Field Changes/ Field Progress Reports	FQM	Amber Guilfoyle	amber.guilfoyle@ch2m.com (828) 505-7256	Prepares documentation of field activities and SAP deviations (made with the approval of the AM and/or QAO) in field log books; provides daily progress reports to the PM.
Data tracking from field collection to database upload	Project Data Manager (PDM)	Troy Horn	troy.horn@ch2m.com (757) 671-6288	Tracking data from sample collection through database upload.
Reporting Laboratory Data Quality Issues	Laboratory PM/TriMatrix Laboratories	Walt Roudebush	roudebushw@trimatrixlabs.com (616) 975-4561	All quality assurance (QA)/quality control (QC) issues with project field samples will be reported within 1 day to the Project Chemist (PC) by the laboratory.
Reporting Data Validation (DV) Issues	Data Validator/DataQual	Laura Maschhoff	dataqual@charter.net (314) 330-1327	The CH2M HILL PDM will be copied on all communications pertaining to DV issues and resubmissions from the laboratory. The DV report will be due within 14 calendar days of data receipt.
Field and analytical corrective actions (CAs)	PC	Bianca Kleist	bianca.kleist@ch2m.com (704) 543-3274	CAs for field and analytical issues will be determined by the FTL and/or the PC and reported to the PM within 4 hours.

Communication Drivers	Responsible Affiliation	Name	Phone Number and/or E-mail	Procedure, Pathway, etc.
Release of Analytical Data	PC	Bianca Kleist	bianca.kleist@ch2m.com (704) 543-3274	No analytical data can be released until validation of the data is completed and has been approved by the PC. The PC will review analytical results within 7 days of receipt for release to the project team. Should analytical laboratory issues affect data usability by rendering a significant amount of rejectable or unusable data, such that the project completeness goal cannot be attained, the PC will notify the project team, including the Navy RPM and Navy QAO.
Field CAs	FQM	Amber Guilfoyle	amber.guilfoyle@ch2m.com (828) 505-7256	Field and analytical issues requiring CA will be determined by the FQL and TM or PM; the PM will ensure QAPP requirements are met by field staff.
	TM	Amber Guilfoyle	amber.guilfoyle@ch2m.com (828) 505-7256	
	PM	Keri Hallberg	keri.hallberg@ch2m.com (704) 543-3260	

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2 Project Approach

[\(UFP-QAPP Manual Section 2.5.1 – Worksheet #9, #10, #11, #12, #17 Elements\)](#)

2.1 Project Planning Session Participants Sheet

[\(UFP-QAPP Manual Section 2.5.1 – Worksheet #9\)](#)

Project Name:		UXO-23 D-9 Skeet Range Remedial Investigation (RI)		Site Name:	MCIEAST-MCB CAMLEJ UXO-23, D-9 Skeet Range
Projected Date(s) of Sampling:		October/November 2012		Site Location:	MCIEAST-MCB CAMLEJ, North Carolina
Project Manager:		Keri Hallberg			
Date of Session:		January 19, 2012			
Scoping Session Purpose:		UXO-23 D-9 Skeet Range RI Approach and Scoping			
Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Dave Cleland	Navy RPM	NAVFAC Mid-Atlantic	(757) 322-4851	david.t.cleland@navy.mil	RPM
Bryan Beck	Navy RPM	NAVFAC Mid-Atlantic	(757) 322-4734	bryan.k.beck@navy.mil	RPM
Charity Rychak	MCIEAST-MCB CAMLEJ RPM	MCIEAST-MCB CAMLEJ EMD	(910) 451-9385	charity.rychak@usmc.mil	Base Rep
Gena Townsend	EPA RPM	USEPA Region 4	(404) 562-8538	townsend.gena@epa.gov	EPA Rep
Randy McElveen	NCDENR RPM	NCDENR	(919) 707-8341	randy.mcelveen@ncdenr.gov	State Rep
Matt Louth	CH2M HILL AM	CH2M HILL	(757) 671-6240	matt.louth@ch2m.com	Contractor Rep
Kim Henderson	CH2M HILL AM	CH2M HILL	(757) 671-6231	kimberly.henderson@ch2m.com	Contractor Rep
Shaun Whitworth	Osage AM	Osage	(757) 440-0400	swhitworth@osageva.com	Contractor Rep

Comments/Decisions:

Consensus was reached on the UXO-23 RI sampling scheme that was presented during the January 19, 2012 scoping session, as outlined below. During preparation of this SAP, the number of surface water samples to be collected along Beaver Dam Creek decreased from 16 to 6, and the analysis of total organic carbon (TOC) in 10 sediment samples along Bearhead Creek was added. TOC samples were added to characterize the TOC along the stretch of Bearhead Creek. TOC serves as an indicator of metals and PAH binding and is used in the Ecological Risk Assessment (ERA) food chain model. The number of surface water samples collected from Beaver Dam Creek was decreased from 16 to 6; 6 surface water samples along this stretch of Beaver Dam Creek are sufficient to confirming the presence or absence of contamination.

Issue/Impacted Medium	Scoping Session RI Approach	Variations from the Original Approach
<u>North Area Groundwater</u> <i>Polycyclic aromatic hydrocarbons (PAHs) in shallow groundwater</i>	<p>Confirm presence of PAHs</p> <p>Installation and groundwater sampling of up to 10 surficial aquifer monitoring wells as follows: Install 2 shallow monitoring wells. If PAHs detected at similar concentrations, install up to 8 additional shallow monitoring wells.</p>	None
<u>South Area Groundwater</u> <i>Lead in shallow groundwater</i>	<p>Establish baseline for lead</p> <p>Install 8 surficial aquifer monitoring wells and 1 upper Castle Hayne aquifer monitoring well. Conduct future monitoring post-Non Time Critical Removal Action (NTCRA)</p>	None
<u>Bearhead Creek and Drainages</u> <i>Lead in sediment</i>	<p>Confirm ecological risk</p> <p>Conduct field survey Collect up to 50 sediment samples for lead analysis and collect water quality parameters</p>	Add TOC analysis to 10 sediment samples for inclusion in the ERA food chain model.
<u>Beaver Dam Creek and Drainages</u> <i>Lead and PAHs in upstream soil</i>	<p>Delineate lead and PAH impacts</p> <p>Conduct field survey Collect up to 16 sediment and surface water samples for lead, PAHs, and TOC, and collect water quality parameters</p>	Decrease number of surface water samples from 16 to 6; 6 samples are sufficient for determining the presence or absence of contamination.

2.2 Conceptual Site Model

[\(UFP-QAPP Manual Section 2.5.2 – Worksheet #10\)](#)

This section provides a summary of site background and key elements of the conceptual site model (CSM), followed by a narrative description of the problems to be addressed.

2.2.1 Background

MCIEAST-MCB CAMLEJ

MCIEAST-MCB CAMLEJ is a 156,000-acre military installation located in Onslow County, North Carolina, adjacent to the southern side of the City of Jacksonville (**Figure 1**). In 1942, the Base was commissioned as a training area to prepare Marines for combat. Today the mission of MCIEAST-MCB CAMLEJ is to maintain combat-ready units for expeditionary deployment. The MCIEAST-MCB CAMLEJ complex consists of six geographical locations under the jurisdiction of the Base command. These areas include Camp Geiger, Montford Point, Courthouse Bay, Mainside, the Greater Sandy Run Area, and the Rifle Range Area. The Base provides housing, training facilities, and logistical support for Fleet Marine Force units and other assigned units.

UXO-23, D-9 Skeet Range

UXO-23 is the former D-9 Skeet Range and is also referred to as Archives Search Report (ASR) site number 2.82 in the Range Identification and Preliminary Range Assessment (United States Army Corps of Engineers [USACE], 2001). UXO-23 is located north of Birch Street and west of Holcomb Boulevard and encompasses approximately 200 acres in the Mainside area of the Base (**Figure 2**) (CH2M HILL, 2011c). The Skeet Range began operation in 1953 and was closed in July 2011 due to a planned military construction (MILCON) project covering approximately 100 acres north of Hadnot Point and south of Wallace Creek. The MILCON project consists of constructing barracks support buildings (e.g., mess hall, fitness center) and parking areas.

The Skeet Range was one of four live-fire ranges within a training area known as Area D. The range was used for recreational shooting and was operated by the Marine Corps Community Services (MCCS). The weapons accommodated at the Skeet Range included 12, 16, 20, 28, and 410-gauge shot guns and the sizes of lead shot used included 7.5 millimeter (mm), 8 mm, 8.5 mm, and 9 mm. The types of clay pigeons used on the Skeet Range included White Flyer clays and biodegradable targets (White Flyer, 2007). The fields were raked every 6 months to clear the clay pieces, which were then disposed of offsite. It is estimated that several hundred thousand rounds were fired at the Skeet Range each year (Singhas, 2007) from 10 firing points.

2.2.2 Historical Site Investigations

For investigation purposes, UXO-23 was divided into three areas: the theoretical shot fall zone, the North Area (north of Bearhead Creek), and the South Area (south of Bearhead Creek, excluding the theoretical shot fall zone). This RI will be conducted in the North Area, the South Area, the theoretical shot fall zone, and along Bearhead and Beaver Dam Creeks, which flow beyond the MILCON project boundaries. Investigations in support of the MILCON project have been ongoing in the area of UXO-23 since 2007 (CH2M HILL, 2011c).

A summary of historical investigations is provided in **Table 1**.

TABLE 1
 Summary of Previous Investigations, UXO-23

Investigation/Phase	Date	Reference	Activities
Focused Site Inspection	2007 - 2008	CH2M HILL, 2008b	A field investigation was conducted to evaluate the distribution of lead within the area south of Bearhead Creek. Surface soil samples were field screened using X-ray fluorescence (XRF) to identify potential lead impacts. Soil and groundwater samples were also collected and analyzed for lead. Lead concentrations exceeded regulatory screening criteria for surface soil and groundwater in the theoretical shot fall zone. Additional investigation of surface soils and groundwater and a human health risk assessment (HHRA) were recommended.
Focused Preliminary Assessment/Site Inspection	2008 - 2010	CH2M HILL, 2010a	The Focused PA/SI was conducted to assess potential impacts to human health and the environment in the area north of Bearhead Creek. Soil, groundwater, surface water, and sediment samples were collected and were analyzed for perchlorate, PAHs, and metals. Potentially unacceptable human health risks to future residents from PAHs in groundwater north of Bearhead Creek and potentially unacceptable ecological risks from metals and PAHs in Bearhead Creek were identified.
Wallace Creek Expanded SI	2009 - 2010	CH2M HILL, 2010b	Additional soil sampling was conducted in the theoretical shot fall zone to assess the horizontal and vertical extents of lead impacts and to investigate potential impacts to drainage features that convey surface water runoff from the theoretical shot fall zone. Based on elevated concentrations of lead in surface soil within the theoretical shot fall zone, a removal action for lead-contaminated soil was recommended once the Skeet Range was closed.
Engineering Evaluation/Cost Analysis (EE/CA)	2011-2012	CH2M HILL, 2012a	The EE/CA evaluated alternatives for the Non-Time-Critical Removal Action (NTCRA) to address potentially unacceptable risks from lead and PAHs in the theoretical shot fall zone. The alternatives were no action, excavation with offsite disposal, excavation with particle separation and backfill, excavation with stabilization and offsite disposal, and In-situ stabilization.
Action Memorandum	2011-2012	CH2M HILL, 2012b	An Action Memorandum was prepared to document in-situ stabilization with excavation and offsite disposal of lead- and PAH-impacted soil within the theoretical shot fall zone as the selected alternative.
Non-Time-Critical Removal Action	2012	Osage	The NTCRA was initiated in April 2012 is currently ongoing. At the writing of this SAP, approximately 300 tons of surface soil from the three drainages (D, E, and F) connecting to the southern portion of the theoretical shot fall zone and located within the MILCON area of UXO-23 (Figure 2) had been removed and confirmation soil samples had been collected for PAH and lead analysis. Analytical results are currently pending. The NTCRA is scheduled for completion in 2012.

Conceptual Site Model

Site Setting

UXO-23 encompasses approximately 200 acres and is approximately 60 percent wooded. There are cleared areas near the firing positions, along the power line corridor that runs north-south through the site, and around developed portions of UXO-23. Developed areas of UXO-23 include parachute towers; a power line right-of-way in the eastern portion of the site; and a K9 unit facility and a cemetery in the western portion of the site.

UXO-23 is bisected by the tidally influenced Bearhead Creek, which flows from east to west across the site. Bearhead Creek flows into Wallace Creek, which discharges into the tidally influenced New River. Drainage

features connect the theoretical shot fall zone of the Skeet Range with Bearhead Creek and are labeled A through F in **Figure 2**. Several smaller unnamed drainage features are also present throughout UXO-23.

Beaver Dam Creek flows from east to west into Wallace Creek south of UXO-23. Drainages B, C, D, E, and F discharge into Beaver Dam Creek from UXO-23 (**Figure 2**). Drainages D, E, and F were excavated during the soil removal NTCRA in 2012 and analytical results of confirmation samples collected for PAH and lead analysis are currently pending. Based on a field reconnaissance that occurred in April 2012, the stretch of Beaver Dam Creek to be investigated during this RI does not appear to be tidally influenced.

Site Geology and Hydrogeology

Site-specific geologic information for UXO-23 is limited to the maximum depth of intrusive investigation, roughly 24 feet below ground surface (bgs). Shallow soils to the north of Bearhead Creek generally consist of silty sands or sandy silts, extending to depths of 7 to 16 feet bgs. The silty deposits are underlain by a poorly graded medium- or coarse-grained sand that extends to at least 24 ft bgs, which has also been reported to underlie the shallow soils south of Bearhead Creek. The shallow soils to the south of Bearhead Creek are typically characterized by clayey sands and sandy clays, ranging in thickness from 4 to 13 feet.

Site-specific hydrogeological information was derived from the five temporary groundwater monitoring wells installed within the unconfined, surficial aquifer as part of the Focused PA/SI. Water level measurements were collected from the temporary monitoring wells in October 2008 and used to estimate the potentiometric surface of the water table, as shown in **Figure 3**. The October 2008 data suggest that shallow groundwater generally flows toward Bearhead Creek. The horizontal hydraulic gradient for the surficial aquifer north of Bearhead Creek was calculated to be approximately 0.002 foot per foot (ft/ft) and the horizontal hydraulic gradient for the surficial aquifer south of Bearhead Creek was calculated to be approximately 0.006 ft/ft (CH2M HILL, 2010b). Depth to groundwater in the area north of Bearhead Creek is anticipated to be approximately 5 to 15 feet bgs.

Nature and Extent of Contamination

Based on the results of the previous phased investigations conducted at UXO-23, the chemicals of concern (COCs) and impacted media posing potentially unacceptable risk are as follows:

- PAHs in shallow groundwater within the North Area (**Figure 4**)
- Lead and PAHs in soil in the theoretical shot fall zone (NTCRA area **Figure 5**)
- Lead in surface soil in Grid D10, located in the South Area (**Figure 5**)
- Lead in shallow groundwater in the theoretical shot fall zone (**Figure 4**)
- Lead in Bearhead Creek sediment and soil from Drainage A (**Figure 5**)

Receptors

Potential receptors include residents, military personnel, visitors, trespassers, industrial workers, and construction workers. Current receptors may come in contact with surface soil, subsurface soil, surface water, sediment, and groundwater. Exposure routes may include incidental ingestion, dermal contact, or particulate inhalation; however, shallow groundwater is not currently and is not likely to be used as a potable water supply at UXO-23 or the Base.

Potential ecological receptors are also present at the site and may include plants, invertebrates, fish, mammals, reptiles, and birds.

2.3 Data Quality Objectives/Systematic Planning Process Statements

[\(UFP-QAPP Manual Section 2.6.1 – Worksheet #11\)](#)

2.3.1 Problem Statement

Previous investigations identified potentially unacceptable human health risks to future residents from exposure to PAHs in groundwater in the North Area, potentially unacceptable risks to environmental receptors due to exposure to lead in the sediment of Bearhead Creek (CH2M HILL, 2010a), and potentially unacceptable risks to human health and the environment from exposure to lead and PAHs in surface soil in the theoretical shot fall zone (CH2M HILL, 2010b). A NTCRA was initiated following the Skeet Range closure and is currently ongoing at the site to address lead and PAHs in surface soil (**Figure 5**).

Based on results of previous investigations and activities, the UXO-23 RI will be conducted to: (1) characterize potential lead and/or PAH impacts associated with UXO-23 North Area and theoretical shot fall zone groundwater, Bearhead Creek sediment, and Beaver Dam Creek surface water and sediment; (2) to evaluate lead concentrations in surface soil in South Area Grid D10, which is not slated for removal as part of the NTCRA and exhibited elevated XRF results; (3) evaluate potential risks to human health and the environment posed by any identified impacts; and (4) conduct additional sampling based on these results if needed. Proposed sampling locations are depicted in **Figure 6** and **Figure 7**. The samples will be analyzed for the following constituents:

Sample Media	Location	Analyte
Groundwater	Theoretical Shot Fall Zone	Lead
	North Area	PAHs
Surface Water	Beaver Dam Creek	PAHs and Lead
Sediment	Beaver Dam Creek	PAHs, Lead, and TOC
	Bearhead Creek	Lead and TOC
Surface Soil	South Area	Lead

The rationale for the media and locations to be sampled and the analytical protocol is provided below and in Section 2.5. The analytical results of the RI field activities will be used to complete an HHRA and an ERA.

2.3.2 Environmental Questions to be Answered

The purpose of this RI is to refine the assessment of groundwater quality in the North Area and the theoretical shot fall zone and sediment within Bearhead Creek and upstream of UXO-23 boundaries, and to assess the sediment and surface water quality south of UXO-23 in Beaver Dam Creek.

Are PAHs present in North Area groundwater at concentrations above background and regulatory screening criteria (Regional Screening Level [RSLs], North Carolina Administrative Code 2L Title 15A, Subchapter 2L, Groundwater Quality Standards [NCGWQS], and Maximum Contaminant Levels [MCLs])? If so, what is the extent of PAH impacts?

The PAH concentrations detected in the North Area groundwater during the Focused PA/SI (CH2M HILL, 2010a) were above regulatory screening criteria but were qualified as estimated detections. Therefore, this question will be addressed using a phased approach. The first phase will consist of installing two monitoring wells (**Figure 6**) and collecting groundwater samples from the surficial aquifer in the North Area for an expedited analysis of PAHs.

If the presence of PAHs is confirmed by the raw analytical data, up to eight additional surficial aquifer monitoring wells will be installed in the North Area and groundwater samples will be collected from the newly installed wells to assess the extent of potential PAH impacts. The rationale for the number and locations of wells and analytical protocol is provided in Section 2.5.

If the groundwater analytical results of these 10 wells indicate that the extent of PAH impacts is not delineated, additional monitoring wells may be installed. Additional monitoring wells may be installed until the extent of PAH impacts can be reasonably estimated.

Do PAH concentrations in North Area groundwater present potentially unacceptable risks to human and ecological receptors?

This question will be addressed by performing human health and ecological risk assessments using the new groundwater analytical data collected in the North Area. Previous groundwater data were collected from temporary wells and these locations are the basis for the proposed permanent monitoring well locations. Only groundwater data from the new permanent monitoring wells will be used in the risk assessments.

What is the extent of lead impacts in groundwater in the theoretical shot fall zone that exceed background and regulatory screening (RSLs, NCGWQS, and MCLs)?

This question will be addressed by installing eight shallow and one deep monitoring wells within or downgradient from the theoretical shot fall zone (**Figure 6**) and collecting groundwater samples from those wells. The groundwater samples will be analyzed for lead. The rationale for the number and locations of wells and analytical protocol is provided in Section 2.5.

If the groundwater analytical results of these nine wells indicate that the extent of lead impacts is not delineated, additional monitoring wells may be installed. Additional monitoring wells may be installed until the extent of lead impacts can be reasonably estimated.

What is the concentration of lead in South Area Grid D10 surface soil area (outside of the NTCRA area) that exhibited elevated XRF results?

Two surface soil samples will be collected from Grid D10, identified in previous investigations as exhibiting elevated lead concentrations by XRF. These samples will be analyzed for lead. As part of the field investigation, the area around this area will also be visually inspected to assess whether a potential source of lead is present.

Do lead concentrations in surface soil located in the South Area, but outside of the NTCRA, present potentially unacceptable risks to human and ecological receptors?

This question will be addressed by comparing the detected concentrations of lead in surface soil to human health and ecological risk screening criteria.

Are lead concentrations in the theoretical shot fall zone groundwater declining as a result of the NTCRA?

Groundwater data will be collected from the eight new shallow monitoring wells for lead analysis to establish a baseline data set for lead. The NTCRA is expected to remove the source of lead contamination and eventually reduce lead concentrations in groundwater. Therefore, future groundwater monitoring will be conducted post-NTCRA to further evaluate lead concentrations over time.

What is the extent of lead impacts in Bearhead Creek sediments?

This question will be addressed by collecting up to 50 sediment samples in Bearhead Creek downstream and upstream of the UXO-23 boundaries and submitting the samples for lead analysis. Two background sediment samples will be collected in the upstream section of the creek not likely to have been impacted by UXO-23 activities. These samples will serve to determine if there could be an upstream, on-Base source of lead contributing to lead concentrations in the lower reaches that receive runoff from UXO-23. If the analytical results of the background samples indicate elevated lead concentrations, additional assessment of the background inputs

to Bearhead Creek may be warranted. The rationale for the number and locations of sediment samples and analytical protocol is provided in Section 2.5.

Do lead concentrations in Bearhead Creek sediments present unacceptable risks to human and ecological receptors?

This question will be addressed by performing human health and ecological risk assessments using the sediment data collected within Bearhead Creek. The ERA will also consider (1) habitat quality, which was partially assessed by the site walk conducted during the ecological survey in April 2012, (2) bioavailability of contaminants in sediment, which will be evaluated by the presence of TOC, and (3) general water quality via hardness, pH, and turbidity.

What is the extent of lead and PAH impacts in Beaver Dam Creek surface water and sediment?

This question will be addressed by collecting surface water and sediment samples in the reach of Beaver Dam Creek closest to the UXO-23 boundary (see **Figure 7**) as well as three sediment samples and one surface water sample upstream of the recently excavated Drainages D, E, and F. Sediment samples will be analyzed for lead, PAHs, and TOC. Surface water samples will be analyzed for lead (total and dissolved) and PAHs, and hardness, pH, and turbidity will be measured. The rationale for the number and locations of samples and analytical protocol is provided in Section 2.5.

Do lead and PAH concentrations in Beaver Dam Creek surface water and sediment present potentially unacceptable risks to human and ecological receptors?

This question will be addressed by performing human health and ecological risk assessments using the sediment and surface water data collected within Beaver Dam Creek. The ERA will also consider (1) habitat quality, which was partially assessed by the site walk conducted during the ecological survey in April 2012, (2) bioavailability of contaminants in sediment, which will be evaluated by the presence TOC, and (3) general water quality via hardness, pH, and turbidity.

Who will use the data and what will they be used for?

The data will be used by the MCIEAST-MCB CAMLEJ project team to evaluate the extent of PAHs and/or lead impacts to groundwater, surface water, surface soil, and sediment at UXO-23, to evaluate potential human health and ecological risks, and to assess whether further assessment or action is warranted.

2.3.3 Project Action Limits (PALs)

Groundwater

1. Groundwater analytical results for lead and PAHs will be compared to the background threshold values (BTVs) (CH2M HILL, 2011b) to evaluate whether the concentrations detected are site-related.
2. Groundwater analytical results will be compared to the lower of the NCGWQS (NCDENR, 2010) and the federal drinking water MCLs applicable and relevant and appropriate requirements (ARARs).
3. Groundwater analytical results will be compared to the USEPA Adjusted Tap Water RSLs (USEPA, 2012) for use in the HHRA.
4. For use in the ERA, groundwater analytical results will be compared to the National Ambient Water Quality Criteria (NAWQC) for freshwater.

Surface Water

1. Surface water analytical results will be compared to the North Carolina Administrative Code Title 15A, Subchapter 2B (NC2B) Surface Water Quality Standards ARARs/to be considered (TBC) criteria.
2. Surface water analytical results will be compared to either the Freshwater or Saltwater (chronic) Region IV ecological screening values (ESVs) for use in the ERA, depending on salinity field test results.

3. Surface water analytical results will be compared to National Recommended Water Quality Criteria (NRWQC) human health water plus organism for use in the HHRA.
4. Surface water analytical results will be compared to the adjusted USEPA RSLs for tap water (USEPA, 2012) for use in the HHRA.

Surface Soil

1. Surface soil analytical results will be compared to the North Carolina Soil Screening Levels (NC SSLs) for protection of groundwater ARARs/TBC criteria.
2. Soil analytical results will be compared to Region IV Soil ESVs for use in the ERA.
3. Soil analytical results will be compared to the adjusted USEPA Industrial and Residential RSLs for soil (USEPA, 2012) for use in the HHRA.

Sediment

1. Sediment analytical results will be compared to the NC SSLs for protection of groundwater ARARs/TBC criteria.
2. Sediment analytical results will be compared to Region IV Sediment ESVs for use in the ERA.
3. Sediment analytical results will be compared to the adjusted USEPA Industrial and Residential RSLs for soil (USEPA, 2012) for use in the HHRA.

If a standard for a substance is less than the laboratory practical quantitation limit (PQL), the detection of that substance at or above the PQL will indicate a violation of that standard. The project quantitation limit for each analyte is half of the most conservative PAL.

What types of data are needed?

Laboratory analytical data, field measurements and geospatial data will be collected during the UXO-23 RI, as tabulated below. The rationale for laboratory analyses and field measurement collection is provided in Section 2.5. The **Sample Details Table** of Section 3.3 provides a comprehensive summary of all the samples to be collected for laboratory analysis.

Type of Data	Media	Area	Constituents / Data to be Gathered	Method or Instrument
Laboratory Analytical Data	Groundwater	North Area	PAH	SW846 8270C
		Theoretical Shot Fall Zone	Lead (total)	SW846 6020A
	Surface Soil	South Area	Lead	SW846 6020A
	Surface Water	Beaver Dam Creek	TOC	Lloyd Khan
			PAH	SW846 8270C
			Lead (total and dissolved)	SW846 6020A
		Bearhead Creek	TOC	Lloyd Khan
	Sediment	Beaver Dam Creek	Lead	SW846 6020A
			PAH	SW846 8270C
		Bearhead Creek	Lead	SW846 6020A
TOC			Lloyd Khan	
Field Measurements	Soil	North Area	Lithology description	USCS / Visual Inspection
		South Area		
		Theoretical Shot Fall Zone		
	Groundwater	North Area	Water Quality Parameters	Horiba U-22 or similar

Type of Data	Media	Area	Constituents / Data to be Gathered	Method or Instrument
		Theoretical Shot Fall Zone		
	Surface Water	Beaver Dam Creek	Water Quality Parameters, Salinity and Hardness	Horiba U-22 or similar, HACH Hardness Test Kit or similar
		Bearhead Creek		
	Sediment	Beaver Dam Creek	Sediment description	USCS / Visual Inspection
		Bearhead Creek		
	Geospatial Data	Groundwater	North Area Monitoring Wells	Northing, Easting, Top of Casing Elevation, and Ground Surface Elevation
Theoretical Shot Fall Zone Monitoring Wells				
Surface Soil		South Area	Latitude and Longitude	Hand-held GPS Unit
Surface Water		Beaver Dam Creek		
Sediment		Beaver Dam Creek		
		Bearhead Creek		

Notes:

Water Quality Parameters include: pH, oxygen reduction potential (ORP), dissolved oxygen (DO), temperature, specific conductivity, and turbidity

Hardness will be analyzed using a field test kit only if salinity readings indicate fresh water

USCS = Unified Soil Classification System

Are there any special data quality needs, field or laboratory, in order to support environmental decisions?

Laboratory analytical data will be distributed to a third-party validator for data quality evaluation. Laboratory analytical methods and Standard Operating Procedures (SOPs) will be used to evaluate compliance against QA/QC criteria. The data qualifiers that may be used are those presented in *National Functional Guidelines for Organic Data Review* (USEPA, 1999) and *National Functional Guidelines for Superfund Inorganic Data Review* (USEPA, 2010), as appropriate. National Functional Guidelines will not be used for 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.

How will data be collected and generated? How will the data be reported?

Groundwater, surface water, surface soil, and sediment samples will be collected as outlined in Section 3.

Surface soil, soil, sediment and surface water sample location information will be collected using a hand-held GPS unit and monitoring well location and elevation information will be collected and reported by a North Carolina licensed surveyor.

Laboratory analyses will be performed and reported by TriMatrix Laboratories under subcontract to CH2M HILL. TriMatrix Laboratories is DoD ELAP accredited (with a certification expiration date of April 2013) and NC certified.

Laboratory analytical data will be submitted to DataQual for validation against analytical methodology requirements and measurement performance criteria (MPC) presented in this SAP.

CH2M HILL will receive validated data and upload the data into a centralized electronic database used for Navy projects (Navy Installation Restoration Information Solution [NIRIS]) by the project team.

Data will be reported in the RI report, which will be submitted to the Navy and MCIEAST-MCB CAMLEJ as a draft for review prior to distribution to the NCDENR and USEPA for review and approval.

Field activities will be recorded in field log books to document adherence to the approved work plan. The CH2M HILL Preparing Field Log Books SOP located in SOP-001 describes the necessary documentation required for log book completion.

How will the data usability be determined and documented?

The usability assessment process and all procedures, including interim steps and any statistics, equations, and computer algorithms that will be used, are summarized below.

- Non-detected constituents will be evaluated to ensure that project required quantitation limits in **Tables A-1a to A-1g** were achieved. If project quantitation limits were achieved and the verification and validation steps yielded acceptable data, then the data will be considered usable.
- The data validator is the only party that may apply qualifiers to the data. Minor QC exceedances will result in “estimated” data, represented by J, J+, J-, NJ, and UJ qualifiers. Major QC exceedances will result in “rejected” data, represented by R qualifiers. The effect on availability and usability of rejected results will be evaluated.
- For duplicate sample results, the most conservative value will be used for project decisions.
- Analytical data will be checked to ensure that the values and any qualifiers are appropriately transferred to the electronic database. These checks include comparison of hardcopy data and qualifiers to the electronic data deliverable. Once the data have been uploaded into the electronic database, another check will be performed to ensure that all results were loaded accurately.
- Field and laboratory precision will be compared as relative percent difference (RPD) between the two results.
- Deviations from the SAP will be reviewed to assess whether corrective action (CA) is warranted and to assess impacts on achievement of project objectives.

The evaluative procedures used to assess overall measurement error associated with the project are outlined below:

- To assess whether a sufficient quantity of acceptable data is available for decision-making, the data will be reconciled with MPC following validation and review of data quality indicators (DQIs).
- If significant biases are detected with laboratory QA/QC samples, they will be evaluated to assess their impact on decision-making. Low biases will be described in greater detail as they represent a possible inability to detect compounds that may be present.

If significant deviations are noted between lab and field precision, the cause will be evaluated to assess the impact on decision-making.

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 is outlined below:

- Data tables will be produced to reflect detected and non-detected constituents and geochemical parameters. Data qualifiers will be reflected in the tables and discussed in the RI report.
- If needed, a technical memorandum will be produced that will identify any data usability limitations and make recommendations for CA.

The personnel responsible for performing the usability assessment include the CH2M HILL PM, PC, and other team members as necessary.

The RI report will include a data quality analysis conducted by the project chemist.

How will the data be archived?

Data will be archived according to procedures specified in the Navy CLEAN program/contract. All data will be uploaded into NIRIS. At the end of the project, paper copies of archived laboratory data and validation reports will be archived by Iron Mountain.

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

North Area Groundwater

If the North Area Phase 1 groundwater analytical results indicate PAHs above PALs, then up to eight additional wells will be installed and groundwater samples will be collected from the additional wells to evaluate the extent of PAH concentrations in groundwater.

If North Area groundwater sampling activities do not indicate the presence of PAHs above PALs during the first phase, then the groundwater within the surficial aquifer in the North Area of UXO-23 will be considered not impacted to a degree that warrants risk assessment or action.

If the results of the Phase 2 North Area groundwater sampling activities indicate the presence of PAHs in groundwater above PALs, then the HHRA and ERA will assess potential risks to human and ecological receptors. The data will also be used to assess the need for additional investigation and/or action. Additional wells may be installed until the extent of PAH impacts can be reasonably estimated based on groundwater analytical results.

Theoretical Shot Fall Zone Groundwater

If the analytical results of the groundwater samples collected from wells within and near the theoretical shot fall zone indicate the presence of lead above the PALs, then the HHRA and ERA will assess potential risks to human and ecological receptors. The data will also be used to assess the need for additional investigation and/or action. Additional wells may be installed until the extent of lead impacts can be reasonably estimated based on groundwater analytical results.

If the results of the groundwater monitoring activities within and near the theoretical shot fall zone does not indicate the presence of lead above PALs, then groundwater within and near the theoretical shot fall zone will be considered not impacted to a degree that warrants risk assessment or action.

South Area Soil

If the analytical results of the surface soil samples collected within the South Area Grid D10 indicate the presence of lead above the PALs, then the need for additional investigation and/or action will be assessed.

Bearhead Creek Sediment

If the sediment investigation activities along Bearhead Creek result in the detection of lead above PALs, then the HHRA and ERA will assess potential risks to human and ecological receptors. The data will also be used to assess the need for additional investigation and/or action.

If the sediment investigation activities along Bearhead Creek do not result in the detection of lead above PALs, then the area will be considered not impacted to a degree that warrants risk assessment or action.

Beaver Dam Creek Sediment

If PAHs or lead are detected at concentrations above PALs in Beaver Dam Creek sediment, then the HHRA and ERA will assess potential risks to human and ecological receptors. The data will also be used to assess the need for additional investigation and/or action.

If PAHs or lead are not detected at concentrations above PALs in Beaver Dam Creek sediment, then the sediment will be considered not impacted to a degree that warrants risk assessment or action.

Beaver Dam Creek Surface Water

If PAHs or lead are detected at concentrations above PALs in Beaver Dam Creek surface water then the HHRA and/or ERA will assess potential risks to human and ecological receptors. The data will also be used to assess the need for additional investigation and action.

If PAHs or lead are not detected at concentrations above PALs in Beaver Dam Creek surface water, then the Beaver Dam Creek surface water will be considered not impacted to a degree that warrants risk assessment or action.

2.4 Field Quality Control Samples

[\(UFP-QAPP Manual Section 2.6.2 – Worksheet #12-1\)](#)

TABLE 1A
 Measurement Performance Criteria Table for Field QC Samples

Matrix: Groundwater, Surface Water

Analytical Group: PAHs

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators	Measurement Performance Criteria
Field Duplicate	PAHs	1 per 10 field samples of similar matrix	Precision	RPD \leq 30%
Equipment Blank		1 per day of sampling, per type of equipment	Bias / Contamination	No target analytes detected > 1/2 LOQ
Cooler Temperature Indicator		1 per cooler to the laboratory	Representativeness	Temperature > than 0°C but \leq 6°C

TABLE 1B
 Measurement Performance Criteria Table for Field QC Samples

Matrix: Groundwater, Surface Water

Analytical Group: Metal (Lead), Total and Dissolved¹

Concentration Level: Medium

QC Sample	Analytical Group	Frequency	Data Quality Indicators	Measurement Performance Criteria
Field Duplicate	Metal (Lead)	1 per 10 field samples of similar matrix	Precision	RPD \leq 30%
Equipment Blank		1 per day of sampling, per type of equipment	Bias / Contamination	No target analytes detected > 1/2 LOQ
Cooler Temperature Indicator		1 per cooler to the laboratory	Representativeness	Temperature > than 0°C but \leq 6°C

¹Surface water only

TABLE 1C
 Measurement Performance Criteria Table for Field QC Samples

Matrix: Sediment
Analytical Group: PAHs
Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators	Measurement Performance Criteria
Field Duplicate	PAHs	1 per 10 field samples of similar matrix	Precision	RPD ≤ 30%
Equipment Blank		1 per day of sampling, per type of equipment	Bias / Contamination	No target analytes detected > 1/2 LOQ
Cooler Temperature Indicator		1 per cooler to the laboratory	Representativeness	Temperature > than 0°C but ≤ 6°C

TABLE 1D
 Measurement Performance Criteria Table for Field QC Samples

Matrix: Sediment, Soil
Analytical Group: Metal (Lead)
Concentration Level: Medium

QC Sample	Analytical Group	Frequency	Data Quality Indicators	Measurement Performance Criteria
Field Duplicate	Metal (Lead)	1 per 10 field samples of similar matrix	Precision	RPD ≤ 30%
Equipment Blank		1 per day of sampling, per type of equipment	Bias / Contamination	No target analytes detected > 1/2 LOQ
Cooler Temperature Indicator		1 per cooler to the laboratory	Representativeness	Temperature > than 0°C but ≤ 6°C

TABLE 1E
 Measurement Performance Criteria Table for Field QC Samples

Matrix: Sediment
Analytical Group: Wet Chemistry (TOC¹)
Concentration Level: Medium

QC Sample	Analytical Group	Frequency	Data Quality Indicators	Measurement Performance Criteria
Cooler Temperature Indicator	TOC ¹	1 per cooler to the laboratory	Representativeness	Temperature > than 0°C but ≤ 6°C

¹Total Organic Carbon

2.5 Sampling Design and Rationale

[\(UFP-QAPP Manual Section 3.1.1 - Worksheet #17\)](#)

2.5.1 General Approach

Groundwater sampling in the North Area will be conducted using a phased approach. The first phase will consist of the installation of two monitoring wells (**Figure 6**) in the surficial aquifer and collection of groundwater samples for an expedited analysis of PAHs. If the presence of PAHs is confirmed by the raw analytical data, up to eight additional surficial aquifer monitoring wells will be installed in the North Area and groundwater samples will be collected and submitted for PAH analysis to assess the extent of potential PAH impacts. If the extent of PAH

impacts is not delineated after collection of groundwater samples from these wells, additional monitoring wells may be installed.

Eight shallow and one deep monitoring well will be installed within or downgradient from the theoretical shot fall zone (**Figure 6**) and groundwater samples will be collected from those monitoring wells. Groundwater samples will be analyzed for lead. If the extent of lead impacts is not delineated after collection of groundwater samples from these wells, additional monitoring wells may be installed.

All groundwater samples will be collected by either low flow sampling methods or well volume methods. Historical purge logs and the well response to pumping (i.e. excessive drawdown) will be used to determine which method will groundwater sampling method will be used.

Two confirmation surface soil samples will be collected in a section of the South Area (Grid D10) previously identified as containing elevated lead concentrations via XRF.

Up to 50 sediment samples will be collected in Bearhead Creek downstream and upstream of the UXO-23 boundaries and analyzed for lead. Ten of these sediment samples will also be analyzed for TOC.

Up to 16 sediment and 6 surface water samples will be collected in the reach of Beaver Dam Creek closest to the UXO-23 boundary (see **Figure 7**) as well as upstream of the recently excavated Drainages D, E, and F. Sediment samples will be analyzed for lead, PAHs, and TOC. Surface water samples will be analyzed for lead (total and dissolved) and PAHs.

The rationale for the number and locations of groundwater, surface water, and sediment samples and a summary of the analytical protocol are provided in Section 2.5.3.

2.5.2 Sample Matrices

Sample media to be collected during this RI were determined based on results and recommendations of previous investigations, as outlined in Section 2.2.2. Sample matrices will include groundwater collected in the North Area and the theoretical shot fall zone, surface soil collected in the South Area, surface water and sediment collected in and along Beaver Dam Creek, and sediment collected along Bearhead Creek.

2.5.3 Analytical Groups, Sample Numbers, and Locations

Previous investigations and preliminary human health and ecological risk screenings in the North Area have identified elevated concentrations and potentially unacceptable risks associated with exposure to PAHs in groundwater. As a result, PAH analyses will be performed on up to 10 groundwater samples collected in the North Area. Previous investigations and preliminary human health and ecological risk screenings in the theoretical shot fall zone have identified elevated lead concentrations and potentially unacceptable risks due to exposure to lead. Therefore, nine groundwater samples will be collected in the southern portion of the site (theoretical shot fall zone) and analyzed for lead. Results of the groundwater investigation will be used to conduct an HHRA and ERA and to assess potential lead and PAH impacts to determine a path forward for groundwater at UXO-23.

All North Area groundwater samples will be collected from wells installed within the surficial aquifer. Eight of the nine groundwater samples collected from the theoretical shot fall zone will be collected from the surficial aquifer to assess the horizontal extent of potential lead impacts, and one groundwater sample will be collected from the upper Castle Hayne aquifer beneath the theoretical shot fall zone to assess the vertical extent of potential lead impacts.

Based on results of previous investigations in the South Area, an isolated area of elevated XRF results (Grid D10) indicate this area may be impacted with lead. Two surface soil confirmation samples will be collected to assess the concentration of lead in this area.

Based on results of previous investigations in the theoretical shot fall zone and the potential for contaminant migration via surface water and erosion (Section 2.2.2), lead, PAH, and TOC analysis will be performed on 16

sediment samples and lead and PAH analysis will be performed on 6 surface water samples collected from Beaver Dam Creek and Drainages B and C. Results of the sediment and surface water sampling will be used to conduct an HHRA and an ERA and to evaluate the extent of potential lead and PAH impacts to Beaver Dam Creek.

Previous investigations and preliminary risk screenings of sediment in Bearhead Creek indicate elevated concentrations and potentially unacceptable risks due to exposure to lead. To evaluate the extent of lead and evaluate potentially unacceptable risks, up to 50 sediment samples will be collected from Bearhead Creek and Drainage A and analyzed for lead. Ten of these sediment samples will also be analyzed for TOC. Results of the sediment and surface water investigation will be used to evaluate the extent of potential lead impacts and conduct an HHRA and an ERA for Bearhead Creek.

The analytical protocol and field parameter rationale is summarized below:

Media	Groundwater		Soil	Surface Water	Sediment		Rationale
Area	North Area	Theoretical Shot Fall Zone	South Area	Beaver Dam Creek	Beaver Dam Creek	Bearhead Creek	
Field Parameters							
pH	X	X		X	X	X	<ul style="list-style-type: none"> Field quality control Support the ERA
DO	X	X					<ul style="list-style-type: none"> Field quality control
ORP	X	X					<ul style="list-style-type: none"> Field quality control
Conductivity	X	X					<ul style="list-style-type: none"> Field quality control
Turbidity	X	X		X	X ^b	X ^b	<ul style="list-style-type: none"> Field quality control Support the ERA Determine if elevated turbidity correlates with elevated analytical results
Temperature	X	X					<ul style="list-style-type: none"> Field quality control
Salinity				X	X ^b	X ^b	<ul style="list-style-type: none"> To evaluate the salinity of the creeks, which will determine if hardness will be measured Support the ERA
Hardness ^a				X	X ^b	X ^b	<ul style="list-style-type: none"> Used for benchmark lead adjustments
Laboratory Analytical Parameters							
Total Lead (SW846 6020A)		X	X	X	X	X	<ul style="list-style-type: none"> Determine the nature and extent of lead present at UXO-23 and in Beaver Dam and Bearhead Creeks Support the HHRA & ERA
Dissolved Lead (SW846 6020A)				X			<ul style="list-style-type: none"> Determine the nature and extent of lead present in Beaver Dam Creek surface water Support the ERA^c
PAHs [SW846 8270C]	X			X	X		<ul style="list-style-type: none"> Determine the nature and extent of PAHs present in Beaver Dam Creek sediments and the North Area groundwater of UXO-23 Support the HHRA & ERA

Media	Groundwater		Soil	Surface Water	Sediment		Rationale
Area	North Area	Theoretical Shot Fall Zone	South Area	Beaver Dam Creek	Beaver Dam Creek	Bearhead Creek	
TOC (Lloyd Khan)					X	X	<ul style="list-style-type: none"> Determine whether metals and/or PAHs may be binding to organic matter in surface water and sediments Evaluation of the ecological food chain model

Notes:

All water quality parameters will be conducted in the field using test kits or water quality meters, such as the Horiba U-22

^a Hardness will be analyzed using a field test kit only if salinity readings indicate fresh water

^b These parameters will be collected from surrounding surface water during sediment sampling activities

^c Dissolved lead is considered the most bioavailable (i.e. potentially the most toxic) form and will thus be used in the ERA; however, total lead will be considered as part of the “worst-case” exposure scenario.

Groundwater Sample Locations

Groundwater samples will be collected from newly installed wells in the North Area in the theoretical shot fall zone as follows:

- Groundwater samples collected from surficial aquifer monitoring wells MR23N-MW01 through MR23N-MW02 will be used to assess the presence or absence of PAHs in North Area surficial aquifer groundwater. The proposed locations for these two wells were selected based on previous groundwater investigations and are adjacent to two temporary wells where elevated PAH concentrations were identified in groundwater at estimated values that exceeded regulatory screening criteria (**Figure 4**).
- If PAHs are detected at concentrations above PALs in groundwater samples collected from MRN23-MW01 and/or MR23N-MW02, monitoring wells MR23N-MW03 through MR23N-MW010 will be installed and groundwater samples will be collected and used to evaluate the extent of PAH impacts to the surficial aquifer in the North Area. The locations of these monitoring wells were chosen to assess groundwater upgradient (MR23N-MW05, -06, and -07) and downgradient (MR23N-MW03 and -MW04) of MR23N-MW01 and MR23N-MW02, and to cover a large area (MR23N-MW08, -09, and -10) so that the extent of PAH impacts can be assessed and the groundwater flow pattern of the surficial aquifer in this area can be refined.
- Groundwater samples collected from surficial aquifer monitoring wells MR23S-MW01 through MR23S-MW08 will be used to evaluate lead concentrations of the surficial aquifer groundwater within and downgradient of the theoretical shot fall zone. MR23S-MW01 serves as the downgradient monitoring well, and the locations of monitoring wells MR23S-MW02 through MR23S-MW08 were selected to cover the lateral extent of the theoretical shot fall zone. This will allow the assessment of lead impacts on groundwater within the theoretical shot fall zone area, as well as the groundwater flow regime.
- One upper Castle Hayne aquifer monitoring well, MR23S-MW09, located near historical maximum lead concentrations in groundwater (**Figure 4**) will also be installed within the theoretical shot fall zone to allow assessment of the vertical extent of potential lead impacts in this area.

All proposed groundwater sample locations are shown in **Figure 6**. The final locations of the monitoring wells may be altered based on the field conditions. Additional locations may be selected based on the analytical results.

Surface Soil Sample Locations

Two surface soil samples (MR23-SS01 and MR23-SS02) will be collected from the area where previous investigations reported the presence of elevated lead concentrations as detected by XRF screening (CH2M HILL, 2007) (**Figure 7**).

Sediment and Surface Water Sample Locations

Sediment samples will be collected from up to 50 locations along Bearhead Creek and Drainage A. For investigation purposes, the creek has been divided into five sections based on proximity to UXO-23 and drainage features. The sections closest to UXO-23 (Sections 2-4) have been assigned the greatest density of sediment sampling locations while the upstream section (Section 1) and downstream section (Section 5) have been assigned a lower density of sediment sampling locations (**Figure 7**), in accordance with *Guidance for Sediment Quality Evaluations* (New Jersey Department of Environmental Protection [NJDEP], 2011). Sections were numbered sequentially from upstream (Section 1) to downstream (Section 5). Background sediment samples will be collected in upstream sections of the creek that are not likely to have been impacted by UXO-23 activities. All sediment samples will be analyzed for lead. Ten sediment samples will be analyzed for TOC. The sediment sampling locations will be as follows:

- Section 1: Sediment samples will be collected from locations MR23-BHCS1-SD01 through MR23-BHCS1-SD05, and analytical data collected from these locations will be used to assess the creek sediments upstream of UXO-23. In addition to lead, the sample collected from MR23-BHCS1-SD01 will be analyzed for TOC.
- Section 2: Sediment samples will be collected from locations MR23-BHCS2-SD06 through MR23-BHCS2-SD15, and analytical data collected from these locations will be used to assess the creek sediments within the boundaries of UXO-23, upstream of Drainage A. In addition to lead, the samples collected from MR23-BHCS2-SD06 and MR23-BHCS2-SD07 will be analyzed for TOC.
- Section 3: Sediment samples will be collected from locations MR23-BHCS3-SD16 through MR23-BHCS3-SD25 (at least one of which will be collected from Drainage A), and analytical data collected from these locations will be used to assess the creek sediments within the boundaries of UXO-23 and to assess the inputs to the creek via Drainage A. In addition to lead, the samples collected from MR23-BHCS3-SD16 and MR23-BHCS3-SD17 will be analyzed for TOC.
- Section 4: Sediment samples will be collected from locations MR23-BHCS4-SD26 through MR23-BHCS4-SD35, and analytical data collected from these locations will be used to assess the creek sediments within the boundaries of UXO-23, downstream of Drainage A. In addition to lead, the samples collected from locations MR23-BHCS4-SD26 and MR23-BHCS4-SD27 will be analyzed for TOC.
- Section 5: Sediment samples will be collected from locations MR23-BHCS5-SD36 through MR23-BHCS5-SD50, and analytical data collected from these locations will be used to assess the creek sediments downstream of the UXO-23 boundaries. In addition to lead, the samples collected from MR23-BHCS5-SD36 through MR23N-BHCS5-SD38 will be analyzed for TOC.

Similar rationale was used for selecting the sediment and surface water locations along Beaver Dam Creek. Sediment samples will be collected from up to 16 locations along Beaver Dam Creek and drainages. Surface water samples will be collected from six locations along Beaver Dam Creek (**Figure 7**). Beaver Dam Creek has been divided into four sections based on proximity to UXO-23 and drainage features. The sections closest to UXO-23 (Sections 2-3) have been assigned the greatest density of sediment and surface water sampling locations while the upstream section (Section 1) and downstream section (Section 4) have been assigned a lower density of sediment and surface water sampling locations, in accordance with NJDEP, 2011. Background sediment samples will be collected in upstream sections of the creek that are not likely to have been impacted by UXO-23 activities. All sediment samples will be analyzed for lead, PAHs and TOC. All surface water samples will be analyzed for total

and dissolved lead and PAHs. The sediment and surface water sampling locations along Beaver Dam Creek will be as follows:

- Section 1: Sediment samples will be collected from locations MR23-BDCS1-SD01 through MR23-BDCS1-SD03 and one surface water sample will be collected from location MR23-BDCS1-SW01. Data collected from these locations will be used to evaluate the lead and PAH impacts to Beaver Dam Creek upstream of the UXO-23 drainages to Beaver Dam Creek.
- Section 2: Sediment samples will be collected from locations MR23-BDCS2-SD04 through MR23-BDCS2-SD08 and surface water samples will be collected from locations MR23-BDCS2-SW02 and MR23-BDCS2-SW03. Data collected from these locations will be used to evaluate the lead and PAH impacts to Beaver Dam Creek downstream of Drainages D, E, and F.
- Section 3: Sediment samples will be collected from locations MR23-BDCS3-SD09 and MR23-BDCS3-SD12 (at least one of which will be collected from Drainage C) and surface water samples will be collected from locations MR23-BDCS3-SW04 and MR23-BDCS3-SW05. Data collected from these locations will be used to evaluate the lead and PAH impacts to Beaver Dam Creek downstream and within Drainage C
- Section 4: Sediment samples collected from locations MR23-BDCS4-SD13 through MR23-BDCS4-SD16 (at least one of which will be collected from Drainage B) and one surface water sample will be collected from location MR23-BDCS4-SW06. Data collected from these locations will be used to evaluate the lead and PAH impacts to Beaver Dam Creek downstream and within Drainage B

An ecological survey was conducted April 25 – 27, 2012 to qualitatively characterize the ecological habitats associated with Bearhead Creek, Beaver Dam Creek, and their tributaries, identify pathways via which potentially site-impacted runoff could enter these water bodies, and select representative sediment sample locations. Representative sediment sample locations were selected as follows:

- Emphasis was placed on selecting sediment sampling locations in depositional areas, which was determined based on bends in the creeks and evaluation of sediment composition. Upstream sediment in Bearhead Creek consisted of detritus and other organic material and sediment closer to Wallace Creek consisted of very fine, muddy organic material. Upstream and downstream sediment in Beaver Dam Creek consisted mainly of sand and silt with a very small percentage of organic material.
- The highest density of sediment sampling locations were assigned immediately adjacent to the site and adjacent to the confluences of tributaries originating inside the potentially impacted areas.

Representative sediment and surface water sample locations are presented on **Figure 7**. Final sampling locations may be altered based on field conditions. Additional locations may be selected based on the analytical results.

Sampling Frequency

The field sampling activities will be completed in a single mobilization following completion of the soil removal action in 2012. The **Sample Details Table** of Section 3.3 indicates the total number of samples to be collected.

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2.6 Data Verification and Validation (Steps I and IIa/IIb) Process Table

[\(UFP-QAPP Manual Section 5.2.1, UFP-QAPP Manual Section 5.2.2, Figure 37 UFP-QAPP Manual, Table 9 UFP-QAPP Manual – Worksheets #34, 35, 36\)](#)

¹Internal/External is with respect to the data generator.

SAP Worksheets #34-36: Data Verification and Validation (Steps I and IIa/IIb) Process Table

Data Review Input	Description	Responsible for Verification/Validation	Internal/External ²
Field Log Books	Field log books will be reviewed internally and placed into the project file for archival at project closeout.	Field Team Leader/CH2M HILL	Internal
Chain-of-Custody and Shipping Forms	Chain-of-custody forms and shipping documentation will be reviewed internally upon their completion and verified against the packed sample coolers they represent. The shipper's signature on the chain-of-custody will be initialed by the reviewer, a copy of the chain-of-custody forms retained in the site file, and the original and remaining copies taped inside the cooler for shipment. Chain-of-custody forms will also be reviewed for adherence to the SAP by the PC.	Field Team Leader/CH2M HILL PC/CH2M HILL PDM/CH2M HILL	Internal & External
Sample Condition upon Receipt	Any discrepancies or missing or broken containers will be communicated to the PDM in via laboratory logins.	PDM/CH2M HILL	External
Documentation of Laboratory Method Deviations	Laboratory Method Deviations will be discussed and approved by the PC. Documentation will be incorporated into the case narrative which becomes part of the final hardcopy data package.	PC/CH2M HILL	External
Electronic Data Deliverables	Electronic Data Deliverables will be compared against hardcopy laboratory results (10% check).	PDM/CH2M HILL	External
Case Narrative	Case narratives will be reviewed by the data validator during the data validation process. This is verification that they were generated and applicable to the data packages.	Data Validator/CH2M HILL	External
Laboratory Data	All laboratory data packages will be verified internally by the laboratory performing the work for completeness and technical accuracy prior to submittal.	Laboratory Quality Assurance Officer	Internal
Laboratory Data	The data will be verified for completeness by the PDM.	PDM/CH2M HILL	External
Audit Reports	Upon report completion, a copy of all audit reports will be placed in the site file. If CAs are required, a copy of the documented CA taken will be attached to the appropriate audit report in the QA site file. Periodically, and at the completion of site work, site file audit reports and CA forms will be reviewed internally to ensure that all appropriate CAs have been taken and that CA reports are attached. If CAs have not been taken, the FTL will be notified to ensure action is taken.	PM/CH2M HILL PC/CH2M HILL	Internal
Corrective Action Reports	Corrective action reports will be reviewed by the PC or PM and placed into the project file for archival at project closeout.	PM/CH2M HILL PC/CH2M HILL	External
Laboratory Methods	Ensure the laboratory analyzed samples using the correct methods.	PC/CH2M HILL	External

SAP Worksheets #34-36: Data Verification and Validation (Steps I and IIa/IIb) Process Table (continued)

Data Review Input	Description	Responsible for Verification	Internal/External ²
Target Compound List and Target Analyte List	Ensure the laboratory reported all analytes from each analysis group.	PC/CH2M HILL	External
Reporting Limits	Ensure the laboratory met the project-designated quantitation limits. If quantitation limits were not met, the reason will be determined and documented.	PC/CH2M HILL	External
Field SOPs	Ensure that all field SOPs were followed.	Field Team Leader/CH2M HILL	Internal
Laboratory SOPs	Ensure that approved analytical laboratory SOPs were followed.	Respective Laboratory Quality Assurance Officer	Internal
Raw Data	10 percent review of raw data to confirm laboratory calculations.	Data Validator/CH2M HILL	External
Onsite Screening	All non-analytical field data will be reviewed against SAP requirements for completeness and accuracy based on the field calibration records.	Field Team Leader/CH2M HILL	Internal
Documentation of Method QC Results	Establish that all required QC samples were run.	Data Validator/CH2M HILL	External
Documentation of Field QC Sample Results	Establish that all required QC samples were run.	PC/CH2M HILL	Internal
DoD Environmental Laboratory Accreditation Program (ELAP) Evaluation	Ensure that each laboratory is DoD ELAP certified for the analyses they are to perform. Ensure evaluation timeframe does not expire.	PC/CH2M HILL	External
Analytical data for VOCs, PAHs and Metals (total and dissolved) in all matrixes analyzed (groundwater, surface water, and sediment)	Analytical methods and laboratory SOPs as presented in this SAP will be used to evaluate compliance against QA/QC criteria. Should adherence to QA/QC criteria yield deficiencies, data may be qualified. The data qualifiers used are those presented in <i>National Functional Guidelines for Superfund Organic Methods Data Review</i> (EPA, 2008) and <i>National Functional Guidelines for Inorganic Superfund Data Review</i> (EPA, 2010). 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.	Data Validator/CH2M HILL	External
Analytical data for TOC (sediment)	TOC data will not undergo third-party data validation, but are subject to all other data review protocols detailed above.	NA	NA

Notes:

¹ Verification (Step I) is a completeness check that is performed before the data review process continues in order to determine whether the required information (complete data package) is available for further review. Validation (Step IIa) is a review that the data generated are in compliance with analytical methods, procedures, and contracts. Validation (Step IIb) is a comparison of generated data against measurement performance criteria in the SAP (both sampling and analytical).

² Internal or external is in relation to the data generator.

3 Field Project Implementation

[\(Field Project Instructions\) \(Worksheet #14, #18, #19, #20, #21, and #30\)](#)

3.1 Field Project Tasks

[\(UFP-QAPP Manual Section 2.8.1 – Worksheet #14\)](#)

3.1.1 Utility Clearance

Prior to initiation of intrusive sampling activities, North Carolina One-Call will be notified of field activities and buried utilities will be identified and marked within a 20-foot radius by a subcontracted utility locator. Each intrusive sampling location will be cleared of utilities with a hand auger to a minimum depth of 5 feet bgs.

3.1.2 Land Surveying

Land surveying will be conducted by a North Carolina Professional Land Surveyor in accordance with Section 3.3 of the Master Project Plans (CH2M HILL, 2008a). A survey will be conducted after environmental sampling activities have concluded and will include surveying the horizontal coordinates of the newly installed monitoring wells. Top-of-casing elevation and ground surface elevation will also be surveyed at the newly installed monitoring well locations.

3.1.3 Vegetation Clearing

If necessary, limited vegetation clearing will be conducted to provide access for sampling activities. Efforts will be made to avoid cutting trees greater than 6 inches in diameter. Any stumps of trees or saplings will be cut to within 6 inches of ground surface, mulched, and left in place.

3.1.4 Monitoring Well Installation

The monitoring wells to be installed within the surficial aquifer will be screened to bracket the water table, resulting in screened intervals of roughly 15 to 25 ft bgs, while the upper Castle Hayne aquifer well will be screened from roughly 55 to 60 ft bgs. All well borings will be advanced using direct push technology (DPT) and rotary hollow stem auger drilling techniques. Continuous soil cores will be collected using DPT equipment for lithologic characterization. Precise well construction depths will be determined in the field following a review of the soil cores. The proposed well construction details are summarized in **Table 2**.

TABLE 2
 Proposed Well Construction Details

Monitoring Well ID	Aquifer Zone	Total Well Depth (ft bgs)	Screen Length (ft)	Screen Interval (ft bgs)
MR23N-MW01	Surficial	26	10	15 - 25
MR23N-MW02	Surficial	26	10	15 - 25
MR23N-MW03	Surficial	26	10	15 - 25
MR23N-MW04	Surficial	26	10	15 - 25
MR23N-MW05	Surficial	26	10	15 - 25
MR23N-MW06	Surficial	26	10	15 - 25
MR23N-MW07	Surficial	26	10	15 - 25

TABLE 2
 Proposed Well Construction Details

Monitoring Well ID	Aquifer Zone	Total Well Depth (ft bgs)	Screen Length (ft)	Screen Interval (ft bgs)
MR23N-MW08	Surficial	26	10	15 - 25
MR23N-MW09	Surficial	26	10	15 - 25
MR23N-MW10	Surficial	26	10	15 - 25
MR23S-MW01	Surficial	26	10	15 - 25
MR23S-MW02	Surficial	26	10	15 - 25
MR23S-MW03	Surficial	26	10	15 - 25
MR23S-MW04	Surficial	26	10	15 - 25
MR23S-MW05	Surficial	26	10	15 - 25
MR23S-MW06	Surficial	26	10	15 - 25
MR23S-MW07	Surficial	26	10	15 - 25
MR23S-MW08	Surficial	26	10	15 - 25
MR23S-MW09UCH	Upper Castle Hayne	61	5	55 - 60

Monitoring Well Construction

Upon completion of the borehole to the desired depth, approximately 1 ft of sand filter pack will be placed on the bottom of the borehole. The shallow wells will be constructed using a 10-ft section of 2-inch-inner-diameter (ID), 0.010-inch factory slotted Schedule 40 polyvinyl chloride (PVC) screen with a bottom cap. The deeper well will be constructed using a 5-foot section of screen. The screens will be connected to a threaded, flush-jointed, Schedule 40 PVC riser.

The annular space around the well screens will be filled with a well-graded, 30/40 silica sand filter pack consisting of a thoroughly washed, round, durable, siliceous material containing less than 5 percent silt or clay. During placement of the filter pack, the well casing will be suspended above the bottom of the borehole. The casing will remain suspended until placement of the filter pack and transition seal (silica sand and bentonite) is completed. The top of the casing will have a temporary cap during installation of the annulus materials. The sand filter pack will extend to approximately 2 ft above the top of the screened interval. The filter pack will be installed in approximately 2-ft lifts to prevent bridging. The augers will be moved upward as the annulus is filled. The depth to the top of the sand filter pack will be measured periodically using a weighted measuring tape.

Sodium bentonite pellets will be placed above the sand pack to form a seal at least 2 ft thick. The depth to the top of the bentonite seal will be measured periodically using a weighted measuring tape.

After hydration of the bentonite (at least 1 hour), the remaining borehole annular space will be completed with a cement-bentonite grout slurry using a side-discharge tremie method. The grout slurry will extend from the top of the bentonite seal to approximately 1 ft bgs.

Each monitoring well will be completed approximately 3 ft above ground surface with a lockable, steel protective stickup cover and 2-ft x 2-ft x 4-inch concrete pad. A bollard (3.5 ft tall and 4-inch diameter) will be placed at each corner of the concrete pad, and each will be painted bright yellow. Sand will be placed in the annular space

between the riser and protective cover. Well identification tags will be attached to the outside of the steel protective cover. An expansion plug and lock will be added to each monitoring well.

All drilling and well installation activities will be conducted by a North Carolina-licensed well driller, in accordance with the North Carolina Well Construction Standards, under the supervision of a CH2M HILL representative.

Well Development

Well development will not start until the last pumped grout in the well has had at least 24 hours to cure. Each well will be developed using a surge block and over-pumping. Well development will be considered complete when visible sediment is removed or 1 hour of active development has been completed, whichever is sooner. Field parameters (specific conductance, temperature, pH, DO, ORP, and turbidity) will be measured during development.

Sampling Tasks

- Groundwater Level Measurements:
 - Prior to purging, the depth to groundwater will be measured in each monitoring well. Groundwater depths will be measured with a water level indicator to the nearest 0.01 ft. The downhole instruments will be decontaminated after use in each well, in accordance with SOP-011 (**Appendix B**).
- Collection of groundwater samples:
 - Refer to SOPs 004 (low-flow purging and well volume purging sampling techniques), 007 (Blank Prep), 008 (Chain of Custody), and 009 (Shipping Samples) for specific implementation guidelines and details.
 - Groundwater samples will be collected from monitoring wells using a bladder, submersible, or peristaltic pump. Monitoring wells will be purged in accordance with SOP-004 (**Appendix B**) low-flow sampling protocol. As an attachment to SOP-004, the well volume purging method SOP is included and will be followed if the water level drawdown is greater than 0.3 ft during low-flow purging. A list of all parameters to be analyzed is included in **Worksheets #17 (Section 2), #18, and #19 (Appendix B)**. Samples collected for dissolved lead analysis will be filtered in the field.
 - All groundwater samples will be collected from monitoring wells by placing the pump intake at the middle of the well screen interval. Water quality parameters (WQPs) (specific conductance, pH, turbidity, temperature, DO, and ORP) will be measured and recorded (approximately every 5 minutes) using a multi-parameter water quality meter (e.g., Horiba U-22), calibrated at a minimum on a daily basis and as subsequently warranted. Sample collection will begin when WQPs have stabilized for three consecutive readings while maintaining a drawdown of less than 0.3 foot. If drawdown exceeds 0.3 foot, then a minimum of three well volumes must be purged. Depth to water, WQPs, and total well depth measurements will be recorded on Groundwater Sampling Data Sheets. Stabilization is achieved when the water quality parameters meet the following criteria:
 - Temperature: constant
 - pH: within 0.1 pH unit
 - Specific conductance: within 3 percent
 - DO: within 10 percent
 - Turbidity: within 10 percent or as low as practicable given sampling conditions
 - ORP: within 10 millivolts (mV)
 - Groundwater sampling procedures are detailed in SOP 004.
- Decontamination
 - Refer to SOPs 011 and 012 (Decontamination Procedures) for specific implementation guidelines and details.

- All non-disposable sampling equipment will be decontaminated before use and immediately after each use in accordance with applicable SOPs referenced in (Section 3.2). The water level indicator and submersible pump, if used, will be cleaned withalconox, deionized water and isopropyl alcohol after each measurement.
- IDW Handling
 - Refer to SOP 013 (IDW Handling) and the Waste Management Plan (CH2M HILL, 2011a) for specific implementation guidelines and details.
 - Wastes generated during the investigation of potentially contaminated sites are classified as IDW and will be managed to protect human health and the environment, as well as to meet legal requirements. IDW is expected to consist of soil cuttings and drilling fluids from well installation, purge water from groundwater sampling, and disposable equipment items. The FTL will be responsible for supervising the containerization of IDW, and transportation to the appropriate on-Base staging facility. The containers will be handled and labeled in accordance with the Waste Management Plan. Tubing, gloves, paper towels, etc., will be placed in opaque, black garbage bags, which will be placed into on-Base trash receptacles.
- Analyses and Testing Tasks
 - The analytical laboratory will process and prepare samples for analyses and will analyze all samples for various groups of parameters in accordance with **Worksheet #17 (Section 2)** and the **Sample Details Table** of Section 3.3.

3.1.5 Surface Soil Sample Collection

Two discrete surface soil samples will be collected from 0 to 1 ft bgs using a stainless steel hand auger, decontaminated prior to and after use. Samples will be homogenized in a stainless steel bowl and placed in the laboratory-supplied sample containers. Samples will be placed in an iced cooler pending shipping to the laboratory.

3.1.6 Surface Water and Sediment Sample Collection

Sampling will proceed from downstream to upstream locations to prevent disturbing the sediment and potential cross-contamination of downstream samples. Sampling activities will not occur for 24 hours after periods of heavy rainfall (greater than 1-inch within a 24 hour period). Because Bearhead Creek is tidally influenced, sampling in Bearhead Creek will be conducted at low tides, where appropriate, to minimize dilution of possible contaminants.

Surface Water

Surface water samples will be collected from Beaver Dam Creek and drainage ditches and/or wetlands areas. Field parameters (e.g., DO, temperature, specific conductance, turbidity, salinity, and pH) will be measured prior to sample collection. Surface water samples will be collected by submersing the sampling container directly into the surface water body or by using a “thief” type sampler and then transferring the sample to the sample container. The body of the immersed sampling container will face downstream so that any sediment disturbed during the immersion of the container does not enter the sampling vessel. If the volume of surface water encountered is insufficient to allow the direct submersion of the sampling containers, a glass interim vessel will be used to transfer the surface water sample to the sample containers. The glass interim vessel will be laboratory cleaned to the same specifications as the sample containers. Appropriate preservatives will be added to the sample containers by the contracted laboratory before shipment to the field team. Samples collected for dissolved lead analysis will be filtered in the field. Samples will be placed in an iced cooler pending shipping to the laboratory.

Sediment

Sediment samples will be collected from Beaver Dam Creek and Drainages B and C and Bearhead Creek and Drainage A. Water quality parameters (e.g., DO, temperature, specific conductance, turbidity and pH) will be measured along Beaver Dam Creek and Bearhead Creek once within each section during sampling activities.

Surface water samples will be collected in conjunction with sediment samples. At locations where both sediment and surface water samples are being collected, the surface water sample will be collected first. This will reduce the potential for sediment to enter the surface water sampling container. Several different types of equipment may be used to collect sediment samples, including stainless steel trowels, stainless-steel hand augers, and Ponar Dredges or Ekman samplers. During sediment collection, the sample will be placed into a stainless-steel bowl and mixed thoroughly. After mixing, sample containers will be filled. Samples will be kept cool in the field using bagged ice.

Quality Control Tasks

- Quality control guidance and directions as outlined in Section 3.2, including laboratory, data validation, and field SOPs will be implemented throughout the duration of the project. QC samples are described in the **Sample Details Table** of Section 3.3.

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3.2 Field SOPs Reference Table

[\(UFP-QAPP Manual Section 3.1.2 – Worksheet #21\)](#)

SOP Reference Number	Title/Author	Revision Date or Version Number	Location of SOP (if not included in the SAP)	Any planned deviation from SOP	Comments
SOP-001	Preparing Field Log Books, CH2M HILL	Revised 05/2011		No	
SOP-002	Locating and Clearing Underground Utilities, CH2M HILL	Revised 05/2011		No	
SOP-003	Installation of Monitoring Wells by Hollow Stem Auger Drilling, CH2M HILL	Revised 05/2011		No	
SOP-004	Low-Flow Groundwater Sampling from Monitoring Wells, CH2M HILL	Revised 05/2011		No	
SOP-005	Field Measurement of pH, Specific Conductance, Turbidity, DO, ORP, and Temperature Using a Water Quality Parameter Meter with Flow-through Cell, CH2M HILL	Revised 05/2011		No	
SOP-006	Water Level Measurement, CH2M HILL	Revised 05/2011		No	
SOP-007	Equipment Blank and Field Blank Preparation, CH2M HILL	Revised 05/2011		No	
SOP-008	Chain-of-Custody, CH2M HILL	Revised 05/2011		No	
SOP-009	Packaging and Shipping Procedures for Low-Concentration Samples, CH2M HILL	Revised 05/2011		No	
SOP-010	Multi RAE Photoionization Detector, CH2M HILL	Revised 05/2011		No	
SOP-011	Decontamination of Personnel and Equipment, CH2M HILL	Revised 05/2011		No	
SOP-012	Decontamination of Drilling Rigs and Equipment, CH2M HILL	Revised 05/2011		No	
SOP-013	Disposal of Waste Fluids and Solids, CH2M HILL	Revised 05/2011		No	
SOP-014	Global Positioning System, CH2M HILL	Revised 05/2011		No	
SOP-015	Sediment Sampling, CH2M HILL	Revised 05/2011		No	
SOP-016	Surface Water Sampling, CH2M HILL	Revised 05/2011		No	
SOP-017	Soil Sampling, CH2M HILL	Revised 03/2010		No	

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3.3 Sample Details Table

(UFP-QAPP Manual Sections 3.1.1 and 3.5.2.3 – Worksheets #18, 19, 20 and 30)

<p style="text-align: center;">CTO-WE40 MCIEAST-MCB CAMLEJ</p> <p style="text-align: center;">Laboratory: TriMatrix Laboratories 5560 Corporate Exchange Ct. SE Grand Rapids, MI 49512 Walt Roudebush - (616) 975-4561</p>					Groundwater, Surface Water Samples			Sediment, Soil Samples			
					Analysis Group	PAHs	Metal (Lead), Total	Metal (Lead), Dissolved	PAHs	Metal (Lead)	TOC
					Analytical Method	SW846 8270C	SW846 6020A		SW846 8270C	SW846 6020A	Lloyd Khan
					Analytical Laboratory/ Analytical SOP Reference	TriMatrix/GR-04-103	TriMatrix/GR-01-129		TriMatrix/GR-04-103	TriMatrix/GR-01-129	TriMatrix/GR-05-132
					Data Package Turnaround Time:	28 Calendar-day TAT					
					Container Type/ minimum amount required	Two 1-liter NM amber glass/1000ml	500ml NM HDPE/100ml		8oz WM glass/30g	8oz WM HDPE/50g	4oz WM glass/5g
					Preservative	Cool to <6°C but >0°C	pH <2 w/HNO ₃ , Cool to <6°C but >0°C		Cool to <6°C but >0°C	Cool to <6°C but >0°C	Cool to <6°C but >0°C
					Holding Time (Preparation/Analysis)	7 days for extraction from sample collection, 40 days for analysis from date of extraction	180 days from sample collection		14 days for extraction from sample collection, 40 days for analysis from date of extraction	180 days from sample collection	14 days from sample collection
Matrix	Area	Section	Station ID	Sample ID	Sampling Depth						
Groundwater Samples											
GW	North Area	NA	MR23N-MW01	MR23N-GW01-12C	NA	X					
	North Area	NA	MR23N-MW02	MR23N-GW02-12C		X					
	North Area	NA	MR23N-MW03	MR23N-GW03-12C		X					
	North Area	NA	MR23N-MW04	MR23N-GW04-12C		X					
	North Area	NA	MR23N-MW05	MR23N-GW05-12C		X					
	North Area	NA	MR23N-MW06	MR23N-GW06-12C		X					
	North Area	NA	MR23N-MW07	MR23N-GW07-12C		X					
	North Area	NA	MR23N-MW08	MR23N-GW08-12C		X					
	North Area	NA	MR23N-MW09	MR23N-GW09-12C		X					
	North Area	NA	MR23N-MW10	MR23N-GW10-12C		X					
	South Area	NA	MR23S-MW01	MR23S-GW01-12C			X				
	South Area	NA	MR23S-MW02	MR23S-GW02-12C			X				
	South Area	NA	MR23S-MW03	MR23S-GW03-12C			X				
	South Area	NA	MR23S-MW04	MR23S-GW04-12C			X				
	South Area	NA	MR23S-MW05	MR23S-GW05-12C			X				
	South Area	NA	MR23S-MW06	MR23S-GW06-12C			X				
	South Area	NA	MR23S-MW07	MR23S-GW07-12C			X				
	South Area	NA	MR23S-MW08	MR23S-GW08-12C			X				
	South Area	NA	MR23S-MW09	MR23S-GW09-12C			X				
Groundwater QA/QC Samples											
FD	North Area	NA	MR23N-MW05	MR23N-GW05D-12C	NA	X					
FD	South Area	NA	MR23S-MW01	MR23S-GW01D-12C			X				
MS	North Area	NA	MR23N-MW03	MR23N-GW03-12C-MS		X					
MSD	North Area	NA	MR23N-MW03	MR23N-GW03-12C-SD		X					
MS	South Area	NA	MR23S-MW03	MR23S-GW03-12C-MS			X				
MSD	South Area	NA	MR23S-MW03	MR23S-GW03-12C-MSD			X				
EB		NA	UXO23-QC	MR23-EB01-MMDDYY-GW		X	X				
Surface Water Samples											
SW	Beaver Dam Creek	Section 1	MR23-BDCS1-SW01	MR23-BDCS1-SW01-12C	NA	X	X	X			
	Beaver Dam Creek	Section 2	MR23-BDCS2-SW02	MR23-BDCS2-SW02-12C		X	X	X			
	Beaver Dam Creek	Section 2	MR23-BDCS2-SW03	MR23-BDCS2-SW03-12C		X	X	X			
	Beaver Dam Creek	Section 3	MR23-BDCS3-SW04	MR23-BDCS3-SW04-12C		X	X	X			
	Beaver Dam Creek	Section 3	MR23-BDCS3-SW05	MR23-BDCS3-SW05-12C		X	X	X			
	Beaver Dam Creek	Section 4	MR23-BDCS4-SW06	MR23-BDCS4-SW06-12C		X	X	X			

<p style="text-align: center;">CTO-WE40 MCIEAST-MCB CAMLEJ</p> <p style="text-align: center;">Laboratory: TriMatrix Laboratories 5560 Corporate Exchange Ct. SE Grand Rapids, MI 49512 Walt Roudebush - (616) 975-4561</p>					Groundwater, Surface Water Samples			Sediment, Soil Samples			
					Analysis Group	PAHs	Metal (Lead), Total	Metal (Lead), Dissolved	PAHs	Metal (Lead)	TOC
					Analytical Method	SW846 8270C	SW846 6020A		SW846 8270C	SW846 6020A	Lloyd Khan
					Analytical Laboratory/ Analytical SOP Reference	TriMatrix/GR-04-103	TriMatrix/GR-01-129		TriMatrix/GR-04-103	TriMatrix/GR-01-129	TriMatrix/GR-05-132
					Data Package Turnaround Time:	28 Calendar-day TAT					
					Container Type/ minimum amount required	Two 1-liter NM amber glass/1000ml	500ml NM HDPE/100ml		8oz WM glass/30g	8oz WM HDPE/50g	4oz WM glass/5g
					Preservative	Cool to <6°C but >0°C	pH <2 w/HNO ₃ , Cool to <6°C but >0°C		Cool to <6°C but >0°C	Cool to <6°C but >0°C	Cool to <6°C but >0°C
					Holding Time (Preparation/Analysis)	7 days for extraction from sample collection, 40 days for analysis from date of extraction	180 days from sample collection		14 days for extraction from sample collection, 40 days for analysis from date of extraction	180 days from sample collection	14 days from sample collection
Matrix	Area	Section	Station ID	Sample ID	Sampling Depth						
Surface Water QA/QC Samples											
FD	Beaver Dam Creek	Section 1	MR23-BDCS1-SW01	MR23-BDCS1-SW01D-12C		X	X	X			
MS	Beaver Dam Creek	Section 2	MR23-BDCS2-SW02	MR23-BDCS2-SW02-12C-MS		X	X	X			
MSD	Beaver Dam Creek	Section 2	MR23-BDCS2-SW02	MR23-BDCS2-SW02-12C-SD		X	X	X			
EB	Beaver Dam Creek	NA	UXO23-QC	MR23-BDC-EB01-MMDDYY-SW		X	X	X			
TB	Beaver Dam Creek	NA	UXO23-QC	MR23-BDC-TB01-MMDDYY-SW		X	X	X			
Soil Samples											
SS	South Area	NA	MR23-SS01	MR23-SS01-X-Y-12C					X		
SS	South Area	NA	MR23-SS02	MR23-SS02-X-Y-12C					X		
Soil QA/QC Samples											
FD	South Area	NA	MR23-SS01	MR23-SS01D-X-Y-12C					X		
MS	South Area	NA	MR23-SS01	MR23-SS01-12C-X-Y-MS					X		
MSD	South Area	NA	MR23-SS01	MR23-SS01-12C-X-Y-MSD					X		
EB	South Area	NA	UXO23-QC						X		
Sediment Samples											
SD	Beaver Dam Creek	Section 1	MR23-BDCS1-SD01	MR23-BDCS1-SD01-12C					X	X	
	Beaver Dam Creek	Section 1	MR23-BDCS1-SD02	MR23-BDCS1-SD02-12C					X	X	
	Beaver Dam Creek	Section 1	MR23-BDCS1-SD03	MR23-BDCS1-SD03-12C					X	X	
	Beaver Dam Creek	Section 2	MR23-BDCS2-SD04	MR23-BDCS2-SD04-12C					X	X	
	Beaver Dam Creek	Section 2	MR23-BDCS2-SD05	MR23-BDCS2-SD05-12C					X	X	
	Beaver Dam Creek	Section 2	MR23-BDCS2-SD06	MR23-BDCS2-SD06-12C					X	X	
	Beaver Dam Creek	Section 2	MR23-BDCS2-SD07	MR23-BDCS2-SD07-12C					X	X	
	Beaver Dam Creek	Section 2	MR23-BDCS2-SD08	MR23-BDCS2-SD08-12C					X	X	
	Beaver Dam Creek	Section 3	MR23-BDCS3-SD09	MR23-BDCS3-SD09-12C					X	X	
	Beaver Dam Creek	Section 3	MR23-BDCS3-SD10	MR23-BDCS3-SD10-12C					X	X	
	Beaver Dam Creek	Section 3	MR23-BDCS3-SD11	MR23-BDCS3-SD11-12C					X	X	
	Beaver Dam Creek	Section 3	MR23-BDCS3-SD12	MR23-BDCS3-SD12-12C					X	X	
	Beaver Dam Creek	Section 4	MR23-BDCS4-SD13	MR23-BDCS4-SD13-12C					X	X	
	Beaver Dam Creek	Section 4	MR23-BDCS4-SD14	MR23-BDCS4-SD14-12C					X	X	
	Beaver Dam Creek	Section 4	MR23-BDCS4-SD15	MR23-BDCS4-SD15-12C					X	X	
Beaver Dam Creek	Section 4	MR23-BDCS4-SD16	MR23-BDCS4-SD16-12C					X	X		
SD	Bearhead Creek	Section 1	MR23-BHCS1-SD01	MR23-BHCS1-SD01-12C					X	X	
	Bearhead Creek	Section 1	MR23-BHCS1-SD02	MR23-BHCS1-SD02-12C					X	X	
	Bearhead Creek	Section 1	MR23-BHCS1-SD03	MR23-BHCS1-SD03-12C					X	X	
	Bearhead Creek	Section 1	MR23-BHCS1-SD04	MR23-BHCS1-SD04-12C					X	X	
	Bearhead Creek	Section 1	MR23-BHCS1-SD05	MR23-BHCS1-SD05-12C					X	X	
	Bearhead Creek	Section 2	MR23-BHCS2-SD06	MR23-BHCS2-SD06-12C					X	X	
	Bearhead Creek	Section 2	MR23-BHCS2-SD07	MR23-BHCS2-SD07-12C					X	X	
	Bearhead Creek	Section 2	MR23-BHCS2-SD08	MR23-BHCS2-SD08-12C					X	X	
	Bearhead Creek	Section 2	MR23-BHCS2-SD09	MR23-BHCS2-SD09-12C					X	X	
	Bearhead Creek	Section 2	MR23-BHCS2-SD10	MR23-BHCS2-SD10-12C					X	X	
	Bearhead Creek	Section 2	MR23-BHCS2-SD11	MR23-BHCS2-SD11-12C					X	X	
	Bearhead Creek	Section 2	MR23-BHCS2-SD12	MR23-BHCS2-SD12-12C					X	X	
	Bearhead Creek	Section 2	MR23-BHCS2-SD13	MR23-BHCS2-SD13-12C					X	X	
	Bearhead Creek	Section 2	MR23-BHCS2-SD14	MR23-BHCS2-SD14-12C					X	X	
	Bearhead Creek	Section 2	MR23-BHCS2-SD15	MR23-BHCS2-SD15-12C					X	X	

<p style="text-align: center;">CTO-WE40 MCIEAST-MCB CAMLEJ</p> <p style="text-align: center;">Laboratory: TriMatrix Laboratories 5560 Corporate Exchange Ct. SE Grand Rapids, MI 49512 Walt Roudebush - (616) 975-4561</p>					Groundwater, Surface Water Samples			Sediment, Soil Samples			
					Analysis Group	PAHs	Metal (Lead), Total	Metal (Lead), Dissolved	PAHs	Metal (Lead)	TOC
					Analytical Method	SW846 8270C	SW846 6020A		SW846 8270C	SW846 6020A	Lloyd Khan
					Analytical Laboratory/ Analytical SOP Reference	TriMatrix/GR-04-103	TriMatrix/GR-01-129		TriMatrix/GR-04-103	TriMatrix/GR-01-129	TriMatrix/GR-05-132
					Data Package Turnaround Time:	28 Calendar-day TAT					
					Container Type/ minimum amount required	Two 1-liter NM amber glass/1000ml	500ml NM HDPE/100ml		8oz WM glass/30g	8oz WM HDPE/50g	4oz WM glass/5g
					Preservative	Cool to <6°C but >0°C	pH <2 w/HNO ₃ , Cool to <6°C but >0°C		Cool to <6°C but >0°C	Cool to <6°C but >0°C	Cool to <6°C but >0°C
					Holding Time (Preparation/Analysis)	7 days for extraction from sample collection, 40 days for analysis from date of extraction	180 days from sample collection		14 days for extraction from sample collection, 40 days for analysis from date of extraction	180 days from sample collection	14 days from sample collection
Matrix	Area	Section	Station ID	Sample ID	Sampling Depth						
	Bearhead Creek	Section 3	MR23-BHCS3-SD16	MR23-BHCS3-SD16-12C						X	X
	Bearhead Creek	Section 3	MR23-BHCS3-SD17	MR23-BHCS3-SD17-12C						X	X
	Bearhead Creek	Section 3	MR23-BHCS3-SD18	MR23-BHCS3-SD18-12C						X	
	Bearhead Creek	Section 3	MR23-BHCS3-SD19	MR23-BHCS3-SD19-12C						X	
	Bearhead Creek	Section 3	MR23-BHCS3-SD20	MR23-BHCS3-SD20-12C						X	
	Bearhead Creek	Section 3	MR23-BHCS3-SD21	MR23-BHCS3-SD21-12C						X	
	Bearhead Creek	Section 3	MR23-BHCS3-SD22	MR23-BHCS3-SD22-12C						X	
	Bearhead Creek	Section 3	MR23-BHCS3-SD23	MR23-BHCS3-SD23-12C						X	
	Bearhead Creek	Section 3	MR23-BHCS3-SD24	MR23-BHCS3-SD24-12C						X	
	Bearhead Creek	Section 3	MR23-BHCS3-SD25	MR23-BHCS3-SD25-12C						X	
	Bearhead Creek	Section 4	MR23-BHCS4-SD26	MR23-BHCS4-SD26-12C						X	X
	Bearhead Creek	Section 4	MR23-BHCS4-SD27	MR23-BHCS4-SD27-12C						X	X
	Bearhead Creek	Section 4	MR23-BHCS4-SD28	MR23-BHCS4-SD28-12C						X	
	Bearhead Creek	Section 4	MR23-BHCS4-SD29	MR23-BHCS4-SD29-12C						X	
	Bearhead Creek	Section 4	MR23-BHCS4-SD30	MR23-BHCS4-SD30-12C						X	
	Bearhead Creek	Section 4	MR23-BHCS4-SD31	MR23-BHCS4-SD31-12C						X	
	Bearhead Creek	Section 4	MR23-BHCS4-SD32	MR23-BHCS4-SD32-12C						X	
	Bearhead Creek	Section 4	MR23-BHCS4-SD33	MR23-BHCS4-SD33-12C						X	
	Bearhead Creek	Section 4	MR23-BHCS4-SD34	MR23-BHCS4-SD34-12C						X	
	Bearhead Creek	Section 4	MR23-BHCS4-SD35	MR23-BHCS4-SD35-12C						X	
	Bearhead Creek	Section 5	MR23-BHCS5-SD36	MR23-BHCS5-SD36-12C						X	X
	Bearhead Creek	Section 5	MR23-BHCS5-SD37	MR23-BHCS5-SD37-12C						X	X
	Bearhead Creek	Section 5	MR23-BHCS5-SD38	MR23-BHCS5-SD38-12C						X	X
	Bearhead Creek	Section 5	MR23-BHCS5-SD39	MR23-BHCS5-SD39-12C						X	
	Bearhead Creek	Section 5	MR23-BHCS5-SD40	MR23-BHCS5-SD40-12C						X	
	Bearhead Creek	Section 5	MR23-BHCS5-SD41	MR23-BHCS5-SD41-12C						X	
	Bearhead Creek	Section 5	MR23-BHCS5-SD42	MR23-BHCS5-SD42-12C						X	
	Bearhead Creek	Section 5	MR23-BHCS5-SD43	MR23-BHCS5-SD43-12C						X	
	Bearhead Creek	Section 5	MR23-BHCS5-SD44	MR23-BHCS5-SD44-12C						X	
	Bearhead Creek	Section 5	MR23-BHCS5-SD45	MR23-BHCS5-SD45-12C						X	
	Bearhead Creek	Section 5	MR23-BHCS5-SD46	MR23-BHCS5-SD46-12C						X	
	Bearhead Creek	Section 5	MR23-BHCS5-SD47	MR23-BHCS5-SD47-12C						X	
	Bearhead Creek	Section 5	MR23-BHCS5-SD48	MR23-BHCS5-SD48-12C						X	
	Bearhead Creek	Section 5	MR23-BHCS5-SD49	MR23-BHCS5-SD49-12C						X	
	Bearhead Creek	Section 5	MR23-BHCS5-SD50	MR23-BHCS5-SD50-12C						X	

CTO-WE40 MCIEAST-MCB CAMLEJ Laboratory: TriMatrix Laboratories 5560 Corporate Exchange Ct. SE Grand Rapids, MI 49512 Walt Roudebush - (616) 975-4561					Groundwater, Surface Water Samples			Sediment, Soil Samples			
					Analysis Group	PAHs	Metal (Lead), Total	Metal (Lead), Dissolved	PAHs	Metal (Lead)	TOC
					Analytical Method	SW846 8270C	SW846 6020A		SW846 8270C	SW846 6020A	Lloyd Khan
					Analytical Laboratory/ Analytical SOP Reference	TriMatrix/GR-04-103	TriMatrix/GR-01-129		TriMatrix/GR-04-103	TriMatrix/GR-01-129	TriMatrix/GR-05-132
					Data Package Turnaround Time:	28 Calendar-day TAT					
					Container Type/ minimum amount required	Two 1-liter NM amber glass/1000ml	500ml NM HDPE/100ml		8oz WM glass/30g	8oz WM HDPE/50g	4oz WM glass/5g
					Preservative	Cool to <6°C but >0°C	pH <2 w/HNO ₃ , Cool to <6°C but >0°C		Cool to <6°C but >0°C	Cool to <6 °C but >0°C	Cool to <6°C but >0°C
					Holding Time (Preparation/Analysis)	7 days for extraction from sample collection, 40 days for analysis from date of extraction	180 days from sample collection		14 days for extraction from sample collection, 40 days for analysis from date of extraction	180 days from sample collection	14 days from sample collection
Matrix	Area	Section	Station ID	Sample ID	Sampling Depth						
Sediment QA/QC Samples											
FD	Beaver Dam Creek	Section 1	MR23-BDCS1-SD01	MR23-BDCS1-SD01D-12C					X	X	
FD	Beaver Dam Creek	Section 2	MR23-BDCS2-SD08	MR23-BDCS2-SD08D-12C					X	X	
FD	Bearhead Creek	Section 2	MR23-BHCS2-SD10	MR23-BHCS2-SD10D-12C						X	
FD	Bearhead Creek	Section 3	MR23-BHCS3-SD20	MR23-BHCS3-SD20D-12C						X	
FD	Bearhead Creek	Section 4	MR23-BHCS4-SD30	MR23-BHCS4-SD30D-12C						X	
FD	Bearhead Creek	Section 5	MR23-BHCS5-SD40	MR23-BHCS5-SD40D-12C						X	
FD	Bearhead Creek	Section 5	MR23-BHCS5-SD50	MR23-BHCS5-SD50D-12C						X	
MS	Beaver Dam Creek	Section 3	MR23-BDCS3-SD12	MR23-BDCS3-SD12-12C-MS					X	X	
MS	Bearhead Creek	Section 3	MR23-BHCS3-SD16	MR23-BHCS3-SD16-12C-MS						X	
MS	Bearhead Creek	Section 4	MR23-BHCS4-SD33	MR23-BHCS4-SD33-12C-MS						X	
MS	Bearhead Creek	Section 5	MR23-BHCS5-SD43	MR23-BHCS5-SD43-12C-MS						X	
MSD	Beaver Dam Creek	Section 3	MR23-BDCS3-SD12	MR23-BDCS3-SD12-12C-SD					X	X	
MSD	Bearhead Creek	Section 3	MR23-BHCS3-SD16	MR23-BHCS3-SD16-12C-SD						X	
MSD	Bearhead Creek	Section 4	MR23-BHCS4-SD33	MR23-BHCS4-SD33-12C-SD						X	
MSD	Bearhead Creek	Section 5	MR23-BHCS5-SD43	MR23-BHCS5-SD43-12C-SD						X	
EB	Bearhead Creek		UXO23-QC	MR23-BHC-EB01-MMDDYY-SD						X	
EB	Beaver Dam Creek		UXO23-QC	MR23-BDC-EB01-MMDDYY-SD	NA				X	X	
					Total Number of Samples to the Laboratory:	198					

Notes:

¹ For a complete reference of laboratory SOPs, see the Analytical SOP References Table.

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

³ Field QC counts may change depending on the duration of field event. Frequency of QA/QC sample collection is noted on the Measurement Performance Criteria Table in Section 2.4 of the UFP-SAP and is as follows :

Field Duplicate (FD) - One per 10 field samples

MS/MSD - One pair per 20 field samples of similar matrix (including field duplicates)

Equipment Blank (EB) - For disposable equipment, one per week of sampling; for decontaminated equipment, one per type of sampling equipment, per day of sampling

4 Data Validation, Management, and Reporting

Data Validation, Review, and Management Tasks

- Perform third party data validation in accordance with **Worksheets #34, #35, and #36 (Section 2)**.
- Perform a data usability assessment in accordance with **Worksheet #11 (Section 2)**.
- Incorporate validated data into the NIRIS database, in accordance with the Navy CLEAN Data Management Plan (**Appendix C**). The laboratory accreditation documentation is included in **Appendix D**.

Documentation and Reporting

- Activities and data will be documented in the RI Report.

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5 References

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- CH2M HILL. 2010a. *Focused Preliminary Assessment/Site Inspection D-9 Skeet Range Proposed MILCON Area.* April.
- CH2M HILL. 2010b. *Expanded Site Inspection Report Wallace Creek MILCON Environmental Support Former Naval Research Lab Area IR Sites 19 and 20), IR Site 25, and D-9 Skeet Range South Area.*
- CH2M HILL. 2011a. *Investigation and Remediation Waste Management Plan, Marine Corps Base Camp Lejeune, North Carolina.* May.
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- United States Army Corps of Engineers (USACE). 2001. *Final Range Identification and Preliminary Range Assessment, Marine Corps Base Camp Lejeune, Onslow, North Carolina. St. Louis District.* December.
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- USEPA. 2010. *National Functional Guidelines for Superfund Inorganic Data Review.*
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- White Flyer. 2007. <http://www.whiteflyer.com>

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Figures



- Legend**
- Highways
 - Skeet Range
 - Installation Boundary

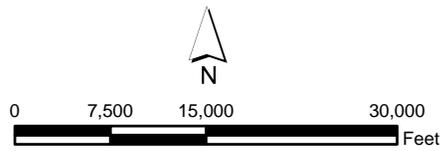
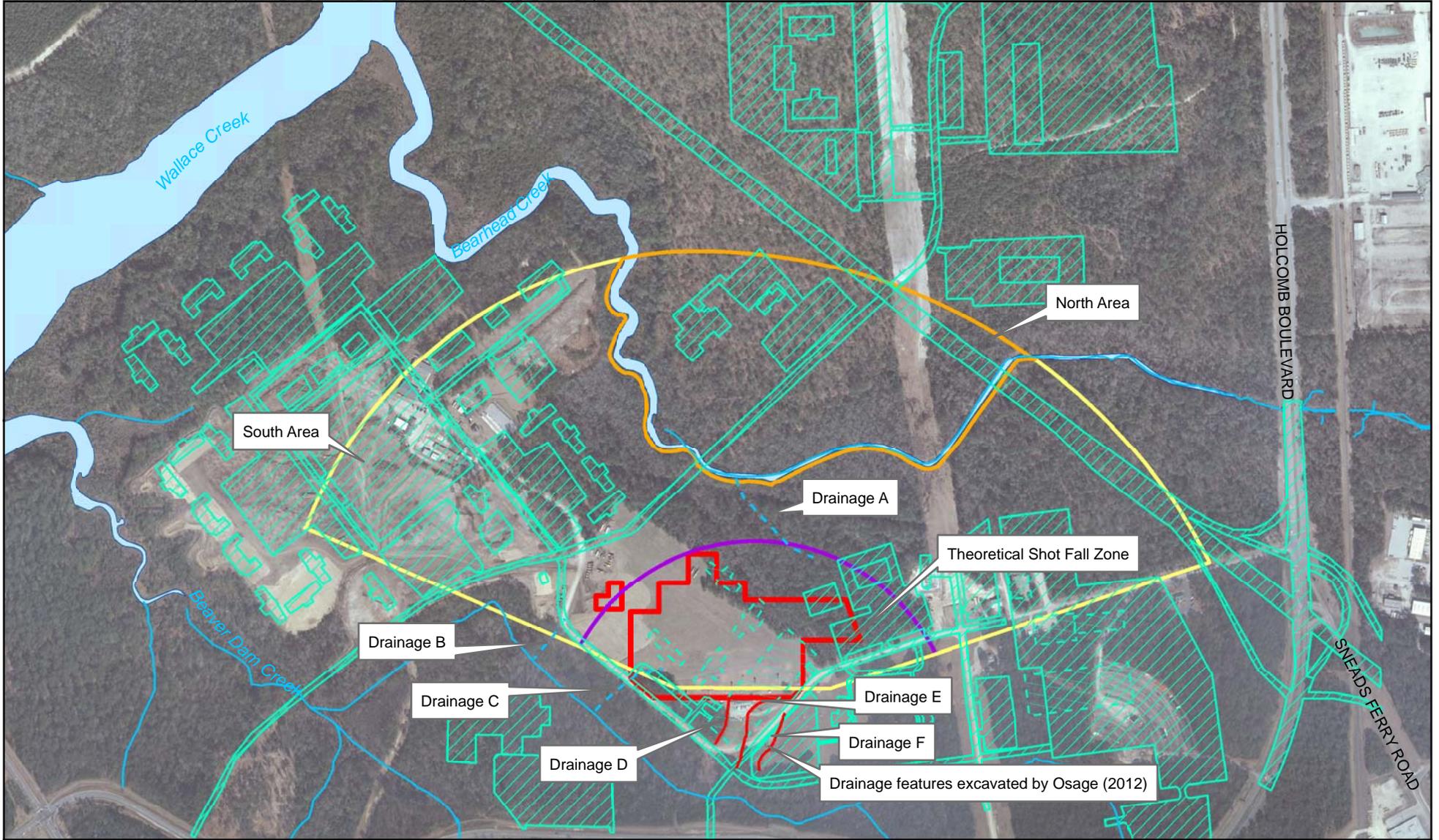


Figure 1
Base Location Map
UXO-23, Former D-9 Skeet Range
Expanded Site Investigation Sampling and Analysis Plan
MCIEAST-MCB CAMLEJ
North Carolina





Legend

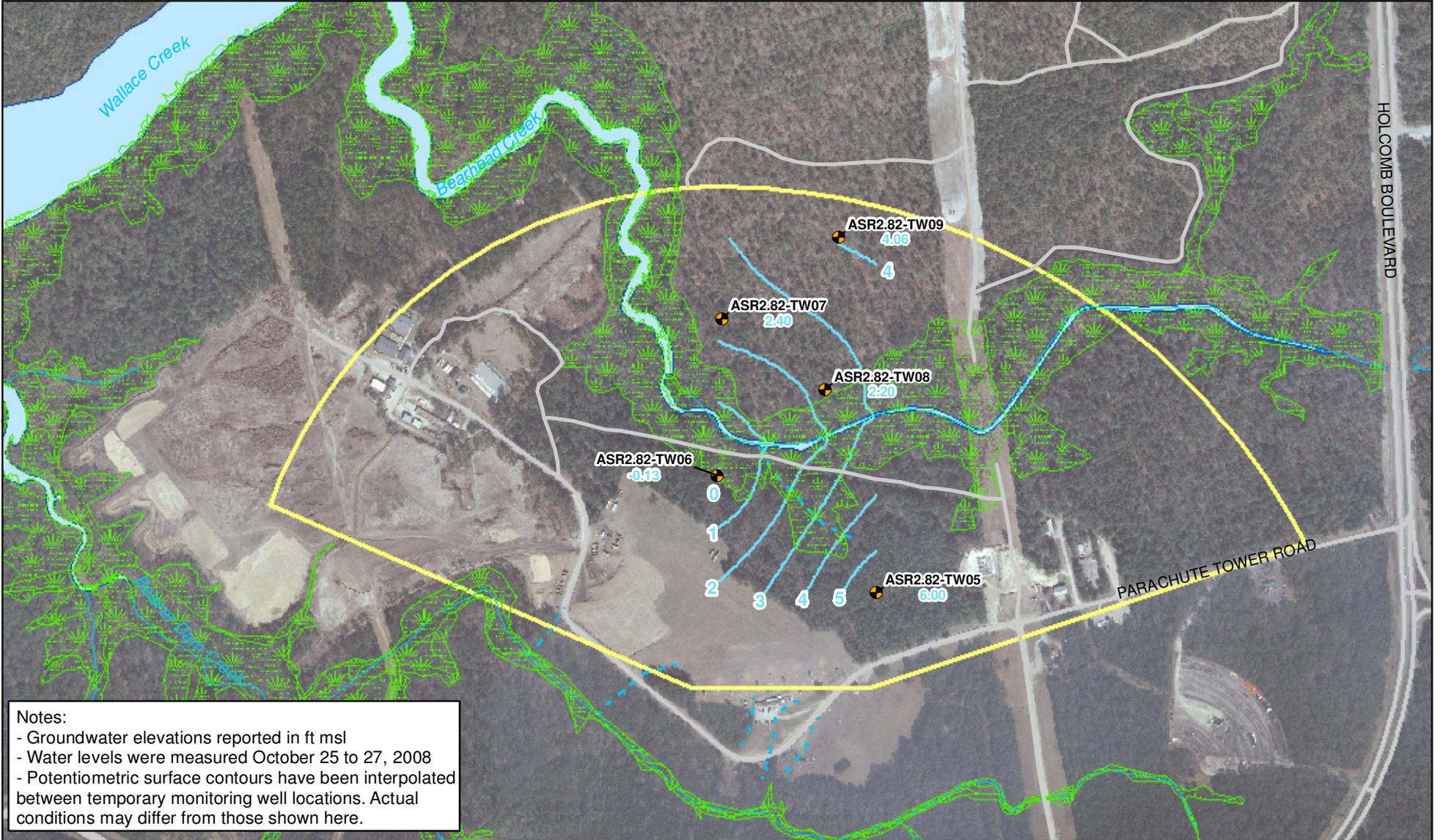
- Approximate Drainage Feature Location
- Approximate Drainage Feature Location - NTCRA
- Stream
- Surface Water Course Area
- Future Construction Area
- Proposed Construction Area
- D-9 Skeet Range North Area
- Skeet Range
- Theoretical Shot Fall Zone
- NTCRA Area



1 inch = 800 feet

Figure 2
 Site Location Map
 UXO-23, Former D-9 Skeet Range
 Expanded Site Investigation Sampling and Analysis Plan
 MCIEAST-MCB CAMLEJ
 North Carolina





Notes:
 - Groundwater elevations reported in ft msl
 - Water levels were measured October 25 to 27, 2008
 - Potentiometric surface contours have been interpolated between temporary monitoring well locations. Actual conditions may differ from those shown here.

- Legend**
- Temporary Wells
 - Road
 - Potentiometric Surface Contour
 - - - Approximate Drainage Feature Location
 - Stream
 - Surface Water Course Area
 - Jurisdictional Wetland Area
 - Skeet Range

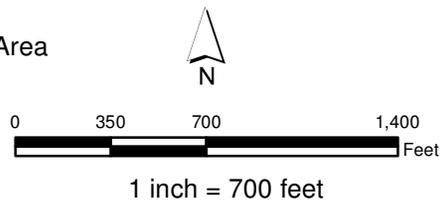
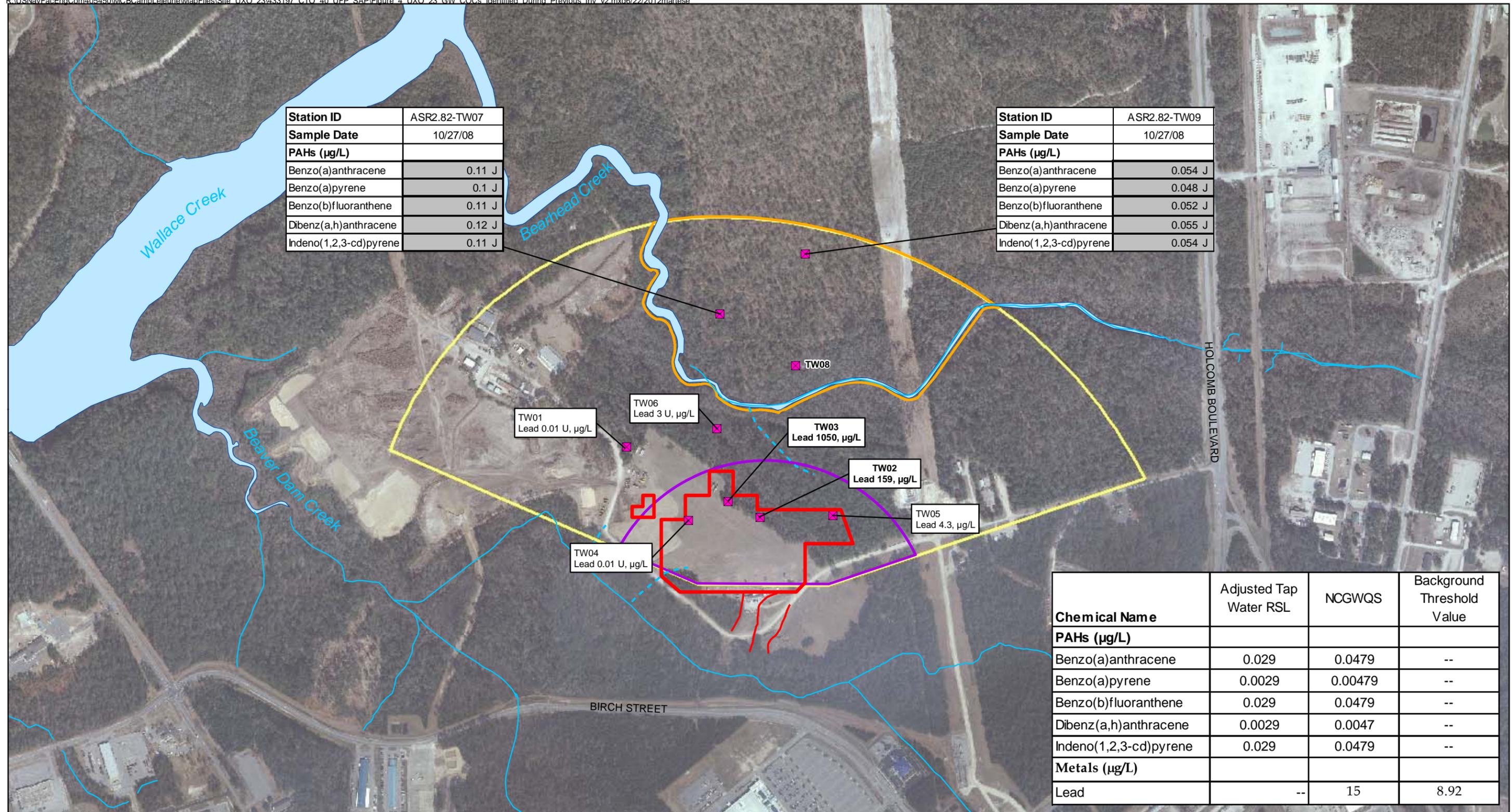


Figure 3
 Potentiometric Surface Map of the Water Table - October 2008
 UXO-23, Former D-9 Skeet Range
 Expanded Site Investigation Sampling and Analysis Plan
 MCIEAST-MCB CAMLEJ
 North Carolina





Station ID	ASR2.82-TW07
Sample Date	10/27/08
PAHs (µg/L)	
Benzo(a)anthracene	0.11 J
Benzo(a)pyrene	0.1 J
Benzo(b)fluoranthene	0.11 J
Dibenz(a,h)anthracene	0.12 J
Indeno(1,2,3-cd)pyrene	0.11 J

Station ID	ASR2.82-TW09
Sample Date	10/27/08
PAHs (µg/L)	
Benzo(a)anthracene	0.054 J
Benzo(a)pyrene	0.048 J
Benzo(b)fluoranthene	0.052 J
Dibenz(a,h)anthracene	0.055 J
Indeno(1,2,3-cd)pyrene	0.054 J

TW01
Lead 0.01 U, µg/L

TW06
Lead 3 U, µg/L

TW03
Lead 1050, µg/L

TW02
Lead 159, µg/L

TW05
Lead 4.3, µg/L

TW04
Lead 0.01 U, µg/L

Chemical Name	Adjusted Tap Water RSL	NCGWQS	Background Threshold Value
PAHs (µg/L)			
Benzo(a)anthracene	0.029	0.0479	--
Benzo(a)pyrene	0.0029	0.00479	--
Benzo(b)fluoranthene	0.029	0.0479	--
Dibenz(a,h)anthracene	0.0029	0.0047	--
Indeno(1,2,3-cd)pyrene	0.029	0.0479	--
Metals (µg/L)			
Lead	--	15	8.92

- Legend**
- ✦ Groundwater Sample Location
 - - - Approximate Drainage Feature Location
 - - - Approximate Drainage Feature Location - NTCRA
 - Light Blue Area Surface Water Course Area
 - Orange Area D-9 Skeet Range North Area
 - Purple Area Theoretical Shot Fall Zone
 - Yellow Area D-9 Skeet Range
 - Red Area NTCRA Area

Notes:
 µg/L - micrograms per liter
 mg/L - milligrams per liter
 J - Analyte present, value may or may not be accurate or precise
 U - The material was analyzed for, but not detected
 Data displayed for metals exceeded both the Base backgroundthreshold value and at least one regulatory standard.
 Shading indicates exceedance of Adjusted Tap Water RSL
Bold text indicates exceedance of the Base background threshold value
Bold box indicates exceedance of NCGWQS

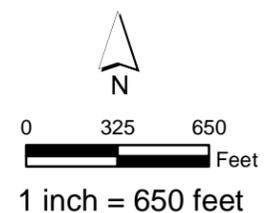
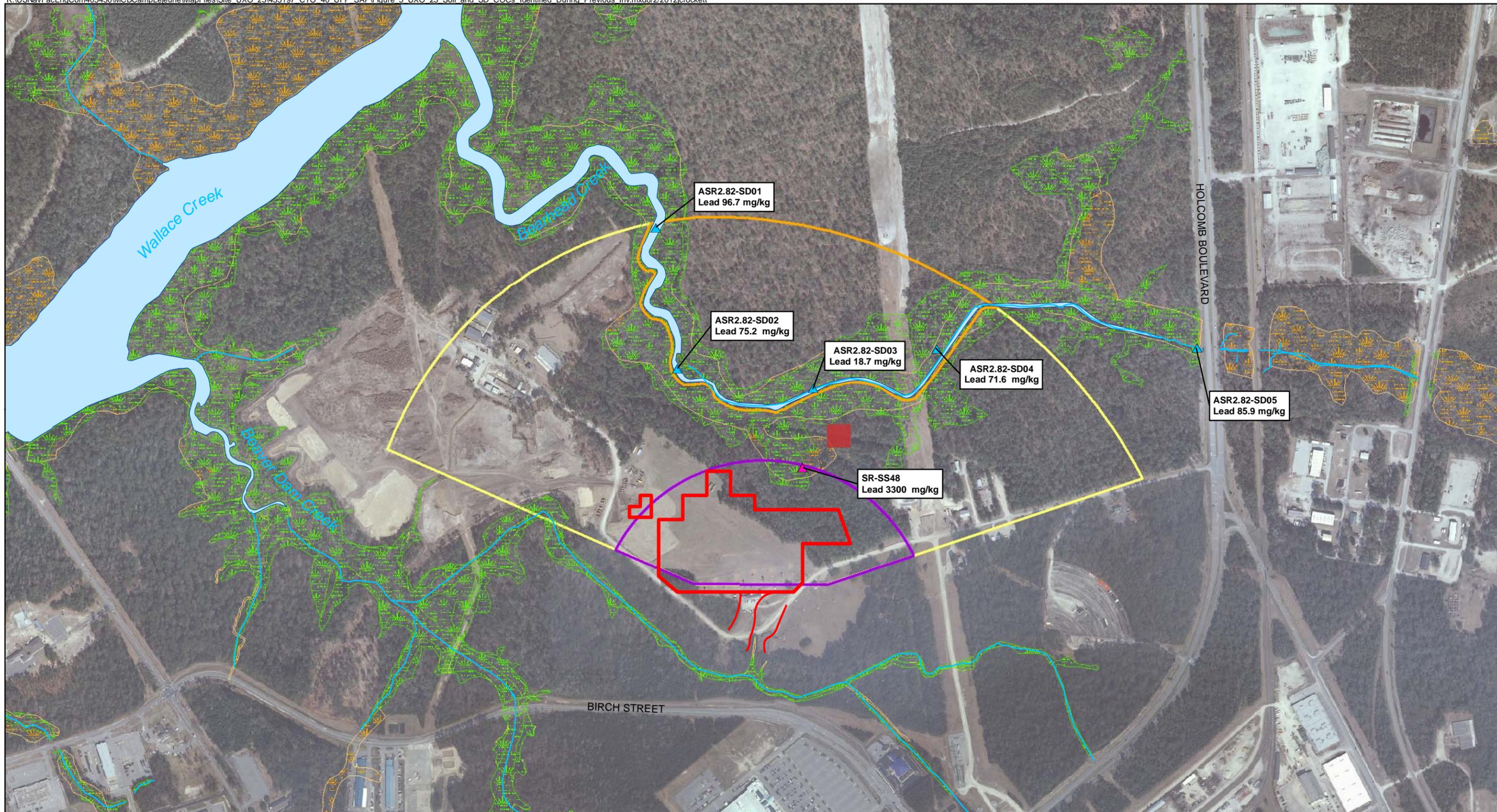


Figure 4
 Groundwater COCs Identified during Previous Investigations
 UXO-23, Former D-9 Skeet Range
 Expanded Site Investigation Sampling and Analysis Plan
 MCIEAST-MCB CAMLEJ
 North Carolina



- Legend**
- ▲ Surface Soil Sample Location
 - ▲ Sediment Sample Location
 - - - Approximate Drainage Feature Location
 - - - Approximate Drainage Feature Location - NTCRA
 - Surface Water Course Area
 - Theoretical Shot Fall Zone
 - Jurisdictional Wetland Area
 - Planning Wetland Area

- D-9 Skeet Range
- D-9 Skeet Range North Area
- NTCRA Area
- Isolated area of elevated XRF lead results (Grid D10)

Notes:
 Lead Ecological Screening Value for sediment equals 30 mg/kg
 Lead Ecological Screening Value for surface soil equals 11 mg/kg
 mg/kg -milligram/kilograms

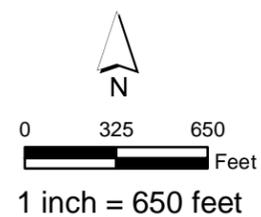
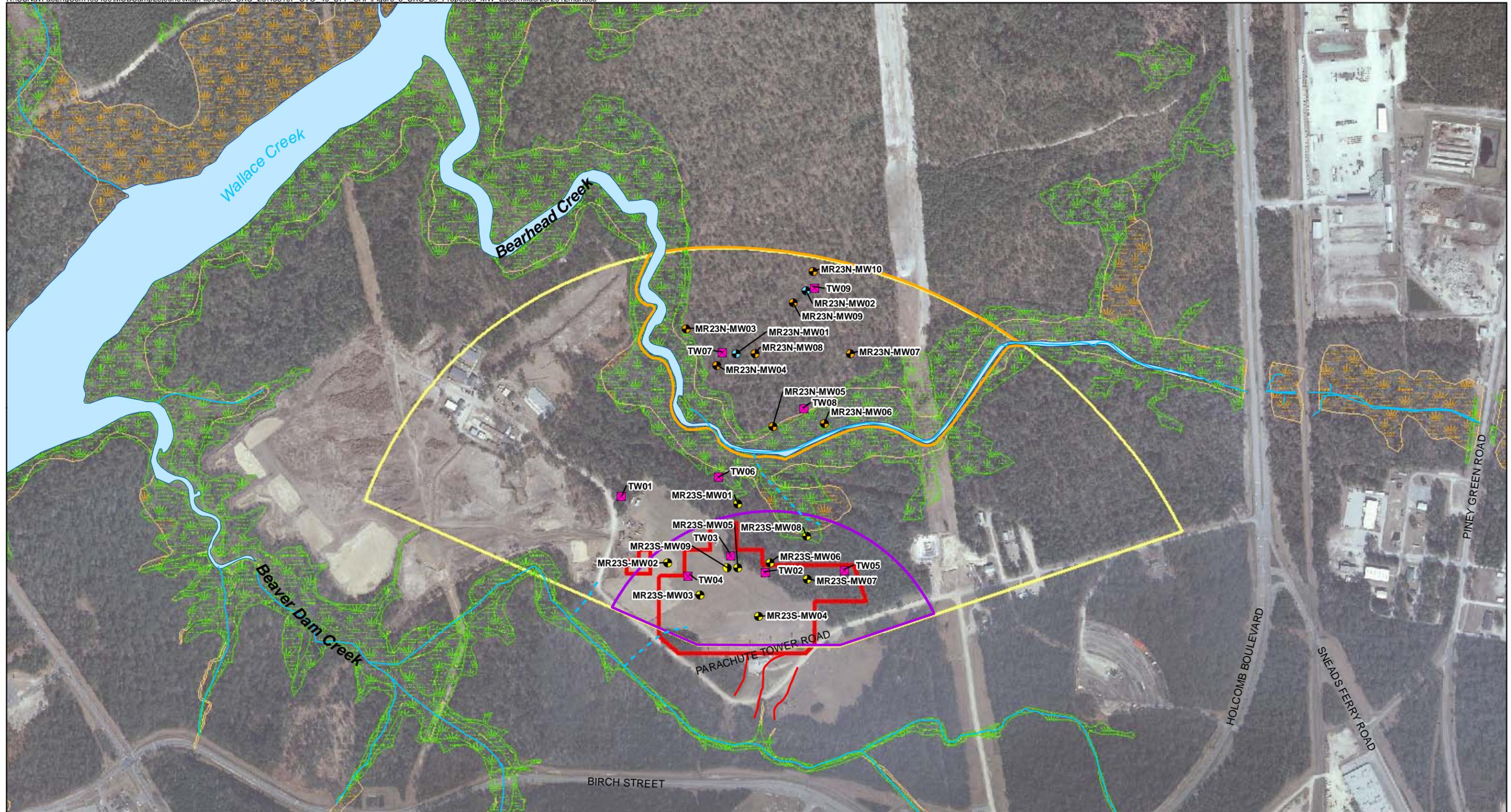


Figure 5
 Soil and Sediment COCs Identified during Previous Investigations
 UXO-23, Former D-9 Skeet Range
 Expanded Site Investigation Sampling and Analysis Plan
 MCIEAST-MCB CAMLEJ
 North Carolina



Legend

- Proposed Surficial Aquifer Monitoring Well Location – North (First Phase)
- Proposed Surficial Aquifer Monitoring Well Location – North (Second Phase)
- Proposed Surficial Aquifer Monitoring Well Location - Theoretical Shot Fall Zone
- Proposed Upper Castle Hayne Aquifer Monitoring Well Location - Theoretical Shot Fall Zone
- Previous Groundwater Sample Location
- - - Approximate Drainage Feature Location
- - - Approximate Drainage Feature Location - NTCRA
- Stream
- Surface Water
- D-9 Skeet Range North Area
- Theoretical Shot Fall Zone
- Jurisdictional Wetland Area
- Planning Wetland Area
- D-9 Skeet Range
- NTCRA Area

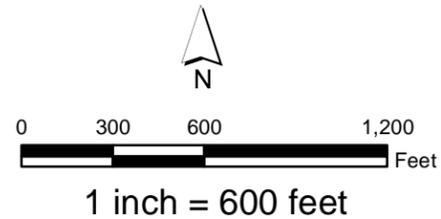
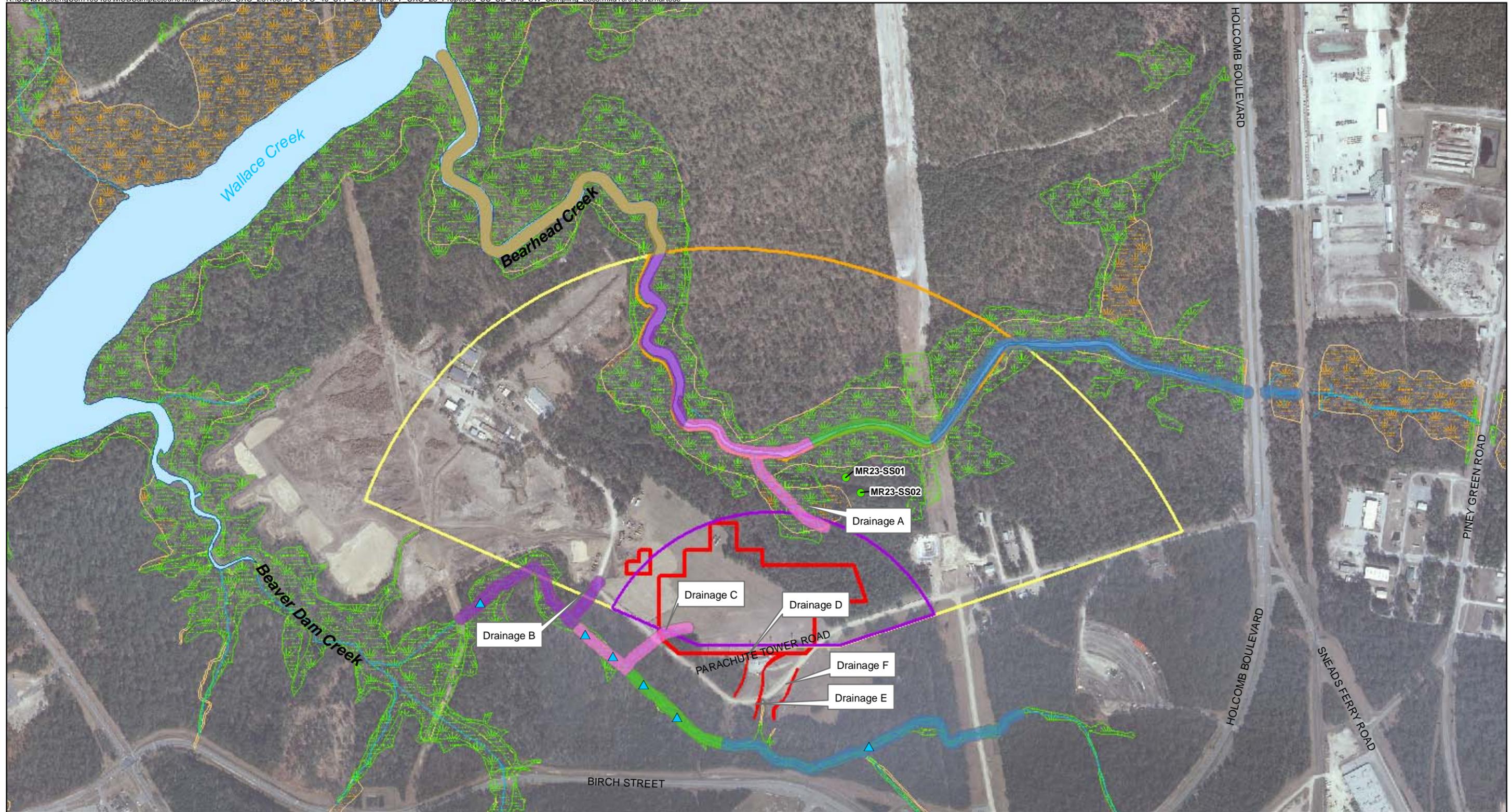


Figure 6
 Proposed Monitoring Well Locations
 UXO-23, Former D-9 Skeet Range
 Expanded Site Investigation Sampling and Analysis Plan
 MCIEAST-MCB CAMLEJ
 North Carolina



- Legend**
- Proposed Surface Soil Sample
 - ▲ Proposed Surface Water Sample
 - Section 1
 - Section 2
 - Section 3
 - Section 4
 - Section 5
 - New Road
 - - - Approximate Drainage Feature Location
 - - - Approximate Drainage Feature Location - NTCRA
 - Surface Water Course Area
 - Jurisdictional Wetland Area
 - Planning Wetland Area
 - D-9 Skeet Range North Area
 - Theoretical Shot Fall Zone
 - D-9 Skeet Range
 - NTCRA Area

Bearhead Creek Sediment Samples
 Section 1 - 5 samples
 Section 2 - 10 samples
 Section 3 - 10 samples
 Section 4 - 10 samples
 Section 5 - 15 samples

Beaver Dam Creek Sediment Samples
 Section 1 - 3 samples
 Section 2 - 5 samples
 Section 3 - 4 samples
 Section 4 - 4 samples

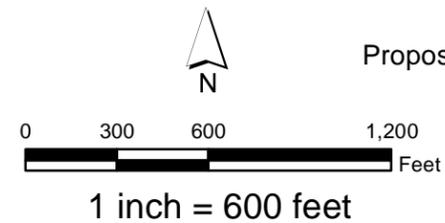


Figure 7
 Proposed Surface Soil, Sediment and Surface Water Sample Locations
 UXO-23, Former D-9 Skeet Range
 Expanded Site Investigation Sampling and Analysis Plan
 MCIEAST-MCB CAMLEJ
 North Carolina

Appendix A
Laboratory Specific Information

A-1 Reference Limits and Evaluation Tables

[\(UFP-QAPP Manual Section 2.8.1 – Worksheet # 15-1\)](#)

TABLE A-1A
Reference Limits and Evaluation Table

Matrix: Groundwater - North and South Areas

Analytical Group: PAHs

Analyte	CAS Number	NC2LGW (January, 2010) (µg/L) ¹	MCL-Groundwater (µg/L) ¹	RSLs Tapwater Adjusted (November 2011) (µg/L) ¹	Project Quantitation Limit Goal ² (µg/L)	Laboratory-Specific (µg/L)			LCS, MS, and MSD ??%R and %RPD Limits ³		
						LOQ	LOD	DL	LCL	UCL	%RPD
1-Methylnaphthalene	90-12-0	NC	1	0.97	0.485	0.5	0.1	0.0238	30	120	30
2-Methylnaphthalene	91-57-6	30	NC	2.7	1.35	0.5	0.1	0.0361	45	105	30
Acenaphthene	83-32-9	80	NC	40	20	0.5	0.1	0.029	45	110	30
Acenaphthylene	208-96-8	200	NC	40	20	0.5	0.1	0.036	50	105	30
Anthracene	120-12-7	2000	NC	130	65	0.5	0.05	0.038	55	110	30
Benzo(a)anthracene	56-55-3	0.05	NC	0.029	0.0145	0.5	0.1	0.0319	55	110	30
Benzo(a)pyrene	50-32-8	0.005	0.2	0.0029	0.00145	0.5	0.1	0.0294	55	110	30
Benzo(b)fluoranthene	205-99-2	0.05	NC	0.029	0.0145	0.5	0.1	0.0683	45	120	30
Benzo(g,h,i)perylene	191-24-2	200	NC	8.7	4.35	0.5	0.5	0.273	40	125	30
Benzo(k)fluoranthene	207-08-9	0.5	NC	0.29	0.145	0.5	0.1	0.0397	45	125	30
Chrysene	218-01-9	5	NC	2.9	1.45	0.5	0.1	0.0356	55	110	30
Dibenz(a,h)anthracene	53-70-3	0.005	NC	0.0029	0.00145	0.5	0.25	0.116	40	125	30
Fluoranthene	206-44-0	300	NC	63	31.5	0.5	0.1	0.0327	55	115	30
Fluorene	86-73-7	300	NC	22	11	0.5	0.1	0.0439	50	110	30
Indeno(1,2,3-cd)pyrene	193-39-5	0.05	NC	0.029	0.0145	0.5	0.25	0.111	45	125	30
Naphthalene	91-20-3	6	NC	0.14	0.07	0.5	0.1	0.0307	40	100	30
Phenanthrene	85-01-8	200	NC	130	65	0.5	0.1	0.0347	50	115	30
Pyrene	129-00-0	200	NC	8.7	4.35	0.5	0.1	0.0376	50	130	30

Notes:

¹ Refer to Section 2.3.2 for a detailed discussion on the development of PALs, and refer to Section 2.3.4 for specific identification of PALs by matrix.

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

³ DoD QSM (Quality Systems Manual)v.4.1 is the basis for LCS and MS/MSD limits. Bolded values represent in-house limits when DoD QSM v.4.1 limits do not exist.

NC indicates that there is no criterion for a particular analyte.

Shading indicates instances where the PAL is lower than the LOD. Non-detects will not be treated as exceedances, though they will be reported at a value greater than the PAL.

TABLE A-1B
Reference Limits and Evaluation Table

Matrix: Groundwater - North and South Areas

Analytical Group: Metal (Lead)

Analyte	CAS Number	NC2LGW (January, 2010) (µg/L) ¹	MCL-Groundwater (µg/L) ¹	RSLs Tapwater Adjusted (November 2011) (µg/L) ¹	BTV (µg/L) ¹	Project Quantitation Limit Goal ² (µg/L)	Laboratory-Specific (µg/L)			LCS, MS, and MSD %R and %RPD Limits ³		
							LOQ	LOD	DL	LCL	UCL	%RPD
Lead	7439-92-1	15	15	15	8.92	4.46	1	0.5	0.152	80	120	20

Notes:

¹ Refer to Section 2.3.2 for a detailed discussion on the development of PALs, and refer to Section 2.3.4 for specific identification of PALs by matrix.

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

³ DoD QSM v.4.1 is the basis for LCS and MS/MSD limits. Bolded values represent in-house limits when DoD QSM v.4.1 limits do not exist.

TABLE A-1C
Reference Limits and Evaluation Table

Matrix: Surface Water - Beaver Dam

Analytical Group: PAHs

Analyte	CAS Number	NC2B-SW-Water Supply (µg/L) ¹	NRWQC-Human Health- Water + Organism (µg/L) ¹	CLEAN RSLs Tap X 10 for SW Adjusted (November 2011) (µg/L) ¹	Region IV Ecological Screening Value - Freshwater (Chronic) (µg/L) ¹	Region IV Ecological Screening Value - Saltwater (Chronic) (µg/L) ¹	Project Quantitation Limit Goal ² (µg/L)	Laboratory-Specific (µg/L)			LCS, MS, and MSD %R and %RPD Limits ³		
								LOQ	LOD	DL	LCL	UCL	%RPD
1-Methylnaphthalene	90-12-0	NC	NC	9.7	NC	NC	4.85	0.5	0.1	0.0238	30	120	30
2-Methylnaphthalene	91-57-6	NC	NC	27	NC	NC	13.5	0.5	0.1	0.0361	45	105	30
Acenaphthene	83-32-9	NC	670	400	17	9.7	4.85	0.5	0.1	0.029	45	110	30
Acenaphthylene	208-96-8	NC	NC	400	NC	NC	200	0.5	0.1	0.036	50	105	30
Anthracene	120-12-7	NC	8300	1300	NC	NC	650	0.5	0.05	0.038	55	110	30
Benzo(a)anthracene	56-55-3	0.0028	0.0038	0.29	NC	NC	0.0014	0.5	0.1	0.0319	55	110	30
Benzo(a)pyrene	50-32-8	0.0028	0.0038	0.029	NC	NC	0.0014	0.5	0.1	0.0294	55	110	30
Benzo(b)fluoranthene	205-99-2	0.0028	0.0038	0.29	NC	NC	0.0014	0.5	0.1	0.0683	45	120	30
Benzo(g,h,i)perylene	191-24-2	NC	NC	87	NC	NC	43.5	0.5	0.5	0.273	40	125	30
Benzo(k)fluoranthene	207-08-9	0.0028	0.0038	2.9	NC	NC	0.0014	0.5	0.1	0.0397	45	125	30
Chrysene	218-01-9	0.0028	0.0038	29	NC	NC	0.0014	0.5	0.1	0.0356	55	110	30
Dibenz(a,h)anthracene	53-70-3	0.0028	0.0038	0.029	NC	NC	0.0014	0.5	0.25	0.116	40	125	30
Fluoranthene	206-44-0	NC	130	630	39.8	1.6	0.8	0.5	0.1	0.0327	55	115	30
Fluorene	86-73-7	NC	1100	220	NC	NC	110	0.5	0.1	0.0439	50	110	30
Indeno(1,2,3-cd)pyrene	193-39-5	0.0028	0.0038	0.29	NC	NC	0.0014	0.5	0.25	0.111	45	125	30
Naphthalene	91-20-3	NC	NC	1.4	62	23.5	0.7	0.5	0.1	0.0307	40	100	30
Phenanthrene	85-01-8	NC	NC	1300	NC	NC	650	0.5	0.1	0.0347	50	115	30
Pyrene	129-00-0	NC	830	87	NC	NC	43.5	0.5	0.1	0.0376	50	130	30

Notes:

¹ Refer to Section 2.3.2 for a detailed discussion on the development of PALs, and refer to Section 2.3.4 for specific identification of PALs by matrix.

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

³ DoD QSM v.4.1 is the basis for LCS and MS/MSD limits. Bolded values represent in-house limits when DoD QSM v.4.1 limits do not exist.

NC indicates that there is no criterion for a particular analyte.

Shading indicates instances where the PAL is lower than the LOD. Non-detects will not be treated as exceedances, though they will be reported at a value greater than the PAL.

TABLE A-1D
Reference Limits and Evaluation Table

Matrix: Surface Water - Beaver Dam

Analytical Group: Metal (Lead), Total and Dissolved

Analyte	CAS Number	NC2B-SW-Water Supply (µg/L) ¹	NRWQC-Human Health- Water + Organism (µg/L) ¹	CLEAN RSLs Tap X 10 for SW Adjusted (November 2011) (µg/L) ¹	Region IV Ecological Screening Value - Freshwater (Chronic) (µg/L) ¹	Region IV Ecological Screening Value - Saltwater (Chronic) (µg/L) ¹	Project Quantitation Limit Goal ² (µg/L)	Laboratory-Specific (µg/L)			LCS, MS, and MSD %R and %RPD Limits ³		
								LOQ	LOD	DL	LCL	UCL	%RPD
Lead	7439-92-1	NC	NC	15	1.32	8.5	0.66	1	0.5	0.152	80	120	20

Notes:

¹ Refer to Section 2.3.2?? for a detailed discussion on the development of PALs, and refer to Section 2.3.4 for specific identification of PALs by matrix.

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

³ DoD QSM v.4.1 is the basis for LCS and MS/MSD limits. Bolded values represent in-house limits when DoD QSM v.4.1 limits do not exist.

NC indicates that there is no criterion for a particular analyte.

TABLE A-1E
Reference Limits and Evaluation Table

Matrix: Sediment - Beaver Dam

Analytical Group: PAHs

Analyte	CAS Number	RSLs Industrial Soil Adjusted, (November, 2011) (µg/kg) ^{1,4}	RSLs Residential Soil Adjusted, (November, 2011) (µg/kg) ^{1,4}	Region IV Ecological Screening Value (µg/kg) ^{1,4}	NCSLs (June, 2011) (µg/kg) ^{1,4}	Project Quantitation Limit Goal ^{2,4} (µg/kg)	Laboratory-Specific (µg/kg)			LCS, MS, and MSD %R and %RPD Limits ³		
							LOQ	LOD	DL	LCL	UCL	%RPD
1-Methylnaphthalene	90-12-0	99000	22000	NC	50	25	17	17	3.91	50	150	30
2-Methylnaphthalene	91-57-6	370000	31000	20.2	1600	10.1	17	1.7	1.67	45	105	30
Acenaphthene	83-32-9	3300000	340000	6.71	8400	3.355	17	3.3	3.33	45	110	30
Acenaphthylene	208-96-8	3300000	340000	5.87	20900	2.935	17	3.3	3.33	45	105	30
Anthracene	120-12-7	17000000	1700000	46.9	660000	23.45	17	3.3	1.05	55	105	30
Benzo(a)anthracene	56-55-3	2100	150	74.8	180	37.4	17	3.3	3.33	50	110	30
Benzo(a)pyrene	50-32-8	210	15	88.8	59	7.5	17	3.3	3.33	50	110	30
Benzo(b)fluoranthene	205-99-2	2100	150	NC	600	75	17	3.3	1.95	45	115	30
Benzo(g,h,i)perylene	191-24-2	1700000	170000	NC	7800000	85000	33	3.3	1.88	40	125	30
Benzo(k)fluoranthene	207-08-9	21000	1500	NC	5900	750	17	3.3	1.78	45	125	30
Chrysene	218-01-9	210000	15000	108	18000	54	17	3.3	1.22	55	110	30
Dibenz(a,h)anthracene	53-70-3	210	15	6.22	190	3.11	33	17	16.7	40	125	30
Fluoranthene	206-44-0	2200000	230000	113	330000	56.5	17	3.3	3.33	55	115	30
Fluorene	86-73-7	2200000	230000	NC	56000	28000	33	3.3	1.99	50	110	30
Indeno(1,2,3-cd)pyrene	193-39-5	2100	150	NC	2000	75	33	3.3	1.67	40	120	30
Naphthalene	91-20-3	18000	3600	34.6	210	17.3	17	3.3	1.67	40	105	30
Phenanthrene	85-01-8	17000000	1700000	NC	67600	33800	17	3.3	0.723	50	110	30
Pyrene	129-00-0	1700000	170000	153	220000	76.5	17	3.3	1.67	45	125	30

Notes:

¹ Refer to Section 2.3.2 for a detailed discussion on the development of PALs, and refer to Section 2.3.4 for specific identification of PALs by matrix.

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

³ DoD QSM v.4.1 is the basis for LCS and MS/MSD limits. Bolded values represent in-house limits when DoD QSM v.4.1 limits do not exist.

⁴ PALs and Project QL Goals assume dry weight basis.

Shading indicates instances where the PAL is lower than the LOD. Non-detects will not be treated as exceedances, though they will be reported at a value greater than the PAL.

TABLE A-1F
Reference Limits and Evaluation Table

Matrix: Soil – South Area, Sediment - Bearhead Creek and Beaver Dam
Analytical Group: Metal (Lead)

Analyte	CAS Number	RSLs Industrial Soil Adjusted, (November, 2011) (mg/kg) ^{1,4}	RSLs Residential Soil Adjusted, (November, 2011) (mg/kg) ^{1,4}	Region IV Ecological Screening Value (mg/kg) ^{1,4}	NCSLs (June, 2011) (mg/kg) ^{1,4}	Project Quantitation Limit Goal ^{2,4} (mg/kg)	Laboratory-Specific (mg/kg)			LCS, MS, and MSD %R and %RPD Limits ³		
							LOQ	LOD	DL	LCL	UCL	%RPD
Lead	7439-92-1	800	400	30.2	270	15.1	0.1	0.02	0.0066	80	120	20

Notes:

¹ Refer to Section 2.3.2 for a detailed discussion on the development of PALs, and refer to Section 2.3.4 for specific identification of PALs by matrix.

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

³ DoD QSM v.4.1 is the basis for LCS and MS/MSD limits. Bolded values represent in-house limits when DoD QSM v.4.1 limits do not exist.

⁴ PALs and Project QL Goals assume dry weight basis.

TABLE A-1G
Reference Limits and Evaluation Table

Matrix: Sediment - Beaver Dam, Bearhead Creek

Analytical Group: Wet Chemistry (TOC)

Analyte	CAS Number	Laboratory-Specific (mg/kg)			LCS, MS, and MSD %R and %RPD Limits ³		
		LOQ	LOD	DL	LCL	UCL	%RPD
TOC	TOC ¹	1000	1000	225	75	125	20

Notes:

There are no action limits for TOC.

TOC will serve as an indicator for the binding of metals and PAHs to sediments.

¹ Contractor-generated CAS number.

A-2 Analytical SOP References Table

[\(UFP-QAPP Manual Section 2.8.1 – Worksheet # 15-2\)](#)

[\(UFP-QAPP Manual Section 3.2.1 – Worksheet #23\)](#)

TABLE A-2A
Analytical SOP References Table

Laboratory Name and Address: TriMatrix Laboratories, 5560 Corporate Exchange Ct. SE, Grand Rapids, MI 49512

Point of Contact: Walt Roudebush

Phone Number: (616) 975-4561

Lab SOP Number	Title, Revision Date, and Number	Date Reviewed/Revised	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Variance to QSM	Modified for Project Work? (Y/N)
GR-01-129	Inductively Coupled Plasma Mass Spectrometry Perkin Elmer ELAN-6000, 09/25/11, rev. 4.0, 6020A	9/25/2011	Definitive	Water and Soil - Metals	Perkin Elmer ELAN ICP/MS 6000, 6100	N	N
GR-01-137	Acid Digestion of Sediments, Sludges and Soils Using Block Digestion, 09/20/11, rev 1.6, 3050B	9/20/2011	Definitive	Soil - Metals	Environmental Express Hot Block	N	N
GR-01-148	Block Digestion of Aqueous Samples and Extracts for Total/Dissolved Metals by ICPMS 10/20/11, rev 0.4, 3020A	10/20/2011	Definitive	Water - Metals	Environmental Express Hot Block	N	N
GR-04-103	Semi-Volatile Laboratory Mass Spectrometry Analysis of Base/Neutral/Acid Compounds, 05/15/11, rev. 5.7, 8270C	5/15/2011	Definitive	Water and Soil - SVOCs	Agilent GC 6890 5973N MSD or Agilent GC 6890 5975N MSD	N	N
GR-05-132	Leco Carbon Analyzer (Organic Carbon), 01/20/12, rev 0.0, Lloyd Khan	1/20/2012	Definitive	Soil - TOC	LECO Carbon Analyzer	N	N
GR-09-101	The Extraction of BNAs in Water, 05/02/11, rev 3.4, 3510C	5/2/2011, review in progress	Definitive	Water - SVOCs	NA	N	N
GR-09-103	Extraction of Semi-Volatile BNA's in Soil, Sediment and Sludge, 10/31/11, rev. 3.8, 3550B	10/31/2011	Definitive	Soil - SVOCs	NA	N	N
GR-10-104	Internal Chain of Custody Procedure, 11/10/11, rev 2.3	11/10/2011	NA	Storage and Custody	NA	N	N
GR-15-100	Sample Receiving/Sample Log-In, 01/25/12, rev. 3.3	1/25/2012	NA	Login and Storage	NA	N	N
GR-15-102	Laboratory Waste Disposal, 04/25/11, rev 2.3	4/25/11, review in progress	NA	Waste Disposal	NA	N	N

A-3 Laboratory QC Samples Table

[\(UFP-QAPP Manual Section 3.4 – Worksheet #28-1\)](#)

[\(UFP-QAPP Manual Section 3.4 – Worksheet #28-2\)](#)

TABLE A-3A
Laboratory QC Samples Table

Matrix: Groundwater, Surface Water

Analytical Group: PAHs

Analytical Method/SOP Reference: SW846 8270C/GR-04-103

QC Sample:	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	One per preparatory batch of up to 20 samples.	No analytes detected > 1/2 LOD and greater than 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes detected > LOD.	Correct the problem. If required, reprep and reanalyze the method blank and all samples processed with the contaminated blank.	Analyst/Laboratory Area Supervisor	Contamination/Bias	No analytes detected > 1/2 LOD and greater than 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes detected > LOD.
Laboratory Control Sample (LCS) containing all analytes to be reported, including surrogates	One per preparatory batch of up to 20 samples.	QC acceptance criteria specified in DoD QSM v4.1, if available. Otherwise use in-house limits.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.		Accuracy/Bias	QC acceptance criteria specified in DoD QSM v4.1, if available. Otherwise use in-house limits.
Laboratory Control Sample Duplicate (LCSD) containing all analytes to be reported, including surrogates	One per preparatory batch of up to 20 samples.	QC acceptance criteria specified in DoD QSM v4.1, if available. Otherwise use in-house limits.	Correct problem, then reprep and reanalyze the LCS/LCSD and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.		Accuracy/Bias	QC acceptance criteria specified in DoD QSM v4.1, if available. Otherwise use in-house limits.
Matrix Spike (MS)	One per preparatory batch of up to 20 samples.	For matrix evaluation use QC acceptance criteria specified for LCS.	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.		Accuracy/Bias	For matrix evaluation use QC acceptance criteria specified for LCS.
Matrix Spike Duplicate (MSD)	One per preparatory batch of up to 20 samples.	MSD: For matrix evaluation, use QC acceptance criteria specified for LCS. MSD: RPD < 30% (between MS and MSD).	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.	Analyst/Laboratory Area Supervisor	Precision/Accuracy/Bias	MSD: For matrix evaluation, use QC acceptance criteria specified for LCS. MSD: RPD < 30% (between MS and MSD).
Internal Standards (IS) verification	Every field sample, standard, and QC sample	Retention times for internal standards must be ± 30 seconds from retention time of the midpoint standard in the initial calibration (ICAL) and the responses within -50% to +100% of ICAL midpoint standard.	Inspect mass spectrometer and/or gas chromatograph for malfunctions. Reanalysis of samples analyzed while system was malfunctioning is mandatory.			Retention times for internal standards must be ± 30 seconds from retention time of the midpoint standard in the ICAL and the responses within -50% to +100% of ICAL midpoint standard.
Surrogate Spike	All field and QC samples.	Nitrobenzene-d5 40-110; 2-Fluorobiphenyl 50-110; o-Terphenyl 50-135	For QC and field samples, correct problem then reprep and reanalyze all failed samples for failed surrogates in the associated preparatory batch, if sufficient sample material is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary.		Accuracy/Bias	Nitrobenzene-d5 40-110; 2-Fluorobiphenyl 50-110; o-Terphenyl 50-135

TABLE A-3B
Laboratory QC Samples Table

Matrix: Groundwater, Surface Water

Analytical Group: Metal (Lead), Total and ¹Dissolved

Analytical Method/SOP Reference: SW-846 6020A/GR-01-129

QC Sample:	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	One per preparatory batch of up to 20 samples.	No analytes detected > 1/2 LOD and greater than 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes detected > LOD.	Correct the problem. If required, reprep and reanalyze the method blank and all samples processed with the contaminated blank.	Analyst/Laboratory Area Supervisor	Contamination/Bias	No analytes detected > 1/2 LOD and greater than 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes detected > LOD.
Laboratory Control Sample (LCS) containing all analytes to be reported	One per preparatory batch of up to 20 samples.	QC acceptance criteria specified in DoD QSM v4.1, if available. Otherwise use in-house limits.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.		Accuracy/Bias	QC acceptance criteria specified in DoD QSM v4.1, if available. Otherwise use in-house limits.
Matrix Spike (MS)	One per preparatory batch of up to 20 samples.	For matrix evaluation use QC acceptance criteria specified for LCS.	Examine results of LCS. If both the LCS and MS/MSD or MS/DUP are unacceptable, re-prepare and analyze the associated samples and QC, otherwise report and narrate.		For matrix evaluation use QC acceptance criteria specified for LCS.	
Matrix Spike Duplicate (MSD) or Sample Duplicate (DUP)	One per preparatory batch of up to 20 samples.	MSD: For matrix evaluation, use QC acceptance criteria specified for LCS. MSD or sample duplicate: RPD < 20% (between MS and MSD or sample and sample duplicate).	Examine results of LCS. If both the LCS and MS/MSD or MS/DUP are unacceptable, re-prepare and analyze the associated samples and QC, otherwise report and narrate.		Precision/ Accuracy/Bias	MSD: For matrix evaluation, use QC acceptance criteria specified for LCS. MSD or sample duplicate: RPD < 20% (between MS and MSD or sample and sample duplicate).
Serial Dilution (aka Dilution test)	One per preparatory batch for samples with concentration > 50 x LOQ.	Five-fold dilution must agree within ± 10% of the original measurement.	Perform Post Digestion Spike (PDS) addition.		Precision/Accuracy	Five-fold dilution must agree within ± 10% of the original measurement.
Post Digestion Spike (PDS)	When serial dilution fails or analyte concentration in all samples < 50 x LOD.	Recovery within 75-125%.	Run all associated sample in the preparatory batch by method of standard additions (MSA) or qualify results.		Recovery within 75-125%.	
Internal Standards (IS)	NA.	IS intensity within 30-120% of intensity of the IS in the ICAL.	Reanalyze sample at 5-fold dilution with addition of appropriate amounts of internal standards.	Accuracy/Bias	IS intensity within 30-120% of intensity of the IS in the ICAL.	

Notes:

¹Surface water only

TABLE A-3C
Laboratory QC Samples Table

Matrix: Sediment
Analytical Group: PAHs
Analytical Method/SOP Reference: SW-846 8270C/GR-04-103

QC Sample:	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	One per preparatory batch of up to 20 samples.	No analytes detected > 1/2 LOD and greater than 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes detected > LOD.	Correct the problem. If required, reprep and reanalyze the method blank and all samples processed with the contaminated blank.	Analyst/Laboratory Area Supervisor	Contamination/Bias	No analytes detected > 1/2 LOD and greater than 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes detected > LOD.
Laboratory Control Sample (LCS) containing all analytes to be reported, including surrogates	One per preparatory batch of up to 20 samples.	QC acceptance criteria specified in DoD QSM v4.1, if available. Otherwise use in-house limits.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.		Accuracy/Bias	QC acceptance criteria specified in DoD QSM v4.1, if available. Otherwise use in-house limits.
Laboratory Control Sample Duplicate (LCSD) containing all analytes to be reported, including surrogates	One per preparatory batch of up to 20 samples.	QC acceptance criteria specified in DoD QSM v4.1, if available. Otherwise use in-house limits.	Correct problem, then reprep and reanalyze the LCS/LCSD and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.			QC acceptance criteria specified in DoD QSM v4.1, if available. Otherwise use in-house limits.
Matrix Spike (MS)	One per preparatory batch of up to 20 samples.	For matrix evaluation use QC acceptance criteria specified for LCS.	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.			For matrix evaluation use QC acceptance criteria specified for LCS.
Matrix Spike Duplicate (MSD)	One per preparatory batch of up to 20 samples.	MSD: For matrix evaluation, use QC acceptance criteria specified for LCS. MSD: RPD < 30% (between MS and MSD).	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.	Analyst/Laboratory Area Supervisor	Precision/Accuracy/Bias	MSD: For matrix evaluation, use QC acceptance criteria specified for LCS. MSD: RPD < 30% (between MS and MSD). Retention times for internal standards must be ± 30 seconds from retention time of the midpoint standard in the ICAL and the responses within -50% to +100% of ICAL midpoint standard.
Internal Standards (IS) verification	Every field sample, standard, and QC sample	Retention times for internal standards must be ± 30 seconds from retention time of the midpoint standard in the ICAL and the responses within -50% to +100% of ICAL midpoint standard.	Inspect mass spectrometer and/or gas chromatograph for malfunctions. Reanalysis of samples analyzed while system was malfunctioning is mandatory.		Retention times for internal standards must be ± 30 seconds from retention time of the midpoint standard in the ICAL and the responses within -50% to +100% of ICAL midpoint standard.	
Surrogate Spike	All field and QC samples.	Nitrobenzene-d5 35-100; 2-Fluorobiphenyl 45-105; o-Terphenyl 30-125	For QC and field samples, correct problem then reprep and reanalyze all failed samples for failed surrogates in the associated preparatory batch, if sufficient sample material is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary.		Accuracy/Bias	Nitrobenzene-d5 35-100; 2-Fluorobiphenyl 45-105; o-Terphenyl 30-125

TABLE A-3D
Laboratory QC Samples Table

Matrix: Sediment and Soil

Analytical Group: Metal (Lead)

Analytical Method/SOP Reference: SW846 6020A/GR-01-129

QC Sample:	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	One per preparatory batch of up to 20 samples.	No analytes detected > 1/2 LOD and greater than 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes detected > LOD.	Correct the problem. If required, reprep and reanalyze the method blank and all samples processed with the contaminated blank.	Analyst/Laboratory Area Supervisor	Contamination/Bias	No analytes detected > 1/2 LOD and greater than 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes detected > LOD.
Laboratory Control Sample (LCS) containing all analytes to be reported	One per preparatory batch of up to 20 samples.	QC acceptance criteria specified in DoD QSM v4.1, if available. Otherwise use in-house limits.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.		Accuracy/Bias	QC acceptance criteria specified in DoD QSM v4.1, if available. Otherwise use in-house limits.
Matrix Spike (MS)	One per preparatory batch of up to 20 samples.	For matrix evaluation use QC acceptance criteria specified for LCS.	Examine results of LCS. If both the LCS and MS/MSD or MS/DUP are unacceptable, re-prepare and analyze the associated samples and QC, otherwise report and narrate.		For matrix evaluation use QC acceptance criteria specified for LCS.	
Matrix Spike Duplicate (MSD) or Sample Duplicate (DUP)	One per preparatory batch of up to 20 samples.	MSD: For matrix evaluation, use QC acceptance criteria specified for LCS. MSD or sample duplicate: RPD < 20% (between MS and MSD or sample and sample duplicate).	Examine results of LCS. If both the LCS and MS/MSD or MS/DUP are unacceptable, re-prepare and analyze the associated samples and QC, otherwise report and narrate.		Precision/Accuracy/Bias	MSD: For matrix evaluation, use QC acceptance criteria specified for LCS. MSD or sample duplicate: RPD < 20% (between MS and MSD or sample and sample duplicate).
Serial Dilution (aka Dilution test)	One per preparatory batch for samples with concentration > 50 x LOQ.	Five-fold dilution must agree within ± 10% of the original measurement.	Perform Post Digestion Spike (PDS) addition.	Analyst/Laboratory Area Supervisor	Precision/Accuracy	Five-fold dilution must agree within ± 10% of the original measurement.
Post Digestion Spike (PDS)	When serial dilution fails or analyte concentration in all samples < 50 x LOD.	Recovery within 75-125%.	Run all associated sample in the preparatory batch by method of standard additions (MSA) or qualify results.			Recovery within 75-125%.
Internal Standards (IS)	NA.	IS intensity within 30-120% of intensity of the IS in the ICAL.	Reanalyze sample at 5-fold dilution with addition of appropriate amounts of internal standards.		Accuracy/Bias	IS intensity within 30-120% of intensity of the IS in the ICAL.

TABLE A-3D
Laboratory QC Samples Table

Matrix: Sediment
Analytical Group: Wet Chemistry (TOC)
Analytical Method/SOP Reference: Lloyd Kahn/GR-05-132

QC Sample:	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	One per preparatory batch of up to 20 samples.	Analyte not detected > 1/2 LOD and greater than 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results.	Re-prepare and analyze all associated samples. Discuss with client/qualify if re-analysis not feasible.	Analyst/Laboratory Area Supervisor	Contamination/ Bias	Analyte not detected > 1/2 LOD and greater than 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results.
Laboratory Control Sample (LCS)	One per preparatory batch of up to 20 samples.	See Table A-1g	Re-prepare and analyze all associated samples. Discuss with client/qualify if re-analysis not feasible.		See Table A-1g	
Matrix Spike (MS)	One per preparatory batch of up to 20 samples.	For matrix evaluation use QC acceptance criteria specified for LCS.	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.		Accuracy/Bias	For matrix evaluation use QC acceptance criteria specified for LCS.
Matrix Spike Duplicate (MSD)	One per preparatory batch of up to 20 samples.	MSD: For matrix evaluation, use QC acceptance criteria specified for LCS. MSD: RPD < 20% (between MS and MSD).	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.		MSD: For matrix evaluation, use QC acceptance criteria specified for LCS. MSD: RPD < 20% (between MS and MSD).	

Appendix B
Field Standard Operating Procedures

Preparing Field Log Books

I. Purpose

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

II. Scope

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

III. Equipment and Materials

- Log book
- Indelible pen

IV. Procedures and Guidelines

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

A. PROCEDURES FOR COMPLETING FIELD LOG BOOKS

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

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

B. INFORMATION TO BE INCLUDED IN FIELD LOG BOOKS

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

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

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

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

C. SUGGESTED FORMAT FOR RECORDING FIELD DATA

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

V. Attachments

Example field notes.

(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 ~~STARTS~~ (JS) CALIBRATES
 PID: 101 ppm/100 ppm OK
 PID MODEL #, SERIAL #

0730 BB CALIBRATES HORIBA MEYER
 MODEL #, SERIAL #
 → LIST CALIBRATION RESULTS

0738 SURVEY CREW ARRIVES ON SITE
 → LIST NAMES

0745 BB HOLDS H+S TALK ON SLIPS,
 TRIPS, FALLS, TICKETS + 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 GWD 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 TAT 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 PAPER PUSHER AND HE STATED
 HE WILL CHECK ON GAINING ACCESS
 WITH BASE CONTACT.

0955 Mobilize to well MW-19

JS
5-12-03

Locating and Clearing Underground Utilities

I. Purpose

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

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

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

II. Scope

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

Scenario 1

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

Scenario 2

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

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

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

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

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

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

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

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

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

III. Services and Equipment

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

Services

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

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

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

Equipment

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

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

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

IV. Procedures and Guidelines

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

Activity Notification and Dig Permit Procedures

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

Activity Specific: To be provided by Activity or Project Manager

CH2M HILL Utility Clearance Procedures

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

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

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

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

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

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

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

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

V. Attachments

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

Attachment A – Example SOW for Subcontracting Underground Utilities Locating Services

CTO-**XXX**

Scope of Work

Subsurface Utility Locating

Site **XX**

Navy Activity

City, State

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

Proposed Scope of Work

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

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

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

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

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

Field Marking and Documentation

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

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

Bid Sheet/Payment Units

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

Health and Safety Requirements

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

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

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

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

Security

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

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

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

Quality Assurance

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

Subcontractor Standby Time

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

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

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

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

Down Time

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

Schedule

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

Attachment B - Services Available for Identifying and Marking Underground Utilities

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

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

Each are discussed below.

Navy Public Works Department

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

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

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

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

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

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

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

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

Private Subcontractors

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

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

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

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

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

Notes:

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

¹Equipment types are:

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

²Other services include:

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

Attachment C – Equipment Used for Identifying Underground Utilities

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

CH2M HILL In-house Utility Location Experts

Tamir Klaff/WDC

Home Office Phone – 703-669-9611

Electromagnetic Induction (EMI) Methods

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

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

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

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

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

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

Ground Penetrating Radar (GPR)

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

Magnetic Field Methods

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

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

Optical Methods

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

Attachment D – Utility Clearance Documentation Form

Attachment E – Utility Marking Color Codes

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

White - Proposed excavations and borings

Pink - Temporary survey markings

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

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

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

Blue - Potable water

Purple - Reclaimed water, irrigation and slurry lines

Green - Sewer and storm drain lines

General Guidance for Monitoring Well Installation

I. Purpose

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

II. Scope

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

III. Equipment and Materials

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

IV. Procedures and Guidelines

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

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

Monitoring Well Installation

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

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

Well Development

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

V. Attachments

None.

VI. Key Check and Items

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

Low-Flow Groundwater Sampling from Monitoring Wells – EPA Region IV

I. Purpose and Scope

This SOP presents general guidelines for the collection of groundwater samples from monitoring wells using low-flow purging and sampling procedures. Operations manuals should be consulted for specific calibration and operating procedures. This SOP is consistent with the EPA Region IV Groundwater Sampling Science and Ecosystem Support Division (SESD) Operating Procedure (effective October 2011).

II. Equipment and Materials

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

III. Procedures and Guidelines

A. Setup and Purging

1. Obtain information on well location, diameter(s), depth, and screen interval(s), and the method for disposal of purged water.
2. Calibrate instruments according to manufacturer's instructions.

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

12. During purging, the field parameters are measured frequently (every 5 minutes) until the parameters have stabilized. Field parameters are considered stable when measurements meet the following criteria:
 - pH: within 0.1 pH units
 - Specific conductance: within 10 percent
 - Turbidity: <10 NTU or within 10 percent
 - Temperature: constant

B. Sample Collection

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

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

VOC samples are normally collected first and directly into pre-preserved sample containers (see Special Conditions for Sampling with Peristaltic Pumps).

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

1. The cap is removed from the sample bottle, and the bottle is tilted slightly.
2. The sample is slowly poured from the bailer or discharged from the pump so that it runs down the inside of the sample bottle with a minimum of splashing. The pumping rate should be reduced to approximately 100 ml per minute when sampling VOCs.
3. Inorganics, including metals, may be collected and preserved in the filtered form as well as the unfiltered form. Disposable in-line filters (0.45 micron filter), connected to the end of the sample tubing,, are typically used for field filtration. Samples are field filtered as the water is being placed into the sample container. If a bailer is used, filtration may be driven by a peristaltic pump.
4. Adequate space is left in the bottle to allow for expansion, except for VOC vials, which are filled to the top with a positive meniscus.
5. The bottle is capped and clearly labeled.
6. Samples are placed in appropriate containers and, if necessary, packed with ice in coolers as soon as practical.
7. Nondedicated equipment is cleaned and decontaminated in accordance with the *Decontamination of Personnel and Equipment SOP*.

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

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

Special Conditions for Sampling with Peristaltic Pumps

It is not acceptable to collect samples for organic compounds analyses through the flexible tubing used in the pump head. When collecting samples for organic compound analyses it is necessary to use a vacuum container, placed between the pump and the well for sample collection.

The following step-by-step procedures describe the process of sampling with a peristaltic pump and vacuum jug (see note following these procedures for collection of VOC samples):

1. Disconnect the purge tubing from the pump. Make sure the tubing is securely attached to the protective casing or other secure object.
2. Insert the tubing into one of the ferrule nut fittings of a Teflon® vacuum container transfer cap assembly.
3. Place a suitable length of Teflon® tubing between the remaining transfer cap assembly ferrule nut fitting and the vacuum side of the flexible tubing in the peristaltic pump head. Securely hand-tighten both fittings.
4. Turn the pump on. Water should begin to collect in the transfer container (typically a 1-liter "Boston round" glass sample container) within a few minutes. If water does not begin to flow into the container within several minutes, check the transfer cap fittings and make sure the assembly is tightly attached to the container. It may be necessary to tighten the ferrule nuts with a wrench or pliers to achieve a vacuum in the system, particularly when approaching the maximum head difference between the pump and water table (limit of suction).
5. When the transfer container is nearly full, turn off the pump, remove the transfer cap assembly, and pour the sample into the appropriate containers.
6. If additional sample volume is needed, replace the transfer cap assembly, turn the pump on, and collect additional volume.

NOTE: Samples for volatile organic compound analyses cannot be collected using the vacuum jug method. If samples for VOC analyses are required, they must be collected with a bailer or by other approved methods, such as the “soda straw” method. The “soda straw” method involves allowing the tubing to fill, by either lowering it into the water column (A) or by filling it via suction applied by the pump head (B). If method (A) is used, the tubing is removed from the well after filling and the captured sample is allowed to drain into the sample vial. If method (B) is used, after running the pump and filling the tubing with sample, the pump speed is reduced and the direction reversed to push the sample out of the tubing into the vials. Avoid completely emptying the tubing when filling the sample vials when using method (B) to prevent introducing water that was in contact with the flexible pump head tubing. Either method is repeated, as necessary, until all vials are filled.

Samples for some constituents, primarily inorganic analytes such as metals and cyanide, may be collected directly from the peristaltic pump head tubing. This method is acceptable under the following conditions:

- The pump head tubing must be changed between sampling locations;
- An equipment rinsate blank must be collected by pumping de-ionized water through a piece of the tubing.

C. Additional remarks

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

IV. Attachments

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

V. Key Checks and Preventative Maintenance

- The drawdown in the well should be minimized as much as possible (preferably no more than 0.5-foot to 1 foot) so that natural groundwater-flow conditions are maintained as closely as possible.

- The highest purging rate should not exceed 1 liter per minute. This is to keep the drawdown minimized.
- Stirring up of sediment in the well should be avoided so that turbidity containing adsorbed chemicals is not suspended in the well and taken in by the pump.
- Overheating of the pump should be avoided to minimize the potential for losing VOCs through volatilization.
- Keep the working space clean with plastic sheeting and good housekeeping.
- Maintain field equipment in accordance with the manufacturer's recommendations. This will include, but is not limited to:
 - Inspect sampling pump regularly and replace as warranted
 - Inspect quick-connects regularly and replace as warranted
 - Verify battery charge, calibration, and proper working order of field measurement equipment prior to initial mobilization and daily during field efforts

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

White Paper on Low-Flow Sampling

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

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

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

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

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

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

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

Groundwater Sampling from Monitoring Wells

I. Purpose and Scope

This procedure presents general guidelines for collecting groundwater samples from monitoring wells. The procedure does not address purging and sampling using “low-flow” techniques (see SOP *Low-Flow Groundwater Sampling from Monitoring Wells*). Operations manuals should be consulted for specific calibration and operating procedures.

II. Equipment and Materials

- Peristaltic pump, bladder pump, or submersible sampling pump with tubing, support cables, and power supply
- Horiba® U-22 or equivalent device for monitoring pH, specific conductance, turbidity, dissolved oxygen, oxidation-reduction potential (ORP), and temperature
- Probe box with inlet/outlet ports for purged groundwater and watertight ports for each probe
- Disposable 0.45µm filters (QED® FF8100 or equivalent), if applicable
- Bailer (Teflon or stainless steel), if applicable

Note: bailers and peristaltic pumps should only be used when site access or other limitations prevent using a submersible sampling pump

III. Procedures and Guidelines

A. Setup and Purging

1. Obtain information on well location, diameter(s), depth, and screened interval(s), and the method for disposal of purged water.
2. A pump will be used for well purging if the well yield is adequate; otherwise, a bailer may be used depending on project requirements.
3. Sampling equipment is cleaned and decontaminated prior to sampling in accordance with SOP *Decontamination of Personnel and Equipment*.
4. Instruments are calibrated according to manufacturer's instructions.

5. The well number, site, date, and condition are recorded in the field logbook.
6. Plastic sheeting is placed on the ground, and the well is unlocked and opened.
7. Water level measurements are collected in accordance with the *Water Level Measurement SOP*.
8. The volume (v) of water in a well casing is calculated as follows:

$$v = 7.48(\pi r^2 h)$$

where: $\pi = 3.14$

v = volume of water in well (gallons)

r = Radius of the well (feet)

h = height of water in well (feet)

The volume of water in common well casing diameters may be calculated as follows:

2-inch diameter well:

0.163 gal/ft x ___ (linear feet of water) = gallons

4-inch diameter well:

0.653 gal/ft x ___ (linear feet of water) = gallons

6-inch diameter well:

1.469 gal/ft x ___ (linear feet of water) = gallons

9. Attach tubing, support cable or rope, and air line (if applicable to the pump). The support line should bear the weight of the pump. Set pump in the well at the desired sampling interval, typically mid-screen, and begin purging. If a bailer is being used, it is removed from its protective covering and attached to a cord compatible with constituents.
10. Field parameters including pH, ORP, turbidity, dissolved oxygen, specific conductance, and temperature are measured and recorded in the field logbook. The measurement probes are inserted into a probe box. The purged groundwater is directed through the box, allowing measurements to be collected before the water contacts the atmosphere.
11. During purging, the field parameters are measured at least once for each well volume. In productive wells, the well purging end point is determined using the field measurements. In nonproductive wells, the well is repeatedly bailed dry to obtain a minimum of three well volumes, then allowed to recover before sampling.
12. Three to five well volumes are purged (more may be purged if parameters do not stabilize). Purging is stopped when field parameters have stabilized over three consecutive well volumes. Field parameters are considered stable when pH measurements agree within 0.1 units, specific conductance measurements agree within 3 percent, ORP

measurements agree within 10 mV, dissolved oxygen measurements agree within 10 percent, and turbidity measurements agree within 10 percent or are as low as practicable given sampling conditions.

B. Sample Collection

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

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

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

8. The cap is removed from the sample bottle, and the bottle is tilted slightly.
9. The sample is slowly poured from the bailer or discharged from the pump so that it runs down the inside of the sample bottle with a minimum of splashing. The pumping rate should be reduced to approximately 100 ml per minute when sampling VOCs.
10. Inorganics, including metals, may be collected and preserved in the filtered form as well as the unfiltered form. Disposable in-line filters (0.45 micron filter), connected to the end of the sample tubing, are typically used for field filtration. Samples are field filtered as the water is being placed into the sample container. If a bailer is used, filtration may be driven by a peristaltic pump.
11. Adequate space is left in the bottle to allow for expansion, except for VOC vials, which are filled to the top with a positive meniscus.
12. The bottle is capped and clearly labeled.
13. Samples are placed in appropriate containers and, if necessary, packed with ice in coolers as soon as practical.
14. If the sample tubing or bailer is dedicated, it is returned to the well and the well is capped and locked. Nondedicated equipment is cleaned and decontaminated in accordance with the *Decontamination of Personnel and Equipment* SOP.

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

6. Sample identification (site name, location, and project number; sample name/number and location; sample type and matrix; time and date; sampler's identity)
7. Sample source and source description

8. Field observations and measurements (appearance, volatile screening, field chemistry, sampling method), volume of water purged prior to sampling, number of well volumes purged, and field parameter measurements
9. Sample disposition (preservative; laboratory name, date and time sent; laboratory sample number, chain-of-custody number, sample bottle lot number)
10. Additional remarks

IV. Attachments

None.

V. Key Checks and Preventative Maintenance

- Use of peristaltic pumps and bailers should be avoided, if possible.
- Allow the field parameters to stabilize within the specified criteria as much as possible.
- Fill bottles for VOC samples first.
- Be sure the sample identification is properly specified.
- Maintain field equipment in accordance with the manufacturer's recommendations. This may include, but is not limited to:
 - Inspect sampling pump regularly and replace as warranted
 - Bring supplies for replacing the bladder if using a positive-displacement bladder pump
 - Inspect tubing regularly and replace as warranted
 - Inspect air/sample line quick-connects regularly and replace as warranted
 - Verify battery charge, calibration, and proper working order of field measurement equipment prior to initial mobilization and daily during field efforts

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

I. Purpose and Scope

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

II. Equipment and Materials

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

III. Procedures and Guidelines

A. Parameters and Specifications:

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

B. Calibration:

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

Horiba Calibration procedure:

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

YSI Calibration procedure:

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

A. *Conductivity Calibration:*

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

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

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

B. Dissolved Oxygen Calibration:

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

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

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

C. *pH Calibration:*

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

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

D. ORP Calibration:

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

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

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

Record the calibration data (e.g. time, instrument ID, solution lot number and expiration date, final calibrated readings, and solution temperature in the field logbook.

C. Sample Measurement:

Horiba measurement procedure:

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

record data in a field notebook.

YSI measurement procedure:

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

IV. Key Checks and Preventive Maintenance

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

V. References

YSI 556 Multi Probe System Operator Manual

Water-Level Measurements

I. Purpose and Scope

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

II. Equipment and Materials

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

III. Procedures and Guidelines

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

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

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

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

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

Where WL_c = Corrected water-level elevation

WL_a = Apparent water-level elevation

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

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

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

IV. Attachments

None.

V. Key Checks

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

Equipment Blank and Field Blank Preparation

I. Purpose

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

II. Scope

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

III. Equipment and Materials

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

IV. Procedures and Guidelines

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

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

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

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

V. Attachments

None.

VI. Key Checks and Items

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

Chain-of-Custody

I Purpose

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

II Scope

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

III Definitions

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

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

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

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

IV Responsibilities

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

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

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

V Procedures

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

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

V.1 Sample Identification

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

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

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

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

Measurements and observations shall be recorded using waterproof ink.

V.1.1 Sample Label

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

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

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

V.2 Chain-of-Custody Procedures

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

V.2.1 Field Custody Procedures

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

V.2.2 Transfer of Custody and Shipment

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

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

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

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

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

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

VI Quality Assurance Records

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

VII Attachments

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

VIII References

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

Attachment A
Example Sample Label



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: _____

Attachment B
Example Chain-of-Custody Record

CH2M Hill Project # □□□□□□□□□□□□□□□□		Purchase Order #		# O F C O N T A I N E R S	LAB TEST CODES										SHADED AREA- FOR LAB USE ONLY						
Project Name															Lab 1 #		Lab 2 #				
Company Name CH2M HILL Office															Quote #		Kit Request #				
Project Manager & Phone # Mr. [] Ms. [] Dr. []					Report Copy to:		ANALYSES REQUESTED										Project #				
Requested Completion Date:		Sampling Requirements SDWA <input type="checkbox"/> NPDES <input type="checkbox"/> RCRA <input type="checkbox"/> OTHER _____			Sample Disposal: Dispose <input type="checkbox"/> Return <input type="checkbox"/>												No. of Samples		Page	of	
Sampling		Type			Matrix			CLIENT SAMPLE ID (9 CHARACTERS)										Login		LIMS Ver	
Date	Time	COMP	GRAB		WATER	SOIL	AIR											REMARKS		LAB 1 ID	LAB 2 ID
Sampled By & Title (Please sign and print name)					Date/Time		Relinquished By (Please sign and print name)				Date/Time		QC Level: 1 2 3 Other: _____ COC Rec ICE Ana Req TEMP Cust Seal Ph								
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																	

Attachment C
Example Custody Seal



CUSTODY SEAL

Date

Signature

Packaging and Shipping Procedures for Low-Concentration Samples

I. Purpose and Scope

The purpose of this guideline is to describe the packaging and shipping of low-concentration samples of various media to a laboratory for analysis.

II. Scope

The guideline only discusses the packaging and shipping of samples that are anticipated to have low concentrations of chemical constituents. Whether or not samples should be classified as low-concentration or otherwise will depend upon the site history, observation of the samples in the field, odor, and photoionization-detector readings.

If the site is known to have produced high-concentration samples in the past or the sampler suspects that high concentrations of contaminants might be present in the samples, then the sampler should conservatively assume that the samples cannot be classified as low-concentration. Samples that are anticipated to have medium to high concentrations of constituents should be packaged and shipped accordingly.

If warranted, procedures for dangerous-goods shipping may be implemented. Dangerous goods and hazardous materials pose an unreasonable risk to health, safety, or property during transportation without special handling. As a result only employees who are trained under CH2M HILL Dangerous Goods Shipping course may ship or transport dangerous goods. Employees should utilize the HAZMAT ShipRight tool on the Virtual Office and/or contact a designated CH2M HILL HazMat advisor with questions.

III. Equipment and Materials

- Coolers
- Clear tape
- "This Side Up" labels
- "Fragile" labels
- Vermiculite
- Ziplock bags or bubble wrap
- Ice
- Chain-of-Custody form (completed)
- Custody seals

IV. Procedures and Guidelines

Low-Concentration Samples

- A. 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.
 - Fill bottom of coolers with about 3 inches of vermiculite or absorbent pads.
- B. Arrange decontaminated sample containers in groups by sample number. Consolidate VOC samples into one cooler to minimize the need for trip blanks.
- C. Affix appropriate adhesive sample labels to each container. Protect with clear label protection tape.
- D. Seal each sample bottle within a separate ziplock plastic bag or bubble wrap, if available. Tape the bag around bottle. Sample label should be visible through the bag.
- E. Arrange sample bottles in coolers so that they do not touch.
- F. If ice is required to preserve the samples, cubes should be repackaged in zip-lock bags and placed on and around the containers.
- G. Fill remaining spaces with vermiculite or absorbent pads.
- H. Complete and sign chain-of-custody form (or obtain signature) and indicate the time and date it was relinquished to Federal Express or the courier.
- J. Close lid and latch.
- K. Carefully peel custody seals from backings and place intact over lid openings (right front and left back). Cover seals with clear protection tape.
- L. Tape cooler shut on both ends, making several complete revolutions with strapping tape. Cover custody seals with tape to avoid seals being able to be peeled from the cooler.
- M. 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.

Medium- and High-Concentration Samples:

Medium- and high-concentration samples are packaged using the same techniques used to package low-concentration samples, with potential additional restrictions. If applicable, the sample handler must refer to instructions associated with the shipping of dangerous goods for the necessary procedures for shipping by Federal Express or other overnight carrier. If warranted, procedures for dangerous-goods shipping may be implemented. Dangerous goods and hazardous materials pose an unreasonable risk to health, safety, or property during transportation without special handling. As a result only employees who are trained under CH2M HILL Dangerous Goods Shipping course may ship or transport dangerous goods. Employees should utilize the HAZMAT ShipRight tool on the Virtual Office and/or contact a designated CH2M HILL HazMat advisor with questions.

V. Attachments

None.

VI. Key Checks and Items

- Be sure laboratory address is correct on the mailing label
- Pack sample bottles carefully, with adequate vermiculite or other packaging and without allowing bottles to touch
- Be sure there is adequate ice
- Include chain-of-custody form
- Include custody seals

Multi RAE Photoionization Detector (PID)

I. Purpose

The purpose of this SOP is to provide general reference information for using the Multi RAE PID in the field. Calibration and operation, along with field maintenance, will be included in this SOP.

II. Scope

This procedure provides information on the field operation and general maintenance of the Multi RAE PID. Review of the information contained herein will ensure that this type of field monitoring equipment will be properly utilized. Review of the owner's instruction manuals is a necessity for more detailed descriptions.

III. Definitions

Carbon Monoxide Sensor (CO) - Expresses the Carbon Monoxide concentration in ppm.

Volatile Organic Compound (VOC) - Expresses the VOC concentration in ppm

Lower Explosive Limit (LEL) - Combustible gas is expressed as a percent of the lower explosive limit.

Hydrogen Sulfide Sensor (H₂S) - Expresses the Hydrogen Sulfide concentration in ppm.

Oxygen Sensor (OXY) - Expresses the Oxygen concentration as a percentage.

ppm - parts per million: parts of vapor or gas per million parts of air by volume.

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 selecting qualified individuals for the monitoring activities.

Health and Safety Coordinator - The Health and Safety Coordinator is responsible for developing a site-specific Health and Safety Plan (HASP) which specifies air monitoring requirements.

Field Team Leader - It is the responsibility of the Field Team Leader to implement these procedures in the field, and to ensure that the field team performing air

monitoring activities have been briefed and trained to execute these procedures before the start of site operations.

Safety Coordinator-Hazard Worker (SC-HW)- The SC-HW is responsible for ensuring that the specified air monitoring equipment is on site, calibrated, and used correctly by the field personnel. The SC-HW will coordinate these activities with the Field Team Leader if the SC-HW is not the Field Team Leader as well.

Field team - It is the responsibility of the field team to follow these procedures or to follow documented project-specific procedures as directed by the Field Team Leader/ Safety Coordinator-Hazard Worker. The field personnel are responsible for documenting all air monitoring results in the field logbook during each field investigation.

V. Procedures

The Multi RAE utilizes the principle of detecting sensors. The PID operates on the principle that most organic compounds and some inorganic compounds are ionized when they are bombarded by high-energy ultraviolet light. These compounds absorb the energy of the light, which excites the molecules and results in a loss of electron and the formation of a positively charged ion. The number of ions formed and the ion current produced is directly proportional to mass and concentration. The amount of energy required to displace an electron is called ionization potential (IP). The air sample is drawn into a UV lamp using a pump or a fan. The energy of the lamp determines whether a particular chemical will be ionized. Each chemical compound has a unique ionizing potential. When the UV light energy is greater than the ionization potential of the chemical, ionization will occur. When the sample is ionized, the electrical signal is displayed on an analog or digital output. Although the output does not distinguish between chemicals, it does detect an increase in the ion current. If only one chemical is present in the air, it is possible to use PIDs quantitatively. Chemical structure and lamp intensity affects the sensitivity of the instrument to a given contaminant. All PID readings are relative to the calibration gas, usually isobutylene. It is important to calibrate the PID in the same temperature and elevation that the equipment will be used, and to determine the background concentrations in the field before taking measurements. For environments where background readings are high, factory zero calibration gas should be used.

The following subsections will discuss Multi RAE calibration, operation, and maintenance. These sections, however, do not take the place of the instruction manual.

A. Calibration

For Multi RAE configured with O₂, LEL, H₂S, CO, sensors and a 10.6eV PID Lamp.

Start up Instrument

- Press **Mode** button
- Observe displays:

On!.....

Multi RAE
Version X.XX

Model Number
SN XXXX

Date Time
Temp

Checking Sensor
Ids....

VOC Installed

CO Installed

H₂S Installed

OXY Installed

LEL Installed

H₂S VOC CO
LEL OXY

Alarm Limits=

XX XX.X XX
XX High XX.X

XX XX.X XX
XX Low XX.X

XX XX.X XX
STEL

XX XX.X XX
TWA

Battery = X.XV
Shut off at 4.2V

User Mode=

Alarm Mode=

Datalog Time Left

Datalog Mode

Datalog Period

Unit ready in.....
10 Seconds

- The pump will start, the seconds will count down to zero, and the instrument will be ready for use

Calibration Check and Adjustment

Allow instrument to warm up for 15 minutes.

- Depress the [N/-] key first, then while depressing the [N/-], depress the [Mode] key also and depress both keys for 5 seconds.

- Display will read:

Calibrate
Monitor?

- Press the [Y/+] key

- Display will read:

Fresh Air
Calibration?

- If "Zero Air" is necessary, attach the calibration adapter over the inlet port of the Multi RAE Monitor and connect the other end of the tube to the gas regulator (HAZCO loaner regulator LREG.5, RAE Systems P/N 008-3011 or suitable .5 LPM regulator) on the Zero Air bottle (HAZCO P/N SGZA, RAE P/N 600-0024). If no Zero Air is available, perform the Fresh Air Calibration in an area free of any detectable vapor.

- Press the [Y/+] key

- Display will read:

Zero....
In progress...

CO Zeroed!
Reading = X

VOC Zeroed!
Reading = X

LEL Zeroed!
Reading = X

OXY Zeroed!
Reading = X

Zero Cal done!
H₂S Zeroed!
Reading = X

In each of the above screens, "X" is equal to the reading of the sensor before it was zeroed.

- Display will then read:

Multiple Sensor
Calibration?

- Press the [Y/+] key
- The display shows all of the pre-selected sensors and the "OK?" question:

CO H₂S
LEL OK? OXY

- Apply calibration gas - use either HAZCO Services Part Number R-SGRAE4 or Rae Systems Part Number 008-3002 - using a .5 LPM regulator and direct tubing.
- Press the [Y/+] key. Display will read:

Apply Mixed gas

Calibration
In progress ...

- The display will count down showing the number of remaining seconds:

CO cal'ed
Reading=50

H₂S cal'ed
Reading=25

LEL cal'ed
Reading=50

OXY cal'ed
Reading=20.9

Calibration done
Turn off gas!

- Display will read:

Single Sensor
Calibration?

- Press the [Y/+].
- Display will read:

CO VOC H₂S
LEL pick? OXY

- Attach 100 ppm Isobutylene (HAZCO P/N r-SGISO or Rae P/N 600-0002) using a 1.0 LPM regulator (HAZCO P/N LR10HS or Rae P/N 008-3021). Open regulator.
- Press the [Mode] key once, the V of VOC will be highlighted.
- Press the [Y/+]. The display will read:

Apply VOC Gas

Calibration
In progress...

- The display will count down showing the number of remaining seconds, then display:

VOC cal'd
Reading=100

Calibration done
Turn off gas!

Single Sensor
Calibration?

- Press [Mode] key twice to return to main screen.
- **CALIBRATION IS COMPLETE!**

B. Operation

Due to the Multi RAE having many functions in terms of operation, it is recommended that you follow the operational procedures as outlined in the instruction manual from pages 9 to 14.

C. Site Maintenance

After each use, the meter should be recharged and the outside of the instruments should be wiped clean with a soft cloth.

D. Scheduled Maintenance

Function

Frequency

Check alarm and settings	Monthly/before each use
Clean screens and gaskets around sensors	Monthly
Replace sensors	Biannually or when calibration is unsuccessful

VI. Quality Assurance Records

Quality assurance records will be maintained for each air monitoring event. The following information shall be recorded in the field logbook.

- Identification - Site name, date, location, CTO number, activity monitored, (surface water sampling, soil sampling, etc), serial number, time, resulting concentration, comments and identity of air monitoring personnel.
- Field observations - Appearance of sampled media (if definable).
- Additional remarks (e.g. Multi RAE had wide range fluctuations during air monitoring activities.)

VII. References

Multi RAE Plus Multiple Gas Monitor User Manual, RAE Systems, Revision B1, November 2003.

Decontamination of Personnel and Equipment

I. Purpose

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

II. Scope

This is a general description of decontamination procedures.

III. Equipment and Materials

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

IV. Procedures and Guidelines

A. PERSONNEL DECONTAMINATION

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

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

B. SAMPLING EQUIPMENT DECONTAMINATION – GROUNDWATER SAMPLING PUMPS

Sampling pumps are decontaminated after each use as follows.

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

C. SAMPLING EQUIPMENT DECONTAMINATION – OTHER EQUIPMENT

Reusable sampling equipment is decontaminated after each use as follows.

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

D. HEALTH AND SAFETY MONITORING EQUIPMENT DECONTAMINATION

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

E. SAMPLE CONTAINER DECONTAMINATION

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

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

F. HEAVY EQUIPMENT AND TOOLS

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

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

V. Attachments

None.

VI. Key Checks and Items

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

Decontamination of Drilling Rigs and Equipment

I. Purpose and Scope

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

II. Equipment and Materials

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

III. Procedures and Guidelines

A. Drilling Rigs and Monitoring Well Materials

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

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

B. Downhole Drilling Tools

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

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

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

C. Field Analytical Equipment

1. Water Level Indicators

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

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

2. Probes

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

IV. Attachments

None.

V. Key Checks and Preventative Maintenance

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

Disposal of Waste Fluids and Solids

I. Purpose and Scope

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

II. Equipment and Materials

A. Fluids

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

B. Solids

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

III. Procedures and Guidelines

A. Methodology

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

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

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

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

B. Labels

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

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

C. Fluids

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

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

D. Solids

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

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

E. Storage and Disposal

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

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

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

IV. Attachments

None.

V. Key Checks and Preventative Maintenance

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

Global Positioning System

I. Purpose

The procedure describes the calibration, operation, and functions associated with a Trimble® Pro XRS GPS Unit with a TSC-1 Asset Surveyor for datalogging. GPS signal information is differentially corrected to sub-meter accuracy on a continual basis using a second satellite signal broadcast from OmniSTAR satellite subscription service. The procedure applies to all field data collection activities.

II. Scope

This procedure provides information regarding the field operation and general maintenance of a Trimble® Pro XRS GPS Unit with a TSC-1 Asset Surveyor for datalogging. The information contained herein presents the operation procedures for this equipment. Review of the equipment's instruction manual is a necessity for more detailed descriptions pertaining to the operation and maintenance of the equipment.

III. Definitions

GPS: Global Positioning System - A system of 24 satellites developed and operated by the US DOD. Continuous 3D coordinate information is broadcast free of charge on a worldwide basis enabling precise positional location. Three standard categories of positional accuracy are generally used:

1. Uncorrected Signal - accuracy +/-10 meters - a single satellite transmission is used
2. Differentially Corrected Signal - accuracy +/- <1 meter - additional positional transmissions are recorded simultaneously and used to triangulate coordinate position.
3. Carrier Phase Signal- accuracy +/- <1 centimeter - requires a second receiver and additional software. Both receivers need to be equipped to receive Carrier Phase signals.

IV. Procedures and Guidelines

The procedure for calibration, operation, and maintenance of the GPS unit is outlined below. Daily calibration and battery recharging is typical operating procedure; frequencies other than daily shall be noted in the logbook and reason for increased frequency recorded. If using a different instrument, the operation manual supplied by the manufacturer should be consulted for instructions.

The procedures described below include additional features pre-programmed into the GPS datalogger to aid the data collection process.

A. Calibration

1. Check to ensure that the datalogger and antenna cables are properly connected to the receiver and that the batteries are securely connected.
2. Turn the datalogger unit on by pressing the green **On** key in the bottom left corner. The datalogger will perform a self-calibration. Wait to ensure that the antenna is receiving a sufficient number of satellite signals (usually a minimum of 3).
3. Once the datalogger receives a satellite signal then it is ready for operation.

B. Operations for surveying coordinates of a location

1. The datalogger and GPS receiver are ready for use after the initial self-calibration.
2. Field data may be immediately recorded in the datalogger.
3. The first screen view is the 'Main Menu'. Use the round keypad to select 'Data Collection' and press the **Enter** key.
4. Use the round keypad to select either 'Create new file' or 'Open existing file' and press the **Enter** key. It is not necessary to create a new file at each new location; however, it may be useful to create a new file at the beginning of each day.
5. If a new file is created then the GPS unit will automatically assign it a file name. The file name may be changed if desired. Press the enter key after the file name is assigned. If opening an existing file then use the round keypad to scroll through existing file names.
6. The next screen is 'Antenna options'. Press the **Enter** key to move to the next screen.
7. Select the type of activity to be performed. At the beginning of each day 'Sample Site Detail' should be completed. This allows the operator to enter each field team member, weather, objectives, health and safety meetings, etc. Once the 'Sample Site Detail' is completed then data entry activities may begin including well purging, water level elevations, and sample collection
8. The datalogger prompts the operator when a data field is required and by using the round key pad, numeric, alphanumeric, enter, and escape keys, the operator can perform electronic data capture on the GPS datalogger.
9. Once all information pertaining to an individual site has been recorded, press enter to complete data entry. If GPS signal is obstructed (tree canopy, building height, etc) user may choose to remain in same location until satellite transmission clears the obstruction. This usually takes only a few moments. Data may still be captured and recorded electronically even if GPS signal is insufficient for positioning.
10. To shut down, press the **Escape** key to return to the 'Main Menu'. The unit can be turned off by pressing the green key in the left hand corner. The datalogger should only be turned off when the 'Main Menu' screen is displayed.
11. All data from the datalogger should be downloaded into Trimble Pathfinder Office software on a PC a minimum of once daily. It is recommended that data is downloaded twice daily. Data may be viewed and mapped using Pathfinder Office or exported to

other software. Export file formats support standard ASCII text, generic database .dbf and most GIS and CAD software.

C. Operations for locating a point using coordinates/reacquiring a previously surveyed location

1. The datalogger and GPS receiver are ready for use after the initial self-calibration.
2. Use the Trimble Pathfinder software to load the data file containing the coordinates for each desired location ("programmed location").
3. The first screen view is the 'Main Menu'. Use the keypad to select 'Navigation' and press the **Enter** key.
4. Use the round keypad to select 'Open existing file' to open the file loaded in Step 2 above.
5. Select the location to be reacquired from the screen and press the enter key.
6. A circle with an arrow will appear. As you begin walking, the arrow will point in the direction of the programmed location. Walk in the direction indicated by the arrow.
7. Once you are within 10-feet of the location being reacquired, the GPS unit will display a circle (representing the programmed location) and an "X" (representing the GPS unit). Continue to walk in the direction of the circle until the "X" is centered in the circle. Once the "X" is centered, you are standing at the programmed location.
8. To shut down, press the **Escape** key to return to the 'Main Menu'. The unit can be turned off by pressing the green key in the left hand corner. The datalogger should only be turned off when the 'Main Menu' screen is displayed.

D. Preventive Maintenance

The antenna and datalogger are weatherproof. It is recommended that the receiver remain in the provided backpack carrier. Care should be taken not to crease, pinch or bend the antenna cable. Data should be downloaded from the datalogger a minimum of once daily, twice daily is preferred. At the end of each day the receiver batteries should be recharged. For technical assistance call the rental company through which you acquired the Trimble® unit. Guidance is also provided in the manual and at <http://www.trimble.com>.

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 or plastic disposable scoop 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 or plastic disposable scoop. 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.

Surface Water Sampling

I. Purpose and Scope

This procedure presents the techniques used in collecting surface water samples. Materials, equipment, and procedures may vary; refer to the Field Sampling Plan and operators manuals for specific details.

II. Materials and Equipment

Materials and equipment vary depending on type of sampling; the Field Sampling Plan should be consulted for project-specific details. Typical equipment required includes:

- Open tube sampler
- Dip sampler
- Weighted bottle sampler
- Hand pump
- Kemmerer or Van Dorn sampler
- Depth-integrating sampler
- Peristaltic pump
- Sample containers
- Meters for specific conductance, temperature, pH, and dissolved oxygen

III. Procedures and Guidelines

Before surface water samples are taken, all sampler assemblies and sample containers are cleaned and decontaminated as described in *SOP Decontamination of Personnel and Equipment*. Surface water samples collected from water bodies tidally influenced should be collected at low tide and under low flow conditions to minimize the dilution of potential contaminants. Methods for surface water sample collection are described below.

A. Manual Sampling

Surface water samples are collected manually by submerging a clean glass, stainless steel, or Teflon container into the water body. Samples may be collected at depth with a covered bottle that can be removed with a tripline. The most common sampler types are beakers, sealable bottles and jars, pond samplers, and weighted bottle samplers. Pond samplers have a fixed or telescoping pole attached to the sample container. Weighted bottle samplers are lowered below water surface, where the attached bottle is opened, allowed to fill, and pulled out of the water. When retrieved, the bottle is tightly capped and removed from the sampler assembly.

Specific types of weighted bottle samplers include dissolved oxygen, Kemmerer, or Van Dorn, and are acceptable in most instances.

A sample is taken with the following specific steps:

1. The location and desired depth for water sampling are selected.
2. The sample site is approached from downstream in a manner that avoids disturbance of bottom sediments as much as possible. The sample bottle is gently submerged with the mouth pointed upstream and the bottle tilted slightly downstream. Bubbles and floating materials should be prevented from entering the bottle. If using a Peristaltic pump, lower the tubing into the water to the desired depth.
3. For weighted bottle samplers, the assembly is slowly lowered to the desired depth. The bottle stopper is unseated with a sharp tug and the bottle is allowed to fill until bubbles stop rising to the surface.
4. When the bottle is full, it is gently removed from the water. If sample transfer is required, it should be performed at this time.
5. Measure dissolved oxygen, specific conductance, temperature, and pH at the sampling location.

IV. Attachments

None.

V. Key Checks and Items

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

Appendix C
Navy CLEAN 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.

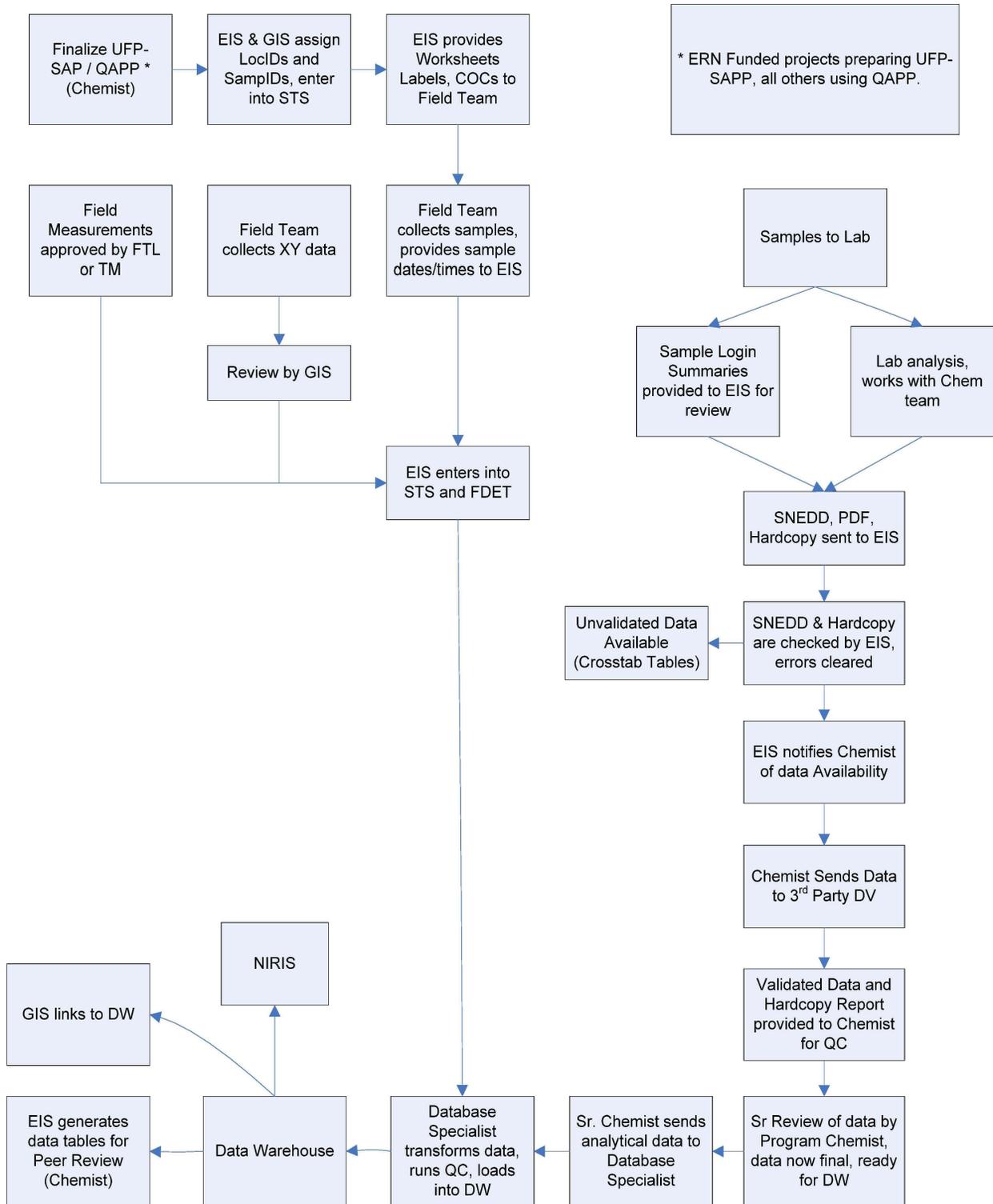
Any modifications made to the tools will be communicated to the project team via e-mail. As revisions are finalized, they will be distributed electronically to all users. After revision, it is the user’s responsibility to conform to revised portions of the DMP.

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.

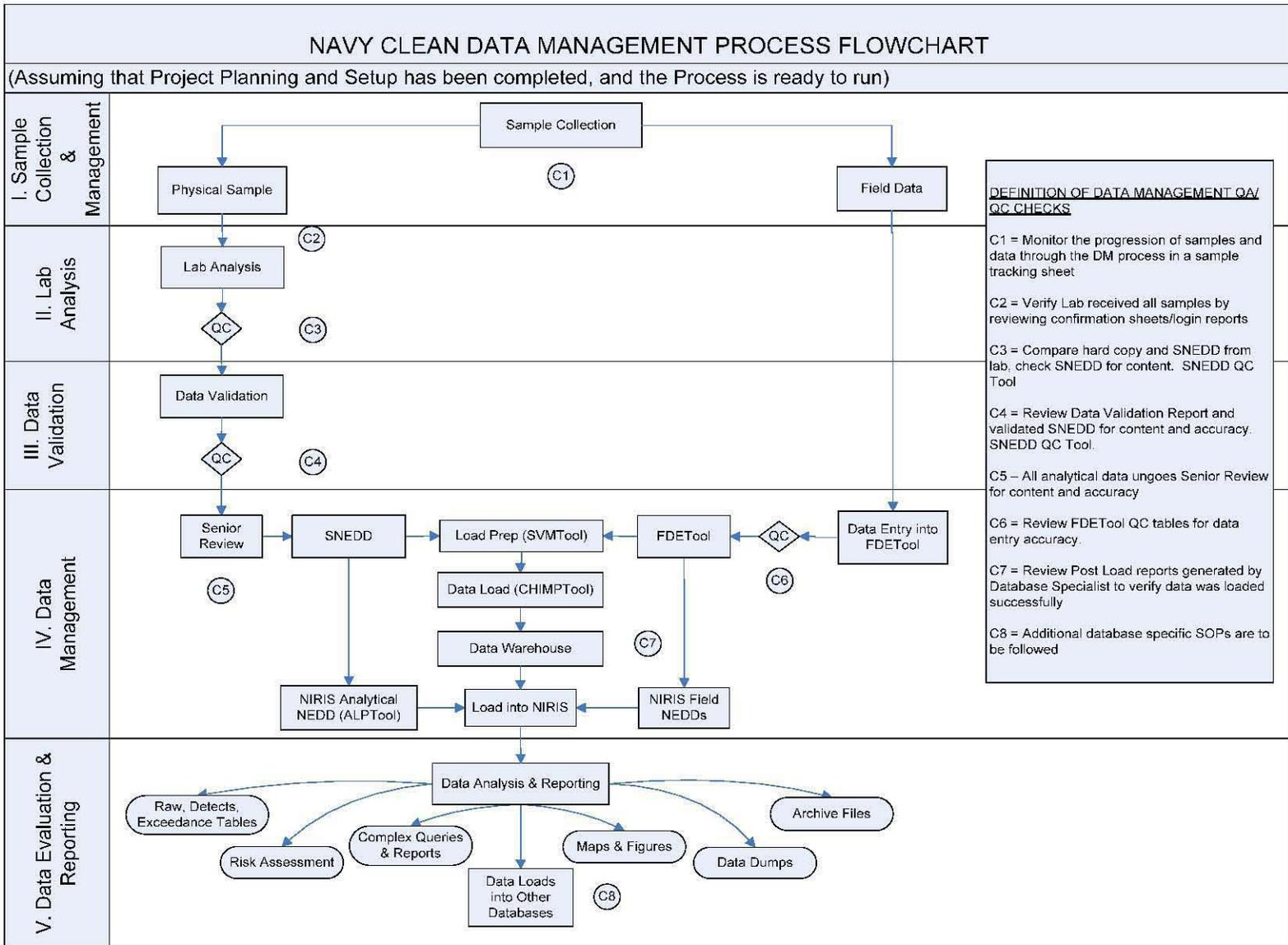
REVISION HISTORY

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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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
SVMTTool	SNEDD to VDMS Mapping Tool
VDMS	Validated Data Management System

Introduction

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

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

1.1 Purpose

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

1.2 Scope of the Data Management Plan

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

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

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

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

SECTION 2

Roles and Responsibilities

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

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

TABLE 1

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

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

TABLE 1

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

Title	Name/Address	Phone	Fax	E-mail
Project Chemist (PC)	Bianca Kleist 5700 Cleveland Street. Suite 101 Virginia Beach, VA 23462	757-671-6281	757-497-6885	bkleist@ch2m.com
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	mriissing@critigen.com
GIS Analyst (GA)	Forrest Cain 5700 Cleveland Street. Suite 101 Virginia Beach, VA 23462	757-671-6271	757-497-6885	fcain@critigen.com

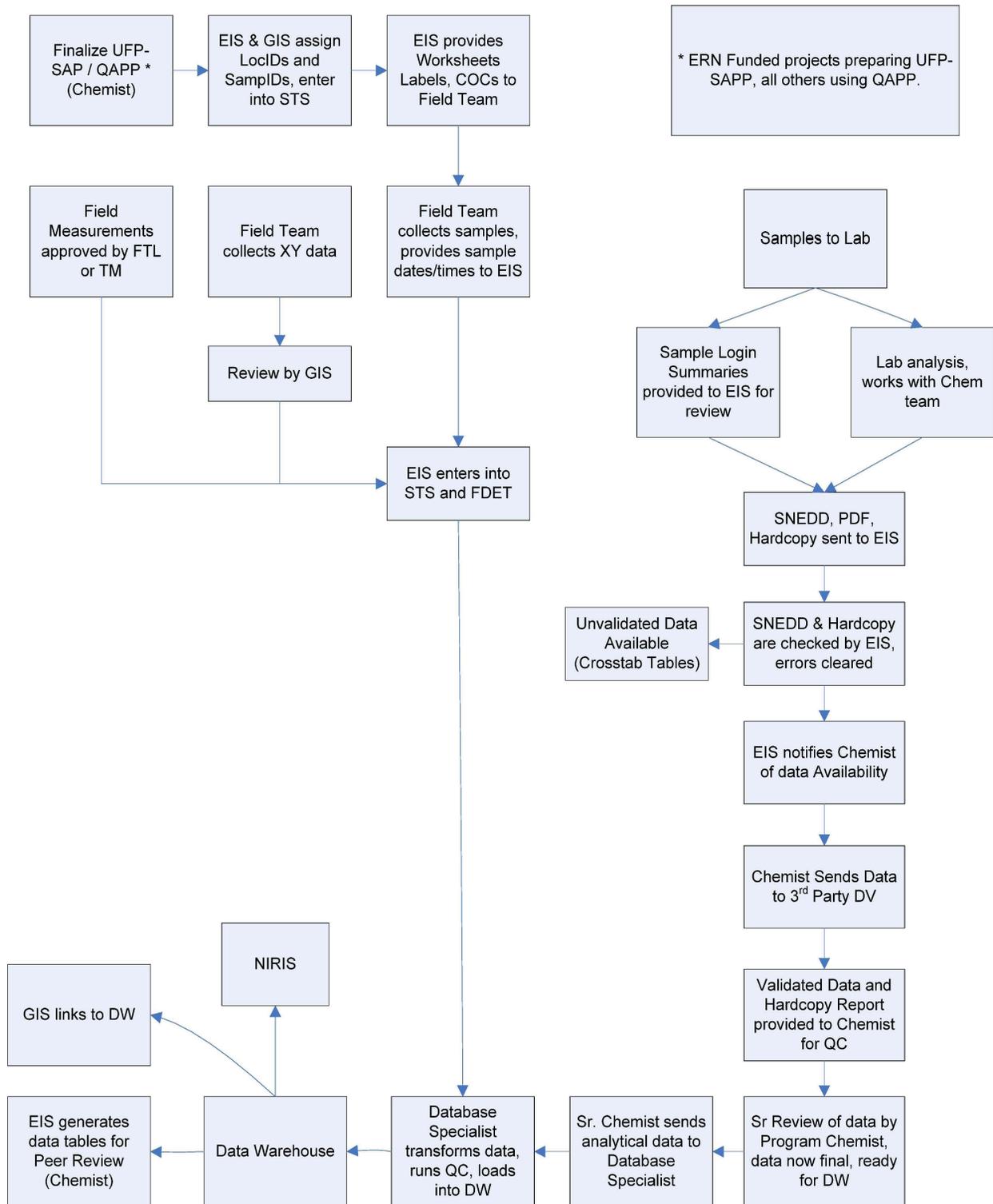
SECTION 3

Data Management System Description

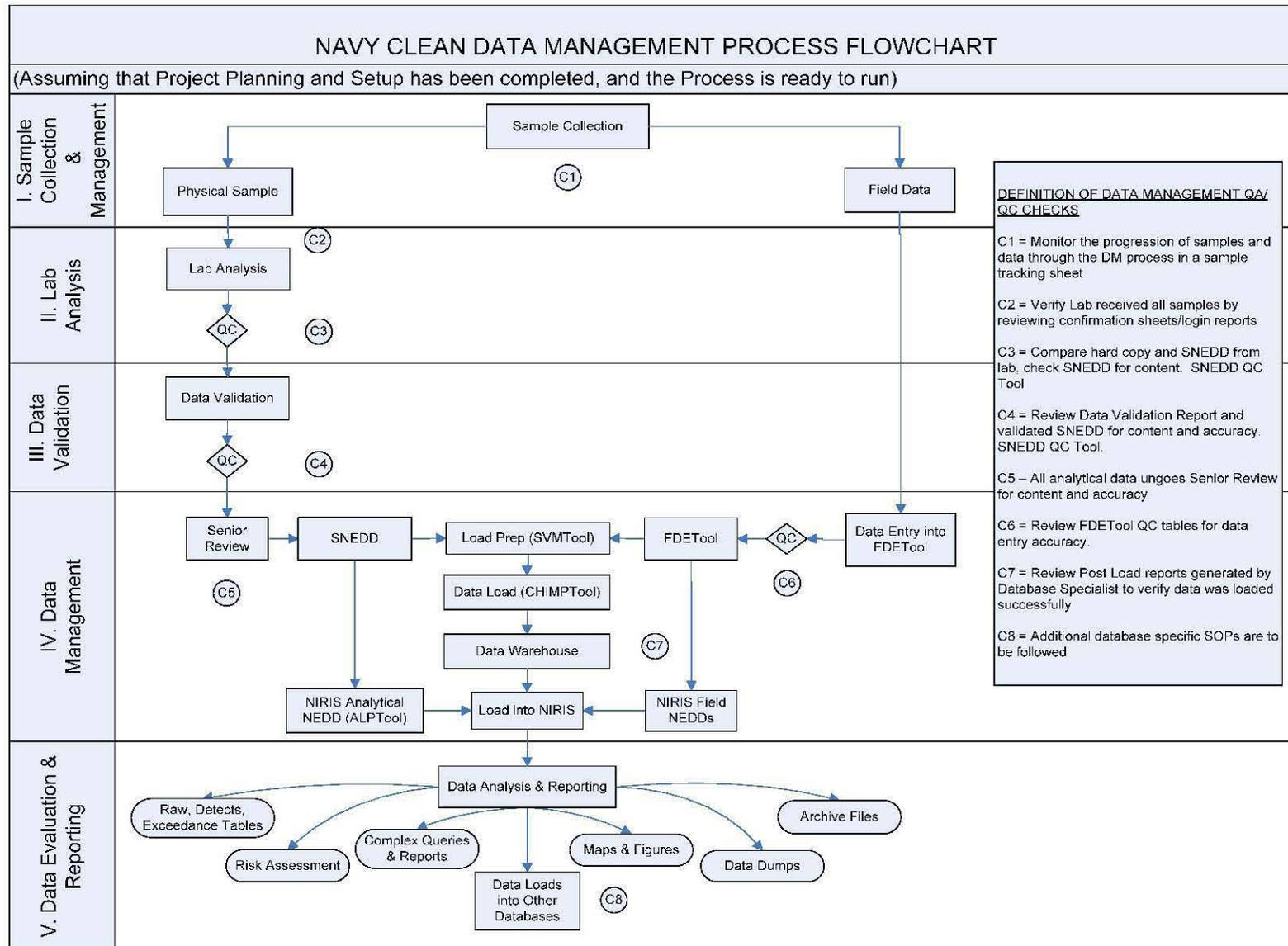
During field investigation, monitoring, and remedial activities, CH2M HILL will collect a variety of environmental information to support data analysis, reporting, and decision-making activities. To meet current regulatory QA requirements, a complete audit trail of the information flow must be implemented.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

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

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



**FIGURE 1
ENVIRONMENTAL DATA MANAGEMENT WORKFLOW PROCESS**



**FIGURE 2
DBMS PROCESS**

Phases of Data Management

4.1 Project Planning and Setup

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

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

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

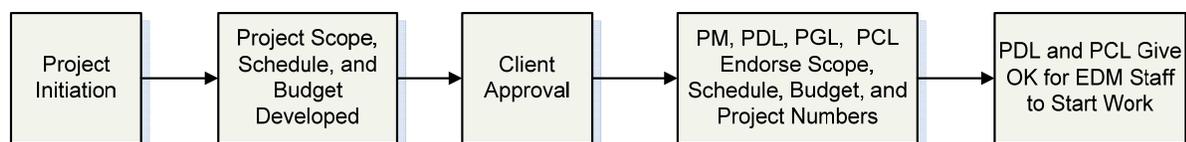


FIGURE 3
PROJECT PLANNING

4.1.1 Database Setup and Administration

CH2M HILL Database

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

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

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

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

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

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

NIRIS Database

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

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

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

4.1.2 Data Security Procedures

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

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

4.1.3 Data Backup and Recovery

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

4.2 Sample Collection and Management

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

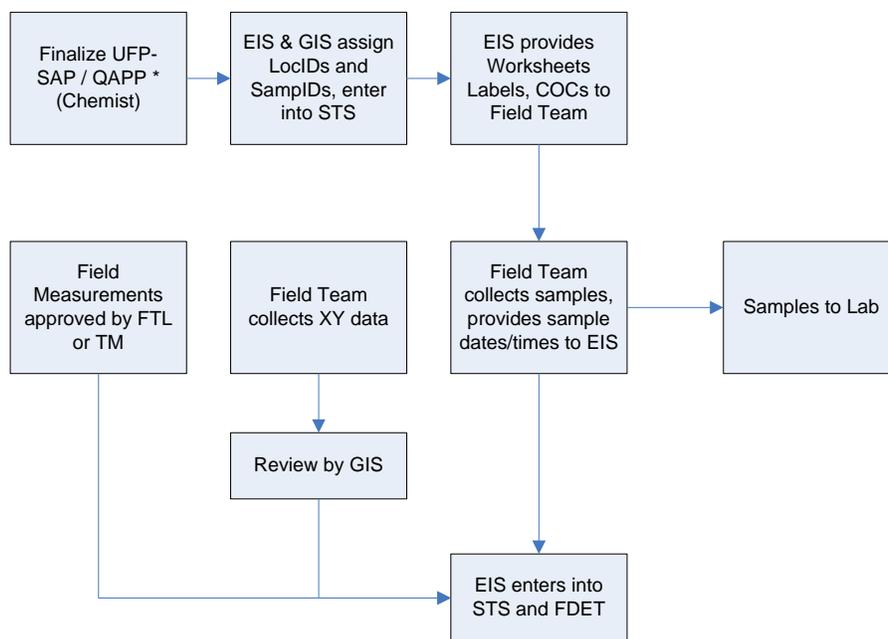


FIGURE 4
FIELD SAMPLING

4.2.1 Sample Tracking Sheet

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

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

4.2.2 Sample Nomenclature Guidelines

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

Station ID (Location)

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

Before beginning fieldwork, the FTL will review the proposed level of effort and coordinate a list of unique station identification names, or station IDs, with the PDL or EIS. The FTL will be

responsible for enforcing the use of the standardized ID system and agreed upon station IDs during all field activities.

Each station will be uniquely identified by an alphanumeric code that will describe the station's attributes. These attributes are facility, Area of Concern (AOC)/Site/Operable Unit (OU) number, station type, sequential station number, and possibly an additional qualifier as needed. The naming scheme to be used for the identification of a sampling station is documented in Table 2.

For example, if the first sample location at next month's event within Yorktown Site 30 is at a soil location, then the location ID could possibly be YS30-SO391 because that was the next available sequence number for soil locations. This should also be reflected in the Sample ID. QC and IDW station IDs must be established for each site that they are associated with.

Please consult with the PDL or EIS should any questions arise. This will avoid complications that could occur if a station is mislabelled and ensure there are unique identifiers for every sampling location. Required deviations to this format in response to field conditions will be documented in the field logbook.

Sample ID

Field sample data are information assigned to a physical piece of material collected in the field for which some sort of analysis will be run. Before collecting samples, the FTL will review the proposed level of effort and coordinate a list of unique sample identification names, or sample IDs, with the PDL or EIS. The FTL will be responsible for enforcing the use of the standardized ID system and agreed upon sample IDs during all field activities.

Each sample will be uniquely identified by an alphanumeric code that will describe the sample's attributes. These attributes are facility, Area of Concern (AOC)/Site/Operable Unit (OU) number, sample/station type, sequential station number, modifier (as needed), depth (as needed), date, and date modifier (as needed). The naming scheme to be used for the identification of samples is documented in Table 3.

The standardized ID system will identify all samples collected during sampling activities. The system will provide a tracking procedure to ensure accurate data retrieval of all samples taken. For example, a surface soil sample collected from station YS30-SO391 reference above in June of 2009 will result in a sample ID of YS30-SS391-0609.

Please consult with the PDL or EIS should any questions arise. This will avoid complications that could occur if a sample is mislabelled and ensure there are unique identifiers for every sample. Required deviations to this format in response to field conditions will be documented in the field logbook.

Navy Clean		
First Segment	Second Segment	
Facility, Site Number	Station Type	Station Number, Modifier
AA,ANN	AA	NNN _A
Notes: "A" = alphabetic "N" = numeric		
<u>Facility:</u> A = ABL AN = Anacostia BA = Bainbridge BW = Bloodsworth Island BR = Bremerton CA = Cheatham Annex CH = Cherry Point CI = Craney Island CL = Camp Lejeune CP = Camp Peary CR = Carderock DA = Dahlgren DN = Dam Neck DR = Driver IH = Indian Head LS = Little Creek NA = Naval Academy NB = Naval Station Norfolk NM = NNMC (Bethesda Naval Hospital) NN = Norfolk Naval Shipyard NR = Naval Research Laboratory NWA = Northwest Annex OC = Oceana PA = Pax River PI = Pineros Islands QU = Quantico RO = Rota RR = Roosevelt Roads SI = Sigonella SJ = St. Juliens SS = Sabana Seca VE = Vieques East VW = Vieques West WN = Washington Navy Yard WO = White Oak Y = Yorktown <u>Site/AOC/SWMU Number - Sequential Number:</u> Site = S01, S02, S03... Site Screening Area = SA01, SA02, SA03... AOC = A01, A02, A03... AOI = AI01, AI02, AI03... SWMU = W01, W02... Building = B01, B02, B03... Range = R01, R02... LIA - LI Area, East Vieques BSxx = Background locations outside of site (BS25 = Background Site 25) BKL = Background locations outside of the facility BKG = Background locations (inside base) <u>QC and IDW Stations</u> Site ID (First Segment) followed by -QC or -IDW	<u>Station Type:</u> AGT = Above Ground Tank AS = Ash BH = Borehole CO = Concrete DP = Direct Push DR = Drill Rig EW = Extraction Well FG = Frog FS = Fish GB = Geotechnical Boring GP = Geoprobe GV = Gas Vent HP = Holding Pond/Lagoon IDW = Investigative Derived Waste IW = Injection Well LW = Leach Well MA = Alluvial Monitoring Well MB = Bedrock Monitoring Well MU = UST Monitoring Well MW = Monitoring Well (GW for Y) PC = Paint Chip PW = Production Well QC = Quality Control RK = Rock RC = Recovery Well RM = Remediation Well RW = Residential Well SD = Sediment Location SG = Soil Gas SL = Storm Sewer Line Sediment SO = Soil Location SP = Seep ST = Storm Water SU = Sump SV = Soil Vapor SW = Surface Water SWS = Surface Water Body (for SW and SD) UST = Underground Storage Tank TA = Tap Water TD = Tidal Station TI = Tissue Sample (general) TO = Tadpole TP = Test Pit TR = Trench Sediment TS = Treatment System TW = Temporary Well WA = Alluvial Extraction Well WB = Bedrock Extraction Well WL = Water Supply Well WN = Pore Water WP = Wipe Sample WT = Water Table Piezometer <u>Station Number:</u> Sequential Station Number (i.e., 01, 02, 03...) <u>Modifier (used selectively):</u> D = Deep monitoring well S = Shallow monitoring well	
<u>Example Station IDs:</u> <u>YS01-DP02</u> = Direct push soil location #2 at Yorktown Naval Weapons Station Site 1 <u>CHR05-MW02S</u> = Shallow monitoring well location 2, at the Cheatham Annex facility, Range 5. <u>NMBKL-SD02</u> = Background sediment location #2 located outside of NNMC <u>CHBS03-SO05</u> = Soil location #5, located in reference area outside of Site 3 in Cherry Point <u>VEW04-QC</u> = QC Station at East Vieques SWMU-4 <u>CAA08-IDW</u> = IDW Station at Cheatham Annex AOC-8		

TABLE 2
STATION ID SCHEME

Navy Clean			
First Segment	Second Segment	3rd Segment	Fourth Segment
Site ID Facility, AOC Number	Station/Sample Type, Station Number, Modifier	Depth (As Needed)	Date (MMYY) _A
AA,ANN	AANNNA	A	NNNN _A
Notes: "A" = alphabetic "N" = numeric			
<p>A = ABL AN = Anacostia BA = Bainbridge BW = Bloodsworth Island BR = Bremerton CA = Cheatham Annex CH = Cherry Point CI = Craney Island CL = Camp Lejeune CP = Camp Peary CR = Carderock DA = Dahlgren DN = Dam Neck DR = Driver IH = Indian Head LS = Little Creek NA = Naval Academy NB = Naval Station Norfolk NM = NNMC (Bethesda Naval Hospital) NN = Norfolk Naval Shipyard NR = Naval Research Laboratory NWA = Northwest Annex OC = Oceana PA = Pax River PI = Pineros Islands QU = Quantico RO = Rota RR = Roosevelt Roads SI = Sigonella SJ = St. Juliens SS = Sabana Seca VE = Vieques East VW = Vieques West WN = Washington Navy Yard WO = White Oak Y = Yorktown</p> <p><u>Site/AOC/SWMU - Sequential Number:</u> Site = S01, S02, S03... Site Screening Area = SA01, SA02, SA03... AOC = A01, A02, A03... AOI = AI01, AI02, AI03... SWMU = W01, W02... Building = B01, B02, B03... Range = R01, R02... LIA - LI Area, East Vieques</p> <p>BSxx = Background locations outside of site (BS25 = Background Site 25) BKL = Background locations outside of the facility BKG Background locations (inside base)</p>	<p><u>Sample Type:</u> AGT = Above Ground Tank AH = Air - Headspace AS = Ash BH = Borehole CO = Concrete DR = Drill Rig DS = Direct Push – Soil DW = Direct Push – Groundwater EW = Extraction Well FG = Frog FS = Fish GB = Geotechnical Boring GP = Geoprobe GV = Gas Vent HP = Holding Pond/Lagoon IW = Injection Well LF = Free Product LW = Leach Well MA = Alluvial Monitoring Well MB = Bedrock Monitoring Well MU = UST Monitoring Well MW = Monitoring Well (GW for Y) PC = Paint Chip PW = Production Well RK = Rock SW = Surface Water RC = Recovery Well RM = Remediation Well RW = Residential Well SB = Subsurface Soil SD = Sediment Location SG = Soil Gas SL = Storm Sewer Line Sediment SO = Soil Location (Composite) SP = Seep SS = Surface Soil SSD = Subsurface Sediment ST = Storm Water SU = Sump SV = Soil Vapor SW = Surface Water UST = Underground Storage Tank TA = Tap Water TD = Tidal Station TI = Tissue Sample (general) TO = Tadpole TP = Test Pit TR = Trench Sediment TS = Treatment System TW = Temporary Well WA = Alluvial Extraction Well WB = Bedrock Extraction Well WL = Water Supply Well WN = Pore Water WP = Wipe Sample WT = Water Table Piezometer</p> <p><u>Station Number:</u> Sequential Number (e.g., 001, 002, 003)</p> <p><u>Modifier (used selectively):</u> D = Deep monitoring well S = Shallow monitoring well P = Duplicate</p>	<p><u>Depth:</u> Use only if applicable. A sequential letter is used to reflect varying depths, as actual depths can change in the field after sample planning has occurred. E.g. A, B, C...</p> <p><u>Sample Number:</u> 1. Duplicate Samples - Use a 'P' modifier in the second segment of the sample ID, directly after the location number to indicate a duplicate sample. E.g. AB01-MW11P-0506 2. MS/MSD Samples - Append a modifier of '-MS' for matrix spike or '-SD' for matrix spike duplicate to the end of the sample ID. 3. QC & IDW Samples (Blank Samples & Waste Char.) - Format consists of Facility, AOC Number, Qualifier Code, Sequential Qualifier Number-Date (AAANN-AANN-MMDDYY). E.g. LSA05-TB02-061106</p> <p><u>Qualifier Codes:</u> TB = Trip Blank FB = Field Blank EB = Equipment Blank WQ = Source Blank WS = Waste Char. Soil WW = Waste Char. Water</p> <p>4. Drill Rig Samples - Format consists of Facility, AOC Number, Station Type, Station Number, Date. E.g. YS12-DR02-020507 5. Multiple samples - Should multiple samples be collected from the same location in a given day/month (affects only samples not differentiated by depth), a sequential letter will be added to the end of the fourth segment (date). E.g. A, B, C...</p>	
<p><u>Example Sample IDs:</u> WNA01-MW102S-0105A = The first shallow groundwater sample collected at monitoring well location 102 in January 2005 in AOC01 at the Washington Navy Yard facility. PIW01-SW023P-0306 = Pineros Island duplicate surface water sample collected at location 23, at SMWU-1 in March 2006. SSW06-FB01-061106 = The first field blank collected on June 11, 2006 at SMWU-6 in Sabana Seca.</p>			

TABLE 3
STATION ID SCHEME

4.2.3 Sample Collection

A photocopy of each field logbook page completed during sampling and of each COC will be made by the FTL and forwarded to the EIS at predefined intervals during sampling events. This information will serve as notification to the EIS of samples being shipped to an offsite lab and of the field crew's sampling progress.

Communication with field and laboratory staff will occur daily during the field event. The EIS will resolve issues that arise in the field (i.e. bottle ware shortage, equipment failure, etc). The lab will be informed of the shipment dates and the number of coolers or samples being sent. Laboratory login reports will be reviewed to ensure samples were received in good condition (i.e. no breakage, within holding time, within designated temperature). The field crew and PM will be notified if there were problems with shipment.

4.2.4 Chain-of-Custody

A single COC number per laboratory / cooler should be generated each day (there can be multiple pages to one COC number). MSs and MSDs will be requested at a set frequency for each project (usually one per 20 samples collected). MS and MSD samples should not be taken from field duplicates (FDs) or field blanks. FDs will be requested at a set frequency for each project (usually one per 10 samples). FDs should not be taken from MSs, MSDs, or field blanks. The MS and MSD samples listed on the COC should be spiked and analyzed by the laboratory.

A 100% QC will be performed on COCs received from the field crew. The field crew and/or lab will be notified if corrections need to be made to the COCs or lab login reports. Any corrections or modifications made will be noted in a Corrections-To-File Letter.

4.2.5 Sample and Document Tracking

The STS will be updated with sample collection and tracking information, and kept current throughout the data management process. All samples collected, resulting deliverables, and deliverable dates will be tracked throughout the data management process to ensure that the project schedule is met and subcontractor invoices are evaluated correctly.

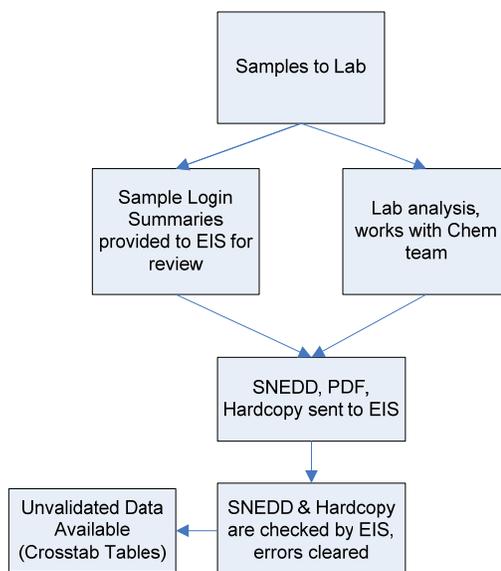
All documentation acquired during the data management process, including Statements of Work (SOWs), Bids, COCs, Field Notes, Sample Tracking Sheets, Login Reports, Corrections-to-File Letters, FDETool QC tables, Post Load Reports, Invoices, and Communication Logs shall be compiled throughout the process to be stored in the appropriate Activity's Project Notebook.

4.2.6 Field Data

Once the field data and samples are collected, necessary field measurements, such as water levels and other data collected in the field should be entered into the FDETool. Any data entered into the FDETool must be exported into an excel file to facilitate a manual QC review of the data. The correction of any anomalies should be verified with the PM and PC. The information entered into the FDETool will be linked with related analytical data reported in the SNEDD within the SVMTool. Field data and laboratory analytical data are linked by sample ID and date/time. This allows verification analytical results for all samples have been received and reported by the laboratory.

4.3 Laboratory Analysis

Figure 5 shows the laboratory analysis process. Upon receipt of samples from the field, the laboratory will verify that the COC forms correctly identify and detail all samples submitted. Each COC form must be signed with the date and time of receipt by the laboratory. Samples will be logged in by the laboratory using information from the COC forms and the project instructions.



**FIGURE 5
LABORATORY ANALYSIS**

Samples will be analyzed as specified on the accompanying COC forms and in the Laboratory SOW. Generally, questions or noted inconsistencies identified by the laboratory should be addressed directly to the EIS. Login summaries detailing all samples and analyses received by the lab should be provided daily to the EIS for review. All discrepancies should be corrected to ensure that all samples are analyzed as per project instructions.

The SNEDD-QC-Tool is used to QC the laboratory's SNEDD. Before the laboratory analytical data is formatted into data tables or sent for validation, the laboratory SNEDD must be processed through CH2M Hill's SNEDD-QC-Tool Microsoft Access database application. The SNEDD-QC-Tool includes several automated diagnostic checks to verify format and content compliance with SNEDD specifications.

- The analytical laboratory may, at their discretion, utilize the tool to QC and correct any errors before transmitting the SNEDD to CH2M HILL. The laboratory will forward the checked SNEDD and a hard copy of the data to the EIS, who will manage the SNEDD verification process.
- Upon receipt at CH2M Hill, the EIS will check the SNEDD using the SNEDD-QC-Tool to verify correct format and content. If errors are found, the laboratory will be notified of the errors, and the SNEDD corrected.

The laboratory will attach the signed COCs to their hard copy data deliverables to officially relinquish control of the data back to the Environmental Contractor within the specified turnaround time. Data archiving forms will be generated and affixed to each laboratory report received per Sample Delivery Group (SDG) for cataloguing, tracking, and archiving purposes.

Hard copy data and SNEDDs will be reviewed to ensure that they are complete and acceptable as outlined in the Data QC Checklist. A 10% comparison between the hard copy and SNEDD content will be conducted to ensure consistency, resolve discrepancies, and document data error issues (for example, EDD re-submissions, turnaround time problems, hard copy incompleteness). All detected errors should be resolved with the laboratory.

These checks ensure the consistency and the validity of the SNEDD and hardcopy content before the data are reported in preliminary tables or sent for validation. The objective of using the SNEDD-QC-Tool is to ensure that the validation process is performed on consistently high-quality data and minimize the chance of finding data errors later in the validation process, which would require the laboratory to resend corrected data and start the validation process over again.

Preliminary raw and detects tables will be generated from data reported in the SNEDD by the Navy RD Formatting Tool – Unval/Val SNEDD. A separate table must be created for each matrix, and provided to the PM for review.

4.4 Data Validation

Once the preliminary data verification is complete, the PC is notified by the EIS that the data is available for validation. The PC will notify the data validator in advance of when to expect data and of any samples or analyses that should not be validated (i.e. grain size should not be validated). For internal data validation, the EIS will notify the PC of data availability, and provide the hardcopy data and a QC Association Table.

Upon receipt of data from CH2M HILL, data validation will be performed in accordance with the Data Validation SOW, UFP SAP, and any other documents required. Generally, questions or noted inconsistencies identified by the validator should be addressed directly to laboratory, with the PC notified of issues and resolutions identified.

4.4.1 External Data Validation

For external data validation, a copy of the SNEDD, hard copy data, and a QC Association Table will be provided to the data validator. The PC will coordinate the return of the data package to CH2M HILL for archiving with the data validator.

Data Validators will provide the following materials to the PC within the required turn around time:

- Hardcopy Data Validation Report
- Validated Version of the SNEDD (external validation)

Once returned to CH2M HILL, the SNEDD will be run through the SNEDD-QC-Tool, which includes automated diagnostic checks for validated data to verify format and content compliance with SNEDD validation specifications. The PC will review the validated data to ensure that they are complete and acceptable as outlined in the Data QC Checklist. A 100% QC check will be performed on the validated results to ensure that the hard copy data matches the SNEDD. All detected errors should be resolved with the data validator.

Data archiving forms will be generated and affixed to each Data Validation Report per SDG received for cataloguing, tracking, and archiving purposes.

Validated raw and detects tables will be generated from data reported in the validated SNEDD by the Navy RD Formatting Tool – Unval/Val SNEDD. A separate table must be created for each matrix, and provided to the PM for review.

4.4.2 Internal Data Validation

For internal data validation, a copy of the SNEDD, hard copy data, and a QC Association Table will be provided to the PC.

The PC will evaluate QC information, associated validation logic, and apply qualifiers to data in the SNEDD and on the laboratory Form Is when QC criteria are not achieved. Qualifier criteria will be based on the Quality Assurance Project Plan. A hardcopy data validation report will be generated. Data archiving forms will be generated and affixed to each Data Validation Report per SDG validated for cataloguing, tracking, and archiving purposes.

Validated raw and detects tables will be generated from data reported in the validated SNEDD by the Navy RD Formatting Tool – Unval/Val SNEDD. A separate table must be created for each matrix, and provided to the PM for review.

4.4.3 Unvalidated Data Preload Check

Occasionally, unvalidated data will need to be loaded into the database. Although the data will not be validated, it will undergo a basic Preload Check by the PC to ensure laboratory compliance with project guidelines and determine results to be reported as the best result where multiple runs were conducted for a given sample/analysis. The PCL will provide input and oversight to ensure that data flags are applied correctly by the PC.

4.4.4 Senior Review

The PCL will verify that the final SNEDD and hardcopy data are complete and acceptable. Any identified discrepancies will be resolved with the assistance of the PC, EIS, laboratory, or validator as needed.

4.5 Data Preparation and Loading

Once the data are considered final and approved by the PCL, they are exported from the SNEDD to the project Data Warehouse. Field and laboratory data are merged into a format that is amenable to the warehouse. The backbone is a SQL-server-based data warehouse.

4.5.1 Data Preparation

As part of the normal process of loading data into the warehouse, data standardization tasks must be completed. A Database Specialist (DBS) will load data into the warehouse using the following three programs: SNEDD-QC-Tool, SVMTool and CH-IMPTool.

A final QC of the data reported in the SNEDD is conducted with the SNEDD-QC-Tool. Any identified discrepancies will be resolved with the assistance of the PCL, PC, or EIS as needed. SNEDDs that pass all of the QA/QC checks in the SNEDD-QC-Tool are then processed with the SVMTool.

The SVMTool links the field data contained in the FDETool to the analytical data contained in the SNEDD. A series of logical QC checks are run to ensure that all data links correctly minimum data requirements are met. The tool then merges the data into a format compatible with the data warehouse structure.

4.5.2 Data Loading

CH2M HILL Loading

The CH-IMPTool runs an additional series of QC checks and adds project-specific formatting, and loads the data into the warehouse. The following tasks need to be completed to load the data for project use:

- **Unit Standardization:** Analytical units and the associated results, reporting limits, and method detection limits will need to be converted to a consistent set of units as required by the project.
- **Resolve Reanalysis and Dilutions:** All samples that had an associated reanalysis or dilution run by the laboratory must have all of the excluded or rejected results marked as not the best result for reporting.
- **Resolve Analytical Overlap and Split Samples:** Analytical overlap occurs when a sample is analyzed by two or more methods that report the same analyte. To resolve any issues not previously resolved, the following logic is used to select the usable result:
 - If the overlapping results are all non-detections, the lowest non-detection result is selected.
 - If the overlapping results are all detected, the highest detected result is selected.
 - If the overlapping results consist of a mixture of detections and non-detections, the highest detected result is selected.

When data are loaded into the warehouse, an automated script will run to identify the “best” result when more than one analytical result exists.

NIRIS Loading

All Navy CLEAN and Joint Venture data must be loaded into NIRIS. Following the successful loading of data into the data warehouse, the DBS will use the FDETool and ALPTool to generate project NIRIS Electronic Data Deliverables (NEDD) files. Field-related NEDDs will be generated from the final version of the FDETool. The final version of the project SNEDD will be processed through the ALPTool to generate the analytical NEDD.

The DBS will use NIRIS's Data Checker Loader Tool to QC and submit the project NEDD files into NIRIS. The NIRIS Regional Database Manager (RDM) will load the data into NIRIS, and will work with the DBS to resolve any potential issue that may arise during loading. Following notification of successful data loading from the RDM, the DBS will query the data from NIRIS for review to ensure data integrity and accuracy.

4.5.3 Data Warehouse

The data warehouse is a Microsoft SQL Server 2005 relational database. This database, and all other "CH" tools used, has a data structure designed to achieve compliance with the Environmental Restoration Program Information Management System (ERPIMS) standard specified by Air Force Center for Engineering and the Environment (AFCEE). ERPIMS is an effective, comprehensive standard for environmental management.

The warehouse will use valid value tables when applying reference attributes to project data. Such reference data include the names of site objects and sampling locations, sampling matrix and method categories, analyte names, units. These reference tables are critical for maintaining the completeness and accuracy of data sets and are essential for accurate querying of the data.

Data are loaded and stored so that relationships among categories of data are enforced. For instance, all sampling records must be associated with a valid site object such as a planned sediment sampling location. The project repository database and collection, analysis, and reporting tools used in the DBMS are designed to enforce, for any project data record, entries in fields that refer to other types of data as required by the overall data model.

4.6 Data Reporting

Data reporting includes the following tasks:

- Retrieving data from the data warehouse for project deliverables, data visualization, or consumption by third parties
- Reviewing initial data and producing data queries and draft reports to dissect and disassemble the data
- Producing any requested client and regulatory agency data deliverables

Data for project deliverables, data visualization, or consumption by third parties will be retrieved from the warehouse, and will be equivalent to the real-time state of the project repository database. PMs and GIS Analysts (GAs) will work with the EIS and PCL for quality queries and data for reports.

4.6.1 Tables, Figures, and Diagrams

Once the data have been sufficiently analyzed, the list of requested data reports (tables, figures, diagrams) can be developed and finalized by the project team and submitted to the PCL and PM for review.

All requests for figures or graphics are to be directed to the GA assigned as the Point of Contact (POC) for that particular Navy installation. All requests for analytical data (crosstab tables, data dumps, third party deliverables etc) should be directed to the EIS assigned as the POC for that particular Navy installation. The EIS will generate a data deliverable from the data warehouse

or NIRIS (as needed) suitable for end use and will provide data support to the end user. All requests for data statistics and calculations should be directed to the Risk Assessor assigned to the project.

4.6.2 GIS

The Navy CLEAN program will utilize ESRI's suite of GIS software for the majority of GIS-related tasks. The GIS data model will consist of one or more geodatabases (GDBs) per installation. Each installation will maintain one common installation GDB, which will store the common infrastructure data such as buildings, roads, topography, hydrography, utilities, etc. The common installation GDB should adhere, as much as possible, to the Spatial Data Standards for Facilities, Infrastructure, and Environment (SDSFIE) data model. All project specific GDBs shall be developed and named for ease of interpretation by the GA.

All station location information for each installation will be pulled directly from the data warehouse and stored in the common installation GDB as a data table. The data warehouse must contain valid coordinate information for the locations to be displayed correctly. Valid coordinate information will be maintained in the data warehouse by the EIS, and updated as necessary by the DBS.

ESRI's ArcMap 9.3 (or the latest version available) will be utilized for spatially displaying the environmental data within maps and figures, as well as for spatial analysis. The GA will need to coordinate efforts with the EIS on all requests that require the display of environmental sample data on a map to ensure that the appropriate data is queried from the data warehouse and linked to the appropriate station location table within the GIS.

4.6.3 Site Information Management System

This is currently not being used on the Navy CLEAN and Joint Venture Programs.

SIMS is a tool for publishing data of sufficient quality from the project. However, the project data warehouse will remain the database of record for the project.

SIMS provides many standard report formats, all of which are used in conjunction with the Query Tool feature, to isolate and retrieve information. Users can generate and save their queries using a graphical point-and-click tool. Reports in a wide variety of formats also can be requested and produced.

4.6.4 Legacy Data

Legacy data are those collected from any contractor other than CH2M HILL and data collected by CH2M HILL that have not been managed in accordance with Navy CLEAN and Joint Venture Program requirements. Legacy data are commonly compiled from various electronic and hard copy sources including spreadsheets, databases, technical reports, and laboratory hard copy data reports. When working with legacy data, usability assessment must be completed for the project team to be able to use the data with confidence. In order to assess the data properly, the legacy data needs to be evaluated by skilled professionals that are familiar with the type of data being evaluated so that any errors identified in the data can be corrected when possible or qualified in a manner to reflect the limitations of the data's use.

The PM has overall responsibility for the selection for inclusion of legacy data into the data management process. The PDL and PCL will work with the PM to establish the data review

and import process, compile a comprehensive data inventory, and identify staff to facilitate data review.

The PDL and PCL will work with the EIS to determine the appropriate intermediary files and tools used to collect the data. The PDL and PCL will oversee the data review and flagging process and approve the data for upload into the Data Warehouse. The EIS is responsible for assembling the field and laboratory data in formats that facilitate data review, aid the PDL and PCL in overseeing the data review and flagging process, schedule, conversion of the data to the proper data warehouse format, and then loading the data into the Data Warehouse after approval by the PDL and PCL.

The GA, PDL, PCL, and PM have the primary responsibility for reviewing the data in their area of expertise and providing the PCL with data usability flags to be associated with each record.

SECTION 5

Project Closeout

The project completion/closeout phase includes the following:

- Archive hard copy and electronic documents
- Conduct project closeout meeting

5.1 Archive Procedures

A large variety of technical data will be generated during the field investigations. The EIS and PC will collect all hard copy and electronic data they are responsible for and verify that the incoming records are legible and in suitable condition for storage. Record storage will be performed in two stages:

- Storage during the project
- Permanent storage following project completion

During the project, CH2M HILL will store data hardcopy reports in CH2M HILL offices. Physical records will be secured in steel file cabinets or shelves, and labelled with the appropriate project identification. Electronic data will be maintained on CH2M HILL's corporate local area network servers.

Information generated from field activities will be documented on appropriate forms and will be maintained in the project file. These include COC records, field logbooks, well construction forms, boring logs, location sketches, and site photographs. In addition, notes from project meetings and telephone conversations will be filed.

Following project completion, both hard copy and electronic data deliverables will be archived. Team staff will provide all hard copies of laboratory and validation reports to the Data Closeout Coordinator to be prepped and shipped to Stone Mountain for archiving. Final laboratory SNEDDs and loading files will be provided to the PDL, to be archived on CH2M HILL's corporate local area network servers.

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

5.2 Invoice Review and Approval

The EIS is responsible for tracking all data deliverables throughout the data management process to ensure that the project schedule is maintained, subcontractors comply with all required turn around times, and data provided are complete and acceptable. Following project completion, EISs are to review and provide comments on all laboratory and data validator invoices regarding data quality and schedule compliance prior to approval by the PM.

5.3 Project Closeout

At the end of each project, the PM will notify team staff of project closeout. The PM will coordinate and verify that all pertinent data has been archived. The PM may also review lessons learned, suggest process improvements, or revisions to the DMP and other project documentation as deemed necessary.

Appendix A

Environmental Data Management Work Process

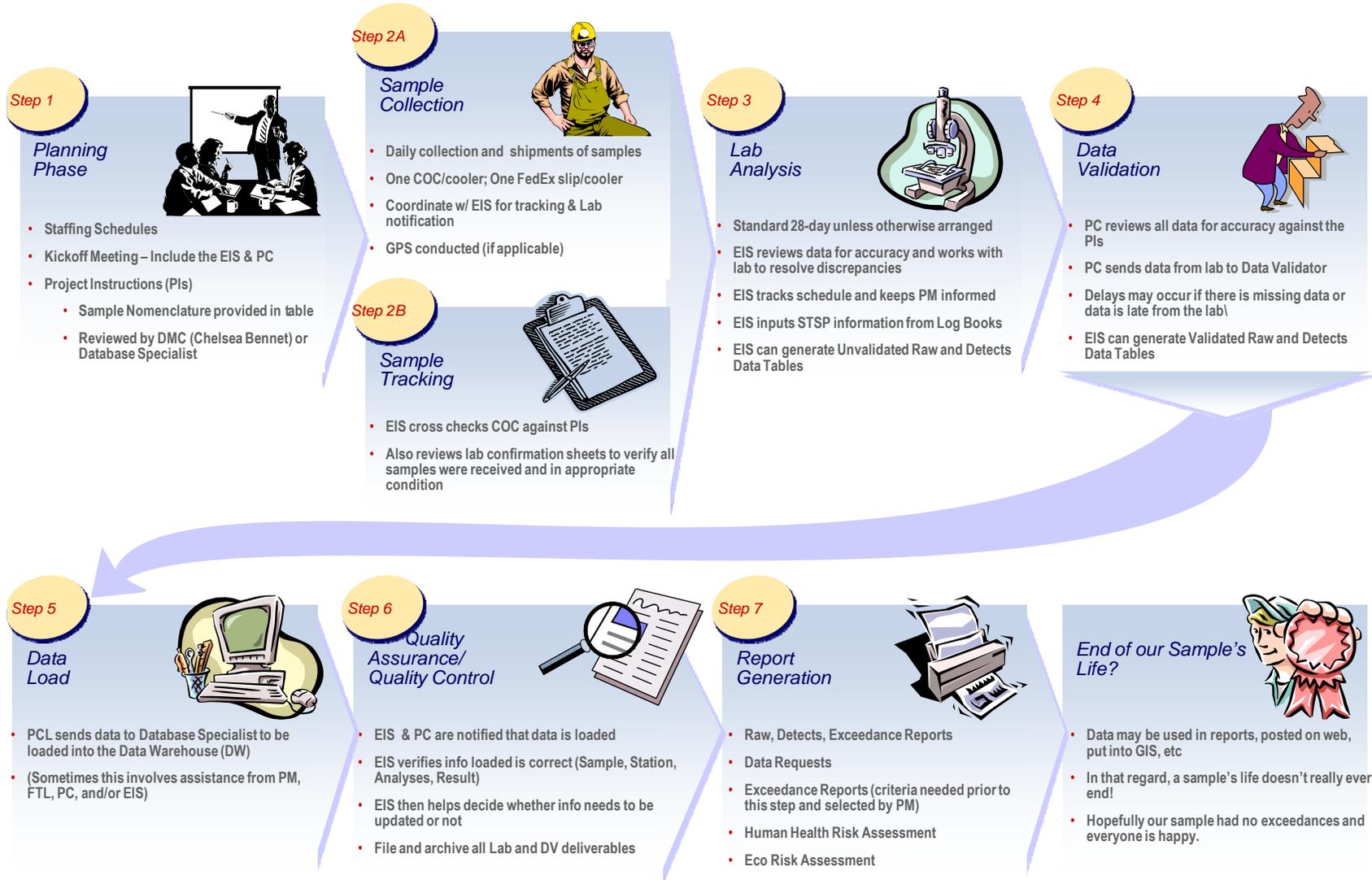
Environmental Data Management Work Process

1.0 Project Planning & Setup	2.0 Sample Collection & Management	3.0 Lab Analysis	4.0 Data Validation	5.0 Data Management	6.0 Data Evaluation & Reporting
1.1 Project Setup	2.1 Sample Management	3.1 Sample Analysis	4.1 Internal Chemical Data Validation	5.1 CH2M HILL Data	6.1 Data Prep & Processing for Reporting
1.2 QAPP, SAP, DMP, DQOs Integration	2.2 Sample Collection	3.2 EDD Management	4.2 External Chemical Data Validation	5.2 Other Contractor & Legacy Data	6.2 Tabular Data Queries & Reports
1.3 Laboratory Setup	2.3 Sample Data Management	3.3 Hard Copy Management	4.3 Senior Review of Validated Data	5.3 Database Maintenance & Administration	6.3 Field Logs and Graphs
1.4 Database Setup					6.4 GIS Queries and Maps

Appendix B
Life of a Sample

A Sample's Life

Step-by-Step Outline of Navy CLEAN and JV Data Management Process, and Roles & Responsibilities



Appendix C
Standard Operating Procedures

Checklist - Archive and NIRIS Load Prep

Checklist - Data QC

Checklist - EIS Project Start-up Questions

Checklist - Generating RDE Tables

Checklist - Historic Data Cleanup

Checklist - SNEDD DM Process

Roles - Data Management Coordinator

Roles - EIS

Roles - Project Manager

Template - STS & QC Association Table

SOP-114 - CHIMPTool

SOP-126 - XTab Reports Tool

SOP - Access to NIRIS

SOP - Cherry Point Exceedance Formatting Wizard

SOP - CLEAN SNEDD Loading with CHIMPTool

SOP - Corrections to File

SOP - Data Archiving Procedures

SOP - Data Shipping

SOP - FDET

SOP - FDET Setup

SOP - NIRIS Importer Validator Tool

SOP - SVMTool

SOP - Valid Value Setup

Appendix D

Electronic Data Deliverable Specifications

CH2M HILL SNEDD Format			
Field Name	Field Format	REQ	Field Description
Contract_ID	A13	R	Contract ID assigned by Division Contracting Office, not including dashes. Found on Statement of Work. (e.g. D459559365800)
DO_CTO_Number	A4	R	CTO or TO # assigned by Navy. (e.g. CTO-12 = 0012, TO-54 = TO54)
Phase	A8	NR	Task Phase, SubTask Number or Annual Quarter. (e.g. QTR1)
Installation_ID	A20*	R	Unique identifier for installation. (e.g. WHIDBEY)
Sample_Name	A50	R	CH2M HILL Sample ID (from Chain Of Custody).
CH2M_Code	A4*	R	CH2M HILL Preparation Method Code (e.g. NONS)
Analysis_Group	A9*	R	The CH2M HILL code for the analysis performed on the sample.
Analytical_Method	A20*	R	Analytical Method used to analyze sample fraction. (e.g. 6010)
PRC_Code	A15*	R	NIRIS code for the analytical method category (e.g. PCHAR)
Lab_Code	A10*	R	CH2M HILL Code assigned to the laboratory (e.g. COMP)
Lab_Name	A50*	R	The name of the laboratory that conducted the analysis, in all CAPS.
Leachate_Method	A16*	RA	Code for the leachate method used on sample. (e.g. SW1310)
Sample_Basis	A16*	R	Sample basis of analysis; wet weight, dry weight etc. (e.g. DRY)
Extraction_Method	A16*	RA	Code for the extraction method used on sample. (e.g. FLTRES)
Result_Type	A16*	R	Type of results; dilution, reanalysis etc. (e.g. 000)
Lab_QC_Type	A15*	R	Code for Laboratory Sample (MS, MSD, LBLK, LCS)
Sample_Medium	A16*	R	Sample medium reported by the laboratory. (e.g. L)
QC_Level	A16*	R	QC Level of data package : EPA levels I to IV. (e.g. 3)
DateTime_Collected	MM/DD/YYYY 00:00	R	Date and time sample was collected. Use 24 hour clock. (e.g. 02/13/2007 15:34)
Date_Received	MM/DD/YYYY	R	The date the sample was received in the lab (in 10 characters). (e.g. 03/24/2007)
Leachate_Date	YYYYMMDD	RA	Date the sample was leached. Req'd if sample was leached and/or Leachate Method provided. (e.g. March 12, 2007 = 20070312)
Leachate_Time	HH:MM:SS	RA	Time the sample was leached. Use 24 hour clock, with 8 characters. (e.g. 14:30:05). Req'd if sample was leached and/or Leachate Method provided.
Extraction_Date	YYYYMMDD	RA	Date that the lab extracted the sample. Req'd if Extraction Method provided.
Extraction_Time	HH:MM:SS	RA	Time of day lab extracted the sample. Use 24 hour clock, with 8 characters. Req'd if Extraction Method provided. (e.g. 02:15:00)
Analysis_Date	YYYYMMDD	R	Date that the lab performed the analysis.
Analysis_Time	HH:MM:SS	R	Time of day that the lab extracted the sample. Use 24 hour clock, with 8 characters.
Lab_Sample_ID	A20	R	Unique ID assigned to the sample by the laboratory.

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.

Appendix D
Laboratory Accreditation



CERTIFICATE OF ACCREDITATION

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

This is to certify that

TriMatrix Laboratories, Inc.
5560 Corporate Exchange Court, SE
Grand Rapids, MI 49512

has been assessed by AClass
and meets the requirements of

ISO/IEC 17025:2005 and DoD-ELAP

while demonstrating technical competence in the field(s) of

TESTING

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

ADE-1542

Certificate Number

AClass Approval



Certificate Valid: 4/30/2011-04/30/2013
Version No. 002 Issued: 12/23/2011



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



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

TriMatrix Laboratories, Inc

5560 Corporate Exchange Court, SE, Grand Rapids, MI 49512

Rick Wilburn Phone: 616-975-4500

TESTING

Valid to: April 30, 2013

Certificate Number: ADE - 1542

I. Environmental

Table with 4 columns: MATRIX, SPECIFIC TEST or ANALYTE GROUP**, SPECIFICATION OR STANDARD METHOD (all EPA unless specified), * KEY EQUIPMENT OR TECHNOLOGY USED. Rows include tests for TKN, Nitroaromatics and Nitramines, Ignitability, HEM Oil and Grease/SGT-HEM Non-Polar Material, Metals, Calcium Hardness As CaCO3, Total Hardness As CaCO3, and Mercury.



MATRIX	SPECIFIC TEST or ANALYTE GROUP**	SPECIFICATION OR STANDARD METHOD (all EPA unless specified)	* KEY EQUIPMENT OR TECHNOLOGY USED
Solid	Mercury	7471A	CVAA
Water	Volatiles Organics	601/602/8021B	GC-PID; HECD
Solid	Volatile Organics	8021B	GC-PID; HECD
Water	Volatile Organics	524.2/624/8260B	GCMS
Solid	Volatile Organics	8260B	GCMS
Water	Organochlorine Pesticides	608/8081B	GC-ECD
Solid	Organochlorine Pesticides	8081B	GC-ECD
Water	Semivolatile Organic Compounds	625/8270C	GCMS
Solid	Semivolatile Organic Compounds	8270C	GCMS
Water	PCBs	608/8082A	GC
Solid	PCBs	8082A	GC
Water/Solid	Chlorinated Herbicides	8151A	GC-ECD
Solid	Paint Filter Test	9095B	Filtration
Water	Sulfate	ASTM D516-02(90); 9038	Turbidimetric
Water	Dissolved Gas Analysis	RSK-175	GC-FID
Water	Color	SM 2120B	Platinum-Cobalt Color
Water	Turbidity	SM2130B	Nephelometric
Water	Acidity	SM2310B	Titrimetric

MATRIX	SPECIFIC TEST or ANALYTE GROUP**	SPECIFICATION OR STANDARD METHOD (all EPA unless specified)	* KEY EQUIPMENT OR TECHNOLOGY USED
Water	Total Alkalinity (as CaCO ₃)	SM2320B	Titrimetric
Water	Conductivity	SM2510B/9050A	Specific Conductance
Water	Total Residue/Solids (TS)	SM2540B	Gravimetric
Water	Filterable Residue (TDS)	SM2540C	Gravimetric
Water	Non-Filterable Residue (TSS)	SM 2540 D	Gravimetric
Solid	Chromium (VI) Cr ⁺⁶	3060A	Digestion
Water	Chromium (VI) Cr ⁺⁶	SM3500-Cr B/7196A	Spectrophotometric
Solid	Chromium (VI) Cr ⁺⁶	7196A	Spectrophotometric
Water	Ferrous Iron	SM 3500-Fe B	Spectrophotometric
Water	Chloride	SM 4500-Cl E/9251	Spectrophotometric
Water/Solid	Fluoride	SM 4500-F C	ISE
Water	pH and Corrosivity	SM 4500-H ⁺ B/9040C	Potentiometric
Solid	pH and Corrosivity	9045D	Potentiometric
Water/Solid	Ammonia-N	SM 4500-NH ₃ B	Distillation
Water/Solid	Ammonia-N	SM 4500-NH ₃ G	Spectrophotometric
Water	Nitrite-N	SM 4500-NO ₂ B/NO ₃ F	Spectrophotometric
Water/Solid	Nitrate-N	SM 4500-NO ₃ F	Spectrophotometric
Water	Nitrate+Nitrite-N	SM 4500-NO ₃ F	Spectrophotometric

MATRIX	SPECIFIC TEST or ANALYTE GROUP**	SPECIFICATION OR STANDARD METHOD (all EPA unless specified)	* KEY EQUIPMENT OR TECHNOLOGY USED
Water	Sulfide	SM 4500-S ₂ D	Spectrophotometric
Water	Sulfide	SM 4500-S ₂ F	Titrimetric
Water/Solid	Sulfide	9034	Titrimetric
Water	Sulfite	SM 4500-SO ₃ ²⁻ B	Titrimetric
Water	o-Phosphate	SM 4500-P E	Spectrophotometric
Water/Solid	Phosphorus Total	SM 4500-P E	Spectrophotometric
Water	Silica as SiO ₂	SM 4500-SiO ₂ D	Spectrophotometric
Water	COD	SM 5220 D	Spectrophotometric
Water	Total Organic Carbon (TOC)	SM 5310 C/9060A	Oxidation/CO ₂ Det
Water	Surfactants (MBAS)	SM 5540 C	Spectrophotometric
Water	Heterotrophic Bacteria (Std Plate)	SM 9215 B	Microbiological
Water	Fecal Coliform	SM 9222 D	Microbiological
Water	Total Coliform, E. Coli	SM 9223 B	Microbiological
Solid	Total Residue/Solids (TS)	SM 2540B	Gravimetric
Water/Solid	Diesel Range Organics (DRO)	Wisconsin DRO/8015C	GC-FID
Water/Solid	Gasoline Range Organics (GRO)	Wisconsin GRO/8015C	GC-FID
Water/Solid	Oil Range Organics	8015C	GC-FID
Water/Solid	TCLP	1311	Acetic Acid Leaching

MATRIX	SPECIFIC TEST or ANALYTE GROUP**	SPECIFICATION OR STANDARD METHOD (all EPA unless specified)	* KEY EQUIPMENT OR TECHNOLOGY USED
Water/Solid	SPLP	1312	Acetic Acid Leaching
Solid	Semivolatiles Extraction	3550C	Ultrasonic Extraction
Water	Metals Digestion	200.2	Block Digestion
Solid	Semivolatiles Extraction	3545A	Pressurized Fluid Ext
Solid	Volatiles Extraction	5035A	Purge & Trap
Solid	Cyanide Extraction	9013A	Extraction
Water	Metals Digestion	3010A	Block Digestion
Water	Metals Digestion	3020A	Block Digestion
Solid	Metals Digestion	3050B	Block Digestion
Water	Semivolatiles Extraction	3510C	Separatory Funnel Ext
Water	Volatiles Extraction	5030B	Purge & Trap/Water
Water	Volatile Residue (VS)	160.4	Gravimetric
Water	Methoxychlor	608	GC-ECD
Water	1,2-Dibromo-3- Chloropropane & 1,2- Dibromoethane	8011	GC-ECD
Water/Solid	Nitroglycerine and PETN	8332	HPLC-UV
Water	Mercury, Low-Level	1631E	CVAF
Water	Anions	300.0/9056A	Ion Chromatographic
Solid	Anions	9056A	Ion Chromatographic



MATRIX	SPECIFIC TEST or ANALYTE GROUP**	SPECIFICATION OR STANDARD METHOD (all EPA unless specified)	* KEY EQUIPMENT OR TECHNOLOGY USED
Water	Total Phenolics	420.4/9065	Spectrophotometric
Solid	Total Phenolics	9065	Spectrophotometric
Water	Nonhalogenated Organics	8015C	GC-FID
Water/Solid	Semivolatile Organic Compounds	8270C SIM	GCMS
Water/Solid	Carbonyl Compounds	8315A	HPLC-UV
Water	Total Organic Halides (TOX)	9020B	Coulometric Titration
Water/Solid	Sulfide	9030B	Distillation
Solid	Acid Volatile Sulfide and Selected Simultaneously Extractable Metals	EPA Method 821-R-91- 100	Distillation/ Spectrophotometric
Solid	Total Organic Carbon (TOC)	Lloyd Kahn	Infrared
Water/Solid	Cyanide Available	OIA-1677	Amperometry
Water	Calcium Hardness As CaCO ₃	SM 2340 C	Titrimetric
Water	Total Hardness As CaCO ₃	SM 2340 C	Titrimetric
Water	Cyanide	SM 4500-CN C/9010C	Distillation
Solid	Cyanide	9010C	Distillation
Water	Cyanide Total	SM 4500-CN E/9014	Spectrophotometric
Solid	Cyanide Total	9014	Spectrophotometric
Water	Cyanide Amenable	SM 4500-CN G/9014	Spectrophotometric
Solid	Cyanide Amenable	9014	Spectrophotometric



MATRIX	SPECIFIC TEST or ANALYTE GROUP**	SPECIFICATION OR STANDARD METHOD (all EPA unless specified)	* KEY EQUIPMENT OR TECHNOLOGY USED
Water	BOD and CBOD	SM 5210 B	Luminescence
Solid	Total Organic Carbon (TOC)	WALKLEY BLACK	Titrimetric
Water	Bromide	ASTM D1246-88	ISE

Notes:

1. * = As Applicable
2. ** = Refer to Accredited Analyte Listing for specific analytes in which the laboratory is accredited.
3. This scope is part of and must be included with the Certificate of Accreditation No. ADE-1542



Vice President



Accredited Analytes/Methods (by matrix)

TriMatrix Laboratoires, Inc.

Grand Rapids, MI

NELAC Code	Analyte	Matrix							
		Aqueous				Solid			
	Trace Metals								
1000	Aluminum	200.7	200.8	6010C	6020A			6010C	
1005	Antimony		200.8		6020A				6020A
1010	Arsenic	200.7	200.8	6010C	6020A			6010C	6020A
1015	Barium	200.7	200.8	6010C	6020A			6010C	6020A
1020	Beryllium	200.7	200.8	6010C	6020A			6010C	6020A
1025	Boron	200.7	200.8	6010C	6020A			6010C	6020A
1030	Cadmium	200.7	200.8	6010C	6020A			6010C	6020A
1035	Calcium	200.7		6010C				6010C	
1040	Chromium, total	200.7	200.8	6010C	6020A			6010C	6020A
1045	Chromium VI	SM3500Cr B				7196A			7196A
1050	Cobalt	200.7	200.8	6010C	6020A			6010C	6020A
1055	Copper	200.7	200.8	6010C	6020A			6010C	6020A
1070	Iron	200.7		6010C				6010C	
1075	Lead	200.7	200.8	6010C	6020A			6010C	6020A
1085	Magnesium	200.7		6010C				6010C	
1090	Manganese	200.7	200.8	6010C	6020A			6010C	6020A
1095	Mercury	245.1				7470A			7471A
1095	Mercury (Low Level)					1631E			
1100	Molybdenum	200.7	200.8	6010C	6020A			6010C	6020A
1105	Nickel	200.7	200.8	6010C	6020A			6010C	6020A
1125	Potassium	200.7		6010C				6010C	
1140	Selenium	200.7	200.8	6010C	6020A			6010C	6020A
1150	Silver	200.7	200.8	6010C	6020A			6010C	6020A
1155	Sodium	200.7		6010C				6010C	
1160	Strontium	200.7	200.8	6010C	6020A			6010C	6020A
1165	Thallium	200.7	200.8	6010C	6020A			6010C	6020A
1175	Tin	200.7	200.8	6010C	6020A			6010C	6020A
1180	Titanium	200.7		6010C				6010C	
1185	Vanadium	200.7	200.8	6010C	6020A			6010C	6020A
1190	Zinc	200.7	200.8	6010C	6020A			6010C	6020A
	Demands								
2040	TOC	SM5310C	9060A					Walkley Black	Lloyd Kahn
1565	COD			SM5220D					
	Misc Analytes								
1505	Total Alkalinity (as CaCO ₃)	SM2320B							
	BOD and CBOD	SM5210B							
	Calcium Hardness as CaCO ₃	SM2340B	SM2340C						
1550	Total Hardness as CaCO ₃	SM2340B	SM2340C						
1960	Total Residue/Solids (TS)	SM2540B						3550C	
1705	Filterable Residue (TDS)		SM2540C						
1780	Ignitability							1020A	
1955	Non-Filterable Residue (TSS)	SM2540D							
	Volatile Residue (VS)		160.4						
	pH			9040C	SM4500H+B			9045D	
2005	Sulfide	SM4500S2-D	SM4500S2-F	9034				9034	
1645	Total Cyanide	SM4500CN E	9014					9014	
1510	Cyanide, Amenable	SM4500-CN G	9014					9014	
1515	Ammonia	SM4500NH3-G						SM4500NH3-G	
1610	Conductivity	SM2510B	9050A						
1795	Nitrogen, Total Kjeldahl (TKN)	351.2						351.2	
1905	Total Phenolics	420.4	9065					9065	
2045	Total Organic Halides (TOX)	9020B							
1540	Bromide	ASTM D1246-88			9056A			9056A	
1575	Chloride	SM4500Cl-E	9251	300.0	9056A			9056A	
1730	Fluoride	SM4500F-C		300.0	9056A			9056A	SM4500F-C
1810	Nitrate as N	SM4500NO3-F		300.0	9056A			9056A	SM4500NO3-F
1840	Nitrite as N	SM4500NO2-B	SM4500NO3-F	300.0	9056A			9056A	
1820	Nitrate + Nitrite as N	SM4500NO3-F		300.0	9056A			9056A	
1870	ortho-phosphorus	SM4500P-E							
1910	Total Phosphorus	SM4500P-E						SM4500P-E	
1990	Silica as SiO ₂	SM4500 Si D							
2000	Sulfate	ASTM D516-02	9038	300.0	9056A			9056A	
2025	Surfactants - MBAS	SM5540C							
	Fecal Coliform	SM9222D							
	Heterotrophic Bacteria (Std Plate)	SM9215B							
	Total Coliform, E. Coli	SM9223B							
2055	Turbidity		SM2130B						
	Petroleum Hydrocarbons								
1935	SGT-HEM; Non-Polar Material	1664A	9070A					9071B	
1860	HEM; Oil and Grease	1664A	9070A					9071B	
9408	Gasoline Range Organics (GRO)	8015C	Wisconsin GRO					8015C	Wisconsin GRO
9369	Diesel Range Organics (DRO)	8015C	Wisconsin DRO					8015C	Wisconsin DRO
	Oil Range Organics (ORO)	8015C						8015C	
	VOCs								
4315	Acetone		624	8260B					8260B
4320	Acetonitrile		624	8260B					8260B
4325	Acrolein		624	8260B					8260B
4340	Acrylonitrile		624	8260B					8260B
4375	Benzene	524.2	624	8260B		602	8021B	8021B	8260B
4385	Bromobenzene	524.2		8260B	601		8021B	8021B	8260B
4390	Bromochloromethane	524.2		8260B					8260B
4395	Bromodichloromethane	524.2	624	8260B	601		8021B	8021B	8260B
4400	Bromoform	524.2	624	8260B	601		8021B	8021B	8260B
4950	Bromomethane	524.2	624	8260B	601		8021B	8021B	8260B
4410	2-Butanone (MEK)		624	8260B					8260B
4435	n-Butylbenzene	524.2		8260B					8260B
4440	sec-Butylbenzene	524.2		8260B					8260B
4445	tert-Butylbenzene	524.2		8260B					8260B
4450	Carbon disulfide		624	8260B					8260B
4455	Carbon Tetrachloride	524.2	624	8260B	601		8021B	8021B	8260B

Accredited Analytes/Methods (by matrix)										
TriMatrix Laboratoires, Inc.										
Grand Rapids, MI										
NELAC Code	Analyte	Matrix								
		Aqueous						Solid		
4475	Chlorobenzene	524.2	624	8260B	601	602	8021B	8021B	8260B	
4575	Chlorodibromomethane	524.2	624	8260B	601		8021B	8021B	8260B	
4485	Chloroethane	524.2	624	8260B	601		8021B	8021B	8260B	
4500	2-Chloroethylvinylether		624	8260B	601		8021B	8021B	8260B	
4505	Chloroform	524.2	624	8260B	601		8021B	8021B	8260B	
4960	Chloromethane	524.2	624	8260B	601		8021B	8021B	8260B	
4535	2-Chlorotoluene	524.2		8260B					8260B	
4540	4-Chlorotoluene	524.2		8260B					8260B	
4570	1,2-Dibromo-3-chloropropane (DBCP)		624	8260B	601		8021B	8021B	8260B	
4585	1,2-Dibromoethane (EDB)		624	8260B	601		8021B	8021B	8260B	
4595	Dibromomethane	524.2	624	8260B	601		8021B	8021B	8260B	
4610	1,2-Dichlorobenzene	524.2	624	8260B	601	602	8021B	8021B	8260B	
4615	1,3-Dichlorobenzene	524.2	624	8260B	601	602	8021B	8021B	8260B	
4620	1,4-Dichlorobenzene	524.2	624	8260B	601	602	8021B	8021B	8260B	
4625	Dichlorodifluoromethane	524.2	624	8260B	601		8021B	8021B	8260B	
4630	1,1-Dichloroethane	524.2	624	8260B	601		8021B	8021B	8260B	
4635	1,2-Dichloroethane	524.2	624	8260B	601		8021B	8021B	8260B	
4640	1,1-Dichloroethene	524.2	624	8260B	601		8021B	8021B	8260B	
4645	cis-1,2-Dichloroethene	524.2	624	8260B	601		8021B	8021B	8260B	
4700	trans-1,2-Dichloroethene	524.2	624	8260B	601		8021B	8021B	8260B	
4975	Dichloromethane (Methylene Chloride)	524.2	624	8260B	601		8021B	8021B	8260B	
4655	1,2-Dichloropropane	524.2	624	8260B	601		8021B	8021B	8260B	
4660	1,3-Dichloropropane	524.2		8260B					8260B	
4665	2,2-Dichloropropane	524.2		8260B					8260B	
4670	1,1-Dichloropropene	524.2		8260B					8260B	
4680	cis-1,3-Dichloropropene	524.2	624	8260B	601		8021B	8021B	8260B	
4685	trans-1,3-Dichloropropene	524.2	624	8260B	601		8021B	8021B	8260B	
9375	Di-isopropylether (DIPE)			8260B					8260B	
4765	Ethylbenzene	524.2	624	8260B		602	8021B	8021B	8260B	
3815	1,1,2-trichloro-1,2,2-trifluoroethane (Freon 113)			8260B					8260B	
4835	Hexachlorobutadiene	524.2	624	8260B					8260B	
4860	2-Hexanone		624	8260B					8260B	
4900	Isopropylbenzene	524.2	624	8260B	601		8021B	8021B	8260B	
4910	4-Isopropyltoluene	524.2		8260B					8260B	
4995	4-Methyl-2-pentanone (MIBK)		624	8260B					8260B	
5000	Methyl-tert-butylether (MTBE)	524.2	624	8260B		602	8021B	8021B	8260B	
5005	Naphthalene	524.2	624	8260B	601		8021B	8021B	8260B	
5090	n-Propylbenzene	524.2		8260B					8260B	
5100	Styrene	524.2	624	8260B	601		8021B	8021B	8260B	
4370	tert-amylmylether (TAME)			8260B					8260B	
5105	1,1,1,2-Tetrachloroethane	524.2	624	8260B	601		8021B	8021B	8260B	
5110	1,1,1,2,2-Tetrachloroethane	524.2	624	8260B	601		8021B	8021B	8260B	
5115	Tetrachloroethene	524.2	624	8260B	601		8021B	8021B	8260B	
5140	Toluene	524.2	624	8260B		602	8021B	8021B	8260B	
5150	1,2,3-Trichlorobenzene	524.2		8260B					8260B	
5155	1,2,4-Trichlorobenzene	524.2	624	8260B	601		8021B	8021B	8260B	
5160	1,1,1-Trichloroethane	524.2	624	8260B	601		8021B	8021B	8260B	
5165	1,1,2-Trichloroethane	524.2	624	8260B	601		8021B	8021B	8260B	
5170	Trichloroethene	524.2	624	8260B	601		8021B	8021B	8260B	
5175	Trichlorofluoromethane (Freon 11)	524.2	624	8260B	601		8021B	8021B	8260B	
5180	1,2,3-Trichloropropane	524.2	624	8260B	601		8021B	8021B	8260B	
5210	1,2,4-Trimethylbenzene	524.2		8260B					8260B	
5215	1,3,5-Trimethylbenzene	524.2		8260B					8260B	
5225	Vinyl acetate		624	8260B	601		8021B	8021B	8260B	
5235	Vinyl chloride	524.2	624	8260B	601		8021B	8021B	8260B	
5250	o-Xylene		624	8260B		602			8260B	
5240	m+p-Xylene		624	8260B		602			8260B	
5260	Xylenes, total	524.2	624	8260B		602	8021B	8021B	8260B	
SVOCs - Base/Neutrals/Acids										
5500	Acenaphthene	8270C SIM	625	8270C				8270C	8270C SIM	
5505	Acenaphthylene	8270C SIM	625	8270C				8270C	8270C SIM	
5545	Aniline		625	8270C				8270C		
5555	Anthracene	8270C SIM	625	8270C				8270C	8270C SIM	
5575	Benzo(a)anthracene	8270C SIM	625	8270C				8270C	8270C SIM	
5585	Benzo(b)fluoranthene	8270C SIM	625	8270C				8270C	8270C SIM	
5600	Benzo(k)fluoranthene	8270C SIM	625	8270C				8270C	8270C SIM	
5590	Benzo(g,h,i)perylene	8270C SIM	625	8270C				8270C	8270C SIM	
5580	Benzo(a)pyrene	8270C SIM	625	8270C				8270C	8270C SIM	
5595	Benzo(e)pyrene		625	8270C				8270C		
5610	Benzoic acid		625	8270C				8270C		
5630	Benzyl alcohol		625	8270C				8270C		
5660	4-Bromophenyl-phenylether		625	8270C				8270C		
5670	Butyl benzyl phthalate		625	8270C				8270C		
5680	Carbazole							8270C		
5745	4-Chloroaniline		625	8270C				8270C		
5760	bis(2-Chloroethoxy)methane		625	8270C				8270C		
5765	bis(2-Chloroethyl)ether		625	8270C				8270C		
5780	bis(2-Chloroisopropyl) ether		625	8270C				8270C		
5700	4-Chloro-3-methylphenol		625	8270C				8270C		
5795	2-Chloronaphthalene		625	8270C				8270C		
5825	4-Chlorophenyl-phenylether		625	8270C				8270C		
5800	2-Chlorophenol		625	8270C				8270C		
5855	Chrysene	8270C SIM	625	8270C				8270C	8270C SIM	
5895	Dibenzo(a,h)anthracene	8270C SIM	625	8270C				8270C	8270C SIM	
5905	Dibenzofuran		625	8270C				8270C		
5925	Di-n-butylphthalate		625	8270C				8270C		
4610	1,2-Dichlorobenzene		625	8270C				8270C		
4615	1,3-Dichlorobenzene		625	8270C				8270C		
4620	1,4-Dichlorobenzene		625	8270C				8270C		
5945	3,3'-Dichlorobenzidine		625	8270C				8270C		
6000	2,4-Dichlorophenol		625	8270C				8270C		
6005	2,6-Dichlorophenol		625	8270C				8270C		
6070	Diethyl phthalate		625	8270C				8270C		
6130	2,4-Dimethylphenol		625	8270C				8270C		

Accredited Analytes/Methods (by matrix)

TriMatrix Laboratoires, Inc.

Grand Rapids, MI

NELAC Code	Analyte	Matrix							
		Aqueous				Solid			
6135	Dimethylphthalate		625	8270C				8270C	
6175	2,4-Dinitrophenol		625	8270C				8270C	
6185	2,4-Dinitrotoluene		625	8270C				8270C	
6190	2,6-Dinitrotoluene		625	8270C				8270C	
6200	Di-n-octylphthalate		625	8270C				8270C	
4740	p-Dioxane			8270C				8270C	
6065	bis(2-ethylhexyl) phthalate		625	8270C				8270C	
6265	Fluoranthene	8270C SIM	625	8270C				8270C	8270C SIM
6270	Fluorene	8270C SIM	625	8270C				8270C	8270C SIM
6275	Hexachlorobenzene		625	8270C				8270C	
4835	Hexachlorobutadiene		625	8270C				8270C	
6285	Hexachlorocyclopentadiene		625	8270C				8270C	
4840	Hexachloroethane		625	8270C				8270C	
6315	Indeno(1,2,3-cd)pyrene	8270C SIM	625	8270C				8270C	8270C SIM
6320	Isophorone		625	8270C				8270C	
6360	2-Methyl-4,6-Dinitrophenol		625	8270C				8270C	
6400	2-Methylphenol		625	8270C				8270C	
6410	4-Methylphenol (and/or 3-Methylphenol)		625	8270C				8270C	
6385	2-Methylnaphthalene	8270C SIM	625	8270C				8270C	8270C SIM
5005	Naphthalene	8270C SIM	625	8270C				8270C	8270C SIM
6460	2-Nitroaniline		625	8270C				8270C	
6465	3-Nitroaniline		625	8270C				8270C	
6470	4-Nitroaniline		625	8270C				8270C	
5015	Nitrobenzene		625	8270C				8270C	
6490	2-Nitrophenol		625	8270C				8270C	
6500	4-Nitrophenol		625	8270C				8270C	
6525	N-Nitrosodimethylamine		625	8270C				8270C	
6530	N-Nitrosodimethylamine		625	8270C				8270C	
6535	N-Nitrosodiphenylamine		625	8270C				8270C	
6545	N-Nitroso-di-n-propylamine		625	8270C				8270C	
6590	Pentachlorobenzene		625	8270C				8270C	
6605	Pentachlorophenol		625	8270C				8270C	
6615	Phenanthrene	8270C SIM	625	8270C				8270C	8270C SIM
6625	Phenol		625	8270C				8270C	
6665	Pyrene	8270C SIM	625	8270C				8270C	8270C SIM
5095	Pyridine		625	8270C				8270C	
6715	1,2,4,5-Tetrachlorobenzene		625	8270C				8270C	
6735	2,3,4,6-Tetrachlorophenol		625	8270C				8270C	
5145	α-Toluidine		625	8270C				8270C	
5155	1,2,4-Trichlorobenzene		625	8270C				8270C	
6835	2,4,5-Trichlorophenol		625	8270C				8270C	
6840	2,4,6-Trichlorophenol		625	8270C				8270C	
	Nitroaromatic and Nitramines								
9306	4-Amino-2,6-dinitrotoluene	8330A						8330A	
9303	2-Amino-4,6-dinitrotoluene	8330A						8330A	
6160	1,3-Dinitrobenzene	8330A						8330A	
6185	2,4-Dinitrotoluene	8330A						8330A	
6190	2,6-Dinitrotoluene	8330A						8330A	
9522	HMX (Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine)	8330A						8330A	
5015	Nitrobenzene	8330A						8330A	
6485	Nitroglycerin	8332						8332	
9507	2-Nitrotoluene	8330A						8330A	
9510	3-Nitrotoluene	8330A						8330A	
9513	4-Nitrotoluene	8330A						8330A	
9558	Pentaerythritol tetranitrate	8332						8332	
9432	RDX (hexahydro-1,3,5-trinitro-1,3,5-triazine)	8330A						8330A	
6415	Tetryl (methyl-2,4,6-trinitrophenylnitramine)	8330A						8330A	
6885	1,3,5-Trinitrobenzene	8330A						8330A	
9651	2,4,6-Trinitrotoluene	8330A						8330A	
	Pesticides								
7025	Aldrin	608	8081B					8081B	
7110	alpha-BHC	608	8081B					8081B	
7115	beta-BHC	608	8081B					8081B	
7105	delta-BHC	608	8081B					8081B	
7120	gamma-BHC (Lindane)	608	8081B					8081B	
7240	alpha-Chlordane	608	8081B					8081B	
7245	gamma-Chlordane	608	8081B					8081B	
7250	Chlordane (technical)	608	8081B					8081B	
7355	DDD (4,4)	608	8081B					8081B	
7360	DDE (4,4)	608	8081B					8081B	
7365	DDT (4,4)	608	8081B					8081B	
7470	Dieldrin	608	8081B					8081B	
7510	Endosulfan I	608	8081B					8081B	
7515	Endosulfan II	608	8081B					8081B	
7520	Endosulfan sulfate	608	8081B					8081B	
7540	Endrin	608	8081B					8081B	
7530	Endrin aldehyde	608	8081B					8081B	
7535	Endrin ketone	608	8081B					8081B	
7685	Heptachlor	608	8081B					8081B	
7690	Heptachlor Epoxide (beta)	608	8081B					8081B	
7810	Methoxychlor	608,2	8081B					8081B	
8250	Toxaphene (total)	608	8081B					8081B	
	Organophosphorus Pesticides								
7475	Dimethoate		8270C					8270C	
8610	Dichlorvos		8270C					8270C	
8625	Disulfoton		8270C					8270C	
7955	Parathion, ethyl		8270C					8270C	
7825	Parathion, methyl		8270C					8270C	
7985	Phorate		8270C					8270C	
8155	Sulfotep		8270C					8270C	
	Herbicides								

Accredited Analytes/Methods (by matrix)

TriMatrix Laboratoires, Inc.

Grand Rapids, MI

NELAC Code	Analyte	Matrix							
		Aqueous				Solid			
8655	2,4,5-T	8151A						8151A	
8650	2,4,5-TP (Silvex)	8151A						8151A	
8545	2,4-D	8151A						8151A	
8560	2,4-DB	8151A						8151A	
8555	Dalapon	8151A						8151A	
8595	Dicamba	8151A						8151A	
8605	Dichloroprop	8151A						8151A	
8620	Dinoseb	8151A						8151A	
7775	MCPA	8151A						8151A	
7780	MCPP	8151A						8151A	
6605	Pentachlorophenol							8151A	
8645	Picloram							8151A	
	PCBs								
8880	Aroclor 1016	608	8082A					8082A	
8885	Aroclor 1221	608	8082A					8082A	
8890	Aroclor 1232	608	8082A					8082A	
8895	Aroclor 1242	608	8082A					8082A	
8900	Aroclor 1248	608	8082A					8082A	
8905	Aroclor 1254	608	8082A					8082A	
8910	Aroclor 1260	608	8082A					8082A	
	Misc. Analytes -Additional								
	Iron, Ferrous	SM 3500-Fe B							
	Cyanide, Available	OIA-1677						OIA-1677	
	Acidity	SM 2310 B							
	Sulfite	SM 4500-SO ³ B							
	Paint Filter Liquids Test							9095B	
	Color	SM 2120 B							
	Acid Volatile Sulfides (AVS/SEM)							EPA-821-R-91-100	
	PCBs - Additional Aroclors								
	Aroclor 1262	608	8082A					8082A	
	Aroclor 1268	608	8082A					8082A	
	Misc. Organics								
	Ethane	RSK-175							
	Ethylene	RSK-175							
	Methane	RSK-175							
	Additional Compounds								
	Volatiles								
	1,2-dibromo-3-chloropropane	8011							
	1,2-dibromoethane	8011							
	1,2,3-Trimethylbenzene			8260B				8260B	
	1,2,3-trichlorobenzene			8260B				8260B	
	1,2,3-trichloropropane			8260B				8260B	
	1,4-dichlorobenzene			8260B				8260B	
	1,4-dioxane			8260B				8260B	
	1-chlorohexane			8260B				8260B	
	sec-butanol		8015C	8260B			8015C	8260B	
	2-chloro-1,3-butadiene			8260B				8260B	
	2-methylnaphthalene			8260B				8260B	
	2-nitropropane			8260B				8260B	
	allyl chloride			8260B				8260B	
	cyclohexane			8260B				8260B	
	ETBE			8260B				8260B	
	ethyl acetate			8260B				8260B	
	ethyl ether			8260B				8260B	
	ethyl methacrylate			8260B				8260B	
	hexachloroethane			8260B				8260B	
	hexane			8260B				8260B	
	iodomethane			8260B				8260B	
	isobutanol		8015C	8260B			8015C	8260B	
	isopropanol		8015C	8260B			8015C	8260B	
	isopropyl ether			8260B				8260B	
	methacrylonitrile			8260B				8260B	
	methyl acetate			8260B				8260B	
	methyl methacrylate			8260B				8260B	
	methylcyclohexane			8260B				8260B	
	n-butanol		8015C	8260B			8015C	8260B	
	n-butyl acetate			8260B				8260B	
	n-propanol		8015C	8260B			8015C	8260B	
	propionitrile			8260B				8260B	
	t-butanol		8015C	8260B			8015C	8260B	
	tetrahydrofuran			8260B				8260B	
	trans-1,4-dichloro-2-butene			8260B				8260B	
	trichlorotrifluoromethane			8260B				8260B	
	SVOCs - Base/Neutrals/Acids			8270C				8270C	
	1,1'-Biphenyl			8270C				8270C	
	1,2-Bis(2-chloroethoxy)ethane			8270C				8270C	
	1,2-Diphenylhydrazine			8270C				8270C	
	1,3-Dinitrobenzene			8270C				8270C	
	1,4-Naphthoquinone			8270C				8270C	
	1,4-Phenylenediamine			8270C				8270C	
	1-Methylnaphthalene			8270C				8270C	
	1-Naphthylamine			8270C				8270C	
	1-Nitrosopyrrolidine			8270C				8270C	
	2-Acetylaminofluorene			8270C				8270C	
	2-Chloroaniline			8270C				8270C	
	2-Naphthylamine			8270C				8270C	
	2-Picoline			8270C				8270C	
	3,3'-Dimethylbenzidine			8270C				8270C	

Accredited Analytes/Methods (by matrix)

TriMatrix Laboratoires, Inc.

Grand Rapids, MI

NELAC Code	Analyte	Matrix							
		Aqueous				Solid			
	3-Methylcholanthrene				8270C				8270C
	4,6-Dinitro-2-methylphenol				8270C				8270C
	4-Aminobiphenyl				8270C				8270C
	5-Nitro-o-toluidine				8270C				8270C
	7,12-Dimethylbenz(a)anthracene				8270C				8270C
	a,a-Dimethylphenethylamine				8270C				8270C
	Acetophenone				8270C				8270C
	Aramite				8270C				8270C
	Atrazine				8270C				8270C
	Benzaldehyde				8270C				8270C
	Benzob(f)fluoranthene				8270C				8270C
	Bis(2-ethylhexyl) adipate				8270C				8270C
	Caprolactam				8270C				8270C
	Chlorobenzilate				8270C				8270C
	Diallate				8270C				8270C
	Dicyclohexyl Phthalate				8270C				8270C
	Dimethoate				8270C				8270C
	Disulfoton				8270C				8270C
	Ethyl Methacrylate				8270C				8270C
	Ethyl Methanesulfonate				8270C				8270C
	Famphur				8270C				8270C
	Hexachloropropene				8270C				8270C
	Isodrin				8270C				8270C
	Isosafrole				8270C				8270C
	Kepone				8270C				8270C
	Methapyrilene				8270C				8270C
	Methyl Methacrylate				8270C				8270C
	Methyl Methanesulfonate				8270C				8270C
	Methylparathion				8270C				8270C
	N-Nitroso-di-n-butylamine				8270C				8270C
	N-Nitrosomethylethylamine				8270C				8270C
	N-Nitrosomorpholine				8270C				8270C
	N-Nitrosopiperidine				8270C				8270C
	o,o,o-Triethylphosphorothioate				8270C				8270C
	Parathion				8270C				8270C
	p-Dimethylaminoazobenzene				8270C				8270C
	Penacetin				8270C				8270C
	Pentachloroethane				8270C				8270C
	Pentachloronitrobenzene				8270C				8270C
	Phorate				8270C				8270C
	Pronamide				8270C				8270C
	Safrole				8270C				8270C
	Sulfotepp				8270C				8270C
	Thionazin				8270C				8270C
	1,3,5-Trinitrobenzene				8270C				8270C
	Carbonyls								
	Formaldehyde	8315A							8315A
	Acetaldehyde	8315A							8315A
	Propanal	8315A							8315A
	Crotonaldehyde	8315A							8315A
	Butanal	8315A							8315A
	Pentanal	8315A							8315A
	Cyclohexanone	8315A							8315A
	m-Tolualdehyde	8315A							8315A
	Hexanal	8315A							8315A
	Heptanal	8315A							8315A
	Octanal	8315A							8315A
	Nonanal	8315A							8315A
	Decanal	8315A							8315A