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FINAL TIER II SAMPLING AND ANALYSIS PLAN AREA B OFFISITE MIGRATION EVALUATION SITE 1 CAMP ALLEN LANDFILL NB NORFOLK VA

7/1/2012

CH2M HILL

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Final
Tier II Sampling and Analysis Plan

Area B Offsite Migration Evaluation

Sampling and Analysis Plan Site 1, Camp Allen Landfill
Naval Station Norfolk
Norfolk, Virginia

Prepared for

Department of the Navy

Naval Facilities Engineering Command Mid-Atlantic

Contract No.
N62470-08-D-1000
CTO-WE05

July 2012

Prepared by

CH2MHILL

Title and Approval Page

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Under the
NAVFAC CLEAN 1000 Program
Contract N62470-08-D-1000

Prepared by:

CH2MHILL.

Virginia Beach, Virginia

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7/19/12
Steven Hirsh — Date
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Eric Salopek — Date
VDEQ – Remedial Project Manager

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Executive Summary

This Tier II Sampling and Analysis Plan (SAP) presents the technical approach for the Area B offsite migration evaluation to be conducted by CH2M HILL at Environmental Restoration Program (ERP) Site 1 at Naval Station Norfolk (NSN), Norfolk, Virginia. This investigation is being conducted for the United States Department of the Navy (Navy), Naval Facilities Engineering Command (NAVFAC) Mid-Atlantic Division, under the Comprehensive Long-term Environmental Action – Navy (CLEAN) 1000 Program, in accordance with Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and, to the extent practicable, the National Oil and Hazardous Substances Contingency Plan (NCP).

This Tier II SAP has been completed under contract number N62470-08-D-1000, Contract Task Order (CTO) WE05, in accordance with the Navy's Tier II SAP policy guidance to ensure that environmental data collected are scientifically sound, of known and documented quality, and suitable for intended purposes. The objectives and technical approach included in this SAP were jointly scoped by the NSN Tier I Partnering Team, which includes representatives from the Navy, United States Environmental Protection Agency (USEPA) Region III, and Virginia Department of Environmental Quality (VDEQ). The laboratory information cited in this Work Plan is specific to Environmental Conservation Laboratories (ENCO). If additional laboratory services are requested, requiring modification to the existing Tier II SAP, revised Tier II SAP worksheets will be submitted to the Navy and regulatory agencies for approval.

Site 1, the Camp Allen Landfill (CALF), includes two distinct areas (Area A, the 45-acre landfill, and Area B, the 2-acre fire disposal area) located in the south-central portion of NSN (**Figure 1**). This SAP addresses only Area B. A Non-time-critical Removal Action (NTCRA) was implemented at Area B in May 1994 and completed in January 1995 to remove the primary source areas of contamination. Groundwater contamination was detected in the water-table aquifer at Area B and is currently addressed by a remedy consisting of a pump-and-treat system installed in accordance with the Site 1 Decision Document (DD) (Navy, 1995) and Record of Decision (ROD) (Navy, 2010). As a requirement of the selected remedy, CALF is part of the Long-term Monitoring (LTM) program at NSN.

The primary contaminants at Site 1 are volatile organic compounds (VOCs). While concentrations of VOCs in the groundwater at Area B have been investigated as part of previous studies, additional investigation is necessary to evaluate whether offsite migration of contaminants from Site 1 Area B is occurring. Specifically, the investigation will assess whether VOCs in shallow groundwater have migrated beneath a surface water and drainage feature located south of Area B. The following tasks are proposed to allow for evaluation of potential offsite migration of contaminants from Area B at the site:

1. Using direct-push technology (DPT), ten grab groundwater samples will be collected from the shallow aquifer and analyzed for select VOCs
2. Data evaluation will be conducted
3. A permanent shallow monitoring well will be installed for future sampling as part of the LTM program

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3 Shallow Monitoring Well LTM Analytical Results
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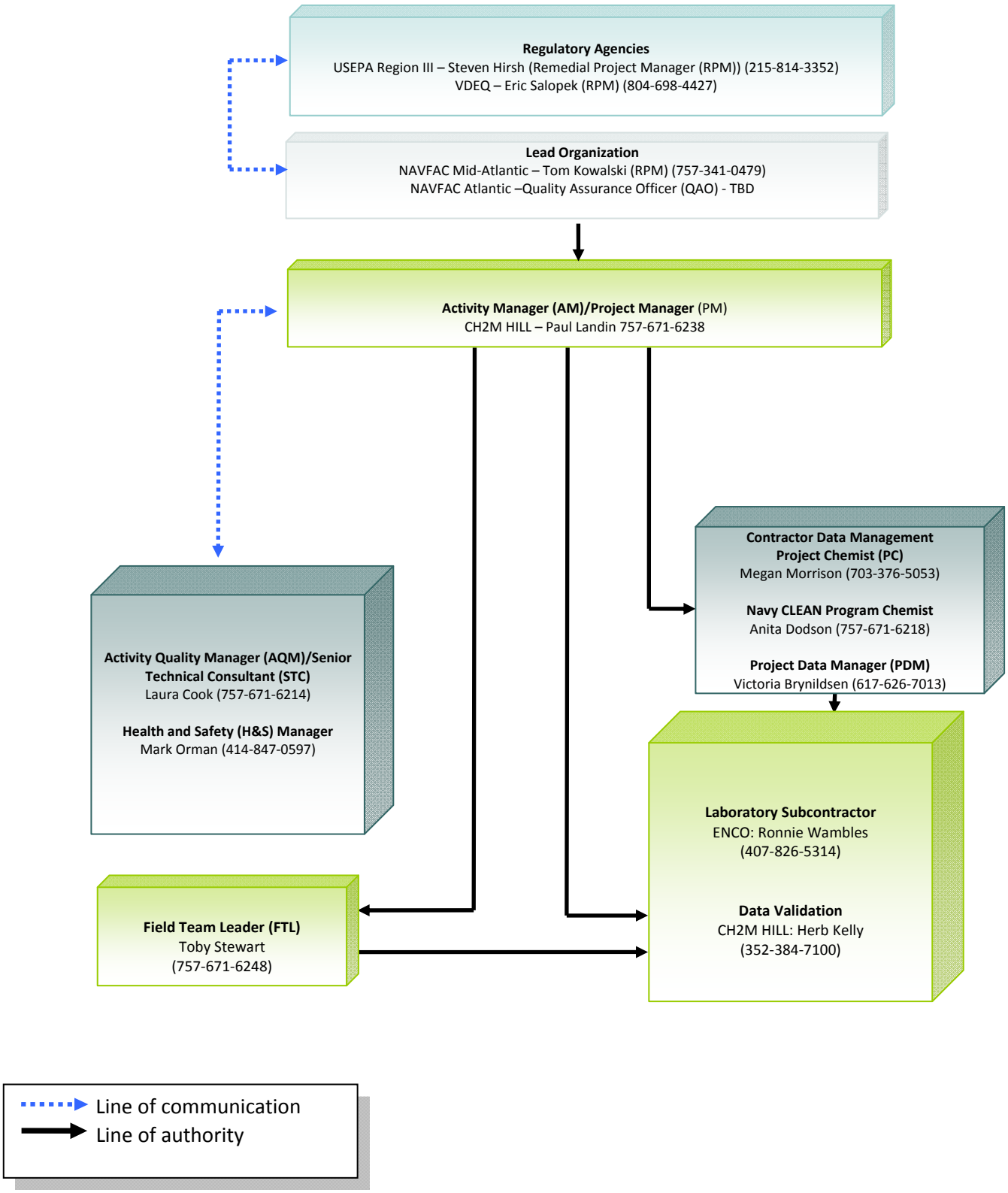
Acronyms and Abbreviations

°C	degree Celsius
µg/L	microgram per liter
AM	Activity Manager
AQM	Activity Quality Manager
BEQ	Bachelor's Enlisted Quarters
CA	Corrective Action
CALF	Camp Allen Landfill
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CLEAN	Comprehensive Long-term Environmental Action – Navy
CLP	Contract Laboratory Program
CSM	Conceptual Site Model
CTO	Contract Task Order
DD	Decision Document
DL	Detection Limit
DO	dissolved oxygen
DoD	Department of Defense
DPT	direct-push technology
DQI	Data Quality Indicator
DQO	Data Quality Objective
DV	Data Validator
ELAP	Environmental Laboratory Application Program
ENCO	Environmental Conservation Laboratories
ERP	Environmental Restoration Program
FTL	Field Team Leader
GC	gas chromatograph
H&S	Health and Safety
ICAL	initial calibration
ID	identification
IS	Internal Standards
LCS	Laboratory Control Sample
LOD	Limit of Detection
LOQ	Limit of Quantification
LTM	Long-term Monitoring
LUC	Land Use Control
MAROS	Monitoring and Remediation Optimization Software
MCL	Maximum Contaminant Level
ml	milliliter
MPC	Measurement Performance Criteria
MS	mass spectrometer
MTBE	Methyl-tert-butyl ether
N/A	Not Applicable

NAVFAC	Naval Facilities Engineering Command
Navy	United States Department of the Navy
NC	No Criteria
NCP	National Oil and Hazardous Substances Contingency Plan
NIRIS	Naval Installation Restoration Information System
NSN	Naval Station Norfolk
NTCRA	Non-time-critical Removal Action
PAL	project action limit
PC	Project Chemist
PDM	Project Data Manager
PM	Project Manager
POC	Point Of Contact
PQL	Project Quantification Limit
PVC	polyvinyl chloride
QA	Quality Assurance
QAO	Quality Assurance Officer
QC	Quality Control
QL	Quantitation Limit
QSM	Quality Systems Manual
RI	Remedial Investigation
ROD	Record of Decision
RPM	Remedial Project Manager
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act of 1986
SNEDD	Supplemental NIRIS Electronic Data Deliverable
SOP	Standard Operating Procedure
SSC	Site Safety Coordinator
STC	Senior Technical Consultant
USEPA	United States Environmental Protection Agency
VDEQ	Virginia Department of Environmental Quality
VOC	volatile organic compound

1 Project Organization

1.1 Project Organizational Chart



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1.2 Communication Pathways

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathway To/From, etc.)
Communication with United States Department of the Navy (Navy) (lead agency)	Navy Remedial Project Manager (RPM)	Tom Kowalski	757-341-0479	Oversees all remedial activities at Naval Station Norfolk (NSN). Any issues that may impact operations should be reported to the Navy RPM immediately.
Communication with United States Environmental Protection Agency (USEPA) (regulatory agency)	USEPA RPM	Steve Hirsh	215-814-3352	Primary Point of Contact (POC) for USEPA. USEPA RPM 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 will be presented and discussed during Partnering Team meetings.
Communication with Virginia Department of Environmental Quality (VDEQ) (regulatory agency)	VDEQ RPM	Eric Salopek	804-698-4427	Primary POC for VDEQ. VDEQ RPM can delegate communication to other internal or external POCs. Upon notification of field changes, VDEQ will have 24 hours to approve or comment on the field changes. All data will be presented and discussed during Partnering Team meetings.
Communication regarding overall project status and implementation and primary POC with Navy, USEPA, and VDEQ RPMs	CH2M HILL Activity Manager (AM)/Project Manager (PM)	Paul Landin	757-671-6238	All information and materials related to the project will be forwarded to the Partnering Team by the NSN AM, Paul Landin. Paul will work with the Navy RPM to communicate fieldwork status to the Partnering Team as needed. If changes to the proposed field approach are necessary, the changes will be communicated via email and/or phone within 24 hours. All data will be communicated to the Partnering Team via email and meetings.
Overall quality and Technical communications for Tier II Sampling and Analysis Plan (SAP) implementation and data interpretation	CH2M HILL Activity Quality Manager (AQM)	Laura Cook	757-671-6214	If it is noted that changes to an approach should be made to allow for more consistency with the overall base objective, the AQM will be notified by the PM within 24 hours.
Overall Technical guidance for project implementation and data interpretation	CH2M HILL Senior Technical Consultant (STC)	Laura Cook	757-671-6214	Communication feedback related to technical quality or recommended involvement of additional resources will be provided as soon as possible after determining communication is necessary.
Health and Safety (H&S) Team Leader; ensures H&S in the field	CH2M HILL Site Safety Coordinator (SSC)	Gwen Buckley	(757) 671-6292	Daily safety tailgates; daily observations; real-time discussions of observations and changes to be implemented with field staff. If safety issues are identified the SSC will stop work and inform PM.

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathway To/From, etc.)
Implementation of sampling activities; SAP changes in the field; field Corrective Actions (CAs); daily field progress reports	CH2M HILL Field Team Leader (FTL)	Gwen Buckley	(757) 671-6270	Documentation of deviations from the Tier II SAP in field logbooks and rationale for deviations, made within 24 hours of deviation; assistance in material procurement and delivery; injection oversight and implementation; deviations made only with approval from contractor PM and/or environmental manager. FTL will email or fax daily field progress reports to contractor PMs weekly; telephone communication with PMs on as-needed basis.
Data tracking from collection through upload to database	CH2M HILL Project Data Manager (PDM)	Hillary Ott	(703) 376-5165	PDM will track data from sample collection through upload to the database ensuring Work Plan requirements are met by laboratory and field staff. PDM will act as main POC for laboratory Quality Assurance Officer (QAO). Laboratory issues will be reported to the PM and Project Chemist (PC) within 4 hours.
Management and Quality Assurance(QA) of analytical lab and data validation subcontractors	CH2M HILL PC	Megan Morrison	703-376-5053	Any CAs for analytical issues will be determined by the PC and reported to the PM within 4 hours. 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 obtained, the PC will notify the project team including the Navy RPM and Navy QAO.
Reporting data quality issues	Data Validator (DV) – CH2M HILL	Herb Kelly	352-384-7100	The DV reviews and qualifies analytical data as necessary. The data, along with a validation narrative, are returned to the CH2M HILL PC and PDM within 14 calendar days.
Reporting Lab Data Quality Issues	Environmental Conservation Laboratories (ENCO) PM	Ronnie Wambles	407-826-5314	All QA/Quality Control (QC) issues with project field samples will be reported by the laboratory to the PC (Megan Morrison) as soon as they are discovered.

2 Project Approach

2.1 Project Planning Session Participants Sheet

Project Name: NSN Site 1 Camp Allen Landfill (CALF) Area B Delineation			**Site Name:** Site 1, CALF		
Projected Date(s) of Sampling: January 2012			**Site Location:** NSN, Norfolk, Virginia		
Project Manager: Paul Landin					
Date of Session: July 18, 2011					
Scoping Session Purpose:	2011 Long-term Monitoring (LTM) Results and Data Gap Discussion				
Name	**Title**	**Affiliation**	**Phone #**	**E-mail Address**	**Project Role**
Krista Parra	Acting Naval Facilities Engineering Command (NAVFAC) Mid-Atlantic RPM	NAVFAC	757-341-0395	krista.parra@navy.mil	RPM
Kathy Davies	Hydrogeologist	USEPA	215-814-3315	davies.kathy@epa.gov	Technical Support
Steven Hirsh	RPM	USEPA	215-814-3352	hirsh.steven@epa.gov	Regulator
Eric Salopek	RPM	VDEQ	804-698-4427	ejsalopek@deq.virginia.gov	Regulator
Paul Landin	AM/PM	CH2M HILL	757-671-6238	Paul.Landin@ch2m.com	AM
Angela Petree	Deputy AM	CH2M HILL	757-671-6248	Angela.Petree@ch2m.com	Deputy AM/Recorder

Comments and Decisions: A presentation was provided to the NSN Tier I partnering team (consisting of the Navy, USEPA, and VDEQ) to present the 2011 LTM analytical results (unvalidated) from NSN Site 1. During the discussion, the partnering team reviewed the LTM results from Area B. Vinyl chloride was detected at a concentration of 187 micrograms per liter (µg/L) from B-MW16 during the most recent LTM event (April 2011). B-MW16 is located adjacent to a surface water and drainage ditch feature that borders the site. Military housing is located on the opposite side of the drainage ditch. The NSN Partnering team agreed to conduct a limited investigation to grab shallow groundwater samples (five proposed direct-push technology [DPT] samples) for analysis of volatile organic compounds (VOCs) only and the installation of 1 new shallow monitoring well to ensure VOCs are not migrating offsite (across the drainage ditch), and to provide groundwater elevation data to confirm groundwater flow direction and (if necessary) provide for a future groundwater sampling location. The DPT grab groundwater samples should be collected west of B-MW16, across the drainage ditch, and spaced approximately 50 feet apart within the shallow aquifer.

Action Items: Generate Tier II SAP and procure a DPT and drilling subcontractor and analytical laboratory subcontractor to conduct the limited Area B delineation at NSN Site 1.

Consensus Decisions: Not Applicable (N/A).

2.2 Naval Station Norfolk Site 1 Background

NSN is the largest naval base in the United States and is situated on 4,631 acres of land in the northwestern portion of Norfolk, Virginia. NSN includes approximately 4,000 buildings, 20 piers, and an airfield. The western portion of the facility is a developed waterfront area containing the piers and facilities for loading, unloading, and servicing naval vessels. The remaining portions of the facility consist of a combination of industrial, commercial, and residential uses. Residential and recreational areas also border the facility to the south, east, and northeast. The locations of NSN and Site 1 are shown on **Figure 1**.

Site 1, the CALF, includes two distinct areas (Area A, the 45-acre landfill, and Area B, the 2-acre fire disposal area) located in the south-central portion of NSN (**Figure 2**). The primary contaminants found in all media at the site are chlorinated VOCs. A Non-time-critical Removal Action (NTCRA) was implemented at Area B in May 1994 and completed in January 1995 to remove the primary source areas of contamination; Area A was not addressed by the NTCRA. Groundwater contamination was detected in the water-table aquifer at Areas A and B and is currently addressed by a remedy consisting of a groundwater pump-and-treat system installed in accordance with the Site 1 Decision Document (DD) (Navy, 1995). The pump-and-treat system was installed and has been running continuously (with the exception of necessary maintenance activities) since 1996. The remedy was reaffirmed in 2010 by a Basewide Record of Decision (ROD) including signature approval from the Navy and USEPA with concurrence from VDEQ. As a requirement of the DD and ROD (Navy, 2010), CALF is part of the LTM program at NSN. Monitoring for CALF currently consists of annual sampling of groundwater monitoring wells in the shallow and deep aquifer to evaluate the concentrations of contaminants at the site and determine if these constituents are migrating offsite or into the deep aquifer. The Bachelor's Enlisted Quarters (BEQ) and Camp Allen Elementary are located in the vicinity of Area B. A vapor intrusion investigation is ongoing at the barracks located at Camp Allen; an indoor air evaluation at Camp Allen Elementary was conducted during the Remedial Investigation (RI) (Baker, 1994) and subsequently reviewed by the 2008 Five-Year Review (CH2M HILL, 2008). The 2008 Five-Year Review concluded there are no unacceptable risks with the inhalation of indoor air in Camp Allen Elementary School. Land Use Controls (LUCs) have been implemented and enforced at the site to achieve the following objectives:

- Prohibit use of the site for residential land use.
- Maintain the existing soil cover and fencing.
- Prohibit use of the groundwater beneath the site for purposes other than environmental monitoring and testing.

Groundwater flow was evaluated and presented to the NSN Partnering Team in the Draft 2010 LTM Report (AGVIQ-CH2M HILL, 2011). The water level data collected in March 2010 were evaluated by computer modeling software (MODUS and MVS), and the model indicated shallow groundwater in the vicinity of Area B is effected by the active extraction well B-EW8A (**Figure 2**). The 2011 LTM results indicated vinyl chloride and 1,2-dichloroethane are present at B-MW16 at concentrations above the federal Maximum Contaminant Levels (MCLs) (**Figure 4**; previous LTM events did not detect these constituents above respective clean-up goals (MCLs) at this monitoring well); therefore, the NSN Partnering Team questioned the ability of extraction well B-EW8A to capture contaminated groundwater in the vicinity of B-MW16 and discussed the potential for a source area to the northwest of B-MW16 that may be influenced either by pumping at B-EW8A or groundwater flow toward Bousch Creek, resulting in migration of contaminants toward the creek and well. Based on the 2011 LTM results, USEPA requested a limited investigation to ensure VOCs are not migrating under the creek toward Navy residential housing in the vicinity of B-MW16 (**Figure 4**). The need for additional data gap investigation in this area was also discussed, but it was decided that this evaluation would be completed following the Monitoring and Remediation Optimization Software (MAROS) analysis that is currently being completed. Therefore, the intent of this SAP is to propose sampling to evaluate the potential for migration under the creek only.

2.3 Conceptual Site Model

The three-dimensional Conceptual Site Model (CSM) is provided on **Figure 5**. Elements of the site-specific CSM are described as follows:

- Lithology – Shallow lithology at the site generally consists of three hydrogeologic units: the Columbia aquifer, Yorktown confining unit, and Yorktown aquifer. The Yorktown confining unit is not continuous at Site 1.
- Contaminant distribution – Groundwater flow (shallow and deep) is controlled via a pump-and-treat system at NSN Site 1. The pump-and-treat system was installed and is running continuously per a DD signed in 1996. The majority of the VOCs detected in shallow groundwater at Site 1 are present at higher concentrations at the bottom of the shallow (Columbia) aquifer compared to concentrations at the water table. In 2011, vinyl chloride was detected at a concentration of 187 µg/L at monitoring well B-MW16, which is greater than the clean-up goal (an MCL of 2 µg/L). Additionally, 1,2-dichloroethane was detected at a concentration of 7.56 µg/L, which is greater than the clean-up goal (an MCL of 5 µg/L). These contaminants were not detected in any of the monitoring wells in the immediate vicinity B-MW16 or in upgradient wells located in the vicinity of the elementary school in 2011. However, there is a potential that a source exists to the northwest of B-MW16, where there are currently no monitoring wells. This data gap will be investigated following the ongoing MAROS investigation being completed at the site. Additionally, it is uncertain whether contamination may be flowing beneath the creek toward the Navy housing area to the south. Based on the size of Bousch Creek, it is anticipated that any groundwater not captured by the pumping system would discharge to the creek. However, this investigation is intended to confirm the lack of migration under the creek.
- Receptor and Exposure Pathways – Groundwater underlying Site 1 is not currently used for potable or nonpotable uses. LUCs prevent exposure to groundwater by onsite construction workers in accordance with the DDs. Historical LTM results indicated insignificant concentrations of VOCs are present at site surface water locations; surface water sampling was eliminated from the LTM program for Site 1 per recommendations in the 2008 Five-Year Review Report (CH2M HILL, 2008). Potential vapor intrusion pathways are being evaluated under a separate investigation.

Environmental Questions to be Answered by this Project

The environmental question and problem to be addressed by the groundwater sampling at Site 1 is:

Is migration of VOCs (in the vicinity of B-MW16 located at NSN Site 1 Area B) occurring toward Navy residential housing to the southwest of well B-MW16. In other words, is extraction well B-EW8A ineffective at capturing groundwater in the area where VOC concentrations above clean-up levels were detected in the 2011 LTM event, or is migration under the creek occurring from a source area to the northwest of B-MW16, which may or may not be within the capture zone of B-EW8A?

Ten groundwater samples will be collected from 10 DPT sample locations across the drainage ditch from B-MW16. The proposed locations are shown on **Figure 4** and identified as NBS01-B-DW01 through NBS01-B-DW10. These locations are located along the southern boundary of NSN Site 1. Samples will be analyzed for select VOCs. Results will be compared to the clean-up goals (MCLs) established by the ROD (Navy, 2010) to determine if offsite migration is occurring.

The need for additional data gap investigation in this area was also discussed, but it was decided that this evaluation would be completed following the MAROS analysis that is currently being completed. Therefore, the intent of this SAP is to propose sampling to evaluate the potential for migration under the creek only.

2.4 Data Quality Objectives and Systematic Planning Process Statements

What are the Data Quality Objectives (DQOs)?

If the analytical results from the DPT groundwater samples indicate concentrations of contaminants are present in shallow groundwater above clean-up goals, then offsite migration of contamination above clean-up levels may be occurring and the existing pump-and-treat system may need modification to prevent potential unacceptable human health and ecological risks.

Following collection and analysis of the DPT groundwater samples, the location of the monitoring well will be agreed to by the NSN Partnering Team based on the analytical results of the DPT grab groundwater samples. The purpose of the new well will be to monitoring contamination (if present) and to aid in understanding groundwater flow in this area (if contamination is or is not present). The new monitoring well will be utilized as part of the future LTM program for Site 1.

If sample results indicate levels of contaminants in groundwater are below clean-up goals for Site 1, then it can be assumed the existing pump and treat system and/or discharge to Bousch Creek is currently controlling offsite migration of contaminants and no additional action will be needed in this area to address offsite migration. Additional delineation of a potential source within the site boundary will be completed following the ongoing MAROS evaluation.

Who will use the data?

The data will be used by the NSN Tier I Partnering Team (Navy, USEPA Region III, and VDEQ) to evaluate potential migration under Bousch Creek to the Navy housing area. The data and associated evaluations, conclusions, and recommendations will be documented in a Technical Memorandum.

Hydrogeologists within each organization will evaluate the data with respect to possible plume configuration and the existence of a migration pathway that differs from the current understanding. Chemists will use the data to evaluate overall data quality with respect to data usability. Engineers may use the data to optimize or modify the remedial system.

What are the Project Action Limits (PALs)?

Monitoring Activity	PALs	Rationale
Groundwater Monitoring	Established clean-up goals for the existing remedy at the site are MCLs for groundwater	The MCLs will help the NSN Partnering Team determine if groundwater is migrating toward Navy residential housing at levels that exceed clean-up goals for the existing remedy at the site.

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How will the data be used?

The data will be used to accomplish the following objectives:

- Determine if migration of VOCs (in the vicinity of B-MW16 located at NSN Site 1 Area B) has occurred or is occurring toward Navy residential housing.
- Use groundwater quality monitoring to evaluate whether the contamination is migrating off site.
- If the limit of detection (LOD) for a particular constituent is greater than the associated PALs, a non-detect result will be assumed to be lower than the PALs. Detections will be assumed to be exceedances of the associated PALs. See the **Reference Limits and Evaluation Table** in Section 4.1 for numerical values of PALs and laboratory-specific LODs.

What types of data are needed?

Five DPT grab groundwater samples will be collected and analyzed for select VOCs. The sample identity nomenclature is provided in the Sample Details section of this Tier II SAP.

Water-level measurements are used to determine the depth of the water table at the DPT location to ensure the grab groundwater sample is collected beneath the water table.

Field measurements of water quality parameters during well purging are used to determine water quality at the time the sample is taken.

How "good" must the data be to support the environmental decision?

VOCs sampled in groundwater should achieve reporting limits at or less than the screening criteria to which they will be compared. This is necessary so that concentrations at or greater than clean-up goals (MCLs) can be detected and reported by the laboratory. The **Sample Detail Table** describes the quantities and appropriate analysis to be conducted during the sampling activities. The data need to be of sufficient quantity and quality for determining the representative concentrations of constituents in media collected at each site, and to screen against the appropriate criteria, thereby allowing for a determination of whether offsite migration has occurred and warrants further investigation or action.

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

Detailed information on the number and type of samples to be collected and the associated analyses is provided under the Sampling Design and Rationale section of this SAP. No QA/QC samples will be taken in the field, as unvalidated results will be sufficient for determining migration under Bousch Creek. The well to be installed based on the DPT results will not be sampled as part of this SAP, but will be included in future rounds of LTM at Site 1.

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

During fall 2011, 10 DPT groundwater samples will be collected within Site 1 Area B (**Figure 4**). Data will be collected and generated in accordance with the Standard Operating Procedures (SOPs) outlined in this Tier II SAP.

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

- CH2M HILL field staff will collect the DPT grab groundwater samples.
- Laboratory analysis will be performed by ENCO.
- The data report will include a Contract Laboratory Program (CLP) Level IV-equivalent package that includes a hardcopy of the raw data. This will include a Supplemental Naval Installation Restoration Information System (NIRIS) Electronic Data Deliverable (SNEDD) in Microsoft Excel format and a hardcopy of the raw data.
- The Sample Handling System will be carried out as described in the following exhibit:

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): Toby Stewart, FTL/CH2M HILL. Field SOPs are listed in the **Field SOPs Reference Table**
Sample Packaging (Personnel/Organization): Toby Stewart, FTL/CH2M HILL. Field SOPs are listed in the **Field SOPs Reference Table**
Coordination of Shipment (Personnel/Organization): Toby Stewart, FTL/CH2M HILL
Type of Shipment/Carrier: FedEx Priority Overnight
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): Ronnie Wambles/ENCO Orlando
Sample Custody and Storage (Personnel/Organization): Kim Casey/ENCO Orlando
Sample Preparation (Personnel/Organization): Kurt Bentzen/ENCO Orlando
Sample Determinative Analysis (Personnel/Organization): Kurt Bentzen/ENCO Orlando
SAMPLE ARCHIVING
Field Sample Storage (Number of days from sample collection): See **Sample Details Table**
Sample Extract/Digestate Storage (Number of days from extraction/digestion): See **Sample Details Table**
Biological Sample Storage (Number of days from sample collection): N/A
SAMPLE DISPOSAL
Personnel/Organization: ENCO Orlando
Number of Days from Analysis: After submission, the laboratory will keep samples 90 days and the sample extracts for a minimum of 60 days.

How will the data usability be documented?

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

- Non-detected site contaminants will be evaluated to ensure that Project Quantitation Limit (PQL) goals in the **Reference Limits and Evaluation Tables** were achieved. If PQLs were achieved and the verification and validation steps yielded acceptable data, then the data are considered usable.
- During verification and validation steps, data may be qualified as estimated with the following qualifiers: J, UJ, K, L, or UL. These qualifiers represent minor QC deficiencies that will not affect the usability of the data. When major QC deficiencies are encountered, data will be qualified with an R and in most cases is not considered usable for project decisions. If R-qualified data are used in evaluations and, ultimately, project decisions, the rationale for their use will be included in the Technical Memorandum.
  - J = Analyte present. Reported value may or may not be accurate or precise.
  - UJ = Analyte not detected. Quantitation Limit (QL) may be inaccurate or imprecise.
  - K = Analyte present. Reported value may be biased high. Actual value is expected to be lower.
  - L = Analyte present. Reported value may be biased low. Actual value is expected to be higher.
  - UL = Analyte not detected. QL is probably higher.
  - R = Rejected result. Result not reliable.

- Additional qualifiers that may be given by the validator are:
  - B = Not detected substantially (more than five times) above the level reported in laboratory blanks.
  - E = Interferences present that may cause the results to be biased high.
  - N = Tentative identification. Consider present. Special methods may be needed to confirm its presence or absence in future sampling efforts.
  - NJ = Qualitative identification questionable due to poor resolution. Presumptively present at approximate quantity.
  - U = Not detected. For decision making purposes, non-detect values will be treated as if the constituent is not present.

The documentation that may be generated during the usability assessment are the following:

- Data tables will be produced to reflect detected and non-detected analytes. Data qualifiers will be reflected in the tables and discussed in the data sample quality evaluation.
- Graphical representations will be produced to reflect increasing and/or decreasing concentrations of VOCs.
- A data quality evaluation will be provided as part of the Technical Memorandum prepared to assess remedy effectiveness.
- The Technical Memorandum will identify any data usability limitations and make recommendations for CAs if necessary

How will the data be archived?

Data will be archived according to procedures dictated by the Navy Comprehensive Long-term Environmental Action (CLEAN) program and contract. All analytical data will be uploaded into a centralized database developed and maintained for Navy projects by CH2M HILL and provided for upload to NIRIS. At the end of the project, paper copies of archived laboratory data and validation reports will be returned to the Navy.

2.5 Field Quality Control Samples

Measurement Performance Criteria Table – Field QC Samples

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria (MPC)
No field QA/QC will be collected during this investigation.				

2.6 Sampling Design and Rationale

General Approach

- The general sampling approach was developed to meet Navy, USEPA, and VDEQ requirements for the sampling of groundwater that may have been impacted by migration of contaminants at Site 1 Area B. The objectives of this event are to evaluate whether migration toward the Navy housing area has occurred and to evaluate if any further action is necessary.

Sample Matrices

- The sample matrix to be evaluated is groundwater, which is the potentially contaminated environmental medium.

Analytical Groups

- The only target analytical group is select VOCs, which are the contaminants evaluated as part of LTM. The rationale for the analysis is based upon previous sampling results documented in LTM reports.

Site Sample Numbers and Locations

- **Figure 4** shows the proposed DPT grab groundwater sample locations. Groundwater sample locations were determined to evaluate potential migration of VOCs (in the vicinity of B-MW16 located at NSN Site 1 Area B) toward Navy residential housing and agreed to by the NSN Tier I Partnering Team. Deviations from the Tier II SAP necessary in the field will be documented and their affect or potential affect on satisfying the project objectives will be included in the subsequent report.

Sampling Frequency

- The field team will collect one round of environmental samples from this site. One round is sufficient for determining if migration under the creek is occurring and the need for further assessment or modifications to the remedial action.

Matrix	Depth of Samples	Analysis	Method	Number of Samples	Rationale	Sampling Strategy
Groundwater	Field determined based on presence of Yorktown confining unit	Select VOCs	SW846 8260B	10 DPT Groundwater grab samples. No field QA/QC samples will be collected during this investigation.	In 2011, concentrations of vinyl chloride and 1,2-dichloroethane were detected at monitoring well B-MW16 in exceedance of Site 1 clean-up goals. Sampling is needed to determine if contamination is migrating beneath Bousch Creek toward Navy housing. Ten DPT grab groundwater samples will be collected to evaluate possible offsite migration of VOCs.	Samples are located across the creek located west of monitoring well B-MW16 to evaluate possible contaminant migration of VOCs toward Navy residential housing. The NSN Partnering Team agreed the locations should be spaced approximately 50 feet from one another along the bank of the drainage ditch (**Figure 4**). Sample locations may be adjusted based on field decisions identified during DPT investigation.

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

Data Review Input	Description	Responsible for Verification (name, organization)	Internal/External
Step 1: Verification			
Planning Documents	Evidence of approval and completeness of Tier II -SAP.	PM: Paul Landin/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 retained in the site file, and the original and remaining copies taped inside the cooler for shipment. See Chain-of-Custody SOP for further details.	FTL: Gwen Buckley/CH2M HILL PDM: Hillary Ott/CH2M HILL PC: Megan Morrison/CH2M HILL	Internal
Field Log Notebooks	Field notes will be reviewed to ensure completeness of field data parameters, shipping information, sample collection times, and so forth. The logbook will also be used to document, explain, and justify all deviations from the approved work plan and Tier II SAP.	PM: Paul Landin/CH2M HILL PDM: Hillary Ott/CH2M HILL PC: Megan Morrison/CH2M HILL	Internal
Sample Login/Receipt	Upon their arrival at the laboratory, the samples will be cross-referenced against the chain-of-custody records. All sample labels will be checked against the chain-of-custody, and any mislabeling will be identified, investigated, and corrected. The samples will be logged-in at every storage area and work station required by the designated analyses. Individual analysts will verify the completeness and accuracy of the data recorded on the forms. Laboratory Sample Logins will be reviewed against the chain-of-custody records and the Tier II SAP to ensure that the proper number and type of samples have been logged in at the laboratory.	Sample Receipt Personnel/ENCO Respective Laboratory Personnel/ENCO PDM: Hillary Ott/CH2M HILL PC: Megan Morrison/CH2M HILL	External/Internal External
QC Summary Report	A summary of all laboratory QC sample results will be verified for completeness once the data are received from the laboratory.	PC: Megan Morrison/CH2M HILL	External

Data Review Input	Description	Responsible for Verification (name, organization)	Internal/External
Validation: Step IIa			
SOPs	Review field logbooks, laboratory case narratives, data deliverables for compliance to methods and signatures.	FTL: Gwen Buckley/CH2M HILL PM: Paul Landin/CH2M HILL PC: Megan Morrison/CH2M HILL	Internal/External
QC Results	Establish that all lab QC samples were run as specified in the **Laboratory Quality Control Samples** tables.	PC: Megan Morrison/CH2M HILL DV: Ward Dickens/CH2M HILL	External
Validation: Step IIb			
QC Results	Verify that laboratory QC samples were run and compliant with MPC limits established in the Tier IISAP.	PC: Megan Morrison/CH2M HILL	External
PQLs	Ensure all sample results met the project quantification and action limits specified in the **Reference Limits and Evaluation Table**.	PC: Megan Morrison/CH2M HILL	External
Raw data	10 percent review of raw data to confirm laboratory calculations.	DV: Ward Dickens/CH2M HILL	External

Validation Summary			
Step IIa: Data Validation Criteria – All analytical groups to be validated.	Analytical methods and laboratory SOPs as presented in this Tier II 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 *Region III Modifications to the National Functional Guidelines for Organic Data Review, Multi-Media, Multi-Concentration*, (USEPA1994). 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.	DV: Ward Dickens/CH2M HILL	External
Step IIb: PAL and MPC Check – All analytical groups	QC check against PALs in **Reference Limits and Evaluation Table** and method QC criteria in **Laboratory Quality Control Samples** table	PC: Megan Morrison/CH2M HILL	External

3 Field Project Implementation

3.1 Field Project Instructions

3.1.1 Project and Field Objectives

Groundwater quality monitoring will be conducted to help determine whether the migration of VOCs (in the vicinity of B-MW16 located at NSN Site 1 Area B) toward Navy residential housing is occurring at NSN. Using DPT, 10 temporary locations will be drilled and sampled through the screen (**Figure 4**). Based on these results, a permanent monitoring well will be installed for use in the base LTM program.

3.1.2 Project Tasks

Gwen Buckley/VBO will be the FTL for this event. He will be responsible for providing oversight during the Area B delineation, which includes but is not limited to:

- Utility location
- DPT locations
- Placement of DPT grab groundwater screen
- Depth of DPT sample collection
- Shallow permanent monitoring well installation

3.1.3 Sampling Locations, Methods, and Analysis

DPT soil cores will be collected continuously from the ground surface to the Yorktown confining unit. Continuous soil cores will be logged to determine the depth of the Yorktown confining unit. The DPT screen will be placed to tag the first foot of the Yorktown confining unit, and the FTL will collect one grab groundwater sample from each of the 10 locations using a peristaltic pump. At least a gallon of water will be purged using low-flow technique. Parameters, as outlined in Section **Data Quality Objectives and Systematic Planning Process Statements***,* will be collected using a Horiba U-22 or equivalent instrument. All relevant SOPs are listed in the Field SOPs Reference Table, as follows. No development of the DPT locations is required. No field QA/QC will be collected.

Proposed sample locations are shown on **Figure 4**, but are subject to change at the FTL's discretion.

Sample analyses are outlined in the following table:

TABLE 3-1
Sample Analyses

Station Identification (ID)	Depth of Well	Depth of Sample	Sample ID	Matrix	VOCs by 8260B
NBS01-B-DW01	Field Determined	Within temporary screen	NBS01-B-DW01-MMYY	GW	X
NBS01-B-DW02	Field Determined	Within temporary screen	NBS01-B-DW02-MMYY	GW	X
NBS01-B-DW03	Field Determined	Within temporary screen	NBS01-B-DW03-MMYY	GW	X
NBS01-B-DW04	Field Determined	Within temporary screen	NBS01-B-DW04-MMYY	GW	X
NBS01-B-DW05	Field Determined	Within temporary screen	NBS01-B-DW05-MMYY	GW	X
NBS01-B-DW06	Field Determined	Within temporary screen	NBS01-B-DW06-MMYY	GW	X
NBS01-B-DW07	Field Determined	Within temporary screen	NBS01-B-DW07-MMYY	GW	X
NBS01-B-DW08	Field Determined	Within temporary screen	NBS01-B-DW08-MMYY	GW	X
NBS01-B-DW09	Field Determined	Within temporary screen	NBS01-B-DW09-MMYY	GW	X
NBS01-B-DW10	Field Determined	Within temporary screen	NBS01-B-DW10-MMYY	GW	X

All samples shipped should be marked on the chain-of-custody form to instruct the laboratory of a 24-hour turn-around time. Global positioning system coordinates will be collected for each of the DPT locations.

Installation of the permanent shallow monitoring well will be performed by the same DPT field team. The shallow well will be installed using 4.25-inch inner diameter hollow stem augers. Samples for lithology will be collected continuously and recorded in a field log book. Observations such as color, grain size, moisture content, density, and presence of contamination will be noted. The well will be constructed of Schedule 40 polyvinyl chloride (PVC) and screened in the bottom 10 feet of the Columbia aquifer. DSI #1 sand filter pack will be placed in the annular space surrounding the well screen to an elevation of 2 feet above the top of the screened interval. A 2-foot-thick bentonite seal will be placed above the well screen, and the well will be grouted to the surface. The monitoring well be of flush-mount construction and identified as B-MW38S for future implementation in the LTM program at the site. The FTL will be responsible for monitoring well development following installation; however, no samples will be collected from this location under this Tier II SAP.

Investigation derived waste (IDW), consisting of soil cuttings from monitoring well installation, purge water from groundwater sample collection and monitoring well development, as well as decontamination fluids, will be generated. Soil cuttings will be staged in 55-gallon drums, characterized, and disposed off-site at a facility permitted to accept the material. Aqueous IDW will be containerized and disposed at the Site 1 groundwater treatment plant.

Field SOPs Reference Table
All relevant SOPs, including but not limited to, decontamination, drilling, sampling, parameter readings through a flow-through cell, and so forth (**Appendix B**).

SOP Reference Number	Title/Author	Revision Date or Version Number	Any Planned Deviation for Project Work
CH2M01	Chain-of-custody/CH2M HILL	1	N/A
CH2M02	Direct-push Groundwater Sampling/CH2M HILL	1	N/A
CH2M03	Equipment Blank and Field Blank Preparation/CH2M HILL	1	N/A
CH2M04	Field Documentation/CH2M HILL	1	N/A
CH2M05	Field Measurement of Dissolved Oxygen (DO)/CH2M HILL	1	N/A
CH2M06	Field Measurement Using a Water Quality Parameter Meter/CH2M HILL	1	N/A
CH2M07	Global Position System/CH2M HILL	1	N/A
CH2M08	Low-flow Groundwater Sampling from Monitoring Wells/CH2M HILL	1	N/A
CH2M09	Mini RAE Photoionization Detector/CH2M HILL	1	N/A
CH2M10	Packaging and Shipping Procedures/CH2M HILL	1	N/A
CH2M11	Preparing Field Log Books/CH2M HILL	1	N/A
CH2M12	Utility Location General Void/CH2M HILL	1	N/A
CH2M13	VOC Sampling-Water/CH2M HILL	1	N/A
CH2M14	Water Level Measurements/CH2M HILL	1	N/A

3.2 Sample Details Table

CTO-WE05 NSN Site 1, Area B **Fall 2011** ENCO 10775 Central Port Drive Orlando, Florida 32824 Ronnie Wambles 407.826.5314						**Analysis Group**	Select VOCs
						Preparation and Analytical Method	SW-846 5030B/8260B
						Analytical Laboratory/Analytical SOP Reference[1]	ENCO/VGCMS-05
						Data Package Turnaround Time	24 hours for Form 1s; 28 calendar days for full data deliverable
						Container Type/Volume required (if different than container volume)	3 x 40-milliliter (ml) Vials (Glass)
						Preservative	HCl to pH<2, Cool to 0-6 degrees Celsius (°C)
						Holding Time[2] (Preparation/Analysis)	14 days
Site	**Matrix**	**Station ID**	**Sample ID**	**Coordinates (optional)**		**Depth/Sampling Interval**	
				x	**y**		
1	GW	NBS01-B-DW01	NBS01-B-DW01-MMYY			Approximately 15 feet below ground surface	X
		NBS01-B-DW02	NBS01-B-DW02-MMYY				X
		NBS01-B-DW03	NBS01-B-DW03-MMYY				X
		NBS01-B-DW04	NBS01-B-DW04-MMYY				X
		NBS01-B-DW05	NBS01-B-DW05-MMYY				X
		NBS01-B-DW06	NBS01-B-DW06-MMYY				X
		NBS01-B-DW07	NBS01-B-DW07-MMYY				X
		NBS01-B-DW08	NBS01-B-DW08-MMYY				X
		NBS01-B-DW09	NBS01-B-DW09-MMYY				X
		NBS01-B-DW10	NBS01-B-DW10-MMYY				X
						Total Number of Samples to the Laboratory	**10**

Field QA/QC will not be collected for this event.
[1] The field team will ship sample directly to the laboratory indicated in this row.
[2] Maximum holding time is calculated from the time the sample is collected to the time the sample is prepared or extracted.

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4 Laboratory-Specific Information

4.1 Reference Limits and Evaluation Table

Matrix: Groundwater

Analytical Group: Select VOCS

Analyte	Chemical Abstract Services Number	PAL (MCLs)	PQL Goal (µg/L)	Laboratory Specific Limits			Laboratory Control Sample (LCS) Recovery Limits	
				Limit of Quantification (LOQ) (µg/L)	LOD (µg/L)	Detection Limit (DL) (µg/L)	Lower Control Limit (%)	Upper Control Limit (%)
Vinyl chloride	75-01-4	2	1	1.0	1.0	0.71	50	145
cis-1,2-Dichloroethene	156-59-2	70	35	1.0	1.0	0.49	70	125
1,1,1-Trichloroethane	71-55-6	200	100	1.0	1.0	0.59	65	130
Benzene	71-43-2	5	2.5	1.0	1.0	0.58	89	120
1,2-Dichloroethane	107-06-2	5	2.5	1.0	1.0	0.50	70	130
Trichloroethene	79-01-6	5	2.5	1.0	1.0	0.55	70	125
Toluene	108-88-3	1000	500	1.0	1.0	0.58	75	120
Tetrachloroethene	127-18-4	5	2.5	1.0	1.0	0.76	45	150
Ethylbenzene	100-41-4	700	350	1.0	1.0	0.69	75	125
xylene, total	1330-20-7	10000	5000	3.0	3.0	1.8	N/A	N/A

[1] PALs were developed to be protective of human health and the environment. Refer to **Site Background** for a discussion on development of PALs.
[2] PQL Goals were determined on a case by case basis and in most cases are at least 2 times less than the PAL.
MCLs are the federal Maximum Contaminant Levels.

4.2 Analytical SOP References Table

Laboratory Name and Address:
ENCO
10775 Central Port Drive
Orlando, Florida 32824

Point of Contact: Ronnie Wambles

Phone Number: 407.826.5314

Lab SOP Number	Title, Revision Date, and Number	Last Reviewed	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Variance to Quality Systems Manual (QSM)	Modified for Project Work? (Y/N)
LOGINS-03	Receiving Samples (Rev. 10, Effective 1/23/2010)	4/20/2011	N/A	N/A	N/A	N	N
ADMIN-14	Waste Disposal and Characterization (Rev. 5, 12/1/2009)	1/4/2011	N/A	N/A	N/A	N	N
VGCMS-05	Analysis of VOCs by Gas Chromatograph (GC)/Mass Spectrometer (MS) (Rev.17, Effective 8/26/2011)	N/A	Definitive	Aqueous VOC	GC/MS	N	N

Required Laboratory Accreditation: Department of Defense (DoD) Environmental Laboratory Application Program (ELAP)
Expiration Date: March 31, 2012 (Currently working with accrediting body to renew)

4.3 Laboratory QC Samples Table

Matrix: Groundwater

Analytical Group: Select VOCs

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

Measurement Performance Criteria are from DoD QSM version 4.1

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method blank	One per preparatory batch	No analytes detected > 1/2 LOQ. Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes detected > LOQ.	Correct problem, then see criteria in DoD QSM Box D-1. If required, reprepare and reanalyze method blank and all samples processed with the contaminated blank.	Analyst	Bias/Contamination	No analytes detected > 1/2 LOQ. Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes detected > LOQ.
LCS		Refer to **Reference Limits and Evaluation Table**.	Correct problem, then reprepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient samples material is available.		Precision and Accuracy/Bias	Refer to **Reference Limits and Evaluation Table**
Internal Standards (IS)	Spiked in Every Sample	Retention time within 30 seconds from retention time of the midpoint standard in the initial calibration (ICAL); areas within -50% to +100% of ICAL midpoint standard.	Inspect MS and GC for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning.		Precision and Accuracy	Retention time within 30 seconds from retention time of the midpoint standard in the ICAL; areas within -50% to +100% of ICAL midpoint standard.
Surrogates		Dibromofluoromethane 85-115%, Toluene-d_8 85-120%, 1,2-Dichloroethane-d4 70-120%, 4-Bromofluorobenzene 75-120%	For QC and field samples, correct problem then reprepare and reanalyze all failed samples for failed surrogates in the associated preparatory batch, if sufficient sample material is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary.		Precision and Accuracy/Bias	Dibromofluoromethane 85-115%, Toluene-d_8 85-120%, 1,2-Dichloroethane-d4 70-120%, 4-Bromofluorobenzene 75-120%

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5 References

AGVIQ-CH2M HILL. 2011. *Draft Long-term Monitoring Report for Three Sites, Naval Station Norfolk, Norfolk, Virginia*. March.

Baker Environmental, Inc. (Baker). 1994. *Final Camp Allen Landfill Remedial Investigation/Feasibility Study Report, Naval Base Norfolk, Norfolk, Virginia*. July.

CH2M HILL. 2008. *Final Five-Year Review Report, Naval Station Norfolk, Norfolk, Virginia.* October.

United States Department of the Navy (Navy). 1995. *Final Decision Document, Camp Allen Landfill, Naval Base Norfolk, Norfolk, Virginia*. July.

Navy. 2010. *Record of Decision Site 1: Camp Allen Landfill (Operable Unit 01), Site 3: Q-Area Drum Storage Yard (Operable Unit 03), Site 18: Former Naval Magazine Waste Storage Area (Operable Unit 14). Site 20: Building LP-20 (Operable Unit 04), Naval Station Norfolk, Norfolk, Virginia.* September.

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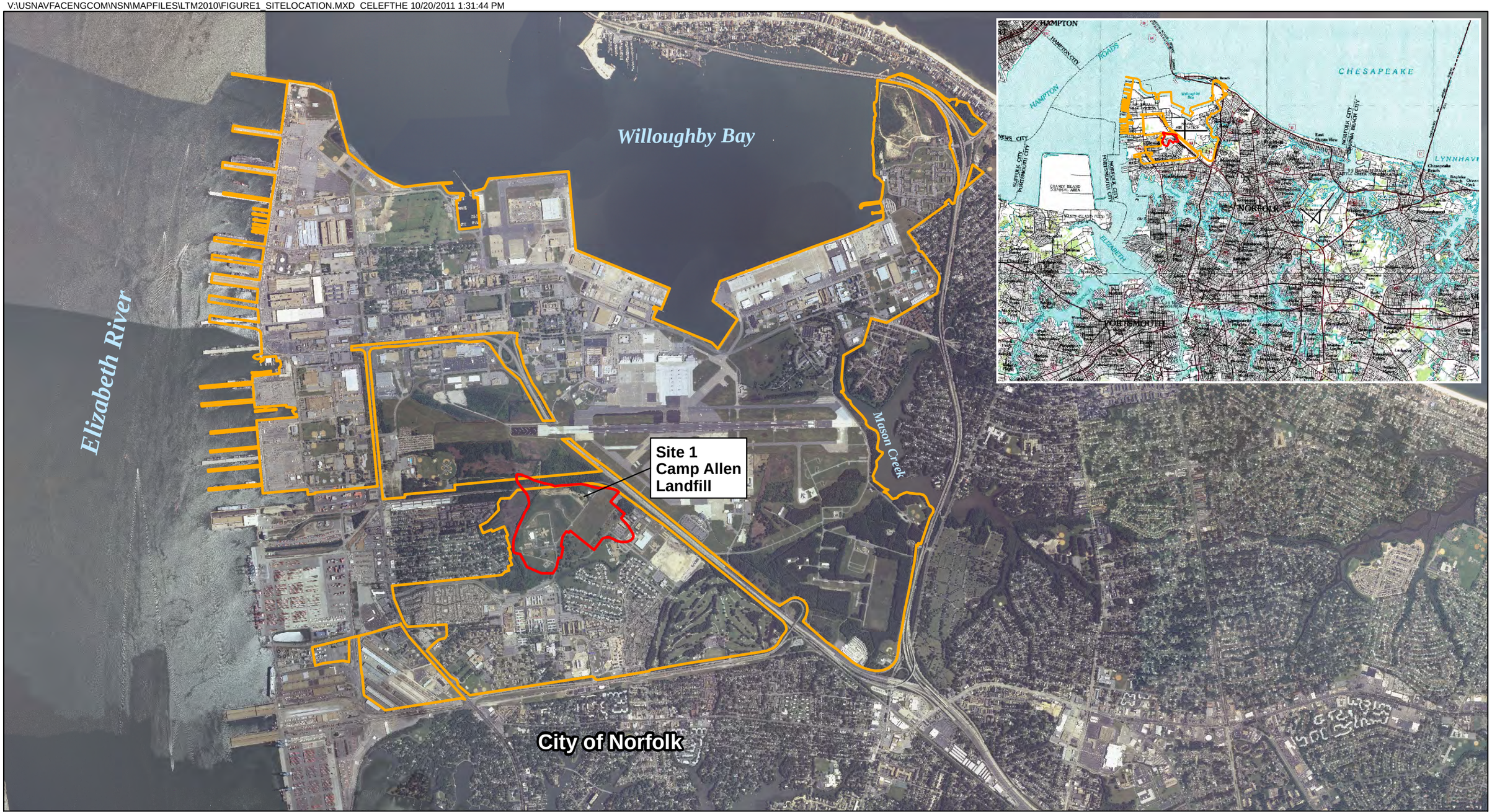
Figures

V:\USNAVFACENGCOM\NSN\MAPFILES\LTM2010\FIGURE1_SITELOCATION.MXD CELEFTHE 10/20/2011 1:31:44 PM



Legend

Base Boundary

Installation Restoration Site

2008 Aerial Photography

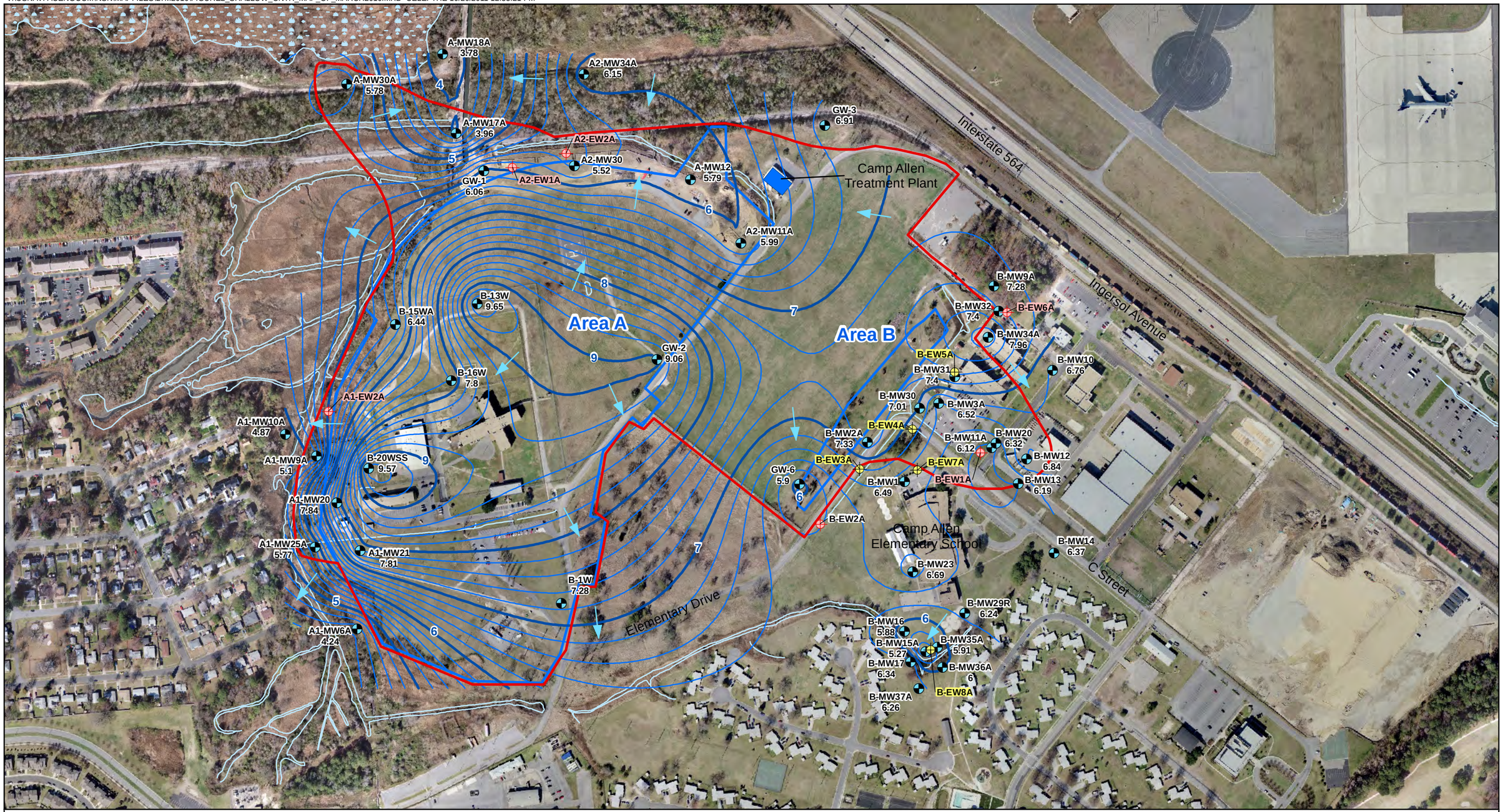
N

0 2,500 5,000 Feet

Figure 1
Site Location Map
Naval Station Norfolk
Norfolk, Virginia

CH2MHILL

V:\USNAVFACENGCOM\NSN\MAPFILES\LTM2010\FIGURE2_SHALLOW_CNTR_MAP_OF_MARCH2010.MXD CELEFTHE 10/20/2011 12:33:21 PM



Legend

- Land Use Control Area
- Site Boundary
- Shallow Monitoring Well
- Active Shallow Extraction Well
- Inactive Shallow Extraction Well
- Groundwater Elevation Contour (1 ft interval)
- Groundwater Elevation Contour (0.2 ft interval)
- Groundwater Flow Direction
- Surface Water Features

N
W E
S

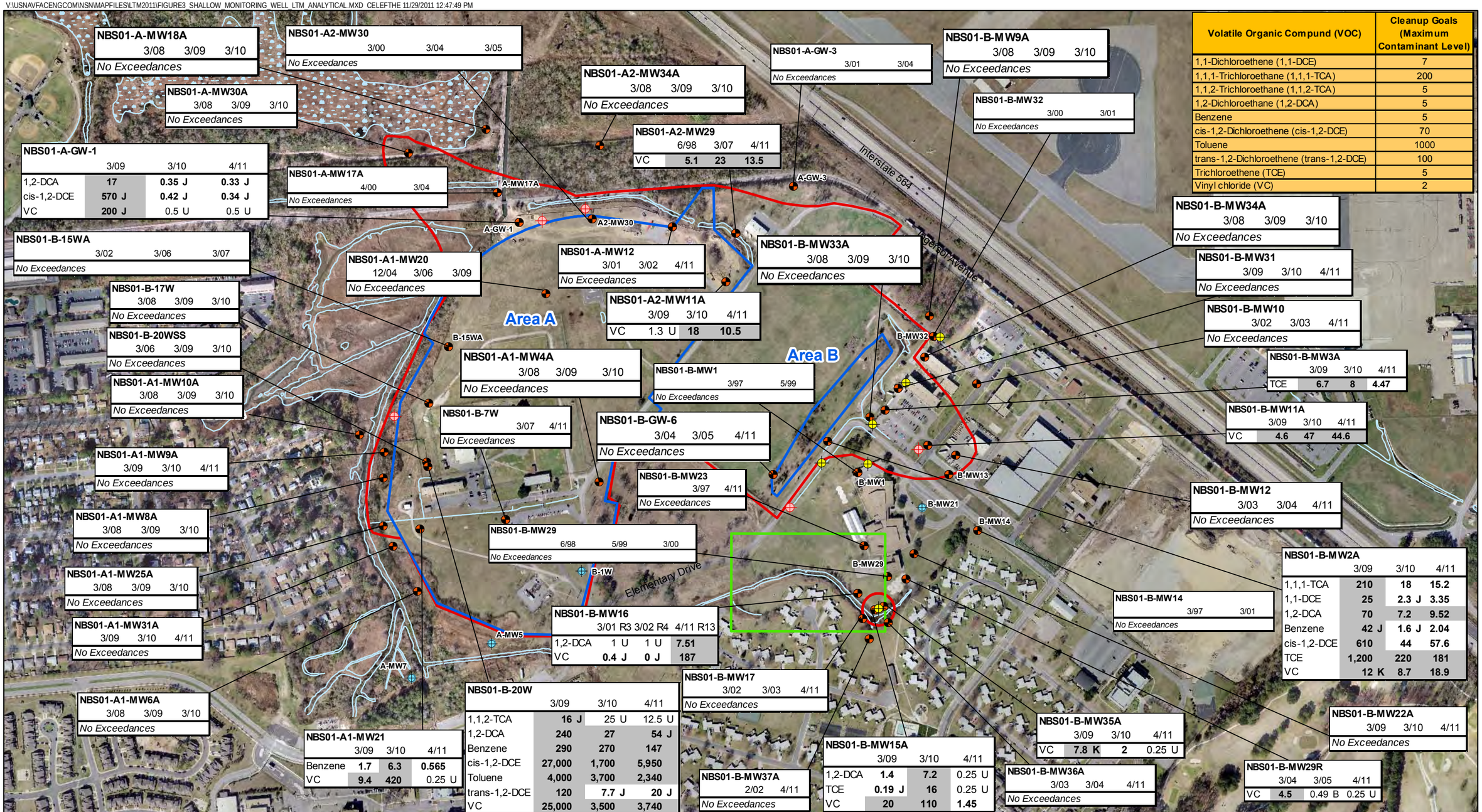
0 400 800
Feet

Refernce: 2008 Aerial Photography

Figure 2
Groundwater Contour Map of March 2010
Shallow Aquifer Groundwater Elevations
Naval Station Norfolk
Norfolk, Virginia

CH2MHILL

V:\USNAVFACENGCOM\NSN\MAPFILES\LTM2011\FIGURE3_SHALLOW_MONITORING_WELL_LTM_ANALYTICAL.MXD CELEFTHE 11/29/2011 12:47:49 PM



Volatile Organic Compund (VOC)	Cleanup Goals (Maximum Contaminant Level)
1,1-Dichloroethene (1,1-DCE)	7
1,1,1-Trichloroethane (1,1,1-TCA)	200
1,1,2-Trichloroethane (1,1,2-TCA)	5
1,2-Dichloroethane (1,2-DCA)	5
Benzene	5
cis-1,2-Dichloroethene (cis-1,2-DCE)	70
Toluene	1000
trans-1,2-Dichloroethene (trans-1,2-DCE)	100
Trichloroethene (TCE)	5
Vinyl chloride (VC)	2

NBS01-A-MW18A
3/08 3/09 3/10
No Exceedances

NBS01-A2-MW30
3/00 3/04 3/05
No Exceedances

NBS01-A-MW30A
3/08 3/09 3/10
No Exceedances

NBS01-A-GW-1

	3/09	3/10	4/11
1,2-DCA	**17**	**0.35 J**	**0.33 J**
cis-1,2-DCE	**570 J**	**0.42 J**	**0.34 J**
VC	**200 J**	0.5 U	0.5 U

NBS01-A-MW17A
4/00 3/04
No Exceedances

NBS01-B-15WA
3/02 3/06 3/07
No Exceedances

NBS01-A1-MW20
12/04 3/06 3/09
No Exceedances

NBS01-B-17W
3/08 3/09 3/10
No Exceedances

NBS01-B-20WSS
3/06 3/09 3/10
No Exceedances

NBS01-A1-MW10A
3/08 3/09 3/10
No Exceedances

NBS01-A1-MW9A
3/09 3/10 4/11
No Exceedances

NBS01-A1-MW8A
3/08 3/09 3/10
No Exceedances

NBS01-A1-MW25A
3/08 3/09 3/10
No Exceedances

NBS01-A1-MW31A
3/09 3/10 4/11
No Exceedances

NBS01-A1-MW6A
3/08 3/09 3/10
No Exceedances

NBS01-A1-MW21

	3/09	3/10	4/11
Benzene	**1.7**	**6.3**	**0.565**
VC	**9.4**	**420**	0.25 U

NBS01-A2-MW34A
3/08 3/09 3/10
No Exceedances

NBS01-A2-MW29

	6/98	3/07	4/11
VC	**5.1**	**23**	**13.5**

NBS01-A-MW12
3/01 3/02 4/11
No Exceedances

NBS01-A2-MW11A

	3/09	3/10	4/11
VC	1.3 U	**18**	**10.5**

NBS01-A1-MW4A
3/08 3/09 3/10
No Exceedances

NBS01-B-7W
3/07 4/11
No Exceedances

NBS01-B-GW-6
3/04 3/05 4/11
No Exceedances

NBS01-B-MW23
3/97 4/11
No Exceedances

NBS01-B-MW29
6/98 5/99 3/00
No Exceedances

NBS01-B-MW16

	3/01 R3	3/02 R4	4/11 R13
1,2-DCA	1 U	1 U	**7.51**
VC	**0.4 J**	**0 J**	**187**

NBS01-B-20W

	3/09	3/10	4/11
1,1,2-TCA	**16 J**	25 U	12.5 U
1,2-DCA	**240**	**27**	**54 J**
Benzene	**290**	**270**	**147**
cis-1,2-DCE	**27,000**	**1,700**	**5,950**
Toluene	**4,000**	**3,700**	**2,340**
trans-1,2-DCE	**120**	**7.7 J**	**20 J**
VC	**25,000**	**3,500**	**3,740**

NBS01-B-MW17
3/02 3/03 4/11
No Exceedances

NBS01-B-MW37A
2/02 4/11
No Exceedances

NBS01-A-GW-3
3/01 3/04
No Exceedances

NBS01-B-MW9A
3/08 3/09 3/10
No Exceedances

NBS01-B-MW32
3/00 3/01
No Exceedances

NBS01-B-MW33A
3/08 3/09 3/10
No Exceedances

NBS01-B-MW15A

	3/09	3/10	4/11
1,2-DCA	**1.4**	**7.2**	0.25 U
TCE	**0.19 J**	**16**	0.25 U
VC	**20**	**110**	**1.45**

NBS01-B-MW34A
3/08 3/09 3/10
No Exceedances

NBS01-B-MW31
3/09 3/10 4/11
No Exceedances

NBS01-B-MW10
3/02 3/03 4/11
No Exceedances

NBS01-B-MW3A

	3/09	3/10	4/11
TCE	**6.7**	**8**	**4.47**

NBS01-B-MW11A

	3/09	3/10	4/11
VC	**4.6**	**47**	**44.6**

NBS01-B-MW12
3/03 3/04 4/11
No Exceedances

NBS01-B-MW2A

	3/09	3/10	4/11
1,1,1-TCA	**210**	**18**	**15.2**
1,1-DCE	**25**	**2.3 J**	**3.35**
1,2-DCA	**70**	**7.2**	**9.52**
Benzene	**42 J**	**1.6 J**	**2.04**
cis-1,2-DCE	**610**	**44**	**57.6**
TCE	**1,200**	**220**	**181**
VC	**12 K**	**8.7**	**18.9**

NBS01-B-MW14
3/97 3/01
No Exceedances

NBS01-B-MW35A

	3/09	3/10	4/11
VC	**7.8 K**	**2**	0.25 U

NBS01-B-MW36A
3/03 3/04 4/11
No Exceedances

NBS01-B-MW22A
3/09 3/10 4/11
No Exceedances

NBS01-B-MW29R

	3/04	3/05	4/11
VC	**4.5**	0.49 B	0.25 U

Legend

- Active Extraction Well Location
- Inactive Extraction Well Location
- Shallow Monitoring Well Location
- Water Level Monitoring Well Location
- Investigation Area
- Land Use Control Area
- Site Boundary
- Surface Water Features
- Wetland

Notes:
Bold text indicates detection
Gray shading indicates exceedance of Cleanup goals
The detected concentration values that exceed the clean up goals are highlighted.
Results for the most recent 3 rounds of sampling are shown for each sample location (where available).
4/11 indicates the month/year the sample was collected
All concentrations are in micrograms per liter
B - Analyte not detected above the level reported in blanks
J - Analyte Present, value may or may not be accurate or precise
K - Analyte present, value may be biased high
U - The material was analyzed for, but not detected

Reference: 2008 Aerial Photography

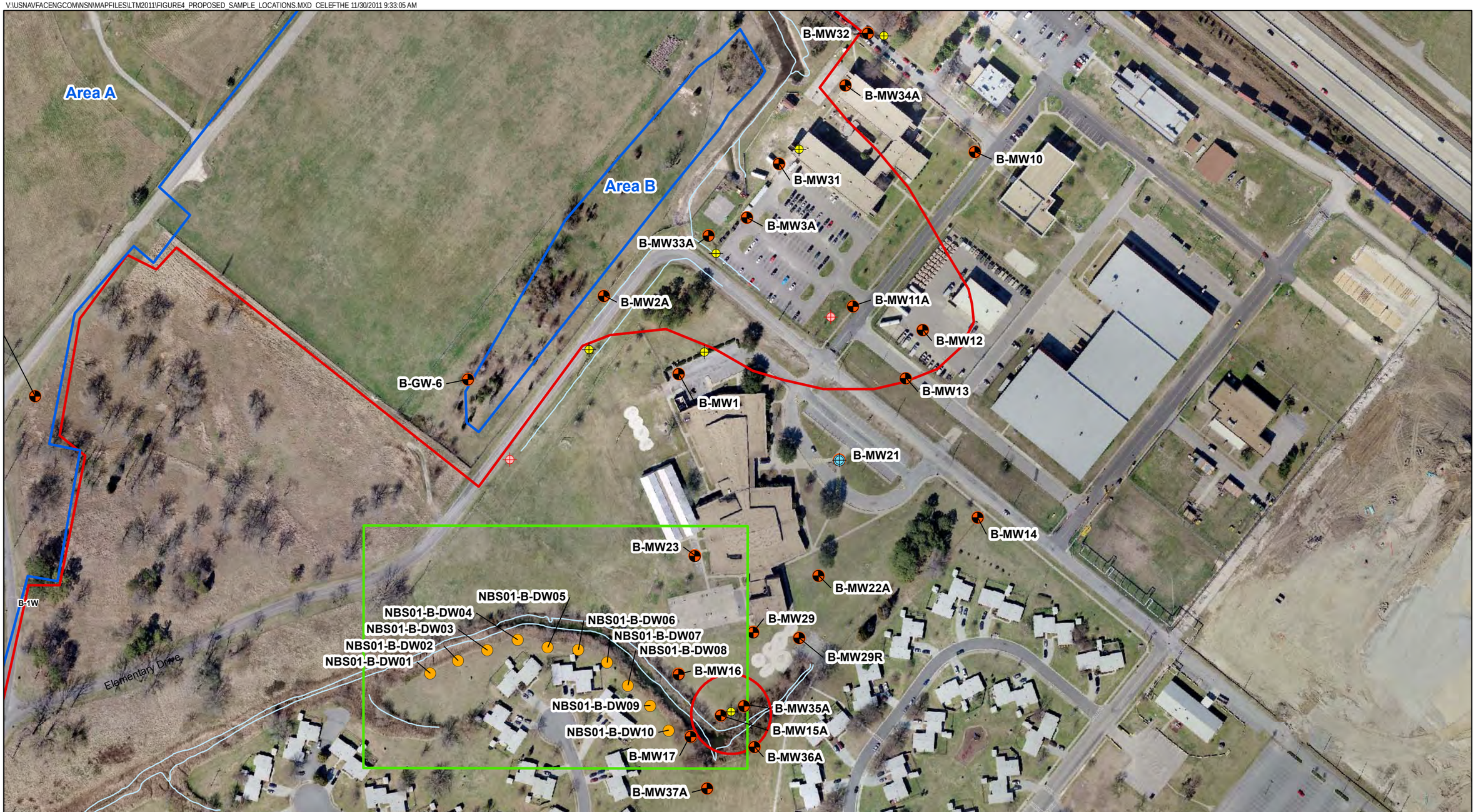
N W E S

0 500 1,000 Feet

Figure 3
Shallow Monitoring Well LTM Analytical Results
Naval Station Norfolk
Norfolk, Virginia

CH2MHILL

V:\USNAVFACENGCOM\NSN\MAPFILES\LTM2011\FIGURE4_PROPOSED_SAMPLE_LOCATIONS.MXD CELEFTHE 11/30/2011 9:33:05 AM



Legend

- Proposed DPT Grab
- Active Extraction Well Location
- Inactive Extraction Well Location
- Water Level Monitoring Well Location
- Shallow Monitoring Well Location
- Investigation Area
- Land Use Control Area
- Site Boundary
- Surface Water Features
- Wetland

Notes:
1. Placement of DPT grab groundwater samples may be altered based on field decisions by the FTL
2. One shallow monitoring well (B-MW38S) will be installed following the DPT investigation.

N
W E
S

0 150 300
Feet

Figure 4
Proposed Sample Locations
Naval Station Norfolk
Norfolk, Virginia

CH2MHILL

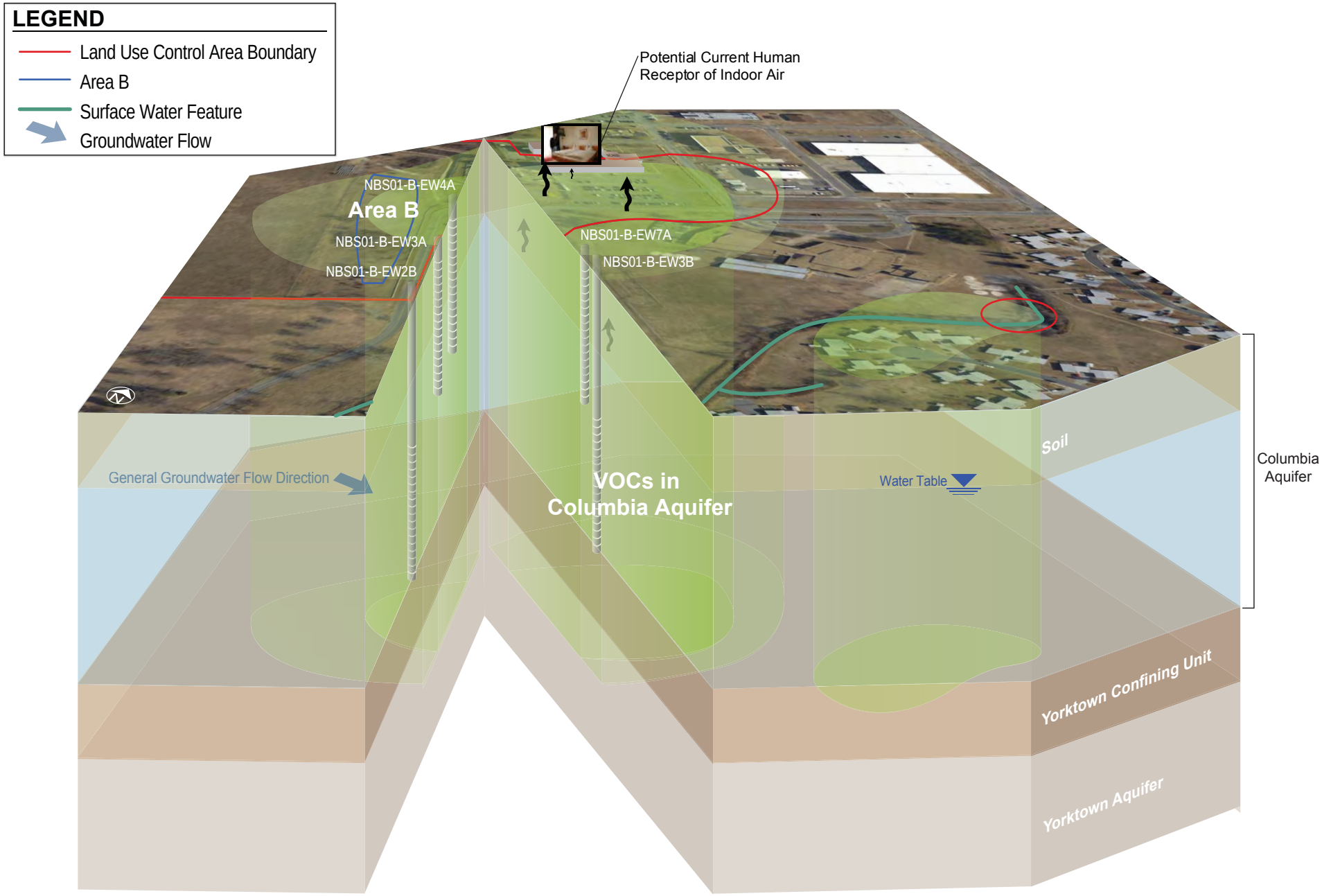


FIGURE 5
Camp Allen Landfill, Area B Conceptual Site Model
Sampling and Analysis Plan Site 1, Camp Allen Landfill
Naval Station Norfolk, Norfolk, Virginia

CH2MHILL

ES020612012105WDC NSN_Site1_CSM_v4 03.23.12 mlb

Appendix A
ENCO DoD ELAP Letter

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005

ENVIRONMENTAL CONSERVATION LABORATORIES – ORLANDO
10775 Central Port Drive
Orlando, FL 32824
Lori Mangrum Phone: 407 826 5314
lmangrum@encolabs.com

ENVIRONMENTAL

Valid To: March 31, 2012 Certificate Number: 3000.01

In recognition of the successful completion of the A2LA evaluation process, (including an assessment of the laboratory's compliance with ISO IEC 17025:2005, the 2003 NELAC Chapter 5 Standard, and the requirements of the DoD Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in the current DoD Quality Systems Manual for Environmental Laboratories) accreditation is granted to this laboratory to perform recognized EPA methods using the following testing technologies and in the analyte categories identified below:

Testing Technologies

Analyte / Parameter	Non-Potable Water	Solid Hazardous Waste
Metals	EPA 6020A/200.8	EPA 6020A
Aluminum	EPA 6020A/200.8	EPA 6020A
Antimony	EPA 6020A/200.8	EPA 6020A
Arsenic	EPA 6020A/200.8	EPA 6020A
Barium	EPA 6020A/200.8	EPA 6020A
Beryllium	EPA 6020A/200.8	EPA 6020A
Cadmium	EPA 6020A/200.8	EPA 6020A
Calcium	EPA 6020A/200.8	EPA 6020A
Chromium	EPA 6020A/200.8	EPA 6020A
Cobalt	EPA 6020A/200.8	EPA 6020A
Copper	EPA 6020A/200.8	EPA 6020A
Hardness	SM 2340 B	----------
Iron	EPA 6020A/200.8	EPA 6020A
Lead	EPA 6020A/200.8	EPA 6020A
Magnesium	EPA 6020A/200.8	EPA 6020A
Manganese	EPA 6020A/200.8	EPA 6020A
Mercury	EPA 245.1/7470A	EPA 7471B
Molybdenum	EPA 6020A/200.8	EPA 6020A
Nickel	EPA 6020A/200.8	EPA 6020A
Potassium	EPA 6020A/200.8	EPA 6020A
Selenium	EPA 6020A/200.8	EPA 6020A
Silver	EPA 6020A/200.8	EPA 6020A
Sodium	EPA 6020A/200.8	EPA 6020A
Thallium	EPA 6020A/200.8	EPA 6020A
Tin	EPA 6020A/200.8	EPA 6020A

5301 Buckeystown Pike, Suite 350 | Frederick, Maryland 21704-8373 | Phone: 301 644 3248 | Fax: 301 662 2974 | www.A2LA.org

Analyte / Parameter	Non-Potable Water	Solid Hazardous Waste
Titanium	EPA 6020A/200.8	EPA 6020A
Vanadium	EPA 6020A/200.8	EPA 6020A
Zinc	EPA 6020A/200.8	EPA 6020A
Microbiology		
Total Coliforms	SM 9222B	----------
Fecal Coliforms	SM 9222D	----------
General Chemistry		
Acidity, as $CaC0_3$	EPA 305.1/SM 2310 B (4A)	----------
Alkalinity as $CaC0_3$	EPA 310.1/SM 2320 B	EPA 310.1/SM 2320 B
Alkalinity as $CaC0_4$	EPA 310.2	EPA 310.2
Ammonia as N	----------	EPA 350.1
Biochemical oxygen demand	EPA 405.1/SM 5210 B	----------
Bromide	EPA 300.0/9056A	EPA 9056A
Carbonaceous BOD (CBOD)	SM 5210 B	----------
Chemical oxygen demand	EPA 410.4	----------
Chloride	EPA 300.0/9056A	EPA 9056A
Chromium VI	EPA 7196/ SM 3500-Cr D	EPA 7196
Conductivity	EPA 120.1	----------
Cyanide	EPA 335.2/SM 4500-CN E	EPA 9014
Ferric iron (calculated)	SM 3500-Fe D	----------
Ferrous iron	SM 3500-Fe D	----------
Fluoride	EPA 300.0/9056A	EPA 9056A
Hardness	EPA 130.2/SM 2340 C	----------
Kjeldahl nitrogen -total	EPA 351.2	EPA351.2
Nitrate as N	EPA 300.0/353.1/9056A	EPA 353.1/9056A
Nitrate-nitrite	EPA 300.0/353.1/9056A	EPA 353.1/9056A
Nitrite as N	EPA 300.0/354.1/9056A/SM 4500-NO_2 B	EPA 9056A/ SM 4500-NO_2 B
Organic nitrogen	EPA 351.2/350.1	EPA 351.2/350.1
Orthophosphate as P	EPA 365.1	----------
Orthophosphate as P	EPA 365.3	----------
pH	EPA 150.1/9040C/SM 4500-H^+-B	EPA 9040C
Phosphorus, total	EPA 365.4	EPA 365.4
Residue-filterable (TDS)	SM 2540 C	----------
Residue-nonfilterable (TSS)	SM 2540 D	----------
Residue-total	SM 2540 B/SM 2540 G/EPA 160.3	SM 2540G/EPA 160.3
Residue-volatile	EPA 160.4	EPA 160.4
Sulfate	EPA 300.0/9056A	EPA 9056A
Sulfide	EPA 376.1/SM 4500-S E	----------
Surfactants -MBAS	SM 5540 C	----------
Total nitrate-nitrite	EPA 9056 A/SM 4500-$N0_3$ H	EPA 9056 A/SM 4500-$N0_3$ H
Total cyanide	EPA 9014	EPA 9014
Total nitrogen	TKN + Total nitrate-nitrite	TKN + Total nitrate-nitrite
Total Organic Carbon	EPA 9060A/SM 5310B	TOC Walkley Black
Total phenolics	EPA 420.1	EPA 420.1
Total, fixed, and volatile residue	SM 2540 G	SM 2540 G
Turbidity	EPA 180.1	----------
Un-ionized ammonia	DEP SOP 10/03/83	DEP SOP 10/03/83
Extractable Organics		

Analyte / Parameter	Non-Potable Water	Solid Hazardous Waste
1,2,4-Trichlorobenzene	EPA 8270D/625	EPA 8270D
1,2,4,5-Tetrachlorobenzene	EPA 8270D/625	EPA 8270D
1,2-Dichlorobenzene	EPA 8270D/625	EPA 8270D
1,2-Diphenylhydrazine	EPA 8270D/625	EPA 8270D
1,3-Dichlorobenzene	EPA 8270D/625	EPA 8270D
1,4-Dichlorobenzene	EPA 8270D/625	EPA 8270D
1- Methylnaphthalene	EPA 8270D/625/ Scan-Sim	EPA 8270D/ Scan-Sim
2,3,4,6-Tetrachlorophenol	EPA 8270D/625	EPA 8270D
2,4,5-Trichlorophenol	EPA 8270D/625	EPA 8270D
2,4,6-Trichlorophenol	EPA 8270D/625	EPA 8270D
2,4-Dichlorophenol	EPA 8270D/625	EPA 8270D
2,4-Dimethylphenol	EPA 8270D/625	EPA 8270D
2,4-Dinitrophenol	EPA 8270D/625	EPA 8270D
2,4-Dinitrotoluene (2,4-DNT)	EPA 8270D/625/ Scan-Sim	EPA 8270D
2,6-Dichlorophenon	EPA 8270D/625	EPA 8270D
2,6-Dinitrotoluene (2,6-DNT)	EPA 8270D/625	EPA 8270D
2-Chloronaphthalene	EPA 8270D/625	EPA 8270D
2-Chlorophenol	EPA 8270D/625	EPA 8270D
2·Methyl-4,6-dinitrophenol	EPA 8270D/625	EPA 8270D
2-Methylnaphthalene	EPA 8270D/625 Scan-Sim	EPA 8270D Scan-Sim
2-Methylphenol (o-Cresol)	EPA 8270D/625	EPA 8270D
2-Nitroaniline	EPA 8270D/625	EPA 8270D
2-Nitrophenol	EPA 8270D/625	EPA 8270D
3,3'-Dichlorobenzidine	EPA 8270D/625	EPA 8270D
3/4-Methylphenols (m/p-Cresols)	EPA 8270D/625	EPA 8270D
3-Nitroaniline	EPA 8270D/625	EPA 8270D
4-Bromophenyl phenyl ether	EPA 8270D/625	EPA 8270D
4-Chloro-3-methylphenol	EPA 8270D/625	EPA 8270D
4-Chloroaniline	EPA 8270D/625	EPA 8270D
4-Chlorophenyl phenyl ether	EPA 8270D/625	EPA 8270D
4-Nitrophenol	EPA 8270D/625	EPA 8270D
Acenaphthene	EPA 8270D/625 Scan-Sim	EPA 8270D Scan-Sim
Acenaphthylene	EPA 8270D/625 Scan-Sim	EPA 8270D Scan-Sim
4-Melhylphenol (p-Cresol)	EPA 8270D/625	EPA 8270D
4-Nitroaniline	EPA 8270D/625	EPA 8270D
Acetophenone	EPA 8270D/625	EPA 8270D
Anthracene	EPA 8270D/625/ Scan-Sim	EPA 8270D Scan Sim
Atrazine	EPA 8270D/625	EPA 8270D
Benzaldehyde	EPA 8270D/625	EPA 8270D
Benzidine	EPA 8270D/625/ Scan-Sim	EPA 8270D
Benzo(a)anthracene	EPA 8270D/625/ Scan-Sim	EPA 8270D Scan-Sim
Benzo(a)pyrene	EPA 8270D/625/ Scan-Sim	EPA 8270D Scan-Sim
Benzo(b)fluoranthene	EPA 8270D/625/ Scan-Sim	EPA 8270D Scan-Sim
Benzo(g,h,i)perylene	EPA 8270D/625/ Scan-Sim	EPA 8270D Scan-Sim
Benzo(k)fluoranthene	EPA 8270D/625/ Scan-Sim	EPA 8270D Scan-Sim
Benzyl alcohol	EPA 8270D/625	EPA 8270D
1,1-Biphenyl	EPA 8270D/625	EPA 8270D
bis(2-Chloroethoxy) methane	EPA 8270D/625	EPA 8270D
bis(2-Chloroethyl) ether	EPA 8270D/625	EPA 8270D
bis(2-Chloroisopropyl) ether (2,2'-Oxybis(1-chloropropane))	EPA 8270D/625	EPA 8270D

Analyte / Parameter	Non-Potable Water	Solid Hazardous Waste
bis(2-Ethylhexyl) phthalate (DEHP)	EPA 8270D/625	EPA 8270D
Butyl benzyl phthalate	EPA 8270D/625	EPA 8270D
Caprolactam	EPA 8270D/625	EPA 8270D
Carbazole	EPA 8270D/625	EPA 8270D
Chrysene	EPA 8270D/625/ Scan-Sim	EPA 8270D Scan-Sim
Dibenz(a,h)anthracene	EPA 8270D/625/ Scan-Sim	EPA 8270D Scan-Sim
Dibenzofuran	EPA 8270D/625	EPA 8270D
Diethyl phthalate	EPA 8270D/625	EPA 8270D
Dimethyl phthalate	EPA 8270D/625/ Scan-Sim	EPA 8270D
Di-n-butyl phthalate	EPA 8270D/625	EPA 8270D
Di-n-octyl phthalate	EPA 8270D/625	EPA 8270D
Fluoranthene	EPA 8270D/625/ Scan-Sim	EPA 8270D Scan-Sim
Fluorene	EPA 8270D/625 Scan-Sim	EPA 8270D Scan-Sim
Hexachlorobenzene	EPA 8270D/625/ Scan-Sim	EPA 8270D
Hexachlorobutadiene	EPA 8270D/625/ Scan-Sim	EPA 8270D
Hexachlorocyclopentadiene	EPA 8270D/625	EPA 8270D
Hexachloroethane	EPA 8270D/625	EPA 8270D
Indeno(1,2,3-cd)pyrene	EPA 8270D/625/ Scan-Sim	EPA 8270D Scan-Sim
Isodrin	EPA 8270D/625	EPA 8270D
Isophorone	EPA 8270D/625	EPA 8270D
Naphthalene	EPA 8270D/625 Scan-Sim	EPA 8270D Scan-Sim
Nitrobenzene	EPA 8270D/625	EPA 8270D
n-Nitrosodimethylamine	EPA 8270D/625	EPA 8270D
n-Nitrosodi-n-propylamine	EPA 8270D/625	EPA 8270D
n-Nitrosodiphenylamine	EPA 8270D/625	EPA 8270D
n-Nitrosopyrrolidine	EPA 8270D/625	EPA 8270D
Pentachlorophenol	EPA 8270D/625/ Scan-Sim	EPA 8270D
Phenanthrene	EPA 8270D/625 Scan-Sim	EPA 8270D Scan-Sim
Phenol	EPA 8270D/625	EPA 8270D
Pyrene	EPA 8270D/625 Scan-Sim	EPA 8270D Scan-Sim
Total Petroleum Hydrocarbons (TPH)	FL·PRO	FL·PRO
Volatile Organics		
1,1,1,2-Tetrachloroethane	EPA 8260B/624	EPA 8260B
1,1,1-Trichloroethane	EPA 8260B/624	EPA 8260B
1,1,2,2-Tetrachloroethane	EPA 8260B/624	EPA 8260B
1,1,2-Trichloro-1,2,2-trifluoroethane	EPA 8260B/624	EPA 8260B
1,1,2-Trichloroethane	EPA 8260B/624	EPA 8260B
1,1-Dichloroethane	EPA 8260B/624	EPA 8260B
1,1-Dichloroethene	EPA 8260B/624	EPA 8260B
1,1-Dichloropropene	EPA 8260B/624	EPA 8260B
1,2,3-Trichlorobenzene	EPA 504.1/8260B/624	EPA 8260B
1,2,3-Trichloropropane	EPA 8260B/624	EPA 8260B
1,2,4-Trichlorobenzene	EPA 8260B/624	EPA 8260B
1,2,4-Trimethylbenzene	EPA 8260B/624	EPA 8260B
1,2-Dibromo-3-chloropropane (DBCP)	EPA 504 /504.1/8011/8260B	EPA 8260B
1,2-Dibromoethane (EDB, Ethylene dibromide)	EPA 504 /504.1/8011/8260B	EPA 8260B

Analyte / Parameter	Non-Potable Water	Solid Hazardous Waste
1,2-Dichlorobenzene	EPA 8260B/624	EPA 8260B
1,2-Dichloroethane	EPA 8260B/624	EPA 8260B
1,2-Dichloropropane	EPA 8260B/624	EPA 8260B
1,3,5-Trimethylbenzene	EPA 8260B/624	EPA 8260B
1,3-Dichlorobenzene	EPA 8260B/624	EPA 8260B
1,3-Dichloropropane	EPA 8260B/624	EPA 8260B
1,4-Dichlorobenzene	EPA 8260B/624	EPA 8260B
1,4-Dioxane (1,4-Diethylencoxide)	EPA 8260B/8260C SIM/624	EPA 8260B/8260C SIM
2,2-Dichloropropane	EPA 8260B/624	EPA 8260B
2-Butanone (Methyl ethyl ketone, MEK)	EPA 8260B/624	EPA 8260B
2-Chloroethyl vinyl ether	EPA 8260B/624	EPA 8260B
2-Chlorotoluene	EPA 8260B/624	EPA 8260B
2-Hexanone	EPA 8260B/624	EPA 8260B
4-Chlorotoluene	EPA 8260B/624	EPA 8260B
4-Methyl-2-pentanone (MIBK)	EPA 8260B/624	EPA 8260B
Acetone	EPA 8260B/624	EPA 8260B
Acetonitrile	EPA 8260B/624	EPA 8260B
Acrolein (Propenal)	EPA 8260B/624	EPA 8260B
Acrylonitrile	EPA 8260B/624	EPA 8260B
Allyl chloride (3-Chloropropene)	EPA 8260B/624	EPA 8260B
Benzene	EPA 8260B/624	EPA 8260B
Bromobenzene	EPA 8260B/624	EPA 8260B
Bromochloromethane	EPA 8260B/624	EPA 8260B
Bromodichloromethane	EPA 8260B/624	EPA 8260B
Bromoform	EPA 8260B/624	EPA 8260B
Carbon tetrachloride	EPA 8260B/624	EPA 8260B
Carbon disulfide	EPA 8260B/624	EPA 8260B
Chlorobenzene	EPA 8260B/624	EPA 8260B
Chloroethane	EPA 8260B/624	EPA 8260B
Chloroform	EPA 8260B/624	EPA 8260B
Chloroprene	EPA 8260B/624	EPA 8260B
cis-1,2-Dichloroethene	EPA 8260B/624	EPA 8260B
cis-1,3-Dichloropropene	EPA 8260B/624	EPA 8260B
Cyclohexane	EPA 8260B/624	EPA 8260B
Dibromochloromethane	EPA 8260B/624	EPA 8260B
Dibromomethane	EPA 8260B/624	EPA 8260B
Dichlorodifluoromethane	EPA 8260B/624	EPA 8260B
Ethyl methacrylate	EPA 8260B/624	EPA 8260B
Hexachlorobutadiene	EPA 8260B/624	EPA 8260B
Ethylbenzene	EPA 8260B/624	EPA 8260B
Iodomethane (Methyl iodide)	EPA 8260B/624	EPA 8260B
Isobutyl alcohol (2-Methyl-l-propanol)	EPA 8260B/624	EPA 8260B
Isopropylbenzene	EPA 8260B/624	EPA 8260B
m+p-Xylenes	EPA 8260B/624	EPA 8260B
Methacrylonitrile	EPA 8260B/624	EPA 8260B
Methyl acetate	EPA 8260B/624	EPA 8260B
Methyl bromide (Bromomethane)	EPA 8260B/624	EPA 8260B
Methyl chloride (Chloromethane)	EPA 8260B/624	EPA 8260B
Methyl methacrylate	EPA 8260B/624	EPA 8260B
Methyl tert-butyl ether (MTBE)	EPA 8260B/624	EPA 8260B

Analyte / Parameter	Non-Potable Water	Solid Hazardous Waste
Methylcyclohexane	EPA 8260B/624	EPA 8260B
Methylene chloride	EPA 8260B/624	EPA 8260B
Naphthalene	EPA 8260B/624	EPA 8260B
n-Butylbenzene	EPA 8260B/624	EPA 8260B
n-Propylbenzene	EPA 8260B/624	EPA 8260B
o-Xylene	EPA 8260B/624	EPA 8260B
Pentachloroethane	EPA 8260B/624	EPA 8260B
p-Isopropyltoluene	EPA 8260B/624	EPA 8260B
Propionitrile (Ethyl cyanide)	EPA 8260B/624	EPA 8260B
sec-Butylbenzene	EPA 8260B/624	EPA 8260B
Styrene	EPA 8260B/624	EPA 8260B
tert-Butylbenzene	EPA 8260B/624	EPA 8260B
Tetrachloroethene (Perchloroethylene)	EPA 8260B/624	EPA 8260B
Toluene	EPA 8260B/624	EPA 8260B
trans-1,2-Dichloroethene	EPA 8260B/624	EPA 8260B
trans-1,3-Dichloropropene	EPA 8260B/624	EPA 8260B
trans-1,4-Dichloro-2-butene	EPA 8260B/624	EPA 8260B
Trichloroethene (Trichloroethylene)	EPA 8260B/624	EPA 8260B
Trichlorofluoromethane	EPA 8260B/624	EPA 8260B
Vinyl acetate	EPA 8260B/624	EPA 8260B
Vinyl chloride	EPA 8260B/624	EPA 8260B
Xylene (total)	EPA 8260B/624	EPA 8260B
Pesticides-Herbicides-PCBs		
2,4,5-T	EPA 8151A /615	EPA 8151A
2,4-D	EPA 8151A /615	EPA 8151A
2,4-DB	EPA 8151A /615	EPA 8151A
3,5-Dichlorobenzoic acid	EPA 8151A /615	EPA 8151A
4.4'-DDD	EPA 8081B/608	EPA 8081B
4.4'-DDE	EPA 8081B/608	EPA 8081B
4,4'·DDT	EPA 8081B/608	EPA 8081B
4-Nitrophenol	EPA 8151A/615	EPA 8151A
Acifluorfen	EPA 8151A/615	EPA 8151A
Aldrin	EPA 8081B/608	EPA 8081B
alpha-BHC (alpha-Hexachlorocyclohexane)	EPA 8081B/608	EPA 8081B
alpha-Chlordane	EPA 8081B/608	EPA 8081B
Aroclor-1016(PCB-1016)	EPA 8082A/608	EPA 8082A
Aroclor-1221 (PCB-1221)	EPA 8082A/608	EPA 8082A
Aroclor-1232 (PCB-1232)	EPA 8082A/608	EPA 8082A
Aroclor-1242 (PCB-1242)	EPA 8082A/608	EPA 8082A
Aroclor-1248 (PCB-1248)	EPA 8082A/608	EPA 8082A
Aroclor-1254 (PCB-1254)	EPA 8082A/608	EPA 8082A
Aroclor-1260 (PCB-1260)	EPA 8082A/608	EPA 8082A
Aroclor-1262 (PCB-1262)	EPA 8082A/608	EPA 8082A
Aroclor-1268 (PCB-1268)	EPA 8082A/608	EPA 8082A
Azinphos-methyl (Guthion)	EPA 8141B/614	EPA 8141B
Bentazon	EPA 8151A/615	EPA 8151A
beta-BHC (beta-Hexachlorocyclohexane)	EPA 8081B/608	EPA 8081B
Bolstar (Sulprofos)	EPA 8141B/614	EPA 8141B

Analyte / Parameter	Non-Potable Water	Solid Hazardous Waste
Chloramben	EPA 8151A/615	EPA 8151A
Chlordane (tech.)	EPA 8081B/608	EPA 8081B
Chlorpynfos	EPA 8141B/614	EPA 8141B
Coumaphos	EPA 8141B/614	EPA 8141B
Dacthal (DCPA)	EPA 8151A/615	EPA 8151A
Dalapon	EPA 8151A/615	EPA 8151A
delta-BHC	EPA 8081B/608	EPA 8081B
Demeton-o	EPA 8141B/614	EPA 8141B
Demeton-s	EPA 8141B/614	EPA 8141B
Diazinon	EPA 8141B/614	EPA 8141B
Dicamba	EPA 8151A/615	EPA 8151A
Dichlorofenthion	EPA 8141B/614	EPA 8141B
Dichloroprop (Dichlorprop)	EPA 8151A/615	EPA 8151A
Dlchlorovos (DDVP, Dichtorvos)	EPA 8141B/614	EPA 8141B
Dieldrin	EPA 8081B/608	EPA 8081B
Dimethoate	EPA 8141B/614	EPA 8141B
Dinoseb (2-sec-buty1-4 ,6-dinilrophenol, DNB P)	EPA 8151A/615	EPA 8151A
Disulfoton	EPA 8141B/614	EPA 8141B
Endosulfan I	EPA 8081B/608	EPA 8081B
Endosulfan II	EPA 8081B/608	EPA 8081B
Endosulfan sulfate	EPA 8081B/608	EPA 8081B
Endrin	EPA 8081B/608	EPA 8081B
Endrin aldehyde	EPA 8081B/608	EPA 8081B
Endrin ketone	EPA 8081B/608	EPA 8081B
EPN	EPA 8141B/614	EPA 8141B
Ethion	EPA 8141B/614	EPA 8141B
Ethoprop	EPA 8141B/614	EPA 8141B
fensulfothion	EPA 8141B/614	EPA 8141B
fenthion	EPA 8141B/614	EPA 8141B
gamma-BHC (Lindane, gamma-Hexachlorocyclohexane)	EPA 8081B/608	EPA 8081B
gamma-Chlordane	EPA 8081B/608	EPA 8081B
Heptachlor	EPA 8081B/608	EPA 8081B
Heptachlor epoxide	EPA 8081B/608	EPA 8081B
Isodrin	EPA 8081B/608	EPA 8081B
Malathion	EPA 8141B/614	EPA 8141B
MCPA	EPA 8151A/615	EPA 8151A
MCPP	EPA 8151A/615	EPA 8151A
Merphos	EPA 8141B/614	EPA 8141B
Methoxychlor	EPA 8081B/608	EPA 8081B
Methyl parathion (Parathion. methyl)	EPA 8141B/614	EPA 8141B
Mevinphos	EPA 8141B/614	EPA 8141B
Mirex	EPA 8081B/608	EPA 8081B
Monocrotophos	EPA 8141B/614	EPA 8141B
Naled	EPA 8141B/614	EPA 8141B
Parathion, ethyl	EPA 8141B/614	EPA 8141B
Pentachlorophenol	EPA 8151A/615	EPA 8151A
Phorate	EPA 8141B/614	EPA 8141B
Picloram	EPA 8151A/615	EPA 8151A
Ronnel	EPA 8141B/614	EPA 8141B
Silvex (2A.5-TP)	EPA 8151B/615	EPA 8151B

Analyte / Parameter	Non-Potable Water	Solid Hazardous Waste
Stirofos	EPA 8141B/614	EPA 8141B
Sulfotepp	EPA 8141B/614	EPA 8141B
Tetraethyl pyrophosphate (TEPP)	EPA 8141B/614	EPA 8141B
Tokuthion (Prothiophos)	EPA 8141B/614	EPA 8141B
Toxaphene (Chlorinated camphene)	EPA 8081B/608	EPA 8081B
Trichloronate	EPA 8141B/614	EPA 8141B

Preparation Methods

Fraction	Analytical Method	Preparation Method
Cyanide	EPA 9014 EPA 335.2 /SM 4500-CN E	EPA 9010C
TX	EPA 9056A	EPA 5050
Metal water prep	EPA 6020A/200.8	EPA 3005A
Metals soil prep	EPA 6020A	EPA 3050B
Metals TCLP prep	EPA 6020A/200.8	EPA 3010A
Extractable organics and Pesticides water prep	EPA 8270D/625/8081B/8082A/ 608/ 8141B/ 614	EPA 3510C
Extractable organics and Pesticides waste prep	EPA 8270D/625/8081B/8082A/ 608/ 8141B/ 614	EPA 3580A
Extractable organics and Pesticides soil prep	EPA 8270D/625/8081B/8082A/ 608/ 8141B/ 614	EPA 3550C
Organics water and mid-level soil prep	EPA 8260B/624	EPA 5030B
Organics low-level soil prep	EPA 8260B/624	EPA 5035
Soil/water leachate	Wets	ENCO WETS-88
SPLP	Wets, Organics, and Metals	EPA 1312
TCLP	Wets, Organics, and Metals	EPA 1311

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Environmental Testing

In recognition of the successful completion of the A2LA evaluation process that includes an assessment of the laboratory's compliance with ISO/IEC 17025:2005, the 2003 NELAC Chapter 5 Standard, and the requirements of the Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in the DoD Quality Systems Manual for Environmental Laboratories (QSM v4.1); accreditation is granted to this laboratory to perform recognized EPA methods as defined on the associated A2LA Environmental Scope of Accreditation. This accreditation demonstrates technical competence for this defined scope and the operation of a laboratory quality management system (*refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009*).

AMERICAN ASSOCIATION FOR LABORATORY ACCREDITATION
CORPORATE SEAL 1978
DISTRICT OF COLUMBIA
A2LA

Presented this 29h day of March 2010.

President & CEO
For the Accreditation Council
Certificate Number 3000.01
Valid to March 31, 2012

For the tests or types of tests to which this accreditation applies, please refer to the laboratory's Environmental Scope of Accreditation.

Appendix B
Field Standard Operating Procedures

STANDARD OPERATING PROCEDURE

Chain-of-Custody

I Purpose

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

II Scope

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

III Definitions

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

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

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

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

IV Responsibilities

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

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

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

V Procedures

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

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

V.1 Sample Identification

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

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

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

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

Measurements and observations shall be recorded using waterproof ink.

V.1.1 Sample Label

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

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

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

V.2 Chain-of-Custody Procedures

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

V.2.1 Field Custody Procedures

- Samples are collected as described in the site Sampling and Analysis Plan. Care must be taken to record precisely the sample location and to ensure that the sample number on the label matches the Chain-of-Custody Record exactly.

- 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.

STANDARD OPERATING PROCEDURE

Direct-Push Groundwater Sample Collection

I. Purpose

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

II. Scope

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

III. Equipment and Materials

- Truck-mounted hydraulic percussion hammer.
- Direct-push (e.g., Geoprobe®) sampling rods and slotted lead rod
- Polyethylene sampling tubing and stainless steel foot valve
- Pre-cleaned sample containers
- Clean latex or surgical gloves.

IV. Procedures and Guidelines

1. Decontaminate slotted lead rod and other downhole equipment in accordance with SOP *Decontamination of Personnel and Equipment*.

2. Drive slotted steel lead rod to the desired sampling depth using the truck-mounted hydraulic percussion hammer.

3. Insert the stainless steel foot valve into the end of the polyethylene sampling tubing and insert tubing through the rods.

4. Fill all sample containers, beginning with the containers for VOC analysis.

5. Remove polyethylene sampling tubing from the rods. Remove the foot valve and discard polyethylene tubing.

6. Backfill borehole at each sampling location with grout or bentonite and repair the surface with like material (bentonite, asphalt patch, concrete, etc.), as required.

V. Key Checks and Items

- Verify that the hydraulic percussion hammer is clean and in proper working order.
- Ensure that the direct-push operator thoroughly completes the decontamination process between sampling locations.
- Ensure that the slotted lead rod has been inserted to the desired sampling depth.
- Verify that the borehole made during sampling activities has been properly backfilled.

STANDARD OPERATING PROCEDURE

Equipment Blank and Field Blank Preparation

I. Purpose

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

II. Scope

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

III. Equipment and Materials

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

IV. Procedures and Guidelines

A. Decontaminate all sampling equipment that has come in contact with sample according to SOP *Decontamination of Personnel and Equipment.*

B. To collect an equipment blank for volatile analysis from the surfaces of sampling equipment other than pumps, pour blank water over one piece of equipment and into two 40-ml vials until there is a positive meniscus, then seal the vials. Note the sample number and associated piece of equipment in the field notebook as well as the type and lot number of the water used.

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

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

C. When collecting an equipment blank from a pump, run an extra gallon of deionized water through the pump while collecting the pump outflow into appropriate containers. Make sure the flow rate is low when sampling VOCs. If a Grundfos Redi-Flo2 pump with disposable tubing is used, remove the disposable tubing after sampling but before decon. When decon is complete, put a 3- to 5-foot segment of new tubing onto the pump to collect the equipment blank.

D. To collect a field blank, slowly pour ASTM Type II or lab grade water directly into sample containers.

E. Document and ship samples in accordance with the procedures for other samples.

F. Collect next field sample.

V. Attachments

None.

VI. Key Checks and Items

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

STANDARD OPERATING PROCEDURE

Documentation and Records

I. Purpose and Scope

The purpose of this guideline is to provide methods for the documentation of records taken in the field.

II. Field Documentation

Field Logbooks

Field notes commonly are kept in bound, orange-covered logbooks used by surveyors and produced, for example, by Peninsular Publishing Company and Sesco, Inc. Pages should be water-resistant and notes should be taken only with water-proof ink, such as that provided in Sanford Sharpie® permanent markers.

All lines of all pages should be used to prevent later additions of text, which may be questioned in legal terms. Any pages not used should be marked through with a line, the author's initials, and the note "Intentionally Left Blank."

All pertinent information should be entered into the logbook, including times of starting and stopping work, activities, personnel on the work site, and equipment-calibration results and any equipment problems. The weather at the start of the day should be noted at the top of the first page for the day and any changes in weather should be noted at the appropriate time. Descriptions of soil samples and drilling cuttings can be entered in depth sequence, along with PID readings and other observations. It is helpful to include a hand-drawn diagram of well construction and of the locations of soil samples in relation to permanent site features.

No irrelevant material, including comical statements, should be entered into the logbook.

An example of a well-written set of logbook entries is provided as Attachment 1.

Field Notebooks

Field equipment and forms notebooks may be used in lieu of bound field logbooks. Although they do not have the advantage of containing all pertinent information in one volume, they do allow the use of pre-printed forms, which can make note taking easier. The notebooks are maintained to document field equipment maintenance and contain calibration logs and field forms, as described below. The notebooks provide centrally-located three-ring binders, for information which is not recorded in sequentially-numbered, bound site or field logbooks. As an alternate method to using the field equipment and forms notebooks, the information maintained in these notebooks may be documented in the field logbooks. General site information should be documented into the field notebook that includes:

- Site name, personnel onsite and time and date of arrival
- Ambient weather conditions
- Documentation of field activities including decontamination, sampling, and preparation.
- Lot number and brand name for solvent and acid decontamination solutions and analyte-free water used for equipment and field blanks.

An example of well-completed field notebook entries is provided as Attachment 2.

Calibration Logs

Calibration logs may be included in the field equipment notebooks and are used to document the proper maintenance and calibration of field testing equipment. All equipment will be inspected and approved by the Field Team Leader before being used, and a calibration log sheet shall be maintained for each instrument used on-site and shall be kept in the notebook. The calibration log will document:

- Name and identifying number of the instrument
- Date calibrated
- Calibration points
- Identification of the calibrator
- Manufacturer, lot number, and expiration date of calibration standards
- Results of the calibration.

Field Forms

Field forms may also be kept in the field notebook if using a three-ring binder form. Field forms include:

- Soil boring log
- Well construction records
- Well purging records
- Sample collection forms

An example of each of these forms is provided as attachments.

III Attachments

Example of well-completed field logbook entries
Example of well-completed field notebook entries
Soil Boring Log
Well Construction Records Sample Form
Well Purging Records Sample Form
Sample Collection Sample Form

STANDARD OPERATING PROCEDURE

Field Measurement of Dissolved Oxygen

I. Purpose

To provide general guidelines for the calibration and use of the Dissolved Oxygen (DO) meter.

II. Scope

The following general discussion applies to more commonly used meters but may differ between specific brands. The operator's manual should be consulted for specific calibration and operation procedures.

III. Equipment and Materials

- Operations manual
- A DO probe and readout/control unit with batteries
- Electrolyte solution (KCl dissolved in deionized water) and probe membrane

IV. Procedures and Guidelines

A. Calibration

Calibrate prior to initial daily use before any readings are taken. Clean probe according to manufacturer's recommendations.

1. Prepare DO probe according to manufacturer's recommended procedures using electrolyte solution.
2. In the off position, set the pointer to zero using the screw in the center of the meter panel.
3. Turn function switch to red line and adjust using red line knob until the meter needle aligns with red mark at the 31 degrees C position.
4. Turn function switch to zero and adjust to zero using the zero control knob.
5. Attach prepared probe and adjust retaining ring finger tight.
6. Allow 15 minutes for optimum probe stabilization (when meter is off or during disconnection of the probe).
7. For YSI meters, place probe in hollow stopper that is supplied for use with the YSI Calibration Chamber.

8. Place approximately 1/2 inch of deionized water into a 4-ounce, wide mouth screw cap bottle. Keep this bottle capped and with the DO meter.

9. Just before use, shake the bottle to saturate the water with air.

10. Remove cap, place probe in bottle keeping an air-tight seal around the rubber stopper. Swirl water around in the bottle while waiting for conditions to reach equilibrium.

11. Shield chamber from sun and wind to avoid temperature fluctuations during calibration.

12. Turn function switch to temperature and record temperature reading. Determine calibration factor for that temperature and altitude correction factor from tables supplied by manufacturer.

13. Multiply the calibration factor by the correction factor to get a corrected calibration value.

14. Turn function switch to appropriate ppm range and adjust the calibrate knob until the meter reads the corrected calibration value. Wait two minutes to verify calibration value. Re-adjust as necessary.

B. Procedure

1. Before going out into the field:

   a) Check batteries
   b) Obtain fresh electrolyte solution
   c) Prepare DO probe

2. Calibrate meter using calibration procedure.

3. Place probe in water to be measured. The probe should be moved through the water at 1 ft/sec or use a probe with a built-in stirrer.

4. Allow sufficient time for probe to stabilize to water temperature and DO. Record DO meter reading.

V. Attachments

DO Meter Calibration Sheet.

VI. Key Checks and Items

- Battery check
- Calibration

VII. Preventive Maintenance

- Refer to operation manual for recommended maintenance.
- Check batteries, have replacement set on hand.

DO METER
CALIBRATION SHEET

Date	Time	Analyst's Signature	Temp (C)	Alt. (ft)	Predict (ppm 0_2)	Actual (ppm 0_2)	Comment

STANDARD OPERATING PROCEDURE

Field Measurement of pH, Specific Conductance, Turbidity, Dissolved Oxygen, ORP, and Temperature Using a 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® U-22 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® U-22 Water Quality Monitoring System or YSI with flow-though cell
- Auto-Calibration Standard Solution (provided by rental company)
- Distilled water in squirt bottle

III. Procedures and Guidelines

A. Parameters and Specifications:

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

B. Calibration:

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

Horiba U22 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 U22 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

STANDARD OPERATING PROCEDURE

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.

STANDARD OPERATING PROCEDURE

Low-Flow Groundwater Sampling from Monitoring Wells

I. Purpose and Scope

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

II. Equipment and Materials

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

III. Procedures and Guidelines

A. Setup and Purging

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

4. Plastic sheeting is placed on the ground, and the well is unlocked and opened. All decontaminated equipment to be used in sampling will be placed only on the plastic sheeting until after the sampling has been completed. To avoid cross-contamination, do not let any downhole equipment touch the ground.

5. All sampling equipment and any other equipment to be placed in the well is cleaned and decontaminated before sampling in accordance with SOP *Decontamination of Personnel and Equipment*.

6. Water level measurements are collected in accordance with the *Water Level Measurements* SOP. **Do not measure the depth to the bottom of the well at this time**; this reduces the possibility that any accumulated sediment in the well will be disturbed. Obtain depth to bottom information from well construction log.

7. Attach and secure the tubing to the low-flow pump. Lower the pump slowly into the well and set it at approximately the middle of the screen. Place the pump intake in the middle of the saturated screen length and should be at least two feet above the bottom of the well to avoid mobilization of any sediment present in the bottom.

8. Insert the measurement probes into the flow-through cell. The purged groundwater is directed through the cell, allowing measurements to be collected before the water contacts the atmosphere.

9. If using a generator, locate it 30 feet downwind from the well to avoid exhaust fumes contaminating the samples.

10. Start purging the well at 0.2 to 0.5 liters per minute. Avoid surging. Purging rates for more transmissive formations could be started at 0.5-liter to 1 liter per minute. The initial field parameters of pH, specific conductance, dissolved oxygen, ORP, turbidity, and temperature of water are measured and recorded in the field logbook.

11. The water level should be monitored during purging, and, ideally, the purge rate should equal the well recharge rate so that there is little or no drawdown in the well (i.e., less than 0.3-foot). The water level should stabilize for the specific purge rate. There should be at least 1 foot of water over the pump intake so there is no risk of the pump suction being broken, or entrainment of air in the sample. Record adjustments in the purge rate and changes in depth to water in the logbook. Purge rates should, if needed, be decreased to the minimum capabilities of the pump (0.1- to 0.2-liter per minute) to avoid affecting well drawdown.

12. During purging, the field parameters are measured frequently (every 5 minutes) until the parameters have stabilized. Field parameters are considered stable when measurements meet the following criteria:

    - pH: within 0.1 pH units

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

B. Sample Collection

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

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

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

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

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

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

4. Adequate space is left in the bottle to allow for expansion, except for VOC vials, which are filled to the top with a positive meniscus.

5. The bottle is capped and clearly labeled.

6. Samples are placed in appropriate containers and, if necessary, packed with ice in coolers as soon as practical.

7. Nondedicated equipment is cleaned and decontaminated in accordance with the *Decontamination of Personnel and Equipment* SOP.

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

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

2. Sample source and source description

3. Field observations and measurements (appearance, volatile screening, field chemistry, sampling method), volume of water purged prior to sampling, number of well volumes purged, and field parameter measurements

4. Sample disposition (preservative; laboratory name, date and time sent; laboratory sample number, chain-of-custody number, sample bottle lot number)

5. Additional remarks

C. Additional remarks

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

2. Disposable tubing is disposed of with PPE and other site trash.

IV. Attachments

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

V. Key Checks and Preventative Maintenance

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

- The highest purging rate should not exceed 1 liter per minute. This is to keep the drawdown minimized.

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

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

White Paper on Low-Flow Sampling

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

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

Normally, when a well is pumped at an excessive rate that drops the water level in the well below the water level in the aquifer, the water cascades down the inside of the well screen when it enters the well. The turbulence from this cascading causes gases such as oxygen and carbon dioxide to mix with the water in concentrations that are not representative of the native groundwater and are higher than expected. This causes geochemical changes in the nature of the water that can change the concentrations of some analytes, particularly metals, in the groundwater sample, not mention its 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.

STANDARD OPERATING PROCEDURE

Mini RAE Photoionization Detector (PID)

I. Purpose

The purpose of this SOP is to provide general reference information for using the Mini 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 Mini 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

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

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 Mini RAE utilizes the principle of a detecting sensor. 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 Mini RAE calibration, operation, and maintenance. These sections, however, do not take the place of the instruction manual.

A. Calibration

Start up Instrument

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

On!……..

Version X.XX

Model Number SN XXXX

Date Time Temp

- After the monitor is turned on and it runs through the startup menus, the display will read "Ready". Press the **[Y/+]** key to start the pump.
- 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?
```

- Perform the Fresh Air Calibration in an area free of any detectable vapor near your work zone.
- Press the **[Y/+]** key
- Display will read:

```
Zero….
In progress…
```

```
Wait…
```

```
Update data…
```

```
Zeroed…
```

```
Reading = X.X ppm
```

- Press any key and the display will go back to:

```
Fresh Air
Calibration?
```

- Press the **[N/+]** key
- Display will read:

```
Span/Cal?
```

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

Isobutylene = 100 ppm

Apply Gas Now!

- Press the **[Y/+]** key
- 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.

Wait…30

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

Reading = 100

Update data, span cal done. Turn off gas!

- Calibration readings between 99 and 102 ppm are within the acceptable range.
- Display will read:

Span/Cal?

- **CALIBRATION IS COMPLETE!**
- Press any key to return to operational mode.

B. Operation

Due to the Mini 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 2-5 to 2-14.

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, Mini RAE had wide range fluctuations during air monitoring activities.)

VII. References

Mini RAE 2000 Portable VOC PGM-7600, RAE Systems, Revision E, May 2005.

STANDARD OPERATING PROCEDURE

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

STANDARD OPERATING PROCEDURE

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. Heath and Safety Incidents: Record any health and safety incidents and immediately report any incidents to the Project Manager.

13. Subcontractor Information: Record name of company, record names and roles of subcontractor personnel, list type of equipment being used and general scope of work. List times of starting and stopping work and quantities of consumable equipment used if it is to be billed to the project.

14. Problems and Corrective Actions: Clearly describe any problems encountered during the field work and the corrective actions taken to address these problems.

15. Technical and Project Information: Describe the details of the work being performed. The technical information recorded will vary significantly between projects. The project work plan will describe the specific activities to be performed and may also list requirements for note taking. Discuss note-taking expectations with the Project Manager prior to beginning the field work.

16. Any conditions that might adversely affect the work or any data obtained (e.g., nearby construction that might have introduced excessive amounts of dust into the air).

17. Sampling Information; Specific information that will be relevant to most sampling jobs includes the following:

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

C. SUGGESTED FORMAT FOR RECORDING FIELD DATA

1. Use the left side border to record times and the remainder of the page to record information (see attached example).

2. Use tables to record sampling information and field data from multiple samples.

3. Sketch sampling locations and other pertinent information.

4. Sketch well construction diagrams.

V. Attachments

Example field notes.

Standard Operating Procedure

Locating and Clearing Underground Utilities

I. Purpose

The purpose of this SOP is to provide a general guideline for 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 procure utility subcontracting services that meet the needs of individual activities and projects.

This SOP identifies the different utility locating scenarios Activity Managers may face at their activities and spells out the general approaches that should be followed under each scenario to maximize our ability to avoid hitting underground utilities and to minimize liabilities and health and safety risks to CH2M HILL and its subcontractors.
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

The scope of CH2M HILL's utility locating work at each Activity will depend greatly on:

- The utility locating services provided by the Activity. The public works center (PWC) or similar organization at some Activities will provide some degree of utility locating services ranging from comprehensive geophysical surveying to simply providing maps. Most of these services are provided in the form of dig permits which are required before you can dig or drill.
- The degree of faith you can put on the quality/thoroughness of the utility-locating and mapping services provided by the Activity. (I.e.: Does the PWC simply rely on their maps to mark utilities or do they verify mapped locations with field geophysics or other surveys?)

Generally we will find ourselves in one of three scenarios at an Activity:

Scenario 1

The Activity provides very thorough utility locating services for our work and takes on the liability of repairs for damages that may occur if there services are inaccurate. An example of this is Patuxent River NAS.

Scenario 2

The Activity does not get involved in any utility locating processes aside from providing the most recent maps. Examples of this are Indian Head and Carderock.

Scenario 3

An intermediate situation where the Activity provides utility locating services but they (and/or we) do not have a very high level of confidence in their ability to identify everything (e.g.: they may want us to assume liability, they do not field verify and mark utilities, we notice mistakes in their work, etc.). An example of this is Washington Navy Yard.

The general procedures to be followed in each of these three situations are outlined in **Part IV. Procedures and Guidelines** of this SOP. Other qualifying factors that the PM needs to consider in determining what type of effort and budget will be required for utility locating are:

- What are the types and density of underground utilities in the area of the proposed work? (Are you drilling in an open field or a city street?). Utility locations would not be necessary in completely undeveloped areas such as woods. Although we need to be convinced (from historic air photos and site records) that these areas did not have historic uses that may have involved underground utilities.
- What is the history of the area? (A recently developed area of an Activity is likely to have more accurate mapping than an area that has been active for a long time.)
- How fixed are your drilling/digging points? (If you know exactly where you are going to be drilling ahead of time you can simply clear relatively small areas. If you will be revising locations in the field as an investigation progresses you will need to clearly mark larger areas or keep a utility location service on call (or at the site) to clear each location as it is identified.)

III. Services and Equipment

This section identifies 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 look for in the work done by PWC and what we should require from our utility location subs.

Services

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 us)

Attachment A 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 B 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 used by a subcontractor or PWC is adequate.

IV. Procedures and Guidelines

This section presents general procedures for each of the three scenarios identified above in Section II. This assumes that the Activity Manager has already met with PWC, established a contact and evaluated their procedures for identifying underground utilities.

Scenario 1 - Adequate Services are Provided by Activity PWC

1. Identify PWC's procedures, information needs, and time requirements for obtaining dig permits (or equivalent).
2. Obtain utility maps from the Activity and meet with PWC to identify what types of utilities are underground vs. aboveground at the Activity and in the areas you are working at in particular. Get a feeling for the accuracy of these maps by talking with PWC (ask: how often are they updated, how are they updated). Field proof the maps in the area of the proposed investigation to see if manholes, fire hydrants, meters, valves are where they are shown on the maps.
3. Provide PWC with information needed for obtaining dig permit.
4. Identify if there are any "utility-owned" utilities at the Activity that we should rely on Miss Utility (or similar) to mark. PWC would be the first contact for this, and then Miss Utility (or similar).
5. Perform a field check prior to drilling/digging to see if field utility markings coincide with locations on utility maps. If utilities shown on maps are not shown in field markings, notify PWC or Miss Utility.

Scenario 2 – Activity PWC Provides Little or No Services

1. Obtain utility maps from the Activity and meet with PWC to identify what types of utilities are underground vs. aboveground at the Activity and in the areas you are working at in particular. Get a feeling for the accuracy of these maps by talking with PWC (ask: how often are they updated, how are they updated). Field proof the maps in the area of the proposed investigation to see if manholes, fire hydrants, meters, valves are where they are shown on the maps. Determine if there are any unmapped utilities or public utilities on the base.
2. Identify if there are any "utility-owned" utilities at the Activity that we should rely on Miss Utility (or similar) to mark. PWC would be the first contact for this, and then Miss Utility (or similar).
3. If you know the locations of the borings beforehand and plan to use a locator subcontractor to clear the immediate vicinity of each proposed boring only, follow

steps 3a through 3c then go to Step 5. If you need to clear or mark a large area (all or part of a site), skip Steps 3a through 3c and go to step 4.

3a. All known subsurface boring locations should be positioned on a map to avoid known underground utility lines at the site (based on the most accurate maps available). This positioning is accomplished by using figures that show all utilities. These maps should be used as working drawings and kept in the field for use during all intrusive activities.

3b. Field locate the proposed boring locations and mark and label them on the ground (e.g. with stakes, paint, or similar markers). In a well developed area with good maps, field locating can be done by measuring from surface features that appear on the maps (building corners, manholes, etc). Distances from at least two features should be recorded on the map to insure that boring locations can be relocated if stakes or other location markers are tampered with. In areas where there are few surface features to reference and measure from, and where we have maps/GIS with good horizontal controls, proposed boring locations should be identified and field located using horizontal coordinates. In this case, a GPS unit will be required to stake boring locations in the field.

3c. When you are in the field marking boring locations check to see if there is evidence that any nearby utilities (within 50 feet of the proposed boring) are where they are shown on the maps. Look for manholes to check storm sewer and sanitary sewer lines, valve boxes and fire hydrants to check water lines, lamp posts or lighted signs to check electrical lines. For utilities such as gas, telecommunications, and many electrical service lines there may be no evidence on the surface. In this case, identify horizontal coordinates of at least two points along the utility line on the map. (this assumes we have the utilities shown accurately on maps with coordinates that can be easily read - i.e.: GIS) and mark them in the field. This can serve as a check for the utility locator's work.

4. If you need to clear or mark a large area (all or part of a site), delineate the area to be cleared/marked on a site map that includes all known utilities. If the area is not easily distinguished in the field, it may be necessary to stake out the extent of the proposed clearance work with stakes, paint, or other suitable markings. Identify all known types of utilities that may be present in the area.

5. Procure a utility locating subcontractor using the guidelines provided in Attachments A. Provide the subcontractor with copies of the utility maps as part of the procurement package and clearly identify the types of underground utilities and areas that they will be required to identify/mark.

6. Using an appropriate geophysical method selected for the types of utilities or subsurface structures expected, have the subcontractor conduct a geophysical survey within an appropriate area (See steps 3 and 4) and using an appropriate traverse around and over the proposed subsurface boring location(s) to locate any underground utility lines or structures. If clearing of individual drilling/digging locations is desired, it is suggested that the geophysical survey focus on marking all mapped utilities within a 30 foot radius of each proposed location (by tracing lines)

and doing a sweep for potentially undocumented utilities within a 10 foot radius of each proposed location. If all potential drilling/digging locations are not known up front, (such as with a typical Geoprobe investigation) the PM can either have the subcontractor sweep for and mark utilities throughout the entire area that may be addressed by the investigation up front or, keep the subcontractor on call to clear/sweep individual drilling locations as they are identified. Costs will factor in to this decision.

In areas that have only recently been developed, and complete utility as-built maps are available, it may be adequate to simply do a geophysical trace and mark the mapped utilities in the field as opposed to sweeping the entire site of each specific location.

The subcontractor should be required to use the industry standard color codes for marking utilities. See Attachment C.

7. Make note of the apparent difference between the underground utility lines and structures staked by the land survey and the corresponding underground utility lines and structures located by the geophysical survey.

8. Adjust proposed sample locations in order to avoid all subsurface utilities detected during the survey. Conduct an additional confirmatory geophysical survey at the new proposed sample location, if necessary.

9. Obtain copies of all geophysical data recorded by the geophysical surveying subcontractor, along with the subcontractor's report, if necessary. At a minimum the subcontractor should be required to mark his findings on the ground in the field with paint and provide a markup of the utility map with notes identifying what was found and where, with ties to site features.

10. The Project Manager and the Activity Manager should decide how the geophysical data will be used, in addition to its use in adjusting the proposed subsurface boring locations in the field. Geophysical data may also be recorded by professional land survey and uploaded into the Activity's GIS. You may also request the subcontractor to survey in the located utilities and create a map for future use by CH2M HILL. However, Project Managers and Activity Managers should be aware of the inherent limitations of precision and accuracy of geophysical data. In particular, the differences in the precision and accuracy of geophysical data and professional land survey data must be considered before the best use of the geophysical data is determined. **If you are being scoped to make or correct utility maps that will be provided to the navy, special precautions need to be taken to avoid the misuse of the maps and avoid exposing CH2M HILL to unreasonable liability. Requests for this type of work must be reviewed by CH2M HILL's Navy CLEAN Project Delivery Manager and Contracts Administrator.**

Scenario 3 - Activity PWC Provides Some Services, but Quality is Questionable

Under this scenario we should follow the same procedures as we would for Scenario 2, particularly if the Activity does not accept liability for mismarked utilities. Less

extensive procedures on our part may be acceptable in portions of the facility where we are convinced that PWCs records (mapping) or knowledge is likely to be good.

IV. Attachments

A - Services Available for Identifying and Marking Underground Utilities
B – Equipment Used for Identifying Underground Utilities
C – Utility Marking Color Codes

Attachment A - 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 us)

Each are discussed below.

Navy Public Works Center

A Public Works Center (PWC) or Public Works Department (PWD) is usually present at each Activity. The PWC is responsible for maintaining the public works at the base including management of utilities. In many cases, the PWC has a written permit process in place to identify and mark-out the locations of Navy-owned utilities [Note: The PWC 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 PWC in order to identify non-Navy owned, public utilities].

At some Activities, there may not be a PWC, the PWC may not have a written permit process in place, or the PWC may not take responsibility for utility locating and mark-outs. In these cases, the PWC 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 PWC 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 PWC, either directly or through the LANTDIV/EFACHES 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. 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	www.onisi.com/onisi/msutil/default.htm	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.greensboro.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 geophysical surveying support needed for each project will vary depending on which of the three situations described in SOP we find ourselves in:

1. The Activity provides very thorough utility locating services for our work and takes on the liability of repairs for damages (Scenario 1 as described in the SOP).

In this situation, CH2M HILL will normally not need to subcontract additional geophysical surveying support for utility-locating. However, the project manager and field personnel should work closely PWC to position proposed subsurface boring locations clear of all known active and inactive utilities.

2. The Activity does not get involved in any utility locating processes aside from providing the most recent maps. An example of this is NAB Little Creek (Scenario 2 as described in the SOP).

   In this situation, CH2M HILL will require geophysical surveying support for utility-locating and subsurface sample location clearance. 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.

3. The Activity provides utility locating services but they (and/or we) do not have a very high level of confidence in their ability to identify everything (e.g.: they want us to assume liability, they do not field-verify and mark utilities, we notice mistakes in their work, etc.) (Scenario 3 in the SOP).

   In this situation, CH2M HILL may require geophysical surveying support for utility-locating, depending on the nature of the site. At sites where no utilities are expected to exist and the utility location effort is simple, this level of support from the Activity may be acceptable. However, it will be important for the project manager to be familiar with the exact services that were provided by the Activity. At more congested sites where several utilities are known to exist, the project manager may decide to procure the services of a geophysical surveying subcontractor to supplement the Activity's efforts. In this case, the liability issues for damage to subsurface utilities should be clearly defined. For projects where geophysical surveying services are being procured for field activities other than utility-locating, it may be relatively inexpensive and efficient to have the geophysical surveying subcontractor to include the necessary utility-locating effort in the scope of work for the project to supplement the Activity's effort.

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.

[1]Equipment 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

[2]Other 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 B – 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 used by a subcontractor or PWC is adequate.

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 newer 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 C – 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

STANDARD OPERATING PROCEDURE

VOC Sampling-Water

I. Purpose

To provide general guidelines for sampling aqueous volatile organic compounds.

II. Scope

Standard techniques for collecting representative samples are summarized. Site-specific details are discussed in the Field Sampling Plan.

III. Equipment and Materials

- Sample vials pre-preserved at laboratory with Hydrochloric acid (HCl)
- Surgical or latex gloves

IV. Procedures and Guidelines

1. Sample VOCs before sampling other analyte groups.

2. When sampling for VOCs, especially residential wells, evaluate the area around the sampling point for possible sources of air contamination by VOCs. Products that may give off VOCs and possibly contaminate a sample include perfumes and cosmetics, skin applied pharmaceuticals, automotive products (gasoline, starting fluid, windshield deicers, carburetor cleaners, etc.) and household paint products (paint strippers, thinners, turpentine, etc.).

3. Keep the caps off the sample vials for as short a time as possible.

4. Wear clean latex or surgical gloves.

5. Fill the sample vial immediately, allowing the water stream to strike the inner wall of the vial to minimize formation of air bubbles. DO NOT RINSE THE SAMPLE VIALS BEFORE FILLING.

6. Fill the sample vial with a minimum of turbulence, until the water forms a positive meniscus at the brim.

7. Replace the cap by gently setting it on the water meniscus. Tighten firmly, but DO NOT OVERTIGHTEN.

8. Invert the vial and tap it lightly. If you see air bubbles in the sample, do not add more sample. Use another vial to collect another sample. Repeat if necessary until you obtain a proper sample.

V. Attachments

None.

VI. Key Checks and Items

- Check for possible sources of contamination.
- Fill slowly, with as little turbulence as possible.
- Check for air bubbles.

STANDARD OPERATING PROCEDURE

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.